STUDENTS AT RISK OF SCHOOL FAILURE

EDITED BY: José Jesús Gázquez and José Carlos Núñez
PUBLISHED IN: Frontiers in Psychology



frontiers Research Topics

Frontiers Copyright Statement

© Copyright 2007-2018 Frontiers Media SA. All rights reserved.

All content included on this site, such as text, graphics, logos, button icons, images, video/audio clips, downloads, data compilations and software, is the property of or is licensed to Frontiers Media SA ("Frontiers") or its licensees and/or subcontractors. The copyright in the text of individual articles is the property of their respective authors, subject to a license granted to Frontiers.

The compilation of articles constituting this e-book, wherever published, as well as the compilation of all other content on this site, is the exclusive property of Frontiers. For the conditions for downloading and copying of e-books from Frontiers' website, please see the Terms for Website Use. If purchasing Frontiers e-books from other websites or sources, the conditions of the website concerned apply.

Images and graphics not forming part of user-contributed materials may not be downloaded or copied without permission.

Individual articles may be downloaded and reproduced in accordance with the principles of the CC-BY licence subject to any copyright or other notices. They may not be re-sold as an e-book.

As author or other contributor you grant a CC-BY licence to others to reproduce your articles, including any graphics and third-party materials supplied by you, in accordance with the Conditions for Website Use and subject to any copyright notices which you include in connection with your articles and materials.

All copyright, and all rights therein, are protected by national and international copyright laws.

The above represents a summary only. For the full conditions see the Conditions for Authors and the Conditions for Website Use.

ISSN 1664-8714
ISBN 978-2-88945-591-1
DOI 10.3389/978-2-88945-591-1

About Frontiers

Frontiers is more than just an open-access publisher of scholarly articles: it is a pioneering approach to the world of academia, radically improving the way scholarly research is managed. The grand vision of Frontiers is a world where all people have an equal opportunity to seek, share and generate knowledge. Frontiers provides immediate and permanent online open access to all its publications, but this alone is not enough to realize our grand goals.

Frontiers Journal Series

The Frontiers Journal Series is a multi-tier and interdisciplinary set of open-access, online journals, promising a paradigm shift from the current review, selection and dissemination processes in academic publishing. All Frontiers journals are driven by researchers for researchers; therefore, they constitute a service to the scholarly community. At the same time, the Frontiers Journal Series operates on a revolutionary invention, the tiered publishing system, initially addressing specific communities of scholars, and gradually climbing up to broader public understanding, thus serving the interests of the lay society, too.

Dedication to Quality

Each Frontiers article is a landmark of the highest quality, thanks to genuinely collaborative interactions between authors and review editors, who include some of the world's best academicians. Research must be certified by peers before entering a stream of knowledge that may eventually reach the public - and shape society; therefore, Frontiers only applies the most rigorous and unbiased reviews.
Frontiers revolutionizes research publishing by freely delivering the most outstanding research, evaluated with no bias from both the academic and social point of view. By applying the most advanced information technologies, Frontiers is catapulting scholarly publishing into a new generation.

What are Frontiers Research Topics?

Frontiers Research Topics are very popular trademarks of the Frontiers Journals Series: they are collections of at least ten articles, all centered on a particular subject. With their unique mix of varied contributions from Original Research to Review Articles, Frontiers Research Topics unify the most influential researchers, the latest key findings and historical advances in a hot research area! Find out more on how to host your own Frontiers Research Topic or contribute to one as an author by contacting the Frontiers Editorial Office: researchtopics@frontiersin.org

STUDENTS AT RISK OF SCHOOL FAILURE

Topic Editors:
José Jesús Gázquez, Universidad Autónoma de Chile, Chile
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Citation: Gázquez, J. J., Núñez, J. C., eds. (2018). Students at Risk of School Failure. Lausanne: Frontiers Media. doi: 10.3389/978-2-88945-591-1

Table of Contents

08 ***The Relationship Between Teacher Support and Students' Academic Emotions: A Meta-Analysis***
Hao Lei, Yunhuo Cui and Ming Ming Chiu

20 ***Explicit Oral Narrative Intervention for Students With Williams Syndrome***
Eliseo Diez-Itza, Verónica Martínez, Vanesa Pérez and Maite Fernández-Urquiza

38 ***Math Error Types and Correlates in Adolescents With and Without Attention Deficit Hyperactivity Disorder***
Agnese Capodieci and Rhonda Martinussen

47 ***Freshmen Program Withdrawal: Types and Recommendations***
Ana Bernardo, Antonio Cervero, María Esteban, Ellian Tuero, Joana R. Casanova and Leandro S. Almeida

58 ***What and How Much do Children Lose in Academic Settings Owing to Parental Separation?***
Tania Corrás, Dolores Seijo, Francisca Fariña, Mercedes Novo, Ramón Arce and Ramón G. Cabanach

64 ***Procrastinating Behavior in Computer-Based Learning Environments to Predict Performance: A Case Study in Moodle***
Rebeca Cerezo, María Esteban, Miguel Sánchez-Santillán and José C. Núñez

75 ***Corrigendum: Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence***
Ana Bernardo, María Esteban, Estrella Fernández, Antonio Cervero, Ellián Tuero and Paula Solano

76 ***How do Student Prior Achievement and Homework Behaviors Relate to Perceived Parental Involvement in Homework?***
José C. Núñez, Joyce L. Epstein, Natalia Suárez, Pedro Rosário, Guillermo Vallejo and Antonio Valle

89 ***Identifying Gifted Children: Congruence Among Different IQ Measures***
Estrella Fernández, Trinidad García, Olga Arias-Gundín, Almudena Vázquez and Celestino Rodríguez

99 ***Corrigendum: "To be or not to be Retained... That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals and Grades***
Francisco Peixoto, Vera Monteiro, Lourdes Mata, Cristina Sanches, Joana Pipa and Leandro S. Almeida

100 ***School Functioning of a Particularly Vulnerable Group: Children and Young People in Residential Child Care***
Carla González-García, Susana Lázaro-Visa, Iriana Santos, Jorge F. del Valle and Amaia Bravo

112 ***Effects of Direct Instruction and Strategy Modeling on Upper-Primary Students' Writing Development***
Paula López, Mark Torrance, Gert Rijlaarsdam and Raquel Fidalgo

122 ***Teaching Quality in Math Class: The Development of a Scale and the Analysis of its Relationship With Engagement and Achievement***
Jaime Leon, Elena Medina-Garrido and Juan L. Núñez

136 ***Differences in Executive Functioning in Children With Attention Deficit and Hyperactivity Disorder (ADHD)***
M. Rosa Elosúa, Sandra Del Olmo and María José Contreras

147 ***Alcohol and Illicit Drug use are Important Factors for School-Related Problems Among Adolescents***
Ove Heradstveit, Jens C. Skogen, Jørn Hetland and Mari Hysing

158 ***The Four Causes of ADHD: Aristotle in the Classroom***
Marino Pérez-Álvarez

171 ***Childhood Depression: Relation to Adaptive, Clinical and Predictor Variables***
Maite Garaigordobil, Elena Bernarás, Joana Jaureguizar and Juan M. Machimbarrena

180 ***How do B-Learning and Learning Patterns Influence Learning Outcomes?***
María Consuelo Sáiz Manzanares, Raúl Marticorena Sánchez, César Ignacio García Osorio and José F. Díez-Pastor

193 ***A Review of Self-regulated Learning: Six Models and Four Directions for Research***
Ernesto Panadero

221 ***Using Exponential Random Graph Models to Analyze the Character of Peer Relationship Networks and Their Effects on the Subjective Well-being of Adolescents***
Can Jiao, Ting Wang, Jianxin Liu, Huanjie Wu, Fang Cui and Xiaozhe Peng

232 ***The Impact of Inattention, Hyperactivity/Impulsivity Symptoms, and Executive Functions on Learning Behaviors of Children With ADHD***
Carla Colomer, Carmen Berenguer, Belén Roselló, Inmaculada Baixauli and Ana Miranda

242 ***Understanding Rejection Between First-and-Second-Grade Elementary Students Through Reasons Expressed by Rejecters***
Francisco J. García Bacete, Virginia E. Carrero Planes, Ghislaine Marande Perrin and Gonzalo Musitu Ochoa

255 ***Risk and Protective Factors Associated to Peer School Victimization***
Inmaculada Méndez, Cecilia Ruiz-Esteban and J. J. López-García

263 ***Verbal Emotional Disclosure of Traumatic Experiences in Adolescents: The Role of Social Risk Factors***
Silvia Pérez, Wenceslao Peñate, Juan M. Bethencourt and Ascensión Fumero

270 ***Students' Achievement and Homework Assignment Strategies***
Rubén Fernández-Alonso, Marcos Álvarez-Díaz, Javier Suárez-Álvarez and José Muñiz

281 ***Antisocial Behavior and Interpersonal Values in High School Students***
María del Mar Molero Jurado, María del Carmen Pérez Fuentes, José J. Carrión Martínez, Antonio Luque de la Rosa, Anabella Garzón Fernández, África Martos Martínez, Maria del Mar Simón Márquez, Ana B. Barragán Martín and José J. Gázquez Linares

291 ***Self-Regulation, Cooperative Learning, and Academic Self-Efficacy: Interactions to Prevent School Failure***
Javier Fernandez-Rio, Jose A. Cecchini, Antonio Méndez-Gimenez, David Mendez-Alonso and Jose A. Prieto

301 ***Risk Factors for School Dropout in a Sample of Juvenile Offenders***
Asunción Fernández-Suárez, Juan Herrero, Beatriz Pérez, Joel Juarros-Basterretxea and Francisco J. Rodríguez-Díaz

308 ***Student-Teacher Relationships as a Protective Factor for School Adjustment During the Transition From Middle to High School***
Claudio Longobardi, Laura E. Prino, Davide Marengo and Michele Settanni

317 ***Problematic Social Situations for Peer-Rejected Students in the First Year of Elementary School***
Luis J. Martín-Antón, María Inés Monjas, Francisco J. García Bacete and Irene Jiménez-Lagares

330 ***The Relationship Between Impulsivity and Problem Gambling in Adolescence***
Roberto Secades-Villa, Victor Martínez-Loredo, Aris Grande-Gosende and José R. Fernández-Hermida

337 ***Understanding Risk-taking Behavior in Bullies, Victims, and Bully Victims Using Cognitive- and Emotion-Focused Approaches***
Kean Poon

352 ***System to Detect Racial-Based Bullying Through Gamification***
José A. Álvarez-Bermejo, Luis J. Belmonte-Ureña, Africa Martos-Martínez, Ana B. Barragán-Martín and María del Mar Simón-Marquez

365 ***Instructional Changes Adopted for an Engineering Course: Cluster Analysis on Academic Failure***
José A. Álvarez-Bermejo, Luis J. Belmonte-Ureña, África Martos-Martínez, Ana B. Barragán-Martín and María M. Simón-Márquez

376 ***"My Child has Cerebral Palsy": Parental Involvement and Children's School Engagement***
Armanda Pereira, Tânia Moreira, Sílvia Lopes, Ana R. Nunes, Paula Magalhães, Sonia Fuentes, Natalia Reoyo, José C. Núñez and Pedro Rosário

389 ***Estimating the Epidemiology and Quantifying the Damages of Parental Separation in Children and Adolescents***
Dolores Seijo, Francisca Fariña, Tania Corras, Mercedes Novo and Ramon Arce

398 ***Age-Related Differences of Individuals' Arithmetic Strategy Utilization With Different Level of Math Anxiety***
Jiwei Si, Hongxia Li, Yan Sun, Yanli Xu and Yu Sun

409 ***Bullying and Cyberbullying in Minorities: Are They More Vulnerable Than the Majority Group?***
Vicente J. Llorent, Rosario Ortega-Ruiz and Izabela Zych

418 ***Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence***
Ana Bernardo, María Esteban, Estrella Fernández, Antonio Cervero, Ellián Tuero and Paula Solano

427 ***Interpersonal Values and Academic Performance Related to Delinquent Behaviors***
María Del Mar Molero Jurado, María Del Carmen Pérez Fuentes, Antonio Luque De La Rosa, África Martos Martínez, Ana Belén Barragán Martín and María del Mar Simón Márquez

438 ***Profiles of Psychological Well-being and Coping Strategies Among University Students***
Carlos Freire, María Del Mar Ferradás, Antonio Valle, José C. Núñez and Guillermo Vallejo

449 ***"To be or not to be Retained ... That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals, and Grades***
Francisco Peixoto, Vera Monteiro, Lourdes Mata, Cristina Sanches, Joana Pipa and Leandro S. Almeida

462 ***Academic Performance of Native and Immigrant Students: A Study Focused on the Perception of Family Support and Control, School Satisfaction, and Learning Environment***
Miguel A. Santos, Agustín Godás, María J. Ferraces and Mar Lorenzo

474 ***Academic Failure and Child-to-Parent Violence: Family Protective Factors***
Izaskun Ibabe

485 ***Homework Involvement and Academic Achievement of Native and Immigrant Students***
Natalia Suárez, Bibiana Regueiro, Joyce L. Epstein, Isabel Piñeiro, Sara M. Díaz and Antonio Valle

493 ***Differences in Learning Strategies, Goal Orientations, and Self-Concept Between Overachieving, Normal-Achieving, and Underachieving Secondary Students***
Juan L. Castejón, Raquel Gilar, Alejandro Veas and Pablo Miñano

506 ***Sensation-Seeking and Impulsivity as Predictors of Reactive and Proactive Aggression in Adolescents***
María Del Carmen Pérez Fuentes, Maria del Mar Molero Jurado, José J. Carrión Martínez, Isabel Mercader Rubio and José J. Gázquez

514 ***Effect of a Mindfulness Training Program on the Impulsivity and Aggression Levels of Adolescents With Behavioral Problems in the Classroom***
Clemente Franco, Alberto Amutio, Luís López-González, Xavier Oriol and Cristina Martínez-Taboada

522 ***Attention Deficit/Hyperactivity Disorder (ADHD) Diagnosis: An Activation-Executive Model***
Celestino Rodríguez, Paloma González-Castro, Marisol Cueli, Debora Areces and Julio A. González-Pienda

535 ***Limited Near and far Transfer Effects of Jungle Memory Working Memory Training on Learning Mathematics in Children With Attentional and Mathematical Difficulties***
Michel Nelwan and Evelyn H. Kroesbergen

545 ***Profiles of Perfectionism and School Anxiety: A Review of the 2 × 2 Model of Dispositional Perfectionism in Child Population***
Cándido J. Inglés, José Manuel García-Fernández, María Vicent, Carolina Gonzálvez and Ricardo Sanmartín

556 ***Parenting Style Dimensions as Predictors of Adolescent Antisocial Behavior***
David Álvarez-García, Trinidad García, Alejandra Barreiro-Collazo, Alejandra Dobarro and Ángela Antúnez

565 ***Emotional Creativity as Predictor of Intrinsic Motivation and Academic Engagement in University Students: The Mediating Role of Positive Emotions***
Xavier Oriol, Alberto Amutio, Michelle Mendoza, Silvia Da Costa and Rafael Miranda

574 ***Nicotine Dependence as a Mediator of Project EX's Effects to Reduce Tobacco Use in Scholars***
María T. Gonzálvez, José P. Espada, Mireia Orgilés, Alexandra Morales and Steve Sussman

581 ***Untangling the Contribution of the Subcomponents of Working Memory to Mathematical Proficiency as Measured by the National Tests: A Study Among Swedish Third Graders***
Carola Wiklund-Hörnqvist, Bert Jonsson, Johan Korhonen, Hanna Eklöf and Mikaela Nyroos

frontiers in Psychology

REVIEW
published: 22 January 2018
doi: 10.3389/fpsyg.2017.02288

The Relationship between Teacher Support and Students' Academic Emotions: A Meta-Analysis

Hao Lei[1], *Yunhuo Cui*[1]* *and Ming Ming Chiu*[2]*

[1] *Institute of Curriculum and Instruction, East China Normal University, Shanghai, China,* [2] *Department of Special Education and Counselling, The Education University of Hong Kong, Hong Kong, Hong Kong*

This meta-analysis examines the association between teacher support and students' academic emotions [both positive academic emotions (PAEs) and negative academic emotions (NAEs)] and explores how student characteristics moderate these relationships. We identified 65 primary studies with 58,368 students. The results provided strong evidence linking teacher support and students' academic emotions. Furthermore, students' culture, age, and gender moderated these links. The correlation between teacher support and PAEs was stronger for Western European and American students than for East Asian students, while the correlation between teacher support and NAEs was stronger for East Asian students than for Western European and American students. Also, the correlation between teacher support and PAEs was strong among university students and weaker among middle school students, compared to other students. The correlation between teacher support and NAEs was stronger for middle school students and for female students, compared to other students.

Keywords: teacher support, academic emotions, meta-analysis, students, moderator analysis

OPEN ACCESS

Edited by:
Barbara McCombs,
University of Denver, United States

Reviewed by:
María Del Carmen Pérez Fuentes,
University of Almería, Spain
Claudio Longobardi,
Università degli Studi di Torino, Italy
María del Mar Molero,
University of Almería, Spain

***Correspondence:**
Yunhuo Cui
cuiyunhuo@vip.163.com
Ming Ming Chiu
mingmingchiu@gmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *12 April 2017*
Accepted: *18 December 2017*
Published: *22 January 2018*

Citation:
Lei H, Cui Y and Chiu MM (2018) The Relationship between Teacher Support and Students' Academic Emotions: A Meta-Analysis. Front. Psychol. 8:2288. doi: 10.3389/fpsyg.2017.02288

INTRODUCTION

As students spend much of their time with their teachers in school, teacher support can be vital to students' academic development, including not only learning outcomes but also affective or emotional outcomes. Many empirical studies have shown that teacher support was significantly positively correlated with positive academic emotions (PAEs; e.g., enjoyment, interest, hope, pride, and relief) and significantly negatively correlated with negative academic emotions (NAEs; anxiety, depression, shame, anger, worry, boredom, and hopelessness), but their effect sizes vary substantially across studies (Skinner et al., 2008; Mitchell and DellaMattera, 2011; King et al., 2012; McMahon et al., 2013; Liu et al., 2016). Hence, there is a need for a systematic integration of the results of these studies to better understand the relation between teacher support and students' academic emotions and attributes that moderate this relation. This meta-analysis addresses this issue by examining 65 primary studies with 58,368 students. We begin by defining the two central notions: teacher support and academic emotions.

Teacher Support

Self-determination and social support offer two definitions for *teacher support*. The self-determination view suggests that teacher support occurs when students perceive cognitive (Skinner et al., 2008), emotional (Skinner and Belmont, 1993), or autonomy-oriented support from a teacher during the students' learning process (Wellborn and Connell, 1987). According to Ryan and Deci (2000), individuals do work and complete tasks based on their values, interests, and

hobbies, but others close to them can influence their related emotions and motivations. Teacher support includes three dimensions: support for autonomy, structure, and involvement. Support for autonomy is teacher provision of choice, relevance, or respect to students. Structure is clarity of expectations and contingencies. Involvement is warmth, affection, dedication of resources, understanding the student, or dependability (Skinner et al., 2008). Research applying this definition of teacher support has found that it can influence anxiety, depression, hope, and other emotions among students (Reddy et al., 2003; Skinner et al., 2008; Van Ryzin et al., 2009).

In the social support model, teacher support can be viewed in two ways: broad or narrow. The broad perspective, based on Tardy's (1985) social support framework, defines teacher support as a teacher giving informational, instrumental, emotional, or appraisal support to a student, in any environment (Tardy, 1985; Kerres Malecki and Kilpatrick Demary, 2002). Informational support is giving advice or information in a particular content area. Instrumental support is giving resources such as money or time. Emotional support is love, trust, or empathy. Appraisal support is giving evaluative feedback to each student (Malecki and Elliott, 1999). The narrow perspective views teacher support in the form of help, trust, friendship, and interest only in a classroom environment (Fraser, 1998; Aldridge et al., 1999).

Teacher support enhances a teacher's relationship with a student. Specifically, teachers who support students show their care and concern for their students, so these students often reciprocate this concern and respect for the teacher by adhering to classroom norms (Chiu and Chow, 2011; Longobardi et al., 2016). When teachers shout at students, blame them, or aggressively discipline them, these students often show less concern for their teachers and fewer cooperative classroom behaviors (Miller et al., 2000).

As might be expected from this variation and diffuseness in definitions of teacher support, none of them specify a direct relationship between teacher support and students' academic emotions, making it difficult to determine the salient levers for intervention and support. Therefore, we conduct a meta-analysis to integrate these diverse frameworks and streamline the knowledge base, thereby promoting the development of this field.

Academic Emotions

Academic emotions refer to the emotional experience of learning (and teaching), including enjoyment, hopelessness, boredom, anxiety, and anger (Pekrun et al., 2002), which can affect students' learning outcomes (Dong and Yu, 2007). Researchers have generally divided academic emotions into two categories: positive academic emotions (PAEs) and negative academic emotions (NAEs); however, they disagree about how to delineate their boundaries. According to Pekrun et al. (2002), PAEs include relief, hope, enjoyment, and pride, while NAEs include shame, anxiety, boredom, anger, and hopelessness. Other researchers also include calmness and contentment in PAEs or depression and fatigue in NAEs (Dong and Yu, 2007; Sorić, 2007). PAEs may also include excitement, happiness, and other indicators (Dong and Yu, 2007), while NAEs may include sense of threat, fear, and others (Dong and Yu, 2007). Based on the literature, the current study define PAEs as including interest, hope, enjoyment, pride, calmness, contentment, and relief; and NAEs as including shame, anxiety, anger, worry, boredom, depression, fatigue, and hopelessness. For a fuller picture, the measurement of academic emotions should include both PAEs and NAEs.

The Relationship between Teacher Support and Students' Academic Emotions

Many empirical studies have shown that students with more teacher support have higher PAEs or lower NAEs. Specifically, students with more teacher support have more enjoyment, interest, hope, pride, or relief (PAEs); or less anxiety, depression, shame, anger, worry, boredom, or hopelessness (NAEs) (Ahmed et al., 2010; King et al., 2012; Tian et al., 2013). As the effect sizes differ substantially among these studies (Skinner et al., 2008; King et al., 2012; McMahon et al., 2013; Liu et al., 2016), later studies tried to summarize the earlier results (e.g., Weber et al., 2001; Clark, 2008; Arbeau et al., 2010; Lazarides and Ittel, 2013). However, these studies only partly verified the underlying phenomena, as some studies had limitations such as convenience sampling or ignoring sample size –resulting in low reliability and reducing the quality of the research. Therefore, to determine clearly the link between teacher support and students' academic emotions, a meta-analysis is needed.

Through a review of past empirical research on teacher support and students' academic emotions, we found that many effect sizes were heterogeneous, suggesting that moderators might account for these differences. Specifically, we examined the potential moderating roles of students' cultures, ages, and genders.

Potential Moderators of the Link between Teacher Support and Students' Academic Emotions

Culture

Several studies have implied that culture may influence the association between teacher support and students' academic emotions. For example, Karagiannidis et al. (2015) study of students from Greece showed a strong correlation between teacher support and PAE indicators but only a weak correlation between teacher support and NAE indicators. In contrast, King et al.'s (2012) study of students from Philippines, found a weak correlation between teacher support and PAE indicators but a strong one between teacher support and NAE indicators.

Age

The link between teacher support and students' academic emotions might differ by the latter's (Klem and Connell, 2004; Frenzel et al., 2007). For example, past studies found that the relation between teacher support and indicators of PAE was lowest among middle school students and highest among university students, relative to elementary and high school students (Aldridge et al., 2013; Liu et al., 2016). Meanwhile the link between teacher support and indicators of NAE was strongest for middle school students (Taylor, 2003; Huang et al., 2010; Martínez et al., 2011). According to these findings, we

expect age to moderate the relation between teacher support and students' academic emotions.

Gender

Female students tend to receive more teacher support than do male students (Lutz, 1996; Baumeister and Sommer, 1997), and several empirical studies have shown gender differences in the link between teacher support and indicators of students' academic emotions, such as interest, depression, anxiety (Van Ryzin et al., 2009; Sylva et al., 2012; Nilsen et al., 2013). According to these findings, we expect gender to moderate the correlation between teacher support and students' academic emotions.

Study Purpose

This meta-analysis of 65 studies analyzed the relations between teacher support and students' academic emotions (positive and negative) and their moderators. Specifically, this study examined: (a) the correlations between teacher support and students' positive academic emotions, (b) the correlations between teacher support and students' positive academic emotions, and (c) whether culture, age, or gender moderated these correlations.

METHODS

Literature Search

To locate studies on teacher support and students' academic emotions, we systematically searched the literature from January 1994 (Through search in above-mentioned database, "the relationship between teacher support and students' academic emotions" was firstly proposed by Karabenick and Sharma, 1994) to January 2016 using the following electronic databases: ProQuest Dissertations, Web of Science, Google Scholar, Springer, Taylor & Francis, EBSCO, PsycINFO, and Elsevier SDOL. Indexed keywords constituted terms reflecting teacher support (*support*, *involvement*, *care*/*caring*, *warmth*, *closeness*, *teacher enthusiasm*, *teacher help*, *learning environment*, *classroom environment*, *social support*, *relationship between teacher and student/child*) and academic emotions (*anxiety*, *pride*, *shame*, *achievement emotion*, *interest*, *anger*, *depression*, *enjoyment*, *boredom*, *hope*, *worry*, *hopelessness*, *positive affect*, *academic emotions*, *negative affect*, *relief*, *well-being*). We obtained full-text versions of articles from libraries when they could not be found online, limiting ourselves to articles written in English. We used inclusion and exclusion criteria described in the next subsections to analyze and filter the collected studies.

Literature Exclusion Criteria

We included articles based on the following criteria: (a) studying the relationship between teacher support and students' academic emotions, (b) measuring teacher support, including any of the keywords mentioned above, (c) measuring academic emotions, again including any of those above keywords, (d) including an explicit sample size, and (e) explicitly reporting the Pearson product-moment correlation coefficient (r) or a t or F value that could be transformed into r. After applying the inclusion and exclusion criteria, 65 articles remained.

Coding

To facilitate meta-analysis, feature coding was conducted on 65 articles. We considered the following variables: author(s) and publication year, proportion of male students, ages, indicators of teacher support, indicators of academic emotions, types of academic emotions (PAEs and NAEs), number of students, and r effect size. The following criteria guided the coding procedure (see **Table 1**): (a) effect sizes of each independent sample were coded based on an independent sample, and separately coded if a study had several independent samples; (b) correlations between different indicators of teacher support and academic emotions were separately coded; (c) correlations between teacher support and different indicators of academic emotions were separately coded; (d) this number was used if an independent sample provided effect sizes (expressed as r) for sample characteristics such as sex; and (e) if a study reported multiple correlations between teacher support and an academic emotion, their mean value was used.

When coding was complete, effect sizes between teacher support and students' academic emotions were calculated for each sample, based on the principles of meta-analysis (Lipsey and Wilson, 2001). The moderators tested for influence on the association between teacher support and students' academic emotions were (a) culture, (b) age, and (c) gender.

Culture was coded as "East Asia," "Western European/American," or "other"; "East Asia" referred to students from Asian countries such as China (including Hong Kong and Taiwan), South Korea, the Philippines, Singapore, and so on. "Western European/American" referred to students from European and North American countries such as Germany, the United States of America, and so on. "Other" referred to students from Turkey, the United Arab Emirates, Iran, and so on. Age was coded as "elementary," "middle school," "high school," "university," and "mixed." "Mixed" denoted that the participants in a study included at least two categories of the above school categories. Gender was coded as the proportion of male students.

Data Analysis

We used the comprehensive meta-analysis software CMA 2.0 to analyze all the data. A fixed-effects model calculated the homogeneity and mean effects. Averaged weighted correlation coefficients (within- and between- inverse-variance weights) of independent samples were used to compute mean effect sizes. Moderators were identified by the homogeneity test, which revealed variance in effect sizes between different samples' characteristics. Where the homogeneity test was significant ($Q_{Bet} > 0.05$), post-hoc analysis confirmed the different groups statistically. For continuous variables, this study used meta-analysis to examine variation in effect sizes explained by the moderator.

RESULTS

Correlation between Teacher Support and Academic Emotions

After filtering the literature, we used 65 independent samples, and the sizes of 121 effects were calculated (45 effect sizes

TABLE 1 | Studies included in the meta-analysis.

Author (year)	*N*	*r*	TS indicator[a]	AE indicator[b]	AE type	Culture[c]	Age[d]	Male (%)[e]
Afari, 2013	352	0.24	TS	Enjoyment	PAEs	1	4	0.34
Ahmed et al., 2010	238	0.28	TS	Interest	PAEs	2	2	0.46
Ahmed et al., 2010	238	0.45	TS	Enjoyment	PAEs	2	2	0.46
Ahmed et al., 2010	238	−0.21	TS	Anxiety	NAEs	2	2	0.46
Aldridge et al., 2013	352	0.24	TS	Enjoyment	PAEs	3	4	0.656
Allen and Fraser, 2007	520	0.21	TS(p)	Enjoyment	PAEs	2	1	0.5
Allen and Fraser, 2007	520	0.01	TS(s)	Enjoyment	PAEs	2	1	0.5
Arbeau et al., 2010	169	−0.26	C	Anxiety	NAEs	2	1	0.499
Arslan, 2009	466	−0.21	TS	Anger	NAEs	3	3	0.457
Birgani et al., 2015	180	0.36	TS	Enjoyment	PAEs	3	3	1
Burić, 2015	365	0.27	TS	Enjoyment	PAEs	3	3	0.356
Burić, 2015	365	0.22	TS	Hope	PAEs	3	3	0.356
Burić, 2015	365	0.19	TS	Pride	PAEs	3	3	0.356
Burić, 2015	365	0.15	TS	Relief	PAEs	3	3	0.356
Burić, 2015	365	−0.17	TS	Anger	NAEs	3	3	0.356
Burić, 2015	365	−0.06	TS	Anxiety	NAEs	3	3	0.356
Burić, 2015	365	−0.09	TS	Shame	NAEs	3	3	0.356
Burić, 2015	365	−0.06	TS	Hopelessness	NAEs	3	3	0.356
Cheung, 1995	128	−0.28	TS	Depression	NAEs	1	5	0.475
Chirkov and Ryan, 2001	116	−0.14	TS	Depression	NAEs	2	3	0.422
Chirkov and Ryan, 2001	120	0.08	TS	Depression	NAEs	2	2	0.358
Chirkov and Ryan, 2001	119	0.22	TS	Positively emotions	PAEs	2	2	0.532
Chirkov and Ryan, 2001	118	−0.03	TS	Negatively emotions	NAEs	2	2	0.532
Cox et al., 2009	411	0.45	TS	Enjoyment	PAEs	2	2	0.436
Cox et al., 2009	411	−0.16	TS	Worry	NAEs	2	2	0.436
Demaray et al., 2005	82	−0.04	TS	Emotional symptoms	NAEs	2	2	0.354
Elmelid et al., 2015	643	−0.05	TS	Depression	NAEs	2	5	0.455
Elmelid et al., 2015	643	0.17	TS	Anxiety	NAEs	2	5	0.455
Elmelid et al., 2015	643	−0.06	TS	Depression	NAEs	2	5	0.455
Elmelid et al., 2015	643	0.2	TS	Anxiety	NAEs	2	5	0.455
Federici and Skaalvik, 2014	309	−0.14	ES	Anxiety	NAEs	2	2	0.482
Federici and Skaalvik, 2014	309	−0.13	IS	Anxiety	NAEs	2	2	0.482
Frenzel et al., 2009	1,542	0.48	TE	Enjoyment	PAEs	2	2	0.48
Gläser-Zikuda and Fuß, 2008	431	−0.26	TC	Anxiety	NAEs	2	2	0.494
Hagenauer and Hascher, 2010	356	0.51	TC	Enjoyment	PAEs	2	2	0.336
Hill et al., 1996	87	−0.27	TS	Anxiety	NAEs	2	1	0.471
Huang et al., 2010	158	−0.26	TS	Anxiety	NAEs	1	4	0.684
Jia et al., 2009	706	−0.27	TS	Depression	NAEs	1	2	0.495
Jia et al., 2009	709	−0.25	TS	Depression	NAEs	2	2	0.482
Karabenick and Sharma, 1994	288	−0.11	TS	Anxiety	NAEs	2	4	0.36
Karabenick and Sharma, 1994	288	−0.17	TS	Negatively affect	NAEs	2	4	0.36
Karagiannidis et al., 2015	627	0.47	TS	Enjoyment	PAEs	2	2	0.499
Karagiannidis et al., 2015	627	−0.29	TS	Boredom	NAEs	2	2	0.499
King et al., 2012	1,147	0.15	TS	Enjoyment	PAEs	1	2	0.542
King et al., 2012	1,147	0.12	TS	Hope	PAEs	1	2	0.542
King et al., 2012	1,147	0.07	TS	Pride	PAEs	1	2	0.542
King et al., 2012	1,147	−0.4	TS	Anger	NAEs	1	2	0.542
King et al., 2012	1,147	−0.18	TS	Anxiety	NAEs	1	2	0.542
King et al., 2012	1,147	−0.23	TS	Shame	NAEs	1	2	0.542
King et al., 2012	1,147	−0.47	TS	Boredom	NAEs	1	2	0.542

(Continued)

TABLE 1 | Continued

Author (year)	*N*	*r*	TS indicator[a]	AE indicator[b]	AE type	Culture[c]	Age[d]	Male (%)[e]
King et al., 2012	1,147	−0.33	TS	Hopelessness	PAEs	1	2	0.542
Lapointe et al., 2005	593	−0.11	TH	Anxiety	NAEs	2	2	0.496
LaRusso et al., 2008	476	−0.2	TS	Depression	NAEs	2	3	N
Lazarides and Ittel, 2013	212	0.47	TS	Interest	PAEs	2	2	1
Lazarides and Ittel, 2013	149	0.42	TS	Interest	PAEs	2	2	0
Liu et al., 2016	873	0.45	TS	Affect in school	PAEs	1	1	N
Liu et al., 2016	675	0.35	TS	Affect in school	PAEs	1	2	N
Liu et al., 2016	610	0.33	TS	Affect in school	PAEs	1	3	N
Ludwig and Warren, 2009	175	0.43	TS	Hope	PAEs	2	3	0.486
MacPhail, 2012	125	0.25	TS	Positively affect	PAEs	2	1	0.472
MacPhail, 2012	125	−0.18	TS	Negatively affect	NAEs	2	1	0.472
Martínez et al., 2011	140	−0.27	TS	Depression	NAEs	3	2	0.429
Martínez et al., 2011	140	−0.44	TS	Depression	NAEs	3	1	0.429
McMahon et al., 2013	188	0.02	TS	Fear	NAEs	2	5	0.37
McMahon et al., 2013	188	0.09	TS	Worry	NAEs	2	5	0.37
McMahon et al., 2013	188	−0.02	TS	Anxiety	NAEs	2	5	0.37
McMahon et al., 2013	188	−0.18	TS	Depression	NAEs	2	5	0.37
Murberg and Bru, 2009	198	−0.19	TS	Depression	NAEs	2	3	0.439
Myint and Fisher, 2001	1,188	0.31	TS	Enjoyment	PAEs	1	2	0.457
Neville, 2008	159	0.27	TS	Positively affect	PAEs	2	2	0.47
Neville, 2008	159	−0.13	TS	Negatively affect	NAEs	2	2	0.47
Nilsen et al., 2013	319	−0.09	TS	Depression	NAEs	2	5	0.404
Nilsen et al., 2013	319	−0.2	TS	Depression	NAEs	2	5	0.404
Ommundsen and Kvalø, 2007	194	0.63	TS	Enjoyment/Interest	PAEs	2	3	0.515
Ommundsen et al., 2006	760	0.11	TS	Enjoyment	PAEs	2	5	0.499
Pan, 2014	462	0.59	TS	Enjoyment	PAEs	1	3	0.561
Piechurska-Kuciel, 2011	354	−0.78	TS	Anxiety	NAEs	2	2	0.362
Reddy et al., 2003	1,285	−0.28	TS	Depression	NAEs	2	2	1
Reddy et al., 2003	1,300	−0.25	TS	Depression	NAEs	2	2	0
Rey et al., 2007	89	−0.07	TS	Anxiety	NAEs	2	1	0.472
Rueger et al., 2008	108	−0.25	TS	Anxiety	NAEs	2	2	1
Rueger et al., 2008	108	−0.29	TS	Depression	NAEs	2	2	1
Rueger et al., 2008	138	−0.06	TS	Anxious	NAEs	2	2	0
Rueger et al., 2008	138	−0.23	TS	Depression	NAEs	2	2	0
Ryan et al., 2005	474	0.4	TS	Positively affect	PAEs	2	1	0.5
Ryan et al., 2005	474	−0.15	TS	Anxiety	NAEs	2	1	0.5
Sahaghi et al., 2015	180	0.37	TS	Enjoyment	PAEs	3	3	1
Sakiz, 2012	227	0.64	TS	Enjoyment	PAEs	3	4	0.374
Sakiz, 2012	227	−0.55	TS	Hopelessness	NAEs	3	4	0.374
Sakiz, 2012	138	0.6	TS	Enjoyment	PAEs	3	1	0.514
Sakiz, 2012	138	−0.21	TS	Anxiety	NAEs	3	1	0.514
Sakiz et al., 2012	317	0.62	TS	Enjoyment	PAEs	2	2	0.4
Sakiz et al., 2012	317	−0.41	TS	Hopelessness	NAEs	2	2	0.4
Sakiz et al., 2007	99	0.67	TS	Enjoyment	PAEs	2	2	0.343
Sakiz et al., 2007	99	−0.36	TS	Hopelessness	NAEs	2	2	0.343
Skinner et al., 2008	805	−0.1	TS(t)	Bored	NAEs	2	5	0.488
Skinner et al., 2008	805	−0.12	TS(t)	Anxiety	NAEs	2	5	0.488
Skinner et al., 2008	805	−0.1	TS(t)	Frustrated	NAEs	2	5	0.488
Skinner et al., 2008	805	−0.56	TS(s)	Bored	NAEs	2	5	0.488
Skinner et al., 2008	805	−0.36	TS(s)	Anxiety	NAEs	2	5	0.488

(Continued)

TABLE 1 | Continued

Author (year)	*N*	*r*	TS indicator[a]	AE indicator[b]	AE type	Culture[c]	Age[d]	Male (%)[e]
Skinner et al., 2008	805	−0.38	TS(s)	Frustrated	NAEs	2	5	0.488
Sun and Hui, 2007	680	−0.28	TS	Depression	NAEs	1	2	1
Sun and Hui, 2007	678	−0.27	TS	Depression	NAEs	1	2	0
Sun et al., 2006	433	−0.26	TS	Depression	NAEs	1	5	0.552
Sylva et al., 2012	1,766	0.53	TS	Enjoyment	PAEs	2	5	0.481
Sylva et al., 2012	1,766	−0.13	TS	Anxiety	NAEs	2	5	0.481
Tanigawa et al., 2011	239	−0.37	TS	Depression	NAEs	2	2	1
Tanigawa et al., 2011	305	−0.36	TS	Depression	NAEs	2	2	0
Taylor and Fraser, 2003	745	−0.04	TS	Anxiety	NAEs	2	3	N
Telan, 2000	694	−0.07	TS	Depression	NAEs	2	1	0.487
Tian et al., 2013	361	0.42	TS	Positively emotions	PAEs	1	5	0.468
Tian et al., 2013	361	−0.31	TS	Negatively emotions	NAEs	1	5	0.468
Van Ryzin, 2011	423	0.25	TS	Hope	PAEs	2	2	0.533
Van Ryzin et al., 2009	231	0.22	TS	Hope	PAEs	2	2	0.524
Wang, 2009	1,042	−0.09	TS	Depression	NAEs	2	2	0.48
Wang and Eccles, 2013	1,157	0.24	TS	Positively emotions	PAEs	2	2	0.48
Way et al., 2007	1,451	−0.26	TS	Depression	NAEs	2	2	0.458
Weber et al., 2001	46	0.14	TS	Affect	PAEs	2	2	0.522
Weber et al., 2001	46	0.12	TS	Affect	PAEs	2	2	0.522
Wentzel, 1998	167	0.39	TS	Interest	PAEs	2	2	0.509
Yang et al., 2015	472	0.53	TS	Positively motions	PAEs	1	1	0.663

[a] *TS, teacher support; TC, teacher's care; TE, teacher enthusiasm; ET, emotions support; IS, instrumental support; C, closeness; TH, teacher help; (p), parents report; (t), teacher report; (s), students self-report, Others were students self-report.*
[b] *AE, Academic emotions.*
[c] *1, East Asia; 2, Western European/American; 3, other.*
[d] *1, Elementary; 2, Middle School; 3, High School; 4, University; 5, Mixed.*
[e] *N, Not report.*

TABLE 2 | Fixed model of correlations between teacher support and academic emotions.

	k	*N*	Mean *r*	95% CI for *r*		Homogeneity test			Tau-squared			Test of null (two-tailed)
				LL	UL	*Q*(*r*)	*p*	I-squared	Tau-squared	SE	Tau	*z*-value
PAEs	45	21690	0.340	0.328	0.351	823.197	0.00	94.655	0.038	0.011	0.194	51.909***
NAEs	76	36678	−0.215	−0.225	−0.206	1218.358	0.00	93.844	0.032	0.007	0.179	−41.769***

****$p < 0.001$.*

between teacher support and PAEs, 76 between teacher support and NAEs). In all, 58,368 students participated in the studies reviewed; sample sizes of individual studies ranged from 46 to 1,766.

To test our hypotheses, we calculated sample sizes (k), weighted effect sizes (r), and 95% confidence intervals (see **Table 2**). A fixed effects model was used to homogenize the analysis. The results showed that students with more teacher support had higher PAEs [$r = 0.340$ ($z = 51.909$, $p < 0.001$, $k = 45$, 95% CI = 0.328, 0.351)] or lower NAEs [$r = -0.215$ ($z = -41.769$, $p < 0.001$, $k = 76$, 95% CI = −0.225, −0.206)]. These effect sizes were suitable for moderator analysis (Cohen, 1969).

Moderator Analysis

To test the aforementioned factors moderating the relationship between teacher support and students' academic emotions, we conducted two total homogeneity tests across 45 and 76 independent samples for PAEs and NAEs respectively. The results showed significant homogeneity coefficients between teacher support and academic emotions ($Q_{T(44)\text{PAE}} = 823.197$, $p < 0.001$; $Q_{T(75)\text{NAE}} = 1218.358$, $p < 0.001$). This indicates that culture, age, and gender moderated the relations between teacher support and students' PAEs and NAEs. We used meta-analysis of variance to confirm whether culture and age moderated the correlations between teacher support and academic emotions, and used meta-regression analyses to examine whether gender influenced these correlations.

Culture

As indicated in **Table 3**, the homogeneity test showed a significant homogeneity coefficient between teacher support and PAEs across our three cultures (East Asian, Western European/American, and other) ($Q_{\text{BET}} = 60.599$, $df = 2$, $p < 0.001$). As the table shows, the Western European/American

TABLE 3 | Culture and age as moderators of the association between teacher support and academic emotions.

	Between-group effect (Q_{BET})	*k*	*N*	Mean *r*	SE	95% CI for *r*		Homogeneity test within each group (Q_W)
						LL	UL	
PAEs								
Culture	60.599***							
East Asian		11	8434	0.286	0.017	0.266	0.305	270.216***
Western European/American		26	11071	0.384	0.016	0.368	0.400	409.543***
Other		8	2185	0.315	0.025	0.276	0.352	82.839***
Age	42.450***							
Elementary		7	3122	0.348	0.034	0.316	0.378	133.060***
Middle school		23	11841	0.310	0.014	0.294	0.327	378.373***
High school		10	3261	0.350	0.020	0.319	0.379	111.512***
University		2	579	0.415	0.186	0.346	0.481	10.586***
Mixed		3	2887	0.419	0.085	0.388	0.449	121.869***
NAEs								
Culture	119.523***							
East Asian		12	8879	−0.307	0.005	−0.326	−0.288	89.629***
Western European/American		54	24876	−0.190	0.009	−0.202	−0.178	879.848***
Other		10	2923	−0.145	025	−0.181	−0.109	129.358***
Age	164.830***							
Elementary		8	1916	−0.160	0.010	−0.204	−0.116	23.240*
Middle school		34	18929	−0.276	0.007	−0.289	−0.262	435.489***
High school		9	3461	−0.120	0.003	−0.152	−0.086	16.424*
University		5	1313	−0.135	0.075	−0.187	−0.081	105.465***
Mixed		20	11059	−0.158	0.018	-176	−0.140	95.982****

*$p < 0.05$, ***$p < 0.001$.

group had a stronger correlation ($r = 0.384$, 95% CI = 0.368, 0.400) than the East Asian group ($r = 0.286$, 95% CI = 0.266, 0.305). Likewise, the homogeneity test found significant differences in the correlation between teacher support and NAEs across the three cultures (QBET = 119.523, $df = 2$, $p < 0.001$); however, in this case, the East Asian group ($r = -0.307$, 95% CI = −0.326, −0.288) showed a stronger correlation between teacher support and NAEs than the West European/American group ($r = -0.190$, 95% CI = −0.202, −0.178).

Age

The results of the homogeneity test ($Q_{BET} = 42.450$, $df = 4$, $p < 0.001$) suggested that age influenced the link between teacher support and PAEs. Teacher support was significantly correlated with PAEs for elementary school ($r = 0.348$, 95% CI = 0.316, 0.378), middle school ($r = 0.310$, 95% CI = 0.294, 0.327), high school ($r = 0.350$, 95% CI = 0.319, 0.379), and university ($r = 0.415$, 95% CI = 0.346, 0.481); however, undergraduates showed a stronger correlation than the other students, and middle school students showed a weaker correlation than the other students. As shown in **Table 3**, the homogeneity test (QBET = 164.830, $df = 4$, $p < 0.001$) suggested that age moderated the link between teacher support and NAEs. Broken down by age group, significant correlations were observed between teacher support and NAEs for elementary students ($r = -0.160$, 95% CI = −0.204, −0.116), middle school students ($r = -0.276$, 95% CI = −0.289, −0.262), high school students ($r = -0.120$, 95% CI = −0.120, −0.086), and undergraduates ($r = -0.135$, 95% CI = −0.187, −0.081). The results indicated that middle school students had a stronger correlation between teacher support and NAEs than the other three groups.

Gender

To examine whether gender moderated the link between teacher support and students' academic emotions, r was meta-regressed onto the percentage of male students in each sample. As seen in **Table 4**, the meta-regression analysis ($Q_{Model}[1, k = 40]_{PAE} = 0.781$, $p > 0.05$) suggested that gender did not moderate the relationship between teacher support and PAEs. However, meta-regression ($Q_{Model}[1, k = 72]_{NAE} = 4.208$, $p < 0.05$) demonstrated that the relation between teacher support and NAEs was moderated by gender; the effect size of the correlation between teacher support and NAEs for an all-female sample ($r = -0.252$) was much stronger than for an all-male sample ($r = -0.196$).

Publication Bias

To examine whether the results were biased due to the effect sizes from various sources, a funnel plot was drawn (see **Figure 1**); it indicated that the 121 effects were symmetrically distributed on both sides of the average in terms of size. Egger's regression (Egger et al., 1997), an effective method for examining publication bias (Teng et al., 2015), revealed no significant bias [$t_{(119)} = 0.698$, $p = 0.486$]. In addition, we also twice conducted

TABLE 4 | Meta-regression analyses of gender.

	Variable	Parameter	Estimate	SE	*z*-value	95% CI for *b*	
						LL	UL
PAEs	Male (%)	β_0	0.375	0.031	11.961	0.314	0.436
		β_1	−0.055	0.062	−0.884	−0.176	−0.066
		$Q_{Model}(1, k = 40) = 0.781, p > 0.05$					
NAEs	Male (%)	β_0	−0.196	0.014	−13.859	−0.224	−0.168
		β_1	0.056	0.027	−2.051	−0.110	−0.002
		$Q_{Model}(1, k = 72) = 4.208, p < 0.05$					

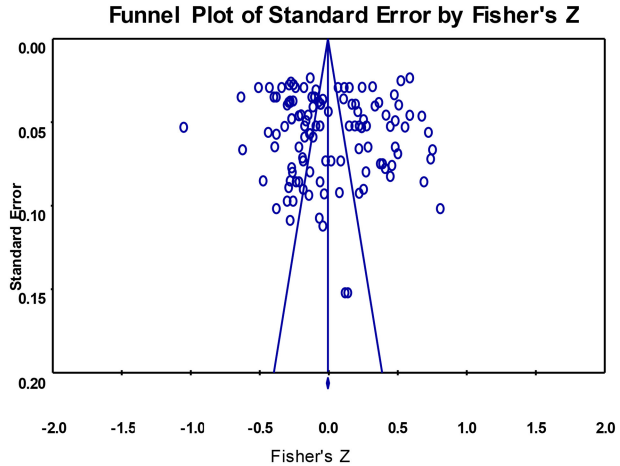


FIGURE 1 | Funnel plot of effect sizes of the correlation between teacher support and academic emotions.

Egger's regression analysis on teacher support, for PAEs and for NAEs. The results showed no publication bias [$t_{PAE(43)} = 0.800$, $p = 0.428$; $t_{NAE(74)} = 0.453$, $p = 0.652$]. This indicates that the overall correlation between teacher support and students' academic emotions was stable.

DISCUSSION

In the current meta-analysis 65 recent studies, including 121 effects and 58,368 students, were analyzed. The overall results showed that teacher support was positively correlated with PAEs and negatively correlated with NAEs; the correlation coefficients for these results were both medium. Furthermore, culture, age, and gender moderated these relations.

The Significant Correlation between Teacher Support and Students' Academic Emotions

Meta-analysis results showed a significant positive correlation between teacher support and PAEs and a significant negative correlation between teacher support and NAEs. These results suggest that teacher support is an important mechanism through which teacher can foster students' PAEs and reduce their NAEs (Lawman and Wilson, 2013). These results support a direct effect model, and future studies can test an indirect effect model.

Furthermore, students with difficult learning problems or other problems can seek teacher support as a strategy to improve their PAEs and reduce their NAEs. Furthermore, teacher support is readily accessible on school days and can supplement a student's other interpersonal relationships, especially if the latter are unreliable. In addition, targeted interventions can help students facing difficulties seek out and capitalize on teacher support to improve their learning outcomes.

Moderation Effects

The results also showed that students' culture, age, and gender moderated the relationship between teacher support and students' academic emotions. Specifically, culture and student age moderated teacher support's links with both PAEs and NAEs, and gender moderated teacher support's links with NAEs.

Moderating Role of Culture

Culture moderated the link between teacher support and students' academic emotions, consistent with many prior studies (Jia et al., 2009; Liu et al., 2016). This result suggests that training and interventions should consider cultural aspects, especially cultural differences when adapting training to a new culture. Specifically, the current study obtains the interesting finding that the Western group showed a stronger correlation between

As teacher support had a stronger positive correlation to PAEs among the Western European/American students than the East Asian students, teachers might have a larger impact on enhancing the PAEs of Western European/American students than those of East Asian students. In contrast, teacher support had a stronger negative correlation to NAEs among East Asian students than among Western European/American students, suggesting that teachers might have a larger impact on reducing the NAEs of East Asian students than those of Western European/American students. Future research can examine the mechanisms for these cultural differences.

Moderating Role of Age

Age moderates the relationship between teacher support and students' academic emotions, consistent with past studies

(Martínez et al., 2011; Tian et al., 2013; Liu et al., 2016). Further analysis found that the middle school group showed a weaker correlation between teacher support and PAEs and a stronger correlation between teacher support and NAEs than other groups, while the university group obtained a stronger correlation between teacher support and PAEs than other groups. Middle school students are in a psychological weaning period (Huizhen, 2014), and teachers can have a large impact on such vulnerable students with large NAEs. However, their low baseline hinders teachers from sharply increasing their PAEs.

Moderating Role of Gender

Gender moderates the relationship between teacher support and NAEs, with a stronger correlation among female students than among male students; in contrast, gender did not moderate the link between teacher support and PAEs. As the emotional understanding and social skills of females often exceed those of males, female students might express their NAEs to their teachers more effectively than male students do, enabling their teacher support to reduce female students' NAEs more than male students' NAEs. In addition, this finding suggests that similar levels of teacher support may lead to lower NAEs among female than among male students. Considering both age and gender differences in the correlation between teacher support and NAEs, middle school boys emerge as the most vulnerable group, so targeting interventions for them might be especially fruitful.

LIMITATIONS AND IMPLICATIONS

The current meta-analysis has several limitations. First, only teacher support, involvement, care/caring, warmth, closeness, enthusiasm, and help were selected as indicators of teacher support; other indicators, such as concern, were excluded. Furthermore, the selected indicators may overlap. Second, parallel concerns also apply to indicators of academic emotions. Third, all the studies reviewed examined only direct effects; other studies have found that teacher support can indirectly affects students' academic emotions across other variables as well (Van Ryzin et al., 2009; Sakiz et al., 2012). Therefore, future studies can test for indirect effects, such as whether teacher support indirectly improves academic achievement via academic emotions. Fourth, the current study only considers whether students' culture, age, and gender moderate the relationship between teacher support and students' academic emotions; other variables, such as socio-economic status, can be examined in future studies. Fifth, this study included only English-language articles; future meta-analyses can include studies in other lanugages. Sixth, this meta-analysis was based on cross-sectional studies, so causal relationships cannot be inferred.

CONCLUSION

The results of this meta-analysis of 65 studies encompassing 121 effect sizes and 58,368 students revealed that teacher support was significantly correlated with students' academic emotions, and that these relations were moderated by culture, age, and gender. The positive link between teacher support and PAEs was stronger among Western European/American students than among East Asian students. In contrast, the negative link between teacher support and NAEs was stronger among East Asian students than among Western European/American students. The positive link between teacher support and PAEs was strongest among university students and weakest among middle school students. Also, the negative link between teacher support and NAEs was strongest among middle school students and among females.

AUTHOR CONTRIBUTIONS

HL provided the idea, designed this study and wrote the manuscript, contributed to data collection. YC provided the idea, designed this study and wrote the manuscript, contributed to data analysis. MC contributed to design this study, analysis data and revise paper. All authors approval of the version to be published and agreement to be accountable for all aspects of the work.

FUNDING

This research was supported by the Philosophy and Social Sciences Major—Breakthrough Project of the Ministry of Education in China (16JZD047), and the summit—education program of East China Normal University.

REFERENCES

*Afari, E. (2013). *The Effects of Psychosocial Learning Environment on Students' Attitudes Towards Mathematics.* Rotterdam: Application of Structural Equation Modeling in Educational Research and Practice Sense Publishers.

*Ahmed, W., Minnaert, A., van der Werf, G., and Kuyper, H. (2010). Perceived social support and early adolescents' achievement: the mediational roles of motivational beliefs and emotions. *J. Youth Adolesc.* 39, 36–46. doi: 10.1007/s10964-008-9367-7

*Aldridge, J. M., Afari, E., and Fraser, B. J. (2013). Influence of teacher support and personal relevance on academic self-efficacy and enjoyment of mathematics lessons: a structural equation modeling approach. *Alberta J. Educ. Res.* 58, 614–633. doi: 10.1037/t38960-000

Aldridge, J. M., Fraser, B. J., and Huang, T.-C. I. (1999). Investigating classroom environments in Taiwan and Australia with multiple research methods. *J. Educ. Res.* 93, 48–62. doi: 10.1080/00220679909597628

*Allen, D., and Fraser, B. J. (2007). Parent and student perceptions of classroom learning environment and its association with student outcomes. *Learn. Environ. Res.* 10, 67–82. doi: 10.1007/s10984-007-9018-z

*Arbeau, K. A., Coplan, R. J., and Weeks, M. (2010). Shyness, teacher–child relationships, and socio-emotional adjustment in grade 1. *Int. J. Behav. Dev.* 34, 259–269. doi: 10.1177/0165025409350959

*Arslan, C. (2009). Anger, self-esteem, and perceived social support in adolescence. *Soc. Behav. Pers. Int. J.* 37, 555–564. doi: 10.2224/sbp.2009.37.4.555

Baumeister, R. F., and Sommer, K. L. (1997). What do men want? Gender differences and two spheres of belongingness: comment on cross and

madson (1997). *Psychol. Bull.* 122, 38–44. doi: 10.1037/0033-2909.122.1.38

*Birgani, S. A., Sahaghi, H., and Mousavi, S. A. (2015). The relationship between teacher affective support and educational enjoyment with attachment to school male high school students of Ahvaz, Iran. *J. Educ. Manag. Stud.* 5, 138–144. Available online at: http://www.jems.science-line.com/attachments/article/29/J.%20Educ.%20Manage.%20Stud.,%205(2)%20138-144,%202015.pdf

*Burić, I. (2015). The role of social factors in shaping students' test emotions: a mediation analysis of cognitive appraisals. *Soc. Psychol. Educ.* 18, 785–809. doi: 10.1007/s11218-015-9307-9

*Cheung, S.-K. (1995). Life events, classroom environment, achievement expectation, and depression among early adolescents. *Soc. Behav. Pers. Int. J.* 23, 83–92. doi: 10.2224/sbp.1995.23.1.83

*Chirkov, V. I., and Ryan, R. M. (2001). Parent and teacher autonomy-support in Russian and US adolescents common effects on well-being and academic motivation. *J. Cross Cult. Psychol.* 32, 618–635. doi: 10.1177/0022022101032005006

Chiu, M. M., and Chow, B. W.-Y. (2011). Classroom discipline across 41 countries: school, economic, and cultural differences. *J. Cross Cult. Psychol.* 42, 516–533. doi: 10.1177/0022022110381115

*Clark, S. L. (2008). *The Role of School, Family, and Peer Support In Moderating the Relationship between Stress and Subjective Well-Being: An Examination of Gender Differences among Early Adolescents Living in an Urban Area*, Doctoral dissertation, Loyola University Chicago.

Cohen, J. (1969). *Statistical Power Analysis for the Behavioral Sciences*. New York, NY: Academic Press.

*Cox, A., Duncheon, N., and McDavid, L. (2009). Peers and teachers as sources of relatedness perceptions, motivation, and affective responses in physical education. *Res. Q. Exerc. Sport* 80, 765–773. doi: 10.1080/02701367.2009.10599618

*Demaray, M. K., Malecki, C. K., Davidson, L. M., Hodgson, K. K., and Rebus, P. J. (2005). The relationship between social support and student adjustment: a longitudinal analysis. *Psychol. Sch.* 42:691. doi: 10.1002/pits.20120

Dong, Y., and Yu, G. L. (2007). The development and application of an academic emotions questionnaire. *Acta Psychol. Sin.* 39, 852–860. Available online at: https://wenku.baidu.com/view/00b64751ad02de80d4d840f8.html

Egger, M., Smith, G. D., Schneider, M., and Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *Br. Med. J.* 315, 629–634. doi: 10.1136/bmj.315.7109.629

*Elmelid, A., Stickley, A., Lindblad, F., Schwab-Stone, M., Henrich, C. C., and Ruchkin, V. (2015). Depressive symptoms, anxiety and academic motivation in youth: do schools and families make a difference? *J. Adolesc.* 45, 174–182. doi: 10.1016/j.adolescence.2015.08.003

*Federici, R. A., and Skaalvik, E. M. (2014). Students' perceptions of emotional and instrumental teacher support: relations with motivational and emotional responses. *Int. Educ. Stud.* 7, 21–26. doi: 10.5539/ies.v7n1p21

Fraser, B. J. (1998). Classroom environment instruments: development, validity and applications. *Learn. Environ. Res.* 1, 7–34. doi: 10.1023/A:1009932514731

*Frenzel, A. C., Goetz, T., Lüdtke, O., Pekrun, R., and Sutton, R. E. (2009). Emotional transmission in the classroom: exploring the relationship between teacher and student enjoyment. *J. Educ. Psychol.* 101, 705–716. doi: 10.1037/a0014695

Frenzel, A. C., Thrash, T. M., Pekrun, R., and Goetz, T. (2007). Achievement emotions in Germany and China a cross-cultural validation of the academic emotions questionnaire—mathematics. *J. Cross Cult. Psychol.* 38, 302–309. doi: 10.1177/0022022107300276

*Gläser-Zikuda, M., and Fuß, S. (2008). Impact of teacher competencies on student emotions: a multi-method approach. *Int. J. Educ. Res.* 47, 136–147. doi: 10.1016/j.ijer.2007.11.013

*Hagenauer, G., and Hascher, T. (2010). Learning enjoyment in early adolescence. *Educ. Res. Eval.* 16, 495–516. doi: 10.1080/13803611.2010.550499

*Hill, H. M., Levermore, M., Twaite, J., and Jones, L. P. (1996). Exposure to community violence and social support as predictors of anxiety and social and emotional behavior among African American children. *J. Child Fam. Stud.* 5, 399–414. doi: 10.1007/BF02233862

*Huang, S., Eslami, Z., and Hu, R.-J. S. (2010). The relationship between teacher and peer support and English-language learners' anxiety. *English Lang. Teach.* 3, 32–40. doi: 10.5539/elt.v3n1p32

Huizhen, S. (2014). "Attention to the inheritance of traditional cultural spirit in ancient literature education," in *Paper presented at the 2014 2nd International Conference on Advances in Social Science, Humanities, and Management (ASSHM-14)* (Guangzhou).

*Jia, Y., Way, N., Ling, G., Yoshikawa, H., Chen, X., Hughes, D., et al. (2009). The influence of student perceptions of school climate on socioemotional and academic adjustment: a comparison of Chinese and American adolescents. *Child Dev.* 80, 1514–1530. doi: 10.1111/j.1467-8624.2009.01348.x

*Karabenick, S. A., and Sharma, R. (1994). Perceived teacher support of student questioning in the college classroom: its relation to student characteristics and role in the classroom questioning process. *J. Educ. Psychol.* 86, 90–103. doi: 10.1037/0022-0663.86.1.90

*Karagiannidis, Y., Barkoukis, V., Gourgoulis, V., Kosta, G., and Antoniou, P. (2015). The role of motivation and metacognition on the development of cognitive and affective responses in physical education lessons: a self-determination approach/O papel da motivação e metacognição no desenvolvimento das respostas afetiva e cognitiva em aulas de educação física: uma abordagem centrada na teoria da autodeterminação. *Motricidade* 11, 135–150. doi: 10.6063/motricidade.3661

Kerres Malecki, C., and Kilpatrick Demary, M. (2002). Measuring perceived social support: development of the child and adolescent social support scale (CASSS). *Psychol. Sch.* 39, 1–18. doi: 10.1002/pits.10004

*King, R. B., McInerney, D. M., and Watkins, D. A. (2012). How you think about your intelligence determines how you feel in school: the role of theories of intelligence on academic emotions. *Learn. Individ. Differ.* 22, 814–819. doi: 10.1016/j.lindif.2012.04.005

Klem, A. M., and Connell, J. P. (2004). Relationships matter: linking teacher support to student engagement and achievement. *J. Sch. Health* 74, 262–273. doi: 10.1111/j.1746-1561.2004.tb08283.x

*Lapointe, J. M., Legault, F., and Batiste, S. J. (2005). Teacher interpersonal behavior and adolescents' motivation in mathematics: a comparison of learning disabled, average, and talented students. *Int. J. Educ. Res.* 43, 39–54. doi: 10.1016/j.ijer.2006.03.005

*LaRusso, M. D., Romer, D., and Selman, R. L. (2008). Teachers as builders of respectful school climates: implications for adolescent drug use norms and depressive symptoms in high school. *J. Youth Adolesc.* 37, 386–398. doi: 10.1007/s10964-007-9212-4

Lawman, H. G., and Wilson, D. (2013). *Self-Determination Theory. Encyclopedia of Behavioral Medicine*. New York, NY: Springer.

*Lazarides, R., and Ittel, A. (2013). Mathematics interest and achievement: what role do perceived parent and teacher support play? a longitudinal analysis. *Int. J. Gender Sci. Tech.* 5, 207–231. Available online at: https://www.researchgate.net/publication/260690091

Lipsey, M. W., and Wilson, D. B. (2001). *Practical Meta-Analysis*. Thousand Oaks, CA: Sage.

*Liu, W., Mei, J., Tian, L., and Huebner, E. S. (2016). Age and gender differences in the relation between school-related social support and subjective well-being in school among students. *Soc. Indic. Res.* 125, 1065–1083. doi: 10.1007/s11205-015-0873-1

Longobardi, C., Prino, L. E., Marengo, D., and Settanni, M. (2016). Student-teacher relationships as a protective factor for school adjustment during the transition from middle to high school. *Front. Psychol.* 7:1988. doi: 10.3389/fpsyg.2016.01988

*Ludwig, K. A., and Warren, J. S. (2009). Community violence, school-related protective factors, and psychosocial outcomes in urban youth. *Psychol. Sch.* 46, 1061–1073. doi: 10.1002/pits.20444

Lutz, C. A. (1996). "Engendered emotion: gender, power, and the rhetoric of emotional control in american discourse," in *Language and the Politics of Emotion*, eds C. A. Lutz and L. Abu-Lughod (Cambridge: Cambridge University Press), 69–91.

*MacPhail, S. S. (2012). *Perceived Competence and Depressive Symptoms in Children with Reading Problems*, Doctoral dissertation, Fordham University.

Malecki, C. K., and Elliott, S. N. (1999). Adolescents' ratings of perceived social support and its importance: validation of the student social support scale. *Psychol. Sch.* 36, 473–483. doi: 10.1002/(SICI)1520-6807(199911)36:6<473::AID-PITS3>3.0.CO;2-0

*Martínez, R. S., Aricak, O. T., Graves, M. N., Peters-Myszak, J., and Nellis, L. (2011). Changes in perceived social support and socioemotional adjustment

across the elementary to junior high school transition. *J. Youth Adolesc.* 40, 519–530. doi: 10.1007/s10964-010-9572-z

*McMahon, S. D., Coker, C., and Parnes, A. L. (2013). Environmental stressors, social support, and internalizing symptoms among African American youth. *J. Community Psychol.* 41, 615–630. doi: 10.1002/jcop.21560

Miller, A., Ferguson, E., and Byrne, I. (2000). Pupils' causal attributions for difficult classroom behaviour. *Br. J. Educ. Psychol.* 70, 85–96. doi: 10.1348/000709900157985

Mitchell, S., and DellaMattera, J. (2011). Teacher support and student's self-efficacy beliefs. *J. Contemp. Issues Educ.* 5, 24–35. doi: 10.20355/C5X30Q

*Murberg, T. A., and Bru, E. (2009). The relationships between negative life events, perceived support in the school environment and depressive symptoms among Norwegian senior high school students: a prospective study. *Soc. Psychol. Educ.* 12, 361–370. doi: 10.1007/s11218-008-9083-x

Myint, K. L., and Fisher, D. L. (2001). "Classroom environment and teachers' cultural background in secondary science classes in an Asian context," in *Paper Presented at the Annual Meeting of the Australian Association for Research in Education* (Perth).

*Neville, K. (2008). *Optimal Balanced Affect: Associations with Urban Adolescents' Perceived Social Support and Life Satisfaction*, Doctoral dissertation, University of Illinois Urbana-Champaign.

*Nilsen, W., Karevold, E., Røysamb, E., Gustavson, K., and Mathiesen, K. S. (2013). Social skills and depressive symptoms across adolescence: social support as a mediator in girls versus boys. *J. Adolesc.* 36, 11–20. doi: 10.1016/j.adolescence.2012.08.005

*Ommundsen, Y., and Kvalø, S. E. (2007). Autonomy–mastery, supportive or performance focused? Different teacher behaviours and pupils' outcomes in physical education. *Scand. J. Educ. Res.* 51, 385–413. doi: 10.1080/00313830701485551

*Ommundsen, Y., Klasson-Heggeb,ø, L., and Anderssen, S. A. (2006). Psycho-social and environmental correlates of location-specific physical activity among 9-and 15-year-old Norwegian boys and girls: the European youth heart study. *Int. J. Behav. Nutr. Phys. Act.* 3, 1–13. doi: 10.1186/1479-5868-3-32

*Pan, Y.-H. (2014). Relationships among teachers' self-efficacy and students' motivation, atmosphere, and satisfaction in physical education. *J. Teach. Phys. Educ.* 33, 68–92. doi: 10.1123/jtpe.2013-0069

Pekrun, R., Goetz, T., Titz, W., and Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Educ. Psychol.* 37, 91–105. doi: 10.1207/S15326985EP3702_4

*Piechurska-Kuciel, E. (2011). Perceived teacher support and language anxiety in Polish secondary school EFL learners. *Stud. Second Lang. Learn. Teach.* 1, 83–100. doi: 10.14746/ssllt.2011.1.1.5

*Reddy, R., Rhodes, J. E., and Mulhall, P. (2003). The influence of teacher support on student adjustment in the middle school years: a latent growth curve study. *Dev. Psychopathol.* 15, 119–138. doi: 10.1017/S0954579403000075

*Rey, R. B., Smith, A. L., Yoon, J., Somers, C., and Barnett, D. (2007). Relationships between teachers and urban African American children the role of informant. *Sch. Psychol. Int.* 28, 346–364. doi: 10.1177/0143034307078545

*Rueger, S. Y., Malecki, C. K., and Demaray, M. K. (2008). Gender differences in the relationship between perceived social support and student adjustment during early adolescence. *School Psychol. Q.* 23, 496–514. doi: 10.1037/1045-3830.23.4.496

*Ryan, A. M., Patrick, H., and Shim, S.-O. (2005). Differential profiles of students identified by their teacher as having avoidant, appropriate, or dependent help-seeking tendencies in the classroom. *J. Educ. Psychol.* 97, 275–285. doi: 10.1037/0022-0663.97.2.275

Ryan, R. M., and Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* 55, 68–77. doi: 10.1037/0003-066X.55.1.68

*Sahaghi, H., Alipour, S., and Yailagh, M. S. (2015). The causal relationship between of perceived teacher affective support with english performance, mediated by academic enjoy, academic self-efficacy and academic effort among first grade high school male student of Ahvaz (Iran). *Int. J. Rev. Life Sci.* 5, 547–554. doi: 10.3126/ijls.v10i1.14510

*Sakiz, G. (2012). Perceived instructor affective support in relation to academic emotions and motivation in college. *Educ. Psychol.* 32, 63–79. doi: 10.1080/01443410.2011.625611

*Sakiz, G., Pape, S. J., and Hoy, A. W. (2012). Does perceived teacher affective support matter for middle school students in mathematics classrooms? *J. Sch. Psychol.* 50, 235–255. doi: 10.1016/j.jsp.2011.10.005

*Sakiz, G., Pape, S. J., and Woolfolk Hoy, A. (2007). "Teacher Affective Support and Its Impact on Early Adolescents," in *Paper Presented at the Annual Meeting of the American Psychological Association* (San Francisco, CA).

*Skinner, E. A., and Belmont, M. J. (1993). Motivation in the classroom: reciprocal effects of teacher behavior and student engagement across the school year. *J. Educ. Psychol.* 85, 571–581. doi: 10.1037/0022-0663.85.4.571

Skinner, E., Furrer, C., Marchand, G., and Kindermann, T. (2008). Engagement and disaffection in the classroom: part of a larger motivational dynamic? *J. Educ. Psychol.* 100, 765–781. doi: 10.1037/a0012840

*Sorić, I. (2007). "The relationship between self-efficacy, causal attributions and experienced emotions in academic context," *Book of Selected Proceedings: 15th Psychology Days in Zadar* (University of Zadar).

*Sun, R. C., and Hui, E. K. (2007). Psychosocial factors contributing to adolescent suicidal ideation. *J. Youth Adolesc.* 36, 775–786. doi: 10.1007/s10964-006-9139-1

*Sun, R. C., Hui, E. K., and Watkins, D. (2006). Towards a model of suicidal ideation for Hong Kong Chinese adolescents. *J. Adolesc.* 29, 209–224. doi: 10.1016/j.adolescence.2005.05.005

*Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., and Taggart, B. (2012). *Effective Pre-School, Primary and Secondary Education Project (EPPSE 3-14): Final Report from the Key Stage 3 Phase: Influences on Students' Development from age 11–14.* London: Department for Education, University of London.

*Tanigawa, D., Furlong, M. J., Felix, E. D., and Sharkey, J. D. (2011). The protective role of perceived social support against the manifestation of depressive symptoms in peer victims. *J. Sch. Violence* 10, 393–412. doi: 10.1080/15388220.2011.602614

Tardy, C. H. (1985). Social support measurement. *Am. J. Community Psychol.* 13, 187–202. doi: 10.1007/BF00905728

*Taylor, B. A. (2003). *The Influence of Classroom Environment on High School Students' Mathematics Anxiety*, Doctoral dissertation, Curtin University of Technology.

Taylor, B. A., and Fraser, B. J. (2003). *The Influence of Classroom Environment on High School Students' Mathematics Anxiety*. ERIC Document Reproduction Service No. ED 476644.

*Telan, P. (2000). *Teacher-Student Relationships and the Link to Academic Adjustment and Emotional Well-Being in Early Adolescence*, Doctoral dissertation, Florida International University.

Teng, Z., Liu, Y., and Guo, C. (2015). A meta-analysis of the relationship between self-esteem and aggression among Chinese students. *Aggress. Violent Behav.* 21, 45–54. doi: 10.1016/j.avb.2015.01.005

*Tian, L., Liu, B., Huang, S., and Huebner, E. S. (2013). Perceived social support and school well-being among Chinese early and middle adolescents: the mediational role of self-esteem. *Soc. Indic. Res.* 113, 991–1008. doi: 10.1007/s11205-012-0123-8

*Van Ryzin, M. J. (2011). Protective factors at school: reciprocal effects among adolescents' perceptions of the school environment, engagement in learning, and hope. *J. Youth Adolesc.* 40, 1568–1580. doi: 10.1007/s10964-011-9637-7

*Van Ryzin, M. J., Gravely, A. A., and Roseth, C. J. (2009). Autonomy, belongingness, and engagement in school as contributors to adolescent psychological well-being. *J. Youth Adolesc.* 38, 1–12. doi: 10.1007/s10964-007-9257-4

*Wang, M.-T. (2009). School climate support for behavioral and psychological adjustment: testing the mediating effect of social competence. *Sch. Psychol. Q.* 24, 240–251. doi: 10.1037/a0017999

*Wang, M.-T., and Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: a longitudinal study of school engagement using a multidimensional perspective. *Learn. Instruction* 28, 12–23. doi: 10.1016/j.learninstruc.2013.04.002

*Way, N., Reddy, R., and Rhodes, J. (2007). Students' perceptions of school climate during the middle school years: associations with trajectories of psychological and behavioral adjustment. *Am. J. Commun. Psychol.* 40, 194–213. doi: 10.1007/s10464-007-9143-y

*Weber, K., Martin, M., and Patterson, B. (2001). Teacher behavior, student interest and affective learning: putting theory to practice. *J. Appl. Commun. Res.* 29, 71–90. doi: 10.1080/00909880128101

Wellborn, J., and Connell, J. (1987). *Manual for the Rochester Assessment Package for Schools*. Rochester, NY: University of Rochester.

*Wentzel, K. R. (1998). Social relationships and motivation in middle school: the role of parents, teachers, and peers. *J. Educ. Psychol.* 90, 202–209. doi: 10.1037/0022-0663.90.2.202

*Yang, L., Sin, K.-F., and Lui, M. (2015). Social, emotional, and academic functioning of children with SEN integrated in Hong Kong primary schools. *Asia Pacific Educ. Res.* 24, 545–555. doi: 10.1007/s40299-014-0198-x

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2018 Lei, Cui and Chiu. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

*References marked with asterisk indicate studies included in the meta-analysis.

frontiers in Psychology

ORIGINAL RESEARCH
published: 15 January 2018
doi: 10.3389/fpsyg.2017.02337

Explicit Oral Narrative Intervention for Students with Williams Syndrome

Eliseo Diez-Itza[1], Verónica Martínez[1], Vanesa Pérez[2] and Maite Fernández-Urquiza[1]*

[1] LOGIN Research Group, University of Oviedo, Oviedo, Spain, [2] SUIGC, University School Gimbernat-Cantabria, Torrelavega, Spain

Narrative skills play a crucial role in organizing experience, facilitating social interaction and building academic discourse and literacy. They are at the interface of cognitive, social, and linguistic abilities related to school engagement. Despite their relative strengths in social and grammatical skills, students with Williams syndrome (WS) do not show parallel cognitive and pragmatic performance in narrative generation tasks. The aim of the present study was to assess retelling of a TV cartoon tale and the effect of an individualized explicit instruction of the narrative structure. Participants included eight students with WS who attended different special education levels. Narratives were elicited in two sessions (pre and post intervention), and were transcribed, coded and analyzed using the tools of the CHILDES Project. Narratives were coded for productivity and complexity at the microstructure and macrostructure levels. Microstructure productivity (i.e., length of narratives) included number of utterances, clauses, and tokens. Microstructure complexity included mean length of utterances, lexical diversity and use of discourse markers as cohesive devices. Narrative macrostructure was assessed for textual coherence through the Pragmatic Evaluation Protocol for Speech Corpora (PREP-CORP). Macrostructure productivity and complexity included, respectively, the recall and sequential order of scenarios, episodes, events and characters. A total of four intervention sessions, lasting approximately 20 min, were delivered individually once a week. This brief intervention addressed explicit instruction about the narrative structure and the use of specific discourse markers to improve cohesion of story retellings. Intervention strategies included verbal scaffolding and modeling, conversational context for retelling the story and visual support with pictures printed from the cartoon. Results showed significant changes in WS students' retelling of the story, both at macro- and microstructure levels, when assessed following a 2-week interval. Outcomes were better in microstructure than in macrostructure, where sequential order (i.e., complexity) did not show significant improvement. These findings are consistent with previous research supporting the use of explicit oral narrative intervention with participants who are at risk of school failure due to communication impairments. Discussion focuses on how assessment and explicit instruction of narrative skills might contribute to effective intervention programs enhancing school engagement in WS students.

Keywords: Williams syndrome, pragmatic impairment, oral narrative, effective intervention, language development, narrative intervention, neurodevelopmental disorders, at risk of school failure

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo, Spain

Reviewed by:
Javier Fiz Pérez, European University of Rome, Italy
Manuel Soriano-Ferrer, Universitat de València, Spain

****Correspondence:***
Eliseo Diez-Itza
ditza@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *02 May 2017*
Accepted: *22 December 2017*
Published: *15 January 2018*

Citation:
Diez-Itza E, Martínez V, Pérez V and Fernández-Urquiza M (2018) Explicit Oral Narrative Intervention for Students with Williams Syndrome. Front. Psychol. 8:2337. doi: 10.3389/fpsyg.2017.02337

INTRODUCTION

Williams syndrome (WS) is a neurodevelopmental genetic disorder which affects an estimated 1 in 7,500 to 10,000 people. It is caused by a deletion of 26 to 28 genes from a specific region on one copy of chromosome 7 (7q11.23). It is characterized by medical problems and mild to moderate intellectual disability and learning problems. In a seminal study, the distinctive cognitive profiles of three adolescents with WS were presented as cases of dissociation between language and cognitive functions (Bellugi et al., 1988). Claims of intactness or selective sparing of language in WS were later challenged by research with individuals speaking Italian, French and Spanish (Volterra et al., 1996; Karmiloff-Smith et al., 1997; Diez-Itza et al., 1998).

Further programs of research of the neurocognitive abilities of children and adults with WS described a specific, uneven profile with peaks and valleys, reflecting dissociations within and across cognitive domains. In this unusual pattern of strengths and weaknesses, language and face recognition were considered relatively spared when compared to visuospatial construction (Bellugi et al., 2000; Mervis et al., 2000). Nevertheless, there is strong evidence of complex interdependence between language and cognitive abilities in school-age children and adults with WS, which is not consistent with the claim for excellent language abilities in the WS population (Mervis, 1999; Mervis et al., 2004; Mervis and Becerra, 2007).

From a developmental point of view, the fractionation of the phenotypical outcomes observed in WS is interpreted as the result of complex and differential trajectories of development from the outset (Karmiloff-Smith, 1998). Such an approach allows for a dynamic interpretation of cognitive and behavioral outcomes in neurodevelopmental genetic disorders involving transactions with the environment at all levels over ontogenetic time (Mervis and Klein-Tasman, 2000; Karmiloff-Smith, 2011). A central assumption is that profiles are potentially modifiable by specific types of environmental inputs such as explicit interventions (Fidler et al., 2011). Using broad assessment and targeted intervention based on prior in-depth syndrome-specific research might then be effective in enhancing protective factors and reducing risk factors in the development of individuals with WS (D'Souza and Karmiloff-Smith, 2016).

Very few studies have assessed cognitive development of individuals with WS longitudinally (Mervis et al., 2012). Only one of them addressed the progress in educational attainment, finding a lack of improvement in academic skills but not a decline in IQ, and concluding the need for interventions focusing on daily language and communication skills (Udwin et al., 1996). A stereotyped description of WS, portraying its profile as showing near-normal language and social skills, has often led to discontinuation of language intervention once the child's speech is fluent. However, despite accelerated development after a delay in language onset, pragmatics remain impaired in WS throughout the school years (Mervis and John, 2010; Mervis and Velleman, 2011). Pragmatic impairment in students with WS involves an additional risk factor for school failure as it may account for some of the difficulties in school engagement. Together with the atypical social phenotype, it may contribute to social vulnerability at school (Jawaid et al., 2012).

Vulnerability and Social Cognition in WS

Social vulnerability and higher rates of social victimization are common in individuals with developmental disorders (Fisher et al., 2013). Atypicalities in social cognition may contribute to social vulnerability in these populations and may increase the risk of social isolation, bullying, and overall unsteady relationships in their social environments. Individuals with WS tend to show indiscriminate approachability, intense gazing, anxiety, distractibility, along with inappropriate and excessive chatter and social evaluation (Jawaid et al., 2012). This atypical social profile may explain why students with WS have difficulty maintaining peer relationships, despite their unusually friendly and social nature (Bellugi et al., 1999; Bellugi et al., 2007; Järvinen-Pasley et al., 2008).

Children with WS and Autism (ASD) have been described as the extremes of a continuum in terms of social cognition (Reilly et al., 1990; Jones et al., 2000). However, recent studies have also pointed out subtle similarities between ASD and WS concerning a number of difficulties in social interaction and pragmatic skills (Brock et al., 2009; Lacroix et al., 2016). Pragmatic assessment and intervention with these populations is recommended to enhance communicative skills necessary for school engagement (Philofsky et al., 2007).

Pragmatic Development in WS

Research on pragmatic development focuses on how children acquire the knowledge for the appropriate and effective use of language in interpersonal situations (Ninio and Snow, 1996). Mastery of appropriate speech use depends on cognitive and social skills. Thus, neurodevelopmental disabilities in students with WS may affect pragmatic development, i.e., the acquisition of conversation and discourse skills, including narrative abilities.

Pragmatic Conversation Skills in WS

The WS population was early characterized as showing ease to engage in conversation and to accept responsibility for maintaining the interaction (Reilly et al., 1990). However, later research has pointed out that their conversational exchanges tend to be inappropriate and superficial. For example, they might reverse the role in interviews, asking personal questions to the researchers (Lacroix et al., 2007; Järvinen-Pasley et al., 2008). Parent and teacher reports signal inappropriate initiations of conversation and use of stereotyped language (Laws and Bishop, 2004; Philofsky et al., 2007). Qualitative analysis of the conversation skills confirm the existence of pragmatic anomalies against the initial impression that endorses individuals with WS for being good at maintaining conversational flow (Brock, 2007; Mervis and Becerra, 2007; Lacroix et al., 2016).

Children and adolescents with WS produced fewer utterances in collaborative conversation and less often satisfied other's requests compared to mental age-matched TD children (Lacroix et al., 2007). In a pilot study, they were found to provide too little information for the conversational partner in the context of high levels of conversational inadequacy (Stojanovik et al.,

2001). Systematic conversational analysis showed that children with WS produced fewer continuations compared to SLI and TD control groups, so their speech was characterized as being heavily 'parasitic' on the interlocutor's contributions. They provided insufficient information as well as a higher number of inadequate responses to requests for information and clarification, and they showed significantly more difficulties with interpreting meaning, either literal or inferential (Stojanovik, 2006). In contrast, the case study of a child with WS suggested that impressions of linguistic competence may be the result of compensatory conversational strategies, such as the awareness of conversational partner's interactive needs and the attentiveness to their affective state. Good interactional skills were reported in areas such as turn-taking, turn maintenance, topic management and conversational repair, so that the conversation flows easily, giving an impression of relevance and control (Tarling et al., 2006).

Developmental delays in communicative intentionality and social cognitive skills, including theory of mind abilities, have also been reported (Tager-Flusberg and Sullivan, 2000; Laing et al., 2002). Using an experimental paradigm, Asada et al. (2010a,b) found that children with WS produced fewer communication repairs than TD children when they were verbally misunderstood and they did not verbalize more when they were not attended to than when they were, thus showing an atypical interactional behavior. These results were interpreted as children with WS having a strong motive to interact with others but little motive to share what they meant, which is highly suggestive of theory of mind deficits. In a referential communication task, children with WS showed more non-verbal clarification requests (i.e., pointing gestures and puzzled gazes) than TD children and poorer abilities to use contextual information during ambiguous reference resolution. This was interpreted as a consequence of overall impairments in attention monitoring, visual search, inferring communicative intentions, as well as interpreting verbal messages (Skwerer et al., 2013). Early joint attention problems and limitations in secondary intersubjectivity may be the basis of later pragmatic difficulties (Laing et al., 2002; Mervis et al., 2003). Longitudinal research found that deficits at ages 9–12 years in the ability to verbally extend information were predicted by pragmatic abilities in triadic interactions at age 4 (John et al., 2012).

Pragmatic Narrative Skills in WS

Pragmatic development involves the ability to produce extended discourse and genre-specific forms as a major achievement of language learning. Extended discourse emerges from conversation both interactively and developmentally (Ninio and Snow, 1996). Conversationally embedded stretches of discourse free themselves and children develop a new level of organization of speech: the comprehension and production of narratives, which are considered a universal, basic mode of thought (Bruner, 1986, 1991; Engel, 1995).

Picture-book narration has traditionally been employed to study the development of narrative skills, being considered a natural setting that mirrors the mother–child interaction format of book reading. Bamberg (1987) introduced a method of narrative research based on the wordless picture-book "Frog, where are you?" (Mayer, 1969), pointing out that it allowed for the assessment of narrative development at very early stages, providing data of natural discourse rich enough to be analyzed at the microstructural linguistic level as well as at the macrostructural level of discourse organization. Within the "Frog story" (FS) paradigm, typical and atypical narrative development has been extensively studied cross-linguistically and throughout the school years and adulthood (Berman and Slobin, 1987, 1994; Berman, 1988).

Concerning the microstructural and the macrostructural aspects of narrative discourse, the narrative skills of children and adolescents with WS have been characterized as proficient when compared to clinical populations of the same cognitive level. Reilly et al. (1990) conducted the first study of narrative skills of four adolescents with WS, using the FS. When compared to a Down syndrome (DS) control group, they generated narratives with more grammatical complexity and structural coherence, showing an excessive use of affective and evaluative devices (i.e., character voice, intensifiers, exclamations, sound effects and rhetorical questions). They concluded that, as a characteristic of WS, is the use of a charming, although anomalous, affective expressivity when retelling a narrative. In a larger study also using the FS, younger children with WS generated narratives with more morphological errors and less complex syntax than those of TD age- and gender-matched children, but with a wider range of evaluative devices. Differences in structural linguistic abilities were explained as a consequence of the linguistic and cognitive impairments while differences in the use of engaging devices were considered a reflection of "excessive sociability" of children with WS (Losh et al., 2000).

The role of language vs. intellectual impairment in narrative production of the FS was investigated comparing school-age children with WS to paired SLI and TD children. Although WS children generated narratives of a similar length than those from TD children, their narratives presented more morphological errors and less frequency of complex sentences, showing a similar morphosyntactic profile to SLI children. However, they scored lower than TD and SLI children on macrostructural narrative measures, failing to integrate the characters and episodes in the thematic structure of the story and tending to focus on elaborated descriptions of specific episodes. Only the use of evaluative devices was considered a relative strength of the WS group. Results were interpreted in terms of a dissociation between the development of linguistic forms and the pragmatic ability to use them in order to build up integrated narratives (Reilly et al., 2004).

Cross-linguistic research with the FS confirmed the atypical narrative profile of WS. American, French, and Italian school-age children and adolescents with WS presented an excessive use of social evaluations during storytelling when compared to TD peers (Reilly et al., 2005). French-speaking WS children and adolescents also performed over DS controls but under TD chronological age (CA)-matched peers in the number of utterances and story-schema elaboration (Lacroix et al., 2007). Narratives of Spanish and Portuguese adolescents and young adults with WS showed low coherence at the local and global levels, lacking integration and inferencing. They tended to

lose the main thread of the story and presented a limited use of cohesive markers and an excessive use of evaluative devices (Garayzábal Heinze et al., 2007). They showed low levels of structural coherence and complexity, and moderate levels of content diversity and emotional commitment with the storytelling, relying on diversity of narrative content at the expense of narrative coherence (Gonçalves et al., 2010). In a longitudinal single-case study, a young adult with WS, after an intervention devised to promote a number of linguistic and cognitive abilities, maintained the reference to affective states along with the use of evaluative devices, but failed to improve the production of cognitive inferences necessary to build up the narrative coherence (Fernández-Prieto et al., 2011).

Using single pictures and picture story sequences, Marini et al. (2010) assessed the narrative abilities of Italian-speaking children, adolescents and young adults with WS. They showed mental-age performance at the microstructural level (i.e., phonological, lexical, and morphosyntactic skills), but their narratives were less informative as well as less coherent on the local and global levels than those produced by the TD group, especially when generating a story upon the picture sequences. Results were interpreted in terms of a selective impairment in macrolinguistic (i.e., discourse-level) processing in WS. Van Den Heuvel et al. (2016) compared the developmental courses of structural and pragmatic language skills in Dutch school-aged children with WS to children with idiopathic intellectual disability (IID). Narrative ability was assessed using the Bus Story Test (Renfrew, 1997). Children with WS showed diverging developmental trajectories across language domains with increasing variability. They produced fewer utterances containing core information, and more unrelated and noise utterances compared to children with IID. Irrelevant and off-topic extraneous information was considered a syndrome-specific characteristic of WS. Based on a silent film adapted from a picture book of the "Frog story" series, we examined the narrative coherence and cohesion of Spanish-speaking adults with WS. Recall and sequential order of scenarios, episodes, and events were assessed together with the use of discourse markers. It was concluded that narrative competence in WS may be more impaired in terms of macrostructural organization of discourse than in terms of linguistic cohesion (Diez-Itza et al., 2016).

Overall, these studies underscore the non-homogeneous character of the conversational and narrative skills of children, adolescents and adults with WS. Despite their strengths in formal language and their sociability, they present pragmatic problems that limit their ability to participate in and benefit from educational opportunities. Therefore, recommendations for intervention for school-age children with WS include focus on pragmatic skills as critical for both academic performance and peer relationships (Mervis and John, 2010; Mervis and Velleman, 2011). Narratives are the natural context for such language skills to develop, and children who are competent at narration tend to do well in school (Griffin et al., 2004). Thus, narrative language skills have been considered an important target of assessment and intervention from the early years, and the narrative-primacy view has greatly influenced curricular practice for early literacy training (Hemphill and Snow, 1996).

Narrative Intervention

In the absence of valid formal assessments, narratives provide very relevant and natural samples of pragmatic language skills as they require the ability of bridging cognitive, linguistic, and social domains. Storytelling abilities are good predictors of learning and literacy difficulties contributing to academic failure. Children with and without language impairment can learn complex language and narrative structure skills through minimal but high-quality explicit narrative language intervention (Spencer and Slocum, 2010; Spencer et al., 2015; Petersen and Spencer, 2016). Narrative intervention provides a flexible framework for dynamic assessment and progress monitoring within "Response to Intervention" (RTI) methods, which intend to go beyond "wait to fail" models in designing early intervention for children at risk of school failure (Petersen and Spencer, 2014).

Narrative assessment with diverse methodologies focuses on measurements of microstructure linguistic features (i.e., vocabulary, morphology, and syntax primarily at the sentence level), and macrostructure elements of the narratives (i.e., content, organization, and overall quality at the discourse level) (Peterson and McCabe, 1983; McCabe and Rollins, 1994; Bliss et al., 1998; McCabe et al., 2008; Heilmann et al., 2010; Petersen and Spencer, 2012).

There is relatively little research on narrative language profiles of children and adolescents with developmental disabilities (Finestack, 2012). Empirical evidence draws on research of children and adolescents with DS, Fragile X syndrome (FXS), Autistic Spectrum Disorder (ASD), WS, and Specific Language Impairment (SLI). Although children with DS and FXS show impairments both at the microstructure and the macrostructure levels of the narratives, macrostructure narrative skills may develop as relative strengths in both populations (Boudreau and Chapman, 2000; Finestack et al., 2012; Channell et al., 2015). Individuals with ASD display difficulties in microstructure language measures and in the use of cohesive and evaluative devices (King et al., 2013). Narratives of children with ASD have been linked to theory of mind and conversational competence, and have been reported to be simplistic from a macrostructural point of view, including odd tangential comments about the story, and lacking causal coherence and organization (Capps et al., 2000; Norbury et al., 2014; Gillam et al., 2015). School-age children with SLI produced poorer narratives both at the microstructure and macrostructure levels compared to TD peers (Fey et al., 2004; Marini et al., 2008). Children with SLI and WS exhibited similar morphosyntactic performances, although the WS group presented fewer story components and less thematic integration than the SLI group (Reilly et al., 2004).

These findings suggest that children and adolescents with developmental disabilities may benefit from narrative intervention targeting both microstructure and macrostructure levels. Ukrainetz (2006) proposed narratives as a context for

teaching students with language impairments the language needed for academic success. This "Contextualized Language Intervention" approach proposes the use of specific teaching steps to scaffold explicit semantic, syntactic and pragmatic language skills. For younger students, the ultimate objective is to promote the moving from a conversational context for storytelling to independent narrative retelling. For older students, intervention focuses on narrative structure, cohesion, and story creation. A contextualized approach for children with language impairment yielded better clinical outcomes than a decontextualized language intervention both in sentence-level measures and in a general measure of narrative language ability. The effect was moderately large on narrative comprehension and narrative microstructure but small on the macrostructure (Gillam et al., 2012).

In a review of three decades of research, Petersen (2011) reported only nine studies evaluating narrative interventions delivered to school-age children with language impairment (aged 3–21). Although results varied depending on the design of the research, significant gains were reported both for narrative microstructure and macrostructure as an effect of narrative intervention with preschool- and school-age children with delayed and impaired language development. Children improved the quality of storytelling, and consequently their ability to participate in and benefit from mainstream classroom activities (Davies et al., 2004; Swanson et al., 2005).

However, evidence of the impact of narrative intervention on populations with developmental disabilities is even scarcer, with no studies on WS. Preschoolers with developmental disabilities exhibited gains in comprehension and production of narratives after a short intervention based on *Story Champs*, a specific curriculum for teaching children narrative skills (Spencer et al., 2013). Individualized narrative interventions for school-age children with ASD based on repeated retellings, script-frameworks, and microstructure and macrostructure explicit instruction proved its efficacy on improving story complexity, story structure, and the use of mental state and causal language (Petersen et al., 2014; Gillam et al., 2015; Hilvert et al., 2016).

Beyond cultural differences, researchers point out the need for effective, targeted interventions to promote independence and to enhance communication and social functioning in students with WS (Järvinen-Pasley et al., 2008; Jawaid et al., 2012; Ji et al., 2014). However, there is a great disproportion between the extensive basic research of WS and the limited applied intervention research of this population. Given the current level of knowledge of the behavioral phenotype of WS, the start of research focusing on the development and evaluation of methods of intervention has been considered a vital effort (Mervis and John, 2010).

There is a need to examine the types of intervention that may be the most beneficial to individuals with WS as there is a lack of evidence about effective interventions focusing on areas of vulnerabilty. Semel and Rosner (2003) authored one of the first comprehensive analyses of the research literature, aiming at providing syndrome-specific intervention and innovative techniques for developing the potential of individuals with WS. They consider the ability to engage in meaningful discourse and produce interesting stories the "pièce de résistance" of expressive language for individuals with WS, and suggest interventions based on those strengths to facilitate discourse and to improve narrative skills.

It has been suggested that storytelling could provide an optimal context for scaffolding skills such as event sequencing or perspective taking, along with the linguistic tools necessary to express the key story elements (Channell et al., 2015). Research-supported principles regarding difficulties in narrative language, strengths in narrative macrostructure, evidence for the impact of interventions, and effects of visual support and narrative tasks have been proposed to design and implement narrative language intervention for children and adolescents with developmental disabilities (Finestack, 2012). Thus, narrative intervention focused on oral storytelling skills could help students with WS in meeting academic requirements, enhancing school engagement and providing a contribution to their academic-social environment.

OBJECTIVES

Students with WS might have relative strengths in grammatical and lexical aspects of language production, but these linguistic skills usually do not correspond to pragmatic abilities necessary for effective communication. This pragmatic impairment observed in school-age individuals with WS results in a limited capacity to build extended discourse in order to relate personal or fictional events in everyday conversational settings. Thus, despite showing remarkable linguistic abilities and a highly social and empathetic behavioral phenotype, limitations in pragmatic narrative ability may account for students with WS struggling to maintain social relations and to benefit from school inclusion to avoid academic failure.

Explicit oral narrative assessment and intervention has proven effectiveness to preventing academic failure and enhancing school achievement in typically and atypically developing students of all ages. Narrative competence has been assessed only to a limited extent in individuals with WS but, to our knowledge, there are no results about possible effects of narrative intervention with this population. Thus, the aims of the present study were:

(i) To assess narrative competence of a group of students with WS of different ages based on their ability to generate and retell oral narratives from a silent film, using linguistic measures of microstructural and macrostructural productivity and complexity.
(ii) To assess the feasibility and effects of an individual explicit oral narrative intervention for the group of students with WS. A short semi-manualized intervention (four sessions) was delivered based on repeated generation and retelling of the story, with visual support and immediate scaffolding from an interventionist. Effects of intervention on narrative microstructure and macrostructure were evaluated.

MATERIALS AND METHODS

Participants

Eight students with WS (four males, four females) from monolingual Spanish-speaking families were drawn from a larger research project on cross-syndrome linguistic comparisons (Diez-Itza et al., 2014). However, the assessment and intervention reported in this paper had not been previously conducted. Their mean CA was 16;8 (range: 8;11–24;04). All the participants had been previously diagnosed with WS using the FISH test (Fluorescence *In Situ* Hybridization) and presented the typical clinical phenotype. They were attending different levels of school in Spain: mainstream primary schools (3), special schools (2), and special vocational education centers (3).

The participants had been matched in previous studies to different samples of 5-year-old typically developing children on the basis of MLU as an indicator of verbal age. In one study of spontaneous conversation (Diez-Itza et al., 2017) the TD group had a mean age of 5;5 (range: 5;0–5;11), and a mean MLUw of 4,8 (range: 2;6–9;0). In another study of narratives in conversation (Shiro et al., 2016), the TD group had a mean age of 5;8 (range: 5;4–6;5), and a mean MLUw of 6,6 (range: 4;7–10;3). Thus, verbal age for the students with WS in the present study corresponds to that of TD children in the last year of preschool in the Spanish educational system (mean age: 5;7; range: 5;5–6;5). Consequently, it was considered that in all cases the participants with WS would have a sufficient level of linguistic skills to avoid floor effects at pretest assessment. Furthermore, they had no physical impairments that would interfere with the ability to perform the narrative tasks during the intervention. In order to control for non-verbal intellectual levels, the performance scales of the WISC-R and WAIS-III (Wechsler, 1999a,b) were administered to the participants at pretest (Mean PIQ: 64; range: 44–90).

Approval for human subjects research was granted by the research ethics board of the affiliated university, and written consent was obtained from the parents/guardians of all participants.

Procedure

Narrative Task

Oral narratives were elicited individually from a 6-min silent episode of the Tom and Jerry cartoon series ("The Puppy Tale"). The same procedure was repeated at pretest (Time 1) and posttest (Time 2). Each subject watched the film in a quiet room, only accompanied by a researcher. The participants were told that they would have to retell the story to the researcher later, so they were advised to be attentive and not to ask any questions as they watched the film on a laptop computer. Immediately after viewing the film, they were requested to retell the story to the researcher while being recorded on video. The researcher used the verbal prompt "*Did you like the film?*", followed by "*Tell me about it,*" to start eliciting the narration, which was allowed to develop naturally with no further prompting. However, when the researcher felt that the storytelling failed to progress, she encouraged the participant to continue by asking unspecific open-ended questions (e.g., "*What happened then?*").

Children's narrative features are expected to differ depending on the type of task in which the narrative is elicited. Namely, narrative genre (fictional vs. personal) has been proven to influence the frequency of use of evaluative devices (Shiro, 2003). Fictional narratives have been elicited through different tasks and modalities [i.e., written, oral, or visual sources such as a film, single picture, comic strip, or picture book like the previously mentioned "Frog story" (Berman and Slobin, 1994)]. Some studies suggest that elicitation from oral narratives has a greater impact on the episodic structure of the retelling, while elicitation from audiovisual narratives may enhance the linguistic features of the narratives. Moreover, results seem to vary not only as a function of modality, but of elicitation procedures. If prompts are introduced, the episodic structure of the retell might be richer and better organized, but the narratives appear to be less detailed and with less syntactic complexity and lexical diversity (Gazella and Stockman, 2003).

Concerning the visual modality, the differences between elicitation methods based on static pictures vs. films have been discussed. Beyond the "Frog story" task, which mirrors an interactive book-reading format, elicitation tasks based on films have also been used, assuming that fictional stories from TV programs are the most frequent fictional narratives in the everyday lives of children and adults (Shiro, 2003). Video stories portray dynamic relationships among characters, events, and scenarios, much as in real events, so the child does not need to generate them from non-moving pictures (Gazella and Stockman, 2003). Based on a picture book of the "Frog story" series, the silent film "Frog goes to dinner" has been used in previous research to elicit narratives and assess their causal coherence and syntactic complexity in pre-school and school-age children with low and average school achievement (Gutierrez-Clellen and Iglesias, 1992; Gutierrez-Clellen, 1998).

In a recent study, we used the same film to elicit narratives from adults with WS for analysis of narrative coherence and cohesion (Diez-Itza et al., 2016). However, we considered it was too complex for the purposes of the present study as it includes children with WS in the early school years, and we found it more convenient to elicit the narratives from the Tom and Jerry cartoon. Using this method, very young TD children (3-year-olds) were able to understand the film and to generate basic oral stories after viewing it (Diez-Itza et al., 2001). Thus, we considered that it would be a feasible elicitation method in order to assess the narrative skills of individuals with limited cognitive and linguistic abilities, such as the students with WS in the present study. It also may allow for cross-syndrome comparisons and for comparisons of populations with developmental disorders to typically developing children, avoiding floor effects.

Transcription and Coding

The 16 video-recorded narratives were transcribed and coded using the CHAT format provided by the CHILDES Project (MacWhinney, 2000). Transcription was conducted by four trained researchers. In the first stage, each researcher transcribed 4 recordings from pretest or posttest, signaling all the unclear passages. In the second stage, each researcher revised the

remaining four transcripts from pretest or posttest. In the third stage, a senior researcher resolved the final difficulties in the transcripts in order to achieve the highest agreement. Coding for microstructure and macrostructure measures was conducted in a different way. In the first stage, one of the authors coded pretest transcripts and another one coded posttest transcripts. In the second stage, the first author and the last author jointly revised the whole set of coding transcripts until total agreement was reached.

Measures

Analysis of oral narratives is recognized as an "ecologically valid" assessment method sensitive to differences in children's language proficiency, which has demonstrated criterion validity with standardized language measures (Tilstra and McMaster, 2007). Multiple discrete language measures at both levels, the microstructure (sentence level) and the macrostructure (discourse level), can be analyzed from transcripts of children's oral narratives, and have the potential to document a student's response to academic intervention. Effects of narrative intervention for school-age children with language impairment have systematically been assessed by means of microstructure and macrostructure measures (Petersen, 2011). Microstructure aspects of narrative performance have been analyzed considering productivity (lexical and utterance output) and complexity (MLU and complex syntax) (Justice et al., 2006). A number of rubrics, schemes, protocols, indexes and standardized scales have been used as outcome indicators of the effect of contextualized intervention on macrostructure productivity (elements of the story grammar) and complexity (episodic structure) (Gillam et al., 2012).

In the present study, narratives were assessed for microstructure and macrostructure, including the following productivity and complexity measures: (i) Microstructure productivity (length of narratives): Total number of utterances, total number of clauses, and total number of words (tokens); (ii) Microstructure complexity (syntactic complexity, lexical diversity and cohesion): Mean length of utterances in words (MLUw), total number of different words (types), and total number of discourse markers (cohesive devices); (iii) Macrostructure productivity (completeness of narratives): Total number of scenarios, total number of episodes, total number of events, and total number of characters; and (iv) Macrostructure complexity measures (sequential order): Order of scenes, order of episodes, order of events, and order (adequacy) of reference to characters.

Microstructure Measures

The microstructure measures were computed by means of the CLAN software provided by the CHILDES Project (MacWhinney, 2000). Counts of Utterances were obtained directly from the transcripts, as these are the units for transcription of the main tiers in the CHAT format. Counts of Clauses required additional segmentation coding. Clauses were analyzed as segments containing at least a finite verb or a non-finite verb (i.e., infinitive, participle, or gerund), although some clauses could contain more than a verb if one of them was a modal or an auxiliary verb. Utterances in which the verb was elliptic were also computed as a clause. Thus, some utterances may consist of a single clause (with or without a verb) while others may contain a main clause and its dependent clauses (with one or more verbs). Counts of word tokens and word types were obtained directly from the transcripts as an output from CLAN software, as well as MLUw, which is derived from productivity measures (tokens/utterances). Counts of discourse markers required additional coding of these cohesive devices. Discourse markers signal an interpretive relationship between the utterance they introduce and the prior segment in discourse. Their cohesive role at the discourse level is different from their syntactic role at the sentence level, so their more specific interpretation is given by the context (Halliday and Hasan, 1976; Fraser, 1999). Thus, in coding for discourse markers, conjunctions, adverbs, verbs, or even interjections and phrases were included when serving particular textual pragmatic functions. Discourse markers comprised progression markers, serving functions of starting, continuing, adding new information, or closing the story (e.g., *there was, and, then, that's the end*), and interaction markers, accomplishing functions such as assertion, negation, causality, or restriction (e.g., *yes, no, because, but*) of what has been previously said in the dialogical parts of the narratives.

Macrostructure Measures

The narratives generated by the participants were compared to a complete version of the story built-up by the researchers, which served as the "gold standard" scheme for coding (see **Table 1**).

Narrative macrostructure was assessed based on the "Pragmatic Evaluation Protocol for the analysis of oral Corpora" (PREP-CORP), which has been used in our previous research with WS and DS groups (Fernández-Urquiza et al., 2016; Shiro et al., 2016). PREP-CORP allowed for coding of the narrative structure at three levels: (i) *Scenarios*: basic or general level, corresponding to the locations or spaces in which the initiating event, complication, high point, and resolution of the story took place; (ii) *Episodes*: intermediate or integrated level, corresponding to sets of actions whose sequencing constitute the plot of the story; (iii) *Events*: complex or detailed level, corresponding to the sequence of single actions making up the story. A total of 4 scenes, 10 episodes, and 25 events were identified in the "gold standard" version of the story.

Macrostructure productivity was assessed as the proportion (in percentage) of scenarios, episodes, and events related in the narratives of participants to the total number of them in the "gold standard" version. The reference to an event in a narrative was computed whenever an action was verbally mentioned by means of a clause, at minimum. Credit for the production of any given event was awarded to the participant based on semantic-pragmatic criteria and independently from phonological or morphosyntactic correctness. At the same time, the event was linked to the correspondent episode and scenario of the plot, as specified in the "gold standard" version. For instance, the mention of event 8 corresponded to episode 4 and scenario 2 (see **Table 2**). Furthermore, PREP-CORP provided codes for the analysis of reference to characters. Introduction of characters as a measure of narrative productivity (completeness) referred to the

TABLE 1 | "Gold standard" scheme for macrostructure coding.

SCN	EPS	EVT
1 River	1	(1) Car/bridge/bag/fall/river
	2	(2) Mouse/rescue/bag/puppy
		(3) Puppy/play/bark/lick/mouse/throw stick
		(4) Puppy/fall/mouse/rescue
2 Cat's house	3	(5) Mouse/takes puppy/house
		(6) Puppy/can't go into mouse's house
		(7) Mouse/puppy/go into cat's house
	4	(8) Puppy/lick/cat's milk/mouse/hide puppy/cat/angry
		(9) Cat/throw puppy out house
	5	(10) Mouse/put puppy back into house/hide puppy/drawer
		(11) Puppy/get into cat's bed/take blanket/cat/wake up/sneeze
		(12) Puppy/lick/cat/throw puppy out again/fall into a bottle
	6	(13) Mouse/puppy back into house again/puppy/lick mouse and cat
		(14) Cat/pursue/puppy and mouse
		(15) Cat/put bar of soap on floor/mouse and puppy/slide/out of house
	7	(16) Cat/sleep/storm
		(17) Thunders/cat/wake up/worried about puppy and mouse
3 River	8	(18) Cat/look for/puppy and mouse/hat/umbrella/whistle/wake up
		(19) Wind/cat/bridge/fall into the water
	9	(20) Puppy and mouse/rescue/cat/unconscious
4 Cat's house	10	(21) Puppy and mouse/take care/cat/heat/soup/fireplace
		(22) Puppy and mouse/give soup/cat/funnel/puppy/lick/cat/wake up
		(23) Cat/give/puppy/bowl of milk/bed
		(24) Puppy/call/brothers/come running
		(25) Puppies/lick/milk/cat and mouse/look at them/happy

TABLE 2 | Example of retelling of episode 4 (participant 08).

PRETEST	*CHI: and (.) well (.) what else (.) and he was eating food [c]. %cod: $SCN2:EPS4:EVT8
POSTTEST	*CHI: Well (.) they pass by the kitchen [c] (.) and when they do [c] (.) the: [//] (.) there's a cat [c] (.) who gets angry [c] (.) because they're going to drink his [/] his milk [c]. %cod: $SCN2:EPS4:EVT8 *INV: uhum. *CHI: ee: (.) hmm (..) later (..) then they go out [c]. *CHI: no (.) he goes out (.) the cat because he gets angry (.) he takes the dog out of the house the cat [c] (.) he takes him out [c]. %cod: $SCN2:EPS4:EVT9

adequate mention of each of the three characters (Mouse, Puppy, Cat) at least once in the story.

Macrostructure complexity of the narratives was assessed considering the sequential order of scenarios, episodes, and events, as well as the adequate reference to characters. The order of events was computed as the proportion (in percentage) of events that appeared in their canonical sequential order to the total of events related. The order at the level of episodes and scenarios was calculated following the same procedure. Order of characters was computed as the proportion (in percentage) of adequate references to characters occurred in a narrative to the total of events related. Adequate references were calculated subtracting the number of inadequate references to characters (i.e., lack of mention when needed, confusion, and mention of unrelated characters) from the total number of events related.

Intervention Delivery

Explicit oral narrative intervention was delivered individually to each participant by an expert interventionist. It was a short intervention scheduled weekly during 1 month (four sessions of approximately 20 min each). Posttest assessment was conducted 2 weeks after the last intervention session. The intervention design was based on a review of previous studies researching the effects of narrative intervention both in typically developing and language impaired students. Narrative generation and retelling have been reported to be the key common factors among all the manualized intervention methods, thus narrative intervention could be procedurally simple (Petersen, 2011). Main strategies featured in narrative intervention studies included: open opportunities for students to retell, systematic support from visual materials, immediate feedback (i.e., expansions/extensions), non-restrictive prompting, and progressive scaffolding fading to build independence. The need for explicitly teaching of linguistic complexity such as the use of specific temporal and causal markers has also been underscored (Petersen and Spencer, 2014, 2016).

A semi-manualized method of intervention was devised based on these principles. During the sessions, the participant had to generate and retell the story repeatedly with visual support and immediate scaffolding from the interventionist. A set of 25 pictures captured from the movie frames was used as the visual support. Each captured picture represented roughly one of the events in the "gold standard" version of the story. Two simplified versions of the cartoon were also video-edited: a short version covering scenarios 1 and 2, and a longer version including all the scenarios, episodes and events.

Sessions started with the retelling of the story by the student without scaffolding. Then the interventionist modeled the retelling using the set of pictures in a scripted way. In order to teach explicitly the narrative structure of the story, the intervention was organized around the sequences of actions occurring within each Scenario, highlighting the Event structure of the Episodes. The first session focused on Scenarios 1 and 2. The interventionist showed the students the set of pictures corresponding to the first scenario one by one, presenting the characters, and providing explicit target verbs for actions (i.e., *fell*, *rescued*, *entered*, *ran after*), and explicit markers (i.e., *and, then, afterward*). Then, the student had to retell the events and episodes within the scenario with the visual support of the pictures and the scaffolding of the interventionist. Explicit prompts along with extension and expansion strategies were used depending on the length and accuracy of the retelling, the correct

identification of characters and actions, the adequate order of events and the use of target verbs and discourse markers. The same procedure was employed to teach the macrostructure and the microstructure within the Scenario 2. The last part of the session was devoted to the viewing of the short version of the film with the support of the pictures and with the scaffolding of the interventionist. The objective was to raise awareness of the event structure of the film based on the correspondences with the pictures. After that, the participant had to retell the story without scaffolding. The second session was devoted to scenarios 3 and 4 using the same methodology. The longer simplified version including all the scenarios was used at the end of this session. The last two sessions had the same structure but focused on the story as a whole, comprising all four scenarios and underscoring the sequential relationships within the general structure: initiating events, complicating actions, high points, and resolutions. Explicit linguistic elements were still provided by the interventionist, although prompting and scaffolding were progressively reduced to boost the highest autonomy in participants' retelling of the story at the end of the session.

Overall, the fidelity of the implementation was judged to be satisfactory on the basis of several criteria used in previous studies of effectiveness of curriculum intervention programs, indicating that it was feasible to deliver the intervention (O'Donnell, 2008). The interventionist's adherence to the structural components of the intervention (quality of delivery) was assured by the fact that there was only one interventionist who was also involved in the intervention design. Therefore, she had a good understanding of the objectives and of the structural components and processes of the intervention, which was manualized, assuring no major variations in its delivery. Improvements at posttest of several microstructure and macrostructure measures provide further evidence that the intervention was delivered as intended and that WS students also adhered to the structural components of the intervention (participant responsiveness). Moreover, the method based on videotapes and literal transcripts allows for an accurate monitoring of the implementation of the intervention, yielding more valid indicators of fidelity than self-reports.

Data Analysis

The effects of intervention were evaluated using a one-group pretest–posttest quasi-experimental design. This is a non-randomized within-subjects study design, which may provide more control of the variables when the sample size is small, as in rare disorders where ethical issues of therapeutic intervention may also arise. Pretest measures provided information about what the narrative performance would have been if the intervention had not occurred. Although this precedence is an important requirement of causality, and allows for the statistical assessment of variation in the outcome, the lack of randomization fails to exclude alternative explanations, which should be discussed.

The Wilcoxon signed-rank test was used as a non-parametric more powered alternative to the paired *t*-test for differences of means before and after the intervention, because the distributions did not always approximate normality as assessed with the Shapiro–Wilk test. In addition to significance tests, estimates of the magnitude of the observed effects were calculated, as they are considered an essential outcome of empirical studies. There are different definitions of a standardized effect size, which requires a choice about the statistic providing the best summary of results. Effect sizes can be grouped into two families: *r* family (based on correlations), and *d* family (based on mean differences). To better examine inherently intra-individual effects, it is recommended to incorporate the correlation between measures. Two viewpoints determine some of the practical choices when reporting results, focusing either on generalizability regardless of the research design (i.e., between- vs. within-subjects design), or on the statistical significance of the differences drawn by the statistical test. The generalizable effect size viewpoint considers that within-subjects designs overestimate effect sizes, while the statistical significance viewpoint regards this larger effect size as a benefit of a more powerful design (Lakens, 2013).

Many texts on statistics do not mention effect sizes for common non-parametric procedures as the Wilcoxon test. G*Power calculates d_z, the standardized mean difference effect size for within-subjects designs, based on pre- and posttest means and standard deviations, and the correlation between measures. Kerby (2014) suggested a simple difference formula to estimate effect sizes: the *r* "matched-pairs rank-biserial correlation" equals the difference between the proportion of favorable (f) and unfavorable (u) evidence from rank sums ($r = f - u$). The proportion of favorable evidence can be also considered with this type of data as the "common language effect size" estimate, as it expresses the meaning of an effect size in the everyday language of a percentage. Thus, it may be easily interpreted as how often a score sampled from the posttest distribution will be greater than a score sampled from the pretest distribution (i.e., probability of superiority). Although *d* is recommended to generalize the impact of a treatment, *r* might be a more flexible statistic and a more ecologically valid predictor of the outcome than *d* when the sample is small. In that circumstance, a multiple perspective using both *r* and *d* has been suggested (McGrath and Meyer, 2006). Further discussion of these issues, formulas, and tables for converting between several effect size estimates (Cohen's *d*, point biserial *r*, squared eta, probability of superiority, area under the ROC curve) can be found in Fritz et al. (2012).

In order to discuss the statistical effect sizes of the differences observed between pre- and posttest measures, three different estimated values of the size of the effect were calculated for each test: (i) d_z from G*Power; (ii) *r* "matched-pairs rank-biserial correlation" calculated from Kerby (2014) simple formula; (iii) Probability of Superiority (PS): common language effect size converted from d_z following Fritz et al. (2012). Gains (in percentage) after intervention were calculated on: microstructure and macrostructure, productivity and complexity, and on a global measure of overall improvements (average combined gains). Furthermore, multiple linear regression analyses were conducted to assess predictability of scores at pretest and gains at posttest from CA, Non-verbal IQ (PIQ), and initial scores on microstructure and macrostructure measures. In spite of small size of the sample, recent studies indicate that linear regression models may require only two subjects per variable for adequate estimations (Austin and Steyerberg, 2015). The proportion of

TABLE 3 | Microstructure measures of narrative productivity.

	PRE	POST	Δ%	*Z*	*p*	*r*	d_z	PS
UTT	15.00 (6.63)	20.38 (3.58)	54.32 (53.24)	2.113	0.035	0.50	1.12	78
CLA	26.13 (14.45)	43.63 (19.45)	85.08 (76.77)	2.524	0.012	1	1.59	87
TOK	145.88 (88.39)	252.63 (109.25)	93.27 (75.69)	2.524	0.012	1	1.33	82

UTT, utterances; CLA, clauses; TOK, tokens.

TABLE 4 | Microstructure measures of narrative complexity.

	PRE	POST	Δ%	*Z*	*p*	*r*	d_z	PS
MLU_w	9.50 (1.89)	12.03 (3.35)	27.58 (32.01)	2.240	0.025	0.75	0.88	74
TYP	69.25 (27.56)	106.50 (38.84)	60.20 (47.92)	2.524	0.012	1	1.24	80
MRK	18.75 (9.47)	32.88 (16.86)	93.95 (94.95)	2.240	0.025	0.75	1.01	76

MLU_w, mean length of utterances in words; TYP, types; MRK, markers.

variance explained by the models was drawn from the adjusted coefficient of determination (AdjR-Squared), to correct for the effects of the small sample size, and its statistical significance was tested by ANOVA (F). Coefficients of partial correlation were also calculated to assess strength and direction of the associations. In order to compare the variability of measures (i.e., heterogeneity), a standardized measure of dispersion (Coefficient of Variation: Relative Standard Deviation) was calculated as the ratio of standard deviation to the mean, and expressed as a percentage.

RESULTS

All the students with WS showed a sufficient level of understanding of task requirements and accomplished the narrative task at pretest. After intervention, all of them presented gains on a global measure of overall percentage of improvement (Mean: 54%; range: 14–97). Mean percentages of gain were also calculated on overall microstructure (Mean: 69%; range: 12–178) and macrostructure (Mean: 38%; range: 5–120), as well as on overall productivity (Mean: 64%; range: 6–122) and complexity (Mean: 43%; range: 11–89), on microstructure productivity (Mean: 78%; range: 11–190) and complexity (Mean: 61%; range: 3–166), and on macrostructure productivity (Mean: 51%; range: 2–121) and complexity (Mean: 25%; range: −10–118).

Tables 3, **4** list scores on microstructure productivity and complexity at pretest and at posttest, percentage of gains, and results of Wilcoxon test (*Z*-values) together with estimations of the effect sizes of the differences. Results indicated statistically significant differences between pretest and posttest in all six microstructure measures. After the intervention, the students with WS generated longer and more complex stories in terms of both morphosyntactic and lexical measures. Gains ranged between 27.6% (MLUw) and 93.9% (Discourse Markers), with high effect sizes in all cases (*r* range: 0.5–1; d_z range: 0.88–1.59; *PS* range: 74–87). However, very high coefficients of variation (CV) in percentages of individual improvements were observed, ranging from 80% (Types) to 116% (MLUw).

At pretest, microstructure productivity measures showed higher ranges of CV (44–61%) than complexity measures (20–51%), with the lowest dispersion observed in MLUw, and the highest in Tokens. At posttest, dispersion of productivity measures was reduced (18–45%), while it increased in complexity measures (28–51%).

Tables 5, **6** list scores on macrostructure productivity and complexity measures at pretest and at posttest, percentage of gains, and results of Wilcoxon test (*Z*-values) together with *r,* d_z, and *PS* estimations of the effect sizes of the differences. Results indicated statistically significant differences between pretest and posttest in all macrostructure productivity measures, except for character introduction. After the intervention, the students with WS generated more complete stories at the integrated and detailed levels (episodes and events), and they included all the scenarios and characters. Gains ranged between 20.8% (scenarios) and 103.3% (events). Significant differences showed high effect sizes (*r* range: 0.62–1; d_z range: 1.18–2.62; *PS* range: 80–97). Again, very high coefficients of variation in percentages of individual improvements were observed, ranging from 70% (events) to 225% (characters). Conversely, no significant differences were observed in macrostructure productivity measures, which might be related both to high scores at pretest, and to the fact that as narrative productivity increases ordering difficulties grow to a similar extent. Effect sizes were near chance, except for order of characters, but improvements showed the greatest heterogeneity.

At pretest, macrostructure productivity measures showed ranges of CV (15–49%) similar to the ranges of dispersion of complexity measures (14–51%). The lowest coefficients of variation were observed in recall of scenarios and order of events, and the highest in recall of events and order of characters. At posttest, heterogeneity was reduced in productivity measures (0–22%), and to a lesser extent in complexity measures (12–23%).

In order to determine which measures at pretest are the best predictors of gains after intervention, multiple regression analyses were conducted controlling in each case for the respective microstructure and macrostructure

TABLE 5 | Macrostructure measures of narrative productivity.

	PRE	POST	Δ%	*Z*	*p*	*r*	d_z	PS
SCN	84.38% (12.94)	100% (0.00)	20.83 (17.25)	2.236	0.025	0.62	1.18	80
EPI	65% (23.91)	86.25% (10.61)	48.85 (56.65)	2.388	0.017	0.87	1.29	82
EVT	37% (18.24)	64.50% (13.93)	103.33 (72.58)	2.530	0.011	1	2.62	97
CHT	87.50% (24.87)	100% (0.00)	31.25 (70.39)	1.342	0.180	0.25	0.50	64

SCN, scenarios; EPI, episodes; EVT, events; CHT, characters.

TABLE 6 | Macrostructure measures of narrative complexity.

	PRE	POST	Δ%	*Z*	*p*	*r*	d_z	PS
SCN	91.67% (15.43)	93.75% (11.57)	4.69 (21.06)	0.535	0.593	0.12	0.13	53
EPI	88.14% (13.68)	91.52% (16.42)	6.03 (23.63)	0.674	0.500	0.37	0.16	53
EVT	89.35% (12.54)	89.55% (17.44)	1.24 (20.30)	0.314	0.753	0	0.01	50
CHT	58.09% (30.67)	75.67% (17.76)	87.43 (150.10)	1.352	0.176	0.12	0.56	66

SCN, scenarios; EPI, episodes; EVT, events; CHT, characters.

productivity or complexity variables. Partial correlations indicated positive or negative direction of the relationships between variables. Participants producing a higher number of utterances showed lower gains in microstructure productivity (AdjR-Squared = 0.423; $F = 6.130$; $p < 0.048$), and lower global improvement of narratives (AdjR-Squared = 0.545; $F = 9.368$; $p < 0.022$). Number of types and discourse markers jointly predicted gains in macrostructure productivity (AdjR-Squared = 0.598; $F = 6.213$; $p < 0.044$): participants with more cohesive narratives (in Discourse Markers) but in proportion less lexical diversity tended to show higher gains in recall of macrostructure. Recall of scenarios, episodes and characters jointly predicted gains in macrostructure productivity (AdjR-Squared = 0.978; $F = 106.874$; $p < 0.001$), macrostructure complexity (AdjR-Squared = 0.716; $F = 6.882$; $p < 0.047$), and overall macrostructure (together with events) (AdjR-Squared = 0.967; $F = 51.934$; $p < 0.004$): gains in productivity were positively predicted by scenarios, and negatively by episodes and characters, while gains in complexity were positively predicted by episodes, and negatively by scenarios and characters, and gains in overall macrostructure showed the same directions of associations and, in addition, a negative one with events. Order of scenarios, episodes, events and characters predicted gains in macrostructure complexity (AdjR-Squared = 0.955; $F = 38.414$; $p < 0.007$): participants with higher order in events but in proportion lower order of scenarios, episodes and characters showed higher gains.

In order to estimate linear dependence between CA or non-verbal IQ (PIQ) and performance at pretest and posttest and gains, multiple regression analyses were conducted, controlling in each case for the respective microstructure and macrostructure productivity or complexity variables. Partial correlations indicated positive or negative direction of the relationships between variables. At pretest, CA significantly predicted utterances, discourse markers, MLUw, and events and characters recalled. At posttest, CA only predicted events recalled, and order of scenarios and characters. Furthermore, CA predicted gains in utterances and in episodes, events and characters recalled. At pretest, non-verbal IQ (PIQ) predicted scenarios, episodes and characters recalled. At posttest, PIQ predicted order of these same variables, and also MLUw and discourse markers. Furthermore, PIQ predicted gains in events and characters recalled and in order of events.

At pretest, older participants generated longer narratives (in utterances) (AdjR-Squared = 0.567; $F = 10.151$; $p < 0.019$), and more cohesive (in discourse markers) but in proportion less complex ones (in MLUw) (AdjR-Squared = 0.775; $F = 13.090$; $p < 0.010$). CA also predicted jointly events and characters recalled before intervention (AdjR-Squared = 0.952; $F = 70.748$; $p < 0.001$): older participants generated more complete narratives (in events), but they included in proportion less characters. At posttest, older participants still generated more complete narratives in terms of events recalled (AdjR-Squared = 0.481; $F = 7.490$; $p < 0.034$), and also more ordered ones at the level of scenarios and characters (AdjR-Squared = 0.665; $F = 7.935$; $p < 0.028$). Percentage of gain in utterances was higher in younger participants (AdjR-Squared = 0.475; $F = 7.331$; $p < 0.035$). CA also predicted jointly percentage of gain in events, episodes and characters recalled (AdjR-Squared = 0.708; $F = 6.655$; $p < 0.049$): younger participants presented with more gains in events recalled, but in proportion their gains in episodes and characters were lower.

At pretest, PIQ predicted jointly scenarios, episodes and characters recalled (AdjR-Squared = 0.877; $F = 17.628$; $p < 0.009$): participants with higher PIQ recalled more episodes, but they included in proportion less Scenarios and Characters. At posttest, participants with higher PIQ produced longer utterances (in MLUw) but in proportion their narratives were less cohesive (in discourse markers) (AdjR-Squared = 0.742; $F = 11.090$; $p < 0.015$). PIQ also predicted jointly order of scenarios, episodes and characters after intervention (AdjR-Squared = 0.776; $F = 9.101$; $p < 0.029$): participants with higher PIQ showed more order in scenarios and characters, but in proportion less order in episodes. PIQ predicted jointly

percentage of gain in events and characters recalled (AdjR-Squared = 0.767; $F = 12.539$; $p < 0.011$): participants with lower PIQ showed more gains in events recalled, but in proportion their gains in recall of characters were lower. Participants with higher PIQ showed higher improvements in order of events recalled (AdjR-Squared = 0.453; $F = 6.792$; $p < 0.040$).

DISCUSSION

The aim of the present study was to determine the feasibility and possible effects of oral narrative assessment and intervention for students with WS. In the case of students with developmental disabilities, pragmatic narrative competence might be essential for school inclusion and achievement, as it provides a crucial bridge between linguistic abilities and cognitive and social skills. Narrative-retelling and narrative-generation tasks constitute a natural, appropriate context for the dynamic assessment of pragmatic abilities from the early years and throughout the school age. They have been used repeatedly in the research on pragmatic abilities of students with developmental disorders and language impairment. However, to our knowledge, no research of narrative intervention for individuals with WS had so far been conducted. Fictional narratives in the present study were elicited from an episode of the "Tom and Jerry" cartoon series at pre- and post-intervention sessions, and they were transcribed and coded for microstructure and macrostructure analyses at sentence- and discourse-levels. The analyses at the microstructure level included measures of productivity (utterances, clauses and words) and complexity (MLUw, lexical diversity and use of discourse markers). The analyses at the macrostructure level included measures of productivity and complexity (story completeness and sequential order in terms of scenarios, episodes, events and characters).

At pretest, all the students with WS showed, at minimum, basic abilities to autonomously generate narratives about some of the characters and events presented in the film. This is consistent with previous results from 3-year-old typically developing preschoolers and DS MLU-matched children using the same elicitation task (Diez-Itza et al., 2001; Fernández-Urquiza et al., 2016). Consequently, no floor effects showed for any of the measures, although a high variability in narrative proficiency within WS students both at microstructure and macrostructure levels was observed. While younger participants performed near floor, some of the older generated quite complete and ordered narratives, which might have had a ceiling effect on intervention outcomes.

Therefore, the method could be adequate for narrative assessment at very early stages of linguistic and cognitive development, but in the case of older students with WS, a more complex story would possibly allow larger room for improvement. In a previous study of young adults with WS, where the narratives were elicited from a more complex story, the scores were higher than those obtained by the students in the present study, which may also be explained by the fact that participants were older and showed higher levels of cognitive and linguistic development (Diez-Itza et al., 2016).

After intervention, all the participants showed overall improvement in a global measure of narrative performance. The best outcomes were observed at the microstructure level, with higher improvements in productivity (i.e., story length). Gains in macrostructure productivity (i.e., story completeness) paralleled overall improvement, but no significant gains were observed at the macrostructure complexity level (i.e., story order). At posttest, WS students generated narratives with more utterances, which included more clauses and tokens. The length of the utterances and the lexical diversity also increased. The highest gains were observed in the use of discourse markers, which were explicitly taught in the intervention sessions to enhance narrative cohesion.

Improvements in language productivity and complexity allowed the students with WS to generate more complete narratives, achieving the highest advances in event recall. Their stories showed considerably more detail after intervention, which could indicate that extensions at the microstructure level can be reflected in narrative macrostructure. Moreover, when controlling for lexical diversity, the participants with more cohesive narratives at pretest had better outcomes. Therefore, the use of discourse markers might be a good predictor of narrative development in school-age children with WS. Narrative integration at the level of episodic structure also showed significant improvement, but it did not parallel the gains in event detail. This proclivity to recall details should be taken into account in future intervention designs, as it could generate an imbalance between over-detailed and under-detailed or omitted episodes within narrative structure.

In a previous study, we had already observed the relative disproportion between event recall and episode integration in narratives of adults with WS (Diez-Itza et al., 2016). The tendency of WS individuals to focus on elaborated descriptions of episodes, weakening the thematic structure of narratives, had also been reported and was interpreted in terms of a dissociation between linguistic abilities and pragmatic integration skills (Reilly et al., 2004). Lack of integration has been related to a detail-focused processing style that is also observed in individuals with ASD (Happé and Frith, 2006). Children with ASD share with their WS pairs a relative weakness in narrative macrostructure, and their stories have been considered simplistic when analyzed for macrostructure features such as organization and causal coherence (Capps et al., 2000; Norbury et al., 2014; Gillam et al., 2015). Children with WS also presented narratives with fewer components and lower integration of thematic structure and characters than SLI pairs, which was discussed in terms of the role of general cognitive impairment (Reilly et al., 2004).

However, syndrome-specific differences in cognitive processing should also be considered, as children with DS and FXS may develop relative strengths in narrative macrostructure (Boudreau and Chapman, 2000; Finestack et al., 2012; Channell et al., 2015). Cognitive impairments in areas such as spatial cognition might account for those differences. In construction tasks, WS individuals present a tendency for local processing and a difficulty in perceiving global structure, which has been explained as an interactive effect of faulty executive processes and fragile spatial representations (Mervis, 2006). In a previous study, we suggested a possible relation between weaknesses in

narrative construction and deficits in global processing, but we failed to find a significant correlation between measures of the Block Design subtest of the Wechsler Intelligence Scales and measures of narrative structure and sequential order (Diez-Itza et al., 2016). Individuals with WS showed more difficulties in macrostructural processing of narratives in a picture-sequence task than in a single picture task, which was discussed as related to deficits in sequential analysis and spatial working memory (Marini et al., 2010). Nevertheless, a direct link between measures of attention or visual-spatial skills and narrative processing was not found, so the authors pointed out that the story effect could be due to the higher narrative skills required to generate a story from a sequence of pictures. Specific research would be needed to better assess the hypothesis of a relationship between cognitive spatial and textual pragmatic domains.

The present study failed to evidence improvements in character introduction, which may be related to near ceiling scores at pretest, as the majority of participants had initially introduced all of the characters. Limited computing for character appearances might also account for this difference. Furthermore, the students with WS did not show advances in macrostructure complexity (i.e., sequential order of events and adequate character management). This could be similarly explained by high-ordered stories at pretest and moreover, by the fact that order keeps a proportion to the total number of scenarios, episodes, events and recalled characters. Increased length of narratives entails greater difficulties in maintaining canonical order of the events, episodes and scenarios. Therefore, future intervention designs should put more focus on macrostructure organization, as the current results confirm that individuals with WS persistently struggle with building narrative coherence and thematic structure. This is consistent with findings of previous research in different languages (Reilly et al., 2004; Garayzábal Heinze et al., 2007; Lacroix et al., 2007; Gonçalves et al., 2010; Marini et al., 2010; Diez-Itza et al., 2016).

Special difficulties with character management were found prominent, including lack of mention when needed, confusion, and mention of unrelated characters, and they continued to be the weakest aspect of narrative performance after intervention. It must be acknowledged that the narrative intervention design of the present study lacked a sufficient and explicit focus on such specific problems, although they had been suggested by some prior research. Reilly et al. (2004) reported failure to integrate characters in the thematic structure of the stories as a consequence of intellectual impairment. In a previous study, we found that children with DS showed verbal-age levels in macrostructure levels, but they performed under verbal-age in adequate reference to characters (Fernández-Urquiza et al., 2016).

As expected given the wide range of ages of participants, performance at pretest and gains after intervention could be in part predicted by CA. At pretest, older students with WS generated narratives that were longer, more cohesive, and more complete. Conversely, younger participants showed more gains in story length and completeness after intervention, while older students tended to show more improvement in episodic organization and character management. Different benefits of intervention with age could be partially explained by increase in IQ as reported by a longitudinal study of students with WS from age 12 to age 21 (Udwin et al., 1996). In line with this, a strong correlation was found between non-verbal IQ (PIQ) and CA. Nevertheless, PIQ was a predictor only of performance on macrostructure, with the exception of a positive relation between PIQ and MLUw after intervention (i.e., MLUw reached non-verbal IQ levels). Students with higher PIQ scores showed better episode integration at pretest and greater gains in the ordering of events. Conversely, students with lower PIQ exhibited higher improvements in event detail. These results support the idea that relation exists between specific features of cognitive processing and narrative coherence in WS, which could be quite independent from linguistic productivity (Reilly et al., 2004).

Losh et al. (2000), also using regression analyses, found that WS children performed at non-verbal mental age levels in the "Frog story." They reported that CA had effects in increasing the length of narratives but not in reducing morphological errors. In previous studies, we also observed the independence of morphological errors from verbal and CA in spontaneous speech (Diez-Itza et al., 2017), but individuals with WS scored at verbal-age in narrative productivity (Shiro et al., 2016). Similar results concerning the length of the stories in number of propositions and utterances had been already reported for English-speaking and French-speaking school-age children where the stories of WS participants were longer than those of DS controls but comparable to mental-age matched TD controls (Reilly et al., 1990; Lacroix et al., 2007).

The relationships between performance at pretest and outcomes after intervention were also assessed in the present study. Participants with shorter stories (in utterances) showed higher gains in microstructure productivity and, most importantly, in overall narrative performance. Macrostructure productivity was predicted by greater use of discourse markers when controlling for number of types. Episode integration was related to higher gains in narrative complexity and lower gains in narrative productivity and overall macrostructure. Finally, higher order of events and lower order of episodes predicted gains in macrostructure complexity.

Number of utterances and use of discourse markers as measures of length and cohesion of narratives may be considered more accurate and predictive when it comes to assess narrative productivity. Conversely, MLUw as a measure of grammatical complexity demonstrated lower sensitivity and predictivity of narrative skills. MLU in morphemes ranging 1–4.4 had proven to be a reliable measure of language development in natural conversational settings as reported by Levy and Eilam (2013) in a longitudinal study with Hebrew-speaking children with DS and WS (under 8 years old) and a TD group (under 4 years old). The authors found high correlations between MLU and most morphosyntactic and vocabulary variables, and high intercorrelation between linguistic variables within MLU stages. Differences in the task (conversational vs. narrative), age of participants (above 8 years old), and MLU values (above MLU 5 in words) may account for the lack of association between MLU and linguistic measures of narrative productivity in the present study. However, our study failed to sufficiently account

for grammatical complexity of the narratives and more in-depth analyses would be required for a better assessment of narrative production at the grammar level.

Inter-individual differences are more salient in populations with developmental disabilities, and the present study revealed high levels of variability in microstructure and macrostructure measures at pretest, as well as in the outcomes. It is important to note that beyond the search for syndrome-specific patterns and homogeneous profiles in neurodevelopmental disorders, the focus on group means and similarities rather than individual differences has been challenged. Porter and Coltheart (2005) questioned methodological limitations of studies of the WS cognitive and developmental profiles based on chronological and mental-age control groups and standardized instruments. They claimed that research focusing on specific task performance and group means tends to hide individual variability and they found no evidence of homogeneous strengths and weaknesses in WS. Notably, their results were inconsistent with the claim for strengths in verbal abilities.

Heterogeneity in cognitive and linguistic abilities of the students with WS in the present research could then account for the high variability of narrative performance at pretest and of individual improvements after intervention. However, the sample size is too small to discuss with more detail the sources of within group variability, and further analysis would be needed in order to better assess the differences observed. Cluster analyses may be adequate tools for assessing the distances between individuals and determine possible subgroups and extreme cases. Preliminary evidence for homogeneous subgroups in different cognitive measures was also reported by Porter and Coltheart (2005). Based on a smaller sample and on standardized and conversational linguistic measures, Stojanovik et al. (2006) found striking individual differences in all linguistic measures, which were interpreted in terms of a heterogeneous linguistic profile in WS. These authors also suggest the need for research on subgroups within WS. Determining whether or not subgroups based on narrative proficiency measures might correspond to different stages in narrative development, such as the three-phase model (preschoolers, schoolchildren, and adults) described by Berman (1988), would provide useful information to better address intervention strategies. Results from the present study show outstanding evidence of differential responses from each of the students with WS to the challenges of narrative generation and to intervention, beyond the above-discussed variability due to age and non-verbal IQ.

It is important to acknowledge several limitations of the present study. First, the design tells us about improvements of students with WS regarding several measures of narrative productivity and complexity following the intervention, but it does not allow to establish a causal relationship between intervention and outcomes. It also does not tell us whether the students would have improved regardless of the intervention, as measurements at pretest and posttest may have varied due to random error and to the regression to the mean effect. Although effect sizes of differences after the intervention were strong, they may have been overestimated by the regression to the mean effect. Second, the design does not tell us whether another approach would have been more effective. Narrative intervention is still at an emerging state of evidence, and a general focus on effectiveness has prevailed over a more precise account of the diverse intervention methodologies. The pilot intervention devised in the present study may be considered too short, but it was intended only as a preliminary design to assess the feasibility of narrative intervention for students with WS. Only a few studies have discussed about the elements of the intervention design, such as group size and intensity of intervention. A series of studies using the *Story Champ* intervention curriculum allowed for a discussion of arrangements or tiers of intervention (large-group, small-group, and individual), as well as of frequency and duration of the sessions. Individual intervention was considered the most intensive arrangement, and it provided better outcomes in spite of shorter less-intense sessions of 10–15 min (Spencer and Slocum, 2010; Petersen et al., 2014; Spencer et al., 2015). Third, although there was a 2 week lapse between the last intervention session and posttest, which may indicate a mid-term maintenance of the effects, a long-term follow-up would be necessary to assess more distal outcomes. Fourth, the present study did not include probes of generalization of outcomes to new fictional stories or to different genres. Retelling of fictional stories may facilitate the kind of historical support described by Ninio and Snow (1996), but narrative intervention should also include activities to promote transfer of learning to narratives of personal experience (Petersen and Spencer, 2016). Personal-themed social stories introduced in the natural school environment have been found to improve social behavior in students with ASD (Scattone et al., 2006). However, additional research is needed to assess effectiveness of narrative intervention in natural settings, for the evidence of proficient storytelling as related to improving opportunities for interaction and social engagement of individuals with language impairment and developmental disabilities remains indirect. Fifth, previous research on narrative intervention was conducted in many cases with small samples, but they were more homogeneous that the sample investigated in the present study. The age range of the students with WS was too broad to avoid effects of age and changing trajectories of development. Such an extended age span allowed for a broader exploration of the feasibility of explicit oral narrative intervention for students with WS at different school settings and levels. However, further in-depth case analyses should be conducted to better account for heterogeneity and differences in the outcomes. Sixth, the narrative task avoided floor effects at pretest, but some of the students with WS accomplished the task with high scores, which left them with less room for improvement. This near ceiling effect could partly explain the reduction of variability at posttest, although only macrostructure measures of scenarios and characters reached ceiling in some cases. Furthermore, the aim of the intervention was to train the students to accomplish the narrative task successfully and, consequently, to promote errorless learning, which entailed an inherent ceiling effect. Therefore, it is not a question of merely using instead a longer and more complex task, but of adjusting assessment and intervention designs to provide different levels of difficulty and scaffolding. In fact, shorter stories can provide similar reliability and sensitivity than longer ones when the design and the scoring systems are

appropriate (Spencer et al., 2013; Petersen and Spencer, 2014). Finer-grained measures of grammatical complexity, discourse cohesion and episodic structure would also be needed to better assess the effect of narrative intervention.

CONCLUSION

Despite substantial limitations, this study extends previous research on both narrative intervention and WS by demonstrating the feasibility and possible effectiveness of a short oral narrative intervention in enhancing pragmatic skills of students with WS. Explicit narrative intervention has been proposed as a flexible and valid framework for language assessment and intervention in natural school settings, which has the potential to foster the development of language and social skills necessary to prevent school failure. However, only a few studies evaluating narrative intervention have included students with developmental disabilities. Therefore, it may be introduced as a novel intervention technique to improve cognitive and social functioning in students with WS, which may draw on their best linguistic and social abilities. Building on strengths to optimize the potential for growth has been considered a high priority of intervention programs for children with WS (Semel and Rosner, 2003). However, the remarkable language skills of school-age children with WS have frequently led to a misperception of their needs in this area, and language intervention has been omitted or discontinued (Mervis and Velleman, 2011). The results of the present study confirm that WS individuals could benefit from language intervention despite language production being considered a relative strength in this population. After intervention, younger students with lower PIQ who at pretest generated shorter stories tended to show greater gains, above all in microstructure and macrostructure productivity, while older students improved narrative complexity to a greater extent. Interventions for pragmatic language use and social conversational skills necessary to tell coherent narratives may usefully become part of the educational profile of students with WS. Narratives are natural language samples that very closely reflect the linguistic abilities children are required to master both for social interaction at school and academic achievement. As long as narrative intervention enhances storytelling proficiency it may give students with WS more opportunities to practice language in school contexts and to get more attention and rewards from the social environment. Since this is a pilot study, further research is needed to validate the feasibility of narrative intervention for school-age children with WS. Ultimately, it is essential to bridge the gap between research and implementation of evidence-based contextualized intervention for students with WS at risk of school failure.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the "Red de Comités de Ética de Universidades y Organismos Públicos de Investigación de España" with written informed consent from all the legal tutors of the subjects. All of them gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the "Comité de Ética en la Investigación de la Universidad de Oviedo".

AUTHOR CONTRIBUTIONS

ED-I had a primary role in the conception and design of the study, in the development of the coding scheme, in data analysis and discussion and in drafting the manuscript. VM helped with the design of the intervention and conducted it, carried out transcription, coding and data analyses, and helped draft the manuscript. VP assisted with transcription, coding and data analysis, and manuscript revision. MF-U had a primary role in the development of the coding scheme, conceptualization of variables, transcription and coding, and drafting the manuscript. All authors have read and approved the final version of this manuscript.

FUNDING

This research was supported by grant FFI2012-39325-C03-03 from the Spanish Ministry of Economy and Competitiveness (MINECO) to the SYNDROLING Project.

ACKNOWLEDGMENTS

The authors wish to thank the families who generously agreed to participate in this study and the collaborators of the LOGIN Research Group at the University of Oviedo.

REFERENCES

Asada, K., Tomiwa, K., Okada, M., and Itakura, S. (2010a). Atypical verbal communication pattern according to others' attention in children with Williams syndrome. *Res. Dev. Disabil.* 31, 452–457. doi: 10.1016/j.ridd.2009.10.010

Asada, K., Tomiwa, K., Okada, M., and Itakura, S. (2010b). Fluent language with impaired pragmatics in children with Williams syndrome. *J. Neurolinguistics* 23, 540–552. doi: 10.1016/j.jneuroling.2010.04.001

Austin, P. C., and Steyerberg, E. W. (2015). The number of subjects per variable required in linear regression analyses. *J. Clin. Epidemiol.* 68, 627–636. doi: 10.1016/j.jclinepi.2014.12.014

Bamberg, M. G. (1987). *The Acquisition of Narratives: Learning to Use Language*. Berlin: Walter de Gruyter. doi: 10.1515/9783110854190

Bellugi, U., Adolphs, R., Cassady, C., and Chiles, M. (1999). Towards the neural basis for hypersociability in a genetic syndrome. *Neuroreport* 10, 1653–1657. doi: 10.1097/00001756-199906030-00006

Bellugi, U., Järvinen-Pasley, A., Doyle, T. F., Reilly, J., Reiss, A. L., and Korenberg, J. R. (2007). Affect, social behavior, and the brain in Williams syndrome. *Curr. Dir. Psychol. Sci.* 16, 99–104. doi: 10.1111/j.1467-8721.2007.00484.x

Bellugi, U., Lichtenberger, L., Jones, W., Lai, Z., and St. George, M. (2000). I. The neurocognitive profile of Williams syndrome: a complex pattern of

strengths and weaknesses. *J. Cogn. Neurosci.* 12(Suppl. 1), 7–29. doi: 10.1162/089892900561959

Bellugi, U., Marks, S., Bihrle, A., and Sabo, H. (1988). "Dissociation between language and cognitive functions in Williams syndrome," in *Language Development in Exceptional Circumstances*, eds D. Bishop and K. Mogford (New York, NY: Churchill Livingstone), 177–189.

Berman, R. A. (1988). On the ability to relate events in narrative. *Discourse Process.* 11, 469–497. doi: 10.1080/01638538809544714

Berman, R. A., and Slobin, D. I. (1987). *Five Ways of Learning to Talk About Events: A Crosslinguistic Study of Children's Narratives*. Berkeley, CA: University of California at Berkeley.

Berman, R. A., and Slobin, D. I. (1994). *Relating Events in Narrative: A Crosslinguistic Developmental Study*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Bliss, L. S., McCabe, A., and Miranda, A. E. (1998). Narrative assessment profile: Discourse analysis for school-age children. *J. Commun. Disord.* 31, 347–363. doi: 10.1016/S0021-9924(98)00009-4

Boudreau, D. M., and Chapman, R. S. (2000). The relationship between event representation and linguistic skill in narratives of children and adolescents with Down syndrome. *J. Speech Lang. Hear. Res.* 43, 1146–1159. doi: 10.1044/jslhr.4305.1146

Brock, J. (2007). Language abilities in Williams syndrome: a critical review. *Dev. Psychopathol.* 19, 97–127. doi: 10.1017/S095457940707006X

Brock, J., Einav, S., and Riby, D. M. (2009). "The other end of the spectrum? Social cognition in Williams syndrome," in *Social Cognition: Development, Neuroscience and Autism*, eds T. Striano and V. Reid (Oxford: Blackwell), 281–300.

Bruner, J. S. (1986). *Actual Minds, Possible Worlds*. Cambridge, MA: Harvard University Press.

Bruner, J. S. (1991). The narrative construction of reality. *Crit. Inq.* 18, 1–21. doi: 10.1086/448619

Capps, L., Losh, M., and Thurber, C. (2000). "The frog ate the bug and made his mouth sad": narrative competence in children with autism. *J. Abnorm. Child Psychol.* 28, 193–204. doi: 10.1023/A:1005126915631

Channell, M. M., McDuffie, A. S., Bullard, L. M., and Abbeduto, L. (2015). Narrative language competence in children and adolescents with Down syndrome. *Front. Behav. Neurosci.* 9:283. doi: 10.3389/fnbeh.2015.00283

Davies, P., Shanks, B., and Davies, K. (2004). Improving narrative skills in young children with delayed language development. *Educ. Rev.* 56, 271–286. doi: 10.1080/0013191042000201181

Diez-Itza, E., Antón, A., Fernández-Toral, J., and García, M. L. (1998). "Language development in Spanish children with Williams syndrome," in *Perspectives on Language Acquisition*, eds A. Aksu-Koç, E. Erguvanli-Taylan, A. Sumru, and A. Küntay (Istanbul: Bogazici University), 309–324.

Diez-Itza, E., Martínez, V., and Antón, A. (2016). Narrative competence in Spanish-speaking adults with Williams syndrome. *Psicothema* 28, 291–297. doi: 10.7334/psicothema2015.190

Diez-Itza, E., Martínez, V., Fernández-Urquiza, M., and Antón, A. (2017). "Morphological profile of Williams syndrome: typical or atypical?," in *Language Development and Disorders in Spanish-speaking Children*, eds A. Auza and R. Schwartz (New York, NY: Springer), 311–327. doi: 10.1007/978-3-319-53646-0

Diez-Itza, E., Martínez, V., Miranda, M., Antón, A., Ojea, A. I., Fernández-Urquiza, M., et al. (2014). "The Syndroling Project: a comparative linguistic analysis of typical development profiles and neurodevelopmental genetic syndromes (Down, Williams and fragile X syndromes)," in *Proceedings of the IASCL-XII International Congress for the Study of Child Language*, Amsterdam.

Diez-Itza, E., Snow, C. E., and Solé, M. R. (2001). "Scripts from Tom and Jerry: Spanish preschoolers relate cartoons," in *Research on Child Language Acquisition*, eds M. Almgren, A. Barreña, M. J. Ezeizabarrena, I. Idiazabal, and B. MacWhinney (Somerville, MA: Cascadilla Press), 399–408.

D'Souza, H., and Karmiloff-Smith, A. (2016). Neurodevelopmental disorders. *Wiley Interdiscip. Rev. Cogn. Sci.* 8:e1398. doi: 10.1002/wcs.1398

Engel, S. L. (1995). *The Stories Children Tell: Making Sense of the Narratives of Childhood*. New York, NY: W.H. Freeman.

Fernández-Prieto, M., Sampaio, A., Lens, M., Carracedo, Á., and Gonçalves, Ó. F. (2011). Longitudinal assessment of narrative profile in a Williams syndrome patient. *Br. J. Dev. Disabil.* 57, 91–99. doi: 10.1179/096979511798967142

Fernández-Urquiza, M., Miranda, M., Martínez, V., and Diez-Itza, E. (2016). "Pragmática textual de las narraciones en el síndrome de Down: perfiles de coherencia y cohesión," in *Proceedings of the 8th International Conference of Language Acquisition*, eds E. Aguilar, D. Adrover, L. Bull, and R. López (Palma de Mallorca: UIB), 30.

Fey, M. E., Catts, H. W., Proctor-Williams, K., Tomblin, J. B., and Zhang, X. (2004). Oral and written story composition skills of children with language impairment. *J. Speech Lang. Hear. Res.* 47, 1301–1318. doi: 10.1044/1092-4388(2004/098)

Fidler, D. J., Lunkenheimer, E., and Hahn, L. (2011). Emerging behavioral phenotypes and dynamic systems theory. *Int. Rev. Res. Dev. Disabil.* 40, 17–42. doi: 10.1016/B978-0-12-374478-4.00002-2

Finestack, L. H. (2012). Five principles to consider when providing narrative language intervention to children and adolescents with developmental disabilities. *Perspect. Lang. Learn. Educ.* 19, 147–154. doi: 10.1044/lle19.4.147

Finestack, L. H., Palmer, M., and Abbeduto, L. (2012). Macrostructural narrative language of adolescents and young adults with Down syndrome or Fragile X syndrome. *Am. J. Speech Lang. Pathol.* 21, 29–46. doi: 10.1044/1058-0360(2011/10-0095)

Fisher, M. H., Moskowitz, A. L., and Hodapp, R. M. (2013). Differences in social vulnerability among individuals with autism spectrum disorder, Williams syndrome, and Down syndrome. *Res. Autism Spectr. Disord.* 7, 931–937. doi: 10.1016/j.rasd.2013.04.009

Fraser, B. (1999). What are discourse markers? *J. Pragmat.* 31, 931–952. doi: 10.1016/S0378-2166(98)00101-5

Fritz, C. O., Morris, P. E., and Richler, J. J. (2012). Effect size estimates: current use, calculations, and interpretation. *J. Exp. Psychol. Gen.* 141, 2–18. doi: 10.1037/a0024338

Garayzábal Heinze, E., Prieto, M. F., Sampaio, A., and Gonçalves, Ó. F. (2007). Valoración interlingüística de la producción verbal a partir de una tarea narrativa en el síndrome de Williams. *Psicothema* 19, 428–434.

Gazella, J., and Stockman, I. J. (2003). Children's story retelling under different modality and task conditions: implications for standardizing language sampling procedures. *Am. J. Speech Lang. Pathol.* 12, 61–72. doi: 10.1044/1058-0360(2003/053)

Gillam, S. L., Gillam, R. B., and Reece, K. (2012). Language outcomes of contextualized and decontextualized language intervention: results of an early efficacy study. *Lang. Speech Hear. Serv. Sch.* 43, 276–291. doi: 10.1044/0161-1461(2011/11-0022)

Gillam, S. L., Hartzheim, D., Studenka, B., Simonsmeier, V., and Gillam, R. (2015). Narrative intervention for children with autism spectrum disorder (ASD). *J. Speech Lang. Hear Res.* 58, 920–933. doi: 10.1044/2015_JSLHR-L-14-0295

Gonçalves, O. F., Pinheiro, A. P., Sampaio, A., Sousa, N., Fernández, M., and Henriques, M. (2010). The narrative profile in Williams syndrome: there is more to storytelling than just telling a story. *Br. J. Dev. Disabil.* 56, 89–109. doi: 10.1179/096979510799102943

Griffin, T. M., Hemphill, L., Camp, L., and Wolf, D. P. (2004). Oral discourse in the preschool years and later literacy skills. *First Lang.* 24, 123–147. doi: 10.1177/0142723704042369

Gutierrez-Clellen, V. F. (1998). Syntactic skills of Spanish-speaking children with low school achievement. *Lang. Speech Hear. Serv. Sch.* 29, 207–215. doi: 10.1044/0161-1461.2904.207

Gutierrez-Clellen, V. F., and Iglesias, A. (1992). Causal coherence in the oral narratives of Spanish-speaking children. *J. Speech Hear. Res.* 35, 363–372. doi: 10.1044/jshr.3502.363

Halliday, M., and Hasan, R. (1976). *Cohesion in English*. London: Longman.

Happé, F., and Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *J. Autism. Dev. Disord.* 36, 5–25. doi: 10.1007/s10803-005-0039-0

Heilmann, J., Miller, J. F., Nockerts, A., and Dunaway, C. (2010). Properties of the narrative scoring scheme using narrative retells in young school-age children. *Am. J. Speech Lang. Pathol.* 19, 154–167. doi: 10.1044/1058-0360(2009/08-0024)

Hemphill, L., and Snow, C. E. (1996). "Language and literacy development: discontinuities and differences," in *Handbook of Education and Human Development*, eds D. R. Olson and N. Torrance (Cambridge, MA: Blackwell), 173–201.

Hilvert, E., Davidson, D., and Gámez, P. B. (2016). Examination of script and non-script based narrative retellings in children with autism spectrum disorders. *Res. Autism Spectr. Disord.* 2, 79–92. doi: 10.1016/j.rasd.2016.06.002

Järvinen-Pasley, A., Bellugi, U., Reilly, J., Mills, D. L., Galaburda, A., Reiss, A. L., et al. (2008). Defining the social phenotype in Williams syndrome: a model for linking gene, the brain, and behavior. *Dev. Psychopathol.* 20, 1–35. doi: 10.1017/S0954579408000011

Jawaid, A., Riby, D. M., Owens, J., White, S. W., Tarar, T., and Schulz, P. E. (2012). "Too withdrawn" or "too friendly": considering social vulnerability in two neuro-developmental disorders. *J. Intellect. Disabil. Res.* 56, 335–350. doi: 10.1111/j.1365-2788.2011.01452.x

Ji, C., Yao, D., Chen, W., Li, M., and Zhao, Z. (2014). Adaptive behavior in Chinese children with Williams syndrome. *BMC Pediatr.* 14:90. doi: 10.1186/1471-2431-14-90

John, A. E., Dobson, L. A., Thomas, L. E., and Mervis, C. B. (2012). Pragmatic abilities of children with Williams syndrome: a longitudinal examination. *Front. Psychol.* 3:199. doi: 10.3389/fpsyg.2012.00199

Jones, W., Bellugi, U., Lai, Z., Chiles, M., Reilly, J., Lincoln, A., et al. (2000). II. Hypersociability in Williams syndrome. *J. Cogn. Neurosci.* 12(Suppl. 1), 30–46. doi: 10.1162/089892900561968

Justice, L. M., Bowles, R. P., Kaderavek, J. N., Ukrainetz, T. A., Eisenberg, S. L., and Gillam, R. B. (2006). The index of narrative microstructure: a clinical tool for analyzing school-age children's narrative performances. *Am. J. Speech Lang. Pathol.* 15, 177–191. doi: 10.1044/1058-0360(2006/017)

Karmiloff-Smith, A. (1998). Development itself is the key to understanding developmental disorders. *Trends Cogn. Sci.* 2, 389–398. doi: 10.1016/S1364-6613(98)01230-3

Karmiloff-Smith, A. (2011). Static snapshots versus dynamic approaches to genes, brain, cognition, and behavior in neurodevelopmental disabilities. *Int. Rev. Res. Dev. Disabil.* 40, 1–15. doi: 10.1016/B978-0-12-374478-4.00001-0

Karmiloff-Smith, A., Grant, J., Berthoud, I., Davies, M., Howlin, P., and Udwin, O. (1997). Language and Williams syndrome: How intact is "intact"? *Child Dev.* 68, 246–262. doi: 10.1111/j.1467-8624.1997.tb01938.x

Kerby, D. S. (2014). The simple difference formula: an approach to teaching nonparametric correlation. *Compr. Psychol.* 3:1. doi: 10.2466/11.IT.3.1

King, D., Dockrell, J. E., and Stuart, M. (2013). Event narratives in 11-14 year olds with autistic spectrum disorder. *Int. J. Lang. Commun. Disord.* 48, 522–533. doi: 10.1111/1460-6984.12025

Lacroix, A., Bernicot, J., and Reilly, J. (2007). Narration and collaborative conversation in French-speaking children with Williams syndrome. *J. Neurolinguistics* 20, 445–461. doi: 10.1016/j.jneuroling.2007.03.004

Lacroix, A., Famelart, N., and Guidetti, M. (2016). Language and emotional abilities in children with Williams syndrome and children with autism spectrum disorder: similarities and differences. *Pediatric Health Med. Ther.* 7, 89–97. doi: 10.2147/PHMT.S66347

Laing, E., Butterworth, G., Ansari, D., Gsödl, M., Longhi, E., Panagiotaki, G., et al. (2002). Atypical development of language and social communication in toddlers with Williams syndrome. *Dev. Sci.* 5, 233–246. doi: 10.1111/1467-7687.00225

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Front. Psychol.* 4:863. doi: 10.3389/fpsyg.2013.00863

Laws, G., and Bishop, D. V. M. (2004). Pragmatic language impairment and social deficits in Williams syndrome: a comparison with Down's syndrome and specific language impairment. *Int. J. Lang. Commun. Disord.* 39, 45–64. doi: 10.1080/13682820310001615797

Levy, Y., and Eilam, A. (2013). Pathways to language: a naturalistic study of children with Williams syndrome and children with Down syndrome. *J. Child Lang.* 40, 106–138. doi: 10.1017/S0305000912000475

Losh, M., Bellugi, U., and Reilly, J. (2000). Narrative as a social engagement tool: the excessive use of evaluation in narratives from children with Williams syndrome. *Narrat. Inq.* 10, 265–290. doi: 10.1075/ni.10.2.01los

MacWhinney, B. (2000). *The CHILDES Project: Tools for Analyzing Talk. Volume I: Transcription Format and Programs*. Mahwah, NJ: Lawrence Erlbaum.

Marini, A., Martelli, S., Gagliardi, C., Fabbro, F., and Borgatti, R. (2010). Narrative language in Williams syndrome and its neuropsychological correlates. *J. Neurolinguistics* 23, 97–111. doi: 10.1016/j.jneuroling.2009.10.002

Marini, A., Tavano, A., and Fabbro, F. (2008). Assessment of linguistic abilities in Italian children with specific language impairment. *Neuropsychologia* 46, 2816–2823. doi: 10.1016/j.neuropsychologia.2008.05.013

Mayer, M. (1969). *Frog, Where are You?* New York, NY: Dial Press.

McCabe, A., Bliss, L., Barra, G., and Bennett, M. (2008). Comparison of personal versus fictional narratives of children with language impairment. *Am. J. Speech Lang. Pathol.* 17, 194–206. doi: 10.1044/1058-0360(2008/019)

McCabe, A., and Rollins, P. R. (1994). Assessment of preschool narrative skills. *Am. J. Speech Lang. Pathol.* 3, 45–56. doi: 10.1044/1058-0360.0301.45

McGrath, R. E., and Meyer, G. J. (2006). When effect sizes disagree: the case of *r* and *d*. *Psychol. Methods* 11, 386–401. doi: 10.1037/1082-989X.11.4.386

Mervis, C. B. (1999). "The Williams syndrome cognitive profile: Strengths, weaknesses, and interrelations among auditory short-term memory, language, and visuospatial constructive cognition," in *Ecological Approaches to Cognition: Essays in Honor of Ulric Neisser*, eds E. Winograd, R. Fivush, and W. Hirst (Mahwah, NJ: Erlbaum), 193–227.

Mervis, C. B. (2006). "Language abilities in Williams-Beuren syndrome," in *Williams-Beuren Syndrome: Research, Evaluation, and Treatment*, eds C. A. Morris, H. M. Lenhoff, and P. P. Wang (Baltimore, MD: Johns Hopkins University Press), 159–206.

Mervis, C. B., and Becerra, A. M. (2007). Language and communicative development in Williams syndrome. *Ment. Retard. Dev. Disabil. Res. Rev.* 13, 3–15. doi: 10.1002/mrdd.20140

Mervis, C. B., and John, A. E. (2010). Cognitive and behavioral characteristics of children with Williams syndrome: implications for intervention approaches. *Am. J. Med. Genet.* 154C, 229–248. doi: 10.1002/ajmg.c.30263

Mervis, C. B., Kistler, D. J., John, A. E., and Morris, C. A. (2012). Longitudinal assessment of intellectual abilities of children with Williams syndrome: multilevel modeling of performance on the Kaufman Brief Intelligence Test-second edition. *Am. J. Intellect. Dev. Disabil.* 117, 134–155. doi: 10.1352/1944-7558-117.2.134

Mervis, C. B., and Klein-Tasman, B. P. (2000). Williams syndrome: cognition, personality, and adaptive behavior. *Ment. Retard. Dev. Disabil. Res. Rev.* 6, 148–158. doi: 10.1002/1098-2779(2000)6:2<148::AID-MRDD10>3.0.CO;2-T

Mervis, C. B., Morris, C. A., Klein-Tasman, B. P., Bertrand, J., Kwitny, S., Appelbaum, L. G., et al. (2003). Attentional characteristics of infants and toddlers with Williams syndrome during triadic interactions. *Dev. Neuropsychol.* 23, 243–268. doi: 10.1080/87565641.2003.9651894

Mervis, C. B., Robinson, B. F., Bertrand, J., Morris, C. A., Klein-Tasman, B. P., and Armstrong, S. C. (2000). The Williams syndrome cognitive profile. *Brain Cogn.* 44, 604–628. doi: 10.1006/brcg.2000.1232

Mervis, C. B., Robinson, B. F., Rowe, M. L., Becerra, A. M., and Klein-Tasman, B. P. (2004). "Relations between language and cognition in Williams syndrome," in *Williams Syndrome Across Languages*, eds S. Bartke and J. Siegmüller (Amsterdam: John Benjamins), 63–92.

Mervis, C. B., and Velleman, S. L. (2011). Children with Williams syndrome: language, cognitive, and behavioral characteristics and their implications for intervention. *Perspect. Lang. Learn. Educ.* 18, 98–107. doi: 10.1044/lle18.3.98

Ninio, A., and Snow, C. E. (1996). *Pragmatic Development*. Boulder, CO: Westview Press.

Norbury, C. F., Gemmell, T., and Paul, R. (2014). Pragmatics abilities in narrative production: a cross-disorder comparison. *J. Child Lang.* 41, 485–510. doi: 10.1017/S030500091300007X

O'Donnell, C. L. (2008). Defining, conceptualizing, and measuring fidelity of implementation and its relationship to outcomes in K-12 curriculum intervention research. *Rev. Educ. Res.* 78, 33–84. doi: 10.3102/0034654307313793

Petersen, D., and Spencer, T. D. (2014). Narrative assessment and intervention: a clinical tutorial on extending explicit language instruction and progress monitoring to all students. *Perspect. Commun. Disord. Sci. Cultur.* 21, 5–21. doi: 10.1044/cds21.1.5

Petersen, D. B. (2011). A systematic review of narrative-based language intervention with children who have language impairment. *Commun. Disord. Q.* 32, 207–220. doi: 10.1177/1525740109353937

Petersen, D. B., Brown, C. L., Ukrainetz, T. A., Wise, C., Spencer, T. D., and Zebre, J. (2014). Systematic individualized narrative language intervention on

the personal narratives of children with autism. *Lang. Speech Hear. Serv. Sch.* 45, 40–51. doi: 10.1044/2013_LSHSS-12-0099

Petersen, D. B., and Spencer, T. D. (2012). The narrative language measures: tools for language screening, progress monitoring, and intervention planning. *Perspect. Lang. Learn. Educ.* 19, 119–129. doi: 10.1044/lle19.4.119

Petersen, D. B., and Spencer, T. D. (2016). Using narrative intervention to accelerate canonical story grammar and complex language growth in culturally diverse preschoolers. *Top. Lang. Disord.* 36, 6–19. doi: 10.1097/TLD.0000000000000078

Peterson, C., and McCabe, A. (1983). *Developmental Psycholinguistics: Three Ways of Looking at a Child's Narrative*. New York, NY: Springer.

Philofsky, A., Fidler, D. J., and Hepburn, S. (2007). Pragmatic language profiles of school-age children with autism spectrum disorders and Williams syndrome. *Am. J. Speech Lang. Pathol.* 16, 368–380. doi: 10.1044/1058-0360(2007/040)

Porter, M. A., and Coltheart, M. (2005). Cognitive heterogeneity in Williams syndrome. *Dev. Neuropsychol.* 27, 275–306. doi: 10.1207/s15326942dn2702_5

Reilly, J., Klima, E. S., and Bellugi, U. (1990). Once more with feeling: affect and language in atypical populations. *Dev. Psychopathol.* 2, 367–391. doi: 10.1017/S0954579400005782

Reilly, J., Losh, M., Bellugi, U., and Wulfeck, B. (2004). Frog, where are you?" Narratives in children with specific language impairment, early focal brain injury, and Williams syndrome. *Brain Lang.* 88, 229–247. doi: 10.1016/S0093-934X(03)00101-9

Reilly, J. S., Bernicot, J., Vicari, S., Lacroix, A., and Bellugi, U. (2005). "Narratives in children with Williams syndrome: a cross linguistic perspective," in *Perspectives on Language and Language Development: Essays in honor of Ruth A. Berman*, eds D. Ravid and H. Bat-Zeev Shyldkrot (Dordrecht: Kluwer), 303–312. doi: 10.1007/1-4020-7911-7_22

Renfrew, C. E. (1997). *The Bus Story Test*. Milton Keynes: Speechmark.

Scattone, D., Tingstrom, D. H., and Wilczynski, S. M. (2006). Increasing appropriate social interactions of children with autism spectrum disorders using social stories. *Focus Autism Other Dev. Disabil.* 21, 211–222. doi: 10.1177/10883576060210040201

Semel, E. M., and Rosner, S. R. (2003). *Understanding Williams Syndrome: Behavioral Patterns and Interventions*. Mahwah, NJ: L. Erlbaum.

Shiro, M. (2003). Genre and evaluation in narrative development. *J. Child Lang.* 30, 165–195. doi: 10.1017/S0305000902005500

Shiro, M., Diez-Itza, E., Viejo, A., and Fernández-Urquiza, M. (2016). "Pragmática evaluativa de las narraciones en el síndrome de Williams," in *Proceedings of the 8th International Conference of Language Acquisition*, eds E. Aguilar, D. Adrover, L. Bull, and R. López (Palma de Mallorca: UIB), 31–32.

Skwerer, D. P., Ammerman, E., and Tager-Flusberg, H. (2013). Do you have a question for me? How children with Williams syndrome respond to ambiguous referential communication during a joint activity. *J. Child Lang.* 40, 266–289. doi: 10.1017/S0305000912000360

Spencer, T. D., Kajian, M., Petersen, D. B., and Bilyk, N. (2013). Effects of an Individualized narrative intervention on children's storytelling and comprehension skills. *J. Early Interv.* 35, 243–269. doi: 10.1177/1053815114540002

Spencer, T. D., Petersen, D. B., and Adams, J. L. (2015). Tier 2 language intervention for diverse preschoolers: an early-stage randomized control group study following an analysis of response to intervention. *Am. J. Speech Lang. Pathol.* 24, 619–636. doi: 10.1044/2015_AJSLP-14-0101

Spencer, T. D., and Slocum, T. A. (2010). The effect of a narrative intervention on story retelling and personal story generation skills of preschoolers with risk factors and narrative language delays. *J. Early Interv.* 12, 178–199. doi: 10.1177/1053815110379124

Stojanovik, V. (2006). Social interaction deficits and conversational inadequacy in Williams syndrome. *J. Neurolinguistics* 19, 157–173. doi: 10.1016/j.jneuroling.2005.11.005

Stojanovik, V., Perkins, M., and Howard, S. (2001). Language and conversational abilities in Williams syndrome: How good is good? *Int. J. Lang. Commun. Disord.* 36(Suppl.), 234–239. doi: 10.3109/13682820109177890

Stojanovik, V., Perkins, M., and Howard, S. (2006). Linguistic heterogeneity in Williams syndrome. *Clin. Linguist. Phon.* 20, 547–552. doi: 10.1080/02699200500266422

Swanson, L. A., Fey, M. E., Mills, C. E., and Hood, L. S. (2005). Use of narrative-based language intervention with children who have specific language impairment. *Am. J. Speech Lang. Pathol.* 14, 131–143. doi: 10.1044/1058-0360(2005/014)

Tager-Flusberg, H., and Sullivan, K. (2000). A componential view of theory of mind: Evidence from Williams syndrome. *Cognition* 76, 59–89. doi: 10.1016/S0010-0277(00)00069-X

Tarling, K., Perkins, M. R., and Stojanovik, V. (2006). Conversational success in Williams syndrome: communication in the face of cognitive and linguistic limitations. *Clin. Linguist. Phon.* 20, 583–590. doi: 10.1080/02699200500266547

Tilstra, J., and McMaster, K. (2007). Productivity, fluency, and grammaticality measures from narratives: potential indicators of language proficiency? *Commun. Disord. Q.* 29, 43–53. doi: 10.1177/1525740108314866

Udwin, O., Davies, M., and Howlin, P. (1996). A longitudinal study of cognitive abilities and educational attainment in Williams syndrome. *Dev. Med. Child Neurol.* 38, 1020–1029. doi: 10.1111/j.1469-8749.1996.tb15062.x

Ukrainetz, T. A. (2006). "Assessment and intervention within a contextualized skill framework," in *Contextualized Language Intervention*, ed. T. A. Ukrainetz (Eau Claire, WS: Thinking Publications), 7–58.

Van Den Heuvel, E., Manders, E., Swillen, A., and Zink, I. (2016). Developmental trajectories of structural and pragmatic language skills in school-aged children with Williams syndrome. *J. Intellect. Disabil. Res.* 60, 903–919. doi: 10.1111/jir.12329

Volterra, V., Capirci, O., Pezzini, G., Sabbadini, L., and Vicari, S. (1996). Linguistic abilities in Italian children with Williams syndrome. *Cortex* 32, 663–677. doi: 10.1016/S0010-9452(96)80037-2

Wechsler, D. (1999a). *WAIS-III: Wechsler Adult Intelligence Scale (Spanish Adaptation)*. Madrid: TEA Ediciones.

Wechsler, D. (1999b). *WISC-R: Wechsler Intelligence Scale for Children-Revised (Spanish Adaptation)*. Madrid: TEA Ediciones.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling editor declared a shared affiliation, though no other collaboration, with several of the authors, ED-I, VM, and MF-U.

Copyright © 2018 Diez-Itza, Martínez, Pérez and Fernández-Urquiza. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 11 October 2017
doi: 10.3389/fpsyg.2017.01801

Math Error Types and Correlates in Adolescents with and without Attention Deficit Hyperactivity Disorder

Agnese Capodieci[1] and Rhonda Martinussen[2]*

[1] Department of General Psychology, University of Padova, Padova, Italy, [2] Department of Human Development and Applied Psychology, University of Toronto, Toronto, ON, Canada

Objective: The aim of this study was to examine the types of errors made by youth with and without a parent-reported diagnosis of attention deficit and hyperactivity disorder (ADHD) on a math fluency task and investigate the association between error types and youths' performance on measures of processing speed and working memory.

Method: Participants included 30 adolescents with ADHD and 39 typically developing peers between 14 and 17 years old matched in age and IQ. All youth completed standardized measures of math calculation and fluency as well as two tests of working memory and processing speed. Math fluency error patterns were examined.

Results: Adolescents with ADHD showed less proficient math fluency despite having similar math calculation scores as their peers. Group differences were also observed in error types with youth with ADHD making more switch errors than their peers.

Conclusion: This research has important clinical applications for the assessment and intervention on math ability in students with ADHD.

Keywords: ADHD, math abilities, types of errors, switching, adolescents

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Ana Miranda, Universitat de València, Spain
María Del Carmen Pérez Fuentes, University of Almería, Spain

****Correspondence:***
Agnese Capodieci
agnesecapox@gmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *30 January 2017*
Accepted: *28 September 2017*
Published: *11 October 2017*

Citation:
Capodieci A and Martinussen R (2017) Math Error Types and Correlates in Adolescents with and without Attention Deficit Hyperactivity Disorder. Front. Psychol. 8:1801. doi: 10.3389/fpsyg.2017.01801

INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is a developmental disorder characterized by symptoms of inattention, impulsivity, and hyperactivity (American Psychiatric Association, 2013) which are associated with difficulties in a wide range of academic skills including mathematical computation and problem-solving, reading and language comprehension, and written expression (Bonafina et al., 2000; DuPaul et al., 2004; Hart et al., 2010; Gremillion and Martel, 2012). While academic achievement has been studied extensively in children with ADHD, less is known about academic skills in adolescents with ADHD – particularly in the domain of mathematics (Wolraich et al., 2005). Given the importance of mathematics to an individual's future health and employment status (Reyna et al., 2009; Ritchie and Bates, 2013), this is a gap that needs to be addressed.

Math appears to be an area of challenge for a number of individuals with ADHD (Tosto et al., 2015). Tosto et al. (2015) reviewed studies investigating math ability in individuals with ADHD who were between the ages of 6 years old and adulthood. They found that 83% of the studies they reviewed reported a statistically significant negative association between ADHD symptoms and mathematical performance. Studies from Tosto's review highlighted the presence of weaknesses in math fluency and math calculation in children and youth with ADHD. Understanding why children and youth with ADHD show weaknesses in math fluency and calculation is an

important research avenue as such information may aid in developing intervention or instructional approaches for this group of students.

One way to gain insight into the nature of the challenges youth with ADHD experience with math fluency is to examine the type of errors that the students make and to assess whether they are similar or different to those made by peers. Although prior studies have explored error patterns in mathematics tasks in children with ADHD (Benedetto-Nasho and Tannock, 1999; Re et al., 2016), it is not clear whether youth with ADHD would make more and specific types of errors in comparison with their non-affected peers on a math fluency task. This is an important gap in the field as poor math fluency may constrain the choices that youth with ADHD make in secondary course selection as they may avoid courses that involve math which in turn may limit their employment options (Fourqurean et al., 1991).

Prior research on math error types and ADHD has focused on children and has identified errors that appear to be related to inattentiveness as well as working memory (Benedetto-Nasho and Tannock, 1999; Raghubar et al., 2009). For example, Benedetto-Nasho and Tannock (1999) found a deficit in math computation performance in their sample of children with ADHD, other researchers hypothesized that math errors could be the result of inattentiveness. Highly inattentive students may not carefully monitor their performance for mistakes during calculation tasks (Raghubar et al., 2009). Such errors would likely occur randomly rather than systematically and reflect an overall lack of monitoring for errors and monitoring ongoing task demands. These types of errors may also be related to problems with working memory as children may lose their place or focus while completing a basic math problem which may increase a range of error types in computation. Difficulty shifting or switching between operations is another error type that has been identified in children with math disabilities (Rourke, 1993). The shifting error only occurs when students switch from completing one type of task (e.g., addition) to another type of math operation (e.g., subtraction; Rourke, 1993). It is interesting to note that researchers studying cognitive shifting often use mathematical switch tasks to index shift-time costs on timed tasks (e.g., Plus-Minus task; St Clair-Thompson, 2011). Hence, one might expect that shift errors would be most evident on a calculation fluency task that requires frequent shifts between operations (plus, minus, multiply, and divide).

While inattentiveness and working memory (which are often correlated with each other, Martinussen and Tannock, 2006) are each associated with math errors (Bull and Scerif, 2001; Rogers et al., 2011), it is not clear if processing speed weaknesses also contribute to a specific pattern of errors during math calculation tasks. This is an interesting variable to study given that processing speed weaknesses (e.g., digit naming speed) are associated with ADHD (Shanahan et al., 2006; Inoue et al., 2008) and are related to less proficient math fluency (Bull and Johnston, 1997). It is possible that individual differences in processing speed are related only to overall productivity (how many questions are answered), but not to specific types of errors.

This study examines error types on a standardized math fluency assessment in youth with a parent-reported diagnosis of ADHD (with confirmation through parent report of current clinically significant symptoms) and youth without ADHD. Given the importance of mathematics to an individual's future employment status (Reyna et al., 2009; Ritchie and Bates, 2013), we believe it is important to analyze the error performance of adolescents with ADHD while completing a timed task to better understand why their performance may be less accurate and/or fluent than their peers. Fluency in particular is important to examine because calculation fluency supports the development of skills such as fractions concepts (Jordan et al., 2013) which in turn predict more advanced math skills (Bailey et al., 2012; Booth et al., 2014).

In the present study, we used the Woodcock Johnson Test of Achievement- Third Edition (WJ-III; Woodcock et al., 2001) Math Fluency subtest to examine error types in single digit operations in youth with ADHD under speeded conditions. This test requires respondents to quickly solve single digit calculation problems that are presented in a mixed format. Hence, this test gave us the opportunity to examine errors that occurred as a result of a need to shift between operation sets (e.g., addition to subtraction) as well as examine other types of errors (e.g., basic operation error). As all calculation problems in the WJ-III are single digit, we were unable to examine errors when completing double digit operations.

We expected that youth with ADHD would exhibit weakness in math fluency relative to their typically developing peers given the association between ADHD and math fluency reported in previous studies (Ackerman et al., 1986; Biederman et al., 2005; Gray et al., 2015). We also predicted the youth with ADHD to make more switch math errors than their peers. Switch errors require attention as well as the ability to shift set and thus we anticipated that this type of error would be most prevalent in youth with ADHD given the association between executive function weaknesses (e.g., working memory, shifting, inhibitory control) and ADHD status in children, youth, and adults (Willcutt et al., 2005; Rohlf et al., 2012; Bueno et al., 2014; Holmes et al., 2014). Finally, we also expected that working memory and processing speed would be associated with a greater number of errors that are indicative of poor cognitive control and attention (e.g., switching errors, incorrect operation errors) (Baddeley et al., 2001; Draheim et al., 2016).

Summarizing, the objectives of the present study was to analyze the types of errors made from adolescents with ADHD in a math fluency task compared to their peers and the association between the types of errors and working memory and processing speed.

MATERIALS AND METHODS

Participants

Data were collected from 109 participants between the ages of 14 and 17 who took part in a larger study conducted by one of the authors and colleagues (2015) examining academic performance and text comprehension in adolescent with and without ADHD. The inclusion criteria for ADHD group were: (1) At least one clinically significant score ($T \geq 70$) on the Diagnostic and

Statistical Manual of Mental Disorders-IV inattention ($\alpha = 0.93$), hyperactivity-impulsivity ($\alpha = 0.92$), or global index subscales of the Conners Third Edition Parent Rating Scales (Conners, 2008); (2) A parent-report of a diagnosis of ADHD from a psychologist or a physician; (3) an estimated intelligence quotient (IQ) $\geq$ 70 based on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) non-verbal reasoning and vocabulary subtests. The inclusion criteria for the control group were: (1) No parent-reported diagnosis of ADHD and no clinically significant symptoms of ADHD as indexed by the DSM-IV Inattention and Hyperactivity and Global Index subscales of the Conners Third Edition Parent Rating Scales ($T \leq 65$); (2) An estimated intelligence quotient (IQ) $\geq$ 70 based on the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) non-verbal reasoning and vocabulary subtests. Adolescents were also excluded if they had received a prior genetic or neurological disorder diagnosis (e.g., autism spectrum or Tourette's syndrome) according to parent report, but other diagnoses (e.g., conduct, mood, or learning disorders) were permitted if the adolescent met all other criteria.

We focused in this study on youth who were not perceived to have a concurrent math disability in basic computation skills according to the performance on the WJ-III Math Calculation subtest. However, as there is no 'gold standard' to define mathematical ability (Tosto et al., 2015), we decided to draw on recent research examining adolescent outcomes of children with ADHD where "academic competence" was defined as scoring at or above the 16th percentile on standardized reading and math achievement measures from the WJ-III (Woodcock et al., 2001; Lee et al., 2008). As a result, we decided to only include students whose standard score on the WJ-III Math Calculation subtest was at or above the 16th percentile (SS $\geq$ 85). According to these various criteria, seven adolescents who did not have a parent-reported diagnosis of ADHD were excluded from the sample. Six participants without a diagnosis who met at least one clinical score on the Conners Third Edition Parent Scale were also excluded from the sample. Four participants who had not completed the math tests and 7 who scored less than 85 on the WJ-III Math Calculation subtest were excluded from the present sample. Finally, 16 participants who had not completed the WASI were excluded.

Therefore, our sample included 30 students (21 male and 9 female) with ADHD and 39 (15 male and 24 female) TD peers who were matched on age, IQ and parent education level (mother, father or the mean of both). Group demographic characteristics are presented in **Table 1**. Parent education was gathered from a parent demographic survey with 1 = No schooling; 2 = Some elementary; 3 = Completed elementary; 4 = Some secondary; 5 = Completed secondary; 6 = Some college; 7 = Completed college program; 8 = Some university; 9 = Completed undergraduate; 10 = Master's degree; 12 = Doctoral degree.

Procedures

This study was carried out in accordance with the recommendations of the second author's institutional research ethics board with written informed consent from all subjects' parents/guardians. All subjects gave written informed consent in accordance with the Declaration of Helsinki. An intake screen was first completed by telephone with the interested parents/guardians to determine each youth's eligibility for the study. Parents/guardians of eligible youth were provided with an information and consent letter to inform them of the study. All parents of the participating youth in this study provided their written consent for the youth to participate in the study. In addition, at the start of each visit to the lab, the research assistant explained the study to each youth and acquired their verbal assent to take part in the study. All youth were reminded that it was their choice to take part in the study and then could stop taking part at any time. Research assistants worked individually for about 5 h with each participant and all participants were provided with breaks when needed. During the assessment, the adolescents completed standardized achievement tests and a battery of self-report measures relating to beliefs and attributions for behavior that were part of a larger study.

Measures

Conners Third Edition-Parent and Adolescent (Conners 3)

The Conners Third Edition- Parent and Adolescent (Conners 3) is a reliable and well-validated diagnostic instrument for ADHD, including adolescent self-report and parent versions (Conners, 2008). The Learning Problems and Executive Functioning subscale scores were used in the present study. The Learning

TABLE 1 | Demographic characteristics by group.

	ADHD (*N* = 30) Mean (*SD*)	TD (*N* = 39) Mean (*SD*)	*F*(1,67)
Age	15.49 (0.97)	15.39 (0.88)	0.64
Conners 3rd Parent DSM-IN T-score	79.83 (15.65)	49.85 (6.67)	116.13***
Conners 3rd Parent DSM-HI T-score	81.40 (16.33)	49.78 (6.93)	119.00***
Conners 3rd Parent learning problems T-score	68.53 (15.92)	49.69 (8.01)	41.21***
Conners 3rd Parent EFs problems T-score	74.37 (10.31)	49.97 (6.80)	139.60***
WASI estimated IQ	109.03 (13.05)	112.67 (8.65)	1.93
Parent education level	8.82 (2.16)	8.11 (2.17)	1.80

*N, number; ADHD, attention deficit hyperactivity disorder; TD, typically developing adolescent; DSM, diagnostic and statistical manual of mental disorder (DSM-IV TR); IN, inattentive; HI, hyperactivity-impulsivity; prob., problems; EFs, executive functions; WASI, Wechsler Abbreviated Scale of Intelligence; IQ, intelligence quotient; SD, standard deviation. *p < 0.05, **p < 0.01, ***p < 0.001.*

Problems subscale (Parent $\alpha = 0.90$; Adolescent $\alpha = 0.84$) represents an indicator of perceived academic competence (i.e., the lower the subscale score, the higher the academic competence). High scores on the Executive Functioning (Parent $\alpha = 0.92$) subscale indicate behavioral problems associated with executive functions (EFs) deficits and acts as an informant-based measure of broader EFs impairments. EFs problems was added to provide an indication of the level of parent reported EF difficulties in both groups. For each item, respondents were asked to evaluate on a 4-point scale (0 = never, rarely; 3 = really true, 4 = very often) the extent the item was true in the past month. Adolescents completed a self-report version; parents completed a parent version. Raw scores were converted to age- and gender-specific standardized *T*-scores.

Wechsler Abbreviated Scale of Intelligence

The Wechsler Abbreviates Scale of Intelligence (WASI; Wechsler, 1999) is a brief, standardized, and well-normed test of verbal and non-verbal intelligence. The Matrix Reasoning and Vocabulary subscales were administered to adolescents to provide a screening measure of general cognitive ability (IQ). The WASI Vocabulary and Matrix Reasoning subtests result in a *T*-score with a mean of 50 and a standard deviation (*SD*) of 15. The reliability coefficients reported in the manual for Vocabulary in children aged 14 to 16 the range is 0.90 to 0.93 and for Matrix Reasoning they ranged from 0.86 to 0.91.

Woodcock–Johnson Tests of Achievement – Third Edition

Math abilities were assessed through two tests of WJ-III: Math Calculations and Math Fluency (Woodcock et al., 2001). Math Calculations measures the ability to perform mathematical computations. The items required the students to perform basic operations, as well as some geometric, trigonometric, logarithmic, and calculus operations. The calculations involved negative numbers, percent, decimals, fractions, and whole numbers. Math Fluency measures the ability to solve simple single-digit addition, subtraction, and multiplication facts quickly and in random order so switching from one operation to another was common. The students had to solve these simple arithmetic problems within 3 min. The WJ-III Math Calculations subscale is reported in the manual to have a median reliability of $\alpha = 0.85$ in the age 5–19 range. The Math Fluency Subscale has a median reliability of $\alpha = 0.89$ in the age range. Each test has a raw score that is converted to an age based standard score.

Test of Memory and Learning – Second Edition

The Test of Memory and Learning – Second Edition is a well-validated, standardized assessment of memory ability (Reynolds and Voress, 2007). From this comprehensive test, the adolescents completed the Digit Forward and Digit Backward subtests. Digit Forward and Digit Backward were used to measure verbal working memory. In the Digit Forward task, students were presented a series of digits (e.g., 5, 9, and 6) and they are asked to repeat the series back to the examiner immediately. The Digit Backward task is similar but the participants need to reverse the order of the numbers when providing the series back to the examiner. The Digit Forward and Digit Backward subtests' raw scores were converted to age adjusted scaled scores which have a mean of 10 and SD of 3. According to the manual for Digit Forward the coefficient $\alpha = 0.97$ for ages 14–16. For Digit Backward the range is 0.97–0.98.

Comprehensive Test of Phonological Processing

We administered the Rapid Digit and Color Naming subtests from the Comprehensive Test of Phonological Processing (CTOPP; Wagner et al., 1999) which is a well-validated, standardized assessment of processing speed abilities and switching. Adolescents were asked to name aloud as fast as possible the names of numbers (Digit Naming) and colors (Color Naming). Not all students of the sample could complete these subtests as the measures were added after some data had been collected in the study. We converted the raw scores to age adjusted scaled scores which have a mean of 10 and *SD* of 3. The coefficient alpha for Digit Naming for youth aged 14–16 range from 0.85 to 0.93 whereas the Color Naming reliability ranges from 0.81 to 0.86.

Types of Errors in Math Fluency

We decided to analyze four types of errors in Math Fluency. First, we reviewed previous studies examining math errors (Benedetto-Nasho and Tannock, 1999; Raghubar et al., 2009) and from these studies we decided to code the Math Fluency subtest for four types of math errors:

(a) Incorrect operation errors: this type of error is when the participant gave a response that could be correct if the sign of the operation was different (e.g., $5 + 2 = 3$ or $6 - 2 = 8$).
(b) Basic errors: the type of error is a basic error in operations and seems to show a lack of understanding of the operation (e.g., $5 \times 3 = 16$).
(c) Switch errors: this type of perseverative error occurred when the student's error on the math problem was incorrect and it showed the persistence of using the operation from the previous question on the test (e.g., $4 + 2 = 6$; $5 - 3 = 8$).
(d) Zero errors: This type of error is a specific type of basic error in which the operation contained a 0 (e.g., $5 \times 0 = 1$).

The numbers of error for each category were calculated as the percentage of error on the total numbers of solved operations in the 3-min time limit (Benedetto-Nasho and Tannock, 1999). For example, if a student solved correctly 82 operations and made 1 incorrect operation and 2 basic errors, he completed in total 85 operations. So, we calculated that he made 1.18% of incorrect operation errors and 2.35% of basic errors.

Interrater Reliability (IRR)

We calculated the interrater reliability of the math errors types. We asked a second coder with clinical training in administering the WJ-III Math Fluency measure to rate a random sample of 15% of the total sample of protocols. IRR was assessed using a two-way mixed, absolute agreement ICC (Intraclass Correlation Coefficient; McGraw and Wong, 1996). The resulting ICC was in the excellent range, ICC = 1.00 (Cicchetti, 1994) for all types of errors, indicating that coders had a high degree of agreement

and suggesting that types of errors were rated similarly across coders.

Statistical Analyses

We compared adolescents with ADHD and TD students on math measures using a univariate analysis of variance (ANOVA). The differences between the two groups in the type of errors in Math Fluency were analyzed using a Mann–Whitney *U* test of variance involving non-parametric variables that do not have a normal distribution. In fact, many participants made no errors, or they made only one to two errors of a particular kind. For an effect size, Grissom and Kim (2012) have suggested that for two-group independent samples design, one can determine an effect size dividing the Mann–Whitney *U* statistic by the product of the two sample sizes. For all the analyses, we controlled for the gender effect. We only reported gender differences when there were significant gender effects in the analyses. We used Spearman correlations to examine the associations between math error types and the processing speed tasks and used logistic regression to determine whether one or both of the cognitive variables (working memory, processing speed) predicted error rates controlling for ADHD group status.

RESULTS

Table 2 presents the results of the first set of analyses on the Math Calculation and Fluency subtests as well as the math error types. There was no statistically significant difference between the ADHD and TD peers on the WJ-III Math Calculation subtest. However, youth with ADHD did score significantly lower than their TD peers on the WJ-III Math Fluency subtest ($F = 21.02$, $p < 0.001$). There was a significant difference between the two groups on the two processing speed tests, Digit Naming ($F = 6.22$, $p = 0.016$) and Color Naming ($F = 7.94$, $p = 0.007$) with youth with ADHD showing slower processing speed relative to their peers on both tasks. There were no statistically significant differences in working memory performance between the two groups. There were no statistically significant differences in the math error types although we found that the effect size for the number of switch errors was moderate in size ($U = 467$, $p = 0.063$, $\eta^2 = 0.40$) with the ADHD group making more switch errors that the typically developing comparison group. Interestingly, the opposite was found for the basic errors and the incorrect operation errors with the comparison group making more of these types of errors relative to the youth with ADHD. We analyzed the frequencies of students who made the distinct types of errors in the two groups as well. We found that 12 (31%) TD students compared to 5 (17%) youth with ADHD made incorrect operations errors, 16 (41%) TD adolescents in comparison with 8 (27%) youth with ADHD made basic errors and 7 (18%) TD students compared to 11 (37%) youth with ADHD made switch errors. Only 4 (10%) TD adolescents made zero errors.

Association between Processing Speed and Math Error Types

When we analyzed the Spearman correlations between the types of errors and the two processing speed measures we found a significant negative correlation between the switch errors and the Color Naming test ($r = -0.335$, $p = 0.013$). Considering the correlations between the types of errors and the two working memory measures we found a negative correlation between the switch errors and the Digit Backward test ($r = -0.213$). Therefore, participants with a high number of switch errors tended to have lower scores (slower naming speed) on the Color Naming and Digit Backward subtest. We decided not to analyze the zero errors due to the low frequency of this kind of errors. The correlations was analyzed even separately for the two groups but being similar we decided to consider the correlation in the whole sample.

As the distributions of the errors were not normal, with many students making no errors, or many making only one to two errors of a particular variety, we decided to create

TABLE 2 | Differences between adolescents with ADHD and TD on math performance, EFs and types of errors in Math Fluency.

	ADHD (*N* = 30) Mean (*SD*)	TD (*N* = 39) Mean (*SD*)	*F*(1,67)	Effect size η_p^2
Math Calculation SS	107.37 (10.49)	112.67 (12.86)	3.37	0.05
Math Fluency SS	87.73 (12.03)	101.62 (11.34)	21.02***	0.24
Digit Forward SS	12.03 (13.87)	9.95 (2.42)	0.85	0.11
Digit Backward SS	11.97 (9.95)	10.87 (2.67)	0.43	0.01
	ADHD (*N* = 28) Mean (SD)	**TD (*N* = 26) Mean (SD)**	***F*(1,52)**	η_p^2
Rapid Digit Naming SS	9.04 (2.10)	10.39 (1.86)	6.22*	0.11
Rapid Color Naming SS	8.68 (2.09)	10.23 (1.95)	7.94**	0.13
	Mean (*SD*)	**Mean (*SD*)**	***U* (67)**	η^2
Incorrect operation errors	0.24 (0.58)	0.37 (0.63)	510	0.44
Basic errors	0.31 (0.54)	0.57 (0.87)	506	0.43
Switch errors	0.60 (0.88)	0.28 (0.73)	467	0.40

*N, number; ADHD, attention deficit hyperactivity disorder; TD, typically developing adolescent; SD, standard deviation; SS, standard score. *p < 0.05, **p < 0.01, ***p < 0.001.*

new dichotomous variable for switch errors. One group was comprised of youth who made no switch errors vs. those who made at least one error (% of errors $< 1 = 0$, % of errors $> 1 = 1$). A logistic regression was then conducted to predict switch error type using the Digit Backward and Color Naming subtests (standard scores, SS) as predictors with ADHD status entered first. We only included these subtests as it were the only shown to be correlated with switch errors. Different variables were introduces in different blocks. Preliminary analyses indicated that ADHD status when entered alone was a significant predictor of being a member of the switch error group (odds ratio $= 3.91$, $p = 0.010$). Youth with ADHD were at increased risk relative to their peers of being members of the switch errors subgroup. However, as shown in **Table 3**, none of the variables (ADHD status, Color Naming, Digits Backward) when entered together were significant unique predictors of membership in the switching errors subgroup. However, youth with better Color Naming tended to be at less risk (odds ratio $= 0.69$, $p = 0.082$) which is consistent with the correlation between Color Naming and switch errors. Also, when entered alone, Color Naming was a predictor of group membership with youth with better Color Naming at lower risk of being a member of the switch errors group (odds ratio $= 0.77$, $p = 0.031$). Considering the interaction between ADHD status and Color naming it was not significant (odds ratio $= 0.28$, $p = 0.108$).

DISCUSSION

The present study provided an analysis of the type of errors that adolescents with ADHD made in a single-digit timed math fluency task, an understudied aspect of mathematical abilities in adolescents with ADHD (Tosto et al., 2015). Importantly, we restricted our sample to youth who did not exhibit marked math calculation difficulties. Given that there is no gold standard to define mathematical ability (see Murphy et al., 2007) we decided only included students with a SS in Math Calculation greater or equal to 85 when conducting the comparisons of the two groups in math abilities, EFs and types of errors. It is possible that had we selected a more stringent cut-off our findings may have changed.

Our first set of analyses revealed that there were no statistically significant differences in Math Calculation between the two groups. This result could be partially due to the restriction of the sample (students with SS in Math Calculation greater or equal to 85) but the same effect could be expected for the Math Fluency. Instead, consistent with prior research (Tosto et al., 2015), there was a significant difference for Math Fluency with youth with ADHD exhibiting less fluent math calculation skills than their peers. Concerning the types of errors, in this case we found that adolescents with ADHD made more switch errors than their peers although the difference was not statistically significant. The effect size, however, was moderate in size indicating that more studies are needed with larger samples to better understand error types in youth with ADHD. In contrast, youth in the comparison group made more basic and zero errors (both procedural errors but in the second case the operation contained a zero). In these analyses, the magnitude of the difference was moderate (Cohen, 1988). TD children likely showed a higher number of basic and zero errors due to the fact that they attempted to complete a great numbers of operations in the 3 min time at disposal [TD mean of total operations done 105 (25) vs. 80 (25) of adolescent with ADHD].

Concerning processing speed, we found that students with ADHD had a lower performance in Color Naming relative to the comparison group. This finding is consistent with previous literature that found an impairment in processing speed in children with ADHD (Rucklidge and Tannock, 2002; Shanahan et al., 2006) and in real-life measures (Lawrence et al., 2004). In contrast, there were no statistically significant differences on the Digits Backward subtest which was our measure of working memory. Given that working memory tends to be lower in individuals with ADHD relative to peers (Willcutt et al., 2005), this finding is somewhat surprising. It is possible that by excluding youth with ADHD with math difficulties we also reduced the number of youth with ADHD with less proficient working memory – this would be an interesting question to address in future research. Alternatively, our measure of working memory may not have placed sufficient load on working memory in a sample of youth with ADHD.

When we conducted the logistic regression to determine if the switch errors in Math Fluency were predicted by the two cognitive measures, we found that Color Naming was not a unique predictor when concurrently entered along with ADHD status and working memory. However, when entered on its own, the results of the logistic regression revealed that it was a significant contributor to classification and better Color Naming was associated with lower odds of a youth being a member of the switch errors group.

In summary, even though the adolescents with ADHD in our sample demonstrated average performance in a math calculation task, they performed significantly lower on the math fluency task compared to their non-affected peers. The math fluency measure we used requires youth not only to use their math abilities but also switch from one operation to another in a 3-min time limit. It is likely that the poorer performance on the math measure is in part due to slow fluency (as indicated by the Color Naming speed task) but also from the nature of the task as it required careful monitoring of problem type and the ability to quickly switch operation types. Previous research suggests that students with ADHD exhibit problems when completing tasks where they must inhibit irrelevant task information when switching from

TABLE 3 | Logistic regression to predict the switch errors in Math Fluency in students with Math Calculation SS > 85.

Variable	*B*	*SE*	Wald	*df*	*p*	OR
Presence of ADHD (yes vs. no)	0.59	0.81	0.52	1	0.470	1.80
Color Naming SS	−0.37	0.21	2.96	1	0.082	0.69
Digit Backward SS	−0.07	0.16	0.19	1	0.671	0.94

Different variables were introduced in different blocks; SE, standard error; df, degree of freedom; OR, odds ratio.

one task to another (Kramer et al., 2001), so in this case to inhibit the preceding operation.

Another important variable is time. In the Math Fluency task students were only permitted 3 min to complete as much as possible of the task. Previous research examining timed tasks (Lewandowski et al., 2007), has shown that with additional time (1.5 times the time), children with ADHD were able to reach the performance level of the control group at standard time. This finding suggests that the required switching process, together with the time limit is likely having a marked impact on the math fluency performance of students with ADHD. This perspective seems to be supported by our findings of switch errors with very few basic or zero errors in adolescents with ADHD and from their poorer performance in one or both test of processing speed, which capture the ability to perform simple cognitive tasks quickly and fluently over a sustained period of time.

This study has some important from a clinical point of view inasmuch as we are interested in acquiring knowledge of "actual" math fluency in students with ADHD. It would be interesting in future research to compare the performance of timed tasks in blocks (all similar operations within a block) vs. mixed. Similar to research with individuals with ADHD on task switching (e.g., Cepeda et al., 2000), it is possible that the switch costs incurred by the nature of the task affect speed of responding as well as accuracy.

Although this research analyzed an understudied and interesting topic concerning computation error types during a math fluency task in adolescents with ADHD, there are some limitations that needed to be considered. First, our sample was small and we included only one measure of math fluency and only few measures of EFs and processing speed. It would be important to replicate our findings with a more diverse sample (perhaps children and youth) using different subgroups (e.g., math LD plus ADHD, ADHD alone). In addition, it would be interesting to compare the performance on math fluency tasks that vary in switching demands to better understand the nature of the math fluency weaknesses in children and youth with ADHD. From a clinical standpoint, this research was useful as it suggests that in some cases students with ADHD could have a lower performance on tasks assessing fluency in comparison with their peers as a result of the nature of the task (mixed blocks vs. single operation blocks). This finding suggests that from a practical perspective, it might be important for educators to consider using math fluency tasks that do not require switching between operations to better understand if the issue is fluency or the executive control needed to switch sets rapidly.

Finally, given the importance of math to future life success, it is important that more research addresses mathematics in youth with ADHD. More research is needed in this field to understand which processes (e.g., switching, inhibition, and speed), compromise the performance of adolescents with ADHD. Furthermore, multi-digit arithmetic operation should be investigated in this range of age to analyze if the pattern of errors remains the same or change with the complexity of the task and with or without the time and the switching request.

ETHICS STATEMENT

The study from which this data was obtained was approved for ethical clearance by the University of Toronto's Research Ethics Committee which follows the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (2010) (http://www.research.utoronto.ca/faculty-and-staff/research-ethics-and-protections/humans-in-research/). Parents/guardians were asked to provide their consent for their child's participation and all youth were asked to provide their assent for participation. We ensured that all assent information for the youth was presented in a way that enhanced comprehension and we prompted youth to ask questions for clarification several times during the assent process.

AUTHOR CONTRIBUTIONS

AC and RM contributed to the design and implementation of the research. AC contributed to the analysis of the results and to the writing of the manuscript. RM contributed to drafting the article and to the critical revision of the article.

FUNDING

The study was funded by the Social Sciences and Humanities Research Council of Canada to RM (P.I.).

REFERENCES

Ackerman, P. T., Anhalt, J. M., and Dykman, R. A. (1986). Arithmetic automatization failure in children with attention and reading disorders: associations and sequela. *J. Learn. Disabil.* 19, 222–232. doi: 10.1177/002221948601900409

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. Lake St. Louis, MO: American Psychiatric Association. doi: 10.1176/appi.books.9780890425596

Baddeley, A., Chincotta, D., and Adlam, A. (2001). Working memory and the control of action: evidence from task switching. *J. Exp. Psychol. Gen.* 130, 641–657. doi: 10.1037/0096-3445.130.4.641

Bailey, D. H., Hoard, M. K., Nugent, L., and Geary, D. C. (2012). Competence with fractions predicts gains in mathematics achievement. *J. Exp. Child Psychol.* 113, 447–455. doi: 10.1016/j.jecp.2012.06.004

Benedetto-Nasho, E., and Tannock, R. (1999). Math computation, error patterns and stimulant effects in children with attention deficit hyperactivity disorder. *J. Atten. Disord.* 3, 121–134. doi: 10.1177/108705479900300301

Biederman, J., Mick, E., Fried, R., Aleardi, M., Potter, A., and Herzig, K. (2005). A simulated workplace experience for nonmedicated adults with and without ADHD. *Psychiatr. Serv.* 56, 1617–1620. doi: 10.1176/appi.ps.56.12.1617

Bonafina, M. A., Newcorn, J. H., McKay, K. E., Koda, V. H., and Halperin, J. M. (2000). ADHD and reading disabilities a cluster analytic approach

for distinguishing subgroups. *J. Learn. Disabil.* 33, 297–307. doi: 10.1177/002221940003300307

Booth, J. L., Newton, K. J., and Twiss-Garrity, L. K. (2014). The impact of fraction magnitude knowledge on algebra performance and learning. *J. Exp. Child Psychol.* 118, 110–118. doi: 10.1016/j.jecp.2013.09.001

Bueno, V. F., da Silva, M. A., Alves, T. M., Louzã, M. R., and Pompéia, S. (2014). Fractionating executive functions of adults with ADHD. *J. Atten. Disord.* 21, 944–955. doi: 10.1177/1087054714545537

Bull, R., and Johnston, R. S. (1997). Children's arithmetical difficulties: contributions from processing speed, item identification, and short-term memory. *J. Exp. Child Psychol.* 65, 1–24. doi: 10.1006/jecp.1996.2358

Bull, R., and Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: inhibition, switching, and working memory. *Dev. Neuropsychol.* 19, 273–293. doi: 10.1207/S15326942DN1903_3

Cepeda, N. J., Cepeda, M. L., and Kramer, A. F. (2000). Task switching and attention deficit hyperactivity disorder. *J. Abnorm. Child Psychol.* 28, 213–226. doi: 10.1023/A:1005143419092

Cicchetti, D. V. (1994). Guidelines, criteria, and rules of thumb for evaluating normed and standardized assessment instruments in psychology. *Psychol. Assess.* 6, 284–290. doi: 10.1037/1040-3590.6.4.284

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Conners, C. K. (2008). *Conners: Manual*, 3rd Edn. London: Multi-Health Systems.

Draheim, C., Hicks, K. L., and Engle, R. W. (2016). Combining reaction time and accuracy: the relationship between working memory capacity and task switching as a case example. *Perspect. Psychol. Sci.* 11, 133–155. doi: 10.1177/1745691615596990

DuPaul, G. J., Volpe, R. J., Jitendra, A. K., Lutz, J. G., Lorah, K. S., and Gruber, R. (2004). Elementary school students with AD/HD: predictors of academic achievement. *J. Sch. Psychol.* 42, 285–301. doi: 10.1016/j.jsp.2004.05.001

Fourqurean, J. M., Meisgeier, C., Swank, P. R., and Williams, R. E. (1991). Correlates of postsecondary employment outcomes for young adults with learning disabilities. *J. Learn. Disabil.* 24, 400–405. doi: 10.1177/002221949102400704

Gray, S. A., Rogers, M., Martinussen, R., and Tannock, R. (2015). Longitudinal relations among inattention, working memory, and academic achievement: testing mediation and the moderating role of gender. *PeerJ* 3:e939. doi: 10.7717/peerj.939

Gremillion, M. L., and Martel, M. M. (2012). Semantic language as a mechanism explaining the association between ADHD symptoms and reading and mathematics underachievement. *J. Abnorm. Child Psychol.* 40, 1339–1349. doi: 10.1007/s10802-012-9650-7

Grissom, R. J., and Kim, J. J. (2012). *Effect Sizes for Research: Univariate and Multivariate Applications*. Abingdon: Routledge.

Hart, S. A., Petrill, S. A., Willcutt, E., Thompson, L. A., Schatschneider, C., Deater-Deckard, K., et al. (2010). Exploring how symptoms of attention-deficit/hyperactivity disorder are related to reading and mathematics performance general genes, general environments. *Psychol. Sci.* 21, 1708–1715. doi: 10.1177/0956797610386617

Holmes, J., Hilton, K. A., Place, M., Alloway, T. P., Elliott, J. G., and Gathercole, S. E. (2014). Children with low working memory and children with ADHD: same or different? *Front. Hum. Neurosci.* 8:976. doi: 10.3389/fnhum.2014.00976

Inoue, Y., Inagaki, M., Gunji, A., Furushima, W., and Kaga, M. (2008). Response switching process in children with attention-deficit–hyperactivity disorder on the novel continuous performance test. *Dev. Med. Child Neurol.* 50, 462–466. doi: 10.1111/j.1469-8749.2008.02049.x

Jordan, N. C., Hansen, N., Fuchs, L. S., Siegler, R. S., Gersten, R., and Micklos, D. (2013). Developmental predictors of fraction concepts and procedures. *J. Exp. Child Psychol.* 116, 45–58. doi: 10.1016/j.jecp.2013.02.001

Kramer, A. F., Cepeda, N. J., and Cepeda, M. L. (2001). Methylphenidate effects on task-switching performance in attention-deficit/hyperactivity disorder. *J. Am. Acad. Child Adolesc. Psychiatry* 40, 1277–1284. doi: 10.1097/00004583-200111000-00007

Lawrence, V., Houghton, S., Douglas, G., Durkin, K., Whiting, K., and Tannock, R. (2004). Executive function and ADHD: a comparison of children's performance during neuropsychological testing and real-world activities. *J. Atten. Disord.* 7, 137–149. doi: 10.1177/108705470400700302

Lee, S. S., Lahey, B. B., Owens, E. B., and Hinshaw, S. P. (2008). Few preschool boys and girls with ADHD are well-adjusted during adolescence. *J. Abnorm. Child Psychol.* 36, 373–383. doi: 10.1007/s10802-007-9184-6

Lewandowski, L. J., Lovett, B. J., Parolin, R., Gordon, M., and Codding, R. S. (2007). Extended time accommodations and the mathematics performance of students with and without ADHD. *J. Psychoeduc. Assess.* 25, 17–28. doi: 10.1177/0734282906291961

Martinussen, R., and Tannock, R. (2006). Working memory impairments in children with attention-deficit hyperactivity disorder with and without comorbid language learning disorders. *J. Clin. Exp. Neuropsychol.* 28, 1073–1094. doi: 10.1080/13803390500205700

McGraw, K. O., and Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychol. Methods* 1, 30–46. doi: 10.1037/1082-989X.1.1.30

Murphy, M. M., Mazzocco, M. M., Hanich, L. B., and Early, M. C. (2007). Cognitive characteristics of children with mathematics learning disability (MLD) vary as a function of the cutoff criterion used to define MLD. *J. Learn. Disabil.* 40, 458–478. doi: 10.1177/00222194070400050901

Raghubar, K., Cirino, P., Barnes, M., Ewing-Cobbs, L., Fletcher, J., and Fuchs, L. (2009). Errors in multi-digit arithmetic and behavioral inattention in children with math difficulties. *J. Learn. Disabil.* 42, 356–371. doi: 10.1177/0022219409335211

Re, A. M., Lovero, F., Cornoldi, C., and Passolunghi, M. C. (2016). Difficulties of children with ADHD symptoms in solving mathematical problems when information must be updated. *Res. Dev. Disabil.* 59, 186–193. doi: 10.1016/j.ridd.2016.09.001

Reyna, V. F., Nelson, W. L., Han, P. K., and Dieckmann, N. F. (2009). How numeracy influences risk comprehension and medical decision making. *Psychol. Bull.* 135, 943–973. doi: 10.1037/a0017327

Reynolds, C. R., and Voress, J. (2007). *Test of Memory and Learning (TOMAL-2)*. Austin, TX: PRO-ED.

Ritchie, S. J., and Bates, T. C. (2013). Enduring links from childhood mathematics and reading achievement to adult socioeconomic status. *Psychol. Sci.* 13, 1301–1308. doi: 10.1177/0956797612466268

Rogers, M., Hwang, H., Toplak, M., Weiss, M., and Tannock, R. (2011). Inattention, working memory, and academic achievement in adolescents referred for attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychol.* 17, 444–458. doi: 10.1080/09297049.2010.544648

Rohlf, H., Jucksch, V., Gawrilow, C., Huss, M., Hein, J., Lehmkuhl, U., et al. (2012). Set shifting and working memory in adults with attention-deficit/hyperactivity disorder. *J. Neural Transm.* 119, 95–106. doi: 10.1007/s00702-011-0660-3

Rourke, B. P. (1993). Arithmetic disabilities specific and otherwise: a neuropsychological perspective. *J. Learn. Disabil.* 26, 214–226. doi: 10.1177/002221949302600402

Rucklidge, J. J., and Tannock, R. (2002). Neuropsychological profiles of adolescents with ADHD: effects of reading difficulties and gender. *J. Child Psychol. Psychiatry* 43, 988–1003. doi: 10.1111/1469-7610.00227

Shanahan, M. A., Pennington, B. F., Yerys, B. E., Scott, A., Boada, R., Willcutt, E. G., et al. (2006). Processing speed deficits in attention deficit/hyperactivity disorder and reading disability. *J. Abnorm. Child Psychol.* 34, 584–601. doi: 10.1007/s10802-006-9037-8

St Clair-Thompson, H. L. (2011). Executive functions and working memory behaviours in children with a poor working memory. *Learn. Individ. Differ.* 21, 409–414. doi: 10.1016/j.lindif.2011.02.008

Tosto, M. G., Momi, S. K., Asherson, P., and Malki, K. (2015). A systematic review of attention deficit hyperactivity disorder (ADHD) and mathematical ability: current findings and future implications. *BMC Med.* 13:204. doi: 10.1186/s12916-015-0414-4

Wagner, R. K., Torgesen, J. K., and Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processing: CTOPP*. Austin, TX: PRO-ED.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence*. New York, NY: Psychological Corporation.

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., and Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biol. Psychiatry* 57, 1336–1346. doi: 10.1016/j.biopsych.2005.02.006

Wolraich, M. L., Wibbelsman, C. J., Brown, T. E., Evans, S. W., Gotlieb, E. M., Knight, J. R., et al. (2005). Attention-deficit/hyperactivity disorder among adolescents: a review of the diagnosis, treatment, and clinical implications. *Pediatrics* 115, 1734–1746. doi: 10.1542/peds.2004-1959

Woodcock, R. W., McGrew, K. S., and Mather, N. (2001). *Woodcock-Johnson III*. Itasca, IL: Riverside Publishing Company.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer MCPF and handling Editor declared their shared affiliation.

Copyright © 2017 Capodieci and Martinussen. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 21 September 2017
doi: 10.3389/fpsyg.2017.01544

Freshmen Program Withdrawal: Types and Recommendations

Ana Bernardo[1], *Antonio Cervero*[1], *María Esteban*[1]*, *Ellian Tuero*[1], *Joana R. Casanova*[2] *and Leandro S. Almeida*[2]

[1] *Facultad de Psicología, Universidad de Oviedo, Oviedo, Spain,* [2] *Centro de Investigação em Educação (CIEd), Universidade do Minho, Braga, Portugal*

University program dropout is a problem that has important consequences not only for the student that leaves but also for the institution in which the withdrawal occurs. Therefore, higher education institutions must study the problem in greater depth to establish appropriate prevention measures in the future. However, most research papers currently focus primarily on the characteristics of students who leave university, rather than on those who choose to pursue alternative courses of study and therefore fail to take into account the different kinds of abandonment. The aim of this paper is to identify the different types of dropout to define their characteristics and propose some recommendations. Thus, an *ex post facto* study was carried out on a sample of 1,311 freshmen from a university in the north of Spain using data gathered using an *ad-hoc* designed questionnaire, applied by telephone or an online survey, and completed with data available in the university data warehouse. A descriptive analysis was performed to characterize the sample and identify five different groups, including 1. Students persisting in their initiated degree 2. Students who change of program (within the same university) 3. Students transferring to a different university 4. Students enrolling in non-higher-education studies 5. Students that quit studying. Also, data mining techniques (decision trees) were applied to classify the cases and generate predictive models to aid in the design of differentiated intervention strategies for each of the corresponding groups.

Keywords: university, undergraduate student, performance, dropout, persistence

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Sandra T. Valadas, University of the Algarve, Portugal
Alfonsa García-López, Universidad Politécnica de Madrid (UPM), Spain

***Correspondence:**
María Esteban
maria_esteban_garcia@hotmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *15 April 2017*
Accepted: *24 August 2017*
Published: *21 September 2017*

Citation:
Bernardo A, Cervero A, Esteban M, Tuero E, Casanova JR and Almeida LS (2017) Freshmen Program Withdrawal: Types and Recommendations. Front. Psychol. 8:1544. doi: 10.3389/fpsyg.2017.01544

INTRODUCTION

Higher education withdrawal—including college and university because of their common environmental characteristics—is a largely studied phenomenon in consequence of its implication for the individual, the educational institution and the society (Cope and Hannah, 1975; Pascarella et al., 1986; Duque, 2014). Therefore, professors, stakeholders, and politicians from many disciplines have attempted to study this problem, usually from one of the four most extended paradigms; economic (Jensen, 1981; Di Pietro, 2006; Belloc et al., 2011), psychological (Marín et al., 2000; Peralta et al., 2006; Naranjo, 2009), sociological (Pincus, 1980; Braxton et al., 2000), organizational (Kamers, 1971; Bean, 1983), or educational (Cabrera et al., 2006). In addition, in 1975 Vincent Tinto published his explanatory model of university attrition, being considered as a markland because of its inclusive approach and stated as an example in this research field. Tinto's perspective entails not only the need of assuming a holistic approach to study dropout (taking in regards different kind of factors, ex. economical, sociological, educational, institutional, etc.) but also the need to understand withdrawal as a process in which one is possible to act (Tinto, 1998).

Since then, there has been a gradual increase in the institutional attention paid to this phenomenon. In Spain, our research base, this attention has proliferated to a greater extent since the publication of the Royal Decree 1947/1995, which established the National Plan for University Quality, urging universities to evaluate both the processes and results of teaching.

It is necessary to understand than when a student enters a degree, usually have the intention to complete it, but sometimes—for different reasons—can change his or her opinion and take a distinct paths, corresponding to different withdrawal profiles (Andrews et al., 2014): the student can transfer to another program remaining in the same institution (transfer to another degree); he or she could also choose to change of institution (transfer to another institution); there are also some students that opt for lower educational levels (ex. vocational training, on accredited courses); and last, some students resolve quit studying.

Therefore, governments and institutions have the responsibility to look into the dropout problem deeply, taking in consideration its different types while analyzing the roots and particularities of this phenomenon; this knowledge is a value a base for the design of intervention measures able to decrease dropout rates, in spite of their handicaps of budget and personnel. This, in turn, leads to important savings for both the university and the students alike, as in Spain the annual cost of academic abandonment surpass 1,500 million Euros (Colás, 2015). Apart from economic cost, Higher Education institutions are affected by their dropout rates at deeper levels as well; their efficacy is called into question, and this can have negative effects on faculty motivation as well as on its enrollment rates (Angulo-Ruiz and Pergelova, 2013; Hossler and Kalsbeek, 2013). Furthermore, a country's national development is often impacted by Higher Education Professional graduation and employability rates; therefore, increases in dropout levels could slow the national development pace. Although these consequences exemplify the high cost of withdrawal, the students, and their families undoubtedly face the worse part as they have to deal not only with the financial loss but also with a new extremely challenging decision process about their future (González et al., 2007; Arriaga et al., 2011).

Hence, the diagnosis of the problem turns into an investment that, if accompanied by the application of preventive and corrective actions, can generate great benefits for every part involved (Colás, 2015). Nevertheless, current research that is developed using exclusively secondary data (available on the university information systems) might be insufficient to establish effective preventative measures, since it ignores important dimensions of the problem. Thus, studies using primary data instead would be much more advisable. Among this type of methodology, there are two major tendencies regarding the kind of information examined:

On the one hand, there are studies aiming to distinguish the characteristics of students who quit, compared with those who remain in the institution (these studies are the most common, as a smaller sample is needed to provide generalizable results). Identifying the differential characteristics of the students who withdraw, allows establishing prevention measures. Nevertheless, unless the diverse types of abandonment are differentiated, preventive strategies will obtain uneven results (Bernardo et al., 2015).

On the other hand, some researchers intend to distinguish between the diverse types of abandonment. The close examination of these profiles of dropout can serve as a base of an early alert system by means of the identification of student risk factors, and ultimately lead to the application of specific intervention strategies in the future (La Red-Martínez et al., 2015; Bernardo et al., 2017b). The project implemented by Arriaga et al. (2011) is the most outstanding current example of this type of research in Spain. The authors interviewed (approximately) one thousand students at the Polytechnical University of Madrid and categorized them into seven separate student profiles, and subsequently proposed specific intervention strategies for each kind of dropout.

Clearly, studying Higher Education dropout is methodologically challenging, as often brings along limitations, being the most common either to be based on basic data recorded by the university system—considering only a limited number of variables but obtaining significant results (Bernardo et al., 2017a)—, or to require a large investment of money on surveys to obtain detailed results—acquiring clusters of students and particular conditions but with a lower statistical significance—. Unfortunately, this decision is most often beyond the control of the researchers themselves (Bernardo et al., 2015).

As several authors have already defined the longitudinal (Willcoxson, 2010) and temporal (Tinto, 1988) dimensions of Higher Education withdrawal, we can conclude that this process can start as early as the time that schooling begins (Bernardo et al., 2017b). Therefore, students often enter university with very different backgrounds (Rumberger, 1983; Bedard, 2001; Crawford, 2014) and personalities (Heilbrun, 1965; Pandey, 1973; Alkan, 2016), which produces a broad casuistry that must be explored in depth by taking into account each student's point of view (Tinto, 2015).

In this sense, the emerging technology of Educational Data Mining creates new opportunities, as it is able to make sense of a large amount of data and find patterns that are difficult to identify with inferential statistics alone (Romero and Ventura, 2013). Data mining compiles the knowledge produced by both Statistics and Artificial Intelligence, while at the same time remaining accessible to educators (Hand, 1998; Baker and Yacef, 2009). In regard to Higher Education dropout, three of the possible techniques have proven helpful to understanding the problem, since they are used to raise and solve classification problems in which a certain number of variables are used as predictors (acting as a criterion variable); these techniques are association rules (López et al., 2015; Badr et al., 2016), Naive Bayes (Moseley and Mead, 2008; Moreno-Salinas and Stephens, 2015; Shaleena and Paul, 2015) and Decision Trees (Escobar et al., 2016; Hasbun et al., 2016; Liang et al., 2016).

Of these techniques, decision trees were considered the most appropriate for the present study, as they fit our phenomenon character by being able to explain a subject's behavior when confronting a decision, and (data permitting) reflect the longitudinal process associated with the decision (Yasmin, 2013; Nagrecha et al., 2017). The analysis output provides a network

of nodes, which show how the dependent variable behaves regarding the rest studied variables. However, since data mining techniques are optimal mainly for a large amount of data and their application to analyzing dropout patterns is not widespread, there are few examples of their use in current literature. Therefore, the present study intends to contribute in this sense, considering that Yasmin (2013) has already demonstrated that decision trees are optimal to identify patterns of learner attrition.

The present paper attempts to apply these techniques to analyze a university student sample collected within the framework of *The Alfa-GUIA Project* for a Comprehensive Management of University Dropout (funded by the European Commission, DCI-ALA/2010/94). The Alfa-GUIA project aims to address the Higher Education dropout phenomenon from a holistic approach. To do so, its aims and actions are based on four strategies: First, to understand the problem by means of an extensive review of both literature and international research; Second, to assess and spread good prevention practices; Third, to promote greater integration in educational policies and, Fourth to engage the different agents involved (Proyecto Alfa-GUIA, 2014a).

Twenty-one higher education institutions took part in the project and collaboratively developed a questionnaire, which was subsequently completed in sixteen of them. Thus, nearly ten thousand students from all over the world participated in the international study. The global results can be consulted on the Alfa-GUIA web page as well as in the official reports (http://www.alfaguia.org; Proyecto Alfa-GUIA, 2014b). The analysis of this paper focuses on a medium size Spanish university that participated in Alfa-GUIA study. The Alfa-GUIA questionnaire included two common blocks to be answered by every subject and other specific blocks for each possible alternative academic pathway. These two blocks aim to examine the different dimensions of student experiences and backgrounds which the literature has found to be closely related to increased Higher Education withdrawal levels: sociodemographic variables (Di Pietro, 2006), cultural background (Ghignoni, 2017), economic status (Belloc et al., 2011), institutional related variables (Tinto, 2012), academic behavior (Hasbun et al., 2016), and academic experience (Tinto, 1998).

Our research team, stated the following research question: Is it possible to find a model able to predict dropout regarding a given set of variables? Taking into account previous findings, we hypothesize that (1) Student academic situation cannot be predicted only using secondary data (from the University warehouse) and (2) Academic progress is a variable present in the model. Next section explains the applied research method in detail, to provide a framework for the results and conclusions.

METHOD

Research Design

This paper applies the most extended dropout definition in Spain, identifying "dropout students" as those having started a particular university program and decided to do not re-enroll during two subsequent academic years (Cabrera et al., 2006). We assume this definition also following the criteria of most governmental bodies across the world (Arriaga et al., 2011), recognizing its potential to disguise between dropouts and stop-outs (students that take a gap year, once they have initiated their university studies).

An *ex post facto* research design was deemed to be the most suitable, given the characteristics of the phenomenon and the specified dropout definition. As for the variables included in the analysis, we set as the criterio variable the students' academic situation. This variable included five possible values: (1) Students persisting in the initiated university program, (2) Students transferring to another program within the same university, (3) Students transferring to a different university (same or different program), (4) Students transferring to lower educational levels, and (5) Students quitting studies altogether. Therefore, we intend to analyze the main characteristics associated to four of the different kinds of withdrawal (groups 2–5), as well the one corresponding to those that persist (group 1); confirming statistical significant difference between groups of students could contribute to understand the profile associated with each group and increase the efficiency of student affair policies.

As for the variables included in the study, it is necessary to highlight that it focused mainly on those corresponding to block 0 and 1 of the Alfa-GUIA questionnaire regarding dropout and persistence decisions (Proyecto Alfa-GUIA and Grupo de Análisis, 2014).

Sample

The original sample was comprised of 1,311 subjects, including 700 students that persisted in their initial university program and 611 students that quit their program (95% confidence level and a 3.3% of sample error for both groups). The participants entered our institution in the academic year 2008/9 (40.3%), 2009/10 (43.4%), 2010/11 (13.9%), or 2011/12 (2.4%), as the research team had the intention of using only the first two cohorts but needed to include the last two in order to complete the programmed interviews. The survey process was developed between April and July 2013. We applied a stratified random sampling procedure, regarding the knowledge areas defined by UNESCO (2004), see **Table 1**.

In regard to the main characteristics of our sample, it is necessary inform that 61.2% of them were 17 or 18 years old, entering university straight away from High School without any

TABLE 1 | Sample distribution regarding UNESCO (2004) knowledge areas.

	Frequency	Percentage
Education	298	23.0
Arts and Humanities	76	5.9
Social Science, Trade, & Law	308	23.7
Science	124	9.6
Building & Engeniering	296	22.8
Agriculture	20	1.5
Salud y Servicios Sociales	139	10.7
Servicios	37	2.9
Total	1,298	100.0

delay (no course repetition or gap years, etc.), and reflect a quite balanced participation between men and women (43.1 and 56.9%, respectively). Their socioeconomic characteristics, 93.9% of them were single, 5.2% were married or live with a partner, and the 0.9% were divorced or widow/widower. Only the 41% of their fathers and 36.8% of their mothers hold a Higher Education Diploma.

Nonetheless, subjects who had not answered all the questions we excluded from the analysis, reducing the sample to 697 students who had persisted, and 601 students who had not persisted in their initial program ($N = 1{,}298$). At this point, it is necessary to clarify that Alfa-GUIA global analysis used a randomized selection of our cases, as it only requires a dropout sample of 541 students and a control group of 174 (Proyecto Alfa-GUIA, 2014b).

Instrument and Procedure

Two procedures were used to gather the data; First, university enrollment services provide us with personal, sociodemographic, and academic information about the students, and second, through the Alfa-GUIA questionnaire completed via email or telephone interview.

As mentioned, the research instrument used was the Alfa-GUIA questionnaire regarding dropout decisions and causes (Proyecto Alfa-GUIA and Grupo de Análisis, 2014). This questionnaire was collaboratively created by all participating institutions and was composed of five blocks: Blocks 2–4, are blocks aiming to a particular student profile that found being useful only for qualitative analysis, far from our current purposes; consequently item from this blocks were excluded from our analysis (Proyecto Alfa-GUIA, 2014b).

Block 0, which included 14 items answered by the institution about student academic profiles and their sociodemographic background, three kinds of variables were measured, including; student sociodemographic background (Cabrera et al., 2006; Trevizán et al., 2009; Belloc et al., 2011), institutional and program characteristics (Tinto, 1975; Braxton et al., 1997; Vries et al., 2011), and student progress in the initiated program (Montmarquette et al., 2001; Willcoxson, 2010; Goldenhersh et al., 2011; La Red-Martínez et al., 2015).

In addition, a large set of variables were provided directly by the students (Block 1) by completing a survey aiming to facilitate a comprehensive analysis of the phenomenon, including six different categories of data: 32 questions about their personal life, culture, economy, university experience, and opinions of several institutional features included as result of an extensive literature review and discussion among the partners of Alfa-GUIA project:

- First, student family background and personal context: Several studies have demonstrated that factors in a student's immediate environment marital status (Di Pietro, 2006), immigration status (Smith and Naylor, 2001), or parental educational level (Rodrigo et al., 2012) might affect their progress in university studies. Thus, this category of variables was included in the present study.
- Second, despite the recent emergence of the "Global Village" phenomenon which tends to decrease discrepancies between cultures (Suárez-Orozco and Qin-Hilliard, 2004; Meneses, 2011; Ghignoni, 2017), cultural characteristics continue to play a role in the dropout phenomenon and were therefore considered in the study.
- The Alfa-GUIA study also considered economic variables to be a key research factor, not only regarding family outcome but also in terms of governmental and institutional support: Belloc et al. (2011), among other authors, has demonstrated that this dimension still plays a remarkable role in Higher Education dropout levels.
- Institutional variables (such as size, infrastructure, and human resources) as well as those specifically related to the program of study and its faculty (including program length and the amount of effort required, quality of teachers or services provided) have also been closely linked to the phenomenon and defined as key factors in prevention measures (Cuseo and Farnum, 2011; Tinto, 2012) Therefore, the present work has deeply examined the student perception of both the institution and the program in great depth.
- Student academic behavior, regarding class attendance, participation in extracurricular activities, time devoted to study, etc. is often associated with academic results and decisions regarding persistence (Trevizán et al., 2009; Santos and Vallerado, 2013; Hasbun et al., 2016).
- The last category included in the study was related to the student academic experience, seeing as how this variable could potentially influence both dropout decisions as well as compound other dimensions of the problem (Pascarella and Terenzini, 1983; Tinto, 1998; Wilcox et al., 2005; Gilardi and Guglielmetti, 2011; Pluut et al., 2015).

Data Analysis

Descriptive and decision tree (exhaustive CHAID) analysis were performed with IBM Statistical Package for the Social Sciences, version 22. A decision tree is a predictive data mining technique that creates a classification model based on flow charts, which then allows for the classification of cases and the prediction of criterio variable values regarding the predictive variables included in the analysis (Berlanga et al., 2013), see **Table 2**.

RESULTS

The sample was composed of students both students who had persisted in their initial university program (53.7%) and students that had quit (46.3%). This second group includes several kinds of dropout, as shown in **Figure 1**.

However, the options "transfer to another university" and "transfer to a lower educational level" represent a low contribution to this subsample, which is why they have been excluded from the tree analysis. Therefore, after having omitted these two values, a decision tree representing the academic situation (including persistence in the initiated degree, transfer to a different program and quit studying altogether) of the students was built which proved to obtain acceptable classification values.

As observed in **Table 3**, el 75.7% of the subjects were classified, being the model particularly accurate for groups 1—persistence in the initial university program—and 3—quit studying—, with

TABLE 2 | Decision tree specifications and results synthesis.

Specifications							Results			
Method	**Dependent variable**	**Independent variable**	**Validation**	**Tree deep**	**Min cases entry nod**	**Min cases exit node**	**Included independent variables:**	**Number of nodes**	**Terminals**	**Depth**
Exhaustive chaid	Academic status	Every variable included in Block 0 and 1 were included as independent variables:	None	3	100	50	Academic progress (%of passed credits regarding the program overall credits), Entry age, Time devoted to studying and kind of housing during the academic year	15	9	3

Method: Exhaustive Chaid. Dependent variable: academic situation.

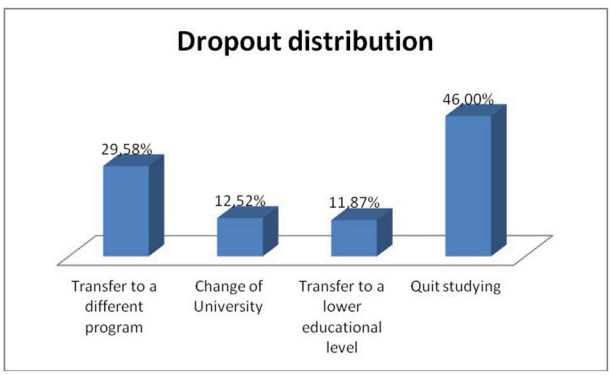


FIGURE 1 | Dropout subsample composition.

TABLE 3 | Confusion matrix.

Observed	Prognosticated			
	Persist on the initial degree	**Transfer to a different program**	**Quit studying**	**Correct percentage**
Persist on initial degree	614	29	54	88.10
Transfer to a different program	18	77	83	43.30
Quit studying	59	37	180	65.20
Overall percentage	60.00	12.40	27.50	75.70

an accuracy of 88.1 and 65.2%, respectively. However, this value is notably lower for group 2—transfer to a different program within the same university (43.3%). However, the latter remains relevant, as the model shows a similitude between the features of students in group 1 and 2 (see **Figure 2**), which will be discussed further in the next section.

Figure 2 shows how student progress is the variable that most predicts the academic situation of the students for each of the three groups, being the percentage of passed credits overall the programs' ($\chi^2 = 669.319$; $p = 0.000$). In this sense, had passed more than the 44.16% of program's credit classify 95.3% of the students that persist, decreasing its classification potential for lower performance intervals. Thus, as academic progress decreases, the probability of dropout increases.

On a second level, the group containing students with lower student progress (<27.33% of overall program credits) is influenced by the age at the time of university entry. The tree in **Figure 2** shows two different situations; first, those with a student progress level equal or lower to 1.33% ($\chi^2 = 17.133$; $p = 0.003$), for students who are 20 years old or younger at the time of enrollment, is associated with lower proportion of dropout and transfer paths (43.9 and 42.1%, respectively). Conversely, enrolling at age 20 or older leads to a higher percentage of dropout cases (81%). Therefore, it can be concluded that a low student progress in addition to entry at an older age can lead to higher dropout, while having a low student progress and a younger age (age 20 or under) tends to result in a higher proportion of students choosing to redirect their educational path by means of degree transfer (42.1%), rather than to quit studying (43.9%). Something similar happens in the group with a student progress level between 1.33 and 27.33% ($\chi^2 = 52.071$; $p = 0.000$), even though in this case the entry age cutoff would be lower: where students over age 19 at the time of university entry tend to quit 71.6% of the time, and those aged 19 or younger are more likely to transfer to another degree and even more if we take in regard time devoted to study. In this last case, devoting a large amount of time to studying is linked to higher rate of degree transfer, whereas the results are uneven in cases that report having devoted a little time to studying regardless of the group being considered.

Lastly, among the students that have shown the highest level of student progress (having passed at least the 44.16% of their program credits), are classified regarding their type of residence ($\chi^2 = 22.346$; $p = 0.000$). Specifically, living with parents, friends or in special student accommodation also increases the probability of academic persistence (96.5%), although the amount of time devoted to studying also remains a relevant factor. Students that report having devoted a lot of time to studying tend to persist in their initial program of study (97.6%),

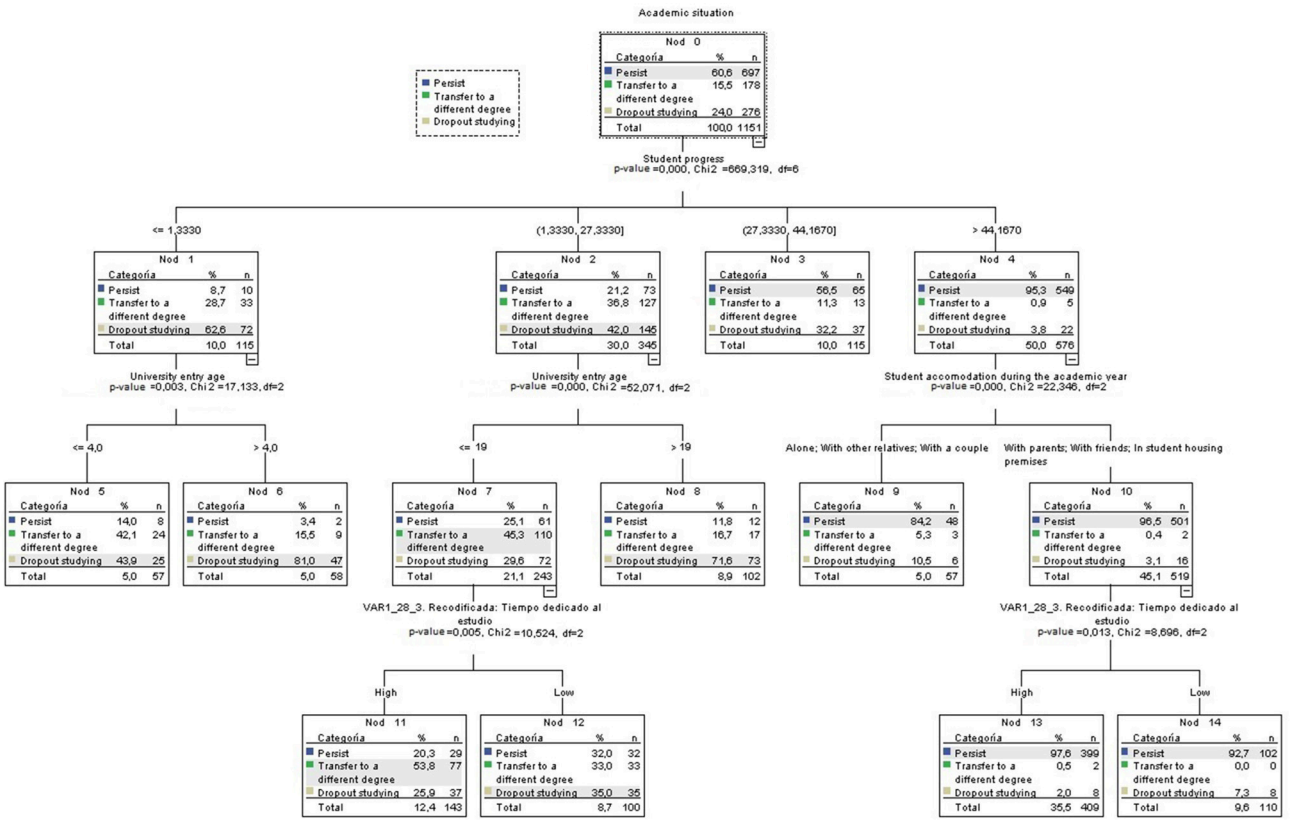


FIGURE 2 | Decision tree.

as opposed to those that declare to have devoted a little time. In contrast, students who live alone, with other relatives but parents or with their partner, have a higher probability of dropping out, doing so 10.5% of the time and persisting in their studies 84.2% of the time. Therefore, living with parents, friends or in student accommodation facilities can help to prevent student withdrawal.

In light of these results, the student profile for each of the studied groups can be defined as follows (**Figure 3**).

As reflected in **Figure 3**, students that persist are characterized by a good progress in the program (having passed more than the 27.33% of its overall credits), live with their parents, friends or in specific student housing premises and consider that they devote a high amount of time to study. Students that opt to transfer to other degree present a lower academic progress (between 1.33 and 27.33% of the program credits passed) are 19 or fewer years old and also consider that they devote a high quantity of time to study. Last, students that quit studying present a really low progress (having passed 1.33% or less of the program credits) and tend to entry university with older age (20 years or more).

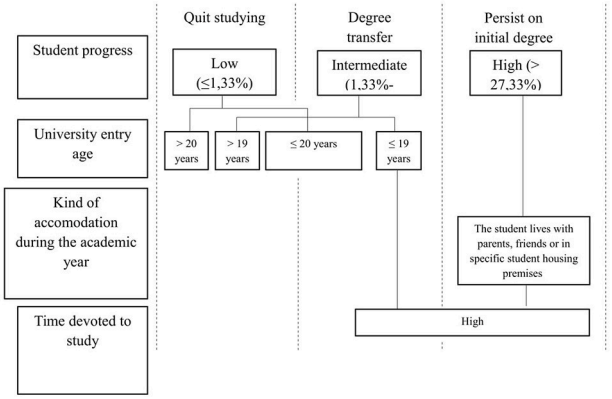


FIGURE 3 | Persistence, Program Transfer, and Dropout Profiles.

DISCUSSION

The previous **Figure 3** illustrates the relationship of the student group related to the academic status, and the variables influencing decisions regarding academic persistence[1], providing a student profile characterizing each group. These profiles provide valuable information for the institutional decision-making process:

[1]As explained before, we studied students that persist on their inicial degree in comparison with those that withdrw it but not necessary exit university studies neither quit studying.

- First, the group of students deciding to quit studying after having started a university program is mainly composed of older students with lower levels of academic progress. Therefore, institutions should establish specific measures for this mature and low-performance students to increase their persistence rates (Rubin and Wright, 2015; Mountford-Zimdars et al., 2017).
- Second, the group of students transferring to another program is mainly composed of students with low to intermediate level of academic progress but who show a high level of dedication to their studies. As stated by Andrews et al. (2014) this profile is harder to characterize, as there are different reasons to transfer and a wider range student processes underlying them. Consequently, we cannot equalize those freshmen that enter a particular program with the idea of transferring (as they could not match their preferred degree entry requirements) to those that transfer as a result of institutional persistence policies or a mismatch between their expectations and the programmed reality.
- And third, the group of students persisting in their degree is characterized by having higher levels of academic progress and living with their parents, friends or in student housing (with a partner or other relatives). Although this profile of students shows an appropriate adaptation to the program requirements, it is also necessary to establish some intervention measures aiming to secure their engagement and maximize their potential development (Arriaga et al., 2011; Duque, 2014; Quaye and Harper, 2014).

Some similarities were found between the persistence and transfer profiles, which can be understood to be connected to the level of determination of the second group to quit the initiated program, but also to continue their university studies (Arriaga et al., 2011).

Above the 46 studied variables, four of them proved to be the most influential on students' withdrawal decisions: Student progress was clearly the most important variable, reflecting the great impact of academic excellence on both policies and student performance. These results are consistent with those which have been obtained by other researchers (Cabrera et al., 2006; Willcoxson, 2010; Belloc et al., 2011; Goldenhersh et al., 2011; Casaravilla et al., 2012; Crawford, 2014; Moreno-Salinas and Stephens, 2015) and suggest to develop educational measures in order to avoid knowledge gaps and promote a better performance (King et al., 2015).

The second most influential variable was the age of the student. The results highlight that younger students entering university straight after High School are more likely to persist in their studies than those who have taken a break (regardless the length) or repeated a year before their entry into university. These findings agree with results obtained by several authors using different methods (Montmarquette et al., 2001; Smith and Naylor, 2001; Di Pietro, 2006; Yasmin, 2013; Soria-Barreto and Zuñiga-Jara, 2014). This results highlight the need that our institution (as many others) have to acquire: older students (often referred as mature or non-traditional students) are increasing their presence in our institutions and require special adaptations (timing, teaching methods, etc.) to match their educational needs (Shepherd and Sheu, 2014). No other variable seems to play a substantial role in student dropout pathways, and moreover these two (academic progress and age) have been linked to the phenomenon not only at university stage, but also in prior academic levels (Brunello and Checci, 2007; Lassibille and Navarro, 2009; Clotfelter et al., 2012; Diaz-Strong and Ybarra, 2016). Perhaps the feeling of failure linked to slow academic progress impacts students' self-esteem (Carabante et al., 2013; Fang and Galambos, 2015) such an extent that it discourages them from studying for a period (Tinto, 2015; Sauvé et al., 2016). This conclusion highlights the importance of promoting student engagement and self-regulation, as it is a variable in which one faculty can act over (Trevors et al., 2016).

In the case of the groups of medium and high academic progress (closely linked to persistence and transfer groups), some additional variables proved to influence their persistence on the institution; Time devoted to studying is the most relevant one, explaining their engagement to the institution by their better academic progress, in comparison to the dropout group (Trevizán et al., 2009; Alarcon and Edwards, 2013; Moulin et al., 2013; Ruiz-Gallardo et al., 2016).

Lastly, and closely linked to students with good academic progress levels, student residence factors (living with parents, friends, or in student housing facilities) stand out as an intermediate variable and contribute to higher levels of academic persistence (Trevizán et al., 2009; Wise, 2013; Moore, 2015). In this sense, Clerici et al. (2015) explain that live-in students spend their day in an environment that motivate them to complete their degrees, meanwhile living with their parents can constraint the time devoted to study as result of the family dynamics, but can also help, as they often act as an external control for the student. Therefore, some kinds of residence can contribute to a better academic progress and, hence, to persist studying (Larsen et al., 2013), making necessary to promote healthy environments to support educational processes (Langford et al., 2011).

CONCLUSION

The longitudinal and contextual character of dropout phenomenon makes its study more complex, as many variables are involved in the process and often interact with one to another. Therefore, in light of the results obtained, which have proven to be consistent with other research findings, Data Mining Techniques have proven to be very useful for the present study, as they allow for a more accurate understanding of the complex relationships between the variables (Abu-Oda and El-Halees, 2015; Meedech et al., 2016; Witten et al., 2016). The decision tree illustrating the predictive model shows that each group has certain characteristics in common, which can also serve to disguise them from other groups, responding partially to our research question. Variables included in our tree proceed only from the university warehouse. Therefore our first hypothesis (student academic situation cannot be predicted only using secondary data) was rejected. Although some limitations are found, to know these features is the key to promoting better persistence policies. Some authors even state that Educational Data Mining could base early warning systems

aiming to prevent a wide range of problematic educational situations (Márquez-Vera et al., 2016).

Above all, the present study highlights the importance of academic progress on persistence decisions among students prior to the European Higher Education Area (EHEA) implantation, confirming our second hypothesis (academic progress is a variable present in the model). EHEA changed the educational perspective, transferring the focus from teaching to learning, from professors to students and stating the European Credit Transfer System was one credit suppose 10 h of lectures and 15 h of students autonomous work (De Wit, 2015). Also, virtual campuses were promoted not only as a teaching tool but also as a space to develop the transversal computational competencies (Tjong and Prabowo, 2016). Regarding that the study programs developed on EHEA frame has proven to be highly demanding regarding self-regulation skills (Triventi, 2014; Ruiz-Gallardo et al., 2016), it would be recommendable to integrate a follow-up of Higher Education Modernization Agenda and student affair services (European Commission, 2006).

This perspective acquires our time (twenty-first century) as the era of technology, where the traditional boundaries to knowledge acquisition have broken down thanks in large part to computer-based environments. Space, time, and even money are no longer the formidable handicaps to accessing quality education that they used to be; and, as stated by the European Commission (2014), virtual learning environments have the potential to spread knowledge, culture, and participation throughout the world, with tertiary education playing a remarkable role in the process (Cerezo et al., 2017). In addition, such a environments facilitate educational research, as they can be used as a tool to access student data (García et al., 2011). Thus, it is paramount for Higher Education Institutions to include consideration of the student withdrawal phenomenon on their agendas, taking the advantage that e-administration open to universities through the implantation of their virtual campuses.

In addition, our study underlines a previously pointed out trend; the recalled non-traditional students (54.4% of our sample was over 19 years old, and 8.7% is over 25 when they enter the institution), related to those students that do not enter the university straight forward high school, and that often have additional responsibilities (family, work and others) that can challenge their progress on the program (Gilardi and Guglielmetti, 2011; Vossensteyn et al., 2015). Since Higher Education is a public good, it is the responsibility of governments and institutions to promote equal opportunities to access, progress, and graduate in this educational setting. In this sense, virtual campuses have the potential not only to better monitor student progress—as previously commented—but also to be used as a mechanism to fill in knowledge gaps and promote the engagement of this non-traditional students (Van Doorn and Van Doorn, 2014).

LIMITATIONS AND FURTHER RESEARCH

As highlighted by Arriaga et al. (2011), to effectively prevent university dropout, it is not enough to act solely during the context in which the dropout occurs, but rather during the previous educational stages as well. To be able to achieve this goal, the creation of a common Data Warehouse would be a great advantage (Miñaca and Hervás, 2013). Not having unlimited access to student data was a limitation of our study, as we could not examine all the available information, neither obtain detail about the transfer to other university profile (which comprises two situations, study the same degree that in the initial institution and start a new degree).

In this sense, Colombia provides a great example of one such warehouse, as it Spadies System[2] integrates the information and makes it accessible to anyone interested in studying the problem. While Spain does not have such an advantageous information system as of yet, some researchers are proposing simple and economical methods to promote greater institutional understanding of the process.

ETHICS STATEMENT

Ethical approval was not required for this study in accordance with the national and institutional guidelines. The applied procedures in the present study were developed in accordance with the ethical standards of the Research Ethics Committee of the University of Oviedo and the Helsinki Declaration of 1975 and 1983.

AUTHOR CONTRIBUTIONS

AB contributed to the design of the study and data interpretation. As principal author, she coordinated the writing process of the manuscript. AC and ME are Ph.D. students that study the dropout phenomenon across learning environments, and therefore have participated on each phase of this research. ET, JC, and LA have joint the research team once the survey had been carried out but, since then have largely contribute to the analysis and interpretation of data, and consequently to the understanding of the phenomenon. Every author have play a remarkable role on the writing of this article.

FUNDING

Alfaguia Project was funded by the European Union (DCI-ALA/2010/94). Additionally, our research team is granted by the European Regional Development Funds (The European Union and Principality of Asturias) in the frame of the Science, Technology and Innovation Plan (GROUPIN14-100 and GROUPIN14-053). Also, Ph.D. students were granted: ME was granted by the Spanish Ministry of Economy, Industry and Competitiviness (BES-2015-072470), AC recibe support of Asturias Regional Department of Education and Culture (BP16014) and JC received funding from the Portuguese Foundation for Science and Technology (SFRH/BD/117902/2016).

[2]http://www.mineducacion.gov.co/sistemasdeinformacion/1735/w3-article-212299.html

REFERENCES

Abu-Oda, G. S., and El-Halees, A. M. (2015). Data mining in higher education: university student dropout case study. *Int. J. Data Mining Knowl. Manage. Process* 5:15. doi: 10.5121/ijdkp.2015.5102

Alarcon, G. M., and Edwards, J. M. (2013). Ability and motivation: assessing individual factors that contribute to university retention. *J. Educ. Psychol.* 105:129. doi: 10.1037/a0028496

Alkan, N. (2016). Psychological sense of university membership: an adaptation study of the PSSM scale for Turkish university students. *J. Psychol.* 150, 431–449. doi: 10.1080/00223980.2015.1087373

Andrews, R., Li, J., and Lovenheim, M. F. (2014). Heterogeneous paths through college: detailed patterns and relationships with graduation and earnings. *Econ. Educ. Rev.* 42, 93–108. doi: 10.3386/w19935

Angulo-Ruiz, L. F., and Pergelova, A. (2013). The student retention puzzle revisited: the role of institutional image. *J. Nonprofit Public Sect. Market.* 25, 334–353. doi: 10.1080/10495142.2013.830545

Arriaga, J., Burillo, V., Carpeño, A., and Casaravilla, A. (2011). "Caracterización de los tipos de abandono. Dividamos el problema y venceremos más fácilmente," in *J. Arriaga I Conferencia Latinoamericana sobre el Abandono en la Enseñanza Superior* (Madrid: Dpto. de Publicaciones de la EUIT de Telecomunicación), 75–82.

Badr, G., Algobail, A., Almutairi, H., and Almutery, M. (2016). "Predicting students' performance in university courses: a case study and tool in KSU mathematics department," in *4th Symposium On Data Mining Applications* (Riyadh).

Baker, R. S., and Yacef, K. (2009). The state of educational data mining in 2009: a review and future visions. *J. Educ. Data Mining* 1, 3–17.

Bean, J. (1983). The application of a model of turnover in work organizations to the student attrition process. *Rev. High. Educ.* 17, 129–148. doi: 10.1353/rhe.1983.0026

Bedard, K. (2001). Human capital versus signaling models: university access and high school dropouts. *J. Polit. Econ.* 109, 749–775. doi: 10.1086/322089

Belloc, F., Maruotti, A., and Petrella, L. (2011). How individual characteristics affect university students drop-out: a semiparametric mixed-effects model for an Italian case study. *J. Appl. Stat.* 38, 2225–2239. doi: 10.1080/02664763.2010.545373

Berlanga, V., Rubio, M. J., and Vilá, R. (2013). Cómo aplicar árboles de decisión en SPSS. *Rev. Innov. Recerca Educ.* 6, 65–79. doi:10.1344/reire2013.6.1615

Bernardo, A., Cerezo, R., Rodríguez-Muñiz, L. J., Núñez, J. C., Tuero, E., and Esteban, M. (2015). Predicción del abandono universitario: variables explicativas y medidas de prevención. *Fuentes* 16, 63–84. doi: 10.12795/revistafuentes.2015.i16.03

Bernardo, A., García, M. E., López, A. G., Rodríguez Muñiz, L. J. (2017a). ASIA[1a], una eina en línia per analitzar l'abandonament universitari. *Rev. Innov. Docent Univ.* 9, 148–159. doi: 10.1344/RIDU2017.9.13

Bernardo, A., Esteban, M., Gonzalez-Pienda, J. A., and Núñez, J. C., and dobarro, A. (2017b). "University dropout: definition, features and prevention measures," in *Factors Affecting Academic Performance*, eds J. A. González-Pienda, A. Bernardo, J. C. Núñez, and C. Rodríguez (New York, NY: Nova Science), 239–260.

Braxton, J. M., Milem, J. M., and Shaw, A. (2000). The influence of Active learning on the college student departure process: toward a revision of tinto's theory. *J. High. Educ.* 71, 569–590. doi: 10.1080/00221546.2000.11778853

Braxton, J. M., Shaw Sullivan, A. V., and Johnson, R. M. (1997). "Appraising Tinto's Theory of College Student Departure," in *Higher Education: Handbook of Theory and Research, Vol. 12,* ed J. C. Smart (New York, NY: Agathon Press), 107–164.

Brunello, G., and Checci, D. (2007). Does school tracking affect equality of opportunity? *N. Int. Evid. Econ. Policy* 52, 781–861. doi: 10.1111/j.1468-0327.2007.00189.x

Cabrera, L., Bethencourt, J. T., Pérez, P. A., and Afonso, M. G. (2006). El problema del abandono de los estudios universitarios. *Rev. Electrón. Invest. Eval. Educ.* 12, 171–203. Available online at: http://www.uv.es/RELIEVE/v12n2/RELIEVEv12n2_1.htm

Carabante, J. M., Muelas, A., Velayos, J., and Moya, J. J. (2013). "Instrumental and social skills in pre-university and university studies: Performance and satisfaction guaranteed," *INTED 2013, Proceedings,* eds L. Gómez, A. López and I. Candel (Valencia: IATED), 4234–4240.

Casaravilla, A., Del Campo, J. M., García, A., and Torralba, M. R. (2012). "Análisis del abandono en estudios de ingeniería y arquitectura en la Universidad Politécnica de Madrid," in *II Conferencia Latinoamericana sobre el Abandono en la Enseñanza Superior*, ed J. Arriaga (Madrid: Dpto. de Publicaciones de la EUIT de Telecomunicación), 83–90.

Cerezo, R., Esteban, M., Rodríguez, L., Bernardo, A., Sanchez, M., Amiero, N., et al. (2017). "Learning. difficulties in computer-based learning environments," in *Factors Affecting Academic Performance*, eds J. A. González-Pienda, A. Bernardo, J. C. Núñez, and C. Rodríguez (New York, NY: Nova Science), 157–171.

Clerici, R., Giraldo, A., and Meggiolaro, S. (2015). The determinants of academic outcomes in a competing risks approach: evidence from Italy. *Stud. High. Educ.* 40, 1535–1549. doi: 10.1080/03075079.2013.878835

Clotfelter, C. T., Ladd, H. F., and Vigdor, J. L. (2012). New destinations, new trajectories? The educational progress of hispanic youth in North Carolina. *Child Dev.* 83, 1608–1622. doi: 10.1111/j.1467-8624.2012.01797.x

Colás, P. (2015). El abandono universitario. *Fuentes* 16, 9–14. doi: 10.12795/revistafuentes.2015.i16

Cope, R. G., and Hannah, W. (1975). *Revolving College Doors: The Causes and Consequences of Dropping Out, Stopping Out, and Transferring*. New York, NY: Wiley Interscience.

Crawford, C. (2014). *Socio-economic Differences in University Outcomes in the UK: Drop-out, Degree Completion and Degree Class*. Londres: Nuffield Foundation.

Cuseo, J., and Farnum, T. (2011). *Seven Myths about Student Retention*. Teresa Farnum & Associates, Inc.

De Wit, H. (2015). The road to a European higher education area. *Int. Hig. Educ.* 25, 4–5. doi: 10.6017/ihe.2001.25.6945

Di Pietro, G. (2006). Regional labour market conditions and university dropout rates: evidence from Italy. *Reg. Stud.* 40, 617–630. doi: 10.1080/00343400600868770

Diaz-Strong, D. X., and Ybarra, M. A. (2016). Disparities in high school completion among Latinos: the role of the age-at-arrival and immigration status. *Child. Youth Serv. Rev.* 71, 282–289. doi: 10.1016/j.childyouth.2016.11.021

Duque, L. C. (2014). A framework for analysing higher education performance: students' satisfaction, perceived learning outcomes, and dropout intentions. *Tot. Qual. Manag. Bus. Excell.* 25, 1–21. doi: 10.1080/14783363.2013.807677

Escobar, H., Burbano, W., and Poris, A. (2016). Intelligent data analysis applied to the grading process at the state technical university of quevedo. *Publicando* 3, 33–44.

European Commission (2006). *Delivering on the Modernization Agenda for Universities: Education, Research and Motivation*. Brussels: COM.

European Commission (2014). *New Modes of Learning and Teaching in Higher Education*. Luxembourg: European Union.

Fang, S., and Galambos, N. L. (2015). Bottom dogs on campus: how subjective age and extrinsic self-esteem relate to affect and stress in first semester of university. *J. Youth Stud.* 18, 537–552. doi: 10.1080/13676261.2014.992308

García, E., Romero, C., Ventura, S., and De Castro, C. (2011). A collaborative educational association rule mining tool. *Internet High. Educ.* 14, 77–88. doi: 10.1016/j.iheduc.2010.07.006

Ghignoni, E. (2017). Family background and university dropouts during the crisis: the case of Italy. *High. Educ.* 73, 127–151. doi: 10.1007/s10734-016-0004-1

Gilardi, S., and Guglielmetti, C. (2011). University life of non-traditional students: engagement styles and impact on attrition. *J. Higher Educ.* 82, 33–53. doi: 10.1080/00221546.2011.11779084

Goldenhersh, H., Coria, A., and Saino, M. (2011). Deserción estudiantil: desafíos de la Universidad pública en un horizonte de inclusión. *Rev. Argent. Educ. Super.* 3, 96–120. Available online at: http://www.untref.edu.ar/raes/documentos/raes_3_goldenhersh.pdf

González, M. C., Álvarez, P. R., Cabrera, L., and Bethencourt, J. T. (2007). El abandono de los estudios universitarios: factores determinantes y medidas preventivas. *Revista Española de Pedagogía* 65, 71–85.

Hand, D. J. (1998). Data mining: statistics and more? *Am. Stat.* 52, 112–118.

Hasbun, T., Araya, A., and Villalon, J. (2016). "Extracurricular activities as dropout prediction factors in higher education using decision trees," in *IEEE 16th International Conference on Advanced Learning Technologies (ICALT)* (Austin, TX), 242–244. doi: 10.1109/ICALT.2016.66

Heilbrun, A. B. Jr. (1965). Personality factors in college dropout. *J. Appl. Psychol.* 49:1. doi: 10.1037/h0021653

Hossler, D., and Kalsbeek, D. (2013). Enrollment management and managing enrollments: revisiting the context for institutional strategy. *Strateg. Enroll. Manage. Q.* 1, 5–25. doi: 10.1002/sem3.20002

Jensen, E. (1981). Student financial aid and persistence in college. *Stud. High. Educ.* 15, 89–99.

Kamers, D. (1971). The college "charter" & college size: effects on occupational choice and college attrition. *Sociol. Educ.* 44, 270–296. doi: 10.2307/2111994

King, E. M., Orazem, P. F., and Paterno, E. M. (2015). Promotion with and without learning: effects on student enrollment and dropout behavior. *World Bank Econ. Rev.* 30, 580–602.

Langford, R., Campbell, R., Magnus, D., Bonell, C. P., Murphy, S. M., Waters, E., et al. (2011). The WHO Health Promoting School framework for improving the health and well-being of students and staff. *Cochrane Database Syst. Rev.* 1:CD008958. doi: 10.1002/14651858.CD008958

La Red-Martínez, D. L., Karanik, M., Giovannini, M., and Pinto, N. (2015). Perfiles de rendimiento académico: un modelo basado en minería de datos. *Campus Virtuales* 4, 12–30. Available online at: http://uajournals.com/ojs/index.php/campusvirtuales/article/view/66/65

Larsen, M. R., Sommersel, H. B., and Larsen, M. S. (2013). *Evidence on Dropout Phenomena at Universities*. Copenhagen: Danish Clearinghouse for Educational Research.

Lassibille, G., and Navarro, M. L. (2009). Tracking students' progress through the Spanish university school sector. *High. Educ.* 58, 821–839. doi: 10.1007/s10734-009-9227-8

Liang, J., Yang, J., Wu, Y., Li, C., and Zheng, L. (2016). "Big data application in education: dropout prediction in edx MOOCs," in *Proceedings of IEEE Second International Conference on Multimedia Big Data (BIGMM)* (Tampei), 440–443.

López, C. E., León, E., and González, F. (2015). A model to predict low academic performance at a specific enrollment using data mining. *Revista Iberoamericana de Tecnologias del Aprendizaje* 10, 119–125. doi: 10.1109/RITA.2015.2452632

Marín, M., Infante, E., and Troyano, Y. (2000). El fracaso académico en la universidad: aspectos motivacionales e intereses profesionales. *Rev. Latinoam. Psicol.* 32, 505–517.

Márquez-Vera, C., Cano, A., Romero, C., Noaman, A. Y. M., Mousa Fardoun, H., and Ventura, S. (2016). Early dropout prediction using data mining: a case study with high school students. *Expert Syst.* 33, 107–124. doi: 10.1111/exsy.12135

Meedech, P., Iam-On, N., and Boongoen, T. (2016). "Prediction of student dropout using personal profile and data mining approach," in *Intelligent and Evolutionary Systems,* eds K. Lavangnananda, S. de fon de Amnuaisuk, W. Engchuan, and J. Chan (Bangok: Springer International Publishing), 143–155.

Meneses, A. I. (2011). Associated factors to school dropout of students admitted with the condition of indigenous exception to the Universidad del Valle in 2001-II. *Sociedad y Economía* 20, 69–98.

Miñaca, M. I., and Hervás, M. (2013). Intervenciones dirigidas a la prevención del fracaso y abandono escolar: Un estudio de revisión. *Revista Española de Educación Comparada,* 21, 203–220.

Montmarquette, C., Mahseredjian, S., and Houle, R. (2001). The determinants of university dropouts: a bivariate probability model with sample selection. *Econ. Educ. Rev.* 20, 475- 484. doi: 10.1016/S0272-7757(00)00029-7

Moore, M. D. (2015). *Academic Performance among Homeless Students: Exploring Relationships of Socio-Economic and Demographic Variables.* Doctoral dissertation, University of Central Florida, Orlando, FL.

Moreno, J. G., and Stephen, C. R. (2015). Applying data mining techniques to identify success factors in students enrolled in distance learning: a case study. *Lecture Notes Artif. Intell.* 9414, 208–219. doi: 10.1007/978-3-319-27101-9_15

Moseley, L. G., and Mead, D. M. (2008). Predicting who will drop out of nursing courses: a machine learning exercise. *Nurse Educ. Today* 28, 469–475. doi: 10.1016/j.nedt.2007.07.012

Moulin, S., Doray, P., Laplante, B., and Street, M. C. (2013). Work intensity and non-completion of university: longitudinal approach and causal inference. *J. Educ. Work* 26, 333–356. doi: 10.1080/13639080.2011.653554

Mountford-Zimdars, A., Sanders, J., Moore, J., Sabri, D., Jones, S., and Higham, L. (2017). What can universities do to support all their students to progress successfully throughout their time at university? *Perspectives* 21, 101–110. doi: 10.1080/13603108.2016.1203368

Nagrecha, S., Dillon, J. Z., and Chawla, N. V. (2017). "MOOC dropout prediction: lessons learned from making pipelines interpretable," in *Proceedings of the 26th International Conference on World Wide Web Companion* (Perth, WA: International World Wide Web Conferences Steering Committee), 351–359.

Naranjo, M. L. (2009). Motivación: perspectivas teóricas y algunas consideraciones de su importancia en el ámbito educativo. *Educación* 33, 153–170. doi: 10.15517/revedu.v33i2.510

Pandey, R. E. (1973). A comparative study of dropout at an integrated university: the 16 Personality Factor Test. *J. Negro Educ.* 42, 447–451. doi: 10.2307/2966557

Pascarella, E. T., and Terenzini, P. (1983). Predicting voluntary freshman year persistence/withdrawal behavior in a residential university: a path analytic validation of Tinto's model. *J. Educ. Psychol.* 75, 215–226. doi: 10.1037/0022-0663.75.2.215

Pascarella, E. T., Terenzini, P. T., and Wolfle, L. M. (1986). Orientation to college and freshman year persistence/withdrawal decisions. *J. High. Educ.* 57, 155–175. doi: 10.1080/00221546.1986.11778760

Peralta, S. C., Ramírez, A. F., and Casta-o, H. (2006). Factores resilientes asociados al rendimiento académico en estudiantes pertenecientes a la universidad. de Sucre (Colombia). *Psicol. Desde Caribe* 17, 196–219.

Pincus, F. (1980). The false promise of community college: class conflict and vocational education. *Harvard Educ. Rev.* 50, 332–361. doi: 10.17763/haer.50.3.y733663386302231

Pluut, H., Curşeu, P. L., and Ilies, R. (2015). Social and study related stressors and resources among university entrants: effects on well-being and academic performance. *Learn. Individ. Differ.* 37, 262–268. doi: 10.1016/j.lindif.2014.11.018

Proyecto Alfa-GUIA (2014a). *Documento de Síntesis del Proyecto Gestión Universitaria Integral del Abandono (GUIA).* Available online at: http://bit.ly/2mYVi5N

Proyecto Alfa-GUIA (2014b). *Informe de Resultados de la Encuesta de Abandono de la Educación Superior*. Available online at: http://bit.ly/1uqVR6l

Proyecto Alfa-GUIA and Grupo de Análisis (2014). *Encuesta Sobre Causas de Abandono y Decisiones del Estudiante Relativas al Abandono de Estudios en Educación Superior*. Cuestionario online España. Available online at: http://www.bit.ly/SAynOl

Quaye, S. J., and Harper, S. R. (Eds.) (2014). *Student Engagement in Higher Education: Theoretical Perspectives and Practical Approaches for Diverse Populations*. New York, NY: Routledge.

Rodrigo, M. F., Molina, J. G., García-Ros, R., and Pérez-González, F. (2012). Efectos de interacción en la predicción del abandono en los estudios de Psicología. *Anal. Psicol.* 28, 113–119. Available online at: http://www.redalyc.org/articulo.oa?id=16723161014

Romero, C., and Ventura, S. (2013). Data mining in education. *Wiley Interdiscipl. Rev.* 3, 12–27. doi: 10.1002/widm.1075

Rubin, M., and Wright, C. L. (2015). Age differences explain social class differences in students' friendship at university: implications for transition and retention. *High. Educ.* 70:427. doi: 10.1007/s10734-014-9844-8

Ruiz-Gallardo, J. R., González-Geraldo, J. L., and Castaño, S. (2016). What are our students oing? Workload, time allocation and time management in PBL instruction. A case study in Science Education. *Teach. Teach. Educ.* 53, 51–62. doi: 10.1016/j.tate.2015.10.005

Rumberger, R. W. (1983). Dropping out of high school: the influence of race, sex, and family background. *Am. Educ. Res. J.* 20, 199–220. doi: 10.3102/00028312020002199

Santos, M. V., and Vallerado, E. (2013). Algunas dimensiones relacionadas con el rendimiento académico de estudiantes de Administración y Dirección de Empresas. *Univ. Psychol.* 12, 739–752. Available online at: http://revistas.javeriana.edu.co/index.php/revPsycho/article/view/2052

Sauvé, L., Fortin, A., Viger, C., and Landry, F. (2016). Ineffective learning strategies: a significant barrier to post-secondary perseverance. *J. Further High. Educ.* 1–18. doi: 10.1080/0309877X.2016.1224329

Shaleena, K. P., and Paul, S. (2015). "Data mining techniques for predicting student performance," *2015 IEEE International Conference on Engineering and Technology (ICETECH)* (Coimbatore), 1–3. doi: 10.1109/ICETECH.2015.7275025

Shepherd, M. M., and Sheu, T. S. (2014). The effects of informal faculty-student interaction and use of information technology on non-traditional students' persistence intentions and educational outcomes. *J. High. Educ. Theor. Pract.* 14:46.

Smith, J. P., and Naylor, R. A. (2001). Dropping out of university: a statistical analysis of the probability of withdrawal for U.K. university students. *J. R. Stat. Soc.* 164, 389–405. doi: 10.1111/1467-985X.00209

Soria-Barreto, K., and Zuñiga-Jara, S. (2014). Determining aspects of academic success of university students. *Formación Universitaria* 7, 41–50.

Suárez-Orozco, M. M., and Qin-Hilliard, D. (2004). *Globalization: Culture and Education in the New Millennium*. Los Angeles, CA: University of California Press.

Tinto, V. (1975). Dropout from higher education: a theoretical synthesis of recent research. *Rev. Educ. Res.* 45, 89–125. doi: 10.3102/00346543045001089

Tinto, V. (1988). Stages of student departure: reflections on the longitudinal character of student leaving. *J. Higher Educ.* 59, 438–455. doi: 10.1080/00221546.1988.11780199

Tinto, V. (1998). Colleges as communities: taking research on student persistence seriously. *Rev. High. Educ.* 21, 167–177.

Tinto, V. (2012). *Completing College: Rethinking Institutional Action*. Chicago, IL: The University of Chicago Press.

Tinto, V. (2015). Through the eyes of students. *J. Coll. Stud. Retent.* doi: 10.1177/1521025115621917. [Epub ahead of print].

Tjong, Y., and Prabowo, H. (2016). Key successful factors for virtual university implementation: a literature study. *J. Telecommun. Electron. Comp. Eng.* 8, 89–93.

Trevizán, A. L., Beltrán, C., and Cosolito, P. (2009). Variables que condicionan la deserción y retención durante el trayecto universitario de alumnos de carrera de Ingeniería Agronómica de la Universidad Nacional de Rosario. *Revista de Epistemología y Ciencias Humanas* 1, 85–95. Available online at: http://www.revistaepistemologi.com.ar/biblioteca/09-Variables%20que%20condicionan%20la%20desercion%20y%20retencion%20durante%20el%20trayecto.pdf

Trevors, G., Feyzi-Behnagh, R., Azevedo, R., and Bouchet, F. (2016). Self-regulated learning processes vary as a function of epistemic beliefs and contexts: mixed method evidence from eye tracking and concurrent and retrospective reports. *Learn. Instruct.* 42, 31–46. doi: 10.1016/j.learninstruc.2015.11.003

Triventi, M. (2014). Does working during higher education affect students' academic progression? *Econ. Educ. Rev.* 41, 1–13. doi: 10.1016/j.econedurev.2014.03.006

UNESCO (2004). *World Higher Education Database*. Available online at: http://www.unesco.org/iau/directories/index.html

Van Doorn, J. R., and Van Doorn, J. D. (2014). The quest for knowledge transfer efficacy: blended teaching, online and in-class, with consideration of learning typologies for non-traditional and traditional students. *Front. Psychol.* 5:324. doi: 10.3389/fpsyg.2014.00324

Vossensteyn, H., Kottmann, A., Jungbloed, B., Kaiser, F., and Cremonini, L. (2015). *Dropout and Completion in Higher Education in Europe: Main Report*. Luxembourg: Publications Office of the European Union.

Vries, W. D., León, P., Romero, J. F., and Hernández, I. (2011). Desertores o decepcionados? Distintas causas para abandonar los estudios universitarios. *Rev. Educ. Super.* 40, 29–49.

Wilcox, P., Winn, S., and Fyvie-Gauld, M. (2005). 'It was nothing to do with the university, it was just the people': the role of social support in the first-year experience of higher education. *Stud. High. Educ.* 30, 707–722. doi: 10.1080/03075070500340036

Willcoxson, L. (2010). Factors affecting intention to leave in the first, second and third year of university studies: a semester-by-semester investigation. *High. Educ. Res. Dev.* 29, 623–639. doi: 10.1080/07294360.2010.501071

Wise, C. (2013). *The Influence of Household/Parental Structure and Student Performance on Standardized Tests* Doctoral dissertation, University of Washington, Washington, DC.

Witten, I. H., Frank, E., Hall, M. A., and Pal, C. J. (2016). *Data mining: Practical Machine Learning Tools and Techniques*. San Francisco, CA: Morgan Kaufmann Publishers.

Yasmin, D. (2013). Application of the classification tree model in predicting learner dropout behaviour in open and distance learning. *Distance Educ.* 34, 218–231. doi: 10.1080/01587919.2013.793642

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Bernardo, Cervero, Esteban, Tuero, Casanova and Almeida. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 11 September 2017
doi: 10.3389/fpsyg.2017.01545

What and How Much Do Children Lose in Academic Settings Owing to Parental Separation?

Tania Corrás[1], Dolores Seijo[2], Francisca Fariña[3], Mercedes Novo[2], Ramón Arce[2] and Ramón G. Cabanach[4]*

[1] Forensic Psychology Institute, Universidade de Santiago de Compostela, Santiago de Compostela, Spain, [2] Political Science and Sociology, Universidade de Santiago de Compostela, Santiago de Compostela, Spain, [3] Faculty of Education Sciences and Sports, University of Vigo, Vigo, Spain, [4] Facultad de Fisioterapia, University of A Coruña, A Coruña, Spain

The literature has firmly established an association between parental separation and school failure. Nevertheless, parental separation does not affect academic aptitudes. Thus, mediators explain such relationship. A field study was designed to identify and quantify damage in the mediating variables between parental separation and school failure (i.e., external school adjustment, aversion to institution, aversion to learning, aversion to instruction, aversion to teachers, indiscipline). A total of 196 children, classified into three age cohorts: 109 in level 1 (from 8 to 11 years), 46 in level 2 (from 12 to 14 years), and 41 in level 3 (15 or more years), were assessed in school adjustment and in underlying dimensions of school (mal)adjustment. The results showed significant effects of parental separation in school adjustment and in the underlying dimensions to maladjustment in the three classification levels. The magnitude of damage increased with age, i.e., small in level 1, moderate in 2, and large in 3. Damage in all the sub-dimensions underlying school (mal)adjustment was quantified. The implications of the results for the design and implementation of prevention and intervention programs for children from separated parents are discussed.

Keywords: parental separation, school (mal)adjustment, aversion to learning, aversion to teachers, school (dis)satisfaction, indiscipline

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Ismael Loinaz, University of Barcelona, Spain
Ana M. Martín, Universidad de La Laguna, Spain

****Correspondence:***
Ramón Arce
ramon.arce@usc.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *17 May 2017*
Accepted: *24 August 2017*
Published: *11 September 2017*

Citation:
Corrás T, Seijo D, Fariña F, Novo M, Arce R and Cabanach RG (2017) What and How Much Do Children Lose in Academic Settings Owing to Parental Separation? Front. Psychol. 8:1545. doi: 10.3389/fpsyg.2017.01545

INTRODUCTION

According to the Eurostat (2015) statistical data on separation and divorce in the EU-28, approximately 65% of adults live as couples (married or in consensual union) with approximately half ending in separation. Almost a million divorces and separations are recoded every year, around half of these involve children. Parental separation is linked to negative effects on children in terms of psychological adjustment, academic performance, behavioral disorders, self-concept, and social adjustment (Amato, 2001). The estimates on the average damage are around 17% in psychological adjustment; a 14.6% increase in the rate of academic failure (school repetition rate) and a 16.9% fall in academic performance; a rise in the mean rate of 13.2% in disruptive and 11.8% in aggressive behavior (behavioral disorders); a mean decrease of 32% in academic, 27%

emotional, 22% physical, and 37% family self-concept; as well as in social adjustment as measured by a mean loss of 16% in self-control in social relations, and an increase of 21% in social withdrawal (Seijo et al., 2016). Moreover, children from broken homes have been found to convert psychological problems into physical symptoms, increasing the probability of developing gastrointestinal, genitourinary, dermatological, and neurological disorders due to parental breakup by 14.1, 7.7, 14.4, and 17.1%, respectively (Martinón et al., 2017). Both the clinical models (American Psychiatric Association, 2013), and the additive or accumulative deficit explanatory models of delinquency (Lösel et al., 1992) assert that damaged areas are interrelated and constitute a cluster of damages, making them highly resistant to intervention, and fostering persistent recidivism in maladjustment (Maruna, 2004; Hutchings et al., 2010). Moreover, some of these spheres may act as protective factors safeguarding from maladjustment (e.g., in academic performance, self-concept), whereas in others they reflect the level of damage such as psychological adjustment, behavioral disorders, and social adjustment. In particular, academic performance may prompt the risk or protect against violence and delinquency (Jolliffe et al., 2016), psychological distress (Lyndon et al., 2014), and dysfunctions in self-concept (Huang, 2011). The Reciprocal Effects Model provides a reasonable explanation for the relationship between self-concept and academic achievement sustaining that prior self-concept affects subsequent academic achievement, and conversely prior academic achievement impacts on subsequent academic self-concept, i.e., the influence is reciprocal (Marsh et al., 2005). This model has obtained substantial empirical evidence (Huang, 2011), and has been extended with success to the relation between other domains (Móller et al., 2011), fitting the interrelationship among the damaged areas resulting from parental separation.

Bearing in mind that parental separation does not affect the child's aptitudes (e.g., IQ), mediators serve to explain the decrease in the damaged domains. The literature has identified beliefs and attitudes toward the educational system (Baker, 2006; Lee, 2016), school engagement (Wang and Holcombe, 2010), school environment (Norton, 2008; Roorda et al., 2011), and behavioral problems (Stipek and Miles, 2008) as the main mediators of academic achievement. Taking into account the literature and the fact that the probability of academic failure is directly associated to parental separation, a filed study was undertaken to assess the mediating variables of this effect and to quantify damage.

MATERIALS AND METHODS

Participants

A total of 196 children from separated parents participated in the study. Participants were classified by the instrument measure (TAMAI) according to the following age cohorts: 109 participants in level 1, 56.9% females and 43.1% males, aged 8–11 years ($M = 9.94$, $SD = 1.04$); 46 participants in level 2, 54.3% males and 45.6% females, aged 12–14 years ($M = 13.20$, $SD = 0.78$); and 41 participants in level 3, 51.2% females and 48.8% males, aged 15 years or more ($M = 16.10$, $SD = 1.05$).

Procedure

Participants were recruited from the pediatric catchment area of Santiago de Compostela, a city in North-western of Spain. Pediatricians were contacted to access the children from separated parents. To measure the chronic effects of separation, a minimum 1-year of parental separation was established. Most of the children (>90%) identified as coming from separated parents participated voluntarily in the study. Informed consent was obtained from parents, and children participated voluntarily. Data were processed in compliance with the Spanish Data Protection Law to guarantee the privacy and anonymity of participants and their families.

Post hoc analysis of design sensitivity ($1-\beta$) for a mean comparison with a test value, a moderate effect size ($d = 0.5$), and a Cronbach's alpha of 0.05 showed a design sensitivity (i.e., the probability of finding significant differences if they exist) for a sample size of 109 subjects (level 1), 46 subjects (level 2), and 41 subjects (level 3) of 99.9, 95.5, and 93.3%, respectively.

Measurement Instrument

Maladjustment in the school setting was measured by the TAMAI (Mutifactorial Self-Administered Test of Child Adjustment) by Hernández-Guanir (2015). The instrument divided the children into three levels according to differences in the underlying maladjustment dimensions mediated by the school level and age of the children: level 1 – from 8 to 11 years, studying 3rd, 4th, or 5th year of primary education in the Spanish school system; level 2 – from 12 to 14 years, studying 6th year of primary education, and 1st and 2nd year of secondary education; and level 3 – 15 years or more, studying 3rd or 4th year of secondary education. The underlying dimensions for school maladjustment at level 1 are: external school maladjustment (i.e., low commitment and indiscipline); aversion to the institution (i.e., toward teachers and school); and aversion to learning (i.e., toward studying and knowledge). For level 2, the sub-dimensions are aversion to instruction consisting of hypo-commitment (i.e., low commitment to learning), hypo-motivation (i.e., little interest in learning), and aversion to teachers (i.e., dissatisfaction with teachers); and indiscipline (i.e., disruptive classroom behavior). For level 3, the sub-dimensions are aversion to instruction consisting of hypo-commitment (i.e., low commitment to learning), hypo-motivation (i.e., little interest in learning), school dissatisfaction (i.e., dissatisfaction in classroom and college), and aversion to teachers (i.e., dissatisfaction with teachers); and indiscipline (i.e., disruptive classroom behavior). The internal consistency obtained for the participants in the study was: Cronbach's alpha of 0.86 for the whole sample; 0.71 for level 1 (sub-dimensions: external school adjustment = 0.79; aversion to instruction = 0.71; and aversion to learning = 0.69); 0.79 for level 2 (sub-dimensions: hypo-commitment = 73; hypo-motivation = 0.81; aversion to teachers = 0.80; indiscipline = 0.72); and 0.83 for level 3 (sub-dimensions: aversion to instruction = 0.89; hypo-commitment = 0.75; hypo-motivation = 0.70; school dissatisfaction = 0.71; aversion to teachers = 0.68; indiscipline = 0.84).

Data Analysis

The mean for the sample of children from separated parents was compared with the mean adjustment of the normative population (test value) provided in the instrument manual. As for the effect sizes Cohen's *d* was computed, being the confidence intervals for *d* derived from with Hunter and Schmidt's (2015) formula to estimate the generalization of the results to other samples. Additionally, the BESD statistic (Rosnow and Rosenthal, 1996) was calculated to quantify mean injury and the intervals of injury for 95% of subjects. In order to contrast differences in damage among levels, the differences among the correlations were computed (Cohen, 1988).

RESULTS

General Damage in School Adjustment

The results (see **Table 1**) show significant positive effects (i.e., separation was related to high maladjustment) in maladjustment at school in the three child classification levels, with a small effect size in level 1, moderate in 2, and large in 3. Notwithstanding, these results are not generalizable (when 95% CIs for *d* include zero, the results may not be generalized) to the entire population of children from separated parents. As for the magnitude of injury, mean injury was 21, 29, and 38%, ranging from 2.3 to 38.3% at level 1; 38.8 to 76.5% at level 2; and 8.2 to 61.6% at level 3. Comparatively, the lower limit of damage was significantly higher at level 2, 38.8% ($r = 0.388$) in contrast to level 1, 2.3% ($r = 0.023$), $q_s = 0.392$, $p < 0.05$. Whereas the upper limit of damages was significantly lower at level 1, 38.3% ($r = 0.383$), as compared to level 2, 76.5% ($r = 0.765$), $q_s = 0.596$, $p < 0.01$.

Analysis of the Sub-dimensions of the School Maladjustment

As for level 1 (i.e., children from 8 to 11 years), the results (see **Table 2**) showed significantly higher external school maladjustment, aversion to the institution, and aversion to learning. Nevertheless, these results may not be generalized to the whole population of children from separated parents (CIs for *d* includes 0). That is, parental separation may have adjustment effects for some samples. These may be up to more than three standard deviations (see the CIs lower limits which are related to adjustment). The average amount of damages was 21, 13, and 25% for external school maladjustment, aversion to the institution, and aversion to learning, respectively. While damages were equal in all the sub-dimensions (CIs for *r* overlap), for external school maladjustment and aversion to learning were positive and significant (CIs of *r* do not include 0), and not significant for aversion to the institution (negative CI lower limit), meaning that for some children separation diminished the aversion to the institution (positive effects).

At level 2 (from 12 to 14 years) (see **Table 3**), significant and positive effects, that is, higher levels of maladjustment, were observed in aversion to instruction, hypo-commitment, hypo-motivation, and aversion to teachers. No effects were registered in indiscipline. However, the results may not be generalized to the entire population of children (CIs for *d* include 0). The average damage registered in aversion to instruction, hypo-commitment, hypo-motivation, and aversion to teachers was 33, 29, 29, and 28%, respectively. Interestingly, the lower limits for hypo-motivation and hypo-commitment were 0 and negative for aversion to teachers, meaning that for some children there were no effects or adjustment effects (negative scores indicate adjustment, and positive scores maladjustment).

As for level 3 ($\geq$15 years), the results (see **Table 4**) revealed that children from separated parents exhibited significantly higher maladjustment manifested by aversion to instruction, hypo-commitment, hypo-motivation, school dissatisfaction, aversion to teachers, and indiscipline. Once again, results may not be generalized to children from the separated parent population. In relation to damage quantification, the observed average was of 38, 30, 42, 33, 23, and 21% for aversion to instruction, hypo-commitment, hypo-motivation, school dissatisfaction, aversion to teachers, and indiscipline, respectively. Notwithstanding, the damage for hypo-commitment, aversion to teachers, and indiscipline was not significant as the CIs lower limits were negative, meaning that for some children more adjustment effects on these variables were registered.

DISCUSSION

Although the data processing design took into account the generalization of the results, this study entails three limitations derived from the design of the field study. First, the study design was transversal (versus longitudinal), thus the evolution of damages throughout the child's development have not been ascertained. Second, the mean effects in children have been considered without taking into account the moderators of this relationship such as the degree of pre-separation and post-separation conflict, the child's gender, and co-parenting. Third, the responses of the children were prone toward biased over-reporting (Arce et al., 2015b) and defensiveness (Arce et al., 2015a) given that the children were immersed in a process involving parental disputes, e.g., judicial litigation, parental interference, and conflict of loyalties.

Bearing in mind the limitations of this study, the following conclusions for mediating variables between parental separation and academic achievement, for quantifying damages may be drawn from the results. First, in general parental separation had negative effects on the children's school adjustment. The magnitude of these negative effects increased with age, being small in level 1, moderate in 2, and large in 3. This tendency was equivalent, compatible, and complementary to the hypothesis of an escalating natural trajectory toward antisocial behavior (e.g., disruptive, violent, delinquent). In other words, the effects on maladjustment follow the natural tendency of increasing with the child's development, i.e., the older the child the greater the negative effects (Hawley, 2003; Arce et al., 2011). The

TABLE 1 | One sample *t*-test for scholar maladjustment by level of studies.

Variable	*t* (*df*)	M_{sf}	*tv*	*d* (95% CI_d)	*r* (95% CI_r)
Level 1	4.35 (108)***	7.07	4.0	0.42 (−3.581, 4.421)	0.21 (0.023, 0.383)
Level 2	4.15 (45)***	10.59	6.0	0.61 (−3.492, 4.712)	0.29 (0.388, 0.765)
Level 3	5.19 (40)***	13.46	7.5	0.81 (−3.373, 4.994)	0.38 (0.082, 0.616)

$^{***}p < 0.001$; M_{sf}: mean of the separated family group; tv: test value (mean of the normative population).

TABLE 2 | One sample *t*-test for the sub-dimensions of scholar maladjustment at level 1.

Variable	*t* (*df*)	M_{sf}	*tv*	*d* (95% CI_d)	*r* (95% CI_r)
External school maladjustment	4.49 (108)***	2.27	1.0	0.43 (−3.306, 4.923)	0.21 (0.023, 0.383)
Aversion to the institution	2.82 (108)**	1.47	1.0	0.26 (−3.713, 4.233)	0.13 (−0.060, 0.310)
Aversion to learning	5.47 (108)***	3.34	1.5	0.52 (−3.503, 4.543)	0.25 (0.065, 0.418)

$^{**}p < 0.01$; $^{***}p < 0.001$; M_{sf}: mean of the separated family group; tv: test value (mean of the normative population).

TABLE 3 | One sample *t*-test for the sub-dimensions of scholar maladjustment at level 2.

Variable	*t* (*df*)	M_{sf}	*tv*	*d* (95% CI_d)	*r* (95% CI_r)
Aversion to instruction	4.66 (45)***	9.11	5.0	0.69 (−3.438, 4.818)	0.33 (0.044, 0.566)
Hypo-application	4.10 (45)***	2.83	1.5	0.61 (−3.492, 4.712)	0.29 (0.000, 0.535)
Hypo-motivation	4.06 (45)***	4.70	3.0	0.60 (−3.499, 4.699)	0.29 (0.000, 0.535)
Aversion to teachers	3.90 (45)***	1.59	0.5	0.58 (−3.514, 4.674)	0.28 (−0.011, 0.527)
Indiscipline	1.62 (45)	1.48	1.0	0.24 (−3.785, 4.265)	0.12 (−0.176, 0.396)

$^{***}p < 0.001$; M_{sf}: mean of the separated family group; tv: test value (mean of the normative population).

TABLE 4 | One sample *t*-test for the sub-dimensions of scholar maladjustment at level 3.

Variable	*t* (*df*)	M_{sf}	*tv*	*d* (95% CI_d)	*r* (95% CI_r)
Aversion to instruction	5.26 (40)***	12.34	7.0	0.82 (−3.367, 5.001)	0.38 (0.082, 0.616)
Hypo-application	4.08 (40)***	4.87	3.0	0.63 (−3.490, 4.750)	0.30 (−0.060, 0.310)
Hypo-motivation	5.93 (40)***	5.02	2.5	0.92 (−3.309, 5.149)	0.42 (0.129, 0.644)
School dissatisfaction	4.58 (40)***	0.63	0.0	0.71 (−3.437, 4.857)	0.33 (0.025, 0.579)
Aversion to teachers	3.05 (40)**	1.80	1.0	0.47 (−3.607, 4.547)	0.23 (−0.074, 0.502)
Indiscipline	2.85 (40)**	1.41	0.5	0.44 (−3.630, 4.510)	0.21 (−0.104, 0.486)

$^{**}p < 0.01$; $^{***}p < 0.001$; M_{sf}: mean of the separated family group; tv: test value (mean of the normative population).

interrelationship between school (mal)adjustment and antisocial behaviors is such that school adjustment (e.g., high academic achievement, positive attitude to school) serves as a robust protective factor against violence (Jolliffe et al., 2016), whereas school maladjustment is one of the central eight antisocial risk factors (Andrews and Bonta, 2010). Moreover, school maladjustment is closely linked to a general and persistent life-long maladjustment trajectory (Fontaine et al., 2009; Arce et al., 2010; American Psychiatric Association, 2013). Second, the results are not generalizable to the global population of children from broken homes. The lack of generalization implies there were moderators of this relation, i.e., the existence of variables mediating the results of the effects. The most important moderator may be conflict, both in pre- and post-separation (Arce et al., 2005; Turner and Kopiec, 2006; Lacey et al., 2014). Moreover, other relevant moderators may be paternal school involvement, parent–child relationship, financial (in)stability, and decision-making concerning legal custody (Pruett et al., 2003; Bernard et al., 2015; Berryhill, 2017). Third, with the exception of the indiscipline sub-dimension in level 2, damage was significant in all of the sub-dimensions and levels. In other words, damage comprises a set of variables underlying academic performance, i.e., in attitudes (i.e., negative attitudes toward school and learning), the school environment (i.e., school dissatisfaction, dissatisfaction with teachers), engagement (low motivation and commitment), and behavioral problems (disruptive behavior, indiscipline). Thus, academic failure is an underlying outcome of these damages, and to cope with academic failure interventions should be targeted to repair them. Fourth, the mean magnitude of injury in school adjustment ranged from small ($0.10 > r < 0.30$) to moderate ($0.30 > r < 0.50$), and for particular children it fluctuated from negative effects

in maladjustment (i.e., more adjustment) to no or large effects ($r > 0.50$) in maladjustment. The results are in line with the previous literature asserting that parental separation has no effect on many children, whereas for others it derives in positive or negative outcomes (Amato and Anthony, 2014), with a mean negative effect for the total population of children from broken homes (Amato, 2001). Fifth, the underlying sub-dimensions to school maladjustment fluctuated among levels. Thus, according to the need principle of the Risk-Need-Responsive model (Andrews and Bonta, 2010), which meta-analyses have found to be valid for intervention (Hanson et al., 2009; Koehler et al., 2013), interventions should target these sub-dimensions.

In terms of the damage detected and its magnitude, the results of this study underscore the need for implementing damage prevention and intervention programs for children from separated parents. Thus, future research should be directed to profile and assess the moderators of adjustment and maladjustment effects to derive protective and risk factors for evidence-based prevention and intervention programs.

ETHICS STATEMENT

This study was approved by the Clinical Research Ethics Committee of the Autonomous Community of Galicia (Spain). Data were processed in compliance with the Spanish Data Protection Law.

AUTHOR CONTRIBUTIONS

The authors TC, DS, FF, MN, RA, and RGC have made a substantial, direct and intellectual contribution to the work.

FUNDING

This research has been sponsored by a grant of the Consellería de Cultura, Educación e Ordenación Universitaria of the Xunta de Galicia (PGC2014/022) and by a grant of the Spanish Ministry of Economy and Competitiveness (PSI2014-53085-R).

REFERENCES

Amato, P. R. (2001). Children of divorce in the 1990s: an update of the Amato and Keith (1991) meta-analysis. *J. Fam. Psychol.* 15, 355–370. doi: 10.1037/0893-3200.15.3.355

Amato, P. R., and Anthony, C. J. (2014). Estimating the effects of parental divorce and death with fixed effects models. *J. Marriage Fam.* 76, 370–386. doi: 10.1111/jomf.12100

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edn. Washington, DC: Author.

Andrews, D., and Bonta, J. (eds). (2010). *The Psychology of Criminal Conduct*, 5th Edn. New Providence, NJ: Matthew Bender & Company.

Arce, R., Fariña, F., and Seijo, D. (2005). Razonamientos judiciales en procesos de separación: análisis cognitivo y de contenido de las motivaciones [Judicial reasoning in parental separation and divorce proceedings: content and cognitive analysis of judicial reasoning]. *Psicothema* 17, 57–63.

Arce, R., Fariña, F., Seijo, D., and Novo, M. (2015a). Assessing impression management with the MMPI-2 in child custody litigation. *Assessment* 22, 769–777. doi: 10.1177/1073191114558111

Arce, R., Fariña, F., and Vilariño, M. (2015b). Daño psicológico en casos de víctimas de violencia de género: un estudio comparativo de las evaluaciones forenses [Psychological injury in intimate partner violence cases: a contrastive analysis of forensic measures]. *Rev. Iberoam. Psicol. Salud* 6, 72–80. doi: 10.1016/j.rips.2015.04.002

Arce, R., Fariña, F., and Vázquez, M. J. (2011). Grado de competencia social y comportamientos antisociales delictivos y no delictivos en menores [Social competence and delinquent, antisocial, and non-deviant behavior in adolescents]. *Rev. Latinoam. Psicol.* 43, 473–486. doi: 10.14349/rlp.v43i3.487

Arce, R., Seijo, D., Fariña, F., and Mohamed-Mohand, L. (2010). Comportamiento antisocial en menores: riesgo social y trayectoria natural de desarrollo [Antisocial behavior in adolescents: social risk and natural developmental trajectory]. *Rev. Mex. Psicol.* 27, 127–142.

Baker, J. A. (2006). Contributions of teacher–child relationships to positive school adjustment during elementary school. *J. Sch. Psychol.* 44, 211–229. doi: 10.1016/j.jsp.2006.02.002

Bernard, J. M., Nalbone, D. P., Hecker, L. L., and Degges-White, S. E. (2015). Co-parenting factors that contribute to academic success. *Eur. Sci. J.* 11, 241–260.

Berryhill, M. B. (2017). Coparenting and parental school involvement. *Child Youth Care Forum* 46, 261–283. doi: 10.1007/s10566-016-9384-8

Cohen, J. (1988). *Statistical Power Analysis for Behavioral Sciences*, 2nd Edn. New York, NY: Academic Press.

Eurostat (2015). *Marriage and Divorce Statistics*. Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Marriage_and_divorce_statistics

Fontaine, N., Carbonneau, R., Vitaro, F., Barker, E. D., and Tremblay, R. E. (2009). Research review: a critical review of studies on the developmental trajectories of antisocial behavior in females. *J. Child Psychol. Psychiatry* 50, 363–385. doi: 10.1111/j.1469-7610.2008.01949.x

Hanson, R. K., Bourgon, G., Helmus, L., and Hodgson, S. (2009). *A Meta-analysis of the Effectiveness of Treatment for Sexual Offenders: Risk, Need, and Responsivity.* User Report 2009-01. Ottawa, ON: Public Safety.

Hawley, P. H. (2003). Prosocial and coercive configurations of resource control in early adolescence: a case for the well-adapted Machiavellian. *Merrill Palmer Q.* 49, 279–309. doi: 10.1353/mpq.2003.0013

Hernández-Guanir, P. (2015). *TAMAI: Test Autoevaluativo Multifactorial de Adaptación Infantil. Manual [TAMAI: Multifactorial Self-Administered Test of Child Adjustment. Manual],* 7th Edn. Madrid: TEA Ediciones.

Huang, C. (2011). Self-concept and academic achievement: a meta-analysis of longitudinal relations. *J. Sch. Psychol.* 49, 505–528. doi: 10.1016/j.jsp.2011.07.001

Hunter, J. E., and Schmidt, F. L. (2015). *Methods of Meta-analysis: Correcting Errors and Bias in Research Findings*, 3rd Edn. Thousand Oaks, CA: Sage.

Hutchings, J. N., Gannon, T. A., and Gilchrist, E. (2010). A preliminary investigation of a new pictorial method of measuring aggression-supportive cognition among young aggressive males. *Int. J. Offender Ther. Comp. Criminol.* 54, 236–249. doi: 10.1177/0306624X08325350

Jolliffe, D., Farrington, D. P., Loeber, R., and Pardini, D. (2016). Protective factors for violence: results from the Pittsburgh Youth Study. *J. Crim. Justice* 45, 32–40. doi: 10.1016/j.jcrimjus.2016.02.007

Koehler, J. A., Lösel, F., Akoensi, T. D., and Humphreys, D. K. (2013). A systematic review and meta-analysis on the effects of young offender treatment programs in Europe. *J. Exp. Criminol.* 9, 19–43. doi: 10.1007/s11292-012-9159-7

Lacey, R. E., Bartley, M., Pikhart, H., Stafford, M., and Cable, N. (2014). Parental separation and adult psychological distress: an investigation of material and relational mechanisms. *BMC Public Health* 14:272. doi: 10.1186/1471-2458-14-272

Lee, J. (2016). Attitude toward school does not predict academic achievement. *Learn. Individ. Differ.* 52, 1–9. doi: 10.1016/j.lindif.2016.09.009

Lösel, F., Kolip, P., and Bender, D. (1992). Stress-resistenz im multi-problem-milieu: sind seelisch widerstandsfähige jugendliche 'Superkids' [Stress-resistance in a multi-problem-milieu: are resilient juveniles 'Superkids']. *Z. Klin. Psychol.* 21, 48–63.

Lyndon, M. P., Strom, J. M., Alyami, H. M., Yu, T.-C., Wilson, N. C., Singh, P. P., et al. (2014). The relationship between academic assessment and psychological

distress among medical students: a systematic review. *Perspect. Med. Educ.* 3, 405–418. doi: 10.1007/s40037-014-0148-6

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., and Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: reciprocal effects models of causal ordering. *Child Dev.* 76, 397–416. doi: 10.1111/j.1467-8624.2005.00853.x

Martinón, J. M., Fariña, F., Corrás, T., Seijo, D., Souto, A., and Novo, M. (2017). Impacto de la ruptura de los progenitores en el estado de salud física de los hijos [Impact of parental breakup on the physical health of children]. *Eur. J. Educ. Psychol.* 10, 9–14. doi: 10.1016/j.ejeps.2016.10.002

Maruna, S. (2004). Desistance and explanatory style: a new direction in the psychology of reform. *J. Contemp. Crim. Justice* 20, 184–200. doi: 10.1177/1043986204263778

Móller, J., Retelsdorf, J., Kóller, O., and Marsh, H. W. (2011). The reciprocal internal/external frame of reference model: an integration of models of relations between academic achievement and self-concept. *Am. Educ. Res. J.* 48, 1315–1346. doi: 10.3102/0002831211419649

Norton, M. S. (2008). *Human Resources Administration of Educational Leaders.* New York, NY: Sage.

Pruett, M. K., Williams, T. Y., Insabella, G., and Little, T. D. (2003). Family and legal indicators of child adjustment to divorce among families with young children. *J. Fam. Psychol.* 17, 169–180. doi: 10.1037/0893-3200.17.2.169

Roorda, D. L., Koomen, H. M., Spilt, J. L., and Oort, F. J. (2011). The influence of affective teacher–student relationships on students' school engagement and achievement: a meta-analytic approach. *Rev. Educ. Res.* 81, 493–529. doi: 10.3102/0034654311421793

Rosnow, R. L., and Rosenthal, R. (1996). Computing contrasts, effect sizes, and counternulls on other people's published data: general procedures for research consumers. *Psychol. Methods* 1, 331–340. doi: 10.1037/1082-989X.1.4.331

Seijo, D., Fariña, F., Corrás, T., Novo, M., and Arce, R. (2016). Estimating the epidemiology and quantifying the damages of parental separation in children and adolescents. *Front. Psychol.* 7:1611. doi: 10.3389/fpsyg.2016.01611

Stipek, D., and Miles, S. (2008). Effects of aggression on achievement: does conflict with the teacher make it worse? *Child Dev.* 79, 1721–1735. doi: 10.1111/j.1467-8624.2008.01221

Turner, H. A., and Kopiec, K. (2006). Exposure to interparental conflict and psychological disorder among young adults. *J. Fam. Issues* 27, 131–158. doi: 10.1177/0192513X05280991

Wang, M., and Holcombe, R. (2010). Adolescents' perceptions of school environment, engagement, and academic achievement in middle school. *Am. Educ. Res. J.* 47, 633–662. doi: 10.3102/0002831209361209

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Corrás, Seijo, Fariña, Novo, Arce and Cabanach. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 24 August 2017
doi: 10.3389/fpsyg.2017.01403

Procrastinating Behavior in Computer-Based Learning Environments to Predict Performance: A Case Study in Moodle

Rebeca Cerezo, María Esteban, Miguel Sánchez-Santillán and José C. Núñez*

Facultad de Psicología, Universidad de Oviedo, Oviedo, Spain

Introduction: Research about student performance has traditionally considered academic procrastination as a behavior that has negative effects on academic achievement. Although there is much evidence for this in class-based environments, there is a lack of research on *Computer-Based Learning Environments (CBLEs)*. Therefore, the purpose of this study is to evaluate student behavior in a blended learning program and specifically procrastination behavior in relation to performance through Data Mining techniques.

Materials and Methods: A sample of 140 undergraduate students participated in a blended learning experience implemented in a Moodle (Modular Object Oriented Developmental Learning Environment) Management System. Relevant interaction variables were selected for the study, taking into account student achievement and analyzing data by means of association rules, a mining technique. The association rules were arrived at and filtered through two selection criteria: 1, rules must have an accuracy over 0.8 and 2, they must be present in both sub-samples.

Results: The findings of our study highlight the influence of time management in online learning environments, particularly on academic achievement, as there is an association between procrastination variables and student performance.

Conclusion: Negative impact of procrastination in learning outcomes has been observed again but in virtual learning environments where practical implications, prevention of, and intervention in, are different from class-based learning. These aspects are discussed to help resolve student difficulties at various ages.

Keywords: procrastination, CBLEs, learning failure, Educational Data Mining

OPEN ACCESS

Edited by:
Meryem Yilmaz Soylu,
University of Nebraska Lincoln,
United States

Reviewed by:
Reza Feyzi Behnagh,
University at Albany, SUNY,
United States
Pin-Ju Chen,
St. Mary's Junior College of Medicine,
Nursing and Management, Taiwan
Marco Giovanni Mariani,
Università di Bologna, Italy

****Correspondence:***
María Esteban
maria_esteban_garcia@hotmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *11 April 2017*
Accepted: *02 August 2017*
Published: *24 August 2017*

Citation:
Cerezo R, Esteban M, Sánchez-Santillán M and Núñez JC (2017) Procrastinating Behavior in Computer-Based Learning Environments to Predict Performance: A Case Study in Moodle. Front. Psychol. 8:1403. doi: 10.3389/fpsyg.2017.01403

INTRODUCTION

Research on self-regulated learning (SRL) behavior covers a wide area of knowledge. It has shown us that learners of all ages have difficulties deploying key cognitive and metacognitive self-regulatory skills during learning in open-ended learning environments (Azevedo, 2015) like many *Computer-Based Learning Environments* (CBLEs). CBLEs have brought new opportunities to

current education (European Commission, 2014) but also bring many challenges for the student. Deciding what, when, how, and for how long to learn, in short, self-regulation, gains importance in this context (Lajoie and Azevedo, 2006; Jacobson, 2008; Winters et al., 2008; Azevedo et al., 2009; Michinov et al., 2011; Klingsieck et al., 2012; You, 2015; Sánchez-Santillán et al., 2016). In this study, we specifically explore a small but determinant part of self-regulation, procrastination, trying to discover its relationship with student failure in CBLEs. Although there is little work on this specific topic, we provide an overview of the key concepts and related research and then try to shed some light on our research questions through the so-called Data Mining methodology Association Rules. Lastly, we propose several ways to use our findings to improve student learning and avoid academic failure.

Self-Regulated Learning, Time Management, and Procrastination in Academic Contexts

SRL involves deploying metacognitive, motivational, and behavioral processes in a systematic way, being able to adapt strategies *to different contexts*, in order to achieve the stated learning goals (Zimmerman, 1990); in this particular case, we would say *to different learning environments* like the increasingly common open-ended CBLEs. Self-regulated students face the learning process with confidence, draw up a plan to guide the study, monitor processes, adapt them to suit changing environments, and know when they have achieved their goals (Zimmerman, 1990). Bearing in mind the complexity of the SRL construct, in this paper, we focus on one of the dimensions of SRL, time management.

Zimmerman and Risemberg observed as early as 1997 that within the personal qualities that differentiate students who succeed from those who do not, there are six underlying self-regulatory processes; time use, goal setting, self-monitoring, self-reactions, self-efficacy, and motivation (Zimmerman and Risemberg, 1997). From these processes, time management, motivation, and perceived self-efficacy play the most important role (Zimmerman, 1998). Along the same lines, several studies highlight the impact of time management on fear of failure and motivation (Visser et al., 2015), anxiety and stress (Hen and Goroshit, 2014; Häfner et al., 2015) and academic achievement (Balkıs, 2011; You, 2015). Therefore, it seems as though time management plays a notable role in educational outcomes from school to higher education and is highly interconnected with many others variables that somehow determine learning (Zimmerman and Risemberg, 1997; Zimmerman, 1998; Liu et al., 2002; Lee, 2005; Stoeger and Ziegler, 2008; Odacı and Kalkan, 2010; Rabin et al., 2011; Kirk et al., 2013; Visser et al., 2015). Thus, although it is possible for students to acquire time management and other self-regulation skills through proper intervention, most continue with this handicap throughout their education, and it is often pointed out as a skill lack that affects students from primary to tertiary education (Reid and Moore, 2008), and in authentic and online learning environments (Lewis et al., 2014; Shukla et al., 2014).

Numerous studies report on the importance of time management and learning, not only in terms of quantity but also the quality of time the students spend learning (Balkıs, 2011). Many of these studies focus on academic procrastination, understood as "the tendency to postpone an activity under one's control to the last possible minute or even not to perform it at all" (Gafni and Geri, 2010, pp. 115) and extensively researched for decades. One of the seminal empirical papers on student procrastination was published by Beswick et al. (1988). In the last few decades, several different approaching to procrastination arose. While some authors see functional forms of procrastination (e.g., Chu and Choi, 2005), others take the view that procrastination has no functional aspects (e.g., Corkin et al., 2011). In a review of procrastination construct typology attempts, Gueorguieva (2011) maintained that there are different theorists using different labels when referring to similar types of procrastination but what it is already well known is that failures in self-regulation are the core of academic procrastination and that this phenomenon poses a serious threat to students' academic achievement and subjective well-being (Steel and Klingsieck, 2016).

In addition, procrastination is one of the most extended lapses in time management and is a common student behavior in every educational stage (Terry, 2002; Rabin et al., 2011; Yang, 2012; Romero, 2013; Katz et al., 2014; Karatas, 2015). For instance, Sánchez (2010) found the presence of these behaviors in 80% of university students and found that it was chronic in 20% of them. Hence, procrastinating behavior—even though it is a common practice in modern western societies—is in need of further research (Levy and Ramim, 2012).

As mentioned previously, the negative effect of procrastination on learning and performance has been observed in authentic educational settings (class-based learning) but there is a lack of research within CBLEs, which is aggravated because, as has been previously observed, procrastination has even greater influence in distance learning settings (Tuckman, 2005). This kind of misbehavior also seems to be related to the higher student dropout rates in online than conventional learning environments. In order to explain or predict dropout in online courses, different conceptual models were suggested (Lee et al., 2013; Cochran et al., 2014). These approaches found several predictors of dropout associated with the difficulty of employing responsible self-generated academic behavior in these environments (Azevedo et al., 2009), leading to the conclusion that a student who displays self-regulation skills is more likely to succeed in CBLE one who does not (Winters et al., 2008).

Returning to previous results specifically related to online learning, Michinov et al. (2011) found that high procrastinators are less successful online learners than low procrastinators. Recently, You (2015) applied multiple regression techniques over LMS data from 569 college students obtaining results that emphasize time management as a predictor of course achievement. However, both studies concluded that although their work sheds some light on the relationship between procrastination and performance, further research is necessary to expand the understanding of procrastination in online learning environments.

Related results were also produced by Goda et al. (2015) in a longitudinal study with the goal of observing university students' learning behavior in an e-learning environment. The authors found seven behavioral profiles (procrastination, learning habit, random, diminished drive, early bird, chevron, and catch-up) and their relation to learning outcomes, highlighting the better performance of students with a learning habit profile, in contrast to those with a procrastinating profile. Meanwhile, Broadbent and Poon (2015) carried out a useful literature review of SRL strategies and academic achievement in online learning environments emphasizing the association of optimal time management and academic success in almost all research reviewed. Moreover, several studies confirm the association of procrastination and other academic misconduct, with the most frequent being the use of fraudulent excuses (Patrzek et al., 2015; Sureda-Negre et al., 2015).

Although some research findings highlight the negative effect of procrastination, others have pointed out an active procrastination profile corresponding to students who decide to postpone tasks in order to produce a better performance (Choi and Moran, 2009; Kim and Seo, 2013). This kind of finding, along with the observed consequences of procrastinating behavior in general learning, make it even more necessary to contextualize the study of this specific phenomena in open-ended CBLEs.

EDM and Association Rules

CBLEs present significant differences in relation to traditional learning settings that should be taken into account but that can also offer an advantageous environment to observe and overcome their aforementioned challenges; In general, CBLEs are ready to collect large amounts of data from the user–machine interaction. In particular, LMSs collect data from students that, properly analyzed, can provide teachers and researchers with the necessary information to support and constantly improve the learning process (García et al., 2009; Paule-Ruiz et al., 2015). One of the most used is Modular Object Oriented Developmental Learning Environment (Moodle), a free LMS enabling the creation of powerful, flexible, and engaging online courses and experiences (Rice, 2006). Unfortunately, these platforms do not provide specific tools to allow educators to thoroughly track and assess all students' learning process but one of the most suitable promising and innovative techniques for handling these data is based on Educational Data Mining (EDM).

EDM is an interdisciplinary research field, developing methods for exploring the unique data that come from computer educational environments (Romero and Ventura, 2013). Different EDM procedures have been used to get a better understanding of the underlying educational processes, to generate recommendations for students, to provide feedback to either students, teachers, or/and researchers, to early detect learning difficulties, to help students with specific learning disabilities, to avoid academic failure, etc.; in short, to help address the difficulties that students of different ages have when learning in highly cognitively and metacognitively demanding learning environments, like open-ended CBLEs (García et al., 2009; Azevedo et al., 2012). Previous research has shown how web usage mining can be applied in Moodle in order to predict the marks that students will obtain in a course (Romero et al., 2013) and even specific Moodle mining tools have been developed for the use of not only experts in data mining but also of newcomers like instructors and courseware authors (Romero et al., 2008).

One of those procedures is the so-called *association rules*, one of the most commonly used and best known Data Mining techniques (Romero et al., 2010a) in very different research disciplines such as medicine (Antonie et al., 2001), earth sciences (Tan et al., 2001), banking (Aburrous et al., 2010), telecommunications (Wei and Chiu, 2002), and the stock-market (Hajizadeh et al., 2010), and also in the educational field. This methodology has been extensively used to identify e-learning indicators and their influence on student performance (Paule-Ruiz et al., 2015), describe learning behavioral profiles (Goda et al., 2015), point out variables that influence instruction (Romero et al., 2010a), to improve a collaborative learning experience (Mora et al., 2014), to test 3D virtual reality environments (Cherenkova et al., 1996), to understand the role of social networks in learning (Paredes and Chung, 2012), and as the basis of adaptive learning systems (Murugananthan and ShivaKumar, 2016). Based on this body of previous research, and as Han already concluded in 2001, it seems as though this methodology could produce enough knowledge to discover patterns from a huge amount of data which would be a useful base for a decision-making process (Han and Kamber, 2001).

In this paper, we intend to apply such analysis techniques to data gathered from a course implemented in an open-ended learning environment managed by a Moodle system in order to discover time management parameters which will, hopefully, be stable over time and samples that could be used as predictors of the learning process and its result.

Research Questions

Considering the limited previous research findings in this particular area, we arrive at the starting research question, does procrastination behavior have any predictive value for the student's performance in LMSs in a distance learning experience? Supported by previously reviewed literature in face-to-face learning environments we hypothesize that procrastinating behavior will have that assumed predictive value. Secondly, and if so, how is procrastinating behavior related to student performance in the LMS? Paule-Ruiz et al. (2015) and You (2015, 2016) found results in this direction but with a very different methodology based on correlation, not necessarily causation. Moreover, although these research findings found a negative effect of procrastination, others have suggested the opposite (Choi and Moran, 2009; Kim and Seo, 2013), leading us to hypothesize with less confidence than the first hypothesis but predicting a negative relationship between procrastination and achievement, and therefore making further research necessary.

Finally, regarding the hypothetical Association Rules' predictions made for a given sample, are they stable enough to apply to another sample in following academic years? In other words, we expect to extrapolate from the hypothetical predictive values for procrastinating behaviors and use them to predict different student's performance in LMSs?

MATERIALS AND METHODS

Participants

To test our research questions, we applied EDM techniques to log file data from a Moodle 2.0 course, 140 undergraduate psychology students from a state university in Northern Spain took part in this research through a Blended-learning course. The sample was formed mainly by women (83%), as the population of psychology students is highly feminized. Their ages at the moment of the study were ranged between 19 and 21 years (mean age = 20.23; SD = 1.01).

This research focuses its attention on the study of *variables related to effort and time spent working*—also needed in order to ensure that students perform the minimum requested tasks—and *variables related to procrastinating behavior* as focal parameters of student interaction with the LMS used in the current work.

Procedure

We analyzed the interaction of two groups of undergraduate psychology students with an LMS over two consecutive academic years ($N_1 = 67$; $N_2 = 73$). The course is *eTraining for Autonomous Learning—eTRAL program* (Cerezo et al., 2010; Núñez et al., 2011) implemented in a university in the North of Spain. eTRAL is a program about SRL and study strategies that take part of the course curriculum but completed entirely outside of teaching hours, and organized into 11 weeks/blocks (blended-learning). Every Monday a new block is accessible to the students, allowing them a 2-week period to complete it. In order to do so, the students ought to carry out three compulsory tasks per block, in any order: First, check a *theoretical* content about learning strategies; second, complete a *practical task* related to the theoretical content; third, contribute with a post in the subsequent *forum*. These tasks merged with the three levels of knowledge to reach an optimal learning (Biggs, 2005): declarative knowledge level: theoretical contents, description, information, and how-to put in practice the strategy or strategies of the week; procedural knowledge level: practical tasks where the students have to put the declarative knowledge into practice; conditional knowledge level: discussion forums where the students have to discuss about how they have or would use the strategy or strategies of the week in different contexts. The role of the instructor was to manage the Moodle course interfering as less as possible in the learning process; just setting the technical details required for running the contents, notifying by mail every time that there were a new unit available—even though it follows a feasible periodicity—moderating the forum if necessary, and answering students questions off-line about technical o theoretical issues.

Due to eTRAL being part of the course content, students were required to complete 80% of the 11 blocks in order to gain an extra point in the final mark of the course. Further information about this program can be found in Cerezo et al. (2015).

Extraction of the Variables

During the implementation of the course, the interaction of the students with the LMS is recorded in the Moodle database logs (Cole and Foster, 2007). The Moodle system tracks student interaction based on actions collected from every student and their metadata, for example; the date, kind of action, and name of the resource which has been worked on. Moodle stores a total of 76 actions, but we selected only eleven raw log actions (see column *Moodle Actions* on **Table 1**), paying particular attention to previously contrasted significant variables of students' interaction with LMSs (Hung and Zhang, 2008; Lust et al., 2012, 2013; Macfadyen and Dawson, 2012; Murray et al., 2012; Kim et al., 2014; Cerezo et al., 2016), and particularly representative of the students' performance in this Moodle course (Cerezo et al., 2016), which allows us to recalculate nine representative variables for our study. A few variables were extracted directly from Moodle records; however, it is sometimes advisable to formulate queries to obtain aggregated results (Talavera and Gaudioso, 2004) so other variables were calculated based on those records with a simple operation (e.g., as seen in **Table 1**, the variable *Days Post* is calculated by subtracting the date that the student *Posts* their opinion in the forum from the date that is officially possible to *View* and *Post* in the forum).

The variables were extracted and organized in two different groups taking into account what they represent at a higher granularity level: *variables related to effort and time spent working* and *variables related to procrastination:*

- *Variables related to effort and time spent working.* One of the most challenging issues was giving meaning to the learning context from the raw data. Aiming to achieve this, we have classified the variables *Time Theory*, *Time Task*, *Time Forum*, and *Relevant Actions* in this group as indirect indexes of student effort.
- *Variables related to procrastination.* On the one hand, the number of days in a 2-week period that the students wait to check each assignment, the task (*Days Task*), the forum subject (*Days Forum*) and the theoretical content (*Days Theory*). On the other, the number of days that they take to hand in the task (*Days hand-in*) and post their opinion (*Days Post*). The rationale was that we wanted to approach procrastination by observing the students' behavioral patterns before the homework deadline and not solely considering late or absent submissions.

In summary, nine student interaction variables from the LMS (**Table 1**) were extracted along with student achievement in this course, used as the tenth variable.

Data Analysis

Class Association Rules (CAR) were applied to the described data. The CAR are a variety of association rules which allow the identification of confluent relationships between a combination of variables and a class variable pre-defined by the researcher. Thus, the association rules are defined by the conditional relation of one of the characteristics to be analyzed (precedent variables) and the previously defined class, which would be the consequent (IF the precedent variable takes place, THEN it is revealed in the categorization of the subject in a given class) (Romero et al., 2010b). Rule interest is based on support and confidence

TABLE 1 | Name of variables considered in the study with their description and extraction method.

Variable	Description	Moodle actions	Extraction method
Variables related to effort and time spent working			
Time Theory	Minutes spent on theoretical contents	*Resource view*	Sum of the periods between *resource view* and the next different action
Time Task	Minutes spent on practical tasks	*Quiz view, quiz attempt, quiz continue attempt, quiz close attempt*	Sum of the periods between *quiz view/quiz attempt/quiz continue attempt/quiz close attempt* and the next different action
Time Forum	Minutes spent in forums	*Forum view, forum view discussion, forum add reply, forum add discussion, forum add post, update post*	Sum of the periods between *forum view/forum view discussion/forum add reply/ forum add discussion/forum add post/update post* and the next different action
Relevant Actions	Total of significant actions in the LMS	All actions related to Time Theory, Time Task, and Time Forum	Actions like log in, log out, profile updating, check calendar, refresh content, etc. are dismissed
Variables related to procrastination behavior			
Days Theory	The days that go by from when a block is available until the student checks the theoretical contents for the first time	Date of the first *resource view* after the block became available	Date of *resource view* after the theoretical contents became available
Days Task	The days that go by from when a block is available until the student checks the practical task for the first time	Date of the first *quiz view* after the block became accessible	Date of *quiz view* since the task became available
Days "hand-in"	The days that go by from when a block is unlocked until the student finishes the task	Date of the first *quiz close attempt* after the block was made available	Date of *quiz close attempt* after the task became available
Days Forum	The days that go by from when a block is unlocked until the student checks the forum for the first time	Date of the first *forum view discussion* after the block was made available	Date of *forum view discussion* after the task became available
Days Post	The days that go by after a block is unlocked until the student writes in the forum for the first time	Date of the first *forum add reply* after the block was made available	Date of *forum add reply* after the task became available

measures (Hastie et al., 2001). Support denotes how frequently the precedent appears in the dataset (Hahsler et al., 2005). Confidence denotes how often the rule appears in the dataset (Hipp et al., 2000).

In this process, we have used the Predictive Apriori algorithm. This algorithm searches with an increasing support threshold for the best n rules concerning a support-based corrected confidence value (Scheffer, 2001). Predictive Apriori considers both the confidence and support in ranking the rules. A Bayesian framework is used to calculate the predictive accuracy out of the support and confidence of a rule (Nahar et al., 2013). Predictive accuracy values are between 0 and 1. Predictive Apriori has been chosen because, in general, it performs better than the Apriori algorithm (García et al., 2011). In order to produce the rules, Weka (Hall et al., 2009), the software used for analysis, needs to receive discrete variables. Discretization is a process that transforms numeric variables into categorical variables (Hussain et al., 1999). Equal-width is a method that discretizes the domain of a variable into equal-width intervals (Chmielewski and Grzymala-Busse, 1996). In the present study, we have selected equal-width method to discretize antecedent variables as seen in previous work (García et al., 2011; Paule-Ruiz et al., 2015). Also, performance was selected as class variable (consequent) and was reasonably discretized based on Spanish typical grading system of students' performance: from 0 to 4.9 points, we assigned the value "Low" (as it means that the student failed the course exam), from 5 to 6.9 points as "Medium" value, and from 7 to 10 points as "High" value (see **Table 2**). These values were extracted from the performance of every student. In this work, it is considered to be an index of general achievement because it is not only the grade for the assignments completed during the LMS e-course but also the sum of the grade with an objective final exam of the subject.

TABLE 2 | Discretization method and discretized values for each variable.

Variable	Discretization method	Discretized values
Time Theory	Equal-width	Low, Medium, High
Time Task	Equal-width	Low, Medium, High
Time Forum	Equal-width	Low, Medium, High
Relevant Actions	Equal-width	Low, Medium, High
Days Theory	Equal-width	Early, Normal, Late
Days Task	Equal-width	Early, Normal, Late
Days "hand-in"	Equal-width	Early, Normal, Late
Days Forum	Equal-width	Early, Normal, Late
Days Post	Equal-width	Early, Normal, Late
Performance	Manual-Method	Low, Medium, High

RESULTS

In many cases, association rules algorithms generate a high number of association rules and it is nearly impossible for teachers to comprehend or validate such a quantity of rules (Kotsiantis and Kanellopoulos, 2006). As the objective was to predict student performance in upcoming years, and we had samples from two courses, we only selected the rules that were repeated in both years. This method allows us to validate the rules' generalizability in order to apply the results to new students in similar contexts, as pointed by Winne and Baker (2013). As result of this procedure, we achieved rules describing behaviors that were consistent throughout the samples and academic years.

Application of the Predictive Apriori algorithm supplied 49 rules during the first academic year and 62 rules during the second academic year with an accuracy greater than 0.94, producing 111 rules in total. The number of times that each variable appears in the rules found, as well as the ratio between the previous and the number of rules found, is shown in **Table 3**.

Next, we merged the 111 rules obtained into one file and with a simple algorithm, we selected those ones that were repeated in both academic years. We considered a rule as repeated if it had the same precedent (same variables with same values), and it had the consequent class value (*Performance: Low, Medium, and High*). If a rule was repeated in both years, with the same precedent and consequent but there was another rule with the same precedent and different consequent value, this rule was automatically discarded by the algorithm. The algorithm found three association rules which are repeated in both academic years:

- *Days Theory = NORMAL and Days Task = LATE → Performance = LOW* (accuracy = 0.972). Rule 1 states that if the access to theoretical content is done in an average time and access to task is carried out late, then, performance is low.
- *Time Theory = LOW and Days Theory = LATE and Days Forum = NORMAL → Performance = LOW* (accuracy = 0.943). Rule 2 shows that if the average time devoted to theoretical content is low, access to the theoretical content is late and access to the forum is in an average time, then performance is low.
- *Time Task = MEDIUM and Days Theory = EARLY and Days Task = NORMAL → Performance = HIGH* (accuracy = 0.943). Rule 3 reflects how if the average time devoted to task fulfillment is medium, access to the theoretical content is early and access to task is in an average time, then performance is high.

DISCUSSION

This work focuses on procrastination, one of the most common problems at every educational level and is an extension of the similarly prevalent and pernicious phenomena in daily life (Steel, 2007). This failure of time management is more frequent when the learning process is not class-based (distance or computer-based learning), as the student has to take an active role, where self-regulation becomes determinant (Yaakub, 2000; Azar et al., 2009; Klingsieck et al., 2012). In this study, we have observed how procrastination behaviors can lead to poor academic results while learning in an LMS, something that has been previously and thoroughly noted in authentic academic contexts (Kim and Seo, 2015) but not as extensively in online learning environments (Michinov et al., 2011; You, 2015).

We tracked and analyzed student behavior in an LMS, specifically procrastination behaviors in relation to performance through Data Mining techniques. Relevant interaction variables were selected for the study, also taking into account student achievement and analyzing data by means of extracting and filtering association rules. The association rules obtained show the importance of academic procrastination when learning in distance CBLEs. At first sight, it can be seen that two out of the three variables making up the antecedents are related to procrastination behavior in most of the Rules. Moreover, in

TABLE 3 | Variables' distribution in the rules obtained for each academic year and their global presence.

Variable	First academic year	Second academic year	Both academic years
Antecedent variables			
Time Theory	33 (67.34%)	37 (59.67%)	70 (63.06%)
Time Task	25 (51.02%)	24 (38.70%)	49 (44.14%)
Time Forum	0	19 (30.64%)	19 (17.12%)
Relevant Actions	17 (34.69%)	18 (29.03%)	35 (31.53%)
Days Theory	15 (30.61%)	13 (20.96%)	28 (25.25%)
Days Task	16 (32.65%)	20 (32.25%)	36 (32.43%)
Days "hand-in"	15 (30.61%)	11 (17.74%)	36 (32.43%
Days Forum	15 (30.61%)	10 (16.12%)	25 (25.25%)
Days Post	19 (38.77%)	26 (41.93%)	45 (40.54%)
Consequent/class variable values			
Performance—High	12 (24.48%)	12 (19.35%)	24 (21.62%)
Performance—Medium	20 (40.81%)	19 (30.64%)	39 (35.13%)
Performance—Low	17 (34.69%)	31 (50%)	48 (43.24%)

Natural numbers indicate the amount of rules containing each variable, and the percentage corresponds to its presence in the total amount of rules.

general terms, evidence of procrastination in the antecedents leads to poor performance, and signs of successful time management end up with satisfactory achievement. The global presence of the variables in the 111 Rules is also revealing. Looking again at **Table 3** it can be seen that three out of the five most commonly present variables belong to actions in the LMS related to procrastination behavior.

In particular, if we analyze Rule 1, we can see how when a student accesses the theoretical resource in an average time but delays dealing with the corresponding task, performance is lower. Looking at Rule 2, it shows that students that access the theoretical resource late, and devote a little time to it, but check the forum topic in an average time-frame, perform worse. It makes sense that when a student starts working late on a topic, they have less time available to take advantage of, and consequently achieve lower marks. Interpreting these results in terms of procrastination, they are more pessimistic but agree with those found by Paule-Ruiz et al. (2015), who found that when students start assignments late, they perform poorly, Michinov et al. (2011) that found that procrastination and performance in online learning environments was mediated by the level of the learners' participation in discussion forums, and You (2015) found that the extent of achievement predictability of academic procrastination in LMSs cumulatively increased at different time points of the course. Therefore, this rule could be indicating that even students who start studying within an average time-frame are at risk of later procrastination behaviors and subsequent consequences in terms of performance. This interpretation could be very valuable considering that students who postpone and cram assignments at the last minute showed poorer long-term retention and achievement (Tuckman, 2005; Asarta and Schmidt, 2013). According to Bannert et al. (2014), there are differences in the temporal pattern of students' spontaneous learning steps when learning in hypermedia environments, also in how their regulatory activities unfold over time. Therefore, early detection of low self-regulated learners is necessary to provide them with support at the right time. A key application of these results concerns personalization in e-learning environments, such as the suitability of different types and times of prompts for different students' learning models (Lehmann et al., 2014) and building Recommender Systems based on e-Learner groups (Kardan et al., 2012). By combining the knowledge from this with previous work about learning in LMSs, this study could contribute to a valid student learning model for adaptive learning systems (Brusilovsky, 2001; Cerezo et al., 2016).

Rule 3 shows how a more organized learning process, around the average, can lead to academic success. When the student accesses the first theoretical resource early, spends a medium amount of time on assignments and accesses the assigned task within an average time-frame, they achieve high performance. It is remarkable that this is the only Rule with an early value in procrastination values and the only one with a satisfactory performance in the consequent. These findings agree with the conclusions of the meta-analysis carried out by Kim and Seo (2015), which found procrastination variables to be negatively correlated to students' performance, but we dare say that the results of this study are more valuable for intervention in low achievers' learning issues.

At this point, the found association rules lead us to clarify our two first research questions, supporting the idea that procrastination variables can be used to predict student performance (first research question) and that the values of procrastination variables are inversely related to student performance (second research question).

With respect to the third research question, about the association rules' predictive potential, it seems as though that is solved by the methodology used itself. Although 111 rules merged from both samples, in two different academic years, the Rules discussed are the only ones present in both academic years, with the same precedent about time management variables and the same consequent in terms of performance. It seems that these indicators are steady over time (different course) and individuals (different samples) and so could potentially be used as predictors for the same course in following academic years benefiting students with knowledge obtained from previous cohorts. Similar practical implications were found by Sekhavatian and Mahdavi (2011), Mosharraf and Taghiyareh (2012), and Murugananthan and ShivaKumar (2016), who used this kind of predictors as a guide for their learning recommender system in subsequent years.

Considering that variables related to procrastinating behavior are present in every Rule and are two out of three variables that define the antecedent, it could be considered that the procrastinating behaviors in the precedent could have a predictive value for early detection of student performance in LMSs. In this sense, it seems as though EDM, and in particular the methodology used in the current study, will be able to contribute beyond strictly predicting student performance, as a guide to improve learning process efficacy, as claimed by Mosharraf and Taghiyareh (2012). Most procrastination studies, even in CBLEs, have used self-reported questionnaires to measure the behavioral tendencies of this phenomena, or statistical techniques such as correlations or multiple regression (You, 2015).

Although these instruments have been validated and the procedures used in many studies, they are intrusive for the students and limited to capturing the variables of interest during a course. In this sense, self-report measures could be not enough to measure a construct with a processual nature, apart from how the questions shape the answers, and other well-known limitations (Schwarz, 1999). Likewise, the current study methodology is one of the values of this research, not for adopting an EDM approaching able to capture the learning process but for applying CAR technique to the study of the procrastination in LMSs. LMSs collect data from students that, when properly analyzed, can provide the different educational agents with the necessary information to support and constantly improve the learning process (Paule-Ruiz et al., 2015). One of the most promising conclusions from this work would have been harder to be learned without using Data Mining techniques. The variables that most of the studies use to research about procrastination and could be expected to shed more light on the research questions were not that relevant in our study (last minute submissions, late

submissions, failure completing assignments, etc.) (Michinov et al., 2011; You, 2015, 2016). In other words, approaching the procrastination phenomena as a result, finalization actions like hand-in the homework on time, or not, seems to be a feasible index of this behavior. However, none of those finalization actions defined the repeated Association Rules in subsequent samples in our study (Days hand-in and Days Post). In contrast to, variables belonging to the procrastination process, always previous to fail with a task deadline, were present, denoting the importance of approaching to learning as a process, not as a result. These particular results have an essential application to Adaptive Hypermedia Systems and Adaptive Educational Systems (De Bra and Calvi, 1998; Brusilovsky, 2001).

To sum up, these results seem to confirm the association of time management and academic achievement in the LMS, particularly for those behaviors denoting procrastination. Those students that perform their academic work early or with average timing, and devote a sufficient amount of time to it, demonstrate satisfactory performance, whereas those students that do not manage timing well (in terms of checking and devoting time to tasks and study) are unable to match the standards and perform worse. Similar results have been obtained by many researchers, regardless of country, educational level, or educational setting (Tuckman, 2005; Stoeger and Ziegler, 2008; Tan et al., 2008; Liu et al., 2009; Rakes and Dunn, 2010; Balkıs, 2011; Michinov et al., 2011; Broadbent and Poon, 2015; Goda et al., 2015; Paule-Ruiz et al., 2015). Therefore, in combination with the aforementioned Adaptive and Educational Hypermedia Systems technology, and knowing that these learning environments can be more challenging for students both with and without learning difficulties (Rodríguez-Málaga et al., 2017), and understanding that procrastination is a failure in academic self-regulation (Clariana et al., 2011), empowerment of SRL in open-ended CBLEs is the key. There is already well-studied software which is able to perform assessment and training in a wide spectrum of SRL [e.g., about epistemic beliefs (Trevors et al., 2016), reading patterns (Bondareva et al., 2013), scaffolding (Azevedo et al., 2010), learning strategies (Trevors et al., 2014), self and social-regulation (Azevedo, 2014), emotions (Azevedo et al., 2013), motivation (Duffy and Azevedo, 2015), and engagement (Azevedo, 2015)], among other things, but at this point it is necessary to work together with computer science to develop reliable prediction models and efficient preventive tools.

Although these results shed light on the phenomenon being studied, several limitations should be noted. With respect to the results of Choi and Moran (2009) and Kim et al. (2014), still further research is needed to determine which procrastination variables could be linked to the different active and passive procrastination profiles found. Regarding methodology, the online learning experience is a core variable to be controlled in future research. However, the context of the present work was a traditional university, and CBLEs have become more conventional, so students are assumed to have similar levels of online learning experience. In addition, LMSs are only one component of the learning ecosystem (García-Peñalvo and Seoane Pardo, 2015). This raises awareness about the future work on data collection moving toward Personal Learning Environments (PLEs) or Massive Open Online Courses (MOOCs), and checking the results in diverse types of learning platforms. Moreover, it would be more appropriate to compare two student groups who studied the course in the same academic year synchronically than over two consecutive years, however, using different sets of data helps to validate the rules' generalizability in order to apply the results to new students in similar contexts. In this line, we have generated valid and consistent rules selecting the repeatedly discovered ones in both samples; this is only the first and previous step to apply those rules to predict the performance in other student groups and check its accuracy, a very close prospect of the present work. Finally, it is well known that novice students report less sophisticated study strategies to address new domains of information (Alexander et al., 2004) so the results of this study could have been different if it had been in freshman students.

To conclude, this study sheds some light on the relationship between procrastination and performance in open-ended learning environments and provides interesting possibilities for improving online learning together with fruitful material for future research.

ETHICS STATEMENT

The research design was developed in accordance with the Declaration of Helsinki and the Spanish Law of Personal Data Protection (15/1999) principles. The data examined in this study was covered by the permission that every student of our university gives on the enrolment moment every year, a procedure supported by *The Ethics Committee for Research at Universidad de Oviedo*. In addition, participation in our study was voluntary and experimenters informed students about data usage.

AUTHOR CONTRIBUTIONS

RC contributed to the design of the study and data interpretation. She also took part in the writing process of the manuscript, research questions setting and interpretations and discussion of the results. JN coordinated the research and gave the final approval of the manuscript to be submitted. ME drafted the work and critically reviewed the theoretical background and conclusions. MS-S was involved in the design of the work as well as the acquisition and data analysis.

FUNDING

This work has been funded by the Department of Science and Innovation (Spain) under the National Program for Research, Development, and Innovation: EDU2014-57571-P and BES-2015-072470. We have also received funds from the European Union, through the European Regional Development Funds (ERDF); and the Principality of Asturias, through its Science, Technology and Innovation Plan (grant GRUPIN14-100 and GRUPIN14-053).

REFERENCES

Aburrous, M., Hossain, M. A., Dahal, K., and Thabtah, F. (2010). Intelligent phishing detection system for e-banking using fuzzy data mining. *Expert Syst. Appl.* 37, 7913–7921. doi: 10.1016/j.eswa.2010.04.044

Alexander, P. A., Sperl, C. T., Buehl, M. M., Fives, H., and Chiu, S. (2004). Modeling domain learning: profiles from the field of special education. *J. Educ. Psychol.* 96, 545–557. doi: 10.1037/0022-0663.96.3.545

Antonie, M. L., Zaiane, O. R., and Coman, A. (2001). "Application of data mining techniques for medical image classification," in *Proceedings of the Second International Conference on Multimedia Data Mining*, eds R. Zaïane and J. Simoff (Berlin: Springer-Verlag), 94–101.

Asarta, C. J., and Schmidt, J. R. (2013). Access patterns of online materials in a blended course. *Decis. Sci. J. Innov. Educ.* 11, 107–123. doi: 10.1111/j.1540-4609.2012.00366.x

Azar, I., Hinojo, F. J., and Cáceres, M. P. (2009). Percepciones del alumnado sobre el blended learning en la universidad. *Comunicar* 33, 165–174.

Azevedo, R. (2014). Issues in dealing with sequential and temporal characteristics of self-and socially-regulated learning. *Metacogn. Learn.* 9, 217–228. doi: 10.1007/s11409-014-9123-1

Azevedo, R. (2015). Defining and measuring engagement and learning in science: conceptual, theoretical, methodological, and analytical issues. *Educ. Psychol.* 50, 84–94. doi: 10.1080/00461520.2015.1004069

Azevedo, R., Behnagh, R., Duffy, M., Harley, J. M., and Trevors, G. J. (2012). "Metacognition and self-regulated learning in student-centered learning environments," in *Theoretical Foundations of Student-Center Learning Environments*, eds D. Jonanssen and S. Land (Mahwah, NJ: Erlbaum), 216–260.

Azevedo, R., Harley, J., Trevors, G., Duffy, M., Feyzi-Behnagh, R., Bouchet, F., et al. (2013). "Using trace data to examine the complex roles of cognitive, metacognitive, and emotional self-regulatory processes during learning with multi-agent systems," in *International Handbook of Metacognition and Learning Technologies*, eds R. Azevedo and V. Aleven (New York, NY: Springer), 427–449.

Azevedo, R., Johnson, A., Burkett, C., Chauncey, A., Lintean, M., Cai, Z., et al. (2010). "The role of prompting and feedback in facilitating students' learning about science with MetaTutor," in *Paper Presented at the 2010 AAAI Fall Symposium Series, Association for the Advancement of Artificial Intelligence*, Arlington, VA.

Azevedo, R., Witherspoon, A. M., Chauncey, A., Burkett, C., and Fike, A. (2009). "MetaTutor: a metacognitive tool for enhancing self-regulated learning," in *Paper Presented at the AAAI Fall Symposium: Cognitive and Metacognitive Educational Systems*, Arlington, VA.

Balkıs, M. (2011). Academic efficacy as a mediator and moderator variable in the relationship between academic procrastination and academic achievement. *Eğit. Araştırmaları Derg.* 45, 1–16.

Bannert, M., Reimann, P., and Sonnenberg, C. (2014). Process mining techniques for analysing patterns and strategies in students' self-regulated learning. *Metacogn. Learn.* 9, 161–185. doi: 10.1007/s11409-013-9107-6

Beswick, G., Rothblum, E. D., and Mann, L. (1988). Psychological antecedents of student procrastination. *Aust. Psychol.* 23, 207–217. doi: 10.1080/00050068808255605

Biggs, J. B. (2005). *Calidad del Aprendizaje Universitario [Quality of Learning at University]*. Madrid: Narcea.

Bondareva, D., Conati, C., Feyzi-Behnagh, R., Harley, J. M., Azevedo, R., and Bouchet, F. (2013). "Inferring learning from gaze data during interaction with an environment to support self-regulated learning," in *Paper Presented at the International Conference on Artificial Intelligence in Education, AIED 2013*, Memphis, TN. doi: 10.1007/978-3-642-39112-5_24

Broadbent, J., and Poon, W. L. (2015). Self-regulated learning strategies & academic achievement in online higher education learning environments: a systematic review. *Internet High. Educ.* 27, 1–13. doi: 10.1016/j.iheduc.2015.04.007

Brusilovsky, P. (2001). Adaptive hypermedia. *User Model. User Adapt. Interact.* 11, 87–110. doi: 10.1023/A:1011143116306

Cerezo, R., Bernardo, A., Esteban, M., Sánchez, M., and Tuero, E. (2015). Programas para la promoción de la autorregulación en educación superior: un estudio de la satisfacción diferencial entre metodología presencial y virtual. *Eur. J. Educ. Psychol.* 8, 30–36. doi: 10.1016/j.ejeps.2015.10.004

Cerezo, R., Núñez, J. C., Rosário, P., Valle, A., Rodríguez, S., and Bernardo, A. (2010). New media for the promotion of self-regulated learning in higher education. *Psicothema* 22, 306–315.

Cerezo, R., Sánchez-Santillán, M., Paule-Ruiz, M. P., and Núñez, J. C. (2016). Students' LMS interaction patterns and their relationship with achievement: a case study in higher education. *Comput. Educ.* 96, 42–54. doi: 10.1016/j.compedu.2016.02.006

Cherenkova, N., Alexandrova, N., and Chuprina, S. (2010). "Methods to assess students' experiences in an immersive 3D VR environment," in *Paper Presented at ICL Conference*, Hasselt.

Chmielewski, M. R., and Grzymala-Busse, J. W. (1996). Global discretization of continuous attributes as preprocessing for machine learning. *Int. J. Approx. Reason.* 15, 319–331. doi: 10.1016/S0888-613X(96)00074-6

Choi, J. N., and Moran, S. V. (2009). Why not procrastinate? Development and validation of a new active procrastination scale. *J. Soc. Psychol.* 149, 195–212. doi: 10.3200/SOCP.149.2.195-212

Chu, A. H. C., and Choi, J. N. (2005). Rethinking procrastination: positive effects of "active" procrastination behavior on attitudes and performance. *J. Soc. Psychol.* 145, 245–264. doi: 10.3200/SOCP.145.3.245-264

Clariana, M., Pros, R. C., Martín, M. D. M. B., and Busquets, C. G. (2011). La influencia del género en variables de la personalidad que condicionan el aprendizaje: inteligencia emocional y procrastinación académica. *Rev. Electrón. Interuniv. Formación Profesorado* 14, 87–96.

Cochran, J. D., Campbell, S. M., Baker, H. M., and Leeds, E. M. (2014). The role of student characteristics in predicting retention in online courses. *Res. High. Educ.* 55, 27–48. doi: 10.1007/s11162-013-9305-8

Cole, J., and Foster, H. (2007). *Using Moodle: Teaching with the Popular Open Source Course Management System*. San Francisco, CA: O'Reilly Media, Inc.

Corkin, D. M., Yu, S. L., and Lindt, S. F. (2011). Comparing active delay and procrastination from a self-regulated learning perspective. *Learn. Individ. Differ.* 21, 602–606. doi: 10.1016/j.lindif.2011.07.005

De Bra, P., and Calvi, L. (1998). AHA! An open adaptive hypermedia architecture. *New Rev. Hypermedia Multimed.* 4, 115–139. doi: 10.1080/13614569808914698

Duffy, M. C., and Azevedo, R. (2015). Motivation matters: interactions between achievement goals and agent scaffolding for self-regulated learning within an intelligent tutoring system. *Comput. Hum. Behav.* 52, 338–348. doi: 10.1016/j.chb.2015.05.041

European Commission (2014). *New Modes of Learning and Teaching in Higher Education*. Luxembourg: European Union.

Gafni, R., and Geri, N. (2010). Time management: procrastination tendency in individual and collaborative tasks. *Interdiscip. J. Inf. Knowl. Manage.* 5, 115–125.

García, E., Romero, C., Ventura, S., and de Castro, C. (2009). An architecture for making recommendations to courseware authors using association rule mining and collaborative filtering. *User Model. User-adapt. Interact.* 19, 99–132. doi: 10.1007/s11257-008-9047-z

García, E., Romero, C., Ventura, S., and de Castro, C. (2011). A collaborative educational association rule mining tool. *Internet High. Educ.* 14, 77–88. doi: 10.1016/j.iheduc.2010.07.006

García-Peñalvo, F. J., and Seoane Pardo, A. M. (2015). Una revisión actualizada del concepto de eLearning. *Educ. Knowl. Soc.* 16, 119–144. doi: 10.14201/eks2015161119144

Goda, Y., Yamada, M., Kato, H., Matsuda, T., Saito, Y., and Miyagawa, H. (2015). Procrastination and other learning behavioral types in e-learning and their relationship with learning outcomes. *Learn. Individ. Diff.* 37, 72–80. doi: 10.1016/j.lindif.2014.11.001

Gueorguieva, J. M. (2011). *Procrastination a Measurement of Types*. Chicago, IL: University of Illinois at Chicago.

Häfner, A., Stock, A., and Oberst, V. (2015). Decreasing students' stress through time management training: an intervention study. *Eur. J. Psychol. Educ.* 30, 81–94. doi: 10.1007/s10212-014-0229-2

Hahsler, M., Grün, B., and Hornik, K. (2005). A computational environment for mining association rules and frequent item sets. *J. Stat. Softw.* 14, 1–25. doi: 10.18637/jss.v014.i15

Hajizadeh, E., Ardakani, H. D., and Shahrabi, J. (2010). Application of data mining techniques in stock markets: a survey. *J. Econ. Int. Finance* 2, 109–118.

Hall, M., Frank, E., Holmes, G., Pfahringer, B., Reutemann, P., and Witten, I. H. (2009). The WEKA data mining software: an update. *ACM SIGKDD Explor. Newsl.* 11, 10–18. doi: 10.1145/1656274.1656278

Han, J., and Kamber, M. (2001). *Data Mining Concepts and Techniques*. Waltham, MA: Morgan Kaufmann Publishers.

Hastie, T., Tibshirani, R., and Friedman, J. (2001). *The Elements of Machine Learning: Data Mining, Inference and Prediction*. New York, NY: Springer.

Hen, M., and Goroshit, M. (2014). Academic procrastination, emotional intelligence, academic self-efficacy, and GPA a comparison between students with and without learning disabilities. *J. Learn. Disabil.* 47, 116–124. doi: 10.1177/0022219412439325

Hipp, J., Güntzer, U., and Nakhaeizadeh, G. (2000). Algorithms for association rule mining — a general survey and comparison. *ACM SIGKDD Explor. Newsl.* 2, 58–64. doi: 10.1145/360402.360421

Hung, J. L., and Zhang, K. (2008). Revealing online learning behaviors and activity patterns and making predictions with data mining techniques in online teaching. *MERLOT J. Online Learn. Teach.* 4, 426–437.

Hussain, F., Liu, H., Tan, C., and Dash, M. (1999). *Discretization: An Enabling Technique*. Technical Report: TRC6/99. Singapore: School of Computing, National University of Singapore.

Jacobson, C. M. (2008). "Knowledge sharing between individuals," in *Knowledge Management: Concepts, Methodologies, Tools, and Applications*, ed. M. E. Jennex (Philadelphia, PA: IGI Global), 1633–1642. doi: 10.4018/978-1-59904-933-5.ch135

Karatas, H. (2015). Correlation among academic procrastination, personality traits, and academic achievement. *Anthropologist* 20, 243–255.

Kardan, A. A., Saryazdi, N. G., and Mirashk, H. (2012). Learner clustering and association rule mining for content recommendation in self-regulated learning. *Int. J. Comput. Sci. Res. Appl.* 2, 69–78.

Katz, I., Eilot, K., and Nevo, N. (2014). "I'll do it later": type of motivation, self-efficacy and homework procrastination. *Motiv. Emot.* 38, 111–119. doi: 10.1007/s11031-013-9366-1

Kim, E., and Seo, E. H. (2013). The relationship of flow and self-regulated learning to active procrastination. *Soc. Behav. Pers.* 41, 1099–1113. doi: 10.2224/sbp.2013.41.7.1099

Kim, J. H., Park, Y., Song, J., and Jo, I. H. (2014). "Predicting students' learning achievement by using online learning patterns in blended learning environments: comparison of two cases on linear and non-linear model," in *Proceedings of the 7th International Conference on Educational Data Mining*, London, 407–408.

Kim, K. R., and Seo, E. H. (2015). The relationship between procrastination and academic performance: a meta-analysis. *Pers. Individ. Dif.* 82, 26–33. doi: 10.1016/j.paid.2015.02.038

Kirk, D., Oettingen, G., and Gollwitzer, P. M. (2013). Promoting integrative bargaining: mental contrasting with implementation intentions. *Int. J. Conflict Manage.* 24, 148–165. doi: 10.1108/10444061311316771

Klingsieck, K. B., Fries, S., Horz, C., and Hofer, M. (2012). Procrastination in a distance university setting. *Distance Educ.* 33, 295–310. doi: 10.1080/01587919.2012.723165

Kotsiantis, S., and Kanellopoulos, D. (2006). Association rules mining: a recent overview. *GESTS Int. Trans. Comput. Sci. Eng.* 32, 71–82.

Lajoie, S. P., and Azevedo, R. (2006). Teaching and learning in technology-rich environments. *Handb. Educ. Psychol.* 2, 803–821.

Lee, E. (2005). The relationship of motivation and flow experience to academic procrastination in university students. *J. Genet. Psychol.* 166, 5–15. doi: 10.3200/GNTP.166.1.5-15

Lee, Y., Choi, J., and Kim, T. (2013). Discriminating factors between completers of and dropouts from online learning courses. *Br. J. Educ. Technol.* 44, 328–337. doi: 10.1111/j.1467-8535.2012.01306.x

Lehmann, T., Hähnlein, I., and Ifenthaler, D. (2014). Cognitive, metacognitive and motivational perspectives on preflection in self-regulated online learning. *Comput. Hum. Behav.* 32, 313–323. doi: 10.1016/j.chb.2013.07.051

Levy, Y., and Ramim, M. M. (2012). A study of online exams procrastination using data analytics techniques. *Interdiscip. J. E Learn. Learn. Objects* 8, 97–113.

Lewis, S., Whiteside, A., and Dikkers, A. G. (2014). Autonomy and responsibility: Online learning as a solution for at-risk high school students. *J. Distance Educ.* 29, 1–11.

Liu, H., Hussain, F., Tan, C. L., and Dash, M. (2002). Discretization: an enabling technique. *Data Min. Knowl. Discov.* 6, 393–423. doi: 10.1023/A:1016304305535

Liu, O. L., Rijmen, F., MacCann, C., and Roberts, R. (2009). The assessment of time management in middle-school students. *Personal. Individ. Differ.* 47, 174–179. doi: 10.1016/j.paid.2009.02.018

Lust, G., Collazo, N. A. J., Elen, J., and Clarebout, G. (2012). Content management systems: enriched learning opportunities for all? *Comput. Hum. Behav.* 28, 795–808.

Lust, G., Elen, J., and Clarebout, G. (2013). "Measuring students' strategy-use within a CMS supported course through students' tool-use patterns," in *Proceedings of the Book of Abstracts 15th Biennial Conference EARLI 2013*, Munich, 571–572.

Macfadyen, L. P., and Dawson, S. (2012). Numbers are not enough. Why e-learning analytics failed to inform an institutional strategic plan. *Educ. Technol. Soc.* 15, 149–163.

Michinov, N., Brunot, S., Le Bohec, O., Juhel, J., and Delaval, M. (2011). Procrastination, participation, and performance in online learning environments. *Comput. Educ.* 56, 243–252. doi: 10.1016/j.compedu.2010.07.025

Mora, N., Caballé, S., Daradoumis, T., Barolli, L., Kulla, E., and Spaho, E. (2014). "Characterizing social network e-assessment in collaborative complex learning resources," in *Proceedings of the Complex, Intelligent and Software Intensive Systems (CISIS), 2014 Eighth International Conference on IEEE*, Washington, DC, 257–264. doi: 10.1109/CISIS.2014.36

Mosharraf, M., and Taghiyareh, F. (2012). "Improving student success rates through a semi-personalized feedback system," in *Proceedings of the 11th European Conference on e-Learning: ECEL*, Prague, 364–369.

Murray, M. C., Pérez, J., Geist, D. B., and Hedrick, A. (2012). Student interaction with online course content: build it and they might come. *J. Inf. Technol. Educ.* 11, 125–140.

Murugananthan, V., and ShivaKumar, B. L. (2016). An adaptive educational data mining technique for mining educational data models in elearning systems. *Indian J. Sci. Technol.* 9, 1–5. doi: 10.17485/ijst/2016/v9i3/86392

Nahar, J., Imam, T., Tickle, K. S., and Chen, Y. P. P. (2013). Association rule mining to detect factors which contribute to heart disease in males and females. *Expert Syst. Appl.* 40, 1086–1093. doi: 10.1016/j.eswa.2012.08.028

Núñez, J. C., Cerezo, R., Bernardo, A., Rosário, P., Valle, A., Fernández, E., et al. (2011). Implementation of training programs in self-regulated learning strategies in Moodle format: results of a experience in higher education. *Psicothema* 23, 274–281.

Odacı, H., and Kalkan, M. (2010). Problematic Internet use, loneliness and dating anxiety among young adult university students. *Comput. Educ.* 55, 1091–1097. doi: 10.1016/j.compedu.2010.05.006

Paredes, W. C., and Chung, K. S. K. (2012). "Modelling learning & performance: a social networks perspective," in *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, Vancouver, BC, 34–42. doi: 10.1145/2330601.2330617

Patrzek, J., Sattler, S., Van Veen, F., Grunschel, C., and Fries, S. (2015). Investigating the effect of academic procrastination on the frequency and variety of academic misconduct: a panel study. *Stud. High. Educ.* 40, 1014–1029. doi: 10.1080/03075079.2013.854765

Paule-Ruiz, M. P., Riestra-Gonzalez, M., Sánchez-Santillan, M., and Pérez-Pérez, J. R. (2015). The Procrastination related indicators in e-learning platforms. *J. Univ. Comput. Sci.* 21, 7–22.

Rabin, L. A., Fogel, J., and Nutter-Upham, K. E. (2011). Academic procrastination in college students: the role of self-reported executive function. *J. Clin. Exp. Neuropsychol.* 33, 344–357. doi: 10.1080/13803395.2010.518597

Rakes, G. C., and Dunn, K. E. (2010). The impact of online graduate students' motivation and self-regulation on academic procrastination. *J. Interact. Online Learn.* 9, 78–93.

Reid, M. J., and Moore, J. L. (2008). College readiness and academic preparation for postsecondary education oral histories of first-generation urban college students. *Urban Educ.* 43, 240–261. doi: 10.1177/0042085907312346

Rice, W. H. (2006). *Moodle E-Learning Course Development A Complete Guide to Successful Learning Using Moodle*. Birmingham: Packt Publishing.

Rodríguez-Málaga, L., Cerezo, R., and Rodriguez, C. (2017). "Metacognition and learning disabilities in higher education," in *Learning Disabilities: Assessment, Management and challenges*, ed. R. Pearson (New York, NY: Nova Science), 25–60.

Romero, C., Espejo, P. G., Zafra, A., Romero, J. R., and Ventura, S. (2013). Web usage mining for predicting final marks of students that use Moodle courses. *Comput. Appl. Eng. Educ.* 21, 135–146. doi: 10.1002/cae.20456

Romero, C., Romero, J. R., Luna, J. M., and Ventura, S. (2010a). "Mining rare association rules from e-learning data," in *Proceedings of the 3rd International Conference on Educational Data Mining*, Pittsburgh, PA, 171–181.

Romero, C., Ventura, S., Vasilyeva, E., and Pechenizkiy, M. (2010b). "Class association rules mining from students' test data," in *Proceedings of the 3rd International Conference on Educational Data Mining*, Tarrytown, NY, 317–319.

Romero, C., and Ventura, S. (2013). Data mining in education. *Wiley Interdiscip. Rev.* 3, 12–27. doi: 10.1002/widm.1075

Romero, C., Ventura, S., and García, E. (2008). Data mining in course management systems: moodle case study and tutorial. *Comput. Educ.* 51, 368–384. doi: 10.1016/j.compedu.2007.05.016

Romero, M. (2013). "Comparing procrastination in arts, sciences, technology, social sciences, and humanities high school students," in *Proceedings of the EDULEARN13: 5th International Conference on Education and New Learning Technologies*, Barcelona, 3465–3465.

Sánchez, A. M. (2010). Procrastinación académica: un problema en la vida universitaria. *Studiositas* 5, 87–94.

Sánchez-Santillán, M., Paule-Ruiz, M., Cerezo, R., and Alvarez-García, V. (2016). MeL: modelo de adaptación dinámica del proceso de aprendizaje en eLearning. *Anal. Psicol.* 32, 106–114. doi: 10.6018/analesps.32.1.195071

Scheffer, T. (2001). "Finding association rules that trade support optimally against confidence," in *Proceedings of the European Conference on Principles of Data Mining and Knowledge Discovery* (Berlin: Springer), 424–435. doi: 10.1007/3-540-44794-6_35

Schwarz, N. (1999). Self-reports: how the questions shape the answers. *Am. Psychol.* 54, 93–105. doi: 10.1037/0003-066X.54.2.93

Sekhavatian, A., and Mahdavi, M. (2011). "Application of recommender systems on e-learning environments," in *Proceedings of the EDULEARN11: 3rd International Conference on Education and New Learning Technologies*, Barcelona, 2679–2687.

Shukla, N. J., Hassani, H., and Casleton, R. (2014). "A comparison of delivery methods for distance learning mathematics courses," in *Paper Presented at SoTL Commons Conference*, Savannah, GA.

Steel, P. (2007). The nature of procrastination: a meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychol. Bull.* 133, 65–94. doi: 10.1037/0033-2909.133.1.65

Steel, P., and Klingsieck, K. B. (2016). Academic procrastination: psychological antecedents revisited. *Aust. Psychol.* 51, 36–46. doi: 10.1111/ap.12173

Stoeger, H., and Ziegler, A. (2008). Evaluation of a classroom based training to improve self-regulation in time management tasks during homework activities with fourth graders. *Metacogn. Learn.* 3, 207–230. doi: 10.1007/s11409-008-9027-z

Sureda-Negre, J., Comas-Forgas, R., and Oliver-Trobat, M. F. (2015). Academic plagiarism among Secondary and High School Students: differences in gender and procrastination/plagio académico entre alumnado de secundaria y bachillerato: diferencias en cuanto al género y la procrastinación. *Comunicar (English edition)* 22, 103–110. doi: 10.3916/C44-2015-11

Talavera, L., and Gaudioso, E. (2004). "Mining student data to characterize similar behavior groups in unstructured collaboration spaces," in *Proceedings of the European Conference on Artificial Intelligence, Workshop: Artificial Intelligence in Computer Supported Collaborative Learning (ECAI 2004)*, Valencia, 17–23.

Tan, C. X., Ang, R. P., Klassen, R. M., Yeo, L. S., Wong, I. Y., Huan, V. S., et al. (2008). Correlates of academic procrastination and students' grade goals. *Curr. Psychol.* 27, 135–144. doi: 10.1007/s12144-008-9028-8

Tan, P., Steinbach, M., Kumar, V., Potter, C., Klooster, S., and Torregrosa, A. (2001). "Finding spatio-temporal patterns in earth science data," in *Proceedings of the Knowledge Discovery and Data Mining2001 Workshop on Temporal Data Mining*, Vol. 19, New York, NY.

Terry, K. P. S. (2002). *The Effects of Online Time Management Practices on Self-Regulated Learning and Academic Self-Efficacy*. Doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Trevors, G., Duffy, M., and Azevedo, R. (2014). Note-taking within MetaTutor: interactions between an intelligent tutoring system and prior knowledge on note-taking and learning. *Educ. Technol. Res. Dev.* 62, 507–528. doi: 10.1007/s11423-014-9343-8

Trevors, G., Feyzi-Behnagh, R., Azevedo, R., and Bouchet, F. (2016). Self-regulated learning processes vary as a function of epistemic beliefs and contexts: mixed method evidence from eye tracking and concurrent and retrospective reports. *Learn. Instr.* 42, 31–46. doi: 10.1016/j.learninstruc.2015.11.003

Tuckman, B. W. (2005). Relations of academic procrastination, rationalizations, and performance in a web course with deadlines. *Psychol. Rep.* 96, 1015–1021. doi: 10.2466/pr0.96.3c.1015-1021

Visser, L. B., Korthagen, F. A. J., and Schoonenboom, J. (2015). Influences on and consequences of academic procrastination of first-year student teachers. *Pedagog. Stud.* 92, 394–412.

Wei, C. P., and Chiu, I. T. (2002). Turning telecommunications call details to churn prediction: a data mining approach. *Expert Syst. Appl.* 23, 103–112. doi: 10.1016/S0957-4174(02)00030-1

Winne, P. H., and Baker, R. S. (2013). The potentials of educational data mining for researching metacognition, motivation and self-regulated learning. *JEDM J. Educ. Data Min.* 5, 1–8.

Winters, F. I., Greene, J. A., and Costich, C. M. (2008). Self-regulation of learning within computer-based learning environments: a critical analysis. *Educ. Psychol. Rev.* 20, 429–444. doi: 10.1007/s10648-008-9080-9

Yaakub, N. F. (2000). *Procrastination among students in institutes of higher learning: Challenges for k-economy. The School of Languages and Scientific Thinking, Universiti Utara Malaysia*, Vol. 10. Available at: http://mahdzan.com/papers/procrastinate/default.asp

Yang, J. (2012). *Research on the Present Situation Procrastination Behavior of Primary School Students*. Guizhou: Journal of Xingyi Normal University for Nationalities, 2.

You, J. W. (2015). Examining the effect of academic procrastination on achievement using LMS data in e-learning. *Educ. Technol. Soc.* 18, 64–74.

You, J. W. (2016). Identifying significant indicators using LMS data to predict course achievement in online learning. *Internet High. Educ.* 29, 23–30. doi: 10.1016/j.iheduc.2015.11.003

Zimmerman, B., and Risemberg, R. (1997). "Self-regulatory dimensions of academic learning and motivation," in *Handbook of Academic Learning: Construction of Knowledge*, ed. G. D. Phye (San Diego, CA: Academic Press), 106–121.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: an overview. *Educ. Psychol.* 25, 3–17. doi: 10.1207/s15326985ep2501_2

Zimmerman, B. J. (1998). Academic studying and the development of personal skill: a self-regulatory perspective. *Educ. Psychol.* 33, 73–86. doi: 10.1080/00461520.1998.9653292

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Cerezo, Esteban, Sánchez-Santillán and Núñez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

CORRECTION
published: 02 August 2017
doi: 10.3389/fpsyg.2017.01355

Corrigendum: Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence

Ana Bernardo[1], María Esteban[1]*, Estrella Fernández[1], Antonio Cervero[2], Ellián Tuero[1] and Paula Solano[1]*

[1] Psychology Department, University of Oviedo, Oviedo, Spain, [2] Department of Education, University of Oviedo, Oviedo, Spain

Keywords: higher education, university drop-out, academic performance, academic adaptation, social adaptation

OPEN ACCESS

Edited and reviewed by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

****Correspondence:***
Ana Bernardo
bernardoana@uniovi.es
María Esteban
maria_esteban_garcia@hotmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *27 January 2017*
Accepted: *24 July 2017*
Published: *02 August 2017*

Citation:
Bernardo A, Esteban M, Fernández E, Cervero A, Tuero E and Solano P (2017) Corrigendum: Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence. Front. Psychol. 8:1355. doi: 10.3389/fpsyg.2017.01355

A corrigendum on

Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence

by Bernardo, A., Esteban, M., Fernández, E., Cervero, A., Tuero, E., and Solano, P. (2016). Front. Psychol. 7:1610. doi: 10.3389/fpsyg.2016.01610

There is an omission on the funding section, as authors specified the project funds, but did not mention additional funds. Therefore, where in the original article says;

"Alfaguia Project was developed thanks to the European Union funding (DCI-ALA/2010/94)."

Should say:

"Alfaguia Project was developed thanks to the European Union funding (DCI-ALA/2010/94). In addition, our research activity is also granted by European Regional Development Funds (European Union and Principality of Asturias) through the Science, Technology and Innovation Plan (GROUPIN14-100 and GROUPIN14-053)."

The authors apologize for any caused inconvenience. This omission does not affect the scientific conclusions of the article.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling Editor declared a shared affiliation, though no other collaboration, with the authors AB, ME, EF, AC, ET, and PS and states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2017 Bernardo, Esteban, Fernández, Cervero, Tuero and Solano. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 27 July 2017
doi: 10.3389/fpsyg.2017.01217

How Do Student Prior Achievement and Homework Behaviors Relate to Perceived Parental Involvement in Homework?

José C. Núñez[1], Joyce L. Epstein[2], Natalia Suárez[1], Pedro Rosário[3], Guillermo Vallejo[1] and Antonio Valle[4]*

[1] Department of Psychology, University of Oviedo, Oviedo, Spain, [2] Center on School, Family and Community Partnerships, Johns Hopkins University, Baltimore, MD, United States, [3] Departamento de Psicologia Aplicada, Universidade do Minho, Braga, Portugal, [4] Department of Developmental and Educational Psychology, University of A Coruña, Corunna, Spain

This study investigated how students' prior achievement is related to their homework behaviors (i.e., time spent on homework, homework time management, and amount of homework), and to their perceptions of parental involvement in homework (i.e., parental control and parental support). A total of 1250 secondary students from 7 to 10th grade participated in the study. Structural equation models were fitted to the data, compared, and a partial mediation model was chosen. The results indicated that students' prior academic performance was significantly associated with both of the students' homework variables, with direct and indirect results linking achievement and homework behaviors with perceived parental control and support behaviors about homework. Low-achieving students, in particular, perceived more parental control of homework in the secondary grades. These results, together with those of previous research, suggest a recursive relationship between secondary school students' achievement and their perceptions of parental involvement in homework, which represents the process of student learning and family engagement over time. Study limitations and educational implications are discussed.

Keywords: students' perceptions of parental involvement in homework, students' homework time management, time spent on homework, amount of homework completed, prior academic achievement

OPEN ACCESS

Edited by:
Meryem Yilmaz Soylu, University of Nebraska Lincoln, Turkey

Reviewed by:
Rodney Michael Schmaltz, MacEwan University, Canada
Angela Jocelyn Fawcett, Swansea University, United Kingdom

****Correspondence:***
Pedro Rosário
prosario@psi.uminho.pt

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *12 April 2017*
Accepted: *03 July 2017*
Published: *27 July 2017*

Citation:
Núñez JC, Epstein JL, Suárez N, Rosário P, Vallejo G and Valle A (2017) How Do Student Prior Achievement and Homework Behaviors Relate to Perceived Parental Involvement in Homework? Front. Psychol. 8:1217. doi: 10.3389/fpsyg.2017.01217

INTRODUCTION

Homework was defined by Cooper (1989) some years ago as the tasks assigned by teachers to students to be completed outside the class. Epstein and van Voorhis (2012) identified homework as a natural connector of school and home. In these ways, homework is one of the most common school activities involving teachers, students, and parents (Rosário et al., 2015). Recently, however, there have been serious debates in Spanish schools and in other countries about whether or not teachers should assign homework. The debates involve students' complaints about the time required to do their homework, parents' complaints about the quantity of homework assigned and their lack of information on how to guide their child on homework tasks, and, teachers' complaints about the lack of time to design effective homework assignments and deliver feedback to students, and the lack of parental support for students to do their work (Cooper et al., 2006).

There are several connections of students' homework, parental involvement, and student achievement that must be understood to address questions about the value of homework and improving the homework process. These relationships have been frequently studied across the decades, with most studies confirming a positive impact of homework on student achievement (Rosário et al., 2009; Bembenutty and White, 2013). However, findings vary depending on the research design (Cooper et al., 2006; Patall et al., 2008), nature of measures (i.e., global vs. specific) (Trautwein et al., 2009), students' grade level (Núñez et al., 2015), and focus of the analysis (e.g., student variables, instructional process variables, or parental involvement) (Núñez et al., 2014). Other studies explored the influence of parental involvement on students' homework behaviors and resulting achievement (Cooper et al., 2001, 2006; Patall et al., 2008; van Voorhis, 2011; Bardou et al., 2012; Dumont et al., 2012; Kim and Fong, 2013).

A substantial number of studies analyzed the association of different student homework behaviors with students' academic achievement (Xu, 2010; Núñez et al., 2013b; Xu et al., 2014). However, few studies have explored whether and how students' achievement levels affect their homework behaviors. This study aims to increase understanding on how students' levels of achievement are related to their homework behaviors (i.e., homework time spent, homework time management, and amount of homework completed), and how students with different achievement levels perceive the involvement of their parents in the homework process (i.e., control and support).

Why Are Parents Involved in Their Children's Homework?

Relationships between parental involvement in homework and academic achievement have been deeply debated and frequently investigated, with inconsistent results (Gonida and Vauras, 2014). Some studies found a positive relationship (Cooper et al., 2001; Pomerantz and Eaton, 2001), others reported a negative relationship between the two variables (Schultz, 1999). Dumont et al. (2012) found both positive and negative relationships, depending on the nature or quality of the involvement. For example, whereas perceived parent–child conflicts about homework were negatively associated with educational outcomes, perceived parental competence and support for students' self-direction were positively related to achievement. Similar results were obtained by Karbach et al. (2013), who found that academic achievement was significantly and negatively associated with parental control and strict structure (i.e., excessive control and pressure on children to complete assignments, consistent guidelines and rules about homework and school work).

In a recent study, Núñez et al. (2015) found that students' perceptions of strong control by parents in the homework process was directly and negatively related to academic achievement. The higher the perceived parental homework control, the lower the students' academic achievement. In the same study, perceived parental homework support was positively related to the achievement of junior high and high school students, but not to that of elementary school students.

Why do parents become involved in children's homework? The literature suggests several reasons for parents' involvement: their own motivation (Hoover-Dempsey et al., 1995; Katz et al., 2011); their socioeconomic status (Davis-Kean, 2005); teacher outreach and homework design that encourages engagement (Hoover-Dempsey and Sandler, 1997; Epstein and Van Voorhis, 2001); and their children's academic functioning (Pomerantz and Eaton, 2001; Grolnick et al., 2002; Cunha et al., 2015), with academic functioning one of the strongest instigators of parents' attention to homework.

That is, parents are more likely to be involved when children are not doing well in school (Levin et al., 1997; Pomerantz and Eaton, 2001; Ng et al., 2004; Silinskas et al., 2010). In that situation, parents are more prone to display controlling forms of involvement (Pomerantz and Eaton, 2001; Grolnick et al., 2002; Ng et al., 2004; Niggli et al., 2007). Thus, although a major assumption in previous studies has been that different types of parental involvement in homework are related to different levels of school achievement, it is also likely that children's academic achievement predicts or motivates parents to become involved in homework in particular ways.

Purpose of This Study

Some studies found that parents' participation in their children's academic life (e.g., monitoring progress through conversations with teachers, attending to subjects their children are struggling with) is related to students' homework completion (Pomerantz et al., 2007) and academic achievement (Wilder, 2013). However, investigations of parental involvement in homework is inconclusive (Patall et al., 2008; Wilder, 2013). Although some authors defend parents' involvement as a positive practice that can enhance children's academic success, others describe this support as a time-consuming exercise that frequently generates discomfort, anxiety and conflict in the family (Cooper et al., 2001; Pomerantz et al., 2005a; Patall et al., 2008). However, the majority of findings confirm a positive association between children's academic functioning (i.e., student achievement and productive homework variables) and parents' involvement in homework.

Most research has focused on how the context (e.g., family or school) or homework variables (e.g., quantity and quality of homework assignments, parental involvement, students' homework behaviors) influences student achievement (Trautwein et al., 2002; Hill et al., 2004; Cooper et al., 2006; Pomerantz et al., 2007; Trautwein, 2007; Trautwein et al., 2009; Zhu and Leung, 2012; Karbach et al., 2013; Núñez et al., 2013b, 2015). Few studies, however, *flipped the coin* to examine the inverse relationship. As Nurmi and Silinskas (2014, p. 455) point out, there is a need to analyze findings from a 'child-directed development' perspective, in their own words, "to see that children are not only the passive targets of their parents' behavior, guidance, and parenting practices but they also influence their parents in many ways." For example, Chen and Stevenson (1989) and Levin et al. (1997) concluded that when children showed low academic skills, their parents were more likely to monitor the amount and quality of their homework. More recently, Silinskas et al. (2010, 2013) analyzed the behavior of first and second grade students. They reported

that the lower the children's literacy and numeracy, the higher the levels of homework help and monitoring displayed by their parents. Silinskas et al. (2013) reinforced these findings, reporting that children's achievement had an "evocative impact" on their parents' behavior. Dumont et al. (2013) analyzed the relationship between fifth and seventh graders' functioning on homework and the quality of their parents' homework involvement (conceptualized as a multidimensional construct). They concluded that students' skills (e.g., levels of reading achievement, reading effort, and homework procrastination) predicted the quality of parental involvement in homework (parental control, parental responsiveness, and parental structure).

This study addresses how children's levels of prior academic achievement affect their perceptions of whether and how their parents are involved in homework. As in previous studies (Núñez et al., 2015), the dimensions of parental involvement in homework are control (i.e., parents' pressure on children to complete assignments) and support (i.e., the value students' place on parents' assistance and the spirit of parents' help to support students' self-direction or autonomy on homework). We explore whether and how student achievement and homework behaviors (i.e., time spent on homework, quality of homework management, and quantity of homework completed) promote specific kinds of parental involvement in homework.

Recent studies (Dumont et al., 2013; Silinskas et al., 2013) using longitudinal designs analyzed the effects of children's achievement on subsequent parental involvement. In both studies, the *direct* relationship between the two constructs was estimated with similar results. The associations were negative, indicating that the lower the children's achievement, the greater the involvement of their parents. However, Dumont et al. (2013) found the significant negative connection only for low achievement on greater parental *control,* but no significant connection with parental *support*. By contrast, Silinskas et al. (2013) reported a significant negative effect of children's reading achievement on both parental monitoring (similar to the Dumont et al., 2013 study) and an even greater or stronger negative effect of achievement on parental support (measured as "parental help") which (Dumont et al., 2013) did not find in their study. The different findings by Dumont et al. (2013) and Silinskas et al. (2013) may be due to the different ages of the participating students (grades 1 and 2 vs. grades 5 and 7, respectively).

Taken together, the data from these studies indicate that in the early elementary grades, students with low achievement prompted parents' control and support behaviors, whereas at the junior high school level, students' low achievement prompted significantly greater control by the parents who were involved. In order to extend analyses on how the level of students' prior achievement affects their parents' involvement, this study included measures of the students' homework behaviors as potential mediating variables as described by Dumont et al. (2013) and Silinskas et al. (2013). Prior studies were not conducted with students or parents at the high school level.

For this study of middle and high school students, a structural equation model (SEM) for homework was elaborated and fitted with the following hypotheses (see **Figure 1**):

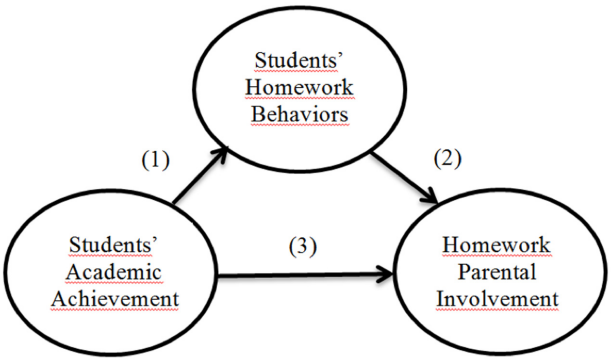


FIGURE 1 | Children's academic functioning and parental involvement relationship.

(1) Prior academic achievement is positively and significantly associated with children's homework behaviors (i.e., time spent on homework, homework time management, and amount of homework completed);
(2) Children's homework behaviors are associated with their perceptions of parental involvement in homework;
(3) Prior academic achievement is associated directly and negatively with students' reports of parental involvement in homework (control and support); and
(4) Perceived parental control and perceived parental support are significantly related.

Previous studies identified grade level as a relevant variable when analyzing the relationships between of academic achievement, students' homework behaviors and parental homework involvement (e.g., Patall et al., 2008; Skaliotis, 2009; Gonida and Cortina, 2014; Núñez et al., 2015). Thus, in this study the sample was divided into two subgroups (7th and 8th = grades—middle school and 9th and 10th grades—high school) to test the model invariance.

MATERIALS AND METHODS

Participants

A total of 1250 Spanish students from 7th to 10th grade with ages ranging from 12 to 16 years participated in this study. These students attended 68 classes in four urban public schools selected at random from all public schools in Asturias. There were 370 students in grade 7, 346 in grade 8, 257 in grade 9, and 277 in grade 10. Fifty one percent of the participants were male. In the Spanish educational system, compulsory secondary education extends through 9th grade. On average, the families of these students were in the middle class, evidenced by the low percentage of students receiving free or reduced-price lunch (18.7%) as reported in schools' office data.

Variables and Measures

Students' perceptions of parental involvement in homework and students' reports of their own homework behaviors were gathered

in questionnaires administered during one regular class period for about 25 min. Students' prior academic achievement data (report card grades) was provided by the secretary of each school.

Secondary students in middle and high schools are the main actors in their own education, thus students' reports about their homework behavior and their perceptions of parental involvement provide important views of the homework process. Teachers' and parents' actions and messages must be accepted, understood, and processed by the students, themselves, to motivate learning and promote achievement in school (Bempechat, 2004; Epstein, 2011). It is likely, as this study hypothesizes, that the characteristics of students affect how their parents react to them. The data from students provide a good starting place for understanding the research questions in this study.

Parental Involvement in Homework

Two dimensions of parental involvement in homework were assessed: students' perceptions of *control* exercised by parents and students' perceptions of *support* provided by their parents. The items were adapted from prior studies (e.g., Carter and Wojtkiewicz, 2000; Trautwein and Lüdtke, 2009; Dumont et al., 2012).

Students' perceptions of parental control were assessed with five items ($\alpha = 0.82$) (e.g., "My parents are fully aware of me completing all my tasks.") on a Likert scale with five responses ranging from 1 (completely false) to 5 (completely true). The five items were used to create a latent variable (Parental Control) for the SEM analysis.

S*tudents' perception of parental support* was computed from student responses to three items ($\alpha = 0.80$) (e.g., "When I have to do homework, explanations by my parents are very useful.") using the same scoring system as for parental control. A latent variable (Parental Support) was built from the three items for the SEM.

Student Homework Behaviors

Variables of homework behaviors were selected from a pool of items used in other studies (e.g., Núñez et al., 2013b, 2015) to create the latent variables.

Time spent on homework was calculated from student responses to two items ($\alpha = 0.70$): "How much time do you usually spend on homework each day, Monday through Friday?" and "How much time do you usually spend doing homework during the weekend?" The items were scored on a five point Likert scale, ranging from 1 (*less than 30 min*), 2 (*30 min to 1 h*), 3 (*1 h to hour and a half*), 4 (*1 h and a half to 2 h*), to 5 (*more than 2 h*.

Homework time management was calculated from student responses to two items ($\alpha = 0.72$): "When I'm doing my homework, I get distracted by anything that is around me," and "When I start homework, I concentrate and do not think about anything else until I finish (reverse coded)." These items were rated on a five-point Likert scale, ranging from 1 (*always*) to 5 (*never*).

Amount of homework completed was assessed from student responses to the following question: "Usually, how many tasks do you complete from the assigned homework?" This item was rated on a five-point Likert scale, ranging from 1 (*none*) to 5 (*all*).

Prior Academic Achievement

Prior academic achievement was obtained from students' report card grades in mathematics, Spanish language, English language, and social sciences at the end of the academic year (June) (see Núñez et al., 2015). The grades for the four subjects were used to build a latent variable (Prior Academic Achievement). The measurement scale of this variable ranged from 0 to 10 with 5 as a passing grade.

Procedure

Participating students were volunteers with approval from their parents. Researchers signed agreements with the collaborating school boards to conduct workshops for participating teachers and for parents on the results and educational implications of the research. All measures except prior academic achievement were collected in October at the beginning of the school year. In the current study the measure for prior academic achievement refers to students' achievement at the end of the previous school year and is used as an explanatory variable.

Data Analysis Strategy

To address the research questions of this study, data were analyzed in several stages. First, we calculated and analyzed descriptive statistics of the variables in the homework model. Second, following Núñez et al. (2015), three models were compared to examine to what extent the students' homework behaviors mediated the association between students' prior academic achievement and perceived parental involvement in homework: a full mediation model (M1), a partial mediation model (M2) [M1 plus a direct path from prior academic achievement to perceived parental involvement in homework (control and support)], and a non-mediation model (M3) [only the direct path from prior academic achievement to homework parental involvement] (see **Figure 2**). Information criteria-based model selection tools were used to compare the fit to the data of the three candidate models, and select the best (see Vallejo et al., 2014).

Third, multi-group analyses were conducted to check the invariance of the homework model chosen for the two subgroups of students at the middle and high school levels. Finally, the best-fit model was used to examine the three hypotheses of the study.

To account for the hierarchical structure of the data (i.e., students in classes), the homework model was fitted with Mplus 5.1 (Muthén et al., 1998–2007) using "type = complex" in the analysis command and "cluster = class" in the variable command. This procedure allowed computation of the standard errors and chi-square tests of model fit, taking into account clustering information and/or non-independence of observations, such as adjusting the standard errors of the regression coefficients. The MLR estimator in Mplus 5.1 (maximum likelihood robust) was selected, which is sensitive to non-normality and non-independence of observations.

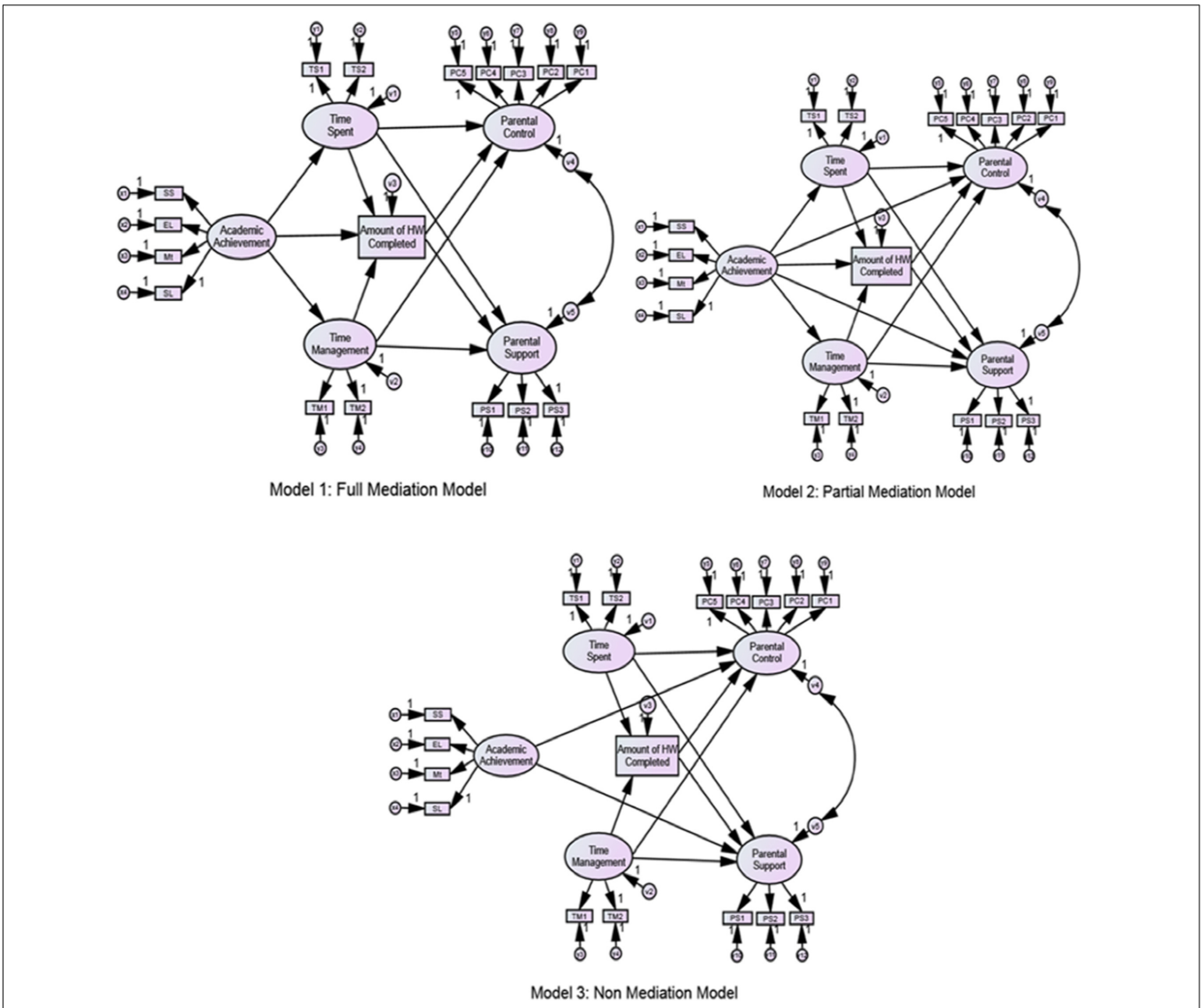


FIGURE 2 | Structural equation model (SEM) of children's academic functioning and homework parental involvement (full, partial, and non-mediation models). PC1,..., PC5 (measures of perceived Parental Control), PS1,..., PS3 (measures of perceived Parental Support), TS1 and TS2 (measures of Time Spent on HW Completion), TM1 and TM2 (measures of HW Time Management), HWC (measure of Amount of HW Completed), SL (measure of Spanish Language Achievement), Mt (measure of Mathematics Achievement), EL (measure of English Language Achievement), SS (measure of Social Sciences Achievement). V1 to V5 represent the variance explained. X1 to X5 and Y1 to Y12 are measurement errors.

A series of statistics and indices were used at different stages of data analysis. Akaike's (1974) Akaike's information criterion (AIC), Raftery's (1993), Bayesian information criterion (BIC), and Browne and Cudeck's (1993), Browne- and Cudeck's criterion (BCC) were used to select the proper mediation model. Then, to assess the fit of the model chosen, in addition to chi-square (χ^2) statistics and their associated probability (p) values, we used two absolute indices, the goodness-of-fit-index (*GFI*) and the adjusted goodness-of-fit-index (*AGFI*); a relative index, the Tucker Lewis Index (*TLI*) and the comparative fit index (*CFI*) (Bentler, 1990); and a close-fit parsimony-based index, the root mean square error of approximation (*RMSEA*), and their 90% confidence intervals (Hu and Bentler, 1999). According to these authors, a model fits well when: *GFI*, *AGFI,* and *TLI* $>$ 0.90, CFI $>$ 0.95, and *RMSEA* $\leq$ 0.05.

RESULTS

Descriptive Data

Table 1 shows descriptive statistics and the correlation matrix for the observed variables in the model. The variables are significantly inter-correlated. Because maximum likelihood (ML) can produce biases when variables fail to follow a normal distribution, we examined the distributions of all the variables (i.e., kurtosis and skewness). Taking the criterion of Finney and

TABLE 1 | Descriptive statistics of the variables in the structural equation homework model ($n = 1250$ middle and high school students).

	SL	PMT	EL	SS	TS1	TS2	TM1	TM2	HWC	PC1	PC2	PC3	PC4	PC5	PS1	PS2	PS3
SL	–																
PMT	0.75**	–															
EL	0.75**	0.68**	–														
SS	0.77**	0.66**	0.75**	–													
TS1	0.16**	0.11**	0.11**	0.16**	–												
TS2	0.33**	0.25**	0.31**	0.34**	0.54**	–											
TM1	0.25**	0.24**	0.20**	0.23**	0.12**	0.14**	–										
TM2	0.26**	0.22**	0.21**	0.25**	0.16**	0.20**	0.56**	–									
HWC	0.43**	0.40**	0.32**	0.36**	0.42**	0.35**	0.36**	0.38**	–								
PC1	−0.09**	−0.05	−0.09**	−0.09**	0.13**	0.08**	0.04	0.08**	0.17**	–							
PC2	0.09**	0.09**	0.06*	0.09**	0.18**	0.15**	0.13**	0.18**	0.28**	0.46**	–						
PC3	−0.05	−0.01	−0.07**	−0.01	0.22**	0.13**	0.11**	0.17**	0.28**	0.45**	0.47**	–					
PC4	0.01	0.04	0.00	0.04	0.27**	0.18**	0.14**	0.20**	0.31**	0.37**	0.37**	0.52**	–				
PC5	−0.01	0.04	0.00	0.02	0.16**	0.11**	0.10**	0.11**	0.21**	0.37**	0.39**	0.43**	0.49**	–			
PS1	0.03	0.01	−0.01	0.02	0.17**	0.17**	0.11**	0.16**	0.21**	0.34**	0.39**	0.37**	0.28**	0.23**	–		
PS2	0.11**	0.10**	0.08**	0.10**	0.15**	0.18**	0.07*	0.13**	0.23**	0.30**	0.33**	0.32**	0.26**	0.23**	0.52**	–	
PS3	0.16**	0.15**	0.12**	0.15**	0.17**	0.23**	0.13**	0.22**	0.28**	0.32**	0.39**	0.37**	0.33**	0.26**	0.55**	0.62**	–
M	5.60	5.22	5.92	5.95	3.21	3.08	3.22	3.21	4.15	3.45	3.73	3.24	3.33	2.99	3.48	3.53	3.49
SD	2.18	2.20	2.33	2.31	1.15	1.30	1.12	1.07	0.97	1.32	1.14	1.43	1.47	1.44	1.36	1.39	1.34
Skewness	0.00	−0.04	−0.20	−0.19	−0.15	0.02	−0.30	−0.25	−1.24	−0.47	−0.67	−0.23	−0.30	0.03	−0.50	−0.54	−0.53
Kurtosis	−0.71	−0.68	−0.55	−0.66	−0.76	−1.10	−0.49	−0.51	1.01	−0.90	−0.29	−1.25	−1.27	−1.31	−0.95	−0.96	−0.86

*PC1,..., PC5 (measures of Perceived Parental Control), PS1,..., PS3 (measures of Perceived Parental Support), TS1 and TS2 (measures of Time Spent on HW Completion), TM1 and TM2 (measures of HW Time Management), HWC (measure of Amount of HW Completed), SL (measure of Spanish Language Achievement), PMT (measure of Prior Mathematics Achievement), EL (measure of English Language Achievement), SS (measure of Social Sciences Achievement). *$p < 0.05$; **$p < 0.01$.*

TABLE 2 | Results of homework model comparison strategy.

	Models		
	Full mediation Model (M1)	**Partial mediation Model (M2)**	**Non-mediation Model (M3)**
NP	45	47	44
DF	108	106	109
χ^2	548.48	480.25	779.31
χ^2/DF	5.08	4.53	7.32
P	0.001	0.001	0.001
GFI	0.948	0.955	0.929
AGFI	0.926	0.936	0.901
TLI	0.938	0.946	0.904
CFI	0.951	0.958	0.923
RMSEA (90% CI)	0.057 (0.052–0.062)	0.053 (0.048–0.058)	0.071 (0.067–0.076)
AIC	638.48	574.25	885.31
BCC	329.32	265.15	576.13
BIC	59.63	5.66	301.34

NP, number of parameters; DF, degrees of freedom; χ^2, chi-square; GFI, goodness-of-fit-index; AGFI, adjusted goodness-of-fit-index; TLI, Tucker Lewis Index; CFI, comparative fit index; RMSEA, root mean square error of approximation; AIC, Akaike's Information Criterion; BCC, Browne-Cudek's Criterion; BIC, Bayesian Information Criterion.

DiStefano (2006), for whom 2 and 7 are the maximum allowable values for skewness and kurtosis, respectively, all of the variables respected those criteria (see **Table 1**). Therefore, with normality conditions met, we fitted the model using MLR.

Selecting the Best Model

The analyses of the comparison models showed that the fit of the non-mediation model was the worst of the three models (see **Table 2**). By comparison, the partial mediation model and the full mediation model showed a satisfactory fit, with the best fit of all provided by the partial mediation model [$\Delta\chi^2(2) = 68.23$, $p < 0.001$]. The likelihood ratio test procedure was favorable to the partial mediation model (M2). Also, to select the best fit model, the statistics provided by AIC, BIC, and BCC were used to determine which of the two models (full or partial mediation model) was more likely to accurately describe the relationships in the matrix data.

Table 2 shows that the partial mediation model has a more valid BIC value than does the full mediation model. Similarly, efficient criteria (i.e., AIC) which tends to choose more complex models (Vallejo et al., 2014), as well as consistent criteria (i.e., BIC), which tends to choose simpler models, favored the selection of the Partial Mediation Model (M2). Based on the suggestions by Burnham and Anderson (2002), we selected M2 as the actual Kullback–Leibler best model for the population of possible samples.

Grade Level Invariance Analysis

The hypothesis of the invariance of the Homework Partial Mediation Model in the two samples of students (7th -8th grade vs. 9th -10th grade) was analyzed with multi-group analyses. Specifically, we tested the similarity of the Homework Partial Mediation Model in both samples with regard to its five dimensions: measurement weights, structural weights, structural covariances, structural residuals, and measurement residuals.

Results showed that the hypothesized homework model is similar in both samples on four of the five criteria (see **Table 3**). Assuming that the unconstrained model is correct [$\chi^2 = 577.614$, df = 212, $p < 0.001$, χ^2/df = 2.725, GFI = 0.948, AGFI = 0.924, CFI = 0.957, RMSEA = 0.037, 90% CI (0.034, 0.041), $p = 1.000$], when testing equality in measurement weights, in structural weights, in structural covariances, and in structural residuals no statistically significant differences were found. Finally, assuming the absence of differences in structural residuals, statistically significant differences were found in measurement residuals.

Therefore, the results show that the Homework Partial Mediation Model is invariant for the two groups of students in the first four dimensions (measurement weights, structural weights, structural covariances, and structural residuals), but not for the last one (measurement residuals). The analysis of structural weights and structural covariances was the main focus of the multi-group analysis, which indicates the appropriateness of using the total sample to analyze the homework model.

Children's Prior Academic Achievement and Perceived Parental Involvement in Homework

Results for the Homework Partial Mediation Model adjustment are provided in **Table 4** and **Figure 3**. Overall, the analyses confirm the three hypotheses initially established for the study. First, as hypothesized, prior academic achievement was significantly associated with students' homework behaviors. Statistically significant and positive associations were found between prior academic achievement and the time students spend on homework, the management of this time, and the amount of homework completed.

Second, children's homework variables and perceived parental homework involvement were significantly and positively related: time spent on homework with perceived parental control and with perceived parental support; time homework management with perceived homework parental control and with perceived homework parental support; and, finally, amount of homework completed with perceived homework parental control and with perceived homework parental support. Third, the direct association between prior academic achievement and perceived parental involvement in homework was significant and negative for perceived parental control, but contrary to our hypothesis not statistically significant for perceived parental support. It is interesting to note, however, that the indirect association between prior performance and perceived homework parental involvement (through time spent on homework, homework time management, and amount of homework completed) was positive and significant for both types of perceived homework parental involvement: support and control. Four, both dimensions of perceived parental involvement in homework were positive and strongly related ($r = 0.573$, $d = 1.40$).

TABLE 3 | Results of grade level invariance analysis.

	$\Delta\chi^2$	ΔDF	P	NFI	IFI	RFI	TLI
Measurement weights	27.199	14	0.018	0.003	0.003	−0.001	−0.002
Structural weights	15.074	10	0.129	0.002	0.002	−0.002	−0.002
Structural covariances	0.000	1	0.999	0.000	0.000	0.000	0.000
Structural residuals	6.424	5	0.267	0.001	0.001	−0.001	−0.001
Measurement residuals	79.683	17	0.000	0.009	0.009	0.004	0.004

$\Delta\chi^2$, difference in χ^2 values between models; ΔDF, difference in number of degrees of freedom between models; P, statistical significance; NFI, normed fit index; IFI, index of fit; RFI, relative fit index; TLI, Tucker Lewis Index.

TABLE 4 | Standardized and unstandardized regression weights, standard errors, *z*-values, and associated *p*-values for the Homework Partial Mediation Model.

			SRW	URW	SE	SRW/SE	*p*-value
Prior academic achievement	→	HW time spent	0.375	0.154	0.049	7.619	0.000
Prior academic achievement	→	HW time management	0.369	0.150	0.030	12.297	0.000
Prior academic achievement	→	Amount of HW completed	0.126	0.074	0.056	2.255	0.004
HW time spent	→	Amount of HW completed	0.317	0.452	0.069	4.592	0.000
HW time management	→	Amount of HW completed	0.310	0.446	0.037	8.453	0.000
HW time spent	→	Parental control	0.277	0.276	0.049	5.682	0.000
HW time spent	→	Parental support	0.255	0.293	0.048	5.344	0.000
HW time management	→	Parental control	0.196	0.197	0.051	3.859	0.000
HW time management	→	Parental support	0.160	0.186	0.045	3.584	0.000
Amount of HW completed	→	Parental control	0.243	0.170	0.045	5.384	0.000
Amount of HW completed	→	Parental support	0.105	0.085	0.044	2.383	0.017
Prior academic achievement	→	Parental control	−0.269	−0.110	0.043	−6.322	0.000
Prior academic achievement	→	Parental support	−0.037	−0.017	0.042	−0.884	0.377
Parental control	↔	Parental support	0.573	0.356	0.029	20.031	0.000

Data of measurement model (relation between the observed variables and the corresponding latent variables) are not included. SRW, standardized regression weights; URW, unstandardized regression weights; SE, standard error.

Additionally, data indicate that both dimensions of perceived parental homework involvement also were moderately predicted by children's achievement levels and students' homework behaviors (see **Figure 3**): 21.3% (perceived homework parental control) and 14.1% (perceived homework parental support).

DISCUSSION

Pomerantz et al. (2007, p. 399) suggested that research is needed on how children's characteristics influence their interactions with and the involvement of parents on school work. In their words: "[the] consideration of the match between children's characteristics and the manner in which parents become involved is a crucial endeavor." Their call identified an important research agenda that has not been adequately addressed. Parental involvement does not "produce" student achievement. Rather the parents' attitudes and actions must flow to and through students, who must interpret and respond to the involvement activities with their own attitudes and actions.

This study responds to that call by focusing on whether student characteristics affect their views of parental involvement. Tests of the data favored SEM analysis of a partial mediation model to explore connections of students' prior levels of achievement, homework behaviors, and perceived parental involvement in homework. Two major topics emerged that are important to discuss.

Prior Academic Achievement and Students' Homework Behaviors Predict Perceived Parental Involvement in Homework

This study explored the connections of middle and high school students' prior levels of achievement and reported homework behaviors with students' perceptions of the nature of their own parents' involvement in homework. Findings indicated that level of achievement was related to students' perceptions of how their parents behaved about homework. Specifically, the data showed that the higher the students' prior achievement, the more time they spent on their homework, the more homework was completed, and the better their homework time management. Further, the more time spent and the more homework completed, the stronger students' reports of their parents' involvement in terms of both control and support of homework.

These findings are aligned with other studies that examined the relationship of these variables in the opposite, more common direction. For example, Núñez et al. (2015), found that the more students' reported their parents' involvement, the more time they

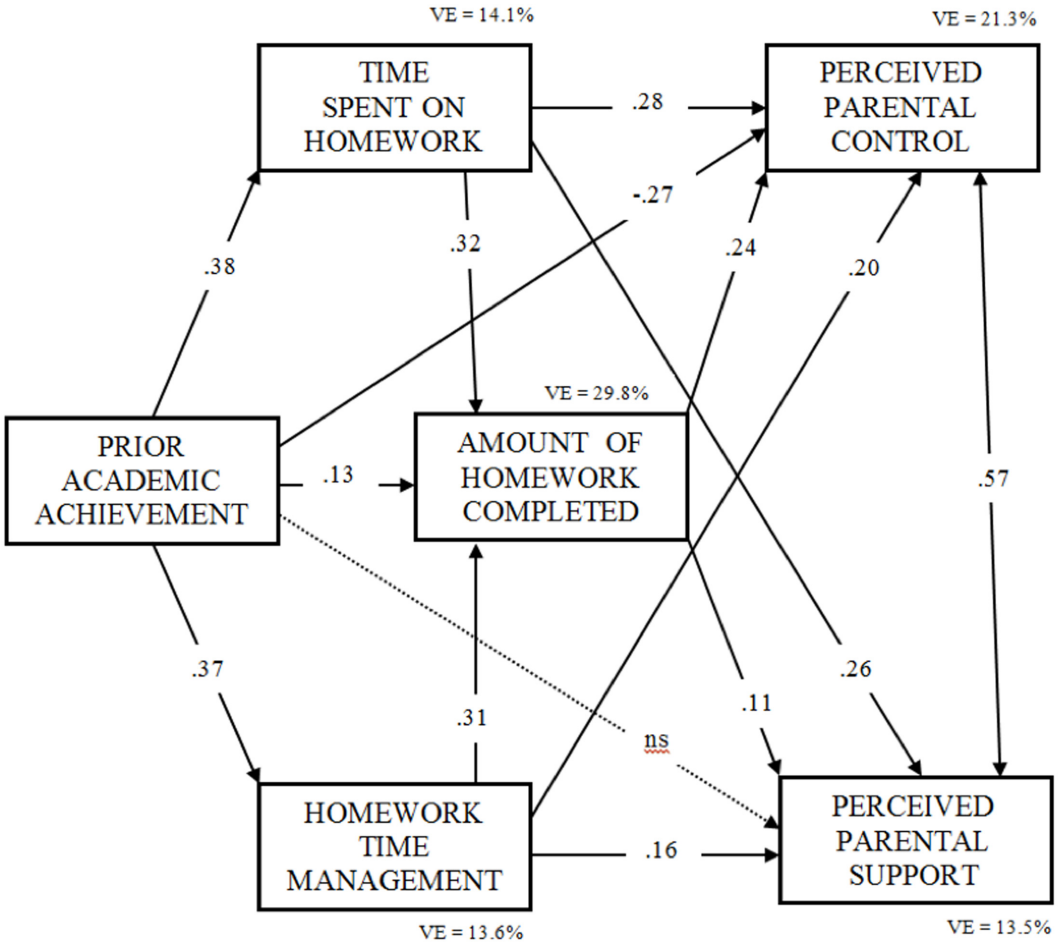


FIGURE 3 | Standardized total effects in the Homework Partial Mediation Model (N = 1250). VE (Variance Explained). All coefficients are statistically significant at $p < 0.001$, except Homework Time Management on Perceived Parental Support ($p < 0.01$), and Prior Academic Achievement on Perceived Parental Support ($p > 0.05$, not statiscally significant).

spent doing homework, the better their time management, and the higher their academic achievement.

By examining different assumptions about the direction of influence of children's characteristics and parents' engagement in homework, we can see that, however viewed, students with higher prior achievement tend to spend more time on homework, manage it better, and do more homework. With achievement level taken into account, students who take time to do their homework, perceive and report that their parents continue to offer controlling and supportive messages about the homework process.

This study reinforced prior findings that when secondary school students' academic performance is poor, they tend to spend less time doing homework, manage their time less effectively, and complete less homework. This study extends prior results by showing that low-achieving students perceived and reported that their parents proffered more controlling messages about homework. Pomerantz et al. (2005b) claimed that children with a history of poor academic performance may be particularly sensitive to the quantity and quality of parental involvement. Low-achieving students, even at the secondary level, may need extra attention from parents to keep them invested in the homework process. If parental involvement is more controlling for these children as suggested in this study and by Núñez et al. (2015), the low-achieving students may progressively disengage from their homework and school tasks. Longitudinal data are needed to examine if parents' extra pressure helps low achievers improve their achievement scores and stay in school compared to low achievers whose parents ignore the homework process.

The Direct Relationships of Students' Levels of Prior Academic Performance with Parental Involvement in Homework Differ for Perceived Parental Controlling and Supportive Behaviors

As in prior investigations, this study found a direct negative relationship between children's academic performance and students' perceptions of parental involvement in homework, particularly parents' controlling behaviors. With other variables

statistically controlled, students with lower achievement reported that their parents conducted more monitoring and controlling behaviors about homework. There was no significant relationship of student achievement with perceived parental support of homework.

Some researchers explain this pattern of results as reflecting parents' recognition that low-achieving children need more direction and control than do more successful students, who take more personal responsibility for completing their homework (Pomerantz and Eaton, 2001; Grolnick et al., 2002; Pomerantz et al., 2005a; Epstein and van Voorhis, 2012). Others explain that some parents lack confidence and competence to guide their children in other ways than by controlling (Hoover-Dempsey and Sandler, 1997). Still, others suggest that parents will be more controlling if they and the children have negative attitudes toward homework or behavior problems while doing homework (Fuligni et al., 2002; Pomerantz et al., 2005a), or if parents feel less competent to help children work independently on homework (Pomerantz and Eaton, 2001), or if the child and parents area frustrated by persistent low school achievement (Pomerantz et al., 2005a). As Pomerantz et al. (2007, p. 383) note "when parents' involvement is controlling, children do not have the experience of solving challenges on their own," and, "when parents are controlling, they may deprive children of feeling that they are autonomous, effective agents."

A pattern of over-control by parents may not help students who are struggling to improve their achievement. Several studies reported a connection of high control of homework by parents and children low academic achievement (Cooper et al., 2000; Dumont et al., 2012; Karbach et al., 2013; Núñez et al., 2015). These students may be particularly sensitive to parents' pressure about homework and may not understand the parents' intent to motivate them to do their work. The findings from this and other research suggest the existence of a *vicious circle* in the relationship between children's prior academic achievement, perceived parental involvement in control of homework, and children's later achievement. That is, unless parental involvement in homework is carefully balanced with caring control and support messages, low-achieving students may avoid homework and disengage from school, especially in the secondary grades. To break the cycle, this study suggests, an optimal combination of control and support messages is needed to encourage middle and high school students to spend time on, manage, and complete their homework.

CONCLUSION

A substantial amount of research has analyzed the association of various student homework behaviors (e.g., time spent on homework, time management, amount of homework done, procrastination, emotions, goals and motivations for doing homework, attitudes) with students' academic achievement. Literature also is replete with studies of how parental involvement in homework affects students' academic achievement. However, few studies *flipped the coin* to examine how students' prior achievement levels affect their homework behaviors and how children's academic functioning affects parents' control or support of homework.

This study examined the little known associations of secondary students' achievement levels with other important elements of the homework process—students' behaviors and parents' involvement. The findings indicated that children's academic functioning was associated with their perceptions of parental involvement in the homework process. The study reveals the recursive nature of these important components of the homework process: children's achievement level affects perceived parental involvement in homework, and, over time, parental involvement in homework affects students' later performance.

This study supports and extends the results of past research to support an interactive model of socialization (Collins et al., 2000; Grusec, 2002). The behaviors of parents and children are modeled progressively as their interactions proceed and progress, and as results accumulate to shape the trajectory of student learning.

Limitations

The presumed reciprocal relationships of parent involvement and student achievement are provocative, but they must be examined in future studies. This study's data were cross-sectional with one-time measures of the independent and dependent variables. This prohibits claims of causality. Future studies using the required longitudinal data and/or experimental designs that guide specific parental behaviors and messages could test the assumption of recursive relationships of parental involvement and student achievement, which may affect each other, over time.

Another limitation of this study is that all measures were reported by the students. This helped us learn what students with different levels of achievement say about their homework time and products, and how they view the involvement of their parents. Although important, one set of reporters is not sufficient for fully understanding the roles and relationships of students and parents that affect the homework process. Behavior-based measures from students (such as a homework diary) and data from parents of their involvement in homework are needed, along with the children's views, to study whether multiple reporters explain their behaviors in the same way. Multiple measures from multiple reporters would confirm or challenge the accuracy of reports of students' homework behaviors of time spent and homework completed, and build a more robust understanding of the complex and continuous influences on student achievement.

Applications

Although research on all aspects of the homework process must continue to improve, the results of this and prior studies (e.g., Grolnick and Slowiaczek, 1994; Epstein, 1995; Cooper and Valentine, 2001; Hill and Taylor, 2004; Pomerantz et al., 2005b; Epstein, 2007), have clear and useful educational applications. Numerous studies confirm that, over time, parental involvement with students on homework is associated with higher student achievement. Positive practices of parental involvement may

promote students' cognitive, linguistic, and mathematical skills, metacognitive skills, and strategies for a self-regulated learning, as well as positive attitudes toward school and motivation to learn. However, as Darling and Steinberg (1993) alerted, the effect of these practices is largely determined by the style in which the practices are carried out. And, results also depend on the quality of the design and clarity of parental involvement activities on homework with specific learning goals for students (Epstein and van Voorhis, 2012). The present study and previous research suggest that parental involvement in homework should be more strongly characterized by autonomy support, process focus, positive affect, and positive beliefs in students' abilities than by too much control, negative affect, and negative beliefs about homework. School administrators, school psychologists, and teachers should offer workshops for secondary school parents on core aspects of their involvement in homework (e.g., how to support students' independent thinking and completion of assignments; how to prevent and cope with children's emotional distress about homework; and how to maintain student motivation but reduce undue parental pressure, particularly on students who are struggling in school).

The results of this and other studies suggest that, with teachers' guidance and materials, more parents could help their students (a) strive to be more independent in their study (Núñez et al., 2013a); (b) understand that their effort (not innate ability) will help them complete their assignments; (c) focus on the positive aspects of school, homework, and learning rather than on negative attitudes (Cunha et al., 2015); and (d) face homework with self-confidence not just to avoid failure but to complete tasks, solve problems, and meet success. The results of this study deepen our understanding about the potential for parents' positive interactions with their teens on homework at the secondary school level.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the ethics committee of the University of Oviedo. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

AUTHOR CONTRIBUTIONS

NS was responsible for the data collection, and for the literature search with JN. GV was responsible for data analysis, and JE for the data interpretation. JN, JE, PR, and AV made important intellectual contribution in research design and manuscript revision. All authors were involved in the writing process of this manuscript.

FUNDING

This work has been funded by the Department of Science and Innovation (Spain) under the National Program for Research, Development and Innovation: project EDU2014-57571-P, and from the European Union, through the European Regional Development Funds and the Principality of Asturias, through its Science, Technology and Innovation Plan (grant GRUPIN14-100 and GRUPIN14-053).

ACKNOWLEDGMENT

This manuscript was completed with the help of funding from Ministry of Science and Innovation of Spain (Ref.: EDU2014-57571-P, EDU2013-44062-P, and PSI2011-23395).

REFERENCES

Akaike, H. (1974). A New Look at the Statistical Model Identification. *IEEE Trans. Automat. Control* 19, 716–723. doi: 10.1109/tac.1974.1100705

Bardou, E., Roussel, N. O., Safont-Mottay, C., Lescarret, O., Deslandes, R., and Rousseau, M. (2012). Predictive factors of adolescents' parental involvement in homework: a comparative study France-Quebec. *Prat. Psychol.* 18, 283–298.

Bembenutty, H., and White, M. C. (2013). Academic performance and satisfaction with homework completion among college students. *Learn. Individ. Differ.* 24, 83–88. doi: 10.1016/j.lindif.2012.10.013

Bempechat, J. (2004). The motivational benefits of homework: a social-cognitive perspective. *Theory Pract.* 43, 189–196. doi: 10.1353/tip.2004.0029

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychol. Bull.* 107, 238–246. doi: 10.1037/0033-2909.107.2.238

Browne, M. W., and Cudeck, R. (1993). "Alternative ways of assessing model fit," in *Testing Structural Equation Models*, eds K. Bollen and J. Long (Newbury Park, CA: Sage), 136–162.

Burnham, K. P., and Anderson, D. R. (2002). *Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach*. New York, NY: Springer.

Carter, R. S., and Wojtkiewicz, R. A. (2000). Parental involvement with adolescents' education: Do daughters or sons get more help? *Adolescence* 35, 29–44.

Chen, C., and Stevenson, H. W. (1989). Homework: a cross-cultural examination. *Child Dev.* 60, 551–561. doi: 10.2307/1130721

Collins, W. A., Maccoby, E. E., Steinberg, L., Hetherington, E. M., and Bornstein, M. (2000). Contemporary research on parenting: the case for nature and nurture. *Am. Psychol.* 55, 218–232. doi: 10.1037/0003-066x.55.2.218

Cooper, H. (1989). *Homework. Research on Teaching Monograph Series*. New York, NY: Longman Homework. doi: 10.1037/11578-000

Cooper, H., Jackson, K., Nye, B. A., and Lindsay, J. J. (2001). A model of homework's influence on the performance evaluations of elementary school students. *J. Exp. Educ.* 69, 181–199. doi: 10.1080/00220970109600655

Cooper, H., Lindsay, J. J., and Nye, B. (2000). Homework in the home: how student, family, and parenting-style differences relate to the homework process. *Contemp. Educ. Psychol.* 25, 464–487. doi: 10.1006/ceps.1999.1036

Cooper, H., Robinson, J. C., and Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Rev. Educ. Res.* 76, 1–62. doi: 10.3102/00346543076001001

Cooper, H., and Valentine, J. C. (2001). Using research to answer practical questions about homework. *Educ. Psychol.* 36, 143–153. doi: 10.1207/s15326985ep3603_1

Cunha, J., Rosário, P., Macedo, L., Nunes, A. R., Fuentes, S., Pinto, R., et al. (2015). Parents' conceptions of their homework involvement in elementary school. *Psicothema* 27, 159–165. doi: 10.7334/psicothema2014.210

Darling, N., and Steinberg, L. (1993). Parenting style as context: an integrative model. *Psychol. Bull.* 113, 487–496. doi: 10.1037/0033-2909.113.3.487

Davis-Kean, P. E. (2005). The influence of parent education and family income on child achievement: the indirect role of parental expectations and the home environment. *J. Fam. Psychol.* 19, 294–304. doi: 10.1037/0893-3200.19.2.294

Dumont, H., Trautwein, U., Lüdtke, O., Alois Niggli, M. N., and Schnyder, I. (2012). Does parental homework involvement mediate the relationship between family background and educational outcomes? *Contemp. Educ. Psychol.* 37, 55–69. doi: 10.1016/j.cedpsych.2011.09.004

Dumont, H., Trautwein, U., Nagy, G., and Nagengast, B. (2013). Quality of parental homework involvement: predictors and reciprocal relations with academic functioning in the reading domain. *J. Educ. Psychol.* 106, 144–161. doi: 10.1037/a0034100

Epstein, J. L. (1995). School/family/community partnerships: caring for the children we share. *Phi Delta Kappan* 76, 701–712.

Epstein, J. L. (2007). "Homework"," in *The Praeger Handbook of American High Schools*, eds K. M. Borman, S. E. Cahill, and B. A. Cotner (Westport, CT: Praeger), 224–228.

Epstein, J. L. (2011). *School, Family, and Community Partnerships: Preparing Educators and Improving Schools*. Boulder, CO: Westview Press.

Epstein, J. L., and Van Voorhis, F. L. (2001). More than minutes: teachers' roles in designing homework. *Educ. Psychol.* 36, 181–194. doi: 10.1207/S15326985EP3603_4

Epstein, J. L., and van Voorhis, F. L. (2012). "The changing debate: from assigning homework to designing homework," in *Contemporary Debates in Child Development and Education*, eds S. Suggate and E. Reese (London: Routledge), 263–273.

Finney, S. J., and DiStefano, C. (2006). "Non-normal and categorical data in structural equation modelling"," in *Structural Equation Modelling: A Second Course*, eds G. R. Hancock and R. O. Mueller (Greenwich, CT: Information Age Publishing), 269–314.

Fuligni, A. J., Yip, T., and Tseng, V. (2002). The impact of family obligation on the daily activities and psychological well-being of Chinese American adolescents. *Child Dev.* 73, 302–314. doi: 10.1111/1467-8624.00407

Gonida, E. N., and Cortina, K. S. (2014). Parental involvement in homework: relations with parent and student achievement-related motivational beliefs and achievement. *Br. J. Educ. Psychol.* 84, 376–396. doi: 10.1111/bjep.12039

Gonida, E. N., and Vauras, M. (2014). The role of parents in children's school life: student motivation and socio-emotional functioning. *Br. J. Educ. Psychol.* 84, 349–351. doi: 10.1111/bjep.12048

Grolnick, W. S., Gurland, S. T., DeCourcey, W., and Jacob, K. (2002). Antecedents and consequences of mothers' autonomy support: an experimental investigation. *Dev. Psychol.* 38, 143–155. doi: 10.1037/0012-1649.38.1.143

Grolnick, W. S., and Slowiaczek, M. L. (1994). Parents' involvement in children's schooling: a multidimensional conceptualization and motivational model. *Child Dev.* 64, 237–252. doi: 10.2307/1131378

Grusec, J. E. (2002). "Parenting socialization and children's acquisition of values"," in *Handbook of Parenting: Practical Issues in Parenting*, Vol. 5, ed. M. H. Bornstein (Mahwah, NJ: Lawrence Erlbaum), 143–167.

Hill, N. E., Castellino, D. R., Lansford, J. E., Nowlin, P., Dodge, K. A., Bates, J. E., et al. (2004). Parent academic involvement as related to school behavior, achievement, and aspirations: demographic variations across adolescence. *Child Dev.* 75, 1491–1509. doi: 10.1111/j.1467-8624.2004.00753.x

Hill, N. E., and Taylor, L. C. P. (2004). Parental school involvement and children's academic achievement: pragmatics and issues. *Curr. Dir. Psychol. Sci.* 13, 161–164. doi: 10.1111/j.0963-7214.2004.00298.x

Hoover-Dempsey, K. V., Bassler, O. C., and Burow, R. (1995). Parents' reported involvement in students' homework: strategies and practices. *Elem. Sch. J.* 95, 435–450. doi: 10.11124/jbisrir-2015-2335

Hoover-Dempsey, K. V., and Sandler, H. M. (1997). Why do parents become involved in their children's education? *Rev. Educ. Res.* 67, 3–42. doi: 10.3102/00346543067001003

Hu, L., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ. Model.* 6, 1–55. doi: 10.1080/10705519909540118

Karbach, J., Gottschling, J., Spengler, M., Hegewald, K., and Spinath, F. M. (2013). Parental involvement and general cognitive ability as predictors of domain-specific academic achievement in early adolescence. *Learn. Instr.* 23, 43–51. doi: 10.1016/j.learninstruc.2012.09.004

Katz, I., Kaplan, A., and Buzukashvily, T. (2011). The role of parents' motivation in students' autonomous motivation for doing homework. *Learn. Individ. Differ.* 21, 376–386. doi: 10.1016/j.lindif.2011.04.001

Kim, S., and Fong, V. L. (2013). How parents help children with homework in China: narratives across the life span. *Asia Pac. Educ. Rev.* 14, 581–592. doi: 10.1007/s12564-013-9284-7

Levin, I., Levy-Shiff, R., Appelbaum-Peled, T., Katz, I., Komar, M., and Meiran, N. (1997). Antecedents and consequences of maternal involvement in children's homework: a longitudinal analysis. *J. Appl. Dev. Psychol.* 18, 207–227. doi: 10.1016/s0193-3973(97)90036-8

Muthén, L. K., and Muthén, B. O. (1998–2007). *Mplus User's Guide*. Los Angeles, CA: Muthén & Muthén.

Ng, F. F., Kenney-Benson, G. A., and Pomerantz, E. M. (2004). Children's achievement moderates the effects of mothers' use of control and autonomy support. *Child Dev.* 75, 764–780. doi: 10.1111/j.1467-8624.2004.00705.x

Niggli, A., Trautwein, U., Schnyder, I., Lüdtke, O., and Neumann, M. (2007). Parental homework support can be beneficial, but parental intrusion is detrimental: family background, parental homework supervision, and performance gains. *Psychol. Erzieh. Unterr.* 54, 1–14.

Núñez, J. C., Rosário, P., Vallejo, G., and González-Pienda, J. A. (2013a). A longitudinal assessment of the effectiveness of a school-based mentoring program in middle school. *Contemp. Educ. Psychol.* 38, 11–21. doi: 10.1016/j.cedpsych.2012.10.002

Núñez, J. C., Suárez, N., Cerezo, R., González-Pienda, J., Rosário, P., Mourão, R., et al. (2013b). Homework and academic achievement across Spanish compulsory education. *Educ. Psychol.* 35, 726–746. doi: 10.1080/01443410.2013.817537

Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Valle, A., and Epstein, J. L. (2015). Relationships between perceived parental involvement in homework, student homework behaviors, and academic achievement: differences among elementary, junior high, and high school students. *Metacogn. Learn.* 10, 375–406. doi: 10.1007/s11409-015-9135-5

Núñez, J. C., Tuero-Herrero, E., Vallejo, G., Rosário, P., and Valle, A. (2014). Student, teacher, and school context variables predicting academic achievement in biology: analysis from a multilevel perspective. *Rev. Psicodid.* 19, 145–171.

Nurmi, J. E., and Silinskas, G. (2014). Parents and their children's school lives – commentary on the special issue, 'parents' role in children's school lives'. *Br. J. Educ. Psychol.* 84, 454–458. doi: 10.1111/bjep.12046

Patall, E. A., Cooper, H., and Robinson, J. C. (2008). Parent involvement in homework: a research synthesis. *Rev. Educ. Res.* 78, 1039–1101. doi: 10.3102/0034654308325185

Pomerantz, E. M., and Eaton, M. M. (2001). Maternal intrusive support in the academic context: transactional socialization processes. *Dev. Psychol.* 37, 174–186. doi: 10.1037/0012-1649.37.2.174

Pomerantz, E. M., Moorman, E. A., and Litwack, S. D. (2007). The how, whom and why of parents' involvement in children's academic lives: more is not always better. *Rev. Educ. Res.* 77, 373–410. doi: 10.3102/003465430305567

Pomerantz, E. M., Wang, Q., and Ng, F. F. (2005a). Mothers' affect in the homework context: the importance of staying positive. *Dev. Psychol.* 41, 414–427. doi: 10.1037/0012-1649.41.2.414

Pomerantz, E. M., Wang, Q., and Ng, F. F. (2005b). "The role of children's competence experiences in the socialization process: a dynamic process framework for the academic arena"," in *Advances in Child Development and Behavior*, ed. R. Kail (San Diego, CA: Academic Press), 193–227.

Raftery, A. E. (1993). "Bayesian model selection in structural equation models," in *Testing Structural Equation Models*, eds K. A. Bollen and J. S. Long (Newbury Park, CA: Sage), 163–180.

Rosário, P., Mourão, R., Baldaque, M., Nunes, T., Núñez, J. C., González-Pienda, J. A., et al. (2009). Homework, self-regulated learning and math achievement. *Rev. Psicodid.* 14, 179–192.

Rosário, P., Núñez, J. C., Vallejo, G., Cunha, J., Nunes, T., Mourão, R., et al. (2015). Does homework design matter? The role of homework purposes on students' mathematics achievement. *Contemp. Educ. Psychol.* 43, 10–24. doi: 10.1016/j.cedpsych.2015.08.001

Schultz, M. D. (1999). *Parental Involvement in Low-Income and Minority Children's Education*. Doctoral dissertation, State University of New York at Stony Brook, New York, SB.

Silinskas, G., Leppänen, U., Aunola, K., Parrila, R., and Nurmi, J. E. (2010). Predictors of mothers' and fathers' teaching of reading and mathematics during kindergarten and grade 1. *Learn. Instr.* 20, 61–71. doi: 10.1016/j.learninstruc.2009.01.002

Silinskas, G., Niemi, P., Lerkkanen, M.-K., and Nurmi, J.-E. (2013). Children's poor academic performance evokes parental homework assistance—but does it help? *Int. J. Behav. Dev.* 37, 44–56. doi: 10.1177/0165025412456146

Skaliotis, E. (2009). Changes in parental involvement in secondary education: an exploration study using the longitudinal study of young people in England. *Br. Educ. Res. J.* 36, 975–994. doi: 10.1080/01411920903342020

Trautwein, U. (2007). The Homework–achievement Relation Reconsidered: differentiating homework time, homework frequency, and homework effort. *Learn. Instr.* 17, 372–388. doi: 10.1016/j.learninstruc.2007.02.009

Trautwein, U., Köller, O., Schmitz, B., and Baumert, J. (2002). Do homework assignments enhance achievement? A multilevel analysis in 7th-grade mathematics. *Contemp. Educ. Psychol.* 27, 26–50. doi: 10.1006/ceps.2001.1084

Trautwein, U., and Lüdtke, O. (2009). Predicting homework motivation and homework effort in six school subjects: the role of person and family characteristics, classroom factors, and school track. *Learn. Instr.* 19, 243–258. doi: 10.1016/j.learninstruc.2008.05.001

Trautwein, U., Schnyder, I., Niggli, A., Neumann, M., and Lüdtke, O. (2009). Chameleon effects in homework research: the homework–achievement association depends on the measures used and the level of analysis chosen. *Contemp. Educ. Psychol.* 34, 77–88. doi: 10.1016/j.cedpsych.2008.09.001

Vallejo, G., Tuero-Herrero, E., Núñez, J. C., and Rosário, P. (2014). Performance evaluation of recent information criteria for selecting multilevel models in behavioral and social sciences. *Int. J. Clin. Health Psychol.* 14, 48–57. doi: 10.1016/s1697-2600(14)70036-5

van Voorhis, F. L. (2011). Costs and benefits of family involvement in homework. *J. Adv. Acad.* 22, 220–249. doi: 10.1177/1932202x1102200203

Wilder, S. (2013). Effects of parental involvement on academic achievement: a meta-synthesis. *Educ. Rev.* 14, 377–397. doi: 10.1080/00131911.2013.780009

Xu, J. (2010). Predicting homework time management at the secondary school level: a multilevel analysis. *Learn. Individ. Differ.* 20, 34–39. doi: 10.1016/j.lindif.2009.11.001

Xu, J., Yuan, R., Xu, B., and Xu, M. (2014). Modeling students' time management in math homework. *Learn. Individ. Differ.* 34, 32–42. doi: 10.1016/j.lindif.2014.05.011

Zhu, Y., and Leung, F. K. S. (2012). Homework and mathematics achievement in Hong Kong: evidence from the TIMSS 2003. *Int. J. Sci. Math. Educ.* 10, 907–925. doi: 10.1007/s10763-011-9302-3

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Núñez, Epstein, Suárez, Rosário, Vallejo and Valle. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 20 July 2017
doi: 10.3389/fpsyg.2017.01239

Identifying Gifted Children: Congruence among Different IQ Measures

Estrella Fernández[1], Trinidad García[1], Olga Arias-Gundín[2], Almudena Vázquez[3] and Celestino Rodríguez[1]*

[1] Faculty of Psychology, Oviedo University, Oviedo, Spain, [2] Department of Psychology, Sociology and Philosophy, Faculty of Education, León University, León, Spain, [3] Asunción León-Primary and Secondary School, León, Spain

This study has two main aims: (1) analysing the relationship between intellectual capacities and levels of creativity in a sample of Spanish students from the third and sixth grades; and (2) examining the discrimination capacities and degree of congruence among different tests of intellectual ability that are commonly used to identify high-ability students. The study sample comprised 236 primary school students. Participants completed different tests of intellectual ability, which were based on both fluid and crystallized intelligence, as well as creativity. Results indicated that it is advisable to use varying tests in the assessment process, and a complementary measure (i.e., creativity) in order to create a multi-criteria means of detection that can more efficiently distinguish this population of students.

Keywords: intellectual ability, creativity, primary school, high ability, assessment methods

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Juan Luis Castejon, University of Alicante, Spain
Faye Antoniou, National and Kapodistrian University of Athens, Greece

****Correspondence:***
Estrella Fernández
fernandezestrella@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *31 January 2017*
Accepted: *06 July 2017*
Published: *20 July 2017*

Citation:
Fernández E, García T, Arias-Gundín O, Vázquez A and Rodríguez C (2017) Identifying Gifted Children: Congruence among Different IQ Measures. Front. Psychol. 8:1239. doi: 10.3389/fpsyg.2017.01239

INTRODUCTION

Identifying students with higher abilities has become a subject of great interest for researchers, education administrators, teachers and families alike. However, it is also a controversial issue because there is still no agreement on which variables must be taken into account to determine whether a student has higher abilities, or how these variables should be measured in these cases.

The different conceptualizations of higher intellectual abilities, either from educational, socio-political or psychometric perspectives, have traditionally tried to identify those children who are exceptional (Pfeiffer, 2015). One of the models that has received more attention is the Three-Ring Conception of Giftedness by Renzulli (1978). This model has helped establish some of the general criteria being used to classify students with higher abilities today. This author defined high intellectual ability as a consistent interaction between three basic human traits that characterize high-ability people: (a) above-average general intelligence; (b) creativity (defined as "that cluster of traits that encompasses curiosity, originality, ingenuity, and a willingness to challenge convention and tradition"; and (c) task commitment (which "represents a non-intellective cluster of traits found consistently in creative and productive individuals, including perseverance, determination, will power or positive energy") (Renzulli, 2012). This model has been used as a reference in Spanish schools to determine which students are gifted and which students are not gifted. In which the creativity acquiring, at a practical level, great protagonism, above-average commitment. Moreover, some studies show that gifted learners are more creative than average learners, for example, when evaluating divergent thinking or amount of original ideas (Ferrando et al., 2008; Jauk et al., 2013).

However, this is not the only model to be considered. Other authors such as Jeltova and Grigorenko (2005), Calero et al. (2007), and Pfeiffer (2012) consider high-ability children as those who demonstrate a higher likelihood of attaining significant achievements in culturally valued domains. These authors take into account a student's intellectual abilities, while also emphasizing the relevance of certain personality traits and the role of stimulating social environments that can effectively favor an individual's learning in specific fields. However, regardless of the theoretical model, there is agreement today that higher intellectual ability is a multi-dimensional construct, and that more human and material resources are needed to identify this often-latent potential in order to provide appropriate educational support to such students (Tourón et al., 1998; Pfeiffer, 2015). It is therefore fundamental that schools and professionals are provided with the right tools to identify high-ability students as early as possible (Reis and Renzulli, 2010).

Traditionally, intellectual ability was the central variable used to discriminate high-ability individuals from the average population. Nowadays, however, various authors agree that intellectual quotient (IQ) cannot be used as a single variable in the conceptualization of high abilities (Calero and García-Martín, 2011; Pfeiffer, 2015). For example, as discussed by Wellisch and Brown (2012) in their study, some authors suggest that the most reliable information would be based on the perception of teachers and families. Nevertheless, IQ remains an important factor to be assessed and, when used in conjunction with other variables, it can provide essential information concerning the identification of students with exceptional abilities (Sternberg, 2010; Renzulli and Gaesser, 2015). Moreover, many educational policies establish that, in order to implement effective identification and intervention processes, a non-negotiable criterion is to evaluate the student's intellectual capacity by means of standardized tests (Wet and Gubbins, 2011). Although other criteria may be used, there are currently authors who consider that these criteria cannot equal the objectivity and reliability of IQ measurements and tasks, especially for students with learning difficulties (Lovett and Lewandowski, 2006). This broader approach to assessment is important, since the responsibility of detecting high-ability students often falls to schools, which commonly only pay attention to the more traditional signals related to high-ability, such as high levels of academic achievement. Evaluation and intervention recommendations come from teachers in most cases (Renzulli and Gaesser, 2015); however, most teachers do not have a vast knowledge in the identification of high-ability students. This may lead to mistakes during the assessment process (Tourón et al., 2006; Reis and Renzulli, 2010) and under-identification of some students, especially those from lower socio-economic backgrounds (Moon and Brighton, 2008; Baker, 2011; Freeman, 2011; Wellisch and Brown, 2012), and/or those who have socio-emotional problems and may appear to have low levels of competence in basic learning processes (emulating students with learning difficulties) (Silverman, 2009; Wellisch and Brown, 2012).

Therefore, although the exclusive use of standardized tests to assess intellectual ability has its detractors (Pfeiffer, 2012) and these tests are not the only measures available nowadays, the fact remains that standardized tests have been accepted as reliable measures of identifying students with higher abilities to date (Lovett and Lewandowski, 2006; Lovett and Sparks, 2011; Erwin and Worrell, 2012) and as Carman (2013) suggests "no matter how often researchers suggest that an IQ score is not the only way of determining giftedness, it is still the most common method of identifying gifted participants for research, either alone or in combination with other criteria." At a practical level, in Spain the information obtained from standardized tests is the first criterion used to determine if a student may have higher abilities, and is essential for continuation of the evaluation process. This measure is used as a baseline analysis of the students' capacities and offers a starting point for the detection of higher intellectual abilities (Renzulli, 2012; Wellisch and Brown, 2012).

Accepting this condition as necessary, a new problem arises concerning which standardized tests to choose and the degree of congruence required between different measures. This difficulty is associated, in part, with the definition of intelligence itself and with the variables that are considered relevant to measure this construct (e.g., abstract reasoning, vocabulary, numerical knowledge). Standardized tests designed to evaluate the IQ are based on different conceptualizations of intelligence and this is an important aspect to consider when deciding which measure should be used. Some authors recommend the use of non-verbal tests to avoid cultural and linguistic biases (Naglieri and Ford, 2003) such as the *Factor "g"* test (Cattell and Cattell, 1994) or "Matrices" (Sánchez-Sánchez et al., 2015), both of which are considered good estimators of fluid intelligence and general intellectual ability (or "g" factor). Other authors, in order to provide a more contextual perspective to the conceptualization of the intelligence, give greater weight to the evaluation of psychological variables relevant to the execution of school tasks, thus estimating intellectual ability by focusing on school competences rather than on purely intellectual capacities (Thurstone and Thurstone, 2005). Finally, some authors state that appropriate testing should take the form of batteries of tests that also collect information on a wide range of variables that, in the last decades, have demonstrated they are good indicators of intelligence, such as students' verbal competence, together with components such as working memory, processing speed, comprehension, analytical capacity, and so forth (Sternberg, 2010; Pierson et al., 2012).

At this point it is worth noting the current interest in the research community in hierarchical models of intelligence and their tests, and specifically in the Cattell–Horn–Carroll Theory of Cognitive Abilities (CHC) (McGrew, 2005). This theory establishes three strata in the conceptualization of intelligence: stratum III – general or global intelligence; stratum II (broad) – 10 general intelligence abilities which are the main focus of interest in the assessment of intellectual ability and are fluid and crystallized intelligence, short-term or immediate memory, long-term memory storage and retrieval, processing speed, quantitative reasoning, reacting or decision making speed, visual processing, auditory processing, reading ability, and writing ability; and stratum I (narrow) – made up of more specific components such as inductive processes, vocabulary, visual memory, spatial relations, and general sequential reasoning,

and which would conform to the general cognitive factors of stratum II.

Although this theory is gradually having an impact on the evaluation and identification of higher ability students at the international level (Pfeiffer, 2015), and new assessment tools are being designed or adapted based on this model (e.g., WISC-V; Wechsler, 2014), at a practical level, at least in Spain, it has not yet become established as a specific assessment protocol adjusted to this perspective. Therefore, both the detection model and the tests used ultimately depend on the experience and knowledge of the professionals in charge of the evaluation, and the assessment measures available in each case.

The present study had two objectives. First, following Renzulli's (1978) model, it aimed to describe intellectual capacities and creativity levels of a sample of primary school students from northern Spain, with the aim of detecting and analysing potential cases of high ability where IQ is 130 or above – or two typical deviations above the average. Students from grades 3 and 6 were chosen as representative of this stage, and two variables of measures, intellectual capacity and creativity, were measured. Second, taking into account that depending on the tests used the students identified as gifted children may be different, this study aimed to establish the congruence and efficacies of different types of intellectual ability measures in order to determine if they concur, with respect to distinguishing students with higher abilities from average students. In schools it is common to use only a test of intellectual capacity in the processes of identification. Therefore, it is necessary to determine if these results in incorrect identification, either by over- or under-identification, due to inconsistencies between different type tests results.

In this analysis, although they are important variables in Renzulli's (1978) model, task involvement and academic performance are not included as discriminating criteria because previous literature suggests that many students with high ability fail in the academic environment due to related factors, such as lack of motivation, and poor recognition by teachers of their real educational needs, both of which can also arise due to "teacher-bias" (Reis and Renzulli, 2004, 2009).

MATERIALS AND METHODS

Participants

A sample of 236 primary school students from northern Spain took part in this study. The students were recruited from the third grade ($n = 117$; 49.6%) and the sixth grade ($n = 119$; 50.4%). Their ages ranged from 8 to 13 years ($M = 9.96$; $SD = 1.65$). The ratio of males to females in the total sample was not ideal ($\chi^2 = 4.90$; $p = 0.027$). There were no statistically significant differences in the percentage of students in the different grades ($p = 0.90$). The ages of the third grade students ranged from 9 to 10 years ($M = 8.38$; $SD = 0.51$), with 63 (53.8%) of the sample being female, and 54 (46.2%) being male. There were no statistically significant differences regarding gender distribution ($p = 0.405$). In the case of the sixth grade students, their ages ranged from 11 to 13 years ($M = 11.50$; $SD = 0.55$), with 47 (39.5%) being female and 72 (60.5%) being male. There were statistically significant differences between the proportion of boys and girls in this group ($\chi^2 = 5.25$; $p = 0.022$).

Measures

The following instruments were administered:

Intellectual Abilities

Three measures traditionally used in the assessment of intelligence were used. The *Test of Educational Aptitudes* (TEA-1) is a test of academic competences based on a selection of the most relevant factors from the "Primary Mental Abilities" by Thurstone (1938). The *Battery of Differential and General Skills* (Badyg) is consistent with the Cattell–Horn–Carroll theory (CHC) as the test is based on a hierarchical model of intelligence with three different levels. Lastly, the *Factor "g"* test is a non-verbal test which provides a measure of fluid intelligence (Gf) and general intellectual ability, or g factor. Due to the age of the students, two different versions of the Badyg were used. Specifically, students in grade 3 completed the Badyg-2, while students in grade 6 completed the Badyg-3. A more detailed description of these tests follows.

Test of Educational Aptitudes (adapted to Spanish by Department I+D of TEA Editions, S.A.) (Thurstone and Thurstone, 2005) test provides an estimation of general intelligence and its factors. It consists of five parts that measure three different components or abilities (i.e., factors): verbal (different words and vocabulary), numerical (calculation), and reasoning (drawing and series). It also offers the possibility to measure verbal and non-verbal abilities separately. It is available in three different versions for different age groups. The TEA-1 version was used in the present study and was administered according to the age range of the sample. Reliability coefficients by mean of Cronbach's alpha ranged between 0.61 and 0.95 for the different subtests, with an alpha of 0.89 for the full scale. The manual reports adequate internal validity, although correlations between different variables are mostly low to moderate. High correlations are only reported between verbal reasoning and academic aptitude ($r = 0.89$), and between academic aptitude and numerical reasoning ($r = 0.85$).

Battery of Differential and General Skills (Badyg) (Yuste et al., 2005) provides an estimation of IQ and presents different versions for different age groups. Students in sixth grade completed the Badyg-E3, which consists of six subtests: (1) analog relations (verbal intelligence), (2) numerical series (inductive reasoning), (3) matrices (fluid intelligence), (4) sentence completion (inductive reasoning), (5) numerical problems (verbal intelligence), and (6) figure matching (visual processing). An overall full-scale IQ index score is also provided. Students in third grade completed the Badyg-E2. It is made up of the same subtests as the Badyg-E3 but varies in difficulty level and application time. Cronbach's alpha was from 0.77 to 0.84 for the different subtests, and 0.95 for the full scale. The Cronbach's alpha obtained in the present study, for the full scale, was 0.72.

While there are more powerful assessment tools to evaluate this component and with better psychometric properties, this

instrument was chosen for the following reasons: (a) it can be used to predict academic performance in a reliable way; (b) it has been used in previous studies which demonstrated a relationship between intellectual ability and academic performance; and (c) factorial analysis showed high correlations between the different sub-scales that compose the Badyg battery. Criterion validity was moderate to high (Pearson's *r* from 0.39 to 0.58). This scale also shows a well-adjusted factorial structure making it possible to carry out additional broad-scoped comparisons (e.g., Sabiston et al., 2013).

The *Factor "g"* test (Cattell and Cattell, 1994 – adapted to Spanish by Associated Specialized Technicians) evaluates intelligence conceived as a general mental ability. It uses non-verbal tasks to eliminate the influence of those abilities that have been acquired through education, such as vocabulary or numerical knowledge. This test has three versions, each with different difficulty levels. The selection of the level depends upon the age of the participant. Level 2 (suitable for children from 8 to 14 years) was used in the present study. It includes four subtests: series, classification, conditions, and matrices. Individual scores are combined to obtain a global IQ score. The participant is asked to establish logical relationships between abstract figures and forms.

Cronbach's alpha ranged between 0.76 and 0.85 for the different subtests (alpha = 0.86 for the full scale), with a complementary index adequate stability of 2.59 (typical measurement errors). Criterion validity was high, finding statistically significant correlations between the different sub-scales and the Test of Educational Aptitudes-TEA 1 and 2 (Pearson's *r* from 0.53 to 0.81; $p < 0.001$).

Creativity

The *Creative Intelligence Test* (CREA) (Corbalán et al., 2003) presents participants with an image (commonly representing a social scene) and they have a limited time frame to formulate all the questions that the situation evokes in them. Version C, which is aimed at children, was used. In addition to providing a global measure of creativity, it offers the possibility to analyze the results qualitatively. Three levels of creativity can be established based on percentages (low = below the 25th percentile; medium = 26th–74th percentiles; and high = 75th percentile and above).

Procedure

Students were recruited from different schools in Northern Spain. Once the schools were selected, principals and head teachers of the participating schools were contacted. They were informed about the aims of the study, its voluntary nature and anonymity, and the ethical treatment of the data recorded. The study was conducted in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki), which reflects the ethical principles for research involving humans (Williams, 2008). Informed consent from families was also obtained. Researchers who were trained in psychology administered the above tests, all of which were conducted using counter-balanced methodology over the course of the testing, in three different testing sessions. Students with severe learning difficulties or special educational needs were excluded from the analyses.

Data Analysis

A descriptive design was used. Due to the objectives of this study, statistical analyses were performed in different steps. First, the sample was described in terms of age, gender, IQ (based on the three measures of intelligence previously described), and creativity. This analysis was conducted separately for students in grade 3 and 6, as different versions of the Badyg were used. The normality of the dependent variables (i.e., global scores in the CREA, Badyg, TEA-1, and *Factor "g"* test) was analyzed, paying special attention to skewness and kurtosis values. Following Finney and Di Stefano's (2006) criterion, the adequacy of these values was demonstrated (**Table 1**). Secondly, to estimate the correspondence between the different measures of intellectual ability, Pearson correlation between global IQ scores were conducted.

Additionally, student's *t*-test was also performed to analyze within-subject differences in IQ estimated with the different tests. To analyze the discriminatory capacity of each test in the detection of students with high abilities, the absolute frequency of students with an IQ of 130 or higher (as determined by the different tests) was then calculated. The congruence among the three intelligence tests was estimated by recording the number of students who were found to have an IQ of 130 or above in all the tests. Congruence between pairs of tests in the detection of high-ability students was also established. Although considering an IQ of 130 or above – or two typical deviations above the average – seems to be an arbitrary criterion, in both research and educational practice this criterion is still used, in most cases, as a cut-off point to determine which students have higher intellectual abilities (Moon and Brighton, 2008; Carman, 2013; Guignard et al., 2016; Peyre et al., 2016).

RESULTS

Intellectual IQ Results of the Students and Correspondence between Measures

Table 1 shows descriptive statistics for the sample, while **Table 2** presents correlations between IQ scores measured using the different tests of intellectual ability described. Analyses for students in grade 3 and 6 are presented separately.

Third Grade Students

As **Table 1** shows, 59% of the students in grade 3 had a medium level of creativity, while only 19% reached high levels of creativity. However, the mean in this variable suggests low levels of creativity in general (values in this variable can range from 0 to 25).

Results from the intelligence tests administered placed the intellectual ability of the group around the average, regardless of the test used. Scores were slightly higher in the case of the *Factor "g"* test (i.e., fluid intelligence). Standard deviations were high, suggesting the presence of large inter-subject variability. IQ values ranged from 68 to 149 points in the case of the *Factor "g"* test, between 65 and 135 in the TEA-1, and between 64 and 139 in the Badyg-2. The correlations between the various measures of intellectual ability were positive and statistically

TABLE 1 | Descriptive statistics for the sample (third and sixth grade students).

	Third grade students ($N = 117$)			Sixth grade students ($N = 119$)		
		M	*SD*		*M*	*SD*
CREA-Q	Low $n = 29$ (24.8%) Medium $n = 69$ (59%) High $n = 19$ (16.2%)			Low $n = 5$ (4.2%) Medium $n = 66$ (55.5%) High $n = 48$ (40.3%)		
CREA-RS		7.94	3.81		10.85	3.60
Factor *g* test		109.28	15.90		94.27	20.87
BADYG		102.03	16.96		99.94	16.71
TEA-1		101.79	12.94		104.35	16.17

CREA-Q, CREA qualitative: low, medium, and high creativity; CREA-RS, CREA raw score; n, number of students by level; M, Mean; SD, Standard Deviation.

TABLE 2 | Bivariate correlations between IQ scores in the different tests (third and sixth grade students).

	Third grade students ($N = 117$)				Sixth grade students ($N = 119$)		
	Factor *g* test	**Badyg-2**	**TEA-1**		**Factor *g* test**	**Badyg-3**	**TEA-1**
Factor *g* test		0.605*	0.373*	Factor *g* test		0.159	0.031
Badyg-2			0.502*	Badyg-3			0.746*
TEA-1				TEA-1			

*$p < 0.001$.

significant between all pairs of tests (see **Table 2**). Statistically significant differences between IQ scores estimated with *Factor "g"* test and Badyg-2 ($t = 5.369$; $p < 0.001$), and between *Factor "g"* test and TEA-1 ($t = 4.964$; $p < 0.001$) were found, but not between the Badyg-2 and TEA-1 ($p = 0.866$). Thus, statistically significant differences were found when the crystallized and fluid intelligence measures were compared, with students' IQ scores being higher when using the latter measure.

Sixth Grade Students

Results show that students in this group obtained higher scores in CREA than the younger students. However, the scores varied from a minimum of 4 to a maximum of 20 in this variable. Again, the proportion of students with medium creativity was greater than the proportion of students with low and high creativity. However, the percentage of students with high levels of creativity was greater than in the third grade students group (see **Table 1**).

Regarding the variable IQ, sixth grade students showed average levels of intelligence, although a large within-subject variability was observed. IQ scores ranged from 30 to 139 points when the *Factor "g"* test was used, from 55 to 136 in the case of the Badyg-3, and from 65 to 135 when the TEA-1 was administered. Correlations between the different measures were positive, but only statistically significant when using the Badyg-3 and TEA-1 (see **Table 2**). At a within-subject level, statistically significant differences in IQ scores were observed when the *Factor "g"* test and Badyg-3 were compared ($t = -2.529$; $p = 0.013$), as well as between the *Factor "g"* test and TEA-1 ($t = -4.237$; $p < 0.001$), and between the Badyg-3 and TEA-1 ($t = -4.092$; $p < 0.001$). Students in grade 6 obtained better results in the TEA-1 than in the other tests.

Discriminatory Values of the Measures in the Detection of Students with High Abilities, and the Intellectual Measures of the Students Detected

To detect students that could be considered high-ability and determine the congruence between the tests, a selection of cases in which a student scored 130 or above in the different IQ tests was made. Results are presented according to school grade (**Tables 3**, **4**).

Third Grade Students

None of the students in this group obtained an IQ score of 130 or above in all three of the tests. However, scores from the *Factor "g"* test and Badyg-2 converged in two cases. With respect to the other possible paired-comparisons of the tests, there were no instances of converging results (**Table 3**). These students showed a medium-to-high percentile in the creativity test and a mean IQ of 139 points in the *Factor "g"* test, with values ranging from 132 to 146 points. They also exhibited a mean of 137.5 points in the Badyg-2, with values between 136 and 139. Regarding IQ assessed by the TEA-1, values were close to 130, ranging from 119 to 128 points.

For students who had an IQ of 130 or greater in only one of the tests, it can be observed that the *Factor "g"* test identified the highest number of students who met this criterion (13 students), while the TEA-1 was the most restrictive test with only one student identified. The Badyg-2, however, detected six students who met the above-mentioned criterion. It should be noted that, in the majority of cases, students identified as having high-abilities showed a medium level of creativity.

TABLE 3 | Descriptive statistic of participants with an IQ equal or above 130 in the different tests (third grade students).

Age	Gender	CREA-Q			CREA-RS	Factor *g* test	Badyg-2	TEA 1
M (*SD*)	M/F	Low	Medium	High	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Convergence between Factor g test and Badyg-2 (n = 2)								
8.5 (0.707)	1M/1F	–	*n* = 1 (50%)	*n* = 1 (50%)	10.501 (2.242)	139 (9.898)	137.5 (2.123)	125.5 (6.363)
IQ above or equal to 130 in Factor g test (n = 13)								
8.38 (0.506)	7M/6F	*n* = 2 (15.4%)	*n* = 10 (76.9%)	*n* = 1 (7.7%)	8.461 (2.781)	136.232 (6.300)	116.846 (14.512)	107.676 (14.332)
IQ above or equal to 130 in Badyg-2 (n = 6)								
8.667 (0.516)	3M/3F	*n* = 1 (16.7%)	*n* = 4 (66.6%)	*n* = 1 (16.7%)	8.667 (3.265)	128 (1.714)	132 (3.982)	118.16 (7.935)
IQ above or equal to 130 in TEA 1 (n = 1)								
9	1F	–	*n* = 1 (100%)	–	8	122	127	135

M/F, male/female; CREA-Q, CREA qualitative: low, medium, and high creativity; CREA-RS, CREA raw score; M, Mean; SD, Standard Deviation.

TABLE 4 | Descriptive statistic of participants with an IQ equal or above 130 in the different tests (sixth grade students).

Age	Gender	CREA-Q			CREA-RS	Factor *g* test	Badyg-3	TEA-1
M (*SD*)	M/F	Low	Medium	High	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Convergence between Factor g test and TEA 1 (n = 1)								
12	1M	–	–	*n* = 1 (100%)	19	139	127	135
IQ above or equal to 130 in Factor g test (n = 4)								
11.5 (0.577)	2M/2F	–	*n* = 1 (25%)	*n* = 3 (75%)	14.750 (3.862)	132.750 (4.193)	117.250 (7.500)	110.250 (17.967)
IQ above or equal to 130 in Badyg-3 (n = 1)								
12	1F	–	*n* = 1 (100%)	–	9	122	136	119
IQ above or equal to 130 in TEA 1 (n = 6)								
11.5 (0.547)	4M/2F	–	*n* = 3 (50%)	*n* = 3 (50%)	12.833 (3.656)	101 (22.172)	116.500 (9.995)	135

M/F, male/female; CREA-C, CREA qualitative: low, medium, and high creativity; CREA-RS, CREA raw score; M, Mean; SD, Standard Deviation.

Finally, IQ scores ranged between 130 and 149 points when measured by the *Factor "g"* test, and between 130 and 139 in the case of the Badyg-2. A unique value of 135 was found in the TEA-1.

Sixth Grade Students

Again, none of the students met the criteria of having an IQ equal or above 130 points in all three of the tests. Regarding the convergence between pairs of tests, the *Factor "g"* test and the TEA-1 converged, but only in a single case. The results of this student can be seen in **Table 4**. He showed a high level of creativity and his IQ was close to 130 when the Badyg-3 was administered.

In relation to students scoring 130 or above in each of the tests, results indicated that the TEA-1 was the test that identified the greatest number of students that met this criterion followed by the *Factor "g"* test. The Badyg-3 was the most restrictive test in this sense, as none of the students showed an IQ score equal to or higher than 130 in this test. **Table 4** presents the results corresponding to each group. In this case, 50% of the children identified as high-ability students in the different tests displayed a high level of creativity. This pattern was different from that found in the group of third grade students, where only 2 out of 20 (10%) of the students identified as having high-abilities showed high levels in this variable. IQ values ranged from 130 to 139 in the case of the students identified by the *Factor "g"* test, whereas all the students identified by the TEA-1 showed an IQ of 135. The student identified by the Badyg-3 had an IQ of 136.

In summary, out of the total of 236 students, 31 students (20 from third grade and 11 from sixth grade) were identified as having an IQ equal to or greater than 130, considering the different tests separately. This corresponds to 13.13% of the sample. There were only three cases in which two tests produced converging results, which equates to only 1.27% of all students evaluated. No convergence of results was found among the three measures of intelligence.

DISCUSSION

This study has two main objectives: analysing the relationship between intellectual capacities of a group of third and sixth grade students from Northern Spain; and to analyze the discriminatory value and congruence between different tests of intelligence traditionally used in the identification of high-ability students. In general, results point to the need to use different tests in the identification process, as well as to include complementary measures (i.e., creativity) to create a multi-criterial system for

the detection of students who fall into this category (Renzulli, 2012).

Intellectual Capacities Results of the Students and Congruence among Measures

In general, results indicated that both third and sixth grade students showed an average intellectual ability (close to 100 in most of the cases). Regarding congruence among the different intelligence measures used, it is important to note that all the tests administered to third grade students showed positive and significant correlations to one another. A moderate to high association between the *Factor "g"* test and the tests of educational and intellectual aptitudes, more related to academic performance (TEA-1 and Badyg), was found. However, for sixth grade students, significant correlations were only found between the Badyg-3 and TEA-1 (both assess general intelligence through those abilities related to learning and academic performance – or crystallized intelligence). Thus, when the same tests were administered to older students, the correlation between crystallized intelligence measures increased, while the association between crystallized and fluid intelligence measures decreased, or even disappeared. These results are consistent with those reported by Pérez and González (2007), who noted that the subscales with a greater cultural basis (and containing more elements of the school curriculum) functioned differently according to age, and showed more congruence as children grow up (and presumably as their knowledge increases).

In addition, regarding the accuracy of the tests detecting high-ability students, it should be noted that the congruence among the various measures examined was disturbingly low. In this sense, none of the students met the criterion of showing an IQ equal to or above 130 in all of the three measures that were administered in a concurrently. On the other hand, considering the different tests separately, 13.13% of the total sample corresponds with students who were identified as having an IQ equal to or greater than 130, when theoretical percentage expectation would be around 2%. Differences in the estimations provided by the different tests for a same student were high. This may point to important constraints regarding the validity of the tests that are being currently being used.

It could thus be assumed that, at earlier stages of development, the different types of intelligence tests can converge, with respect to findings. However, this convergence tends to decrease with age, and congruence only stays present in cases in which those abilities have been facilitated and boosted by on-going learning. These findings have some implications for practice. Specifically, the lack of congruence among intelligence measures (such as that identified in this study) may lead to misdiagnosis, preventing some students from receiving adequate support for their exceptional needs. Likewise, it is appropriate to highlight the need to use different tests of fluid and crystallized intelligence in the identification of high-ability students, always taking into consideration the students' cognitive developmental stages.

Discriminatory Value of the Measures Identifying High-Ability Students and Intellectual Results Differences of the Students Detected

It is necessary to highlight that a reliable evaluation is the basis for an early detection and tailored intervention, and that currently one of the most important concerns regarding higher abilities is that these students often do not receive recognition, and thus appropriate intellectual stimulation, at least in Spain (Calero and García-Martín, 2014). This can lead to a lack of interest, frustration, and failure at school, as well as have a negative effect on the development of self-worth and social acceptance (Kroesbergen et al., 2016) or result in behavioral problems in some cases. On the other hand, a false positive may push students toward overly demanding and frustrating processes that may exceed the limits of their capacity. A total of 31 students in the current study presented an IQ equal or above 130 when the different tests were used separately, which corresponds to 13.13% of the sample. This infers a clear over-estimation of high-ability students, if the acknowledged distribution of IQ in the general population is to be taken into account. When convergence between any two tests was considered, only three students were identified as being high-ability children, which corresponds to only 1.27% of the total sample.

In terms of creativity, students in sixth grade showed higher scores in this variable in comparison to third grade students. This result suggests that creativity may increase as students progress through the different stages of schooling, and draws attention to the need for researchers to conduct more comprehensive studies on what type of teaching methods favor or hinder creativity in the classroom.

It is also worth noting some differences in the functioning of the tests according to grade level. Regarding third grade students, results suggest that the *Factor "g"* test may be less restrictive than the other tests when it comes to detecting potentially higher-ability students, whereas the TEA-1 may be the most liberal in this sense, identifying the greatest number of higher-ability students. However, the discriminating power of the tests in the case of sixth grade students was different. Specifically, the *Factor "g"* test and TEA-1 tests were the most and the least restrictive tests, respectively. Again it seems that the tests that measure fluid intelligence and those which measure crystallized intelligence operate differently at different developmental stages (see **Figure 1**).

With respect to the students' intellectual variables, results indicated that a high IQ is not necessarily accompanied by high creativity, which has already been demonstrated in previous research (Kim, 2005; Marugán et al., 2010; Guignard et al., 2016). In the case of third grade students, 20 participants were identified as high-ability children by at least one of the tests. However, only two of them demonstrated high levels of creativity. Among the sixth grade students, only six of the 11 who were identified as high-ability students also displayed high levels of creativity. Studies carried out with large samples of Spanish students, such as that of Castejón et al. (2016), show how in classrooms, although gifted students are equally categorized, not all of them show

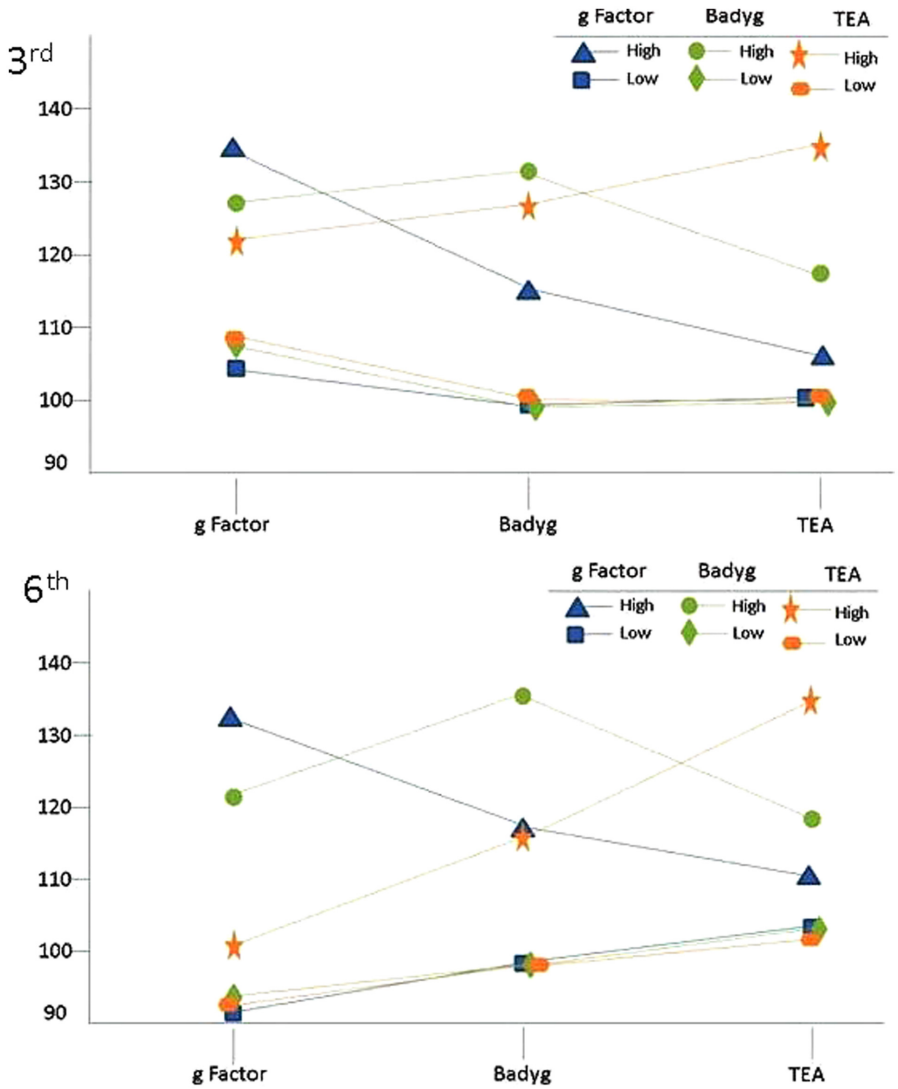


FIGURE 1 | Results of the different measurements for groups with IQ higher and lower than 130 (depending on whether the IQ selection was made using *g Factor*, Badyg or TEA-1).

the same cognitive-motivational profiles. In this way, there are students who exhibit higher scores on creativity and lower scores on general mental ability or self-regulation learning strategies (the group called by these authors as "creative gifted") and there are student profiles that do not show special ability in this variable; for example, students called "gifted achievers," who show high scores in self-regulation learning variables and academic achievement, and lower scores in creativity; or students called "cognitive gifted" who get high scores in general mental ability only.

In summary, and as Heller (2004), Ziegler and Stoeger (2010), and Wellisch and Brown (2012) have pointed out, the use of different tests of intellectual ability in the identification of high-ability students is necessary. Otherwise, this process may be biased. Furthermore, including additional measures not directly related to intellectual ability, such as creativity, would help establish a more detailed profile of the students and thereby assist in identifying their additional strengths and weaknesses. This is even more important in countries such as Spain, where most of the detection protocols available today, although multidisciplinary, still use a single measure of intellectual ability as a starting point to identify those students at a higher level of ability (Hernández and Gutiérrez, 2014). In this sense, it would be necessary to continue analysing the correspondence between different assessment tests, as well as between different measures of creativity, in order to better delimitate to what extent the tests provide a coherent and comprehensive profile of the students' intellectual abilities.

Finally, some limitations should be acknowledged in relation to the present study. Firstly, the sample size was somewhat limited and also geographically localized, which may pose some constraints concerning generalization of the results. It would

be necessary to expand the study sample to include a large number of gifted children and determine if the results obtained on the lack of congruence between the tests are maintained. In the current study, the percentage of students with scores above 130 IQ points appears biased toward the distribution or congruence between the measures. Secondly, future studies may consider the benefits of including additional variables in research of this kind, such as motivation, personality, learning styles, socio-cultural conditions, and/or students' affective-emotional states. These additions to the methodology utilized in the present study would undoubtedly enhance the results of any future investigations of the multidimensional construct widely known as "higher ability" (Reis and Renzulli, 2010; Sternberg, 2010; Hernández and Gutiérrez, 2014). Finally, although through different tests, the same construct (IQ) has been evaluated. Thus, the possibility of an average regression effect or profiles with cluster latent analysis, which is common when evaluating students in a short period of time, has to be considered. It would be interesting to extend the time between evaluations in order to control for this effect in future research.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of University of Oviedo with written informed consent from the parents of all participants. All parents gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the University of Oviedo.

AUTHOR CONTRIBUTIONS

EF, TG, and CR have participated in the design, analysis and drafting of the paper. OA-G, and AV have participated in the application of the measures and drafting of the paper.

ACKNOWLEDGMENT

This work has been supported by a project of the Principality of Asturias (FC-15-GRUPIN14-053).

REFERENCES

Baker, J. (2011). Stability of racial differences in gifted education: the case for stereotype threat. *Talent Dev. Excell.* 3, 27–28.

Calero, M. D., García, M. B., Jiménez, M. I., Kazén, M., and Araque, A. (2007). Self-regulation advantage for high-IQ children: findings from a research study. *Learn. Individ. Differ.* 17, 328–343. doi: 10.1016/j.lindif.2007.03.012

Calero, M. D., and García-Martín, M. B. (2011). *The Evaluation of Gifted Children: When, Why and How?* Available at: http://www.infocop.es/view_article.asp?id=3304

Calero, M. D., and García-Martín, M. B. (2014). Temporal stability of IQ and learning potential in gifted children: diagnostic implications. *Anal. Psicol.* 30, 512–521. doi: 10.6018/analesps.30.2.163801

Carman, C. A. (2013). Comparing apples and oranges. fifteen years of definitions of giftedness in research. *J. Adv. Acad.* 24, 52–70. doi: 10.1177/1932202X12472602

Castejón, J. L., Gilar, R., Miñano, P., and González, M. (2016). Latent class cluster analysis in exploring different profiles of gifted and talented students. *Learn. Individ. Differ.* 50, 166–174. doi: 10.1016/j.lindif.2016.08.003

Cattell, R. B., and Cattell, A. K. S. (1994). *Factor "g" manual. Scales* 2 &3. Madrid: TEA Ediciones.

Corbalán, F. J., Martínez, F., Donolo, D. S., Alonso, C., Tejerina, M., and Limiñana, R. M. (2003). *Creative Intelligence CREA, Manual*. Madrid: TEA Ediciones.

Erwin, J. O., and Worrell, F. C. (2012). Assessment practices and the underrepresentation of minority students in gifted and talented education. *J. Psychoeduc. Assess.* 30, 74–87. doi: 10.1177/0734282911428197

Ferrando, M., Ferrándiz, C., Prieto, M. D., Bermejo, M. R., and Sáinz, M. (2008). Creativity in gifted & talented children. *Int. J. Creat. Problem Solv.* 18, 35–47.

Finney, S. J., and Di Stefano, C. (2006). "Non-normal and categorical data in structural equation modeling," in *Structural Equation Modeling: A second course*, eds G. R. Hancock and R. O. Muller (Greenwich, CT: Information Age), 269–314.

Freeman, J. (2011). A wish for the gifted and talented. *Talent Dev. Excell.* 3, 57–58.

Guignard, J. H., Kermarrec, S., and Tordjman, S. (2016). Relationships between intelligence and creativity in gifted and non-gifted children. *Learn. Individ. Differ.* 52, 209–215. doi: 10.1016/j.lindif.2015.07.006

Heller, K. A. (2004). Identification of gifted and talented students. *Psychol. Sci.* 46, 302–323.

Hernández, D., and Gutiérrez, M. (2014). The study of high intellectual ability in Spain: analysis of the current situation. *Rev. Educ.* 364, 251–272. doi: 10.4438/1988-592X-RE-2014-364-261

Jauk, E., Benedek, M., Dunst, B., and Neubauer, A. C. (2013). The relationship between intelligence and creativity: new support for the threshold hypothesis by means of empirical breakpoint detection. *Intelligence* 41, 212–221. doi: 10.1016/j.intell.2013.03.003

Jeltova, I., and Grigorenko, E. (2005). "Systemic approaches to giftedness: contributions of russian psychology," in *Conceptions of Giftedness*, eds R. J. Sternberg and J. E. Davidson (Cambridge: Cambridge University Press), 171–187.

Kim, K. H. (2005). Can only intelligent people be creative? A meta-analysis. *J. Second. Gifted Educ.* 16, 57–66. doi: 10.4219/jsge-2005-473

Kroesbergen, E. H., Van Hooidonk, M., Van Viersen, S., Middel-Lalleman, M. M. N., and Reijnders, J. J. W. (2016). The psychological well-being of early identified gifted children. *Gifted Child Quart.* 60, 16–30. doi: 10.1177/0016986215609113

Lovett, B. J., and Lewandowski, L. J. (2006). Gifted students with learning disabilities: who are they? *J. Learn. Disabil.* 39, 515–527. doi: 10.1177/00222194060390060401

Lovett, B. J., and Sparks, R. (2011). The identification and performance of gifted students with learning disability diagnoses: a quantitative synthesis. *J. Learn. Disabil.* 46, 304–316. doi: 10.1177/0022219411421810

Marugán, M., Carbonero, M. A., Torres, M. H., and León, B. (2010). Analysis of connections between creativity and high capacities. *Electron. J. Res. Educ. Psychol.* 10, 1081–1098.

McGrew, K. S. (2005). "The Cattell–Horn–Carroll theory of cognitive abilities," in *Contemporary Intellectual Assessment: Theories, Tests, and Issues*, 2nd Edn, eds D. P. Flanagan and P. L. Harrison (New York, NY: Guilford Press), 136–181.

Moon, T. R., and Brighton, C. M. (2008). Primary teachers' conceptions of giftedness. *J. Educ. Gifted* 31, 447–480. doi: 10.4219/jeg-2008-793

Naglieri, J. A., and Ford, D. (2003). Addressing underrepresentation of gifted minority children using the Naglieri Nonverbal Ability Test (NNAT). *Gifted Child Q.* 47, 155–160. doi: 10.1177/001698620304700206

Pérez, L., and González, C. (2007). Differences in development and intellectual variability among students with high capacity. *Faisca* 12, 106–117.

Peyre, H., Ramus, F., Melchior, M., Forhan, A., Heude, B., and Gauvrit, N. (2016). Emotional, behavioral and social difficulties among high-IQ children during the preschool period: results of the EDEN mother–child cohort. *Person. Ind. Diff.* 94, 366–371. doi: 10.1016/j.paid.2016.02.014

Pfeiffer, S. I. (2012). Current perspectives on the indentification and assessment of gifted students. *J. Psychoeduc. Assess.* 30, 3–9. doi: 10.1177/0734282911428192

Pfeiffer, S. I. (2015). The tripartite model on high capacity and best practices in the evaluation of the ablest. *Rev. Educ.* 368, 66–95. doi: 10.4438/1988-592X-RE-2015-368-293

Pierson, E. E., Kilmer, L. M., Rothlisberg, B. A., and McIntosh, D. E. (2012). Use of brief intelligence tests in the identification of giftedness. *J. Psychoeduc. Assess.* 30, 10–24. doi: 10.1177/0734282911428193

Reis, S. M., and Renzulli, J. S. (2004). Current research on the social and emotional development of gifted and talented students: good news and future possibilities. *Psychol. Schools* 41, 119–130. doi: 10.1002/pits.10144

Reis, S. M., and Renzulli, J. S. (2009). Myth 1: the gifted and talented constitute one single homogenous group and giftedness is a way of being that stays in the person over time and experience. *Gifted Child Q.* 53, 233–235. doi: 10.1177/0016986209346824

Reis, S. M., and Renzulli, J. S. (2010). Is there still a need for gifted education? An examination of current research. *Learn. Individ. Differ.* 20, 308–317. doi: 10.1016/j.lindif.2009.10.012

Renzulli, J. S. (1978). What makes giftedness? Reexamination of definition. *Phi Delta Kappan* 60, 180–184.

Renzulli, J. S. (2012). Reexamining the role of gifted education and talent development for the 21st Century: a four-part theoretical approach. *Gifted Child Q.* 56, 150–159. doi: 10.1177/0016986212444901

Renzulli, J. S., and Gaesser, A. H. (2015). A multi criteria system for the identification of high achieving and creative/productive giftedness. *Rev. Educ.* 368, 93–131. doi: 10.4438/1988-592X-RE-2015-368-290

Sabiston, C. M., O'Loughlin, E., Brunet, J., Chaiton, M., Low, N. C., Barnett, T., et al. (2013). Linking depression symptom trajectories in adolescence to physical activity and team sports participation in young adults. *Prev. Med.* 56, 95–98. doi: 10.1016/j.ypmed.2012.11.013

Sánchez-Sánchez, F., Santamaría, P., and Abad, F. J. (2015). *Matrices. General Intelligence Test*. Madrid: TEA Ediciones S.A.

Silverman, L. K. (2009). The two-edged sword of compensation: how the gifted cope with learning disabilities. *Gifted Educ. Int.* 25, 115–130. doi: 10.1177/026142940902500203

Sternberg, R. J. (2010). Assessment of gifted students for identification purposes: New techniques for a new millennium. *Learn. Individ. Differ.* 20, 327–336. doi: 10.1016/j.lindif.2009.08.003

Thurstone, L. L. (1938). *Primary Mental Abilities*. Chicago, IL: University of Chicago Press.

Thurstone, L. L., and Thurstone, T. H. (2005). *Test of Educational Aptitudes*. Madrid: TEA Ediciones S.A.

Tourón, J., Peralta, F., and Repáraz, C. (1998). *Intellectual Giftedness. Models, Identification and Educational Strategies*. Pamplona: EUNSA.

Tourón, J., Repáraz, C., and Peralta, F. (2006). Nominations of teachers in identifying students of high intellectual capacity. *Sobredotação* 7, 7–25.

Wechsler, D. (2014). *Wechsler Intelligence Scale for Children-Spanish*, 5th Edn. Madrid: Pearson Education.

Wellisch, M., and Brown, J. (2012). An integrated identification and intervention model for intellectually gifted children. *J. Adv. Acad.* 23, 145–167. doi: 10.1177/1932202X12438877

Wet, C. F., and Gubbins, E. J. (2011). Teachers' beliefs about culturally, linguistically, and economically diverse gifted students: a quantitative study. *Roeper Rev.* 33, 97–108. doi: 10.1080/02783193.2011.554157

Williams, J. R. (2008). Revising the declaration of Helsinki. *World Med. J.* 54, 120–125.

Yuste, C., Martínez, R., and Galve, J. L. (2005). *Battery of Differential and General Skills (BAD&G)*. Madrid: CEPE.

Ziegler, A., and Stoeger, H. (2010). How fine motor skills influence the assessment of high abilities and underachievement in math. *J. Educ. Gifted* 34, 195–219.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Fernández, García, Arias-Gundín, Vázquez and Rodríguez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

CORRECTION
published: 19 July 2017
doi: 10.3389/fpsyg.2017.01233

Corrigendum: "To be or not to be Retained... That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals and Grades

Francisco Peixoto[1]*, *Vera Monteiro*[1], *Lourdes Mata*[1], *Cristina Sanches*[1], *Joana Pipa*[1] and *Leandro S. Almeida*[2]

[1] Centro de Investigação em Educação, ISPA - Instituto Universitário, Lisbon, Portugal, [2] Instituto de Educação, Universidade do Minho, Braga, Portugal

Keywords: retention, self-esteem, self-concept, achievement goals, academic achievement

OPEN ACCESS

Edited and reviewed by:
Carl Senior,
Aston University, Birmingham, United Kingdom

***Correspondence:**
Francisco Peixoto
fpeixoto@ispa.pt

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *01 June 2017*
Accepted: *06 July 2017*
Published: *19 July 2017*

Citation:
Peixoto F, Monteiro V, Mata L, Sanches C, Pipa J and Almeida LS (2017) Corrigendum: "To be or not to be Retained... That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals and Grades. Front. Psychol. 8:1233. doi: 10.3389/fpsyg.2017.01233

A corrigendum on

"To be or not to be Retained... That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals and Grades

by Peixoto, F., Monteiro, V., Mata, L., Sanches, C., Pipa, J., and Almeida, L. S. (2016). Front. Psychol. 7:1550. doi: 10.3389/fpsyg.2016.01550

There is an error in the Funding statement. The statement should be "This study was supported by the FCT - Fundação para a Ciência e a Tecnologia through the research project PTDC/CPE-CED/121358/2010 and UID/CED/04853/2016."

The authors apologize for this error and state that this does not change the scientific conclusions of the article in any way.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Peixoto, Monteiro, Mata, Sanches, Pipa and Almeida. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 04 July 2017
doi: 10.3389/fpsyg.2017.01116

School Functioning of a Particularly Vulnerable Group: Children and Young People in Residential Child Care

*Carla González-García[1], Susana Lázaro-Visa[2], Iriana Santos[2], Jorge F. del Valle[1] and Amaia Bravo[1]**

[1] Department of Psychology, University of Oviedo, Oviedo, Spain, [2] Department of Education, University of Cantabria, Santander, Spain

A large proportion of the children and young people in residential child care in Spain are there as a consequence of abuse and neglect in their birth families. Research has shown that these types of adverse circumstances in childhood are risk factors for emotional and behavioral problems, as well as difficulties in adapting to different contexts. School achievement is related to this and represents one of the most affected areas. Children in residential child care exhibit extremely poor performance and difficulties in school functioning which affects their transition to adulthood and into the labor market. The main aim of this study is to describe the school functioning of a sample of 1,216 children aged between 8 and 18 living in residential child care in Spain. The specific needs of children with intellectual disability and unaccompanied migrant children were also analyzed. Relationships with other variables such as gender, age, mental health needs, and other risk factors were also explored. In order to analyze school functioning in this vulnerable group, the sample was divided into different groups depending on school level and educational needs. In the vast majority of cases, children were in primary or compulsory secondary education (up to age 16), this group included a significant proportion of cases in special education centers. The rest of the sample were in vocational training or post-compulsory secondary school. Results have important implications for the design of socio-educative intervention strategies in both education and child care systems in order to promote better school achievement and better educational qualifications in this vulnerable group.

Keywords: residential child care, school functioning, school integration, intellectual disability, unaccompanied migrant children

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Shlomo Romi, Bar-Ilan University, Israel
Hans Grietens, University of Groningen, Netherlands

***Correspondence:**
Amaia Bravo
amaiabravo@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *30 January 2017*
Accepted: *16 June 2017*
Published: *04 July 2017*

Citation:
González-García C, Lázaro-Visa S, Santos I, del Valle JF and Bravo A (2017) School Functioning of a Particularly Vulnerable Group: Children and Young People in Residential Child Care. Front. Psychol. 8:1116. doi: 10.3389/fpsyg.2017.01116

INTRODUCTION

One of the greatest challenges facing child protection in Spain concerns the academic achievement of children and adolescents in residential care. The role of education as a key factor in the process of social inclusion has been widely recognized in Spain (Susinos et al., 2015; Fernández Enguita, 2016). The complexity of modern society is reflected in the growing demand for qualifications in order to access the labor market, which leads to significant inequality between those who continue their schooling and those who drop out (Jackson, 2010; Ward et al., 2014). Nonetheless, for children

and adolescents in care, the priority has been to address family and emotional problems, with school being a secondary difficulty in their lives (Trout et al., 2008; Montserrat et al., 2015). It is only recently that attention has started to be paid to school adaptation as an essential aspect of a child's social inclusion (Jackson and Cameron, 2014), highlighting that the transition to adult life, and especially future integration into the workplace, needs certain basic skills which are acquired during schooling. Ferguson and Wolkow (2012) identified the academic environment as one of the most important elements for present and future integration and well-being of minors in care. Furthermore, they argue that the school environment can represent an opportunity to improve a child's resilience when it is a structured, safe setting with dedicated professionals (Höjer and Johansson, 2013).

Current data suggest that children and adolescents in care are in vulnerable situations when it comes to school functioning (Montserrat et al., 2013b). Although most authors would describe the information available as scarce, they all mention the disadvantages facing children and young people in care (Jackson, 2010; Ferguson and Wolkow, 2012; Montserrat et al., 2013a, 2015; Muela et al., 2013), with worse academic results, lower rates of high-school graduation, and entry into post-compulsory education compared with the general population (Snow, 2009; Ferguson and Wolkow, 2012). As part of the YIPPEE project (Montserrat et al., 2013b, 2015), data have been gathered in various European countries which demonstrate a clear difference between the general population and those in the child welfare system in terms of finishing secondary education. They show that in the UK, 41.2% of adolescents in the child welfare system complete their compulsory secondary education, compared to 90.5% of the general population; in Sweden 38% of young people who had been in care had post-compulsory secondary qualifications compared to 85% of the general population and in Denmark 2.5% had post-compulsory secondary qualifications compared to 37.6%, although in this latter case, the number increases when the followup continues to 30 years old (30.8%), according to the data in Montserrat et al. (2015). The situation in Spain has mainly been studied in Catalonia, which highlighted that 31.7% of 15 year olds in care are in the school year corresponding to their age, as opposed to 69.4% in the general population, and a drop out rate from compulsory education of 30.9% in the participating sample of adolescents.

Most research has focused on general school functioning, with less specific research into achievement in different academic areas. The results have generally shown frequent changes of school, expulsions, behavioral problems at school (Trout et al., 2008; Ferguson and Wolkow, 2012; Muela et al., 2013), and academic difficulties related to problems of motivation, attention, learning or cognition (Muela et al., 2013). Recent summaries have highlighted the high probability of being identified as requiring special educational assistance, increased chances of failing or repeating a year, receiving some kind of disciplinary action (Scherr, 2007; Snow, 2009), and presenting higher rates of mental health problems and maladaptive behavior (Zima et al., 2000; Snow, 2009). Some studies have also found gender differences in some areas of school functioning. In general, boys show more problems in school adjustment than girls (Schiff and Benbenishty, 2006; Attar-Schwartz, 2009) and they receive more disciplinary actions (Montserrat et al., 2013a).

The most recent data in Spain covers 10,030 admissions into residential centers in 2015 (Observatorio de la Infancia, 2017). Most children are in residential care due to being in a vulnerable situation in their family of origin. Research has reiterated the impact of these situations on children's social, emotional, and cognitive development (Bravo and Del Valle, 2001; Lázaro and López, 2010; Sainero et al., 2014; Van Vugt et al., 2014; Witt et al., 2016). But this group's difficulties in the academic arena, forgotten for decades in European child welfare systems (Jackson, 2010), are beginning to feature in the scientific literature (Munro and Stein, 2008; Snow, 2009).

Various studies with children and adolescents in out-of-home care indicate different factors related to the appearance and continuation of difficulties in school. Trout et al. (2008) summarized them in a review of 29 international studies, highlighting changes in home placements. This instability leads to significant breaks in schooling making it difficult to develop social relationships or succeed academically, and more likely for behavioral problems to develop at school. These changes can also lead to difficulties in academic supervision by the social educator and interfere with the communication of positive expectations to the children and adolescents about their possible future schooling (Montserrat et al., 2013a). Placement instability has been highlighted in various research as a fundamental factor that negatively affects the child's well-being (Del Valle et al., 2009; Montserrat et al., 2013b; Ward et al., 2014). The nature of the teaching, and the attitudes of teachers, educators and the adolescents themselves may also be factors which affect the child's academic performance. Jackson (2010) highlighted instability, changes of school, and professionals' low expectations about education as obstacles in the way of reducing the schooling gap of those in care. Leonard and Gudiño (2016) did not find that school stability predicted academic results, but did predict internalizing and externalizing problems. Some research has identified greater rejection by classmates, with those in residential care suffering more rejection and being chosen less by classmates for school activities (Martín et al., 2008). Classmates describe them negatively, for example, as having poor relationships with teachers, being aggressive, or seeking attention, which are characteristics that interfere with academic achievement (Martín et al., 2008). A lack of concordance between child welfare services and the education system has also been identified as a barrier to school progress for these children, with one often blaming the other for the children's poor academic achievement (Ferguson and Wolkow, 2012). These difficulties between systems are apparent in the lack of coordination between social educators and teachers (Ferguson and Wolkow, 2012).

Finally, the conditions children experienced prior to entry into the child welfare system, their early experiences, often related to maladaptive functioning in different areas of development, may be having a profound impact on their academic performance (Snow, 2009; Pecora, 2012). Similarly, studies show how it is much more likely to see special educational needs in children in

care than in the general population, (Scherr, 2007; Snow, 2009; Trout et al., 2009).

Particular attention should be paid for to two groups: children and adolescents with intellectual disability (ID) and unaccompanied migrant children (UMC). Both groups are excellent examples of the complexity and variety that exists in the profiles of children and young people in residential care and, consequently, the varied needs that residential care programs must address.

ID in children in residential care is a major problem as the proportion is about five times greater than in the general population (Sullivan and Kuntson, 2000; Scherr, 2007; Slayter, 2016). These children present even more educational needs than the other children in care (Trout et al., 2009). Those authors note that the stressors, similar to those experienced by all children in similar situations (change of school or educational program, new rules, and expectations), can increase their vulnerability and therefore raise the probability of various negative outcomes. Research shows that children with disabilities in residential care have social and attentional difficulties, as well as significant deficits in basic academic areas such as reading and academic knowledge (Trout et al., 2009; Sainero et al., 2013). The combination of these deficits with other risk factors in the children's functioning in residential care place this group in a situation of particular vulnerability.

When it comes to UMC, there is a clear consensus that this relatively new phenomenon is one of the most difficult and complex challenges facing child welfare systems. In Spain, the mass arrival of UMC from North Africa between 2000 and 2008 (numbers fell dramatically during the financial crisis) forced regional governments to open large numbers of residential facilities (Bravo and Santos, 2017) and to create new specialized programs to support the social integration of these young people in terms of education and employment, particularly when they reach adulthood. Very little specific information about their adaptation to the school context can be found in our field. One of the few studies which makes reference to the academic arena indicates the poor motivation these young people feel toward schooling (Auger-Voyer et al., 2014) and suggests that this may result from the inadequacy of their previous academic experience (DARNA UNICEF, 1997; Jiménez, 2003; Quiroga et al., 2010; UNESCO, 2012) and the lack of need for qualifications in order to find work in their countries of origin, as well as from their poor literacy and insufficient skill in the language of their adopted country. All of that represents an enormous barrier to their educational adaptation. Nevertheless, these authors indicate, in agreement with other research (Jackson et al., 2005; Kohli, 2009; Hopkins and Hill, 2010; McCarthy and Marks, 2010), that when this lack of motivation is overcome, these young people demonstrate good school progress. In the case of UMC, this adaptation has a significant effect, both as minors and when reaching their majority. So when they are of school age, adaptation makes it easier to widen their social network and feel less isolated (Wade et al., 2005, 2012), or it may be a normalizing experience which helps them feel safer (Hopkins and Hill, 2010; Kohli, 2011; Wade et al., 2012) and increases their sense of belonging, protecting them against certain psychological problems (Rousseau et al., 2004; Sujoldzic et al., 2006; Kia-Keating and Ellis, 2007; Eide and Hjern, 2013). It also makes future adjustment easier (Jackson and Martin, 1998; Masten and Coastworth, 1998; Wade et al., 2005; Miller and Porter, 2007; Casas et al., 2010; Eide and Hjern, 2013), for example, making it easier to find employment, with all the implications that has for stability and social integration (Arnau-Sabatés and Gilligan, 2015).

The data presented in this research is on a topic of widely recognized importance that has been little explored in our context. The study sample from many regions in Spain allows us to describe the present situation in terms of school achievement, and school functioning, and also allows us to analyze the factors related to these difficulties.

Aims of the Present Study

The general aim of this research is to analyse school functioning of children in care, in terms of academic achievement, and adaptation to this context. This aim is divided in three specific ones: (1) to describe risk factors (personal, family, clinical, and care process) that may affect school functioning of children in residential care; (2) to describe specific results in school functioning for two vulnerable groups: children with intellectual disability and UMC; (3) to analyze the individual, clinical, and care process factors that are associated with indicators of adaptation in the school context and academic achievement in the general sample.

METHODS

Participants

There were 1,216 young people who participated in this study (523 girls and 693 boys aged between 6 and 18 years old) ($M = 13.4$ and $SD = 2.96$) who had spent at least 3 months in one of the homes ($n = 148$) in the child residential care network. Children were fostered in different types of residential care facilities: family children's homes ($n = 87$), autonomy programmes for adolescents ($n = 30$), UMC's homes ($n = 12$), homes for children with disabilities ($n = 3$), and therapeutic residential care for young people with emotional and behavioral problems ($n = 18$).The mean stay in care was 42.7 months ($SD = 37.6$). The sample came from children's homes in Asturias, Cantabria, Extremadura, Murcia, Guipúzcoa, Tenerife, and seven SOS Children's Villages in various parts of Spain. Our sample represents the 10% of the total amount of children aged 6–18 years in residential care in Spain (Observatorio de la Infancia, 2017).

Instruments

Sociodemographic and Family Information

Sociodemographic and family information in each case was obtained via a questionnaire which gathered sociodemographic information and information about variables related to protection measures child care background (time in care home, changes in care homes, history of breakdown of adoptions and fostering, and reasons for going into care). Information about

intellectual disability and the condition of UMC were specificly collected to identify this two specific groups.

Mental Health Needs

Information on the mental health needs in each case was obtained from two sources: (1) information related to emotional and behavioral problems was collected if the child was receiving therapeutic care (psychiatric, psychological, and/or psychopharmacological) (2) The Child Behavioral Checklist (CBCL) (Achenbach and Rescorla, 2001) was used to assess and detect patterns of externalizing or internalizing behavior. The CBCL is made up of 113 items which are each scored between 0 and 2 (0 = not true; 1 = somewhat or sometimes true; 2 = often or very often true). The scores of all the items give eight specific clinical subscales and three broadband scales: internalizing, externalizing, and total. The scores were converted into T scores following international scales from which the following ranges were established: normal ($\leq$59), borderline (60 $\leq$ 63), and clinical ($\geq$64) for the broadband scales of internalization, externalization, and total. For the clinical scales or syndromes, the cutoff points in each range were set at normal $\leq$64, borderline 65 $\leq$ 69, and clinical $\geq$70. The CBCL has good guarantees of reliability and validity, with a Cronbach Alpha of 0.92 and test-retest reliability of 0.92 for the broadband scales (Achenbach et al., 2008).

School Functioning

Information about school functioning came from a number of variables: (1) educational level in each case, codified in terms of educational stage that the young person is in (compulsory education, post-compulsory secondary education, vocational/professional training, or other type of study); (2) information on repetition of school years during their education (yes/no); (3) the existence of any kind of modification to their curriculum (yes/no); (4) attendance at a center for special educational needs (yes/no); (5) evaluation of academic success in terms of numbers of subjects passed or failed (good, average, poor); and (6) the school adaptation assessed by social educators by means of 6 questions organized in a Likert-scale from 1 to 5 (1 = never; 5 = always) about frequency of behaviors. This evaluates aspects related to attitudes toward school and school behavior. The internal consistency of this group of items was good with a Cronbach Alpha of 0.889.

Procedure

This research had official permission from the public bodies responsible for guardianship of children in care. Its design was approved by the ethics committee of the faculty of psychology at the University of Oviedo and all data was collected in accordance with national Law on Personal Data Protection. Data collection was performed in 2013 thanks to financing from the Spanish Ministry of the Economy and Competitiveness through their national research and development plan (PSI2012-33185). Data was collected via key social educators who had been informed of the aims of the study and who followed a procedure designed to guarantee anonymity and data protection.

Data Analysis

Various statistical tests were used depending on the nature of the variables and the group being analyzed. The *Chi-squared* statistic technique was used for the analysis of categorical variables, and the non-parametric *Kruskal-Wallis H* test for the quantitative variables given the size of the groups being compared, and the fact that they did not comply with the assumption of normality. Pairwise comparisons were performed using the *Mann-Whitney* test. To respond the third aim of the study parametric tests were performed using the *Student T*-test and One-way *ANOVA* for the comparison of means, along with the Pearson correlation to estimate the relationship between variables. Finally, a *Stepwise multiple linear regression* analysis was carried out using age, number of changes to care placement and the eight specific clinical subscales from the CBCL as predictor variables, as they had a linear relationship to the criterion variable- school adaptation. Data analysis was done using the statistics program SPSS v19.0.

RESULTS

Factors of Vulnerability in Children in Residential Care

Table 1 shows the results, separating two groups from the general sample: children with ID, representing 16.3% of the sample, and UMC (7.6%).

There is a slightly higher proportion of boys in the total sample (57%), although this reflects the greater representation of boys in the two highlighted subgroups ($\chi^2 = 64.065$, $p < 0.001$): children with ID (61.6%) and UMC are mostly boys (94.6%). The proportions are more equal in the remainder of children in residential care (52.2% boys).

The most numerous age group is 15–17 years old (44.7%), followed by the 12–14 year old group (30.2%). The distribution of ages is significantly different in UMC, as 93.5% of them are over 14 ($\chi^2 = 106.84$, $p < 0.001$).

The mean stay in residential care is very long, three and a half years (42.7 months), and is significantly higher in children with ID, with a mean of 5 years (60 months). For UMC, the mean stay is less than 2 years, which is consistent with these children's situation, where they begin their migration as adolescents with the aim of staying in residential centers until they reach their majority (Kruskal–Wallis test: $H = 62.879$, $p < 0.001$).

In addition to separation from their family of origin, something shared by all the members of this group, 13.4% of the sample had experienced some kind of breakdown in the care process.

Similarly, looking at the number changes of residential centers as an indicator of stability in the process, there is a mean of 0.9 changes ($SD = 1.0$), a little higher for UMC ($M = 1.57$, $SD = 1.3$) (Kruskal–Wallis test: $H = 40.469$, $p < 0.001$).

Table 1 details the different types of threat leading to the adoption of protection measures, more than one type may be present in each child's case. Physical neglect is most frequent (47.7%), and it is important to note the significantly higher prevalence of this type of neglect in children with ID (58.4%)

TABLE 1 | Differences in individual, family, school and care process factors.

Variable	Total ($N = 1,216$)	General sample group ($n = 925$)	ID ($n = 198$)	UMC ($n = 93$)
	% or *M (SD)*	% or *M (SD)*	% or *M (SD)*	% or *M (SD)*
Total	100	76.1	16.3	7.6
Sex				
Male	57	52.2	61.6	94.6*
Female	43	47.8*	38.4	5.4
Age	13.45 (2.95)	13.09* (3.0)	13.81(2.59)*	16.29(0.97)*
6–8	8.1	9.6*	4.5	–
9–11	17	19*	15.7	–
12–14	30.2	32.2*	31.8	6.5
15–17	44.7	39.1	48	93.5*
Mean stay	42.7 (37.6)	41.3(35.7)*	60 (45.7)*	21.3(19.1)*
Break-down	13.4	13.3	14	–
Number of changes of residential facility	0.90 (1.0)	0.82 (0.96)*	0.98 (1)*	1.57(1.3)*
Reason for care				
Physical neglect	47.7	45.4	58.4*	–
Emotional neglect	39.7	38.5	45.4	–
Physical abuse	21.6	20.7	25.4	–
Emotional abuse	28.9	28.3	31.4	–
Sexual abuse	4.9	4.3	8.1*	–
Clinical range	61.4	61.8	68.4*	42*
Anxiety-depression	10.8	10.5	14.2	6.8
Withdrawal-depression	16.9	15.5*	23.2*	17
Somatic complaints	8.7	8.9	8.9	6.8
Social problems	18.1	15.2*	36.8*	8
Thought problems	10.8	9*	21.6*	6.8
Attentional problems	18.5	17.4	28.4*	9.1*
Disruptive behavior	25.1	27.9*	13.2*	22.7
Aggressive behavior	28.5	29.2	27.4	22.7
Internalazing	30.8	30.5	35.8	23.9
Externalizing	51.3	52.9*	50.5	36.4*
Total	46.6	46	55.8*	33*
Mental health treatment	48.7	47.1*	71.9*	15.1*
School Indicators				
Educational Level				
Primary and compulsory school	78.5	82.2	80.3	37
Secondary school (post-compulsory)	1.9	2.4	0.5	–
Vocational training	14.1	11	9.1	56.1
Other type studies	2.9	1.7	7.3	4.4
Curricular adaptation	39.8	29.7	84.7	41.1
Academic Performance				
Good	11.8	12.3	9.2	11
Medium	20.7	18.2	29.1*	28.8
Bad	67.5	69.5*	61.7	60.3

*$p \leq 0.05$; on chi square for categorical variables and Kruskal-Wallis or U de Mann-Whitney test for quantitative variables.

($\chi^2 = 9.796$, $p = 0.002$) and the higher levels of sexual abuse in this subgroup (8.1%) ($\chi^2 = 4.004$, $p = 0.045$). The group of UMC in not included in this description as their reason for being taken into care is their condition of being unaccompanied children.

One important aspect of vulnerability in these children is the presence of emotional and behavioral problems that are clinical according to the criteria of the CBCL. 61.4% exhibited clinical problems in either the internalizing, externalizing or the overall score of the test. The percentage is significantly higher in children with ID (68.4%) and lower in UMC (42%) (χ^2 =17.918, $p < 0.001$). The CBCL indicated that more than half of the children presented clinical externalizing problems (51.3%), and

30.8% presented internalizing problems. In the children with ID, significantly more problems were detected in almost all of the internalizing scales: withdrawal ($\chi^2 = 6.566$, $p = 0.038$), social problems ($\chi^2 = 56.307$, $p = 0.000$), thought problems ($\chi^2 = 27.415$, $p < 0.001$), and attentional problems ($\chi^2 = 18.278$, $p < 0.001$). On the contrary, disruptive behaviors were less frequent ($\chi^2 = 18.436$, $p < 0.001$).

Almost half of the children were seeing a psychological therapist or psychiatrist (48.7%), with significant differences between the subgroups. 71.9% of children with ID were receiving treatment compared to only 15.1% of UMC ($\chi^2 = 85.445$, $p < 0.001$).

Indicators of Adaptation and Academic Achievement

Table 1 also describes the educational situation in the sample using a variety of indicators.

The majority of the general sample (82.2%) and the subgroup with ID (80.3%) are in primary or compulsory secondary education. However, in the group of UMC, it is more common to be in vocational/professional training (56.1%), followed by compulsory education (37%). This difference persists even when looking only at the subgroup of adolescents aged 16 and over, in which 38.1% of UMC are doing vocational training compared to 3.6% of children that age with ID, and 6.6% of the rest of the sample. Very few of the children in any of the three groups are not in any kind of education (between 2.2 and 2.7%).

There are many cases of adaptation of school curricula in children with ID (84.7%), it is important to note that 41.1% of the UMC and 29.7% of the rest of the children in care have also had some curriculum adaptation. This reflects the difficulties this group has in following the standard educational syllabus. The percentage of children attending a special needs school was 7.5%.

The high percentage of children (60.4%) who have repeated a school year in their education is also notable.

In terms of academic performance, most children and adolescents had poor evaluations of their academic achievement (67.5%). The least common evaluation of their performance was "good" (11.8%). (**Table 1**).

Table 2 details the means and standard deviations for each group in each of the items of adaptation to school, along with the probability associated with the Kruskal-Wallis test statistic. The scores for the children in each of the groups are significantly different. The scores for children with intellectual disability stand out in the "do homework," "regular attendance," and "enjoy going" items, whereas in the case of migrant children the items which stand out are "motivation to learn," "respectful toward teachers," "good behavior," and "enjoy going."

In almost all of the items, the mean scores range between 3 and 4, although the high score in the three groups in "regular attendance" (4.23, 4.76) is notable. The indicator "motivation to learn" has the lowest mean scores, especially in the ID group and in the remaining sample.

Factors Associated with Adaptation to School and Academic Achievement

Having described school functioning by looking at the differences between the three groups, next, we detail the factors related to school adjustment in the general sample group ($n = 925$) so that the results are not affected by the specific conditions of the comparison groups.

An ANOVA analysis was used to examine the relationship between the main adjustment indicators (adaptation and academic achievement), which was found to be significant and positive. The mean score in school adaptation was 27.93 ($SD = 2.70$) in children with good achievement, 25.15 ($SD = 3.50$) in those with medium achievement, and 20.71 ($SD = 5.56$) in the case of poor achievement ($F = 121.005$, $p < 0.001$). The same result is found looking at each of the six items to assess school adaptation, with the difference being particularly high in motivation to learn and study ($F = 163.884$, $p < 0.001$).

On analyzing the association between the case and clinical variables and academic success, both age and clinical symptomatology as detected by the CBCL demonstrated a significant relationship. The children with poor academic performance were significantly older than those with medium or good performance ($F = 17.101$, $p < 0.001$), with a mean of 13.31 years old ($SD = 2.69$), as opposed to 12.03 ($SD = 3.39$)—12.07 ($SD = 3.29$) in the groups with better academic performance.

TABLE 2 | Differences in school adaptation variables.

Variable	General sample group ($n = 925$)	Intellectual disabilility ($n = 197$)	UMC ($n = 92$)	Kruskal-Wallis *H*-test	
	M (SD)	*M (SD)*	*M (SD)*	$\chi 2$	*p*
Do homework (daily)[a,b]	3.58 (1.3)	3.68 (1.4)	3.25 (1.4)	6.265	0.044
Motivation to learn[a,c]	3.07 (1.3)	3.02 (1.4)	3.58 (1.2)	13.117	0.001
Regular attendance at school[a,b,c]	4.58 (1.0)	4.76 (0.8)	4.23 (1.2)	27.312	0.000
Respectful toward teachers[c]	3.82 (1.1)	3.86 (1.2)	4.12 (1.3)	6.571	0.037
Good behavior at school[a,c]	3.72 (1.2)	3.7 (1.16)	4.08 (1.1)	9.208	0.010
Enjoy going to school[b,c]	3.52 (1.3)	3.8 (1.19)	3.85 (1.3)	10.728	0.005
Total	22.74 (5.74)	23.06 (6.13)	22.30 (5.79)	2.916	0.233

[a] *Differences between ID and UMC.*
[b] *Differences between ID and general sample group.*
[c] *Differences between UMC and general sample group.*

In terms of the association between clinical symptomatology and performance we found that cases with poor academic performance scored higher in the CBCL subscales of anxiety depression ($F = 7.361$, $p = 0.001$), withdrawal depression ($F = 6.997$, $p = 0.001$), social problems ($F = 15.838$, $p < 0.001$), thought problems ($F = 11.163$, $p < 0.001$), attention problems ($F = 54.161$, $p < 0.001$), rule breaking behavior ($F = 22.360$, $p < 0.001$), and aggressive behavior ($F = 14.377$, $p < 0.001$).

In terms of the relationship with the second criterion variable (adaptation to school), sex, age, number of changes to residential placement, and clinical symptomatology were found to have a significant relationship. Boys had lower scores in almost all of the items (see **Table 3**). Age was related to worse school adaptation, varying between −0.080 and −0.311 (see **Table 4**). More changes in placement was associated with lower levels of adaptation in almost all items, although with low levels of correlation ($p < 0.05$, **Table 4**). All of the CBCL scales had a direct linear negative association with school adaptation, which was especially strong in the *rule-breaking* and *aggressive behavior* scales (**Table 4**).

A multiple regression analysis was performed to select the variables with the most predictive power over the criterion variable, school adaptation. This analysis was done separately for boys and girls given the modulating effect of the variable sex on the results. The predictor variables introduced were age, number of changes of placement, and the eight specific clinical subscales of the CBCL, given that there was a linear relationship with the criterion variable (see **Table 4**).

Table 5 gives the standardized coefficients and their probability values for boys and girls. For the girls, model 5 was the most appropriate, explaining 53.5% of the variance ($R^2 = 0.535$). In this model the rule-breaking variable ($\beta = -0.511$) demonstrated most predictive power, although the equation also included problems of attention ($\beta = -0.364$), age ($\beta = -0.20$), problems of anxiety-depression ($\beta = 0.207$), and the number of placement changes ($B = -0.105$). In order to guarantee the model's validity, an analysis was carried out of independence of residuals giving a Durbin-Watson D value of 1.980. For the boys, model 5 also had the most predictive power, explaining 52.5% of the variance ($R^2 = 0.525$), with rule-breaking again ($\beta = -0.405$) having most explanatory power. Other variables included in the equation were problems of attention ($\beta = -0.272$), age ($\beta = -0.275$), aggressive behavior ($\beta = -0.177$), and social problems ($\beta = 0.101$). Once again, an analysis of the residuals was done, giving a Durbin-Watson value of 1.821.

DISCUSSION

Children and young people in care are a particularly vulnerable group. They have experienced serious adverse family conditions due to neglect or abuse, and they have had to be moved out of home to foster families or residential care, which is another challenge in terms of adaptation and permanency. The consequences of these experiences are well-known, with much research having been done in this area over a long period of time, particularly into behavioral and emotional disorders (González-García et al., 2017). Research into academic and educational development is quite scarce and it is only in the last few years that researchers have begun to pay attention to this topic. This study is an attempt to contribute to the Spanish context, describing some key indicators of academic development from children and young people in residential care.

Vulnerable Factors

The sample description exhibited some of this group's well-known characteristics: residential care in Spain is becoming a specialized program for adolescents (about 45% are over 15), many have had long stays in children's homes (42.7 months on average), which is a matter of some concern in Spain (López and Del Valle, 2015). However, this variable is very different in our two special groups, for young people with ID the average stay increased to 60 months (probably due to the difficulty of placing these children in foster care because of their special needs), but for UMC the average is less than 24 months, as they usually arrive in Spain in late adolescence.

Results related to mental health and well-being showed the high percentage of children diagnosed with ID (16%). This group presents specific needs which are very difficult to meet in heterogeneous peer groups in residential care (Sainero et al., 2013). The results showed that they are the most frequent victims of the more active forms of maltreatment such as physical or sexual abuse, and that they present more emotional and behavioral problems than others in residential care (Casey et al., 2008; Tarren-Sweeney, 2008; Trout et al., 2009). Despite that, this group is almost invisible in international research (Trout et al., 2009).

TABLE 3 | Differences in means in school adaptation by sex.

Variables	Girls		Boys		Difference in means	
	M	*DT*	*M*	*DT*	*t*	*p*
Do homework	3.72	1.240	3.43	1.328	3.380	0.001
Motivation to learn	3.27	1.288	2.87	1.249	4.690	0.000
Regular attendance	4.55	0.993	4.57	0.990	−0.215	0.829
Respectful toward teachers	4.05	1.075	3.60	1.186	5.959	0.000
Good Behavior at school	4.00	1.096	3.45	1.185	7.137	0.000
Enjoy going to school	3.68	1.262	3.36	1.320	3.675	0.000
Adaptation total	23.28	5.618	21.30	5.794	5.143	0.000

TABLE 4 | Correlations between individual factors and school adaptation.

Variables	DH	MTL	RAS	RT	GBS	EGS	AT
Time in care	−0.038	−0.018	0.017	−0.014	0.010	−0.004	−0.014
N° of placement changes	−0.070**	−0.014	−0.081**	−0.090**	0.050	−0.042	−0.070**
Age	−0.311*	−0.207*	−0.315*	−0.118*	−0.080**	−0.275*	−0.272*
Anxiety-depression	−0.211*	−0.192*	−0.138*	−0.192*	−0.206*	−0.168*	−0.232*
Withdrawal	−0.174*	−0.179*	−0.137*	−0.017	−0.048	−0.168*	−0.157*
Somatic complaints	−0.159*	−0.120*	−0.125*	−0.138*	−0.114*	−0.125*	−0.167*
Social problems	−0.245*	−0.278*	−0.137*	−0.286*	−0.302*	−0.224*	−0.311*
Thought problems	−0.260*	−0.269*	−0.163*	−0.263*	−0.293*	−0.228*	−0.314*
Attentional problems	−0.404*	−0.487*	−0.173*	−0.371*	−0.413*	−0.340*	−0.463*
Rule-breaking	−0.506*	−0.488*	−0.503*	−0.557*	−0.569*	−0.494*	−0.642*
Agressive Behavior	−0.397*	−0.403*	−0.235*	−0.551*	−0.550*	−0.378*	−0.526*

DH, do homework; MTL, Motivatión to learn; RAS, Regular attendance at school; RT, Respectful toward teachers; GBS, Good behavior at school; EGS, Enjoy going to school; AT, adaptation total.
*$p < 0.001$; **$p < 0.05$.*

TABLE 5 | Multiple linear regression analysis for individual and academic variables.

Regression model	B (SE)	Beta	R^2	t
BOYS				
Rule-breaking behavior	−0.238 (0.029)	−0.405	0.418	−8.313***
Attentional problems	−0.155 (0.026)	−0.272	0.458	−6.033***
Age	−0.513 (0.066)	−0.275	0.516	−7.728***
Aggressive behavior	−0.083 (0.027)	−0.177	0.521	−3.014**
Social problems	0.63 (0.030)	0.101	0.525	2.072*
GIRLS				
Rule-breaking behavior	−0.290 (0.023)	−0.511	0.419	−12.800***
Attentional problems	−0.207 (0.024)	−0.364	0.471	−8.797***
Age	−0.377 (0.069)	−0.200	0.500	−5.497***
Anxiety-depression	0.134 (0.026)	0.207	0.526	5.204***
Number of placement changes	−0.612 (0.209)	−0.105	0.535	−2.931**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.*

The data also allow us to confirm the elevated presence of emotional and behavioral disorders, which affect more than 60% of the sample. This high prevalence of problems confirms findings from other countries (Burns et al., 2004; Ford et al., 2007; Bronsard et al., 2011). UMC present fewer disorders, probably because their reasons for being in residential care are not linked to experiences of maltreatment, but rather the desire to migrate to a country with more opportunities (Bravo and Santos, 2017).

School Functioning

Results concerning the subject's educational situation show that about 80% of the children and young people are in compulsory education (which in Spain is up to 16 years old). Only one third of the unaccompanied immigrant minors, however, are in compulsory education, due to the difficulties of the language and their previous low level of education in their birth countries (Jiménez, 2003; Quiroga et al., 2010).

One of the most significant results from the subject's educational situation is the need for curriculum adaptation. About 85% of the children with ID required an adapted curriculum, along with 41% of immigrant minors, but what is particularly remarkable is that 30% of the remainder of the children in the sample also needed curriculum adaptation. The average need for curriculum adaptation in compulsory education in Spain is 5.1% (Ministerio de Educación, Cultura y Deporte, 2016). So children in residential care without ID are six times more likely to need an adapted curriculum at school for other behavioral or developmental reasons.

Another indicator of academic development was repeating one or more school years, which was the case for about 60% of our sample, being the percentage for primary and secondary school in Spain from 15 to 36% according to Ministry of Education data (Ministerio de Educación, Cultura y Deporte, 2016). International research states that children in care repeat course at least in a double proportion than their classmates (Ferguson and Wolkow, 2012) Furthermore, when children's academic achievement is evaluated by residential care workers, almost 68% fall into the "bad" category (meaning that they usually get bad grades in several subjects), and only 11% are considered "good" (they pass all their subjects).

In the school adaptation assessment, results showed that despite the difficulties in academic achievement, the children with intellectual disability scored significantly higher in aspects related to fulfilling certain obligations such as attendance, and doing homework, and exhibit more enjoyment going to school, something which is very important for these children's socialization. UMC showed a higher level of motivation to learn and fewer behavioral problems in general, confirming the aforementioned importance for them to adapt to a new culture and obtain a qualification to start working as soon as possible and begin to look after themselves, similar conclusions that ones pointed out in others researches about unaccompanied children (Wallin and Ahlström, 2005).

Factors Associated to School Adaptation and Academic Achievement

Lastly we looked at the relationship of individual variables (age and sex), case variables (time in residential care, number of placement changes), and clinical variables to the main indicators

of school functioning (achievement and school adaptation). In this analysis, both those children with ID and UMC were excluded, given the specific characteristics of those subgroups. The results from the remainder of the sample demonstrated that academic achievement is lower the older the children are, and in those who present clinical symptomatology, whether internalizing or externalizing, something which has been noted in previous research (Cheung et al., 2012).

Worse school adaptation was related not only to being older, but also to sex (girls exhibited better adaptation), and to better scores in the CBCL clinical scales. This was particularly significant with the externalizing scales of disruptive behavior and rule breaking behavior, as well as the attentional problems scale. The presence of clinical problems, especially those which could result in violent, aggressive, or transgressive behavior present a true challenge in the educational environment, as it makes adaptation and adjustment to this social context more difficult, and also affects achievement. We know from previous research (Garland et al., 2001; Burns et al., 2004; McMillen et al., 2005; Jozefiak et al., 2016; González-García et al., 2017) that between 40 and 88% of children in residential care exhibit this type of disorder, which has clear repercussions on school adaptation. Promoting intervention in emotional and behavioral disorders in this population has been identified in previous research as fundamental to improving the process of transition to adult life (Del Valle et al., 2011), a process in which successful adjustment to the educational environment is also key.

One variable which also appeared to be related to worse school adaptation is the number of changes of residential placement. The importance of stability and permanence in out-of-home care, be it family foster care or residential care, has been demonstrated in many studies, and is one of the main challenges of welfare systems (Jackson and Cameron, 2012; Pecora, 2012). It is important to find residential placements which can meet the needs of high demanding children and young people in order to avoid them having to go from one placement to another (Sinclair et al., 2007; Pecora, 2012). Those changes would have a negative impact on academic achievement as they normally involve changes of school and problems of social integration.

The regression analysis carried out to test the predictive value of the variables in the study on the variable adaptation to school environment (carried out separately for boys and girls, given the modulating effect of the gender variable) confirmed the importance of rule breaking behavior, attentional problems, and increased age as the most significant predictors of worse adjustment to the school environment in both boys and girls. The three factors were also associated with worse academic achievement. The impact of externalizing disorders on academic achievement was also found by Harder et al. (2014) with a sample of young people in juvenile justice centers. In boys, the presence of aggressive behavior can be added as a predictor of worse adjustment, whereas the presence of social problems (defined in the scale as children with more infantile behavior and with problems relating to their peers) is associated with better adaptation. In the girls there was something similar, with a higher number of changes to residential placement being an additional predictor of worse adjustment, whereas the presence of anxiety-depression problems was associated with better results for adaptation. It must be remembered that the adaptation variable includes factors such as class attendance, following rules, enjoying going to school, and general motivation. The presence of problems of a more internalizing nature may cause an apparent better adjustment by also being associated with less disruptive behavior. In short, the results seem to indicate that everything which encourages disruptive or transgressive behavior, including, for developmental reasons, getting older, makes it more difficult to adapt to the environment and usually goes hand in hand with worse achievement. Conversely, those factors which inhibit disruptive behavior apparently improve adjustment, but not academic achievement.

In conclusion, the negative impact of disruptive behavior on school adjustment is clear, and its high prevalence in this group, for all the risk factors which these children have in their life histories, has been confirmed. Nonetheless, it is important to note that social problems of an internalizing nature can also impede school functioning, not in such a visible way, but when it comes to evaluating academic progress, with all the impact that may have on these children's futures. Treating these problems, which are very prevalent in this group (Jozefiak et al., 2016), must be established as a priority in intervention.

Conclusions and Recommendations for Policy

This study highlights how the educational arena poses one of the challenges in intervention with children and young people in residential care. Efforts should be directed toward improving adaptation and academic achievement owing to their importance in work and social integration once these children and young people have left care. Factors identified as key for academic achievement include stability in the protection measure and in the school, the stable presence of reference adults who are involved, and have expectations of success, along with the involvement of schools in meeting these children's needs (Montserrat et al., 2011). In order for that to happen successfully, the need for coordination between the school and care services is key. Moreover, as this study has shown, there are many whose needs differ from the majority of children and young people in care. UMC and children with intellectual disabilitymust be considered in the design of programs owing to their particular difficulties.

Limitations and Future Research

As the results in this study form part of a wider piece of research, it was not possible to look more deeply into the variables involved in school functioning. Future research should collect more variables about educational trayectory of these children and include other key informants such as the children and young people themselves, and teaching staff. In addition, it would be desirable to more deeply examine other school adaptation variables such as relationships with peers. Despite this limitation, the results of this study are enormously important, given the

scarcity of research about this topic, as are the implications for policy and practice.

AUTHOR CONTRIBUTIONS

CG and AB carried out the description of objectives, methodology, results, and discussion. SL and IS focused their contribution on the introduction and researched the state of the art of the topic. JdV carried out main part of discussion. All authors were involved in the original study as researches and reviewed all parts of the manuscript.

FUNDING

This research has been supported by the Ministry of Economy and Competitiveness of Spain through the National Plan of I+D+i (PSI2012-33185). The author CG holds a predoctoral scholarship from the National Program of Training for Improving Talent and Employability in the framework of the National Plan of Scientific and Technical Research and Innovation 2013-2016 and co-financed by the European Social Fund (BES-2016-078139).

REFERENCES

Achenbach, T. M., Becker, A., Dopfner, M., Heiervang, E., Roessner, V., Steinhausen, H. C., et al. (2008). Multicultural assessment of child and adolescent psychopathology with ASEBA and SDQ instruments: research findings, applications, and future directions. *J. Child Psychol. Psychiatry Allied Discipl.* 49, 251–275. doi: 10.1111/j.1469-7610.2007.01867.x

Achenbach, T. M., and Rescorla, L. (2001). *Manual for the ASEBA School-Age Forms y Profiles*. Burlington, VT: University of Vermmont; Research Center for Children Youths, and Families.

Arnau-Sabatés, L., and Gilligan, R. (2015). What helps young care leavers to enter the world of work? Possible lessons learned from an exploratory study in Ireland and Catalonia. *Child. Youth Serv. Rev.* 53, 185–191. doi: 10.1016/j.childyouth.2015.03.027

Attar-Schwartz, S. (2009). School functioning of children in residential care: the contributions of multilevel correlates. *Child Abuse Neglect.* 33, 429–440. doi: 10.1016/j.chiabu.2008.12.010

Auger-Voyer, V., Montero-Sieburth, M., and Cabrera, L. (2014). Chasing the European dream: unaccompanied African youths' educational experience in a Canary Islands' reception centre and beyond. *Educ. Policy Anal. Arch.* 22, 1–23. doi: 10.14507/epaa.v22n76.2014

Bravo, A. and Del Valle, J. F. (2001). Evaluación de la integración social en acogimiento residencial. *Psicothema* 13, 197–204.

Bravo, A., and Santos, I. (2017). Menores extranjeros no acompanados en Espana: necesidades y modelos de intervención. *Psychosoc. Interv.* 26, 55–62. doi: 10.1016/j.psi.2015.12.001

Bronsard, G., Lançon, C., Loundou, A., Auquier, P., Rufo, M., and Siméoni, M. C. (2011). Prevalence rate of DSM mental disorders among adolescents living in residential group homes of the French Child Welfare System. *Child. Youth Serv. Rev.* 33, 1886–1890. doi: 10.1016/j.childyouth.2011.05.014

Burns, B. J., Phillips, S. D., Wagner, H. R., Barth, R. P., Kolko, D. J., Campbell, Y., et al. (2004). Mental health need and access to mental health services by youths involved with child welfare: a national survey. *J. Am. Acad. Child Adolesc. Psychiatry* 43, 960–970. doi: 10.1097/01.chi.0000127590.95585.65

Casas, F., Montserrat, C., and Malo, S. (2010). *Young People From a Public Care Background Pathways to Education in Spain*. The Case Study Report. The YIPPEE Project. Available online at: http://www.restore.ac.uk/ISResMeth/Case%20Studies/caseStudyTwo.pdf

Casey, K. J., Hagaman, J. L., Trout, A. L., Reid, R., Chmelka, M. B., Thompson, R. W., et al. (2008). Children with ADHD in residential care. *J. Child Fam. Stud.* 17, 909–927. doi: 10.1007/s10826-008-9198-x

Cheung, C., Lwin, K., and Jenkins, J. M. (2012). Helping youth in care succeed: Influence of caregiver involvement on academic achievement. *Child. Youth Serv. Rev.* 34, 1092–1100. doi: 10.1016/j.childyouth.2012.01.033

Del Valle, J.-F., Lázaro-Visa, S., López, M., and Bravo, A. (2011). Leaving family care Transitions to adulthood from kinship care. *Child. Youth Serv. Rev.* 33, 2475–2481. doi: 10.1016/j.childyouth.2011.08.015

Del Valle, J. F., López, M., Montserrat, C., and Bravo, A. (2009). Twenty years of Foster care in Spain: profiles, patterns and outcomes. *Child. Youth Serv. Rev.* 31, 847–853. doi: 10.1016/j.childyouth.2009.03.007

DARNA and UNICEF (1997). *Journées de Sensibilitation Pour l'enfance en Difficulté*. Tánger: Autores.

Eide, K., and Hjern, A. (2013). Unaccompanied refugee children: vulnerability and agency. *Acta Pediatr.* 102, 666–668. doi: 10.1111/apa.12258

Ferguson, H. B., and Wolkow, K. (2012). Educating children and youth in care: a review of barriers to school progress and strategies for change. *Child. Youth Serv. Rev.* 34, 1143–1149. doi: 10.1016/j.childyouth.2012.01.034

Fernández Enguita, M. (2016). *La Educación en la Encrucijada*. Madrid: Fundación Santillana.

Ford, T., Vostanis, P., Meltzer, H., and Goodman, R. (2007). Psychiatric disorder among British children looked after by local authorities: comparison with children living in private households. *Br. J. Psychiatry* 190, 319–325. doi: 10.1192/bjp.bp.106.025023

Garland, A. F., Hough, R. L., McCabe, K. M., Yeh, M., Wood, P. A., and Aarons, G. A. (2001). Prevalence of psychiatric disorders in youths across five sectors of care. *J. Am. Acad. Child Adolesc. Psychiatry* 40, 409–418. doi: 10.1097/00004583-200104000-00009

González-García, C., Bravo, A., Arruabarrena, M. I., Martín, E., Santos, I., and Del Valle, J. F. (2017). Emotional and behavioral problems of children in residential care: screening detection and referrals to mental health services. *Child. Youth Serv. Rev.* 73, 100–106. doi: 10.1016/j.childyouth.2016.12.011

Harder, A. T., Huyghen, A.-M. N., Knot-Dickscheit, J., Kalverboer, M. E., Köngeter, S., Zeller, M., et al. (2014). Education secured? The school performance of adolescents in secure residential youth care. *Child Youth Care Forum* 43, 251–268. doi: 10.1007/s10566-013-9232-z

Höjer, I., and Johansson, H. (2013). School as an opportunity and resilience factor for young people placed in care. *Eur. J. Soc. Work* 16, 22–36. doi: 10.1080/13691457.2012.722984

Hopkins, P., and Hill, M. (2010). The needs and strengths of unaccompanied asylum-seeking children and young people in Scotland. *Child Fam. Soc. Work* 15, 399–408. doi: 10.1111/j.1365-2206.2010.00687.x

Jackson, S. (2010). Reconnecting care and education. *J. Child. Serv.* 5, 28–59. doi: 10.5042/jcs.2010.0550

Jackson, S., Alayi, S., and Quigley, M. (2005). *Going to University From Care*. London: Thomas Coram Unit, Institute of Education.

Jackson, S., and Cameron, C. (2012). Leaving care: looking ahead and aiming higher. *Child. Youth Serv. Rev.* 34, 1107–1114. doi: 10.1016/j.childyouth.2012.01.041

Jackson, S., and Cameron, C. (2014). "Educational and social inclusion," in *Improving Access to Further and Higher Education for Young People in Public Care. European Policy and Practice*, eds S. Jackson and C. Cameron (London: Jessica Kingsley Publishers), 15–31.

Jackson, S., and Martin, P. Y. (1998). Surviving the care system: education and resilience. *J. Adolesc.* 21, 569–583. doi: 10.1006/jado.1998.0178

Jiménez, M. (2003). *Buscarse la Vida: Análisis Trasnacional de los Procesos Migratorios de los Menores Marroquíes no Acompañados en Andalucía*. Madrid: Ediciones SM.

Jozefiak, T., Kayed, N. S., Rimehaug, T., Wormdal, A. K., Brubakk, A. M., and Wichstrøm, L. (2016). Prevalence and comorbidity of mental disorders among adolescents living in residential youth care. *Eur. Child Adolesc. Psychiatry* 25, 33–47. doi: 10.1007/s00787-015-0700-x

Kia-Keating, M., and Ellis, B. H. (2007). Belonging and connection to school in resettlement: young refugees, school belonging and psychosocial adjustment. *Clin. Child Psychol. Psychiatry* 12, 29–43. doi: 10.1177/1359104507071052

Kohli, R. (2009). Social work with unaccompanied asylum seeking children. *Soc. Work Educ.* 28, 678–687.

Kohli, R. (2011). Working to ensure safety, belonging and success for unaccompanied asylum seeking children. *Child Abuse Rev.* 20, 311–323. doi: 10.1002/car.1182

Lázaro, S., and López, F. (2010). Continuidad de los efectos del maltrato durante la infancia en adolescentes acogidos en centros de protección. *Infancia Aprendizaje* 33, 255–268. doi: 10.1174/021037010791114599

Leonard, S. S., and Gudiño, O. G. (2016). Academic and mental health outcomes of youth placed in out-of-home care: the role of school stability and engagement. *Child. Youth Care Forum* 45, 807–827. doi: 10.1007/s10566-016-9357-y

López, M., and Del Valle, J. F. (2015). The waiting children: pathways (and future) of children in long-term residential care. *Br. J. Soc. Work* 45, 457–473. doi: 10.1093/bjsw/bct130

Martín, E., Muñoz, M. C., Rodríguez, T., and Pérez, Y. (2008). De la residencia a la escuela: la integración social de los menores en acogimiento residencial con el grupo de iguales en el contexto escolar. *Psicothema* 20, 376–382.

Masten, A. S., and Coastworth, J. D. (1998). The development of competence in favourable and unfavorable environments: lessons from research on successful children. *Am. Psychol.* 53, 205–220. doi: 10.1037/0003-066X.53.2.205

McCarthy, C., and Marks, D. F. (2010). Exploring the health and well-being of refugee and asylum seeking children. *J. Health Psychol.* 15, 586–595. doi: 10.1177/1359105309353644

McMillen, J. C., Zima, B. T., Scott, L. D., Auslander, W. F., Munson, M. R., Ollie, M. T., et al. (2005). Prevalence of psychiatric disorders among older youths in the foster care system. *J. Am. Acad. Child Adolesc. Psychiatry* 44, 88–95. doi: 10.1097/01.chi.0000145806.24274.d2

Miller, C., and Porter, K. E. (2007). Barriers to employment among out-of-school youth. *Child. Youth Serv. Rev.* 29, 572–587. doi: 10.1016/j.childyouth.2006.11.001

Ministerio de Educación, Cultura y Deporte (2016). *Las Cifras de la Educación en España. Curso 2013-2014 (Edición 2016)*. Madrid: Ministerio de Educación, Cultura y Deporte. Available online at: http://www.mecd.gob.es/servicios-al-ciudadano-mecd/estadisticas/educacion/indicadores-publicaciones-sintesis/cifras-educacion-espana/2013-14.html

Montserrat, C., Casas, F., and Baena, M. (2015). *La educación de Niños, Niñas y Adolescentes en el Sistema de Protección: Un Problema o una Oportunidad?* Cataluña: Documenta Universitaria.

Montserrat, C., Casas, F., and Bertrán, I. (2013a). Desigualdad de oportunidades educativas entre los adolescentes en acogimiento residencial y familiar. *Infancia Aprendizaje* 36, 443–453. doi: 10.1174/021037013808200267

Montserrat, C., Casas, F., and Malo, S. (2013b). Delayed educational pathways and risk of social exclusion: the case of young people from public care in Spain. *Eur. J. Soc. Work* 16, 6–21. doi: 10.1080/13691457.2012.722981

Montserrat, C., Casas, F., Malo, S., and Bertran, I. (2011). *Los Itineraries Educativos de los Jovenes Ex-Tutelados*. Madrid: Ministerio de Sanidad, Política Social e Igualdad.

Muela, A., Balluerka, N., and Torres, B. (2013). Ajuste social y escolar de jóvenes víctimas de maltrato infantil en situación de acogimiento residencial. *Anal. Psicol.* 29, 197–206. doi: 10.6018/analesps.29.1.124941

Munro, E. R., and Stein, M. (2008). "Introduction: comparative exploration of care leavers transitions to adulthood," in *Young People's Transitions From Care to Adulthood. International Research and Practice*, eds M. Stein and E. R. Munro (London: Jessica Kingsley Publishers), 11–21.

Observatorio de la Infancia (2017). *Estadística Básica de Medidas de Protección a la Infancia, Vol. 18*. Madrid: Ministerio de Sanidad y Sercicios Sociales e Igualdad. Available online at: http://www.observatoriodelainfancia.msssi.gob.es/productos/pdf/Boletinproteccionalainfancia18accesible.pdf

Pecora, P. J. (2012). Maximizing educational achievement of youth in foster care and alumni: factors associated with success. *Child. Youth Serv. Rev.* 34, 1121–1129. doi: 10.1016/j.childyouth.2012.01.044

Quiroga, V., Alonso, A., and Sòria, M. (2010). *Sueños de Bolsillo. Los y las Menores Migrantes no Acompañados/as en España*. Madrid: UNICEF.

Rousseau, C., Drapeu, A., and Platt, R. (2004). Family environment and emotional and behavioural symptoms in adolescent Cambodian refugees: influence of time, gneder and acculturation. *Med. Conflict Surv.* 20, 151–165. doi: 10.1080/13623690420002034735

Sainero, A., Bravo, A., and Del Valle, J. F. (2014). Examining needs and referrals to mental health services for children in residential care in Spain: an empirical study in an autonomous community. *J. Emot. Behav. Disord.* 22, 16–26. doi: 10.1177/1063426612470517

Sainero, A., Del Valle, J. F., López, M., and Bravo, A. (2013). Exploring the specific needs of an understudied group: children with intellectual disability in residential child care. *Child. Youth Serv. Rev.* 35, 1393–1399. doi: 10.1016/j.childyouth.2013.04.026

Scherr, T. G. (2007). Educational experiences of children in foster care. Meta-Analyses of special education, retention and discipline rates. *School Psychol. Int.* 28, 419–436. doi: 10.1177/0143034307084133

Schiff, M., and Benbenishty, R. (2006). Functioning of Israeli group-homes alumni: exploring gender differences and in-care correlates. *Child. Youth Serv. Rev.* 28, 133–157. doi: 10.1016/j.childyouth.2005.02.010

Sinclair, I., Baker, C., Lee, J., and Gibbs, I. (2007). *The Pursuit of Permanence. A Study of the English Child Care System*. London: Jessika Kingsley.

Slayter, E. (2016). Youth with disabilities in the United States Child Welfare System. *Child. Youth Serv. Rev.* 64, 155–165. doi: 10.1016/j.childyouth.2016.03.012

Snow, K. (2009). The case for enhanced educational supports for children in public care: an integrative literature review of the educational pathway of children in care. *Vulnerable Child. Youth Stud.* 4, 300–311. doi: 10.1080/17450120903012933

Sujoldzic, A., Paternel, L., Kulenovic, T., and Tercic, R. (2006). Social determinants of health: a comparative study of Bosnian adolescents in different cultural contexts. *Coll. Antropol.* 30, 703–711.

Sullivan, P. M., and Kuntson, J. F. (2000). Maltreatment and disabilities: a population-based epidemiological study. *Child Abuse Neglect* 24, 1257–1273 doi: 10.1016/S0145-2134(00)00190-3

Susinos, T., Calvo, A., and Rojas, S. (2015). *El Fracaso Escolar y la Mejora de la Escuela*. Madrid: Síntesis.

Tarren-Sweeney, M. (2008). Retrospective and concurrent predictors of the mental health of children in care. *Child. Youth Serv. Rev.* 30, 1–25. doi: 10.1016/j.childyouth.2007.05.014

Trout, A. L., Casey, K., Chmelka, M. B., DeSalvo, C., Reid, R., and Epstein, M. H. (2009). Overlooked: children with disabilities in residential care. *Child Welfare* 88, 111–136.

Trout, A. L., Hagaman, J., Casey, K., Reid, R., and Epstein, M. H. (2008). The academic status of children and youth in out-of-home care: a review of the literature. *Child. Youth Serv. Rev.* 30, 979–994. doi: 10.1016/j.childyouth.2007.11.019

UNESCO (2012). *Education for All Global Monitoring Report: Youth and Skills, Putting Education to Work*. Paris: UNESCO. Available online at: http://unesdoc.unesco.org/images/0021/002180/218003e.pdf

Van Vugt, E., Lanctôt, N., Paquette, G., Collin-Vézina, D., and Lemieux, A. (2014). Girls in residential care: From child maltreatment totrauma-related symptoms in emerging adulthood. *Child Abuse Neglect.* 38, 114–122. doi: 10.1016/j.chiabu.2013.10.015

Wade, J., Mitchell, F., and Baylis, G. (2005). *Unaccompanied Asylum Seeking Children: The Response of Social Work Services*. London: BAAF.

Wade, J., Sirriyeh, A., Kohli, R., and Simmonds, J. (2012). *Fostering Unaccompanied Asylum-Seeking Young People: Creating a Family Life across "A World of Difference"*. London: BAAF.

Wallin, A., and Ahlström, G. (2005). Unaccompanied young adult refugees in Sweden,experiences of their life situation and well-being: a qualitative follow-up study. *Ethnic. Health* 10, 129–144. doi: 10.1080/13557850500071145

Ward, H., Courtney, M., Del Valle, J. F., McDermid, S., and Zeira, A. (2014). Improving outcomes for children and young people in care. *Vulnerable*

Children Youth Stud. Int. Interdiscip. J. Res. Policy Care 4, 101–106. doi: 10.1080/17450120903013014

Witt, A., Münzer, H., Ganser, H. G., Fegert, J. F., Goldbeck, L., and Plener, P. L. (2016). Experience by children and adolescents of more than one type of maltreatment: association of different classes of maltreatment profiles with clinical outcome variables. *Child Abuse Neglect*. 57, 1–11. doi: 10.1016/j.chiabu.2016.05.001

Zima, B. T., Bussing, R., Freeman, S., Yang, X., Belin, T. R., and Forness, S. R. (2000). Behavior problems, academic skill delays and school failure among school-aged children in foster care: their relationship to placement characteristics. *J. Child Fam. Stud.* 9:87. doi: 10.1023/A:1009415800475

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 González-García, Lázaro-Visa, Santos, del Valle and Bravo. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 30 June 2017
doi: 10.3389/fpsyg.2017.01054

Effects of Direct Instruction and Strategy Modeling on Upper-Primary Students' Writing Development

*Paula López[1], Mark Torrance[2], Gert Rijlaarsdam[3] and Raquel Fidalgo[1]**

[1] Department of Psychology, Sociology and Philosophy, Faculty of Education, University of León, León, Spain, [2] Division of Psychology, Nottingham Trent University, Nottingham, United Kingdom, [3] Research Institute for Child Development and Education, University of Amsterdam, Amsterdam, Netherlands

Strategy-focused instruction is one of the most effective approaches to improve writing skills. It aims to teach developing writers strategies that give them executive control over their writing processes. Programs under this kind of instruction tend to have multiple components that include direct instruction, modeling and scaffolded practice. This multi-component nature has two drawbacks: it makes implementation challenging due to the amount of time and training required to perform each stage, and it is difficult to determine the underlying mechanisms that contribute to its effectiveness. To unpack why strategy-focused instruction is effective, we explored the specific effects of two key components: direct teaching of writing strategies and modeling of strategy use. Six classes (133 students) of upper-primary education were randomly assigned to one of the two experimental conditions, in which students received instruction aimed at developing effective strategies for planning and drafting, or control group with no strategy instruction: Direct Instruction ($N = 46$), Modeling ($N = 45$), and Control ($N = 42$). Writing performance was assessed before the intervention and immediately after the intervention with two tasks, one collaborative and the other one individual to explore whether differential effects resulted from students writing alone or in pairs. Writing performance was assessed through reader-based and text-based measures of text quality. Results at post-test showed similar improvement in both intervention conditions, relatively to controls, in all measures and in both the collaborative and the individual task. No statistically significant differences were observed between experimental conditions. These findings suggest that both components, direct teaching and modeling, are equally effective in improving writing skills in upper primary students, and these effects are present even after a short training.

Keywords: writing, strategy-focused instruction, components analysis, modeling, direct instruction

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
Angela Jocelyn Fawcett, Swansea University, United Kingdom
Ruomeng Zhao, MacPractice, Inc., United States

***Correspondence:**
Raquel Fidalgo
rfidr@unileon.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *24 March 2017*
Accepted: *08 June 2017*
Published: *30 June 2017*

Citation:
López P, Torrance M, Rijlaarsdam G and Fidalgo R (2017) Effects of Direct Instruction and Strategy Modeling on Upper-Primary Students' Writing Development. Front. Psychol. 8:1054. doi: 10.3389/fpsyg.2017.01054

INTRODUCTION

Theories of the psychological processes underlying how people write extended text – the processes by which, for example, students write essays and researchers write papers – have historically had two main strands. Writing is characterized as a problem solving process, in which the writer makes deliberate and explicit decisions about content, structure, rhetoric, and word choice

(Flower and Hayes, 1980; Bereiter and Scardamalia, 1987; Hayes, 1996). Writing is also cognitively demanding: the processes associated with text production must be coordinated within the constraints imposed by a limited capacity of working memory (Kellogg, 1988, 1999; McCutchen, 1996; Torrance and Galbraith, 2006). Therefore writers must coordinate several cognitively costly activities including retrieval of prior knowledge, planning and structuring content, formulating sentences, and monitoring output. At the same time, writers need to maintain in mind their communicative goals and the needs of their audience (Flower and Hayes, 1980; Fayol, 1999). Writing is particularly demanding task for young writers. Writers who have not yet fully developed low-level transcription skills – who are not yet able to plan fluently and accurately and execute sentences that are grammatically correct and words that are accurately spelled and neatly written – face a combined challenge. They struggle to produce accurate sentences, and the consequent additional effort draws resources away from the higher-level problem solving activities necessary to generate well-structured and content-rich text. Arguably therefore, as Graham and Harris (2000) observe, writing competence requires not only automatization of transcriptions skills but also self-regulation in order to handle high-level cognitive processes of writing such as planning and revision, which are directly related to the production of high-quality texts (Limpo et al., 2014; for a review see Berninger, 2012).

Strategy-focused writing instruction aims to teach developing writers strategies that give them executive (self-regulatory) control over their own writing processes. Several meta-analyses (Graham and Perin, 2007; Graham et al., 2012; Graham and Harris, 2014) have indicated that strategy-focused instruction is the most effective approach to improve students writing, relative to the other types on instruction identified in their meta-analyses, with typically large positive effects on the quality of students' texts. This approach aims to give students explicit strategies for regulating both what they write and the processes that they adopt when writing it (Alexander et al., 1998; Harris et al., 2008).

Programs of strategy-focused instruction tend to have multiple components, and these vary to some extent across different implementations (Pressley and Harris, 2006; Harris et al., 2011). However, instruction typically includes activities aimed at activating relevant prior knowledge, direct instruction aimed at giving declarative meta-knowledge about appropriate writing strategies, typically based around various mnemonics, modeling of writing strategies in which the instructor "thinks aloud" in front of learners demonstrating a strategy while composing, and scaffolded practice. Merrill (2002) refers to these five components at the "First Principles" of instruction. The aim is for a progressive decrease in scaffolding, with strategies moving from being something that the teacher tells the students to do, to internalized self-talk by which the student regulates their own writing behavior (Pressley and Harris, 2006; Graham and Harris, 2014).

As we have noted, a number of evaluations of instructional programs based on these components have found that the programs as a whole are successful, and more successful than other approaches to writing instruction. However, these studies necessarily have evaluated a package of instructional components. It is unclear whether all or just some of those components contribute to the positive outcome. Therefore several researchers have pointed to the need for component analyses (Graham and Harris, 1989; De La Paz, 2007; Brunstein and Glaser, 2011). Such studies are critical for both theoretical and educational reasons. From a theoretical perspective, understanding the relative contribution of the different components of strategy-focused instruction gives insight into the underlying mechanisms of writing development (Sawyer et al., 1992). Understanding the relative efficacy of different instructional components in a "package intervention" also contributes to understanding of students' learning processes (Hopwood, 2007). From an applied perspective, full strategy-focused interventions typically do not fit well within the normal school curriculum, and teachers are liable to selectively include some but not all components in their classroom practice (De La Paz, 2007). This is for several reasons. Implementing strategy-focused instruction can be challenging for teachers. Some components, and particularly modeling, will often be outside of the teacher's skills set and are typically, in the US at least, not well-supported in professional development (Harris et al., 2009). Also, the best-known approach to strategy-focused instruction (Self-Regulation Strategy Development; e.g., Graham et al., 2000; Harris et al., 2006) requires teaching individual or small groups of students following a criterion-based approach. The number of instructional sessions devoted to master different components and learning-goals therefore varies across implementation and across students. Adopting this approach in a normal, full-range classroom is typically problematic.

The challenge, therefore, is to identify which of the various components that comprise the strategy-focused approach are necessary to result in substantial positive effects on writing quality when taught to full-range classes. A handful of studies have aimed to compare the efficacy of different components. Several of these have focused on the role of instruction targeted specifically at student motivation, on the role of feedback, and on the effects of peer support (see De La Paz, 2007 for a review). Fewer studies have attempted to explore the specific contribution of the main instructional components detailed above (but see Sawyer et al., 1992; Fidalgo et al., 2011, 2015; Torrance et al., 2015).

Our present focus is on the contribution of direct instruction and of modeling to successful learning. Sawyer et al. (1992) assigned fifth and sixth grade students with learning difficulties to four conditions (1) full strategy-focused instruction, (2) strategy-focused instruction without goal setting and self-monitoring, (3) direct teaching only, and (4) practice control. In the direct instruction condition, the authors removed modeling and collaborative practice, and also instruction on the use of self-talk. The results did not show significant differences between conditions concerning text quality at any measurement occasion at either post-test or delayed post-test. This suggests that direct instruction without modeling is sufficient to improve writing quality, at least in struggling writers. Nevertheless, these results need to be treated with caution, given that the efficacy of modeling seems to be heavily dependent on several factors. For

example, in line with Braaksma et al. (2002) findings, weak students benefit more when they can observe weak models. As the specific sample on Sawyer et al. (1992) presented learning disabilities, it might be the case that students did not benefit from a model that provides them with the opportunity to learn by observation.

The opposite result has also been found. Fidalgo et al. (2011), explored whether strategy-focused instruction remained effective when direct teaching was removed from the program. They compared two seven-session programs, both implemented in full-range classes. In one condition students received full strategy-focused instruction, comprising direct teaching (one session), modeling (two sessions), collaborative (two sessions), and independent practice (two sessions). In the other experimental condition, the direct teaching component was omitted. The results showed that both experimental conditions outperformed the control group in text quality, with no significant differences between conditions. In another study, Fidalgo et al. (2015) analyzed the cumulative contribution of modeling, direct instruction, and collaborative and individual practice. Three sixth-grader classes participated in a lagged-group and cross-panel evaluation. Groups showed significant and substantial gains in text quality after an initial component, taught over two sessions, in which the teacher modeled effective use of specific writing strategies, and students then reflected on what they had observed. These sessions did not include any direct instruction or explicit strategy labeling. Subsequent components gave no significant additional benefit. This finding was observed for both compare-contrast essays and opinion essays. These results suggest that observation of a mastery model followed by a whole-class reflection is sufficient to improve sixth grade students' writing skills. Nevertheless, this finding should be interpreted cautiously. For example, it might be that *the first blow is half the battle*: the study does not rule out the possibility that starting with Direct Instruction would have resulted in the same effect, and indeed this is what might be predicted based on the finding detailed above. Therefore, a direct comparison of the benefits of these two forms of instruction is needed.

Our goal in the present study, therefore, was to directly compare the contribution of Direct Instruction and Modeling to writing development, through interventions aimed at improving text quality by teaching planning and drafting strategies. For that purpose, we designed two experimental interventions. In the Direct Instruction condition students received explicit declarative knowledge of planning and drafting strategies, supported by mnemonics. In the Modeling condition students were provided with procedural knowledge of how to implement planning and drafting strategies by observing a model. These two experimental conditions were contrasted with a control condition, in which students were taught about the linguistic and discourse features of good text, but were not taught writing process strategies.

Effects of each condition were tested with two tasks, one collaborative and one individual. Several studies have shown positive effects of collaboration on task performance, finding higher quality texts from collaborative writing than from individual writing (Yarrow and Topping, 2001; Wigglesworth and Storch, 2009). As Ohta (2001) pointed out, no two learners have the same strengths and weaknesses, so when working together they can provide scaffolded assistance to each other and achieve a higher level of performance than they may have achieved on their own. Therefore in the present study we wanted to explore whether differential effects resulted from students working alone or observing and commenting on each other's task, with the aim of encouraging each other to adopt the strategies that they had been taught.

MATERIALS AND METHODS

Design

Six existing classes of 5th and 6th students were randomly assigned to one of two experimental conditions and a control condition, with one 5th and one 6th grade class in each condition. Instruction in all conditions was aimed at training students to produce good quality argumentative texts.

Both experimental conditions received strategy instruction focused on the acquisition of planning and drafting writing strategies. In the *Direct Instruction* condition, the students received direct instruction aimed at delivering declarative knowledge about planning and drafting strategies, supported by the use of mnemonics and graphic organizers. In the *Modeling* condition, students observed an expert model, with the aim of delivering procedural knowledge about the same strategies, but without labeling these strategies or making them explicit. Students in the control condition were taught about the features of good argumentative text, but without any mention to specific strategies for regulating the processes by which these texts might be produced.

Writing performance was assessed before the intervention (pre-test) and immediately after the intervention (post-test). At each measurement occasion students completed two tasks: an individual task and a collaborative writing task performed in pairs that reflected the collaborative learning tasks students practiced during the intervention. All assessment tasks involved writing argumentative texts.

Participants

The sample comprised 133 Spanish upper-primary students in three 5th grade classes ($N = 72$) and three 6th ($N = 61$) classes. These were all drawn from the same *colegio concertado* (mixed state- and privately-funded) school. Students' ages ranged from 10 to 12 years (Direct instruction: $M = 10.48$; $SD = 0.50$; Modeling: $M = 10.75$; $SD = 0.61$; Control: $M = 10.62$; $SD = 0.57$), with 50% of female students in direct instruction condition, 46% in the modeling condition and 49% in the control group. Most students came from families with medium to high incomes. An additional 13 students who had existing diagnoses of special educational needs received the same instruction as their peers, but we did not include their data in the analysis.

Prior to intervention, all students received similar writing instruction following a pattern typical in Spanish primary schools. This focuses on the features of different textual genres,

and on grammatical and spelling accuracy, and did not include any explicit strategy instruction.

Students were allocated to pairs for the collaborative writing task by the teacher, with children of broadly similar ability within each pair. Students were assigned to roles – either *Writer* or *Helper* – which they maintained throughout the intervention. The teacher also decided which student in a pair was more extrovert, that is which student was more likely to think aloud during the composing task. That student then was selected as the writer, while the other student in the pair was the helper.

Instructional Programs

The intervention was delivered by one instructor to whole classes, with the same instructor in all cases. All sessions lasted for approximately 55 min in all conditions and followed the same pattern, consisting of two parts. The first 35–40 min of the session involved delivery of the specific instructional content of that session, varying according to condition. In the second part students practiced what they had been taught or had observed, completing a short writing task in pairs. Students with the writer role performed the writing task, verbalizing all their actions and thoughts throughout. Helpers sat next to the writer and monitored their writing processes and output. On the basis of the instruction that they had received in the first part of the session helpers commented on the Writers text, thoughts and, perhaps, processes, identifying issues and suggesting ways in which these might be resolved.

The similarities and differences of the three conditions are summarized in **Table 1**.

Direct Instruction

Teaching of planning (first session) and drafting (second session) was supported by graphic organizers and mnemonics specifically designed for this study. Students were taught the mnemonic "TARE" to scaffold planning their argumentative texts. *Tesis* (*Thesis*) prompted students to identify their stance on the topic (for or against); *Audiencia* (*Audience*) prompted students to think through the specific informational needs of their reader, and the rhetorical strategies that were likely to be most effective in persuading their readers of their position. *Razones* (*Reasons*) prompted students to identify several claims to justify their position. *Ejemplos* (*Examples*) reminded students of the need to evidence these claims.

In the second session students were taught a strategy for drafting their text based around "IDC," which encouraged planning of specific components of the text: an *Introducción* (*Introduction*) which should interest the reader and clearly state the student's thesis; *Desarrollo* (*Development*), representing the middle paragraphs in their text in which students were instructed to give reasons and evidence examples in coherence and well-structured manner; and a *Conclusión* (*Conclusion*). Both strategies were supported by graphic organizers that showed the TARE and IDC structure, with explanations and examples.

During collaborative practice, the student with the *Helper* role was asked to support their partner's (the *Writer's*) use of the strategy taught in that session, commenting on the Writer's think aloud with specific reference to the associated mnemonic.

TABLE 1 | Summary of differences among conditions.

	Direct Instruction	Modeling	Control
Instructional approach			
Activation of prior knowledge	+	+	+
Motivation supporting	+	+	+
Practice by pairs	+	+	+
Direct teaching of cognitive writing strategies through mnemonics	+		
Modeling of the use of cognitive writing strategies through thinking aloud		+	
Analysis of high-quality argumentative texts			+
Instructional content			
High quality argumentative texts	+	+	+
Planning and drafting writing strategies	+	+	
Kind of knowledge provided			
Self-regulated approach	+	+	
Declarative knowledge	+		+
Procedural knowledge		+	

Modeling

The instructor started these sessions by explaining that they were about to observe a very good writer planning (first session) or drafting (second session) an argumentative text. Students were asked to give close attention to the model because afterward they would be asked to emulate what they had observed. Modeling involved semi-scripted "think aloud" demonstrating a self-regulating approach to writing argumentative text. The model externalized the internal self-talk that is associated with self-regulated strategy use, while implementing the same self-regulated writing procedure that was the intended learning outcome of the Direct Instruction intervention. The instructor therefore articulated her stance on the topic, setting reader-focused goals, generating supporting ideas and so forth as she produced her written plan (Session 1) and draft of her text (Session 2). Importantly her think-aloud did not make direct reference to strategies and, particularly, did not mention the mnemonics taught in the direct instruction condition. In addition, the instructor included self-talk demonstrating self-belief ("I can do it correctly"; "I am sure that I will get a high mark") and self-encouragement to remain motivated and attentive ("It is boring, but it is worth the effort"). After modeling was complete students were given a copy of the written output of the modeled writing session – a written plan in Session 1 and a draft essay in Session 2. Finally, students practiced in pairs, with the Writer aiming to emulate what they had observed and the Helper prompting them (e.g., "You are writing down evidence, but I think the teacher stated her own position first").

Control

In both sessions students received examples of high quality argumentative texts about the same topic, with the text in Session 1 arguing one position, and the text is Session 2 arguing the

opposite position. The text was read to the class and then students read it individually and answered questions about specific features of structure and content (e.g., "What kind of text you just read?," "What is the main topic of the text?," "What evidence do they use?," "Give at least one argument not mentioned in the text."). The instructor then led a whole-class discussion about the text, bringing out ideas about the features that made it a successful argument. As in the other two conditions collaborative practice involved creating a written outline (Session 1) and drafting full text (Session 2). In Session 1 Helpers were encouraged to help their partners to generate ideas. In Session 2 they reminded their partners about specific features of high quality argumentative texts, and were also free to contribute additional ideas during the writing task.

Implementation and Fidelity

Intervention sessions were 1 week apart and occurred toward the start of the Spring school term. Sessions took place in literacy lessons and they were delivered in all cases by the first author who has previous training and experience in delivering similar interventions. To ensure full implementation of the instructional conditions the program for each session were prescribed in detail. All texts written during the intervention were collected in individual portfolios which enabled us to verify that all students completed all tasks. In addition, all sessions were audio-recorded.

The following procedure ensured that ethical standards were maintained. Parents were informed of research aims via letters in which they gave written informed consent. They were given the opportunity to express concerns and to request that their children's data not be included in the study. The intervention took place in a common classroom context through several sessions spread in the normal school timetable. Teaching in all conditions covered, and went beyond, the requirements of the school curriculum. After finishing the study, the school was informed about the results of the different instructional conditions, and a specific strategy-focused instruction program and supportive materials, combining elements of the experimental conditions was provided to the students' normal literacy teacher to be implemented with the control group students.

Instruments and Measures

Writing Assessment Tasks

To avoid a contamination of topic and measurement effects, writing performance was assessed by students writing argumentative essays with topics counterbalanced across assessment tasks and pre-test and post-test. Topics related to animal captivity and the value of reading (for the collaborative writing tasks) and whether or not sport is a good thing and the value of learning languages (for the individual writing tasks). These were presented on small cards which included specific topic with two pictures and the question "for or against?" For both the collaborative and the individual task, students were provided with two work sheets, one for planning or rough drafting, and one for their final text. Students were told that use of the first work sheet was optional. Students were asked to produce the best essay that they could write. For the collaborative task, the instructor also reminded student's roles as well as stressed the need to work together on the text. In both assessment tasks, students had 1 hour to write their texts, despite this, none wrote more than 35–40 min.

Texts from both the individual and collaborative assessment tasks were rated holistically through *reader-based measures* and analyzed in detail to generate *text-based measures*.

Reader-based measures involved assessing the structure, coherence and overall quality of the texts, using methods adapted from Spencer and Fitzgerald (1993). *Structure* was rated on a four-point scale, with 1 = lack of any obvious structure and 4 = well structured. Raters made decisions based on the extent to which the text had a global framework that made clear the argumentative function of each section of text. *Coherence* was also assessed on a four-point scale, with 1 = incoherent and 4 = entirely coherent. This score was based on whether it was possible to identify the main argument, whether the text presented clear progression of ideas without digressions, whether the student defined a general context, and whether the text maintained local cohesion (sentences followed from each other). *Overall Quality* was assessed on a six-point scale, with 1 = not suitable, hard to understand and 6 = excellent. Scores were based on the extent to which the text included rich ideas, diverse and appropriate, vocabulary, interesting detail, and correct sentence structure, punctuation, and spelling.

Two raters with previous experience of using these measures rated all of the texts independent in three separate rounds, one round per dimension. The inter-rater reliability (Pearson's *r*) average across assessment moments was high (Individual task: structure, 0.83; coherence 0.92; overall quality, 0.90; Collaborative task: structure, 0.80; coherence, 0.87; overall quality, 0.94).

Text-based measures focused on the presence of relatively sophisticated coherence devices within the text. Four types of complex devices were identified: structural ties (e.g., first, *secondly, finally*. . .), reformulation ties (e.g., *in conclusion*. . ., *in other words*. . ., *that is to say*. . .), argumentative ties (e.g., *for example*. . ., *therefore*. . ., *however*. . .), and meta-structural ties (e.g., *now, I am going to talk about*. . ., *In this text, I am going to convince you*. . .). Raters counted each instance of a device in each of these categories. The inter-rater reliability was again high ($\geq$0.90 across all measures, and for both tasks). This measure is reported as a number of occurrences per 100 words to give an index of tie density, independent of text length. In addition, we also report text length, counting the number of words written in the final text and removing incomplete or crossed words.

RESULTS

Observed means for reader- and text-based measures across test (pre-test, post-test) and condition (Direct Instruction, Modeling, and control) are shown in **Table 2** (individual -writing task) and **Table 3** (collaborative writing task).

To evaluate intervention effects we tested linear mixed effect models with random by-student and by-class intercepts, and with condition (Direct Instruction, Modeling, Control), time (pre-test, post-test), and their interaction as fixed factors. This

TABLE 2 | Effects of intervention on performance in the individual writing assessment task.

	Direct Instruction		Modeling		Control	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Word count	81.5 (32.4)	80.8 (25.6)	92.4 (32.7)	91.4 (26.5)	72.0 (35.8)	65.8 (23.1)
Structure	1.05 (0.23)	2.89 (1.18)	1.06 (0.34)	2.55 (1.13)	1.03 (0.17)	1.86 (1.15)
Coherence	1.11 (0.31)	2.63 (1.15)	1.18 (0.39)	2.41 (1.10)	1.08 (0.28)	1.69 (0.95)
Overall quality	1.45 (0.69)	3.45 (1.37)	1.38 (0.65)	3.38 (1.30)	1.22 (0.28)	2.08 (1.18)
Sophisticated coherence devices	0.64 (0.96)	3.71 (2.67)	0.42 (0.59)	2.41 (2.44)	0.57 (0.82)	1.83 (2.53)

Mean scores with standard deviation in parentheses.

approach achieves the same end as performing a mixed-effects ANOVA, but allows for the possibility that variance is not homogenous across measurement occasions, a state of affairs that is likely in the present and similar contexts (Quené and Van den Bergh, 2004, 2008). Evidence of an effect of intervention comes from the interaction between condition and time-of-task. Each model therefore evaluated three planned contrasts: the two-way interaction between task (pre-test vs. post-test) and condition (each of Direct vs. control, Modeling vs. control, and Direct vs. Modeling). Statistical significance of these effects was evaluated against a t distribution with degrees of freedom corrected for the dependencies in the observations. We also report Cohen's d as an indication of effect size, calculated within-condition difference between pre-test and post-test.

Relationships among Measures

Correlations among dependent variables can be found in **Table 4**. As might be expected, quality measures were correlated, but these correlations are sufficiently low to suggest good discriminant validity.

Equivalence of Writing Skills at Pre-test

We first determined whether there was evidence of differences among three experimental conditions at pre-test. One-way ANOVA indicated no statistically significant differences between conditions for any of structure, coherence, quality and the use of sophisticated coherence devices, either for the individual or collaborative tasks ($F \leq 1.9$, $p \geq 0.20$ for all analyses). There was some evidence of pre-test differences in the length of students' texts [Individual: $F(2.12) = 3.6$, $p = 0.03$; Collaboratively: $F(2.55) = 4.1$, $p = 0.02$].

Intervention Effects – Pre-test vs. Post-test

Individual Writing

Looking first at the effects of intervention on performance in the individual writing tasks, we found no effect of intervention on the length of the texts produced by students. There were, however, clear effects on reader-based quality measures, with evidence of a greater improvement in performance relative to control group in both the Direct Instruction and Modeling conditions [Direct Instruction: Structure, $t(120) = 4.0$, $p < 0.001$, $d = 2.6$; Coherence, $t(120) = 3.9$, $p < 0.001$, $d = 2.1$; Overall Quality, $t(120) = 4.1$, $p < 0.001$, $d = 1.9$. Modeling: Structure, $t(120) = 2.8$, $p = 0.007$, $d = 2.0$; Coherence, $t(120) = 2.9$, $p = 0.005$, $d = 1.6$; Overall Quality, $t(120) = 4.1$, $p < 0.001$, $d = 2.0$]. Comparing the effects of Direct Instruction and Modeling gave no statistically significant differences.

TABLE 3 | Effects of intervention on performance in the collaborative writing assessment task.

	Direct Instruction		Modeling		Control	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Word count	71.8 (20.6)	64.8 (22.1)	75.5 (26.2)	83.3 (19.8)	55.3 (21.1)	68.1 (16.2)
Structure	1.24 (0.44)	2.28 (0.96)	1.16 (0.38)	3.47 (0.84)	1.06 (0.24)	2.17 (0.92)
Coherence	1.33 (0.48)	3.33 (0.86)	1.53 (0.51)	3.47 (0.84)	1.22 (0.43)	2.33 (0.84)
Overall quality	2.14 (0.66)	4.76 (1.09)	2.26 (0.73)	5 (1.16)	1.94 (0.64)	3.06 (0.94)
Sophisticated coherence devices	0.52 (0.92)	6.27 (3.58)	0.23 (0.45)	3.04 (2.80)	0.58 (0.78)	2.37 (2.10)

Mean scores with standard deviation in parentheses.

TABLE 4 | Correlations among reader-based and text-based measures at pre-test.

	Individual task			Collaborative task		
	Coherence	Quality	Complex coherence devices	Coherence	Quality	Complex coherence devices
Structure	0.46	0.64	0.23	0.57	0.49	−0.008
Coherence		0.51	0.32		0.67	−0.07
Quality			0.36			0.19

Students in the Direct Instruction condition showed an increase in the use of sophisticated coherence devices compared with the control group [Direct Instruction, $t(120) = 3.2$, $p = 0.002$, $d = 1.69$]. Note that although the effect size appears large here, there was also a substantial increase in the use of these devices in the Control condition. We did not find a statistically significant effect for the Modeling, relative to control, and again there was no evidence of a statistically significant difference between the effects of the Modeling and Direct Instruction.

Collaborative Writing

Effects of intervention on performance in the writing-in-pairs task showed statistically significant improvement on all variables apart from text length [Direct Instruction: Structure, $t(58) = 3.3$, $p = 0.002$, $d = 1.5$; Coherence, $t(58) = 2.9$, $p = 0.005$, $d = 3.0$; Overall Quality, $t(58) = 4.6$, $p < 0.001$, $d = 3.0$; Coherence markers, $t(58) = 4.5$, $p < 0.001$, $d = 2.6$. Modeling: Structure, $t(58) = 4.2$, $p < 0.001$, $d = 3.8$; Coherence, $t(58) = 2.7$, $p = 0.010$, $d = 0.68$; Overall Quality, $t(120) = 4.8$, $p < 0.001$, $d = 2.1$; Coherence markers, $t(58) = 2.0$, $p = 0.05$, $d = 1.7$]. Comparing the effects of Direct Instruction and Modeling gave no statistically significant differences for structure, coherence and quality. Regarding the use of complex coherence devices, a significant difference was found favoring direct instruction condition compared with modeling [$t(58) = 2.9$, $p = 0.005$].

Role Effects

It is possible that students' role when practicing in pairs during instruction – whether they were Helper or Writer – affected the extent to which they benefited from intervention. We tested this hypothesis by adding role, and its interaction with other factors, to our model. This did not significantly improve model fit. We therefore did not find evidence that role moderated the intervention effects.

Differential Effects

It is also possible that students' writing ability, as measured by scores on the pre-test task, could moderate effects of the intervention. For example, it could be that although there was no evidence that within the population as a whole Direct Instruction benefits students more that Modeling, weaker students benefit more from Direct Instruction and stronger students more from Modeling (or perhaps the reverse). With this aim we conducted moderator regression analyses using Hayes' implementation of the Johnson–Neyman technique (Johnson and Neyman, 1936; Hayes, 2013). This analysis examined the effect of pre-test score, as a continuous predictor, on the effect of condition on post-test score. We found no evidence that effects of pre-test score on performance differed reliably across condition.

DISCUSSION

The main purpose of this study was to compare the benefits of teaching upper-primary children planning and drafting strategies by either expert modeling or direct instruction. The pattern of results obtained in both collaborative and individual writing tasks confirm that both components of strategy-focused writing instruction are effective. Both experimental conditions showed greater gains in the quality of their texts on reader- and text-based measures, relatively to a control group that received non strategy-focused but text analytic instruction. In the present study we found benefits of strategy instruction after only two intervention sessions. This is in line with Fidalgo et al. (2015) who also found large, immediate benefits of students observing and reflecting on an expert model after two sessions in three different groups.

Improvement in text quality was not simply due to students writing longer compositions. The number of words written in all conditions in the present study did not significantly differ before and after intervention. Some previous studies have found that strategy-focused interventions result in an increase in the number of words written by the students (for reviews, see Graham and Harris, 2003; Graham, 2006; Harris et al., 2009; but see Harris et al., 2012; Torrance et al., 2015). The fact that text quality improvements were not dependent on students writing more words suggests that intervention effects are not readily explained simply in terms of an increase in students' motivation.

The main aim of this study was, however, to determine the relative effects of direct instruction and modeling – two instructional components that are typically combined in strategy-focused instruction. Our findings did not indicate any statistically reliable differences between the effects of these two components: modeling and direct instruction proved similarly effective in improving the quality of students' texts. The instructional content covered by these two conditions were the same. In both conditions, students were exposed to planning and drafting writing strategies associated with identifying audience needs, setting goals, generating and organizing content, and so forth. However, while in direct instruction the strategies were made explicit through mnemonics, in the modeling condition students inferred writing strategies from the observation of a model. Therefore, students in the modeling condition used these strategies but did not label them at any time. This is, to our knowledge, the first study to directly compare these forms of instruction. Previous studies have found that direct instruction, in the absence of modeling, can be effective in developing writing skills (Sawyer et al., 1992) albeit in struggling writers rather than the full-range classes that were the focus of the present study. Fidalgo et al. (2015) found that modeling without direct instruction can be effective in developing writing skills in six graders' typically developing students. Our finding confirms that, for typically developing writers, both approaches, when applied in isolation, are effective. Note, however, that it is possible that if modeling had not been separated from other critical activities such as evaluation or elaboration (Braaksma et al., 2001), students in this condition could have outperformed students in direct instruction condition. This is what Sonnenschein and Whitehurst (1984) showed in their study, in which preschool students in observation plus evaluation condition performed better than their peers in the only observation condition. These results are consistent with findings reported by Fidalgo et al. (2011, 2015), in which modeling including self-reflection showed to be sufficient to improve writing skills in normally achieving upper primary students. However, we explicitly decided to focus only on modeling, removing the reflection component, to avoid

the possible interference of the whole-class reflection and to guarantee that we test what students learned from their own observations and not from the others' reflections. Crucially, however, our results showed that, at least in the present context, even without direct instruction or any formal reflection by the students, they still learned as well from modeling as they did from direct instruction.

The collaborative and individual writing tasks showed similar patterns of results regarding text quality. Students in both experimental conditions improved their texts when writing collaboratively as well as when they wrote individually, which was not previously practized. The only difference found between the two tasks was related to the use of sophisticated coherence devices. In the individual task students in the direct instruction condition showed a larger increase compared to their peers in the control group. On the other hand, in the collaborative task both experimental conditions showed improvements on more sophisticated coherence devices compared to the control group and these were also significantly greater in the direct instruction compared to the modeling group. However, this specific text-based indicator did not have any impact on global text quality measures, which did not reflect any significant difference between collaborative or individual tasks. Research comparing collaborative and individual writing has found evidence of a positive effect of collaboration on task performance, which supports the use of collaborative writing tasks (Sutherland and Topping, 1999; Yarrow and Topping, 2001; Storch and Wigglesworth, 2007; Wigglesworth and Storch, 2009). These studies found that the quality of children's collaborative writing was significantly higher than that of their individual writing. However, in the present study we did not find any difference between collaborative and individual task. It may be the case that the quality of the feedback given to the writers by the helpers was poor due to the complexity of the strategies taught, the duration of the intervention, the fact that only one component was taught in each condition and the short period of time devoted to practize collaborative writing. For example, for helpers in the modeling condition giving high-quality feedback might be especially complicated, given that they should remember the model process to guide their partner (*"I remember that the model first thought in the audience and then tried to find reasons to convince them")* instead of recalling a mnemonic representing planning or drafting steps, as it was the case of helpers in direct instruction condition (*"Before R-reasons, we need to think in A-audience"*). Also, although the pair work was clearly established, previous research on pairs work has documented differences among the way in which learners participated in writing together (e.g., Schultz, 1997; Storch, 2001), which might have an effect on the quality of the final outcome. Therefore, future research is needed to explore the quality of the feedback provided and the kind of relations established between students. A detailed analysis of the pair transcripts recorded during the writing activity may provide interesting information about these issues.

Additionally, the analyses of the students' role during emulative practice in the experimental conditions did not show significant results. Thus, students playing "writer" or "helper" roles in collaborative practice seemed to benefit equally in both intervention conditions. This suggests that engagement with the instructional content – whether delivered directly or by modeling – is similar either if the student responds by producing a text or by coaching another student.

The failure to find a difference in the efficacy of the Modeling and Direct Instruction approaches appeared to be true across the range of student ability. It was not the case that for weak students, or for strong students, one intervention proved more effective than the other. This result is not in line with previous studies, in which stronger students, not sampled by Sawyer et al. (1992), may particularly benefit from modeling (Groenendijk et al., 2013). One possible explanation for the lack of differences in the present study might be because we did not include the data of struggling writers in the analysis or, actually, there were not many abilities differences between students. Additionally, this was not helped by the floor effects and low variability in students' initial writing achievement found at pre-test in our study. In subsequent studies, measures with larger range scales should be considered.

We want to quality our overall conclusion – that teaching writing strategies by modeling and by direct instruction are equally effective – in two ways.

First is possible that the positive effects of both interventions might have resulted just from an increase in student motivation. This is plausible but, as we noted above, we did not find reliable increases in the quantity of text produced by students at post-test, which would be the most likely effect of an increase in motivation. It did appear that the students produced better quality text because they had developed an understanding of text features and text production strategies that improved the quality of their written expression.

The failure to find a difference between the Modeling and Direct Instruction conditions might, however, also have a motivational explanation. It is possible, for example, that direct instruction was better at helping students to understand and remember the writing strategies but modeling was better at motivating them. Again this is plausible but, we believe, unlikely. Motivational features were quite well-controlled in across both conditions: both were delivered by the same instructor and we do not have any reason to believe that the content or delivery of either of the two interventions was intrinsically more motivating. Both conditions were novel and both included activities that, anecdotally, students enjoyed. In fact, both conditions included teaching aimed to promote students' motivation, although there is no way of knowing whether or not these motivational components were equally effective. Again, if the two conditions different in their motivational effects then we would expect to find differences across conditions in the amount that students wrote, and this was not that case, we would expect to find differential.

Second our research does not rule out the possibility that the effects of modeling and direct instruction condition are temporary, or that one of the interventions had more persistent effects than the other.

Finally, in the present study we randomly allocated intact classes, rather than students, to conditions. Random allocation of children to condition is sometimes see as a gold standard. However we do not believe that this is the case for research of

the kind that we report here. If you put a random collection of students together and then teach them as a group, and particularly if you then make them work collaboratively as we did in the present study, you risk both substantially disrupting students' ability to learn and generating findings that do not generalize to the whole-class situation in which teachers will need to apply the intervention. Students placed in a new group will devote attention to making friends, getting comfortable with their new classmates and possibly classroom, and so forth rather than to intervention content That is, some of the whole-class effects that we get if you do not randomly allocate are effects that you actually what to be there. If you randomly allocate student to condition and then teach whole classes, you will still get class-level effects, but these are effects – differential performance across classes as a result of unpredictable new group dynamics – are likely to reduce the benefit they get from the intervention and the generalizability of our findings.

In summary, our findings suggest that, for typically developing upper primary students, both modeling and direct instruction are effective to improve writing skills and result in significantly better quality argumentative texts, even after a short instructional period.

ETHICS STATEMENT

The present study involved students, in all conditions, engaging in normal classroom activities and collection on normal performance data (i.e., nothing that would not happen normally during a school day). Unlike systems in, for example, the US, Spanish national guidelines and guidelines at University of León where the research was based, do not require that research of this kind go before an ethics panel. They require that the researcher commits to conduct research under the Code of Ethics of the World Medical Association (Declaration of Helsinki) (Williams, 2008). Plans for the present research were scrutinized and accepted both by the Spanish national research committee of Educational Sciences Area and the University of León Vice-Rector for research. They were discussed in detail with, and approved by, the schools in which the research was conducted. Additionally, parents were informed of research aims via letters in which they gave written informed consent. They were given the opportunity to express concerns and to request that their children's data not be included in the study.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the design of the work, analysis and data interpretation, drafting and revising it critically and approved it for publication.

FUNDING

The first author has benefited from a research grant (FPU 13/06428) awarded by the Ministerio de Educación, Cultura y Deporte de España (Spanish Ministry of Education, Culture and Sport). Also, this research was funded by Ministerio de Economía y Competitividad de España (Spanish Ministry of Economy and Competitiveness) grant EDU2015-67484-P awarded to the fourth author.

ACKNOWLEDGMENT

We would like to thank staff and students at the Sagrado Corazón de Jesús-Jesuitas de León School for their assistance in completing this study.

REFERENCES

Alexander, P. A., Graham, S., and Harris, K. R. (1998). A perspective on strategy research: progress and prospects. *Educ. Psychol. Rev.* 10, 129–154. doi: 10.1023/A:1022185502996

Bereiter, C., and Scardamalia, M. (1987). *The Psychology of Written Composition*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Berninger, V. W. (ed.). (2012). *Past, Present, and Future Contributions of Cognitive Writing Research to Cognitive Psychology*. New York, NY: Psychology Press.

Braaksma, M. A. H., Rijlaarsdam, G., and Van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. *J. Educ. Psychol.* 94, 405–415. doi: 10.1037/0022-0663.94.2.405

Braaksma, M. A. H., Van den Bergh, H., Rijlaarsdam, G., and Couzijn, M. (2001). Effective learning activities in observation tasks when learning to write and read argumentative texts. *Eur. J. Psychol. Educ.* 16, 33–48. doi: 10.1007/BF03172993

Brunstein, J. C., and Glaser, C. (2011). Testing path-analytic mediation model of how self-regulated writing strategies improve fourth graders' composition skills: a randomized controlled trial. *J. Educ. Psychol.* 103, 922–938. doi: 10.1037/a0024622

De La Paz, S. (2007). Managing cognitive demands for writing: comparing the effects of instructional components in strategy instruction. *Read. Writ. Q.* 23, 249–266. doi: 10.1080/10573560701277609

Fayol, M. (1999). "From on-line management problems to strategies in written composition," in *The Cognitive Demands of Writing: Processing Capacity and Working Memory Effects in Text Production*, eds M. Torrance and G. Jeffery (Amsterdam: Amsterdam University Press), 13–23.

Fidalgo, R., Torrance, M., Rijlaarsdam, G., van den Bergh, H., and Álvarez, M. L. (2015). Strategy-focused writing instruction: just observing and reflecting on a model benefits 6th grade students. *Contemp. Educ. Psychol.* 41, 37–50. doi: 10.1016/j.cedpsych.2014.11.004

Fidalgo, R., Torrance, M., and Robledo, P. (2011). Comparación de dos programas de instrucción estratégica y auto-regulada para la mejora de la competencia escrita [Comparison of two self-regulated and strategic instructional programs for improving writing competence]. *Psicothema* 23, 672–680.

Flower, L., and Hayes, J. R. (1980). "The dynamics of composing: making plans and juggling constraints," in *Cognitive Processes in Writing*, eds L. W. Greeg and E. R. Steinberg (Hillsdale, NJ: Lawrence Erlbaum Associates), 31–49.

Graham, S. (2006). "Strategy instruction and the teaching of writing: a meta-analysis," in *Handbook of Writing Research*, eds C. MacArthur, S. Graham, and J. Fitzgerald (New York, NY: Guilford), 187–207.

Graham, S., and Harris, K. (2014). "Evidence-based writing practices: a meta-analysis of existing meta-analysis," in *Design Principles for Teaching Effective Writing: Theoretical and Empirical Grounded Principles*, eds E. R. Fidalgo, K. Harris, and M. Braaksma (Leiden: Brill Editions).

Graham, S., and Harris, K. R. (1989). Components analysis of cognitive strategy instruction: effects on learning disabled students' compositions and self-efficacy. *J. Educ. Psychol.* 81, 353–361. doi: 10.1037/0022-0663.81.3.353

Graham, S., and Harris, K. R. (2000). The role of self-regulation and transcription skills in writing and writing development. *Educ. Psychol.* 35, 3–12. doi: 10.1207/S15326985EP3501_2

Graham, S., and Harris, K. R. (2003). "Students with learning disabilities and the process of writing: a meta-analysis of SRSD studies," in *Handbook of Learning Disabilities*, eds H. L. Swanson, K. R. Harris, and S. Graham (New York, NY: Guilford), 323–344.

Graham, S., Harris, K. R., and Troia, G. A. (2000). Self-regulated strategy development revisited: teaching writing strategies to struggling writers. *Top. Lang. Disord.* 20, 1–14. doi: 10.1097/00011363-200020040-00003

Graham, S., McKeown, D., Kiuhara, S., and Harris, K. R. (2012). A meta-analysis of writing instruction for students in the elementary grades. *J. Educ. Psychol.* 104, 879–896. doi: 10.1037/a0029185

Graham, S., and Perin, D. (2007). A meta-analysis of writing instruction for adolescent students. *J. Educ. Psychol.* 99, 445–476. doi: 10.1037/0022-0663.99.3.445

Groenendijk, T., Janssen, T., Rijlaarsdam, G., and van den Bergh, H. (2013). The effect of observational learning on students' performance, processes, and motivation in two creative domains. *Br. J. Educ. Psychol.* 83, 3–28. doi: 10.1111/j.2044-8279.2011.02052.x

Harris, K., Graham, S., and Mason, L. (2006). Improving the writing, knowledge, and motivation of young struggling writers: effects of self-regulated strategy development with and without peer support. *Am. Educ. Res. J.* 43, 295–340. doi: 10.3102/00028312043002295

Harris, K. R., Graham, S., Brindle, M., and Sandmel, L. (2009). "Metacognition and children's writing," in *Handbook of Metacognition in Education*, eds D. J. Hacker, J. Dunlosky, and A. C. Graesser (New York, NY: Routledge), 131–153.

Harris, K. R., Graham, S., MacArthur, C. A., Reid, R., and Mason, L. H. (2011). "Self regulated learning processes and children's writing," in *Handbook of Self Regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 187–201.

Harris, K. R., Lane, K. L., Graham, S., Driscoll, S. A., Sandmel, K., Brindle, M., et al. (2012). Practice-based professional development for self-regulated strategies development in writing: a randomized controlled study. *J. Teac. Educ.* 63, 103–119. doi: 10.1177/0022487111429005

Harris, K. R., Santangelo, T., and Graham, S. (2008). Self-regulated strategy development in writing: going beyond NLEs to a more balanced approach. *Instr. Sci.* 36, 395–408. doi: 10.1007/s11251-008-9062-9

Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-based Approach*. New York, NY: Guilford Press.

Hayes, J. R. (1996). "A new framework for understanding cognition and affect in writing," in *The Science of Writing: Theories, Methods, Individual Differences, and Applications*, eds C. M. Levy and S. Ransdell (Mahwah, NJ: Lawrence Erlbaum Associates), 1–27.

Hopwood, C. J. (2007). Moderation and mediation in structural equation modelling: applications for early intervention research. *J. Early Interv.* 29, 262–272. doi: 10.1177/105381510702900305

Johnson, P. O., and Neyman, J. (1936). Tests of certain linear hypotheses and their applications to some educational problems. *Stat. Res. Mem.* 1, 57–93.

Kellogg, R. (1999). "The components of working memory in text production," in *The Cognitive Demands of Writing: Processing Capacity and Working Memory Effects in Text Production*, eds M. Torrance and G. Jeffery (Amsterdam: Amsterdam University Press), 43–62.

Kellogg, R. T. (1988). Attentional overload and writing performance: effects of rough draft and outline strategies. *J. Exp. Psychol. Learn. Mem. Cogn.* 14, 355–365. doi: 10.1037/0278-7393.14.2.355

Limpo, T., Alves, R. A., and Fidalgo, R. (2014). Children's high-level writing skills: development of planning and revising and their contribution to writing quality. *Br. J. Educ. Psychol.* 84, 177–193. doi: 10.1111/bjep.12020

McCutchen, D. (1996). A capacity theory of writing: working memory in composition. *Educ. Psychol. Rev.* 8, 299–325. doi: 10.1007/BF01464076

Merrill, M. D. (2002). First principles of instruction. *Educ. Technol. Res. Dev.* 50, 43–59. doi: 10.1007/BF02505024

Ohta, A. S. (2001). *Second Language Acquisition Processes in the Classroom: Learning Japanese*. Mahwah, NJ: Lawrence Erlbaum.

Pressley, M., and Harris, K. R. (2006). "Cognitive strategies instruction: from basic research to classroom instruction," in *Handbook of Educational Psychology,* eds P. A. Alexander and P. H. Winne (New York, NY: Macmillan), 265–286.

Quené, H., and Van den Bergh, H. (2004). On multi-level modeling of data from repeated measures designs: a tutorial. *Speech Commun.* 43, 103–121. doi: 10.1016/j.specom.2004.02.004

Quené, H., and Van den Bergh, H. (2008). Examples of mixed-effects modeling with crossed random effects and with binomial data. *J. Mem. Lang.* 59, 413–425. doi: 10.1016/j.jml.2008.02.002

Sawyer, R. J., Graham, S., and Harris, K. R. (1992). Direct teaching, strategy instruction, and strategy instruction with explicit self-regulation: effects on the composition skills and self-efficacy of students with learning disabilities. *J. Educ. Psychol.* 84, 340–352. doi: 10.1037/0022-0663.84.3.340

Schultz, K. (1997). "Do you want to be in my story?": collaborative writing in an urban elementary classroom. *J. Lit. Res.* 29, 253–288. doi: 10.1080/10862969709547958

Sonnenschein, S., and Whitehurst, G. J. (1984). Developing referential communication: a hierarchy of skills. *Child Dev.* 55, 1936–1945. doi: 10.2307/1129940

Spencer, S. L., and Fitzgerald, J. (1993). Validity and structure, coherence, and quality measures in writing. *J. Read. Behav.* 25, 209–231. doi: 10.1080/10862969309547811

Storch, N. (2001). How collaborative is pair work? ESL tertiary students composing in pairs. *Lang. Teach. Res.* 5, 29–53. doi: 10.1191/136216801666650977

Storch, N., and Wigglesworth, G. (2007). "Writing tasks: comparing individual and collaborative writing," in *Investigating Tasks in Formal Language Learning*, ed. M. P. García Mayo (London: Multilingual Matters), 157–177.

Sutherland, J. A., and Topping, K. J. (1999). Collaborative creative writing in eight year olds: comparing cross ability fixed role and same ability reciprocal role pairing. *J. Res. Read.* 22, 154–179. doi: 10.1111/1467-9817.00080

Torrance, M., Fidalgo, R., and Robledo, P. (2015). Do sixth-grade writers need process strategies? *Br. J. Educ. Psychol.* 85, 91–112. doi: 10.1111/bjep.12065

Torrance, M., and Galbraith, D. (2006). "The processing demands of writing," in *Handbook of Writing Research*, eds C. MacArthur, S. Graham, and J. Fitzgerald (New York, NY: Guilford Publications), 67–82.

Wigglesworth, G., and Storch, N. (2009). Pair versus individual writing: effects on fluency, complexity and accuracy. *Lang. Test.* 26, 445–466. doi: 10.1177/0265532209104670

Williams, J. R. (2008). Revising the declaration of Helsinki. *World Med. J.* 54, 120–125.

Yarrow, F., and Topping, K. (2001). Collaborative writing: the effects of metacognitive prompting and structured peer interaction. *Br. J. Educ. Psychol.* 71, 261–282. doi: 10.1348/000709901158514

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 López, Torrance, Rijlaarsdam and Fidalgo. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 28 June 2017
doi: 10.3389/fpsyg.2017.00895

Teaching Quality in Math Class: The Development of a Scale and the Analysis of Its Relationship with Engagement and Achievement

Jaime Leon, Elena Medina-Garrido and Juan L. Núñez*

Faculty of Educational Sciences, University of Las Palmas de Gran Canaria, Las Palmas, Spain

Math achievement and engagement declines in secondary education; therefore, educators are faced with the challenge of engaging students to avoid school failure. Within self-determination theory, we address the need to assess comprehensively student perceptions of teaching quality that predict engagement and achievement. In study one we tested, in a sample of 548 high school students, a preliminary version of a scale to assess nine factors: teaching for relevance, acknowledge negative feelings, participation encouragement, controlling language, optimal challenge, focus on the process, class structure, positive feedback, and caring. In the second study, we analyzed the scale's reliability and validity in a sample of 1555 high school students. The scale showed evidence of reliability, and with regard to criterion validity, at the classroom level, teaching quality was a predictor of behavioral engagement, and higher grades were observed in classes where students, as a whole, displayed more behavioral engagement. At the within level, behavioral engagement was associated with achievement. We not only provide a reliable and valid method to assess teaching quality, but also a method to design interventions, these could be designed based on the scale items to encourage students to persist and display more engagement on school duties, which in turn bolsters student achievement.

Keywords: teacher behavior/beliefs, mathematics, motivation, student engagement, education assessment

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
Claudio Longobardi, University of Turin, Italy
Carbonero Martín Miguel Angel, University of Valladolid, Spain

****Correspondence:***
Jaime Leon
jaime.leon@ulpgc.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *08 January 2017*
Accepted: *15 May 2017*
Published: *28 June 2017*

Citation:
Leon J, Medina-Garrido E and Núñez JL (2017) Teaching Quality in Math Class: The Development of a Scale and the Analysis of Its Relationship with Engagement and Achievement. Front. Psychol. 8:895. doi: 10.3389/fpsyg.2017.00895

INTRODUCTION

Unlock students' academic potential is a priority for many researchers and practitioners within the educational context (Hulleman et al., 2016). Academic failure has consequences not only during adolescence, when low academic performance results in feelings of failure and eventually to drop out (Valiente et al., 2014), but also in the future, as adults who did not complete their studies are more likely to have health problems and to need social services (Levpuscek et al., 2012; Blankson and Blair, 2016). Within school subjects, mathematics plays a fundamental role for its implication in other school subjects (Gaspard et al., 2015), importance in future social and labor success (Seaton et al., 2014), effects on decisions making in a changing and ambiguous society (Meder and Gigerenzer, 2014), and its relationship with the Gross Domestic Product (OECD, 2010).

Unfortunately, student math achievement and engagement declines meaningfully all the way through secondary education (Kiemer et al., 2015; Stroet et al., 2015b). Thus, educators at this developmental stage are faced with the challenge of engaging students to learn and achieve. To address this issue, researchers guided by self-determination theory (SDT; Deci and Ryan, 1985, 2000), a broad framework for the study and explanation of human motivation and personality (Liu et al., 2016b), have shown evidence of the role played by the teaching quality (for an overview see: Ryan and Deci, 2009; Núñez and León, 2015). However, knowledge in defining the precise components that lead to an optimal functioning is lacking. Therefore, identification of the key teacher behaviors that raise student performance is a priority (Stroet et al., 2013, 2015a; Hagger and Hardcastle, 2014; Hagger and Chatzisarantis, 2015).

In this article, we begin by describing teaching quality and some of its related concepts. Then, we review researchers' proposals of teaching quality dimensions within SDT. Next, we discuss the benefits of following SDT tenets in the classroom, as well as how engagement might mediate the relationship between teaching quality and academic achievement.

LITERATURE REVIEW

Teaching Quality

For the past 40 years, researchers using several frameworks have focused on the characteristics and practices of teachers who appear to be successful in their teaching (Kunter et al., 2013; Wagner et al., 2013). Unfortunately, researchers often use different terms for similar constructs and the same term for different ideas (Marsh et al., 2003; Seaton et al., 2014). For instance, we can use a number of terms to talk about classroom processes related with students learning: *Teaching quality* (Allen et al., 2011; Fauth et al., 2014), *quality of teaching* (Hattie, 2009) *teaching effectiveness* (Marsh and Roche, 1997; Seidel and Shavelson, 2007), *instructional quality* (Lipowsky et al., 2009; Rjosk et al., 2014), *teaching style* (Cai et al., 2002; Wentzel, 2002), and *instructional style* (Jang et al., 2010). Moreover, because teachers' instructional practices refer to variables within the class level (Wagner et al., 2013), other terms used in the literature are *classroom quality* (Hamre et al., 2014), *classroom environment* (Day et al., 2015; McLean and Connor, 2015), and *classroom management* (Arens et al., 2015).

Within SDT, by "teaching quality" we refer to the specific teacher behaviors that supports the student needs of autonomy (feelings of self-determination and not being controlled), competence (feeling efficient and confident in the interactions with the social context), and relatedness (feeling connected and backed up by important others). Several authors have explored the different dimensions of teaching quality (See Ten Cate et al., 2011; Stroet et al., 2013; Liu et al., 2016a). In **Table 1** we present a summary of different dimension. In the next sections, we explained them in greater detail.

Autonomy Support

Autonomy is the feeling of performing an activity self-determined, that is, from the highest level of reflection, or to put in other words, emanating from our self, without external pressures, and feelings of being the origin, agent, and cause of beginning and maintaining an activity (Stefanou et al., 2004; Domínguez et al., 2010). At school, students feel autonomous when they believe that school actions are not just an obligation but rather a mean to serve their interests (Wang and Eccles, 2013). When students feel forced to comply with school requirements, they feel controlled and not autonomous. Of course, at school, there are many situations and activities that make students feel controlled and not autonomous, but it is important to remark that this is not an "all or nothing" feeling, and it is in teachers' hands to use different strategies to foster student autonomy.

In this sense, there are different teacher behaviors to support student autonomy in class: (A) *Provide meaningful and explanatory rationales.* Teachers ought to clarify why class contents and activities are important or useful (Guay et al., 2013; Stroet et al., 2013; Núñez et al., 2015). Explaining why schoolwork is important and relevant helps students to understand how it is in their interest (Assor et al., 2002). Specific teacher behaviors would be to start a lesson by explaining how students might apply class contents in real life or in other subjects, or by explaining how a specific class activity would help them. (B) *Nurture inner motivational resources:* Teachers could foster student autonomy by reinforcing student interests and developing student curiosity (Stroet et al., 2013; Reeve et al., 2014; Turner et al., 2014; Cheon and Reeve, 2015). A specific teacher behavior might be to explain class contents or frame class activities using interesting and up-to-date examples, or by asking curiosity-inducing questions. (C) *Offer meaningful choices:* Teachers could diminish student feelings of coercion by providing different options, allowing students to choose something closer to their interests (Núñez et al., 2012; Stroet et al., 2013; Vansteenkiste and Ryan, 2013). A specific teacher behavior could be to offer students the possibility to choose what exercises to do in an exam or to let them pick the topic in a class project. (D) A*cknowledge negative feelings:* To make students feel less coerced and controlled, teachers could pay attention and understand negative emotions that arise in class. For example, to consider the sadness, worry, or irritation that a student might feel when dealing with an exam or an activity that the student does not know how to solve (Assor et al., 2002; Taylor and Ntoumanis, 2007; Su and Reeve, 2010; Vansteenkiste et al., 2012). A specific teacher behavior could be to approach a student that is sobbing when doing an exam, and explain that it is common to feel anguish, but you know he or she is a hard worker. (E) *Participation encouragement:* Teachers should try to make students feel part of the class by requesting their opinions or encouraging them to participate in the learning process (Chatzisarantis et al., 2007; Roth et al., 2007; Gillet et al., 2011, 2012; Thapa et al., 2013). A specific teacher behavior might be to ask for the students' opinions about a new topic or welcome student points of view. (F) *Non-controlling language:* Teachers ought to talk to students in a soft, informational tone using

TABLE 1 | Teaching quality dimensions and examples.

Dimension	Example
(A) Provide meaningful and explanatory rationales	Start a lesson by explaining how students might apply class contents in real life
(B) Nurture inner motivational resources	Use interesting and up-to-date examples
(C) Offer meaningful choices	Let students pick the topic in a class project
(D) Acknowledge negative feelings	Consider the anxiety that a student might feel when dealing with class activities
(E) Participation encouragement	Ask for the students' opinions about a new topic
(F) Non-controlling language	Talk to students in a soft, informational tone using non-directive language
(G) Optimal challenge	Assign different class activities according to the students' levels
(H) Focus on the process	Not only value the result, when revising student class activities
(I) Step-by-step instructions	Provide clear instructions and goals
(J) Class preparation	Spend time on activities and explanations before the class
(K) Positive feedback	Provide specific information about what is correct and what could be improve
(L) Caring	Pay attention to students' feelings

non-directive language and inviting forms instead of controlling forms (*you could* versus *you must*), and trying to focus on the didactics rather than on external pressures (Deci et al., 1989; Simons et al., 2005; Hagger et al., 2015).

Competence Support

Competence is the feeling of accomplishment and effectance when interacting with the environment (Ng et al., 2011) or, to put it another way, to know what it means and what it takes to be successful (Wang and Eccles, 2013). Children feel competent at school when they feel capable of achieving learning activities. Therefore, to foster student competence, teachers need to create structured, predictable, contingent, and consistent classrooms (Tessier et al., 2010).

More specifically, teachers need to provide: (A) *Optimal challenge*. Teachers must take into account the student's level when assigning activities, so students can develop and exercise their capacities (Ryan and Powelson, 1991; Cheon and Reeve, 2015). A specific teacher behavior would be to assign different class activities according to the students' levels. (B) *Focus on the process:* Teachers need to stress the importance of learning over to solving activities properly without internalizing its meaning and utility (Legault et al., 2006; Tessier et al., 2010; Kusurkar et al., 2011). A specific teacher behavior would be to take into account all of the procedure to solve a problem, and not only value the result, when revising student class activities or exams. Another teacher behavior would be to stress the importance of learning over exam results. (D) *Step-by-step instructions:* Teachers will provide clear goals and step-by-step instruction when assigning class activities; thus, students could know how to satisfy teacher expectations and achieve the selected academic outcomes (Skinner and Belmont, 1993; Jang et al., 2010; Vansteenkiste et al., 2012; Hospel and Galand, 2016). (D) C*lass preparation*: It is important for teachers to prepare the class well, explain precisely and clearly the class contents, use a good pedagogy during class, and structure the class session to avoid chaos and keep students, as much as possible, on task (Skinner and Belmont, 1993; Legault et al., 2006; Jang et al., 2010; de Naeghel et al., 2014). (E) *Positive feedback*: Guiding students to the desired goals and outcomes is a key teacher behavior optimally delivered using feedback (Thurlings et al., 2013; Hospel and Galand, 2016). According to Hattie and Timperley (2007), there are four different kinds of feedback, and not all are equally effective: *Feedback about the task* (FT), used to provide information about right or wrong answers or other specific issues; *feedback about the processing of the task* (FP), used to provide information about what strategies can be used to acquire a deeper learning; *feedback about self-regulation* (FR), used to provide information about student self-confidence or effort regulation; and *feedback about the student as a person* (FS), which includes praising a characteristic at the self and global level (e.g., "good boy"). This last kind of feedback is the least effective. The more specific the feedback is, the more powerful it is. Whereas FR and FP are useful to encourage a deep process and learning of the task, FT is powerful when the information provided leads to better strategies or bolsters self-regulation.

Relatedness Support

Relatedness is the need to build and maintain positive, meaningful, and lasting relationships (Baumeister and Leary, 1995). Students who feel related with their teacher, feel close, accepted, and backed up by their teacher (León and Liew, 2017). Teachers can foster student relatedness by demonstrating their trust and interest, by being available to them, or by paying attention to their feelings (Stroet et al., 2013). Students who do not feel related to teachers often disengage from class activities (Zee et al., 2013). Yet, when students feel close to and backed up by their teacher, it encourages them to think and learn (Baroody et al., 2014). Students who are more connected to teachers demonstrate positive trajectories of development in academic domains (Hamre and Pianta, 2010). If people are in an environment where they feel cared for and important, it increases the likelihood for the experience of learning out of pleasure and interest (Dietrich et al., 2015).

To sum up, many researchers have addressed the effects of teacher behavior following SDT tenets. However, they have focused not on a global approach but on specific items of each factor: autonomy support, competence support or relatedness support (Stroet et al., 2013). Some authors have focused on an observational basis, while others on self-repot. Observational studies within SDT have not predict strongly (or even not predicted) student academic functioning (Stroet et al., 2013, 2015b). Therefore, and bearing in mind that scales with specific items designed for students to evaluate teaching quality has shown evidence of reliability and validity (Bill and Melinda Gates

Foundation, 2012; Wallace et al., 2016), in this study, we aim to develop a scale to assess student perceptions of the precise teacher behaviors that influence student performance.

Behavioral Engagement as a Mediator between Teaching Quality and Math Performance

As mentioned previously, math performance has large implications on students' lives (e.g., job opportunities, decision making, and self-esteem). To optimize student performance, researchers have explored the effect of teaching quality on student performance (Hattie, 2009). For instance, Riconscente (2014), in a year-long study with a sample of 9th- and 10th-grade students, observed that the students' perception of teachers' emphasis on class content interest, relevance, clarity, and caring predicted unique variance in student grades after accounting for demographics variables.

Nonetheless, research analyzing the mechanism by which teacher classroom behaviors affect student performance is still scarce (Ruzek et al., 2014). Therefore, we aim to shed some light on this topic. Skinner et al. (2009) propose that teacher behaviors affect student performance via motivation and engagement. In line with this proposition, Morin et al. (2014) differentiated between effects at both the class and individual level and concluded that students from 4th to 6th grade who perceived their classroom as challenging and their teacher as focused on mastery goals and interested in them, felt more competent, and this, in turn, bolstered their math achievement.

Many variables fall under the umbrella of motivation and engagement (Eccles, 2016); however, an indicator of behavioral engagement (BE) and a predictor of math achievement is effort regulation or effortful persistence, which can be understood as the perceptions of how much investment in time, energy, and work is dedicated to a task or a goal (Liew et al., 2011b). In another words, it is the students' ability to exert effort and to persevere even when doing so is not easy or entertaining (Pintrich and de Groot, 1990). Depending on the theoretical framework, researchers have labeled this construct differently. One approach is the volitional framework (Corno and Kanfer, 1993; Corno, 2004). Experts under this framework would agree to explain it as the tendency to focus attention and direct effort toward goals despite distractions inside and outside schools (Chen, 2002; Pintrich, 2004). From a temperament perspective (Rothbart et al., 2003), the construct of "effortful control" refers to the capacity to regulate behavior and attention willingly (Liew et al., 2011a). Another similar construct is self-control or "grit," the ability to consciously suppress prepotent responses in the service of a higher goal (Duckworth and Seligman, 2005; Duckworth and Steinberg, 2015). From a self-regulated learning perspective (Zimmerman, 2013), effort regulation can be defined as the student's process to manage his or her behavior to achieve a goal; thus, self-regulated students are those who display appropriate levels of effort and persistence to attain their learning goals (Zimmerman, 1990; Zimmerman and Kitsantas, 2014). To sum up, we understand effort regulation as an indicator of engagement, which imply to keep on with school activities even if they are dull or uninteresting.

THE PURPOSE, RESEARCH QUESTION, AND HYPOTHESES OF THE STUDY

Within SDT research, much remains unknown about the specific and concrete teacher behaviors that foster student academic functioning (Stroet et al., 2013, 2015a; Hagger and Hardcastle, 2014; Hagger and Chatzisarantis, 2015). Therefore, our research question was: can we predict math achievement and engagement via teacher behaviors (teaching quality) asking students?

To answer this question, we depart from two ideas: (1) the individual student's perception about their teacher behaviors might not be a precise indicator, however, if all students in one class perceive their teacher similarly, the average students perception might be a more precise indicator of their teacher behaviors; (2) according to Morin et al. (2014), student responses will vary because of individual perceptions (variance within classes), and because of shared perceptions among students in the same class (variance between classes). Therefore, our first goal was to develop and examine the psychometric properties of a scale for students to evaluate teacher behaviors according to the following dimensions: autonomy support, competence support and relatedness support. Specifically, we hypothesized that the scale would show a sound and robust multidimensional latent structure (Hypothesis 1a), the subscales would be positively associated with each other (Hypothesis 1b), and a significant amount of variance would be due to the group-level (Hypothesis 1c).

Our second goal was to test if the scale predicts student engagement and achievement. Drawing on the model of Skinner et al. (2009) and previous studies analyzing the effect of teaching quality on student engagement or motivation (e.g., Fauth et al., 2014; Morin et al., 2014; Longobardi et al., 2016), and the effect of the latter on achievement (Wang et al., 2015), it might be that in classes where the teacher provide meaningful and explanatory rationales, nurture inner motivational resources, offer meaningful choices, acknowledge negative feelings, encourage participation encouragement, use a non-controlling language, provide optimal challenge and step-by-step instructions, focus on the process, prepare the class, provide positive feedback and care about students, they would be more engaged in class, and are more persistent when dealing with school duties. Specifically, we predicted that at the class level, teaching quality would predict student effort regulation (Hypothesis 2a), and in classes where the students, as a whole, are more persistent on class activities, the average grade would be higher (Hypothesis 2b). Last, we predicted, at the individual level, students who persist and make more effort on school activities would achieve higher (Hypothesis 2c).

STUDY 1

Study 1 Method

Participants

Participants were 548 compulsory secondary students (52% males) with a mean age of 14.247 years ($SD = 1.123$). The

students were grouped in 24 classrooms, with a mean number per class of 22.37 (minimum = 14; maximum = 30, $SD = 3.70$). Students were in grades 2 to 4 of secondary education, equivalent to 8th to 10th grade in the United States system (grade 8, $n = 262$, $M_{age} = 13.48$; grade 9, $n = 124$, $M_{age} = 14.38$; grade 10, $n = 157$, $M_{age} = 15.43$). The studied schools comprised a mix of urban and outlying rural public schools with students predominantly from middle-class families. Students attend 4 h of math lessons per week during the academic year. Students had time enough to know their teacher's behavior in class, because the academic year had started 6 months before the assessment.

Procedure

Students provided informed consent to take part, and participation was strictly voluntary and confidential. Less than 1% declined to take part in the evaluation process. During the data collection, researchers administered the initial pool of items to all students in the classroom during March 2015, and provided them with instructions and clarifications if needed to complete the measures.

Measure

Building upon the SDT framework and previous scales designed to assess teaching quality, a group of research experts on SDT and math teachers designed a pool of 83 items (rated on a 7-point scale, 1 = *strongly disagree* to 7 = *strongly agree*) to cover specific and concrete teacher behaviors. Specifically, items were considered in relation to the following factors: (A) *Meaningful rationales provision*: The teacher explains why what students are learning is important or useful. (B) *Nurture inner motivational resources*: The teacher explains using interesting and up-to-date examples. (C) *Offer meaningful choices*: The teacher offers different options to students. (D) *Acknowledge negative feelings*: The teacher understands negative emotions that arise in class. (E) *Participation encouragement*: The teacher pushes students to take part in class. (F) *Controlling language*: The teacher talks to students using rigid and directive language. (G) *Optimal challenge*: The teacher takes into account the student's level when assigning activities. (H) *Focus on the process*: The teacher stresses the importance of classwork and learning over marks. (I) *Step-by-step instructions*: The teacher explains precisely and systematically how to proceed with class activities. (J) *Classes preparation*: The teacher prepares and structures the classes well. (K) *Quick feedback*: The teacher provides feedback short after the behavior. (L) *Self-regulation feedback*: The teacher provides feedback about student self-confidence or effort. (M) *Specific feedback*: The teacher provides concrete and specific feedback. (N) *Caring*: the teacher looks after and pays attention to the students.

Study 1 Results

To examine the factor structure, we performed a single-level confirmatory factor analysis (CFA) instead of a multilevel factor analysis because there were too many items for the number of classrooms and students to find a proper solution. Because all variables were ordered categorically, we used the Mean- and Variance-adjusted Weighted Least-Squares estimation method. The initial CFA with all items showed correlations higher than one between *Self-Regulation Feedback* and *Speed Feedback* ($r = 1.055$) and between *Providing Meaningful Rationales* and *Offering Choices* ($r = 1.027$), which might be an indicator of misfit. Therefore, to purify the scale (Hair et al., 2010, p. 666), we relied on information from parallel analysis (Horn, 1965; Hayton et al., 2004), exploratory structural equation modeling (ESEM; Asparouhov and Muthén, 2009), and Bayesian structural equation modeling (BSEM; Muthén and Asparouhov, 2012). As recommended by Asparouhov et al. (2015), to generate ideas about model modifications, first we accomplished a BSEM (cross-loadings priors with a distribution of mean 0 and variance 0.01). Next, we ran an ESEM with all of the items; however, the information provided was quite fuzzy, and we decided to divide the scale and analyze the data, exploring items in close factors based on the BSEM results and theoretical meanings.

We started by running a parallel analysis with the items from the factors: Meaningful Rationales Provision, Nurture Inner Motivational Resources, and Offer Meaningful Choices, concluding that a one-factor solution seemed adequate. This new factor assesses teacher emphasis on relevance, utility, and interests of class contents. Next, we removed items because of low loading values and for theoretical and practical reasons.

Concerning items from the factors: Optimal Challenge, Acknowledge Negative Feelings, Control Language, Provide Optimal Challenge, and Caring, we followed a similar procedure as described previously. We accomplished a parallel analysis, and observed that a five-factor solution was not the best, but there was not much difference in comparison with a lower number of factors. We decided to test a five-factor multilevel CFA and observed that the five-factor model showed an adequate fit: $\chi^2(547, 1034) = 3026.221$ ($p = 0.00$), RMSEA = 0.059, $SRMR_{within} = 0.056$, $SRMR_{between} = 0.129$, CFI = 0.962, and TLI = 0.958. Thus, we opted for this five-factor option; next, we removed items because of low loading values and for theoretical and practical reasons.

Finally, we ran a parallel analysis with items from the following factors: Focus on the Process, Class Preparation, Step-By-Step Instruction, and all Feedback items. We observed that three factors seem a good statistical and theoretical solution, and that items from Step-By-Step Instruction and Class tended to load on the same factor, something understandable, as both assess the teacher structure in the classroom. The next step was to remove items from this factor because of low loadings values and for theoretical and practical reasons.

Once we had the final 53 items and 9 factors, we ran a multilevel CFA (MCFA); the χ^2 value and fit indexes were $\chi^2(547, 2578) = 4583.151$ ($p = 0.00$), RMSEA = 0.038, $SRMR_{within} = 0.052$, $SRMR_{between} = 0.121$, CFI = 0.980, and TLI = 0.979. Loadings at the individual level ranged from 0.431 to 0.798. With regard to correlations, at the within level, they ranged from 0.846 (Caring with Positive Feedback) to 0.261 (Controlling Language with Focus on the Process), and at the classroom level, they ranged from 1 (Optimal Challenge with Teaching for Relevance) to 0.755 (Controlling Language with Teaching for Relevance).

To examine reliability, instead of Cronbach's alpha, we used McDonald's Omega (McDonald, 1999) because the former requires factor loadings to be equal for all items (McNeish, 2017) and data to be continuous (Elosua and Zumbo, 2008). Further, McDonald's Omega has shown evidence of better accuracy compared with Cronbach's alpha (Revelle and Zinbarg, 2009). McDonalds' values should be interpreted in a similar fashion as Cronbach's alpha is: values above 0.70 to 0.80 are indicators of reliability. **Table 2** shows that McDonald's Omega varied from 0.650 (Focus on the Process) to 0.893 (Positive Feedback).

To examine the average agreement between students, or the proportion of the total variance at the group level, we estimated intraclass correlation (ICC1). Values close to 1 indicate that all of the variance is due to the class, whereas values close to 0, indicate that the variability is due to the subjects and not to the group. ICC1 varied between 0.415 for Acknowledge negative feelings and 0.013 for Focus on the Process (**Table 2**). Finally, to test the reliability as a group construct, we estimated ICC2. Values close to one are evidence that students in the same classroom share the same feelings or thoughts, whereas values close to one indicate that the construct assessed is independent among students (Morin et al., 2014). ICC2 varied from 0.942 (Acknowledge Negative Feelings) to 0.225 (Focus on the process).

Study 1 Discussion

The first aim of the study was to develop, purify, and examine the psychometric properties of a scale to teacher behaviors according to SDT tenets asking students. We hypothesized that the scale would show a sound and robust multidimensional latent structure, the subscales would be positively associated with each other, and a significant amount of variance would be due to group-level variance.

We developed a pool of 83 items designed to assess 14 factors. After a purifying process, we had a 53 items and 9 factor scale. The factors are teaching for relevance, acknowledge negative feelings, participation encouragement, controlling language, optimal challenge, focus on the process, class structure, positive feedback, and caring. The reduction from 14 to 9 factors was achieved because items designed to measure different feedback factors were merged in one factor. Similarly, the factors meaningful rationales provision, nurture inner motivational resources, and offer meaningful choices, were merged in a unique factor called teaching for relevance. Likewise, items from step-by-step instruction and class preparation were merged into one factor. These results are in line with previous research (Assor et al., 2002; Wang and Eccles, 2013), suggesting that students feel autonomous when they do not feel coerced. Thus, if teachers offer different options but none satisfy their interests or are not useful for students, they would still not feel autonomous. It is not just offering choices or options, but also opening up the range of meaningful possibilities to cover student interests and priorities what matters. Therefore, it seems likely that the factor to assess is teaching for relevance, meaning that the teacher relies on useful and interesting class content and activities, to provide different options to reach the majority of students. We also merged in one-factor (class structure) items designed to tap two factors: Step-by-step instruction and class preparation.

TABLE 2 | Descriptive statistics, intraclass correlation, reliability and correlations at the within and between level for all major variables.

	Variable	Items	*M*	*SD*	ICC	ICC2	ω	1	2	3	4	5	6	7	8	
1	Teaching for relevance	9	3.788	1.468	0.343	0.923	0.867		0.958	0.937	−0.711	1.000	0.976	0.841	0.927	0.946
2	Acknowledge negative feelings	6	3.622	1.562	0.415	0.942	0.818	0.649		0.953	−0.825	0.958	0.886	0.789	0.948	0.975
3	Participation encouragement	5	4.319	1.528	0.361	0.928	0.754	0.715	0.658		−0.824	0.960	0.879	0.905	0.932	0.939
4	Controlling language	5	5.473	1.416	0.294	0.905	0.739	−0.386	−0.371	−0.366		0.755	0.780	0.762	0.886	0.757
5	Optimal challenge	4	4.165	1.594	0.309	0.911	0.747	0.619	0.624	0.632	0.384		0.966	0.860	0.961	0.948
6	Focus on the process	4	4.740	1.444	0.013	0.225	0.650	0.280	0.351	0.372	0.162	0.324		0.992	0.900	0.829
7	Class structure	5	5.323	1.451	0.180	0.834	0.865	0.511	0.415	0.501	0.451	0.518	0.262		0.867	0.766
8	Positive feedback	8	4.623	1.557	0.285	0.901	0.893	0.729	0.686	0.740	0.467	0.681	0.381	0.610		0.930
9	Caring	7	3.955	1.562	0.351	0.925	0.867	0.713	0.724	0.710	0.425	0.703	0.332	0.572	0.813	

ICC, intraclass correlation; ω, McDonald's omega; Lower diagonal triangle, within level correlations; Upper diagonal triangle, between level correlations; Upper diagonal triangle, correlations at the class level.

Step-by-step instructions refer to if teacher explains activities and contents clearly, and class preparation if the teacher knows the class content and organize the class well. Thus, although we hypothesized that students would understand them as two different factors, students seem to perceive it as one factor. It might be that if teachers prepare the classes, they also prepare the activities.

With regard to the hypothesis of observing a sound and robust multidimensional latent structure, reliabilities were adequate, and results of the MCFA revealed that the data fit a nine-factor model, with strong loadings on the intended factors, and correlations between factors. At the individual level, correlations values were moderate, but at the within level, higher values were observed, which is in line with previous studies assessing teaching quality: for instance, Fauth et al. (2014) observed a correlation of 0.89 between cognitive activation and supportive climate, and Morin et al. (2014) observed a correlation of 0.92 between mastery goal structure and challenge. Fast et al. (2010) and Morin et al. (2014) posit that these high correlations might be because factors fall under a common denominator: the teaching style, so it makes sense that student perception of teacher behavior represents a higher-order factor.

We expected that a meaningful part of the variance would be due to the class level variance, and in line with previous studies assessing teacher or class behaviors (Fauth et al., 2014; Decristan et al., 2015). We observed that the scale seems to capture the group nature of a class evaluation. To sum up, these results provided support for sound psychometric properties, supporting the factorial validity of the scale. However, we need evidence that the purified scale fits the data in another sample and predicts student engagement and achievement.

STUDY 2

Study 2 Method

Participants

Participants were 1555 compulsory secondary students (51% females; mean age = 15.30 years, $SD = 1.12$) grouped in 82 classrooms from nine schools, in grades 2 to 4 of secondary education, equivalent to 8th to 10th grade in the United States system (Grade 8, $n = 588$, $M_{age} = 13.94$; Grade 9, $n = 484$, $M_{age} = 15.01$; Grade 10, $n = 483$, $M_{age} = 16.19$). The studied schools comprised a mix of urban and outlying rural public schools with students predominantly from middle-class families. Students attend to 4 h of math lessons per week during the academic year. They had time enough to know their teacher's behavior in class, because the academic year had started 6 months before the assessment.

Procedure

We followed a similar procedure as in the previous study. Students provided informed consent to participate, and partaking was strictly voluntary and confidential. Less than 1% declined to take part in the evaluation process. During the data collection, in May 2015, researchers administered the instruments to students in their classrooms and provided students with instructions and clarifications if needed to complete the measures. At the end of the school year in June, we obtained the student final course grades in mathematics from school records. To maintain anonymity, the school provided records without the name, just the class and the birthdate of each student, which we later linked with the questionnaire of each student. However, in the same class, 5 times three students were born on the same day, and 26 times two students were born on the same day; therefore, we could not match grades with questionnaires for these 67 students.

Measures

To analyze scale reliability, we computed McDonald's Omega. To estimate how much variance was due to group-level variance, we estimated ICC1. To examine the reliability of the measure as a group indicator we calculated ICC2. Finally, to test the factor structure, we ran a MCFA.

Teaching quality

We used the 53-item scale described in the previous study. The scale assesses nine factors: (A) *Teaching for relevance*: the teacher uses useful and interesting class contents and activities. (B) *Acknowledge negative feelings*: The teacher understands negative emotions arisen in class. (C) *Participation encouragement*: The teacher pushes students to take part in class, by asking questions or soliciting students' opinions. (D) *Controlling language*: The teacher talks to student in rigid and directive language. (E) *Optimal challenge*: The teacher takes into account student level when assigning activities. (F) *Focus on the process*: The teacher stresses the importance of classwork and learning over marks. (G) *Classes structure*: The teacher prepares and structures the classes and activities well. (H) *Positive feedback*: The feedback provided is quick, positive, and specific. (I) *Caring*: The teacher looks after and pays attention to students. Reliability ranged from 0.919 (Positive Feedback) to 0.804 (Focus on the Process). ICC1 ranged from 0.545 (Teaching for Relevance) to 0.342 (Focus on the Process). ICC2 ranged from 0.957 (Teaching for Relevance) to 0.905 (Focus on the Process) (**Table 3**). Finally, concerning the MCFA, the χ^2 value and fit indexes were $\chi^2(1524, 2578) = 19843.661$ ($p < 0.001$), RMSEA = 0.067, $SRMR_{within} = 0.046$, $SRMR_{between} = 0.054$, CFI = 0.966, and TLI = 0.964. All items are listed in the Supplemental Material.

Effort regulation

Student *effort regulation* was assessed using four items from the effort regulation subscale of the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1993) on a 7-point scale (1 = *strongly disagree* to 7 = *strongly agree*). Sample items included "When work is difficult, I either give up or study only the easy parts." All items on this measure have demonstrated adequate reliability ($\omega = 0.74$) in prior research (León et al., 2015) and in the present study ($\omega = 0.716$). ICC1 was 0.168, and ICC2 was 0.783. With regard to the MCFA, residual correlation between two of the four items that were worded in a similar way was allowed; the χ^2 value and fit indexes were $\chi^2(1524, 1) = 6.471$ ($p = 0.039$), RMSEA = 0.038, $SRMR_{within} = 0.010$, $SRMR_{between} = 0.013$, CFI = 0.999, and TLI = 0.994.

TABLE 3 | Descriptive statistics, intraclass correlation, reliability and correlations at the within and between level for all major variables.

	Variable	*M*	*SD*	ICC1	ICC2	ω	1	2	3	4	5	6	7	8	9	10	11
1	Teaching for relevance	4.033	1.683	0.545	0.957	0.889		0.946	0.960	−0.495	0.931	0.917	0.874	0.944	0.852	0.409	0.232
2	Acknowledge negative feelings	3.449	1.772	0.467	0.942	0.892	0.684		0.961	−0.531	0.966	0.965	0.809	0.964	0.911	0.443	0.284
3	Participation encouragement	4.436	1.655	0.385	0.921	0.828	0.618	0.598		−0.563	0.935	0.939	0.852	0.958	0.846	0.405	0.181
4	Controlling language	2.732	1.575	0.416	0.930	0.827	−0.147	−0.105	−0.123		−0.469	−0.518	−0.453	−0.602	−0.600	−0.335	0.015
5	Optimal challenge	4.123	1.736	0.472	0.943	0.871	0.532	0.551	0.633	−0.171		0.942	0.847	0.942	0.842	0.434	0.209
6	Focus on the process	4.447	1.732	0.342	0.905	0.804	0.470	0.468	0.544	−0.140	0.569		0.804	0.949	0.846	0.487	0.361
7	Class structure	5.181	1.668	0.400	0.926	0.908	0.519	0.436	0.566	−0.221	0.548	0.571		0.855	0.728	0.327	0.121
8	Positive feedback	4.534	1.706	0.387	0.921	0.919	0.669	0.661	0.721	−0.224	0.687	0.648	0.652		0.923	0.369	0.200
9	Caring	3.907	1.663	0.423	0.931	0.902	0.660	0.750	0.670	−0.138	0.610	0.526	0.521	0.739		0.333	0.242
10	Effort regulation	4.636	1.378	0.161	0.782	0.728	0.199	0.191	0.220	−0.119	0.288	0.209	0.264	0.285	0.294		0.481
11	Math grades	5.217	2.212	0.084	–	–	0.099	0.113	0.113	−0.091	0.257	0.199	0.158	0.183	0.167	0.467	

ICC, intraclass correlation; ω, McDonald's omega; Lower diagonal triangle: within level correlations; Upper diagonal triangle: between level correlations; Upper diagonal triangle: correlations at the class level.

Math grades

Student math performance was indexed by student final course grades in mathematics, which we obtained from the official high school records. Unlike in the United States or United Kingdom, where it is common to assess students using standardized test, in Spain we rely more on school grades assigned by teachers, because there is not such a variety of standardized tests. Teachers have to assign grades using rubrics implemented by the Government based on student knowledge, skills and work in class and at home.

These grades have real-world significance on student academic standing and progress in grade school (Thorsen and Cliffordson, 2012; Simões and Alarcão, 2014; Sánchez-Pérez et al., 2015). Actually, in Spain, students choose different tracks and even different universities based on their high school grades. Grades were coded as 1 being the lowest and 10 being the highest possible mark. Teachers give an average score based on student's skills, knowledge, and homework, as required by Spanish curriculum.

Data Analysis

Descriptive analyses and correlations between major variables, at the within and between level, were conducted. Next, we tested the second hypothesis by running a multilevel structural equation model (MSEM), where at the individual level, effort regulation predicted math performance, and at the class level teaching quality predicted math performance via effort regulation. To test if effort regulation mediated the effect of teaching quality on math performance, we added, in a nested MSEM, a direct effect from teaching quality to math performance; we can conclude that, if this direct effect is not significantly different from zero and the fit of the two-nested model is not different, effort regulation is a mediational variable. We handled missing data using the full information maximum-likelihood method with the Mean-adjusted Weighted Least-Squares estimator (Asparouhov and Muthén, 2010).

Study 2 Results

Descriptive Analysis and Correlations at the within and the between Level

Descriptive statistics (means and standard deviations) and correlation for all major variables are displayed in **Table 3**. The means varied between 2.732 (Controlling Language) and 5.217 (math grades), and standard deviations between 1.378 (Effort Regulation) and 2.212 (math grades). With regard to correlations, at the within level, they ranged from 0.687 (Optimal Challenge with Positive Feedback) to −0.091 (Controlling Language with math grades), and at the between level, they ranged from 0.965 (Acknowledge Negative Feelings and Optimal Challenge) to 0.015 (Controlling Language with math grades).

Multilevel Model

The χ^2 test and fit indexes for the MSEM $\chi^2(1504, 3170) = 23506.247$ ($p = 0.00$), RMSEA = 0.065, $SRMR_{within} = 0.052$, $SRMR_{between} = 0.087$, CFI = 0.962, and TLI = 0.961. In **Figure 1**, we can see, that, at the within level, all Teaching Quality factors loaded on a higher-order factor. Effort Regulation predicted math grades ($\beta = 0.528$; SE = 0.036; $p < 0.001$), explaining 28% of its

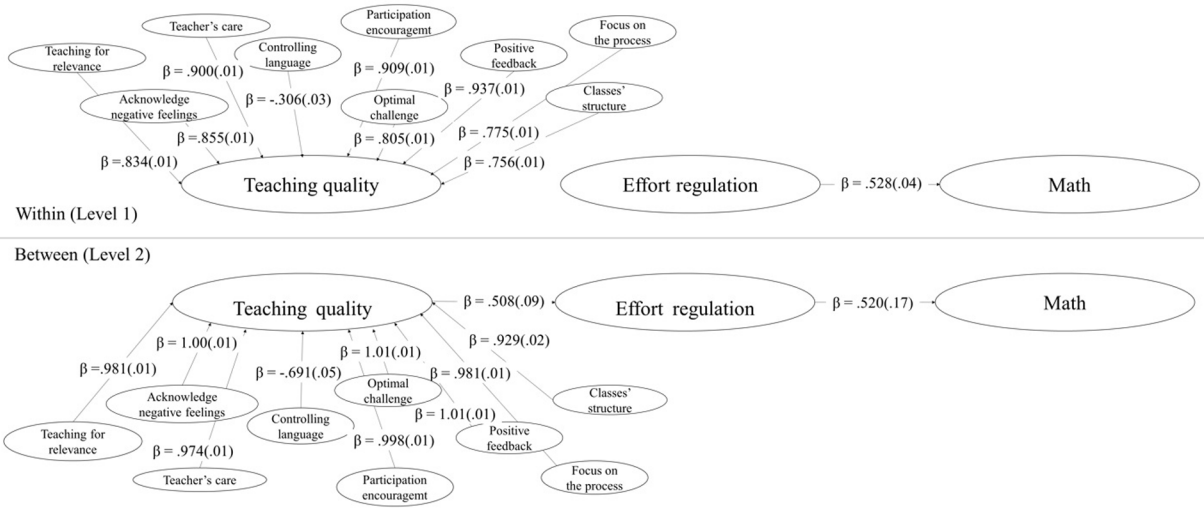


FIGURE 1 | Multilevel structural equation model. All effects are significant ($p < 0.001$). Standard errors between parentheses.

variance. Whereas at the between level, every Teaching Quality factors loaded on its factor, and Teaching Quality predicted Effort Regulation ($\beta = 0.508$; $SE = 0.097$; $p < 0.001$), and this, in terms, math grades ($\beta = 0.520$; $SE = 0.171$; $p < 0.001$); explaining 26% and 27% of its variance, respectively.

With regard to the mediational effect at the between level of Effort Regulation, in the relationship between Teaching Quality and math grades, we compared the above mentioned MSEM with a MSEM with an additional path from math grades to Teaching Quality. The χ^2 test and fit indexes for this MSEM were $\chi^2(1527, 3169) = 23549.585$ ($p = 0.00$), RMSEA = 0.065, $SRMR_{within} = 0.052$, $SRMR_{between} = 0.087$, CFI = 0.962, and TLI = 0.961. The χ^2 test (adjusting for the correction factor) comparing both models was not significant: $\Delta\chi^2(1527, 1) = 2.921$ ($p > 0.05$), and the direct effect from Teaching Quality to math grades was not different from zero ($\beta = -0.076$; $SE = 0.146$; $p = 0.66$). Therefore, we can conclude that, at the between level, Effort Regulation mediates the relationship between Teaching Quality and math achievement.

Study 2 Discussion

This study provides support for the hypotheses tested. At the between level, teaching quality was found to be a predictor of effort regulation (Hypothesis 2a): higher grades were observed in classes where students, as a whole, displayed more effort regulation (Hypothesis 2b). At the within level, students who showed more effort regulation on school activities achieved higher grades (Hypothesis 2c). Therefore, Study 2 provides more support of the scale developed to assess teaching quality.

Teaching Quality and Behavioral Engagement

With regard to Hypothesis 2a, we observed that when the students, as a whole, perceived that their teacher provided quality teaching, more BE was displayed. This in line with the model of Skinner et al. (2009), who propose that teaching quality might predict student academic functioning (e.g., motivation, engagement, and achievement). In this research, we have conceptualized "quality teaching" as when the teacher conducts lessons with useful and interesting class contents and activities (teaching for relevance); understands negative emotions that arise in class (acknowledge negative feelings); pushes students to take part in class (participation encouragement); talks to student in non-controlling and attuned language (controlling language); takes into account students' levels when assigning activities (optimal challenge); stresses the importance of classwork and learning over marks (focus on the process); prepares and structures the classes and activities well (class structure); provides feedback that is quick, positive, and specific (positive feedback); and looks after and pays attention to students (caring). It seems that specific teacher behaviors, such as calming down students when they are nervous doing an exam or bearing in mind the students' levels when assigning class activities, promote students' persistence when studying math. Effort regulation is necessary for students to achieve many school activities and to pay attention in class and perform when there are some more appealing activities to do (watching TV or playing videogames). Thus, educators who provide a quality teaching, as conceptualized in this research, are providing students with prerequisites for persisting on school activities.

Behavioral Engagement and Math Grades

In line with hypotheses 2b and 2c, the multilevel model showed that BE had predictive power for grades. At the individual level, these results, in addition to those from others researchers (Duckworth et al., 2012; Hofer et al., 2012), suggest that students get better grades if they gain the capacity to persist studying even when they find it dull or prefer to do something else. We observed similar results at the class level, where higher grades are observed in classes where the students, as a whole, display more effort regulation. Thus, we agree with Veronneau et al. (2014) that educators who want students to achieve as high as possible

should pay attention to students and try to foster effort regulation in them.

Indirect Effect of Behavioral Engagement between Teaching Quality and Math Grades

Our results indicate that effort regulation, as an indicator of BE, is one mechanism that mediates the link between teaching quality and math performance. These results are in line with the model of Skinner et al. (2009). Other researchers have also focused on the effect of teaching quality on math performance. For example, Kunter et al. (2013), assessing mainly teachers instead of students, observed that pedagogical content knowledge and teacher enthusiasm predicted math grades via the use of applied math problems and classroom disruption and discipline. Morin et al. (2014) also focused on teaching quality and math performance. They observed that self-efficacy mediated the relationship between those two variables. Our study adds to the previous studies a stronger prediction of math grades. Whereas Kunter et al. (2013) explained 13% of math achievement variance, and Morin et al. (2014) reported and effect size of 0.15, we explained 27% of the variance at the between and 28% at the within level. Moreover, in this research, we assessed multiple specific teacher behaviors, which researchers or practitioners could use to design useful interventions to promote student achievement.

GENERAL DISCUSSION

Educators face the challenge of engaging students to learn and achieve during middle and high school math lessons. Teaching quality during class have important influence on student functioning. However, within SDT, the precise teacher behaviors that lead to optimal functioning are not well defined. Therefore, in the first study, we proposed an instrument to assess specific and concrete teacher behaviors, and in the second study, we identified a mechanism by which these teacher behaviors predict math achievement.

In study 1, we developed a scale to assess teaching quality with nine factors to capture specific and concrete teacher behaviors. The developed scale provided evidence of reliability and factorial validity. However, we needed evidence that the scale fit the nine-factor structure in another sample, and that it predicts student engagement and achievement.

Study 2 builds on existing literature that underscores the importance of teaching quality as key predictors of educational attainment (Skinner et al., 2009; Fauth et al., 2014). We observed that effort regulation mediated the relationship between teaching quality and grades. It is important to highlight that it could be that the educators with a positive quality teaching might assign higher grades to students. However, as shown in the results section, the direct effect of teaching quality on math grades, controlling for effort regulation, was not different from zero because effort regulation is the linking variable between teaching quality and math achievement. To put it different, with the precaution of not making causal claims, it seems that teaching quality promotes students' effort regulation, and this, in turn, promotes math achievement. Thus, it seems as it is not that teachers with a better teaching quality assign higher grades, but, that these teachers move students to put more effort on their school activities, which, in turn, leads to higher grades.

Strengths and Limitations

Our study included a number of strengths: We conducted two separate studies to analyze scale psychometric properties, and in the second study, we included two waves of data. In the first one, we assessed teacher behavior and student effort regulation, whereas in the second, we collected math grades 1 month later.

Student ratings of teacher behavior assess the typical teacher performance along the course, and have been proposed as an accepted method to evaluate teaching methods (Wagner et al., 2013; OECD, 2014; Wallace et al., 2016). Usually, teacher observation assesses just one or more days of class behaviors, where the teacher might strive to teach as "good as possible," but we are aware that this observational information might help to grasp a bigger picture of the classroom. Therefore, future studies could gather observational information of teaching quality based on the nine factors proposed in this study.

One limitation regarding study 1 is the limited sample size. This fact, among the high correlations between different factors, precluded us of reaching convergence in the MCFA. Subsequently, we aimed to purify the scale accomplishing an ESEM, unfortunately, results were fuzzy, that is, we did not have information about the optimal number of factors nor about the relationship between items and factors. Therefore, we proceeded to a step-by-step procedure based on the BSEM results and theoretical information. Although this procedure might look arbitrary, we believe that the proposed scale has theoretical foundations and evidence of reliability and validity to warrant its use.

It is also important to stress that this research has been conducted in Spain. In this country, and other European countries, grades are of ultimate importance: students based on their academic grades choose track and, later on, University. Thus, in Spain grades is a variable of ultimate importance for student life. Researchers in other countries, such as United States or United Kingdom, could assess the impact of the scale on other variables such as the SAT, ACT or GCSE.

Finally, the effects of teaching quality on student learning can be diverse. As pointed out by Seidel and Shavelson (2007), some teacher behaviors might have short-term effects (e.g., interest and enthusiasm), whereas others might have longer effects (e.g., motives to study and study strategies). Therefore, it might be interesting to study the effect on different variables, beyond effort regulation and math grades. In a similar fashion, although the study was designed under the SDT umbrella we did not assess key variables such as autonomy, competence or relatedness, because our goal was not to predict these three psychological variables, but to predict behavioral indicators such as student BE and achievement. However, we believe that it could be interesting for future research to test the relationship between the teaching quality factors and autonomy,

competence or relatedness. Finally, we believe that it could be interesting to test the effect of school variables such as percentage of students receiving free and reduced-price meals or school climate (Konold, 2016) on teaching quality.

CONCLUSION

In this study, we aimed to shed some light in the discovery of new path to optimize students' math achievement. Therefore, we focused on a variable amenable to intervention: teaching quality. We provide a reliable and valid instrument for students to assess specific and concrete teachers' behaviors during class, which we grouped under the label teaching quality. The findings of this study have implications for practitioners and researchers. The former could use the developed scale to assess their teaching quality, while researchers could design interventions based on the scale items to promote student persistence and effort on school duties, which in turn, bolsters student achievement.

ETHICS STATEMENT

This study was carried out with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the University of Las Palmas de Gran Canaria.

AUTHOR CONTRIBUTIONS

Conception or design of the work: JL. Data collection: JL, EM-G. Data analysis and interpretation: JL, EM-G. Writing the manuscript: JL, EM-G. Edit the manuscript: JN. Final approval of the version to be published: JL, EM-G, JN.

REFERENCES

Allen, J. P., Pianta, R. C., Gregory, A., Mikami, A. Y., and Lun, J. (2011). An interaction-based approach to enhancing secondary school instruction and student achievement. *Science* 333, 1034–1037. doi: 10.1126/science.1207998

Arens, A. K., Morin, A. J. S., and Watermann, R. (2015). Relations between classroom disciplinary problems and student motivation: achievement as a potential mediator? *Learn. Instr.* 39, 184–193. doi: 10.1016/j.learninstruc.2015.07.001

Asparouhov, T., and Muthén, B. O. (2009). Exploratory structural equation modeling. *Struct. Equ. Modeling* 16, 397–438. doi: 10.1080/10705510903008204

Asparouhov, T., and Muthén, B. O. (2010). *Weighted Least Squares Estimation with Missing Data*. Available at: http://www.statmodel.com/download/GstrucMissingRevision.pdf

Asparouhov, T., Muthén, B. O., and Morin, A. J. S. (2015). Bayesian structural equation modeling with cross-loadings and residual covariances: comments on Stromeyer et al. *J. Manag.* 41, 1561–1577. doi: 10.1177/0149206315591075

Assor, A., Kaplan, H., and Roth, G. (2002). Choice is good, but relevance is excellent: autonomy-enhancing and suppressing teacher behaviours predicting students' engagement in schoolwork. *Br. J. Educ. Psychol.* 72, 261–278. doi: 10.1348/000709902158883

Baroody, A. E., Rimm-Kaufman, S. E., Larsen, R. A., and Curby, T. W. (2014). The link between responsive classroom training and student-teacher relationship quality in the fifth grade: a study of fidelity of implementation. *School Psych. Rev*. 43, 69–85.

Baumeister, R. F., and Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychol. Bull.* 117, 497–529. doi: 10.1037/0033-2909.117.3.497

Bill and Melinda Gates Foundation (2012). *Asking Students About Teaching: Student Perception Surveys and their Implementation*. Seattle, WA: Measures of Effective Teaching (MET) Project.

Blankson, A. N., and Blair, C. (2016). Cognition and classroom quality as predictors of math achievement in the kindergarten year. *Learn. Instr.* 41, 32–40. doi: 10.1016/j.learninstruc.2015.09.004

Cai, Y., Reeve, J., and Robinson, D. T. (2002). Home schooling and teaching style: comparing the motivating styles of home school and public school teachers. *J. Educ. Psychol.* 94, 372–380. doi: 10.1037//0022-0663.94.2.372

Chatzisarantis, N. L. D., Hagger, M. S., and Smith, B. (2007). Influences of perceived autonomy support on physical activity within the theory of planned behavior. *Eur. J. Soc. Psychol.* 37, 934–954. doi: 10.1002/ejsp.407

Chen, C. S. (2002). Self-regulated learning strategies and achievement in an introduction to information systems course. *Inf. Technol. Learn. Perform. J.* 20, 11–25.

Cheon, S. H., and Reeve, J. (2015). A classroom-based intervention to help teachers decrease students' amotivation. *Contemp. Educ. Psychol.* 40, 99–111. doi: 10.1016/j.cedpsych.2014.06.004

Corno, L. (2004). Introduction to the special issue work habits and work styles: volition in education. *Teach. Coll. Rec.* 106, 1669–1694. doi: 10.1111/j.1467-9620.2004.00400.x

Corno, L., and Kanfer, R. (1993). The role of volition in learning and performance. *Rev. Res. Educ.* 19, 301–341. doi: 10.3102/0091732X019001301

Day, S. L., Connor, C. M., and Mcclelland, M. M. (2015). Children' s behavioral regulation and literacy: the impact of the fi rst grade classroom environment. *J. Sch. Psychol.* 53, 409–428. doi: 10.1016/j.jsp.2015.07.004

de Naeghel, J., van Keer, H., and Vanderlinde, R. (2014). Strategies for promoting autonomous reading motivation: a multiple case study research in primary education. *Frontline Learn. Res.* 3, 83–101.

Deci, E. L., Connell, J. P., and Ryan, R. M. (1989). Self-Determination in a work organization. *J. Appl. Psychol.* 74, 580–590. doi: 10.1037//0021-9010.74.4.580

Deci, E. L., and Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York, NY: Plenum. doi: 10.1007/978-1-4899-2271-7

Deci, E. L., and Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: human needs and the self-determination of behavior. *Psychol. Inq.* 11, 227–268. doi: 10.1207/S15327965PLI1104_01

Decristan, J., Klieme, E., Kunter, M., Hochweber, J., Buttner, G., Fauth, B., et al. (2015). Embedded formative assessment and classroom process quality: how do they interact in promoting science understanding? *Am. Educ. Res. J.* 52, 1133–1159. doi: 10.3102/0002831215596412

Dietrich, J., Dicke, A.-L., Kracke, B., and Noack, P. (2015). Teacher support and its influence on students' intrinsic value and effort: dimensional comparison effects across subjects. *Learn. Instr.* 39, 45–54. doi: 10.1016/j.learninstruc.2015.05.007

Domínguez, E. G., Martín, P., Martín-Albo, J., Núñez, J. L., and León, J. (2010). Translation and validation of the Spanish version of the "Echelle de Satisfaction des Besoins Psychologiques" in the sports context. *Span. J. Psychol.* 13, 1010–1020. doi: 10.1017/S1138741600002651

Duckworth, A. L., Quinn, P. D., and Tsukayama, E. (2012). What no child left behind leaves behind: the roles of IQ and self-control in predicting standardized achievement test scores and report card grades. *J. Educ. Psychol.* 104, 439–451. doi: 10.1037/a0026280

Duckworth, A. L., and Seligman, M. E. P. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychol. Sci.* 16, 939–944. doi: 10.1111/j.1467-9280.2005.01641.x

Duckworth, A. L., and Steinberg, L. (2015). Unpacking self-control. *Child Dev. Perspect.* 9, 32–37. doi: 10.1111/cdep.12107

Eccles, J. S. (2016). Engagement: Where to next? *Learn. Instr.* 43, 71–75. doi: 10.1016/j.learninstruc.2016.02.003

Elosua, P., and Zumbo, B. D. (2008). Reliability coefficients for ordinal response scales. *Psicothema* 20, 896–901. doi: 10.1111/vde.12193

Fast, L. A., Lewis, J. L., Bryant, M. J., Bocian, K. A., Cardullo, R. A., Rettig, M., et al. (2010). Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance? *J. Educ. Psychol.* 102, 729–740. doi: 10.1037/a0018863

Fauth, B., Decristan, J., Rieser, S., Klieme, E., and Büttner, G. (2014). Student ratings of teaching quality in primary school: dimensions and prediction of student outcomes. *Learn. Instr.* 29, 1–9. doi: 10.1016/j.learninstruc.2013.07.001

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Haefner, I., Nagengast, B., et al. (2015). Fostering adolescents'value beliefs for mathematics with a relevance intervention in the classroom. *Dev. Psychol.* 51, 1226–1240. doi: 10.1037/dev0000028

Gillet, N., Berjot, S., Vallerand, R. J., and Amoura, S. (2012). The role of autonomy support and motivation in the prediction of interest and dropout intentions in sport and education settings. *Basic Appl. Soc. Psychol.* 34, 278–286. doi: 10.1080/01973533.2012.674754

Gillet, N., Vallerand, R. J., and Lafrenière, M.-A. K. (2011). Intrinsic and extrinsic school motivation as a function of age: the mediating role of autonomy support. *Soc. Psychol. Educ.* 15, 77–95. doi: 10.1007/s11218-011-9170-2

Guay, F., Ratelle, C. F., Larose, S., Vallerand, R. J., and Vitaro, F. (2013). The number of autonomy-supportive relationships: are more relationships better for motivation, perceived competence, and achievement? *Contemp. Educ. Psychol.* 38, 375–382. doi: 10.1016/j.cedpsych.2013.07.005

Hagger, M. S., and Chatzisarantis, N. L. D. (2015). The trans-contextual model of autonomous motivation in education: conceptual and empirical issues and meta-analysis. *Rev. Educ. Res.* 86, 360–407. doi: 10.3102/0034654315585005

Hagger, M. S., and Hardcastle, S. J. (2014). Interpersonal style should be included in taxonomies of behavior change techniques. *Front. Psychol.* 5:254. doi: 10.3389/fpsyg.2014.00254

Hagger, M. S., Sultan, S., Hardcastle, S. J., and Chatzisarantis, N. L. D. (2015). Perceived autonomy support and autonomous motivation toward mathematics activities in educational and out-of-school contexts is related to mathematics homework behavior and attainment. *Contemp. Educ. Psychol.* 41, 111–123. doi: 10.1016/j.cedpsych.2014.12.002

Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2010). *Multivariate Data Analysis*, 7th Edn. New York, NY: Prentice Hall.

Hamre, B. K., Hatfield, B. E., Pianta, R. C., and Jamil, F. (2014). Evidence for general and domain-specific elements of teacher-child interactions: associations with preschool children's development. *Child Dev.* 85, 1257–1274. doi: 10.1111/cdev.12184

Hamre, B. K., and Pianta, R. C. (2010). "Classroom environments and developmental processes," in *Handbook of Research on Schools, Schooling and Human Development*, eds J. L. Meece and J. S. Eccles (New York, NY: Routledge), 25–41.

Hattie, J. (2009). *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. New York, NY: Routledge.

Hattie, J., and Timperley, H. (2007). The power of feedback. *Rev. Educ. Res.* 77, 81–112. doi: 10.3102/003465430298487

Hayton, J. C., Allen, D. G., and Scarpello, V. (2004). Factor retention decisions in exploratory factor analysis: a tutorial on parallel analysis. *Organ. Res. Methods* 7, 191–205. doi: 10.1177/1094428104263675

Hofer, M., Kuhnle, C., Kilian, B., and Fries, S. (2012). Cognitive ability and personality variables as predictors of school grades and test scores in adolescents. *Learn. Instr.* 22, 368–375. doi: 10.1016/j.learninstruc.2012.02.003

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika* 30, 179–185. doi: 10.1007/BF02289447

Hospel, V., and Galand, B. (2016). Are both classroom autonomy support and structure equally important for students' engagement? A multilevel analysis. *Learn. Instr.* 41, 1–10. doi: 10.1016/j.learninstruc.2015.09.001

Hulleman, C. S., Kosovich, J. J., Barron, K. E., and Daniel, D. B. (2016). Making connections: replicating and extending the utility value intervention in the classroom. *J. Educ. Psychol.* 108, 374–391. doi: 10.1037/edu0000146

Jang, H., Reeve, J., and Deci, E. L. (2010). Engaging students in learning activities: it is not autonomy support or structure but autonomy support and structure. *J. Educ. Psychol.* 102, 588–600. doi: 10.1037/a0019682

Kiemer, K., Gröschner, A., Pehmer, A.-K., and Seidel, T. (2015). Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science. *Learn. Instr.* 35, 94–103. doi: 10.1016/j.learninstruc.2014.10.003

Konold, T. (2016). A multilevel MTMM approach to estimating the influences of contextual factors on trait and informant-based method effects in assessments of school climate. *J. Psychoeduc. Assess.* (in press). doi: 10.1177/0734282916683286

Kunter, M., Klusmann, U., Baumert, J., Richter, D., Voss, T., and Hachfeld, A. (2013). Professional competence of teachers: effects on instructional quality and student development. *J. Educ. Psychol.* 105, 805–820. doi: 10.1037/a0032583

Kusurkar, R. A., Croiset, G., and Ten Cate, T. J. (2011). Twelve tips to stimulate intrinsic motivation in students through autonomy-supportive classroom teaching derived from Self-Determination Theory. *Med. Teach.* 33, 978–982. doi: 10.3109/0142159X.2011.599896

Legault, L., Green-Demers, I., and Pelletier, L. (2006). Why do high school students lack motivation in the classroom? Toward an understanding of academic amotivation and the role of social support. *J. Educ. Psychol.* 98, 567–582. doi: 10.1037/0022-0663.98.3.567

León, J., and Liew, J. (2017). Profiles of adolescents' peer and teacher relatedness: differences in well-being and academic achievement across latent groups. *Learn Individ. Differ.* 54, 41–50. doi: 10.1016/j.lindif.2017.01.009

León, J., Núñez, J. L., and Liew, J. (2015). Self-determination and STEM education: effects of autonomy, motivation, and self-regulated learning on high school math achievement. *Learn. Individ. Diff.* 43, 156–163. doi: 10.1016/j.lindif.2015.08.017

Levpuscek, M. P., Zupancic, M., and Socan, G. (2012). Predicting achievement in mathematics in adolescent students: the role of individual and social factors. *J. Early Adolesc.* 33, 523–551. doi: 10.1177/0272431612450949

Liew, J., Johnson, A. Y., Smith, T. R., and Thoemmes, F. (2011a). Parental expressivity, child physiological and behavioral regulation, and child adjustment: testing a three-path mediation model. *Early Educ. Dev.* 22, 549–573. doi: 10.1080/10409289.2010.481551

Liew, J., Xiang, P., Johnson, A. Y., and Kwok, O. (2011b). Effortful persistence and body mass as predictors of running achievement in children and youth: a longitudinal study effortful persistence as index of self-regulatory efficacy. *J. Phys. Act. Health* 8, 234–243.

Lipowsky, F., Rakoczy, K., Pauli, C., Drollinger-Vetter, B., Klieme, E., and Reusser, K. (2009). Quality of geometry instruction and its short-term impact on students' understanding of the Pythagorean Theorem. *Learn. Instr.* 19, 527–537. doi: 10.1016/j.learninstruc.2008.11.001

Liu, W. C., Wang, J. C. K., and Ryan, R. M. (2016a). *Building Autonomous Learners*. Singapore: Springer. doi: 10.1007/978-981-287-630-0

Liu, W. C., Wang, J. C. K., and Ryan, R. M. (2016b). "Understanding motivation in education: theoretical and practical considerations," in *Building Autonomous Learners*, eds C. John, J. C. K. Wang, and R. M. Ryan (Singapore: Springer), 1–8.

Longobardi, C., Prino, L. E., Marengo, D., and Settanni, M. (2016). Student-teacher relationships as a protective factor for school adjustment during the transition from middle to high school. *Front. Psychol.* 7:1988. doi: 10.3389/fpsyg.2016.01988

Marsh, H. W., Craven, R. G., Hinkley, J. W., and Debus, R. L. (2003). Evaluation of the big-two-factor theory of academic motivation orientations: an evaluation of jingle-jangle fallacies. *Multivariate Behav. Res.* 38, 189–224. doi: 10.1207/S15327906MBR3802

Marsh, H. W., and Roche, L. A. (1997). Making students' evaluations of teaching effectiveness effective. *Am. Psychol.* 52, 1187–1197. doi: 10.1037//0003-066x.52.11.1187

McDonald, R. P. (1999). *Test Theory: A Unified Treatment*. Mahwah, NJ: Erlbaum.

McLean, L., and Connor, C. M. (2015). Depressive symptoms in third-grade teachers: relations to classroom quality and student achievement. *Child Dev.* 86, 945–954. doi: 10.1111/cdev.12344

McNeish, D. (2017). Thanks coefficient Alpha, we'll take it from here. *Psychol. Methods* (in press). doi: 10.1037/met0000144

Meder, B., and Gigerenzer, G. (2014). "Statistical thinking: no one left behind," in *Probabilistic Thinking*, eds G. Kaiser and B. Sriraman (New York, NY: Springer), 127–148.

Morin, A. J. S., Marsh, H. W., Nagengast, B., and Scalas, L. F. (2014). Double latent multilevel analyses of classroom climate: an illustration. *J. Exp. Educ.* 82, 143–167. doi: 10.1080/00220973.2013.769412

Muthén, B. O., and Asparouhov, T. (2012). Bayesian SEM: a more flexible representation of substantive theory. *Psychol. Methods* 17, 313–335. doi: 10.1037/a0026802

Ng, J. Y. Y., Lonsdale, C., and Hodge, K. (2011). The Basic Needs Satisfaction in Sport Scale (BNSSS): instrument development and initial validity evidence. *Psychol. Sport Exerc.* 12, 257–264. doi: 10.1016/j.psychsport.2010.10.006

Núñez, J. L., Fernández, C., León, J., and Grijalvo, F. (2015). The relationship between teacher's autonomy support and students' autonomy and vitality. *Teach. Teach.* 21, 191–202. doi: 10.1080/13540602.2014.928127

Núñez, J. L., and León, J. (2015). Autonomy support in the classroom: a review from the self-determination theory. *Eur. Psychol.* 20, 275–283. doi: 10.1027/1016-9040/a000234

Núñez, J. L., León, J., Grijalvo, F., and Martín-Albo, J. (2012). Measuring autonomy support in university students: the Spanish version of the learning climate questionnaire. *Span. J. Psychol.* 15, 1466–1472. doi: 10.5209/rev_SJOP.2012.v15.n3.39430

OECD (2010). *The High Cost of Low Educational Performance*. Paris: PISA, OECD Publishing.

OECD (2014). *PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science*. Paris: PISA, OECD Publishing. doi: 10.1787/9789264201118-en

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educ. Psychol. Rev.* 16, 385–407. doi: 10.1007/s10648-004-0006-x

Pintrich, P. R., and de Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *J. Educ. Psychol.* 82, 33–40. doi: 10.1037//0022-0663.82.1.33

Pintrich, P. R., Smith, D. A. F., Garcia, T., McKeachie, W. J., and García, T. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educ. Psychol. Meas.* 53, 801–813. doi: 10.1177/0013164493053003024

Reeve, J., Vansteenkiste, M., Assor, A., Ahmad, I., Cheon, S. H., Jang, H., et al. (2014). The beliefs that underlie autonomy-supportive and controlling teaching: a multinational investigation. *Motiv. Emot.* 38, 93–110. doi: 10.1007/s11031-013-9367-0

Revelle, W., and Zinbarg, R. E. (2009). Coefficients Alpha, Beta, Omega, and the glb: comments on Sijtsma. *Psychometrika* 74, 145–154. doi: 10.1007/s11336-008-9102-z

Riconscente, M. M. (2014). Effects of perceived teacher practices on latino high school students' interest, self-efficacy, and achievement in mathematics. *J. Exp. Educ.* 82, 51–73. doi: 10.1080/00220973.2013.813358

Rjosk, C., Richter, D., Hochweber, J., Lüdtke, O., Klieme, E., and Stanat, P. (2014). Socioeconomic and language minority classroom composition and individual reading achievement: the mediating role of instructional quality. *Learn. Instr.* 32, 63–72. doi: 10.1016/j.learninstruc.2014.01.007

Roth, G., Assor, A., Kanat-Maymon, Y., and Kaplan, H. (2007). Autonomous motivation for teaching: how self-determined teaching may lead to self-determined learning. *J. Educ. Psychol.* 99, 761–774. doi: 10.1037/0022-0663.99.4.761

Rothbart, M. K., Ellis, L. K., Rueda, M. R., and Posner, M. I. (2003). Developing mechanisms of temperamental effortful control. *J. Pers.* 71, 1113–1143. doi: 10.1111/1467-6494.7106009

Ruzek, E. A., Domina, T., Conley, A. M., Duncan, G. J., and Karabenick, S. A. (2014). Using value-added models to measure teacher effects on students' motivation and achievement. *J. Early Adolesc.* 35, 852–882. doi: 10.1177/0272431614525260

Ryan, R. M., and Deci, E. L. (2009). "Promoting self-determined school engagement: motivation, learning and well-being," in *The Handbook of Motivation at School*, eds K. R. Wentzel and A. Wigfield (New York, NY: Routledge), 171–196.

Ryan, R. M., and Powelson, C. L. (1991). Autonomy and relatedness as fundamental to motivation and education. *J. Exp. Educ.* 60, 49–66. doi: 10.1186/1472-6920-13-151

Sánchez-Pérez, N., Fuentes, L. J., Pina, V., López-López, J. A., and González-Salinas, C. (2015). How do different components of effortful control contribute to children's mathematics achievement? *Front. Psychol.* 6:1383. doi: 10.3389/fpsyg.2015.01383

Seaton, M., Parker, P. D., Marsh, H. W., Craven, R. G., and Yeung, A. S. (2014). The reciprocal relations between self-concept, motivation and achievement: juxtaposing academic self-concept and achievement goal orientations for mathematics success. *Educ. Psychol.* 34, 49–72. doi: 10.1080/01443410.2013.825232

Seidel, T., and Shavelson, R. J. (2007). Teaching effectiveness research in the past decade: the role of theory and research design in disentangling meta-analysis results. *Rev. Educ. Res.* 77, 454–499. doi: 10.3102/0034654307310317

Simões, F., and Alarcão, M. (2014). Mentors and teachers: testing the effectiveness of simultaneous roles on school performance from a basic psychological needs perspective. *Instr. Sci.* 42, 465–483. doi: 10.1007/s11251-013-9288-z

Simons, J., Willy, L., Soenens, B., and Ma, L. (2005). Examining the motivational impact of intrinsic versus extrinsic goal framing and autonomy-supportive versus internally controlling communication style on early adolescents â€™ academic achievement. *Child Dev.* 76, 483–501. doi: 10.1111/j.1467-8624.2005.00858.x

Skinner, E. A., and Belmont, M. J. (1993). Motivation in the classroom: reciprocal effects of teacher behavior and student engagement across the school year. *J. Educ. Psychol.* 85, 571–581. doi: 10.1037//0022-0663.85.4.571

Skinner, E. A., Kindermann, T. A., Connell, J. P., and Wellborn, J. G. (2009). "Engagement and disaffection as organizational constructs in the dynamics of motivational development," in *Handbook of Motivation in School*, eds K. R. Wentzel and A. Wigfield (Malwah, NJ: Erlbaum), 223–246.

Stefanou, C. R., Perencevich, K. C., Dicintio, M., and Turner, J. C. (2004). Supporting autonomy in the classroom: ways teachers encourage student decision making and ownership. *Educ. Psychol.* 39, 97–110. doi: 10.1207/s15326985ep3902

Stroet, K., Opdenakker, M. C., and Minnaert, A. (2013). Effects of need supportive teaching on early adolescents' motivation and engagement: a review of the literature. *Educ. Res. Rev.* 9, 65–87. doi: 10.1016/j.edurev.2012.11.003

Stroet, K., Opdenakker, M. C., and Minnaert, A. (2015a). Need supportive teaching in practice: a narrative analysis in schools with contrasting educational approaches. *Soc. Psychol. Educ.* 18, 585–613. doi: 10.1007/s11218-015-9290-1

Stroet, K., Opdenakker, M. C., and Minnaert, A. (2015b). What motivates early adolescents for school? A longitudinal analysis of associations between observed teaching and motivation. *Contemp. Educ. Psychol.* 42, 129–140. doi: 10.1016/j.cedpsych.2015.06.002

Su, Y.-L., and Reeve, J. (2010). A meta-analysis of the effectiveness of intervention programs designed to support autonomy. *Educ. Psychol. Rev.* 23, 159–188. doi: 10.1007/s10648-010-9142-7

Taylor, I. M., and Ntoumanis, N. (2007). Teacher motivational strategies and student self-determination in physical education. *J. Educ. Psychol.* 99, 747–760. doi: 10.1037/0022-0663.99.4.747

Ten Cate, T. J., Kusurkar, R. A., and Williams, G. (2011). How self-determination theory can assist our understanding of the teaching and learning processes in medical education. AMEE guide No. 59. *Med. Teach.* 33, 961–973. doi: 10.3109/0142159X.2011.595435

Tessier, D., Sarrazin, P. G., and Ntoumanis, N. (2010). The effect of an intervention to improve newly qualified teachers' interpersonal style, students motivation and psychological need satisfaction in sport-based physical education. *Contemp. Educ. Psychol.* 35, 242–253. doi: 10.1016/j.cedpsych.2010.05.005

Thapa, A., Cohen, J., Guffey, S., and Higgins-D'Alessandro, A. (2013). A review of school climate research. *Rev. Educ. Res.* 83, 357–385. doi: 10.3102/0034654313483907

Thorsen, C., and Cliffordson, C. (2012). Teachers' grade assignment and the predictive validity of criterion-referenced grades. *Educ. Res. Eval.* 18, 153–172. doi: 10.1080/13803611.2012.659929

Thurlings, M., Vermeulen, M., Bastiaens, T., and Stijnen, S. (2013). Understanding feedback: a learning theory perspective. *Educ. Res. Rev.* 9, 1–15. doi: 10.1016/j.edurev.2012.11.004

Turner, J. C., Christensen, A., Kackar-Cam, H. Z., Trucano, M., and Fulmer, S. M. (2014). Enhancing students' engagement: report of a 3-year intervention with middle school teachers. *Am. Educ. Res. J.* 51, 1195–1226. doi: 10.3102/0002831214532515

Valiente, C., Swanson, J., Lemery-Chalfant, K., and Berger, R. H. (2014). Children's effortful control and academic achievement: do relational peer victimization

and classroom participation operate as mediators? *J. Sch. Psychol.* 52, 433–445. doi: 10.1016/j.jsp.2014.05.005

Vansteenkiste, M., and Ryan, R. M. (2013). On psychological growth and vulnerability: basic psychological need satisfaction and need frustration as a unifying principle. *J. Psychother. Integr.* 23, 263–280. doi: 10.1037/a0032359

Vansteenkiste, M., Sierens, E., Goossens, L., Soenens, B., Dochy, F., Mouratidis, A., et al. (2012). Identifying configurations of perceived teacher autonomy support and structure: associations with self-regulated learning, motivation and problem behavior. *Learn. Instr.* 22, 431–439. doi: 10.1016/j.learninstruc.2012.04.002

Veronneau, M.-H., Racer, K. H., and Dishion, T. J. (2014). The contribution of adolescent effortful control to early adult educational attainment. *J. Educ. Psychol.* 106, 730–743. doi: 10.1037/a0035831

Wagner, W., Göllner, R., Helmke, A., Trautwein, U., and Lüdtke, O. (2013). Construct validity of student perceptions of instructional quality is high, but not perfect: dimensionality and generalizability of domain-independent assessments. *Learn. Instr.* 28, 1–11. doi: 10.1016/j.learninstruc.2013.03.003

Wallace, T. L., Kelcey, B., and Ruzek, E. A. (2016). What can student perception surveys tell us about teaching? Empirically testing the underlying structure of the tripod student perception survey. *Am. Educ. Res. J.* 53, 1834–1868. doi: 10.3102/0002831216671864

Wang, M.-T., Degol, J., and Ye, F. (2015). Math achievement is important, but task values are critical, too: examining the intellectual and motivational factors leading to gender disparities in STEM careers. *Front. Psychol.* 6:36. doi: 10.3389/fpsyg.2015.00036

Wang, M.-T., and Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: a longitudinal study of school engagement using a multidimensional perspective. *Learn. Instr.* 28, 12–23. doi: 10.1016/j.learninstruc.2013.04.002

Wentzel, K. R. (2002). Are effective teachers like good parents? Teaching styles and student adjustment in early adolescence. *Child Dev.* 73, 287–301. doi: 10.1111/1467-8624.00406

Zee, M., Koomen, H. M., and Van der Veen, I. (2013). Student-teacher relationship quality and academic adjustment in upper elementary school: the role of student personality. *J. Sch. Psychol.* 51, 517–533. doi: 10.1016/j.jsp.2013.05.003

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: an overview. *Educ. Psychol.* 25, 3–17. doi: 10.1207/s15326985ep2501_2

Zimmerman, B. J. (2013). From cognitive modeling to self-regulation: a social cognitive career path. *Educ. Psychol.* 48, 135–147. doi: 10.1080/00461520.2013.794676

Zimmerman, B. J., and Kitsantas, A. (2014). Comparing students' self-discipline and self-regulation measures and their prediction of academic achievement. *Contemp. Educ. Psychol.* 39, 145–155. doi: 10.1016/j.cedpsych.2014.03.004

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Leon, Medina-Garrido and Núñez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 20 June 2017
doi: 10.3389/fpsyg.2017.00976

Differences in Executive Functioning in Children with Attention Deficit and Hyperactivity Disorder (ADHD)

M. Rosa Elosúa[1], Sandra Del Olmo[1,2] and María José Contreras[1]*

[1] Psicología Básica I, Universidad Nacional de Educación a Distancia, Madrid, Spain, [2] Hospital Clínico Universitario Lozano Blesa, Zaragoza, Spain

In recent years, the interest in Attention Deficit and Hyperactivity Disorder (ADHD) and its relation to deficits in working memory (WM) and more specifically the different executive functions (EFs) has grown, to the point of confirming that these are quite frequent in this disorder. The aim of this study was precisely to explore differences in executive functioning of WM in fourth grade Primary school children with and without ADHD (26 and 29 children, respectively), introducing rigorous control measures in the tests used. Four EFs were analyzed: divided attention, updating, attentional shifting and inhibition, measured through four tasks, the dual-task paradigm (digits and box-crossing), the N-Back task, the Trail Making Test and the Stroop task, respectively. The results showed that participants with ADHD, compared to children with typical development (TD), exhibited a smaller verbal memory span as well as deficits in the attentional shifting and updating functions. However, a similar performance for the EF of inhibition was found for both groups of participants. Finally, an unexpected result was obtained with regard to the role of divided attention, as children with ADHD were less impaired when performing the double task than participants in the TD group.

Keywords: executive functions, Attention Deficit and Hyperactivity Disorder, inhibition, divided attention, updating, attentional shifting

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
María-Inmaculada Fernández-Andrés, Universitat de València, Spain
Ana Miranda, Universitat de València, Spain

****Correspondence:***
M. Rosa Elosúa
melosua@psi.uned.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *06 March 2017*
Accepted: *26 May 2017*
Published: *20 June 2017*

Citation:
Elosúa MR, Del Olmo S and Contreras MJ (2017) Differences in Executive Functioning in Children with Attention Deficit and Hyperactivity Disorder (ADHD). Front. Psychol. 8:976. doi: 10.3389/fpsyg.2017.00976

INTRODUCTION

The Attention Deficit and Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by a pattern of inattention and/or hyperactivity-impulsivity above that expected for the individual's level of development. It affects daily life in a clinically significant way and it is present in multiple contexts, hindering academic and work performance, as well as social development. Inattention, hyperactivity, and impulsivity can manifest at a behavioral and cognitive level in different ways, so that it is observed that children with ADHD are often distracted, they have difficulty in sustaining attention over prolonged periods of time, they get up frequently and inappropriately within the situation in which they find themselves, they struggle to remain still, they disrupt the activities of others or respond without thinking and in a disorganized way. A minimum number of these clinical symptoms must be present before the child is 12 years old. The disorder can present itself in a mild, moderate or severe level, and the severity of the symptoms may vary across time (DSM-5; American Psychiatric Association, 2013).

Attention Deficit and Hyperactivity Disorder has been considered one of the most common disorders in childhood, with a prevalence of approximately 3 to 5% (Willcutt, 2012). It has a greater

occurrence in boys than in girls, with a ratio of three boys for every girl (Ramtekkar et al., 2010) and the combined subtype is the most frequent subcategory. In many cases, these children do not see a specialist until third or fourth grade of Primary school, when their academic performance is unsatisfactory, possibly due to the increasing demands in school tasks in comparison with previous years. Their ability to concentrate and to organize becomes insufficient to achieve adequate learning. Therefore, it is possible that their academic performance is lower than expected given their IQ. Moreover, their social functioning and emotional well-being is also affected, with its subsequent impact on their families (Mannuzza et al., 2004).

Among the difficulties faced by children with ADHD, executive functions (EFs, hereinafter) have often been pointed out (Willcutt et al., 2005; Lambek et al., 2011; Re et al., 2015). The EFs is a challenging topic to study, as not only is it elusive to define, but is also difficult to measure (see Jurado and Roselli, 2007; Miyake and Friedman, 2012). The EFs refer to the set of skills that allow the generation, supervision, regulation, and implementation of behaviors appropriate to achieve complex goals, especially those that are not automated and that allow us to address new situations (Miyake and Friedman, 2012). Any alteration in the development of these functions would be reflected in difficulties in making decisions, respecting rules, regulating emotions, having successful social relationships, or ensuring new learning. Moreover, these EFs could be considered as part of the attentional control of working memory (WM), which has a great influence on academic performance (Dehn, 2008; McCloskey et al., 2009; Langberg et al., 2013; García-Madruga et al., 2014; Miranda et al., 2015).

As to the neural basis of EFs seem to be localized significantly in the prefrontal cortex (Fuster, 2008). Some studies have reported that alterations in prefrontal areas produce neuropsychological deficits, particularly in EFs, as well as behaviors of impulsivity, hyperactivity, and inattention. Hence, this area has also been linked to ADHD (e.g., Geurts et al., 2004). These alterations have been found both, in childhood/adolescence and in adulthood, which may indicate they are of stable nature (Biederman et al., 2007).

In the extensive meta-analysis carried out by Willcutt et al. (2005), the authors concluded that ADHD is associated with deficits in WM and various EFs, with inhibition and planning being particularly deteriorated. For this reason, and based on the accumulated evidence suggesting that deficits in EFs have a high prevalence in ADHD, different authors have proposed that the EF performance is the cognitive mechanism that best differentiates participants with and without ADHD (e.g., Boonstra et al., 2005), renaming ADHD as an EF disorder.

Nevertheless, although most studies report deficient results in tasks where EFs are involved, not all children with ADHD invariably exhibit deficits in such functions (Nigg et al., 2005; Lambek et al., 2010; Duff and Sulla, 2015). Nigg et al. (2005) observed that almost 80% of children with ADHD exhibited a deficit in at least one EF, while this only occurred in 50% of children with typical development (TD). Furthermore, a greater number of deficits were present in the ADHD group for the different EFs. Similar results were obtained by Lambek et al. (2010), which entails that although a significantly greater impairment of the EFs is present among the ADHD group, this does not occur in every case or for the same EFs. For this reason, although EFs seem to be affected in this disorder, such affectation is heterogeneous (Sonuga-Barke, 2005), creating the need to deepen the study of the different EFs and their possible and varied performance patterns in ADHD.

In this study, the three main EFs used by Miyake et al. (2000) were chosen (attentional shifting, updating, and inhibition). These three functions were chosen because as Miyake et al. (2000) said "they seem to be relatively circumscribed, lower level functions (in comparison to some other often postulated EFs like "planning") and hence can be operationally defined in a fairly precise manner" (p. 55). Divided attention was added, as one of the most important EFs named and used by Baddeley (2002). Hence, while some studies have examined some of these functions and other studies have worked with other functions, a novel aspect of the present study is precisely the joint use of these four EFs, for the reasons mentioned above. Below, we review these four EFs (divided attention, attentional shifting, updating, and inhibition) and briefly discuss some previous studies carried out with the tasks we have chosen as measures of each EF. Details of each task are provided in the "Materials and Methods" section.

One of the tasks most commonly used to measure divided attention is the dual-task paradigm. The present study uses the dual task paradigm proposed by Baddeley et al. (1997), as it allows for the level of memory span of each participant to be adapted during the performance of the task. Participants must carry out each of the tasks separately first to subsequently carry them out together. In the latter condition, a worse performance is expected, understanding that the secondary task causes interference with the primary task, competing for the same WM (hereinafter) resources. Studies on divided attention with ADHD evaluated through other dual task paradigms have yielded contradictory results. On the one hand, some studies have shown that, in children with ADHD, deficits appear in the divided attention function (Karatekin, 2004; Fuggetta, 2006). For example, Fuggetta (2006) used a dual task that requires the coordination of two task responses, a shift task that makes it necessary to disengage attention from one task and engage onto another, and a stimulus–response spatial compatibility task that requires participants to inhibit a prepotent response. Results indicated that the ADHD group (9–11 years old) needed significantly more time than the TD group to coordinate both responses from the dual task, to disengage their attention from one task to another and to inhibit a prepotent response.

On the other hand, other studies have reported no differences between the ADHD and TD groups, or between the disorder's different subtypes (Inasaridze and Bzhalava, 2010). The present study involved a sample of ADHD children aged between 6 and 16 years and found that the increase of difficulty with the dual task (a list memory task and a computerized tracking task or paper and pencil motor tracking task) did not disproportionately affect children and adolescents with ADHD with respect to the TD group.

The Trail Making Test (TMT) has been traditionally used to evaluate attentional shifting, especially part B of the test

(Pennington and Ozonoff, 1996). It has been reported that the time taken to perform the TMT-B can discriminate between participants with and without ADHD (see Pennington and Ozonoff, 1996; Willcutt et al., 2005). Time and errors committed in this test may be due to the impulsive responses that people with ADHD have when presented with stimuli to which they must respond to sequentially. There is repeated evidence that they take longer and make more mistakes than those without ADHD (Wodka et al., 2008; Hale et al., 2009). Nevertheless, it has occasionally been found that this test does not have an adequate predictive power to differentiate between them (Perugini et al., 2000).

The measurement of the updating function may be addressed through the N-Back task. Although there have been few studies published that used this task on children with ADHD, deficits have been found that yield greater difficulties as the workload of the test increases (Shallice et al., 2002; Karatekin et al., 2009; Bechtel et al., 2012). In Shallice et al.'s (2002) study, differences were found in the N-Back task for both groups of children with ADHD (7- to 8-year-old and 9- to 12-year-old), compared to their age-matched TD groups, obtaining worse results for the ADHD group. Regarding the number of hits, a significant effect of both group and age was found, as well as for the N-Back condition. However, the interaction effect was not significant. Therefore, ADHD children yielded less hits than TD children; Moreover, 7- to 8-year-old participants obtained more errors than the 9- to 12-year-old group. Finally, both groups obtained a significantly greater number of hits in the 0-back condition than in the 1-back condition, and more in the latter than in the 2-back condition.

One of the most important paradigms used to evaluate the role of inhibition has been the Stroop Test. Some authors have considered inhibitory control as the key component in ADHD, referring to it as the very essence of the disorder (Barkley, 1997). There have been many publications that have found that there is a greater interference in the Stroop test in children with ADHD compared to those without this disorder (Lansbergen et al., 2007; Wodka et al., 2008). However, some authors have argued that, rather than an interference effect, what is most often seen in ADHD is a slower response time, a reduced accuracy and/or greater variability, in comparison to TD group (Nigg et al., 2002; van Mourik et al., 2005; Schwartz and Verhaeghen, 2008). For this reason, the validity of the Stroop test to evaluate the inhibitory behavior has been questioned and criticized for evaluating other neurocognitive functions other than interference control (van Mourik et al., 2005).

Given the discrepancy of previous studies regarding the deterioration in EF performance in ADHD, the novelty of this study will apply the necessary control measures in the tests used to avoid the mistakes derived from the clinical approach, which although it uses tests of experimental tradition, it does not always have the rigor and control of this methodology, leading to contradictory results (see Snyder et al., 2015). Therefore, this present study takes into account both traditions, the clinical approach (as data are collected in a hospital and we are interested in the clinical application that its results may entail), and also all the necessary controls to correct all questions that have arisen in the revised bibliography regarding the tests used.

In this context, the main objective of the study was to assess the performance of EFs and WM, according to Baddeley and Hitch (1974); Baddeley, 2012) model, in children with ADHD compared to children with TD. To do this, the following EFs were assessed: divided attention, attentional shifting, updating, and inhibition. Our initial hypotheses pose that if any of these functions were affected in ADHD participants, a significantly lower performance would be obtained in the tasks used to examine these EFs, in comparison to TD children.

MATERIALS AND METHODS

Participants

The study included 26 children with ADHD (20 with ADHD combined subtype and 6 with ADHD inattentive subtype) who visited for the first time the Child and Adolescent Psychiatry outpatient unit of a General Hospital. Children with ADHD had a previous clinical diagnosis of ADHD that was confirmed before their participation in the study. They were not taking medication. The inclusion criteria to participate in the group of children diagnosed with ADHD were: (a) fulfilling the diagnostic criteria for Attention Deficit and Hyperactivity Disorder (DSM-IV-TR; American Psychiatric Association, 2000) as a main diagnosis, and without any other known diagnosis, although emotional or behavioral symptomatology may be comorbidly present; (b) being aged between 9 and 10 years of age and/or currently enrolled in fourth grade of Primary school; (c) not have been under any psychological and/or drug treatment for ADHD before; (d) having an IQ equal to or above 85. Furthermore, a group of 29 children with TD and similar sociodemographic characteristics to the ADHD group were included in the study. All children in TD group were students from fourth grade of Primary from a public school, as that age group is considered critical in relation to the behavioral problems that arise. The inclusion criteria for TD group were the same as for ADHD group, with the exception of the ADHD diagnosis. **Table 1** shows the sociodemographic and clinical characteristics of the sample used in this study.

Materials

Clinical Assessment

The clinical interview collected the symptomatology presented by children with ADHD, as well as the sociodemographic data of all participants. Additionally, the Attention Deficit and Hyperactivity Disorder Assessment Scale (EDAH in Spanish) by Farré and Narbona (2013) was also administered to the ADHD group, which evaluated the symptoms associated with ADHD. In order to fulfill this rating scale, the information collected by these children's teachers on their usual behavior in the school context was included. This scale was validated in Spain on children and scores were recorded in three scales: Hyperactivity, Attention Deficit, and Behavior Disorder.

Neuropsychological Tasks

K-BIT: Kaufman Brief Intelligence Test (Kaufman and Kaufman, 2000)

This test consists of a vocabulary subtest, influenced by school related skills, that measures verbal skills, and a matrix subtest that assesses non-verbal skills through the perception of relationships and the completion of visual analogies. The score used was the total IQ, obtained using both subtests.

Digit Span Task

The participant is presented with a series of digits orally that he/she has to recall immediately thereafter, in the same order in the first part of the task and in reverse order in the second part of the task. The length of the trials is progressively increased at each level of amplitude; starting with series of two digits and adding one digit with each level. Each level has nine trials of the same length, divided into series of three. A series is successfully achieved when the participant does not make any errors in at least two of the three trials. If the participant does not achieve at least two of the three series within each level, the task is ended, scoring the span level of the last level that the participant achieved successfully, that is, the last level in which he/she completed at least two series successfully. In this task, one point is awarded for each span level successfully achieved.

TABLE 1 | Clinical and sociodemographical characteristics of the sample with means and proportions (standard deviation within parentheses).

	ADHD children ($n = 26$)	TD children ($n = 29$)
Age	9.24 (0.40)	9.18 (0.43)
Sex (male/female)	17/9	13/16
IQ	95.15 (1.98)	97.17 (1.70)
Repeats school year	11	5
Nationality (Spanish/Foreign)	23/26	23/29
Parents civil status (married/separated)	21/5	24/5
Parents' education (%)		
- Father		
Primary	23	38
Secondary	39	31
High school	8	3
Professional apprenticeships	15	17
University studies	15	11
- Mother		
Primary	31	38
Secondary	27	31
High school	12	7
Professional apprenticeships	4	7
University studies	26	17
Parents' profession (%)		
- Father		
Qualified professional	12	10
Technical personnel	38	24
Non-technical personnel	50	65
- Mother		
Qualified professional	8	7
Technical personnel	27	24
Non-technical personnel	65	69

Dual-Task Paradigm (Baddeley et al., 1997)

To examine divided attention we used the dual-task paradigm, which involves a digit recall task, adapted to the span level of each participant's WM, and a box-crossing task, where the participant crosses boxes following a path laid out on a sheet with 80 boxes as quickly as possible during 2 min (paper and pencil task). After this time, the task is terminated. First, tasks are performed separately (single task) and afterward, combined (dual task), lasting 2 min each. The *mu* index of the dual task is calculated to measure the distribution of attention as follows:

$$\mu = [1 - (p_m + p_t)/2] \times 100,$$

where p_m is the proportion of digit correct series in the single task subtracting the digit correct series from the dual task and p_t is the number of crossings in the single task minus those in the dual task and then divided by the number of crossings made during the single task. With this formula the performance percentage of the subject in the double task with respect to the single task (Baddeley et al., 1997) is obtained through the *mu* index. The main dependent variable was the distribution of attention measured by *mu* index. The proportion of digit correct series in single and dual tasks were also dependent variables recorded as well as the number of box-crossing put in single and dual tasks. Test–retest reliability is variable according to some studies (between 0.44 and 0.67).

Trail Making Test (Reitan and Wolfson, 1993)

We used the TMT to assess the EF of attentional shifting. This test consists of two parts A and B. In Part A, the participant must link numbers from 1 to 25 in ascending order as quickly as possible without lifting the pencil from the paper. In Part B, participants must link numbers from 1 to 13 in ascending order and the letters A to L in alphabetical order, alternating numbers and letters: 1-A-2-B-3-C, etc. The examiner asks the participant to correct his/her own mistakes, with the increase in time that this entails. To minimize the effects of motor speed and visual tracking speed in the execution of this test, the B-A and B/A indexes are obtained as dependent variables (Arbuthnott and Frank, 2000), plus the time in seconds that they take to complete each of the parts of the test. Test–retest reliability is variable according to some studies (between 0.60 and 0.90).

N-Back Task (Braver et al., 1997)

To examine the EF of updating, the N-Back paradigm with three conditions (1-back, 2-back, and 3-back) was used. In each of these, 20 letters are presented at the rate of one per second. In the 1-back condition, the participant has to indicate when he/she detects the same letter twice in a row; in the 2-back condition, when the same letter is repeated but separated by a single different letter; and in the 3-back condition, he/she must indicate when he/she detects the same letter separated by two different letters. The dependent variable was the total number of errors recorded, specifying whether they are errors of omission, false alarm or

perseveration. Test–retest reliability is variable according to some studies (between 0.65 and 0.92).

Stroop Test (Golden, 1978)

The Stroop test was used to examine the EF of inhibition. The test consists of three sheets of 100 elements each: the Word condition (W), the Color (C) condition and, finally, the Word-Color (WC) condition. In the three conditions, participants have to read aloud all the elements that they can in 45 s. The number of elements obtained in the three conditions and the interference index, which is calculated from the results of the other conditions [WC − (W × C/W + C)], are analyzed as dependent variables. Test–retest reliability is variable according to some studies (between 0.71 and 0.98).

Procedure

The Ethics committees of the University (UNED) and the General Hospital approved the study, in accordance with the Declaration of Helsinki. Oral permission from the children and written informed consent from their parents were obtained before beginning the evaluation. In the case of the participants with ADHD, the tests were applied in the Child and Adolescent Psychiatry outpatient unit at the General Hospital. The assessment was performed by a doctoral-level clinical psychologist in a single session, which lasted an hour and a half, approximately. In the TD group, the application of the tests lasted approximately 1 h. For both groups, the order of administration of the tests was counterbalanced, except for the clinical interview and the K-BIT, which were always applied at the beginning of the session. Halfway through the application of the tests, a rest period was granted to avoid fatigue in the participants.

RESULTS

The statistical analyses of the results were performed using parametric tests. In order to compare the sociodemographic characteristics between groups, the Student *t*-test was used (verifying the homogeneity of variances with Levene's test) for the quantitative variables (age and IQ) and the chi-square test was used to compare qualitative variables (sex, repetition of school year and the parents' sociocultural characteristics). No significant differences between groups in the sociodemographic variables were found, except for the repetition of the school year variable, which showed a greater number of repetitions for the ADHD group ($z = 4.18$; $p = 0.04$) than for the TD group. As for the EDAH scores for the ADHD participants, all were above the 80th percentile regarding the presence of clinical symptoms of hyperactivity, attention deficit, and behavioral disorders. **Table 2** presents the main results of the study.

Digit Span Level

The results indicated that the ADHD group had a lower score than the TD group, both in direct order digits ($t = -3.12$, $p < 0.01$) and in the reverse order ($t = 2.83$, $p = 0.01$).

Dual-Task Paradigm

In the digit recall task, no significant differences between groups were obtained either for the single task ($t = -1.12$; $p = 0.91$) or for the double task ($t = 0.72$; $p = 0.48$). Regarding the box-crossing task, no significant differences between groups were obtained for the dual task ($t = -1.73$; $p = 0.09$); however, significant differences were found for the single task ($t = -5.51$; $p = 0.01$). Participants with ADHD obtained worse scores than TD (see **Table 2**).

The results for the *mu* index showed that there were significant differences between groups ($t = 2.70$; $p = 0.01$), but not in the expected direction, considering our initial hypothesis. That is, the ADHD group outperformed the TD group in the distribution of attention.

Finally, it was also analyzed whether there were differences within each of the two groups when they performed the single and the dual task. In the ADHD group, similar results were obtained in the performance of the digits task ($t = -0.65$; $p = 0.52$) and in the box-crossing task ($t = 0.21$; $p = 0.84$) when they performed them as a single task and in the dual task mode. For the TD group, there were no differences between the single and dual tasks ($t = 0.63$; $p = 0.53$), but in the case of the box-crossing task, the TD group lowered their performance in the dual task ($t = 3.78$; $p < 0.01$).

Trail Making Test

The results indicated that the ADHD group used more time than the TD group to complete the Part B of TMT ($t = 2.42$; $p = 0.02$), yet there were no differences between groups in Part A ($t = 1.06$; $p = 0.29$). Moreover, there were significant differences between groups for both, the B-A index ($t = 2.39$; $p = 0.02$) and the B/A index ($t = 2.04$; $p < 0.05$). It shows that the ratio of the time spent performing Part B with respect to Part A of the TMT differs between the two groups, with participants with ADHD needing significantly more time to perform Part B (more complex) than to perform Part A.

N-Back

A 2(group) × 3(condition: 1-back, 2-back, and 3-back) repeated measures ANOVA was performed for the second factor, considering the total number of errors as the dependent measure. The results indicated that the main effect of the N-Back condition was significant [$F(1,53) = 119.57$, $MC = 295.40$, $p < 0.001$, $\eta_p^2 = 0.69$]. The fit of the Bonferroni multiple comparisons indicated that all comparisons between levels of *n*-back were significant ($p = 0.001$). Therefore, 1-back obtained a significantly lower mean of errors than 2-back and 3-back; 2-back obtained a significantly greater mean of errors than 1-back and lower than 3-back; and 3-back obtained significantly more errors than 1-back and 2-back. Similarly, the group factor was significant [$F(1,53) = 7.82$, $MC = 56.20$, $p = 0.007$, $\eta_p^2 = 0.13$]. The Bonferroni multiple comparisons indicated a greater mean of errors for the ADHD group than the TD group ($p = 0.007$). However, only a trend toward significance was observed in relation to the interaction of the variables ($p = 0.08$). *A posteriori* analyses using the Bonferroni method

TABLE 2 | Means (and standard deviations within parentheses) for the dependent variables used (minimum and maximum values) in the four tasks performed by ADHD and TD children, Student *t*-test and Cohen's *d*.

	ADHD children ($n = 26$)	TD children ($n = 29$)	Students *t* (significance)	Cohen's *d*
Direct digits (min 3–max 6)	4.27 (0.67)	4.83 (0.66)	−3.12 (0.01)	0.84
Reversed digits (min 2–max 5)	3.08 (0.89)	3.66 (0.61)	−2.83 (0.01)	0.76
Total digits (min 5–max 11)	7.35 (1.38)	8.48 (1.12)	−3.36 (0.01)	0.90
Digits single task (min 0.13–max 1)	0.69 (0.19)	0.70 (0.15)	−1.12 (0.91)	0.06
Digits dual task (min 0.18–max 1)	0.72 (0.21)	0.68 (0.17)	0.72 (0.48)	−0.21
Box-crossing single task (min 45–max 146)	89.77 (23.60)	118.79 (14.95)	−5.51 (0.01)	0.47
Box-crossing dual task (min 39–max 156)	89.08 (27.35)	102.38 (29.32)	−1.73 (0.09)	0.47
Mu index (min 61.79–max 128.02)	101.16 (13.04)	91.84 (12.60)	2.70 (0.01)	−0.73
TMT-A (s) (min 27–max 105)	62.35 (15.79)	57.52 (17.68)	1.06 (0.29)	−0.29
TMT-B (s) (min 80–max 503)	195.15 (100.01)	144 (52.07)	2.42 (0.02)	−0.64
B/A index (min 0.7–max 6.28)	3.12 (1.10)	2.51 (1.13)	2.04 (0.05)	−0.55
B-A index (min–max)	132.81 (90.92)	86.48 (48.66)	2.39 (0.02)	−0.64
Stroop-Word (min 65–max 143)	99.15 (16.72)	117.34 (10.14)	−4.94 (0.01)	1.32
Stroop-Color (min 55–max 96)	72.00 (8.93)	76.07 (8.65)	−1.72 (0.09)	0.46
Stroop Word-Color (min 32–max 59)	43.00 (5.73)	45.79 (5.68)	−1.81 (0.08)	0.49
Stroop Interference (min −25.48–max 37.24)	1.68 (11.03)	−0.28 (4.83)	0.87 (0.39)	−0.23
1-Back (errors) (min 0–max 10)	1.85 (2.43)	1.00 (1.07)	1.7 (0.09)	−0.45
2-Back (errors) (min 0–max 10)	5.04 (2.54)	3.10 (2.06)	3.12 (0.01)	−0.84
3-Back (errors) (min 1–max 11)	6.35 (2.15)	5.62 (1.47)	1.47 (0.15)	−0.40
N-Back (total errors) (min 2–max 27)	13.23 (5.81)	9.72 (3.27)	2.78 (0.01)	−0.80
N-Back (omissions) (min 2–max 19)	8.96 (4.37)	7.48 (2.42)	1.58 (0.12)	−0.42
N-Back (false alarms) (min 0–max 21)	2.27 (4.28)	0.83 (1.04)	1.76 (0.08)	−0.46
N-Back (perseverations) (min 0–max 4)	2 (1.27)	1.41 (1.18)	1.78 (0.81)	−0.48

were conducted to determine between which N-Back condition the differences occurred. Pairwise comparisons applying the Bonferroni correction indicated that the condition that best distinguished performance between the two groups was only the 2-back ($p < 0.05$). ADHD group had more significant errors than TD group. Finally, no significant differences between groups were found for the type of error performed [omission ($p = 0.12$); false alarm ($p = 0.08$); perseveration ($p = 0.81$)], although the trend toward significance of the false alarms is remarkable.

Stroop Test

The results showed significant differences between groups in the Stroop-Word task ($t = -4.94$; $p = 0.01$), with the performance of the ADHD group obtaining worse scores than the TD. However, there were no differences between groups with respect to the Stroop-Color ($t = -1.72$; $p = 0.09$), Stroop Word-Color ($t = -1.81$; $p = 0.08$) or the Stroop Interference ($t = 0.87$; $p = 0.39$), although, in the first two conditions, clear trends toward significance were obtained.

To analyze the relationships between the four EFs, the correlations between them were obtained, but only a statistically significant negative correlation was found between the errors obtained in the N-Back and the resistance to interference in the Stroop test ($r = -0.29$, $p < 0.05$). It is important to note the limitations of these results, due to the fact that two extreme groups (ADHD and TD) were considered together. **Table 3** gathers these results.

DISCUSSION

The main objective of this study was to assess the functioning of WM and EFs in a sample of fourth grade Primary school children with ADHD, compared to a TD group. In general, most of the examined functions were affected in the cognitive functioning of children with ADHD, with the exception of the ability to attend to two things at once and the interference, in which no deficits were found in comparison to the TD group.

Regarding the Digit Span task, both groups had more difficulty in performing the digit task in reverse order than in direct order, and the span level obtained for the ADHD group was significantly lower than that for the TD group, both in the direct order and in the reverse order tasks. However, the results obtained in most of the previous studies report that children with ADHD have worse outcomes than TD in the reverse order of the Digit span task, but not in the direct order of this task (e.g., McInnes et al., 2003). It is possible that the rigorous control performed in our study, through the different levels of three series of digits per level, as well as the criteria to pass each level, have made the assessment of this task more sensitive, making it possible to objectify the differences in the performance of the groups. Thus, in ADHD, we have observed difficulties in both, the maintenance and handling of information. These deficits are related to the phonological loop and the central executive system, respectively.

Regarding the divided attention, measured through the performance in the dual-task paradigm (digits and box-crossing), significant differences were found between groups but in the

TABLE 3 | Bivariate correlations among executive functions and the verbal span and IQ tasks.

Bivariate correlations ($n = 55$)	K-Bit	Direct digits	Reversed digits	Stroop Interference	Stroop Word	TMT-B	N-Back errors
Direct digits	0.37**						
Reversed digits	0.45**	0.62**					
Stroop Interference	0.05	0.01	−0.06				
Stroop Word	0.31*	0.55**	0.53**	−0.27			
TMT-B	0.41**	−0.18	−0.32*	0.12	−0.36**		
N-Back (errors)	−0.49**	−0.44**	−0.42**	−0.29*	−0.35**	0.26	
Mu	−0.20	−0.07	−0.04	0.08	−0.10	0.06	0.12

*$p < 0.05$, **$p < 0.01$.

opposite direction than what was expected. The percentage of distribution of attention (*mu*) for the dual task was higher in children with ADHD than TD, not only being less affected by the second task, but actually benefiting from it. In Inasaridze and Bzhalava (2010) study, which used a similar dual task paradigm (a list memory task and a computerized tracking task or paper and pencil motor tracking task), but without adjusting the level of verbal span of each participant, no differences were found. That is, the performance in the distribution of attention among children aged between 6 and 16 years with and without ADHD was similar. It is noteworthy that although this prior study used a greater age range and the conditions of the task differed (the contents of the memory list was not detailed and the span level of each participant was not adjusted), the attentional distribution index was very similar (*mu* index). Note that in our study, the digit span level for each participant was calculated in order to avoid differences in the performance of this paradigm due to the individual's ability to perform the task separately. Therefore, the possibility that a poorer performance in the dual task was due to any reason other than the difficulty of distributing the resources between the two cognitive tasks was discarded. As Inasaridze and Bzhalava (2010) pointed out, in many of the studies that reported differences between groups with this type of task, the level of difficulty of the tasks performed separately has not been adapted to the levels of the individual ability of each participant. Only some studies have adapted the procedure to the level of each participant in the single digits task (e.g., Karatekin, 2004), similarly to ours. This is a good example of how our study has addressed the need for experimental control claimed by Snyder et al. (2015) in this type of research. The results of the present study, controlling for the memory span level of each participant and using a more homogeneous age group, are in line with those of Inasaridze and Bzhalava (2010), confirming that ADHD children's divided attention, measured through this dual task paradigm, is not significantly affected in relation to that of the TD group.

As the single digits task, in our sample, we can confirm that there were no differences between groups and that neither group was affected by the addition of a second task. Moreover, in the case of participants with ADHD, even though it did not reach statistical significance, there was a slight improvement in their performance when they-performed the task together with the box-crossing task (while performance was maintained for the latter). Again, we found a result contrary to those obtained in previous studies in which a secondary task decreases the performance of the primary task. This paradoxical result may suggest that other psychological processes are coming into play, which is not controlled by our study. However, we would like to assess the plausibility of several explanatory arguments. It is possible that motivational factors may have influenced the performance of participants with ADHD in this task. As the cognitive-energetic model suggests, which emphasizes the role of factors such as effort, arousal, and activation in this disorder, the poor response execution in these children may be reflecting a non-optimal energy state (Sergeant, 2005). This would be consistent with ADHD motivational theories in terms that there is a greater aversion to low levels of stimulation. Accordingly, in our study, it is possible that participants in ADHD group were not affected by the dual task as they had a higher level of stimulation that could be optimal for them.

Other studies have obtained similar paradoxical results for children with ADHD in comparison to a TD group. For example, Grodzinsky and Barkley (1999) indicated that, in a digit recall task, there were only differences between groups in the direct order condition. As we have mentioned previously, this finding is contrary to what has been reported by other studies, where the deterioration in the reverse order digits task is more pronounced in the case of people with ADHD. When the task is better performed in reverse order of digits than in the direct order, it is plausible that this does not reflect a lack of ability, but rather, a lack of effort in the single task. Thus, issues such as the intrinsic interest in the task can improve performance.

Regarding the box-crossing task, a worse performance was obtained for the ADHD group, independently of whether it was performed alone or together with the digits task. The presence of differences between the TD group and the ADHD group in the box-crossing task when performed in single mode makes it impossible to confirm with certainty that its combination with other tasks can measure EFs. Therefore, it is possible that the difficulty of the secondary task in the dual-task paradigm is influencing these results, as it has proved to be an important feature. Karatekin (2004) found that participants with ADHD only had difficulty dividing their attention when the secondary task was cognitively demanding, hence, perhaps in our study our secondary task was not sufficiently complex and therefore did not achieve the expected effect.

Regarding the attentional shifting, our results indicated that the ADHD group needed more time to complete Part B of

the TMT than the TD group and this result consistent with previous studies and meta-analysis (Pennington and Ozonoff, 1996; Willcutt et al., 2005; Wodka et al., 2008; Hale et al., 2009). However, there were no significant differences in the performance of Part A of the TMT. It is important to highlight that Part B of the TMT is the part related to cognitive flexibility and attentional shifting (Pennington and Ozonoff, 1996).

As Rohlf et al. (2012) indicated, the poorer performance in the TMT-B by participants with ADHD, compared to the TD group, could be explained to a certain extent by a lower performance in the TMT-A (which is not a measure of attentional shifting). Therefore, it not is advisable to use only the results of the TMT-B to assess performance in attentional shifting. It would be necessary to monitor the results in the TMT-A so that the difference between groups is not overestimated. In our case, both, the B/A index and the B-A index showed significant differences between groups, suggesting that the deficits observed in attentional shifting are not due to a slowing of cognitive and/or motor functions, but rather to a deficit in function of attentional shifting specifically. Therefore, for our sample, the hypothesis of the existence of deficits in the function of attentional shifting in participants diagnosed with ADHD was confirmed.

When interpreting the poorer performance in the TMT -such as deficits in attentional shifting-, it is important to note that the TMT-B has also been considered a measure of WM by certain authors (Boonstra et al., 2005). This might be reasonable, as the TMT-B requires keeping the last number or letter in mind while also looking for the next stimulus. The analyses performed in this study (see **Table 3**) showed correlations between the scores of the level of verbal span memory (digits in reverse order) with the TMT-B scores. Thus, our results could indicate that the performance in the TMT is relatively dependent on span memory, supporting Boonstra et al.'s (2005) hypothesis.

Regarding the EF of updating, measured through the N-Back task, it was observed that there was a deficient performance for the ADHD group, compared to the TD group. Overall, the ADHD participants made a significantly higher number of errors than the TD. Moreover, in both groups, the increased cognitive load of the task resulted in a greater number of errors during its execution. Thus, in the 3-back condition there were more errors than in the 2-back, and in the latter, more errors than in the 1-back, as has been reported previously in other studies (Shallice et al., 2002; Karatekin et al., 2009). The task condition that best discriminated between groups was the 2-back condition, thus being the optimum level of difficulty to study the impairment of this function, as it was not too easy (1-back) or too difficult (3-back), engaging the performance of participants with ADHD without greatly affecting the performance of the TD (see Pelegrina et al., 2015). In line with our study, Bechtel et al. (2012) obtained significant differences between groups only for the 2-back condition; especially highlighting that the easier condition of the task was not sensitive enough to distinguish their updating ability. Similarly, Ehlis et al. (2008) found that participants with ADHD had less activation in the ventro-lateral prefrontal cortex, especially during the 2-back condition, compared to the TD. It is noteworthy that the interaction effect (group × N-Back condition) was not significant in our study. We observed that the increment of the cognitive load within the different conditions of the task worsened the performance of both groups, without a significantly greater number of errors being made by ADHD participants when the difficulty of the task increased, although there was a significant trend. These same results were found in previous studies with children (Shallice et al., 2002) and young adults (Roberts et al., 2012).

As for the type of errors (omissions, false alarms or perseverations) made in the task, no significant differences were found between the two groups. There was, however, a trend toward significance in the case of false alarms, with participants with ADHD making a greater amount of this type of errors. Perhaps this result may be explained by the greater impulsivity that people with this disorder have, making it difficult for them to delay their answer and think about it before submitting it.

In our study, no deficits were observed in ADHD group regarding the interference condition of the Stroop task. This result is consistent with previous studies on children (Nigg et al., 2002). These data are important because, with the discrepancy of previous results in this task, our results show that differences only appeared between groups in the word reading condition, indicating that participants with ADHD were slower than those in the TD group. Similarly, although without finding significant differences between groups, it was observed that participants with ADHD also tended to be slower in the Color and Color-Word conditions. Therefore, these results support previous studies where no differences were found regarding interference, but also show a slower performance for other conditions (Nigg et al., 2002; van Mourik et al., 2005; Schwartz and Verhaeghen, 2008). It is worth highlighting some methodological aspects of the studies that have used this task previously and that could explain the appearance of contradictory findings in previous literature. Traditionally, when comparing participants with ADHD and TD of the same age, some researchers only analyzed their performance in the Color-Word Stroop test condition. The finding that participants with ADHD were slower in this condition was taken as evidence that they had more problems with response inhibition than the TD, regardless of the differences in reading speed of the groups (van Mourik et al., 2005). This is important, because as has been noted above, it has been reported that people with ADHD have lower scores for both, reading ability and color naming. Therefore, an interference score calculated exclusively from the Color-Word test would only be valid if there had been an adequate control of the speed differences in the rest of the conditions of the test, in order to avoid overestimating it. Once again, this highlights the need to compare results amongst studies that use the same conditions of the task and the same scoring indexes, as otherwise conflicting results could be explained by the different application conditions of the task. Similarly, some authors state that other cognitive processes may be intervening in the interference effect in addition to the inhibition function that may explain the results (MacLeod, 1991; cited in Sergeant et al., 2002). Hence, the importance of evaluating the specificity of the task to measure a cognitive process, or in its case, to perform a control over the intervening variables, is noteworthy.

As for the specificity of the four EFs studied, and limiting ourselves to the fact that the correlations obtained in our sample were reduced and even though this was not an objective of our study, we can note that only one significant correlation was obtained, which indicated that the greater the control of response inhibition, the better the updating ability. Therefore, our data do not allow us to confirm the existence, at a global level, of a relationship between all the EFs studied (see **Table 3**). However, Miyake et al. (2000), who studied the relationship between three of the EFs analyzed in this study (attentional shifting, updating, and inhibition), found moderate correlations between them, confirming that although they are three distinct entities, they were not entirely independent of each other, but rather that they shared common underlying characteristics.

In summary, in this study carried out on children with ADHD, deficits in EFs such as updating and attentional shifting, as well as in verbal span were found. It is noteworthy that all the affected functions are especially related to WM, that is, with the ability to remember information over a short period of time and mentally use this information to learn, understand, and reason. Regarding the divided attention, paradoxically, ADHD participants were less affected than the TD when a secondary task was added to the primary task, thus having to divide their attention and cognitive resources between them. This finding may highlight the importance of the motivational variables in children with ADHD, making it possible for them to strive more and get less distracted in tasks they consider as a challenge.

Finally, it is important to note the importance of evaluating the different EFs within the clinical setting in the cases of ADHD, in order not to use the results as a diagnostic decision criteria, as these deficits do not seem to be specific to this disorder, but rather to use them with the objective of obtaining valuable information regarding the cognitive functioning of each child. Furthermore, during clinical interventions, these data will aid in the creation of an intervention plan for each child according to the deficits found and will orientate the professional in relation to the prognosis, as greater difficulties in EFs entail worse performance at a relationship, educational and behavioral level in the future (see Duff and Sulla, 2015). Thus, it is essential that the cognitive difficulties found are taken into account, training such EFs and supplying tools to compensate problems. It is also necessary to adapt school and everyday tasks, obtaining optimum levels of difficulty so that their performance becomes motivating. More precisely, among the specific benefits for education, the results of the present study suggest, on the one hand, that in order to decrease the updating difficulties, tasks need to be broken down into smaller steps and each step must be reinforced. On the other hand, structurizing tasks into shorter times may help children with ADHD to concentrate better and finish tasks successfully, which will reflect onto their academic performance.

LIMITATIONS

In relation to this present study, the following limitations are noteworthy. Firstly, ADHD is a clinically heterogeneous disorder with a high rate of comorbid conditions, thus making it extremely difficult to completely control the comorbidity of a representative sample of children with ADHD. It is relevant to note the importance of controlling comorbid emotional problems and behavior problems of children with ADHD, which were not satisfactorily controlled. In the present study, ADHD was the main diagnosis, without any other diagnosis, although comorbid emotional or behavioral symptomatology may exist in some cases, without constituting a disorder in themselves. Another possible defining variable is the predominant subtype of ADHD that participants suffer, which led this study to analyze the results globally, because in the sample used, the number of participants in each subtype was asymmetrical, hence making more detailed analyses impossible. As for the generalization of this study, the sample size was small and the ADHD group was limited by the low number of females among the participants. Thus, the result of this study may be more applicable to the male population with ADHD, which is the population that most frequently suffers this disorder.

CONCLUSION

Our study adds to this research field results in favor of the existence of alterations in the EFs of children with ADHD, although not all of them would be affected, with relevant differentiation in the specific performance of each EF (divided attention, updating, attentional shifting, and inhibition). We can conclude that our study supported the hypothesis that EF deficits are an important component of the ADHD neuropsychology, although they are not sufficient to fully explain its symptomatology.

This research, with its comprehensive review of previous literature and contradictory results in some of the cognitive functions analyzed, highlights the need to ratify in ADHD the prior results for each of the four EFs studied. Furthermore, this study provides a combination of clinical reality and experimental rigor on a sample of children with ADHD, recently suggested by Snyder et al. (2015), who underlined the need for greater exactitude when comparing results and the need to include experimental controls when implementing tasks.

AUTHOR CONTRIBUTIONS

Conceived and designed the tasks: ME and MC; Performed the experiment: SD; Analyzed the data: ME, MC, and SD. Interpretation of the data: ME, MC, and SD. Drafted the paper: ME, MC, and SD. Contribution to the redaction: ME, MC, and SD.

FUNDING

This research was carried out under the financial support of the research project EDU2013-46437-R, granted by the Ministry of Economy and Competitiveness of Spain.

ACKNOWLEDGMENTS

We would like to thank Mrs. Ángeles Enríquez from the Unidad de Psiquiatría Infanto-Juvenil, Hospital Clínico Universitario Lozano Blesa (Child Adolescent Psychiatric Unit of the University Clinical Hospital Lozano Blesa), and the public school "Recarte y Ornat", both in Zaragoza (Spain), which collaborated with this research. We would also like to thank Dr. María Fernández Cahill for proof-reading this manuscript.

REFERENCES

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edn. Washington, DC: American Psychiatric Association. doi: 10.1176/appi.books.9780890425596

American Psychiatric Association (2000). *Diagnostic and Statistical Manual of Mental Disorders*, 4th Edn. Washington, DC: American Psychiatric Association.

Arbuthnott, K., and Frank, J. (2000). Trail making test, part b as a measure of executive control: validation using a set switching paradigm. *J. Clin. Exp. Neuropsychol.* 22, 518–528. doi: 10.1076/1380-3395(200008)22:4;1-0;FT518

Baddeley, A., and Hitch, G. (1974). "Working memory," in *The Psychology of Learning and Motivation*, Vol. 8, ed. G. A. Bower (New York, NY: Academic Press), 47–90.

Baddeley, A. D. (2002). "Fractionating the central executive," in *Principles of Frontal Lobe Function*, eds D. T. Stuss and R. T. Knight (New York, NY: Oxford University Press), 246–260. doi: 10.1093/acprof:oso/9780195134971.003.0016

Baddeley, A. D. (2012). Working memory: theories, models, and controversies. *Annu. Rev. Psychol.* 63, 1–29. doi: 10.1146/annurev-psych-120710-100422

Baddeley, A. D., Della Sala, S., Papagno, C., and Spinnler, H. (1997). Dual-task performance in dysexecutive and nondysexecutive patients with a frontal lesion. *Neuropsychology* 11, 187–194. doi: 10.1037/0894-4105.11.2.187

Barkley, R. A. (1997). *ADHD and the Nature of Selfcontrol*. New York, NY: Guilford Press.

Bechtel, N., Kobel, M., Penner, I., Specht, K., Klarhöfer, M., Scheffler, K., et al. (2012). Attention-deficit/hyperactivity disorder in childhood epilepsy: a neuropsychological and functional imaging study. *Epilepsia* 53, 325–333. doi: 10.1111/j.1528-1167.2011.03377.x

Biederman, J., Petty, C. R., Fried, R., Doyle, A. E., Spencer, T., Seidman, L. J., et al. (2007). Stability of executive function deficits into young adult years: a prospective longitudinal follow-up study of grown up males with ADHD. *Acta Psychiatr. Scand.* 116, 129–136. doi: 10.1111/j.1600-0447.2007.01008.x

Boonstra, A. M., Oosterlaan, J., Sergeant, J. A., and Buitelaar, J. K. (2005). Executive functioning in adult ADHD: a meta-analytic review. *Psychol. Med.* 35, 1097–1108. doi: 10.1017/S003329170500499X

Braver, T. S., Cohen, J. D., Nystrom, L. E., Jonides, J., Smith, E. E., and Noll, D. C. (1997). A parametric study of prefrontal cortex involvement in human working memory. *Neuroimage* 5, 49–62. doi: 10.1006/nimg.1996.0247

Dehn, M. J. (2008). *Working Memory and Academic Learning. Assessment and Intervention*. Hoboken, NJ: John Wiley.

Duff, C. T., and Sulla, E. M. (2015). Measuring executive function in the differential diagnosis of attention-deficit/hyperactivity disorder: Does it really tell us anything? *Appl. Neuropsychol. Child* 4, 188–196. doi: 10.1080/21622965.2013.848329

Ehlis, A. C., Bähne, C. G., Jacob, C. P., Herrmann, M. J., and Fallgatter, A. J. (2008). Reduced lateral prefrontal activation in adult patients with attention-deficit/hyperactivity disorder (ADHD) during a working memory task: a functional near-infrared spectroscopy (fNIRS) study. *J. Psychiatr. Res.* 42, 1060–1067. doi: 10.1016/j.jpsychires.2007.11.011

Farré, A., and Narbona, J. (2013). *EDAH. Evaluación del Trastorno por Déficit de Atención Con Hiperactividad (Attention Deficit with Hyperactivity Disorder Assessment Scale),* 7th Edn. Madrid: TEA Ediciones.

Fuggetta, G. P. (2006). Impairment of executive functions in boys with attention deficit/hyperactivity disorder. *Child Neuropsychol.* 12, 1–21. doi: 10.1080/09297040500203418

Fuster, J. M. (2008). *The Prefrontal Cortex*, 4th Edn. London: Academic Press.

García-Madruga, J. A., Vila, J. O., Gómez-Veiga, I., Duque, G., and Elosúa, M. R. (2014). Executive processes, reading comprehension and academic achievement in 3th grade Primary students. *Learn. Individ. Differ.* 35, 41–48. doi: 10.1016/j.lindif.2014.07.013

Geurts, H. M., Verté, S., Oosterlaan, J., Roeyers, H., and Sergeant, J. A. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? *J. Child Psychol. Psychiatry* 45, 836–854. doi: 10.1111/j.1469-7610.2004.00276.x

Golden, C. J. (1978). *Stroop Color and Word Test. A Manual for Clinical and Experimental Uses*. Wood Dale, Illinois: Stoelting Co.

Grodzinsky, G. M., and Barkley, R. A. (1999). Predictive power of frontal lobe tests in the diagnosis of attention deficit hyper-activity disorder. *Clin. Neuropsychol.* 13, 12–21. doi: 10.1076/clin.13.1.12.1983

Hale, J. B., Reddy, L. A., Decker, S. L., Thompson, R., Henzel, J., Teodori, A., et al. (2009). Development and validation of an attention-deficit/hyperactivity disorder (ADHD) executive function and behavior rating screening battery. *J. Clin. Exp. Neuropsychol.* 31, 897–912. doi: 10.1080/13803390802687423

Inasaridze, K., and Bzhalava, V. (2010). Dual task performance in children and adolescents with ADHD. *Behav. Neurol.* 23, 193–194. doi: 10.3233/BEN20100292

Jurado, M. B., and Roselli, M. (2007). The elusive nature of executive functions: a review. *Neuropsychol. Rev.* 17, 213–233. doi: 10.1007/s11065-007-9040-z

Karatekin, C. (2004). A test of the integrity of the components of Baddeley's model of working memory in attention-deficit/hyperactivity disorder (ADHD). *J. Child Psychol. Psychiatry* 45, 912–926. doi: 10.1111/j.1469-7610.2004.t01-1-00285.x

Karatekin, C., White, T., and Bingham, C. (2009). Regulation of cognitive resources during an n-back task in youth onset psychosis and attention-deficit/hyperactivity disorder (ADHD). *Int. J. Psychophysiol.* 73, 294–307. doi: 10.1016/j.ijpsycho.2009.05.001

Kaufman, A. S., and Kaufman, N. L. (2000). *K-BIT. Test Breve de Inteligencia de Kaufman (Kaufman Brief Intelligence Test)*, 2nd Edn. Madrid: TEA Ediciones.

Lambek, R., Tannock, R., Dalsgaard, S., Trillingsgaard, A., Damm, D., and Thomsen, P. H. (2010). Validating neuropsychological subtypes of ADHD: how do children with and without an executive function deficit differ? *J. Child Psychol. Psychiatry* 51, 895–904. doi: 10.1111/j.1469-7610.2010.02248.x

Lambek, R., Tannock, R., Dalsgaard, S., Trillingsgaard, A., Damm, D., and Thomsen, P. H. (2011). Executive dysfunction in school-age children with ADHD. *J. Atten. Disord.* 15, 646–655. doi: 10.1177/1087054710370935

Langberg, J. M., Dvorsky, M. R., and Evans, S. W. (2013). What specific facets of executive function are associated with academic functioning in youth with attention-deficit/hyperactivity disorder? *J. Abnorm. Child Psychol.* 41, 1145–1159. doi: 10.1007/s10802-013-9750-z

Lansbergen, M. M., Kenemans, J., and van Engeland, H. (2007). Stroop interference and attention-deficit/hyperactivity disorder: a review and meta-analysis. *Neuropsychology* 21, 251–262. doi: 10.1037/0894-4105.21.2.251

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychol. Bull.* 109, 163–203. doi: 10.1037/0033-2909.109.2.163

Mannuzza, S., Klein, R. G., Abikoff, H., and Moulton, J. L. (2004). Significance of childhood conduct problems to later development of conduct disorder among children with ADHD: a prospective follow-up study. *J. Abnorm. Child Psychol.* 32, 565–573. doi: 10.1023/B:JACP.0000037784.80885.1a

McCloskey, G., Perkins, L. A., and Van Divner, B. (2009). *Assessment and Intervention for Executive Difficulties*. New York, NY: Routledge.

McInnes, A., Humphries, T., Hogg-Johnson, S., and Tannock, R. (2003). Listening comprehension and working memory are impaired in attention-deficit hyperactivity disorder irrespective of language impairment. *J. Abnorm. Child Psychol.* 31, 427–443. doi: 10.1023/A:1023895602957

Miranda, A., Colomer, C., Mercader, J., Fernández, M. I., and Presentación, M. J. (2015). Performance-based tests versus behavioral ratings in the assessment of executive functioning in preschoolers: associations with ADHD symptoms and reading achievement. *Front. Psychol.* 6:545. doi: 10.3389/fpsyg.2015.00545

Miyake, A., and Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: four general conclusions. *Curr. Dir. Psychol. Sci. Am.* 21, 8–14. doi: 10.1177/0963721411429458

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., and Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: a latent variable analysis. *Cogn. Psychol.* 41, 49–100. doi: 10.1006/cogp.1999.0734

Nigg, J. T., Blaskey, L. B., Huang-Pollock, C., and Rappley, M. D. (2002). Neuropsychological executive functions and ADHD DSM-IV subtypes. *J. Amer. Acad. Child Adoles. Psychiatry* 41, 59–66. doi: 10.1097/00004583-200201000-00012

Nigg, J. T., Willcutt, E. G., Doyle, A. E., and Sonuga-Barke, E. J. S. (2005). Heterogenous Causality in ADHD: the need for a neuropsychologically impaired subtype. *Biol. Psychiatry* 57, 1231–1238. doi: 10.1007/s10567-006-0006-0

Pelegrina, S., Lechuga, M. T., García Madruga, J. A., Elosúa, M. R., Macizo, P., Carreiras, M., et al. (2015). Normative data on the n-back task for children and young adolescents. *Front. Psychol.* 6:1544. doi: 10.3389/fpsyg.2015.01544

Pennington, B. F., and Ozonoff, S. (1996). Executive functions and developmental psychopathology. *J. Child Psychol. Psychiatry* 37, 51–87. doi: 10.1111/j.1469-7610.1996.tb01380.x

Perugini, E., Harvey, E. A., Lovejoy, D. W., Sandstrom, K., and Webb, A. H. (2000). The predictive power of combined neuropsychological measures for attention-deficit/hyperactivity disorder in children. *Child Neuropsychol.* 6, 101–114. doi: 10.1076/chin.6.2.101.7059

Ramtekkar, U. P., Reiersen, A. M., Todorov, A. A., and Todd, R. D. (2010). Sex and age differences in attention-deficit/hyperactivity disorder symptoms and diagnoses: implications for DSM-5 and ICD-11. *J. Amer. Acad. Child Adoles. Psychiatry* 49, 217–228. doi: 10.1016/j.jaac.2009.11.011

Re, A. M., Capodieci, A., and Cornoldi, C. (2015). Effect of training focused on executive functions (attention, inhibition, and working memory) in preschoolers exibiting ADHD symptoms. *Front. Psychol.* 6:1161. doi: 10.3389/fpsyg.2015.01161

Reitan, R., and Wolfson, D. (1993). *The Halstead-Reitan Neuropsychological Test Battery: Theory and Clinical Interpretation*. Tucson, AZ: Neuropsychology Press.

Roberts, W., Milich, R., and Fillmore, M. T. (2012). Constraints on information processing capacity in adults with ADHD. *Neuropsychology* 26, 695–703. doi: 10.1037/a0030296

Rohlf, H., Jucksch, V., Gawrilow, C., Huss, M., Hein, J., Lehmkuhl, U., et al. (2012). Set shifting and working memory in adults with attention-deficit/hyperactivity disorder. *J. Neural Transm.* 119, 95–106. doi: 10.1007/s00702-011-0660-3

Schwartz, K., and Verhaeghen, P. (2008). ADHD and stroop interference from age 9 to age 41: a meta-analysis of developmental effects. *Psychol. Med.* 38, 1607–1616. doi: 10.1017/S003329170700267X

Sergeant, J. A. (2005). Modeling attention-deficit/hyperactivity disorder: a critical appraisal of the cognitive-energetic model. *Biol. Psychiatry* 57, 1248–1255. doi: 10.1016/j.biopsych.2004.09.010

Sergeant, J. A., Geurts, H., and Oosterlaan, J. (2002). How specific is a deficit of executive functioning for Attention-Deficit/Hyperactivity disorder? *Behav. Brain Res.* 130, 3–28. doi: 10.1111/j.1469-7610.2004.00276.x

Shallice, T., Marzocchi, G. M., Coser, S., Del Savio, M., Meuter, R. F., and Rumiati, R. I. (2002). Executive function profile of children with attention deficit hyperactivity disorder. *Dev. Neuropsychol.* 21, 43–71. doi: 10.1207/S15326942DN2101_3

Snyder, H. R., Miyake, A., and Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. *Front. Psychol.* 6:328. doi: 10.3389/fpsyg.2015.00328

Sonuga-Barke, E. J. (2005). Causal models of attention-deficit/hyperactivity disorder: from common simple deficits to multiple developmental pathways. *Biol. Psychiatry* 57, 1231–1238. doi: 10.1016/j.biopsych.2004.09.008

van Mourik, R., Oosterlaan, J., and Sergeant, J. A. (2005). The Stroop revisited: a meta-analysis of interference control in AD/HD. *J. Child Psychol. Psychiatry* 46, 150–165. doi: 10.1111/j.1469-7610.2004.00345.x

Willcutt, E. G. (2012). The prevalence of DSM-IV Attention-Deficit/Hyperactivity disorder: a meta-analytic review. *Neurotherapeutics* 9, 490–499. doi: 10.1007/s13311-012-0135-8

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., and Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biol. Psychiatry* 57, 1336–1346. doi: 10.1016/j.biopsych.2005.02.006

Wodka, E. L., Loftis, C., Mostofsky, S. H., Prahme, C., Larson, J., Denckla, M. B., et al. (2008). Prediction of ADHD in boys and girls using the D-KEFS. *Arch. Clin. Neuropsychol.* 23, 283–293. doi: 10.1016/j.acn.2007.12.004

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Elosúa, Del Olmo and Contreras. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 20 June 2017
doi: 10.3389/fpsyg.2017.01023

Alcohol and Illicit Drug Use Are Important Factors for School-Related Problems among Adolescents

Ove Heradstveit[1,2]*, *Jens C. Skogen*[1,3], *Jørn Hetland*[4] and *Mari Hysing*[2]

[1] Center for Alcohol and Drug Research, Stavanger University Hospital, Stavanger, Norway, [2] Regional Centre for Child and Youth Mental Health and Child Welfare, Uni Research Health, Bergen, Norway, [3] Department of Health Promotion, Norwegian Institute of Public Health, Bergen, Norway, [4] Department of Psychosocial Science, University of Bergen, Bergen, Norway

The aim of this study was to investigate the association between alcohol and drug use, and school-related problems measured by low grade point average (GPA) and high school attendance. We also examined potential confounding effects from mental health problems. Although the issue is not new within current literature, the present study has its strengths in a large number of participants and the utilization of registry-based data on school-related functioning. A cross-sectional design is employed in this study using data from a large population-based sample of adolescents, youth@hordaland, in a linkage to official school registry data, and the current study presents data from $N = 7{,}874$. The main independent variables were alcohol use and drug use, as well as potential alcohol- and drug-related problems. The dependent variables were registry-based school attendance and grades. All the alcohol- and drug measures included were consistently associated with low GPA (Odds ratios (OR) ranging 1.82–2.21, all $p < 0.001$) and high levels of missed days from school (ORs ranging 1.79–3.04, all $p < 0.001$) and high levels of hours missed from school (ORs ranging 2.17–3.44, all $p < 0.001$). Even after adjusting for gender, age, socioeconomic status and mental health problems all the associations between alcohol and illicit drug use and the school-related outcomes remained statistically significant. Increasing number of indications on alcohol/drug-related problems and increasing levels of alcohol consumption were associated with more negative school-related outcomes. The results suggest that alcohol- and drug use, and particularly alcohol/drug-related problems, are important factors for school-related problems independently of mental health problems.

Keywords: alcohol use, illicit drug use, alcohol and drug-related problems, school-related problems, grade point average (GPA), school attendance

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
Marie Leiner, Texas Tech University Health Sciences Center, United States
Elisardo Becoña, Universidade de Santiago de Compostela, Spain

***Correspondence:**
Ove Heradstveit
ove.heradstveit@uni.no

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *09 March 2017*
Accepted: *02 June 2017*
Published: *20 June 2017*

Citation:
Heradstveit O, Skogen JC, Hetland J and Hysing M (2017) Alcohol and Illicit Drug Use Are Important Factors for School-Related Problems among Adolescents. Front. Psychol. 8:1023. doi: 10.3389/fpsyg.2017.01023

INTRODUCTION

Adolescents using alcohol and illicit drugs are at risk for prolonged alcohol/drug-related problems (Ellickson et al., 2003), and co-occurrence with mental health problems are often observed among adolescents with alcohol/drug-related problems (Bukstein et al., 1989; Clark et al., 1997). Not least, both alcohol and illicit drug use during adolescence have been found to be associated with long-term negative school-related outcomes, such as lower high school graduation rates (Chatterji, 2006; Renna, 2007; Horwood et al., 2010; Kelly et al., 2015), lower post-secondary educational credentials

(Staff et al., 2008), and higher drop-out rates from school (Van Ours and Williams, 2009; Leach and Butterworth, 2012; Brière et al., 2014).

More immediate consequences of alcohol and illicit drug use on school-related problems, such as poor grade achievement and high absence from school, are also highlighted in the scientific literature. Poor grade achievement has been found to be a potent predictor for dropout from school (Janosz et al., 1997), while lower attendance may be an indicator of disengagement from school and is associated with increased substance use (Chou et al., 2006; Henry and Thornberry, 2010). A study by Perini and Marti (2011) found that substance use had no direct effect on drop-out, but had an indirect impact through the intermediate outcomes of poor grades and high school-absence. In other words, short-term school-related problems appear to be important mediators between alcohol/drug use and long-term negative school-related outcomes. Hence, the investigation of how alcohol/drug-related problems are associated with poor grades and high school-absence may be an important step toward a better understanding of adolescents at risk for more long-term negative school-related outcomes.

Some previous studies report that alcohol and illicit drug use is associated with both poorer grades and lower school attendance. For example, adolescent alcohol and illicit drug use are demonstrated to be related to lower self-reported attendance rates (Roebuck et al., 2004; Chou et al., 2006; King et al., 2006; Henry and Thornberry, 2010; Hemphill et al., 2014) and lower self-reported grade achievement (Williams et al., 2003; DeSimone, 2010; Homel et al., 2014; Stiby et al., 2015), while other contributions report weak or non-significant associations between alcohol use and self-reported grades (Sabia, 2010; Brière et al., 2014) and registry-based grades (Balsa et al., 2011). In sum, the literature is not conclusive to whether alcohol and illicit drug use should be regarded as important factors for poor grade achievement and high school-absence or not.

A range of factors should be noted as potential limitations in the previous literature. First, the extent to which alcohol/drug use is associated with negative school-related outcomes may be influenced by the conceptualization of alcohol/drug use. Alcohol use is very prevalent among adolescents (e.g., Windle, 2003), while only a minority of the adolescent drinkers develop more adverse alcohol/drug-related problems (e.g., Olsson et al., 2016). Nevertheless, most previous studies have used single measures of alcohol or drug use—such as either binge drinking, high-level alcohol consumption, heavy drinking, or illicit drug use—and have not attempted to account for how combinations of potential problematic alcohol/drug-related behaviors relate to school-related problems. In our study we employ combined indicators of potential alcohol/drug-related problems, enabling us to evaluate how high-risk alcohol/drug use patterns are associated with poor grades and low school attendance.

Second, previous studies on associations between alcohol and illicit drug use and grade achievement and school attendance have with only a few exceptions (e.g., Hishinuma et al., 2006; Balsa et al., 2011) relied on self-reported measures of school functioning. A study by Balsa et al. (2011) demonstrated that self-reported grades among adolescents with a present alcohol consumption are not only subject to bias, but also that the bias differs by gender. Specifically, boys are more likely to report deflated grades, while girls are more likely to report inflated grades. Therefore, studies employing registry-based information are needed in the investigation on how adolescent alcohol and illicit drug is associated with school functioning. In our study we utilize a linkage with registry-based data on school grades and attendance, which is rare in previous literature.

Third, it is noted that associations between alcohol and drug use and poor school performance may have significant interactions with socioeconomic status (SES), gender and mental health problems (Busch et al., 2014). In particular, mental health problems are demonstrated as influential factors in relation to both adolescent alcohol and illicit drug use (e.g., Chassin et al., 2013) and to negative school-related outcomes (e.g., Lee et al., 2009), and appears to be particularly important factors to take into account when exploring associations between alcohol and illicit drug use and school-related problems. However, very few studies have included mental health problems in the analyses of associations between alcohol and illicit drug use and grade achievement and school attendance (DeSimone, 2010; Stiby et al., 2015). The present study expands on this by including both internalizing symptoms such as anxiety and depression, along with externalizing symptoms such as inattention/hyperactivity and conduct problems as potential confounders. This enables us to investigate whether or not associations between alcohol and drug use and school grades and attendance are also present when mental health problems are accounted for, or if observed associations between alcohol/drug use and school functioning should merely be regarded as an expression of influences from internalizing and/or externalizing traits (e.g., Chassin et al., 2013).

Fourth, some previous studies have demonstrated that alcohol/drug use is associated with general reductions in grade achievement and school attendance (e.g., Roebuck et al., 2004; Balsa et al., 2011). However, the effect sizes are often small, and it may be difficult to interpret whether or not such reductions in school-related functioning should be regarded as indicators of school-related problems. In our study we address this "interpretation" issue, by investigating associations between alcohol/drug use and school-related problems, defined as low-levels of grade achievement and high-levels of school absence. In this respect, our study provides new knowledge with regard to how alcohol/drug use is associated with short-term school-related problems.

In sum, the present study contributes to the understanding of the association between adolescent alcohol- and illicit drug use and academic achievement in terms of grades and attendance rates. Utilizing a unique linkage between a large scale Norwegian population-based study among adolescents and official school-registry data on student's grades and attendance rates, we aimed to investigate the cross-sectional association between alcohol- and illicit drug use, and alcohol/drug-related problems, and negative school-related outcomes, including low GPA and high number of days and hours missed from class. Importantly, we use official registry based data on both grades and attendance rates, thereby obviating self-report bias in relation to the school-related

outcomes. Additionally, we employed a range of indicators for both alcohol and illicit drug use, along with potential alcohol and drug-related problems, thereby enabling us to investigate associations with school-related functioning across different patterns of alcohol and illicit drug use.

MATERIALS AND METHODS

Study Population

We employed data from the youth@hordaland study, which aimed at providing data on child and adolescent mental health, lifestyle, school performance and use of health services. All adolescents born between 1993 and 1995 living in Hordaland county in western Norway were invited to participate (N = 19,430), and of these 10,257 adolescents chose to participate, giving a participation rate of 53%. After deletion of participants not giving consent to use data from the school registry (N = 682), and those having missing information on either school registry data (N = 1,190) or alcohol- and illicit drug use (N = 511), the final number of participants was 7,874. 52% of the participants were girls, and the mean age in the sample was 17.4 (standard deviation 0.8).

Youth@hordaland is a cross-sectional population-based study carried out during early 2012, and data was collected from adolescents in upper secondary school. The adolescents received information per email and one school hour was used to complete the questionnaires at school. In addition, adolescents not going to school received the questionnaires by mail at their home address, and also mental health services and other institutions were contacted to let adolescents from these settings participate. The questionnaires used in the youth@hordaland study were web-based, and electronic informed consent was obtained from all participants. The study was approved by the Regional Committee for Medical and Health Research Ethics in Western Norway.

In order to provide access to medical care, easy accessible information on mental health services was made available for the adolescents who participated in the youth@hordaland study. Additionally, a direct phone number to the research staff was provided, by which they could call to receive more information. Also, personnel within school health services were informed about the survey, and therefore enabled to be present for the adolescents by the time they answered the questionnaire.

A previous population-based study found that the geographical area from where the adolescents came, Hordaland county, to be regarded as representative of the general Norwegian population (Folkehelseinstituttet, 2010).

Exposure: Alcohol- and Illicit Drug Use

Self-reported measures of alcohol- and illicit drug use were our main independent variables.

Ever Tried Alcohol

Based on a single item "Have you ever tried alcohol?," a dichotomous variable was constructed (Yes/No). N = 6,159 (78.3%) of the sample reported to having consumed alcohol.

Ever Tried Illicit Drugs

Another dichotomous variable was constructed based on a single item "Have you ever tried hash, marijuana or other narcotic substances?" (Yes/No). N = 788 (10.0%) of the sample reported to having tried illicit drugs.

High-Level Alcohol Consumption

Items measuring self-reported glasses of beer, cider, wine, spirits and illegally distilled spirits usually consumed during 14 days were added up. A total of N = 4,503 (61.2%) of the sample reported a present alcohol consumption. The high-level alcohol consumption variable was defined as the above 90th gender-specific percentile alcohol consumption among the adolescents with a present alcohol consumption, and a dichotomous variable was created for high-level alcohol consumption (N = 453). In addition, based on the continuous distribution of alcohol consumption in the sample an ordinal gender-specific variable of alcohol consumption was constructed, including seven levels from never used alcohol to consumption above 90th centile.

Frequent Alcohol Intoxication

Frequency of intoxication was measured based on the question: "Have you ever consumed so much alcohol that you were clearly intoxicated (drunk)?" The original item had five categories ranging from "No, never" to "Yes, more than 10 times." Frequent intoxication was defined as drinking so much that one was clearly intoxicated more than 10 times (Skogen et al., 2014), and on this basis a dichotomous variable was created. N = 1,588 (20.2%) of the sample reported frequent intoxication.

Positive Crafft Score

Alcohol and drug-related problems were measured using the six-item, validated scale CRAFFT. This scale has been designed to identify possible alcohol-and drug related problems among adolescents, and has been demonstrated to have acceptable sensitivity and specificity at a cut-off of $\geq$2 (Dhalla et al., 2011). A dichotomous variable separating those above the cut-off of $\geq$2 on CRAFFT from those below the cut-off were calculated. N = 1,664 (21.2%) of the sample scored above the CRAFFT cut-off, and were operationalized to indicate potential alcohol- or illicit drug-related problems. In our sample the Cronbach's α of the CRAFFT scale was 0.67.

Any and Total Potential Alcohol/Drug-Related Problems

We constructed a dichotomous measure for any potential alcohol/drug-related problems, indicating whether or not an adolescent had a positive score for either having frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT-score or having tried illicit drugs. N = 2,710 (34.4%) of the sample had any potential alcohol/drug-related problem. Similarly, we constructed an ordinal variable for total potential alcohol/drug-related problems, in which we summed up the number of positive scores on frequent alcohol intoxication, high-level alcohol consumption, a positive CRAFFT-score or having tried illicit drugs. A total of 5,164 (66.1%) had none, 1,439 (18.4%)

had one, 743 (9.5%) had two, 384 (4.9%) had three, and 84 (1.1%) had four of these potential alcohol/drug-related problems.

Outcome: Registry-Based Information about School Performance and Attendance

Academic grades were provided by official school registry in Hordaland County. In Norway, secondary schools use a scale running from 1 to 6, with 6 being the highest grade (outstanding competence), 2 being the lowest passing grade (low level of competence), and a 1 is a "fail" (no qualified competence). The grade point average (GPA) was calculated as the average of the student's grades during their time at the school. Mean combined GPA in the sample was 3.85 (standard deviation 0.80). Based on the continuous distribution of GPA in the sample, we dichotomized GPA under/above the 10th gender-specific percentile, constructing a variable indicating low GPA for adolescents scoring below this threshold. 859 (10.9%) of the adolescents had a low GPA.

Official registry-based data on attendance rates were also provided by official registry data from the Hordaland County, and they included both days and school hours of absence for the last semester (6 months). The mean number of days missed in the sample was 4.02 (standard deviation 5.04), while the mean number of hours missed was 7.51 (standard deviation 11.10). Based on the continuous distribution in the sample of respectively days and hours missed from school, we constructed two variables indicating high number of days and high number of hours missed from school for adolescents which were dichotomized under/above the 90th gender-specific levels of respectively number of days and hours they did not attend school. 721 (9.2%) of the adolescents had a high number of days missed, and 767 (9.7%) had a high number of hours missed from school.

Included Co-variates

Demographic information and self-reported symptoms of depression, anxiety, inattention and hyperactivity (ADHD), and conduct problems were included and used as control variables in the main regression analyses.

Demographic Information

Age and gender were retrieved from registry data. In addition, socioeconomic status (SES) was collected by a self-reported item of perceived family economy as either (1) "about the same as others" (67%) (2) "better than others" (26%), or (3) "worse than others" (7%). Information on maternal and paternal educational attainment was collected by two self-report items separating the parental educational attainment variable into only primary school, high school, or more than 4 years of University or higher education. Both perceived family economy and parental educational attainment have been used as measures for SES in previous publications (e.g., Skogen et al., 2014) and have been found to be comparably associated with mental health problems (Bøe et al., 2012). The variables of perceived family economy, paternal educational attainment, and maternal educational attainment were all used as a measure of socioeconomic status (SES), and were included as control variables in the logistic regression models for the associations between alcohol and illicit drug use, and potential alcohol/drug-related problems, and the school-related outcomes of interest.

Mental Health Problems

Symptoms of depression was assessed using the short version of the Mood and Feelings Questionnaire (SMFQ) (Thapar and McGuffin, 1998). The SMFQ consist of 13 items assessing depressive symptoms rated on a 3-point scale, ranging from "Not true," "Sometimes true," and "True." A continuous measure of the SMFQ has recently been validated among Norwegian adolescents (Lundervold et al., 2013), and was used in the regression analyses in our study. In our sample the Cronbach's α of the SMFQ was 0.88.

Symptoms of anxiety were correspondingly identified by employing the five-item inventory SCARED, which is a short form of the 41-item full version screening inventory for anxiety disorders (Birmaher et al., 1999). A continuous measure of the SCARED was used in our regression analyses. The Cronbach's α of the short form of the SCARED instrument in our sample was 0.69.

Symptoms of inattention and hyperactivity were measured using an official Norwegian translation of the Adult ADHD Self-report Scale (ASRS) (Kessler et al., 2007). The ASRS instrument is an 18-item self-report scale, where 9 items construct the hyperactivity-impulsivity subscale and the 9 other items construct the inattention subscale. Responses are given on a 5-point scale ranging from "Never" to "Very often." The Cronbach's α of the ASRS in our sample was 0.89.

Symptoms of conduct problems were measured using the Youth Conduct Disorder (YCD) instrument, consisting of 8 items which are part of the Diagnostic Interview Schedule for Children Predictive Scales (DPS) (Lucas et al., 2001). The DPS scale has been shown to accurately determine adolescents who are at high probability of meeting diagnostic criteria for conduct disorder. The Cronbach's α of the YCD in our sample was 0.79.

Statistical Analysis

The following statistical analyses were conducted: First, the sample was described according to age, gender, socioeconomic status, school-related functioning, and alcohol and drug use (**Table 1**). Second, odds ratios of the associations between alcohol/drug-related variables and the school-related variables were computed using logistic regression models (**Table 2**). More specifically, crude regression models were utilized, followed by adjustments for age, gender and SES, and finally adjusted for age, gender, SES, and mental health problems. Third, logistic regression analyses were conducted for the associations between ordinal number of indications on alcohol/drug-related problems and school-related outcomes, and also these associations were adjusted for the potential confounding by age, gender, SES and mental health problems. Fourth, crude and adjusted logistic regression models were conducted for associations between ordinal levels of alcohol consumption and the school-related outcomes. All analyses were performed using STATA V.14.0 (StataCorp., 2015).

TABLE 1 | Demographical and mental health-related characteristics in the adolescents of the sample ($n = 7,874$).

Demographics	Girls	Boys	*p*-value
Girls, %	52.3		<0.001
Age, mean (SD)	17.4 (0.8)	17.4 (0.8)	n.s.
Perceived family economy, %			<0.01
Below average	8.1	6.2	
Average	70.3	64.6	
Above average	21.6	29.3	
Mothers education, %[a]			n.s.
University/college	11.4	9.7	
High school	40.9	43.3	
Primary school	47.7	47.0	
Fathers education, %[b]			n.s.
University/college	11.5	10.8	
High school	46.3	48.1	
Primary school	42.3	41.1	
ALCOHOL AND ILLICIT DRUG USE			
Tried alcohol, %	81.1	75.2	<0.001
Tried illicit drugs, %	8.5	11.7	<0.001
CRAFFT-score ≥ 2, %	22.9	19.4	<0.001
Frequent drinking to intoxication, %	20.0	20.3	n.s.
MENTAL HEALTH PROBLEMS[c]			
Depression symptoms, mean (SD)	7.29 (6.04)	4.08 (4.87)	<0.001
Anxiety symptoms, mean (SD)	2.02 (1.91)	0.93 (1.51)	<0.001
ADHD symptoms, mean (SD)	28.32 (10.07)	25.08 (10.85)	<0.001
Conduct problems symptoms, mean (SD)	0.38 (0.95)	0.71 (1.48)	<0.001
SCHOOL-RELATED FUNCTIONING			
GPA, mean (SD)	3.95 (0.78)	3.73 (0.80)	<0.001
Days missed, mean (SD)	4.51 (5.26)	3.49 (4.72)	<0.001
Hours missed, mean (SD)	7.58 (10.68)	7.44 (11.55)	n.s.

CRAFFT: screening scale for identification of potential problematic alcohol and drug use among adolescents.

[a] Only includes those who with valid response on mothers education (n = 5,937), excluding those having answered that they don't know (n = 1,881).

[b] Only includes those who with valid response on fathers education (n = 5,819), excluding those having answered that they don't know (n = 1,979).

[c] The measure for mental health problems includes depression (SMFQ), anxiety (SCARED), inattention/hyperactivity (ASRS), and conduct problems (YCD).

RESULTS

Demographical and Mental Health-Related Characteristics in the Sample

The adolescents which were excluded ($n = 2,383$) due to either non-consent for the usage of school registry data, or to missing information on either school registry data or alcohol- and illicit drug use, were found to deviate slightly from the adolescents of the final sample. They were more likely to be younger (mean difference −0.13, $p < 0.001$), to have mothers with higher educational attainment (mean difference 0.11, $p < 0.01$) and fathers with higher educational attainment (mean difference 0.15, $p < 0.001$), to have more symptoms of depression measured by SMFQ (mean difference 0.76, $p < 0.001$), and to have more symptoms of inattention or hyperactivity measured by ASRS (mean difference 0.74, $p < 0.01$). The adolescents who were excluded from the sample and which had valid responses on alcohol and illicit drug use, were found to be less likely to have tried alcohol than the adolescents in the included sample (73.1% compared to 78.3%, $p < 0.001$), but did not deviate on having tried illicit drugs or on the extent to which they had a positive CRAFFT score.

The final sample consisted of $N = 7,874$ participants. **Table 1** outlines the main demographical characteristics of the final sample, as well as the characteristics on alcohol and illicit drugs and school-related variables. The mean age of the sample was 17.4 years (standard deviation 0.83), and the sample included more girls (52.3%, $p < 0.001$). Regarding alcohol- and illicit drug use, a total of 78.3% of the sample had used alcohol, 10.0% had tried illicit drugs, 21.2% scored above the CRAFFT cut-off at ≥2, indicating a problematic alcohol and drug use, and 20.2% of the sample reported to having been intoxicated by alcohol more than 10 times.

Some gender differences were found in the sample. Lower perceived family economy were more common among girls ($p < 0.01$). Girls had higher mean scores compared with boys on symptoms of depression (7.29 vs. 4.08, $p < 0.001$), anxiety (2.02 vs. 0.93, $p < 0.001$) and ADHD (28.32 vs. 25.08, $p < 0.001$), while boys had higher mean scores compared with girls on symptoms of conduct problems (0.71 vs. 0.38, $p < 0.001$). Girls were also more likely to having ever tried alcohol (81.1 vs. 75.2%, $p < 0.001$) and to have a positive CRAFFT score (22.9 vs. 19.4%, $p < 0.001$), while boys were more likely to having tried illicit drugs (11.7 vs. 8.5%, $p < 0.001$). Finally, girls had a higher mean GPA (3.95 vs. 3.74, $p < 0.001$) and a higher number of days missed from school (4.51 vs. 3.49, $p < 0.001$) compared to boys.

Alcohol- and Illicit Drug Use and School-Related Outcomes

Table 2 depicts the crude and adjusted associations between alcohol- and illicit drug use and the school-related outcomes of GPA, days missed from school, and hours missed from school. As detailed in this table, all the alcohol- and drug measures in the crude model were consistently associated (all $p < 0.001$) with low GPA (Odds ratios (OR) ranging 1.82–2.21) and high number of days missed (ORs ranging 1.79–3.04) and hours missed (ORs ranging 2.17–3.44).

When adjusting for age, gender, self-reported family SES and mental health problems the estimated associations were somewhat altered, but even in the fully adjusted model, all measures of alcohol- and illicit drug use still showed statistically significant associations with low GPA (Adjusted odds ratios (AOR) ranging from 1.48 to 2.04, all $p < 0.05$), and high number of days missed (AORs ranging 1.44–2.31, all $p < 0.01$) and high

TABLE 2 | Logistic regression analyses of associations between alcohol- and illicit drug use and negative school-related outcomes.

	Low GPA		High number of days missed from school		High number of hours missed from school	
	OR	95% CI	OR	95% CI	OR	95% CI
TRIED ALCOHOL (n = 6,159)						
Crude	**1.98*****	1.70, 2.31	**2.20*****	1.74, 2.78	**2.99*****	2.32, 3.84
Adjusted for age, gender and SES	**2.12*****	1.79, 2.50	**1.85*****	1.44, 2.36	**2.59*****	1.99, 3.36
+ adj for mental health problems[a]	**1.83*****	1.54, 2.18	**1.60*****	1.25, 2.06	**2.09*****	1.60, 2.73
TRIED ILLICIT DRUGS (n = 788)						
Crude	**1.82*****	1.36, 2.44	**3.04*****	2.51, 3.69	**3.44*****	2.86, 4.14
Adjusted for age, gender and SES	**1.92*****	1.42, 2.58	**2.81*****	2.29, 3.44	**3.12*****	2.57, 3.79
+ adj for mental health problems[a]	**1.48***	1.09, 2.01	**2.31*****	1.87, 2.86	**2.28*****	1.86, 2.80
POSITIVE CRAFFT-SCORE (n = 1,664)						
Crude	**2.04*****	1.65, 2.52	**2.41*****	2.04, 2.83	**2.41*****	2.06, 2.83
Adjusted for age, gender and SES	**2.05*****	1.65, 2.54	**2.13*****	1.80, 2.52	**2.21*****	1.88, 2.60
+ adj for mental health problems[a]	**1.60*****	1.27, 2.00	**1.70*****	1.42, 2.04	**1.53*****	1.28, 1.83
FREQUENT ALC INTOXICATION[b] (n = 1,588)						
Crude	**2.14*****	1.68, 2.72	**1.79*****	1.51, 2.14	**2.17*****	1.84, 2.56
Adjusted for age, gender and SES	**2.31*****	1.80, 2.96	**1.63*****	1.35, 1.96	**2.05*****	1.72, 2.44
+ adj for mental health problems[a]	**2.04*****	1.59, 2.63	**1.44*****	1.19, 1.74	**1.70*****	1.42, 2.04
HIGH ALCOHOL CONSUMPTION[c] (n = 453)						
Crude	**2.12*****	1.42, 3.17	**1.97*****	1.51, 2.56	**2.68*****	2.11, 3.40
Adjusted for age, gender and SES	**2.00****	1.33, 3.00	**1.71*****	1.29, 2.26	**2.51*****	1.96, 3.23
+ adj for mental health problems[a]	**1.66***	1.10, 2.51	**1.48****	1.11, 1.97	**1.90*****	1.46, 2.47
ANY ALCOHOL/DRUG PROBLEM (n = 2,710)						
Crude	**2.21*****	1.86, 2.63	**2.49*****	2.13, 2.90	**2.82*****	2.42, 3.28
Adjusted for age, gender and SES	**2.30*****	1.92, 2.76	**2.17*****	1.85, 2.56	**2.60*****	2.21, 3.04
+ adj for mental health problems[a]	**1.90*****	1.58, 2.30	**1.85*****	1.56, 2.19	**1.98*****	1.67, 2.35

N = 7,874 (girls n = 4,121, boys, n = 3,753).

[a]The measure for mental health problems includes depression (SMFQ), anxiety (SCARED), inattention/hyperactivity (ASRS), and conduct problems (YCD).

[b]Drinking alcohol to intoxication more than 10 times.

[c] ≥90th percentile gender-specific alcohol consumption (n = 453) among adolescents with a present alcohol consumption (n = 4,503).

*Bold font denotes statistical significant mean differences at ***p < 0.001, **p < 0.01, *p < 0.05.*

number of hours missed (AORs ranging from 1.53 to 2.28, all $p < 0.001$).

Ordinal Levels of Potential Alcohol/Drug-Related Problems and School-Related Outcomes

Table 3 outlines the associations between ordinal number of indications on alcohol/drug-related problems and school-related outcomes. For GPA the odds ratios ranged from 2.01 to 2.91 (all $p < 0.001$) in crude models, and from 1.78 to 2.35 in fully adjusted models (all $p < 0.01$). For days missed from school the odds ratios ranged from 2.08 to 4.69 in crude models and from 1.72 to 3.13 in fully adjusted models (all $p < 0.001$), while the odds ratios for hours missed from school ranged from 2.02 to 5.17 in crude models and from 1.62 to 2.93 in fully adjusted models (all $p < 0.001$). In both the crude and adjusted models there were statistically significant monotonous trends in the associations between increasing levels of potential alcohol/drug-related problems and increasingly adverse school-related outcomes (all $p < 0.001$), indicating that more indicators of alcohol/drug-related problems were associated with more negative school-related outcomes.

Ordinal Levels of Alcohol Consumption and School-Related Outcomes

Table 4 depicts the crude associations between ordinal levels of alcohol consumption and the school-related outcomes of low GPA, high number of days missed from school, and high number of hours missed from school. As detailed in the table, increasing levels of alcohol consumption were associated with lower GPA and a higher number of days and hours missed from school, and for all the school-related outcomes of interest these monotonous trends were statistically significant in both the crude and fully adjusted models (all $p < 0.001$).

DISCUSSION

Main Findings

The aim of this study was to investigate the associations between alcohol and drug use, and alcohol/drug-related problems, and school-related problems measured by low GPA and high number

TABLE 3 | Logistic regression analyses of associations between ordinal levels of potential alcohol/drug-related problems and negative school-related outcomes.

	Low GPA[a]		High number of days missed from school[a]		High number of hours missed from school[a]	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
No alc/drug problems ($n = 5,164$)	(Base)		(Base)		(Base)	
1 INDICATION OF ALC/DRUG PROBL ($n = 1,439$)						
Crude	**2.01*****	1.62, 2.49	**2.08*****	1.71, 2.53	**2.02*****	1.66, 2.47
Adjusted for age, gender and SES	**2.03*****	1.63, 2.53	**1.90*****	1.55, 2.33	**1.92*****	1.57, 2.35
+ adj for mental health problems[b]	**1.78*****	1.42, 2.23	**1.72*****	1.39, 2.12	**1.63*****	1.32, 2.01
2 INDICATIONS OF ALC/DRUG PROBL ($n = 743$)						
Crude	**2.81*****	2.02, 3.90	**2.40*****	1.89, 3.06	**3.13*****	2.50, 3.91
Adjusted for age, gender and SES	**2.92*****	2.08, 4.09	**2.13*****	1.66, 2.73	**2.85*****	2.26, 3.59
+ adj for mental health problems[b]	**2.35*****	1.66, 3.31	**1.80*****	1.39, 2.33	**2.17*****	1.70, 2.76
3–4 INDICATIONS OF ALC/DRUG PROBL ($n = 468$)						
Crude	**2.91*****	1.84, 4.60	**4.69*****	3.61, 6.11	**5.17*****	4.00, 6.69
Adjusted for age, gender and SES	**2.98*****	1.87, 4.74	**3.95*****	2.98, 5.22	**4.36*****	3.32, 5.71
+ adj for mental health problems[b]	**2.17****	1.35, 3.48	**3.13*****	2.33, 4.22	**2.93*****	2.17, 3.91

N = 7,874 (girls n = 4,121, boys, n = 3,753).

[a]p-value for trend in the association between potential alcohol/drug-related problems and school-related outcomes, all $p < 0.001$.

[b]The measure for mental health problems includes depression (SMFQ), anxiety (SCARED), inattention/hyperactivity (ASRS), and conduct problems (YCD).

*Bold fonts denotes statistically significant associations: ***$p < 0.001$, **$p < 0.01$.*

TABLE 4 | Logistic regression analyses of associations between ordinal levels of alcohol consumption[a] and negative school-related outcomes.

	Low GPA[b]		High number of days missed from school[b]		High number of hours missed from school[b]	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
CRUDE MODEL						
Never consumed alcohol	(Base)		(Base)		(Base)	
Non-consumption	**1.42****	1.14, 1.76	**1.61****	1.19, 2.19	**1.74****	1.25, 2.42
0.1–19.9th percentile	1.21	0.96, 1.52	**1.59****	1.14, 2.21	**1.88*****	1.32, 2.67
20–49.9th percentile	**1.99*****	1.59, 2.48	**1.97*****	1.49, 2.62	**2.64*****	1.97, 3.55
50–79.9th percentile	**3.24*****	2.50, 4.21	**2.77*****	2.12, 3.64	**4.03*****	3.04, 5.34
80–89.9th percentile	**3.28*****	2.15, 5.01	**3.77*****	2.70, 5.27	**5.09*****	3.61, 7.18
90–100th percentile	**2.97*****	2.01, 4.40	**3.05*****	2.17, 4.29	**6.05*****	4.37, 8.40
FULLY ADJUSTED[c]						
Never consumed alcohol	(Base)		(Base)		(Base)	
Non-consumption	**1.35****	1.08, 1.69	1.36	0.99, 1.88	**1.49***	1.06, 2.10
0.1–19.9th percentile	**1.34***	1.05, 1.72	1.30	0.91, 1.84	**1.60***	1.12, 2.30
20–49.9th percentile	**2.01*****	1.58, 2.56	**1.50****	1.11, 2.03	**1.98*****	1.45, 2.72
50–79.9th percentile	**3.14*****	2.37, 4.17	**1.83*****	1.36, 2.46	**2.83*****	2.09, 3.83
80–89.9th percentile	**2.82*****	1.82, 4.38	**2.50*****	1.74, 3.59	**3.50*****	2.43, 5.04
90–100th percentile	**2.62*****	1.75, 3.94	**2.06*****	1.42, 2.98	**4.01*****	2.81, 5.71

N = 7,874 (girls n = 4,121, boys, n = 3,753).

[a]Presented alcohol level consumption percentiles are calculated among those adolescents who report to have an actual alcohol consumption.

[b]p-value for trend in the association between alcohol variable and school-related variable: all $p < 0.001$.

[c]Adjusted for the confounding of age, gender, SES and mental health problems.

*Bold fonts denotes statistically significant associations: ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.*

of days and hours missed from school. In short, all the alcohol- and drug measures included were consistently associated with low GPA and high number of days and hours missed from school. In this respect, our study supports several previous studies which have reported that adolescent alcohol- and illicit drug use are associated with lower academic achievement (e.g., Williams et al., 2003; DeSimone, 2010; Homel et al., 2014) and increased absence from school (e.g., Roebuck et al., 2004; Hemphill et al., 2014), while it contradicts some recent studies which indicates that alcohol/drug use should not be regarded as particularly important factors for school-related functioning (Sabia, 2010; Balsa et al., 2011; Brière et al., 2014).

Few previous studies have investigated the extent to which the associations between alcohol- and illicit drug use/problems and

negative school-related outcomes may be confounded by mental health problems, along with SES, gender and age. Theoretically, this is a highly relevant issue, as the association between school-related adverse outcomes and adolescent alcohol and illicit drug is likely to be complex and not necessarily causal in its nature (e.g., Busch et al., 2014; Stiby et al., 2015). It is suggested that the often observed association between alcohol and illicit drug use and school-related outcomes may be either direct (e.g., Latvala et al., 2014), that it may be a reverse association (e.g., Crosnoe, 2006; Brière et al., 2014), or that it may be caused by third factors which operate in ways that creates the observed association (e.g., Crosnoe, 2006). Importantly, as developmental models conceptualize alcohol and illicit drug use among adolescents as expressions of a broader tendency toward either internalizing problems or externalizing problems (e.g., Chassin et al., 2013), observed associations between alcohol and illicit drug use and school-related outcomes may therefore be hypothesized to merely be a marker of these broader tendencies.

In our study we adjusted the associations between alcohol- and illicit drug use/problems for the potential confounding from gender, age, socioeconomic factors and mental health problems, in accordance with recommendations from previous studies on this topic (e.g., Sabia, 2010; Balsa et al., 2011). We found that these confounders accounted for some, but not all of the association. In the fully adjusted models all associations between alcohol and illicit drug use/problems and the negative school-related outcomes were still statistically significant, although the size of the odds ratios were generally reduced, particularly when mental health problems were entered into the model. Therefore, our findings suggest that alcohol- and illicit drug use, and potential alcohol/drug-related problems, has a unique contribution to the association with negative school-related outcomes, which only in part may be attributed to the presence of mental health problems, and therefore to the broader tendencies to either internalizing or externalizing problems.

These findings extend the existing literature. A previous study by Sabia (2010) reported that after adjusting for psychological well-being and factors and individual changes in alcohol use, much of the association between alcohol use and grades disappeared. Similarly, Hemphill et al. (2014) reported that most of the association between alcohol use and subsequent grades and school attendance disappeared when adjusting for a range of individual, family, peer and school-related confounders. In our study the association between alcohol and illicit drug use and school-related outcomes consistently remained robust and statistically significant after adjusting for age, gender, socioeconomic status, and mental health.

We also wanted to explore how potential alcohol/drug-related problems contributed to the association between alcohol/drug use and negative school-related outcomes. The CRAFFT instrument is a widely used screening tool for potential alcohol/drug-related problems among adolescents, providing a broader perspective of adolescent alcohol and illicit drug use than self-reported frequency of alcohol and illicit drug use alone (Agley et al., 2015). CRAFFT has been found to correlate with other measures of substance use in adolescents, supporting its efficacy as a screening tool among adolescents (Pilowsky and Wu, 2013; Skogen et al., 2013; Oesterle et al., 2015). In the present findings potential alcohol/drug-related problems as measured by the CRAFFT instrument were consistently associated with negative school-related function in terms of low GPA and high number of days and hours missed from school. The magnitude of the associations between alcohol/drug-related problems as indicated by a positive CRAFFT score and school-related problems was comparable to the magnitudes of the associations between the other included measures of alcohol/drug use and school-related problems. However, we also added supplementary measures for potential alcohol/drug-related problems, in terms of ordinal number of indicators on problematic alcohol and illicit drug use, and we found that higher number of indicators on potential alcohol/drug-related problems was associated with higher levels of school-related problems.

Similarly, the associations with negative school-related outcomes increased with ordinal increases of alcohol consumption levels. This tendency was found with regards to all the negative school-related measures. To our knowledge no previous studies have investigated how increasing levels of either potential alcohol/drug-related problems or alcohol consumption correspond to negative school-related outcomes, such as GPA or school attendance. A previous study reported a dose-response effect between cannabis use and results on standardized assessment test at age 16 (Stiby et al., 2015), while we have not found other studies reporting on how ordinal or continuous levels of alcohol- and illicit drug use/problems are associated with either school grades or school attendance rates. In short, our findings indicate that increasing levels of indicators of alcohol/drug-related problems and increasing levels of alcohol consumption are associated with increasing school-related problems, indicating that high-risk alcohol/drug use is strongly associated with school-related problems. We did not have available data to investigate if these patterns also applied to increasing levels of illicit drug use; something which should be addressed in future studies.

A final noteworthy finding in our study was that the association between alcohol use and negative school-related outcomes were not constricted to only a certain type of drinking pattern, and the magnitude on the association with the school-related problems only slightly varied across different measures of alcohol use. A previous study reported that binge drinking, but not alcohol use without binging, were associated with somewhat lower GPA (DeSimone, 2010). Although we did not have a variable which directly measured binge drinking, we found that both frequent alcohol intoxication and other measures of alcohol use were consistently associated with lower grade achievement, thereby contradicting the findings from DeSimone and colleges. Overall, our findings suggest that all types of alcohol and illicit drug use were associated with negative school-related outcomes, with comparable magnitudes between all measures of alcohol/drug use, and that increasing numbers of indicators for potential alcohol/drug-related problems was associated with more school-related problems.

Implications

Our study suggest that alcohol and illicit drug use should be regarded as important factors for school-related functioning among adolescents, and that alcohol and illicit drug use has

a unique contribution to negative school-related outcomes in terms of low GPA and high number of days and hours missed from school. Although positive associations were found for all included measures of alcohol/drug use, the most high-risk alcohol/drug use patterns had clearly the strongest associations with school-related problems. An important implication of this study is that alcohol/drug use, and particularly the most risky patterns of alcohol/drug use, should be targeted in initiatives aiming at better school-functioning among adolescents. Future studies should be encouraged to investigate to what extent short-term school problems, such as poor grades and high school-absence, serve as mediators between alcohol/drug use and more long-term negative school-related outcomes, as very few studies have explored this possibility (Perini and Marti, 2011).

Strengths and Limitations

The present study has several strengths. First, the sample consists of a well-defined population-based sample of adolescents in the age 16–19 years, which is sufficiently large to enable a detailed investigation of main effects between alcohol- and illicit drug use and school-related outcomes, along with sub-analyses of ordinal levels of alcohol consumption and potential alcohol/drug-related problems. Second, a unique linkage to the official school-registry was utilized, facilitating an investigation of objective data on GPA and days and hours missed from school. Third, the data from our study sample is recent, thus allowing for an updated view into the current status of alcohol- and drug use and its association with school-related outcomes. Fourth, the study used several measures of alcohol- and drug use, including a validated measure of potential alcohol- and drug related problems, i.e., the CRAFFT instrument, along with measures of increasing levels of potential indicators for alcohol/drug-related problems. Fifth, other standardized measures of symptoms on anxiety, depression as well as hyperactivity and inattention, were used in our study. Finally, we adjusted our analyses for a range of potential confounders on the association between alcohol and illicit drug use and school-related problems.

The present study has some limitations. First, the study has a cross-sectional design, and it is therefore not possible to draw conclusion on causality between alcohol and illicit drug use and school-related outcomes based on this study. Second, due to some adolescents not giving consent to use registry data, to missing data in the school-registry, and missing responses on the alcohol- and illicit drug variables, a total of 23% ($n = 2{,}383$) of the school-attending adolescents aged 16–19 were not included in our study. Our analyses revealed that this excluded group reported somewhat higher education among their parents, they were younger, and had more symptoms from depression and ADHD. Additionally, they were less likely to have tried alcohol. In sum, this may affect the generalizability of our findings among the school-attending adolescents. Third, the questionnaire which measured both the alcohol- and illicit drug use and the mental health variables, were solely based on self-report. This may have led to a bias in the data due to misclassification of the independent and control variables used in this study. The use of self-reported measures does not imply the presence of actual psychiatric or substance-related diagnoses, and the lack of clinical interviews in the collection of data on mental health and alcohol- and drug use adds as a limitation to our study. Fourth, we did not include chronic illness as a confounding variable. We may not rule out that chronic illness may have played a confounding role on the association between alcohol/drug use and school-related problems, something which could be addressed in future studies. Fifth, we did not investigate cumulative effects from alcohol/drug use in combination with other potential risk factors such as mental health problems on school-related problems, as this issue is beyond the scope of the present paper. Finally, residual confounding may be an issue.

CONCLUSION

Adolescence is a time period where it is common to experiment with alcohol and illicit drugs, and many of the adolescents which display a risky alcohol and drug use will neither develop long-lasting substance problems nor school- or later work-related problems. However, the results from our study indicate that alcohol- and drug-related problems are important factors in school-related functioning. Importantly, alcohol- and illicit drug use, and potential alcohol/drug-related problems, were consistently associated school-related problems, even when no mental health problems are present, and the associations were particularly strong among adolescents with the most risky alcohol/drug use patterns. Our study highlight the need to keep adolescent's use of alcohol and illicit drugs as an important concern for prevention initiatives at all levels of the society surrounding the adolescents. In particular, efforts aiming to increase school-related functioning among adolescents should be aware of the important role of reducing levels of alcohol and illicit drug use (e.g., Engberg and Morral, 2006). Measures should be made to ensure a proper identification of adolescents at the highest risk for problematic alcohol- and illicit drug use, along with access to and utilization of health care services when needed; while initiatives aiming at reducing total levels of alcohol- and drug use among adolescents are also encouraged.

AUTHOR CONTRIBUTIONS

OH has carried out the literature review for the introduction and discussion sections, conducted the statistical analyses, and has written the manuscript. MH, JH, and JS has been involved in the preparation and conduction of the statistical analyses, and have reviewed and contributed to all parts of the written manuscript.

ACKNOWLEDGMENTS

We thank Regional Centre for Child and Youth Mental Health and Child Welfare at Uni Research Health for making the collection of data, and making the data available for this study. This study was supported by grants provided by the Health Ministry of Western Norway, Fond for Strategic Research on Substance Use (grant number: 912002).

REFERENCES

Agley, J., Gassman, R. A., Jun, M., Nowicke, C., and Samuel, S. (2015). Statewide administration of the CRAFFT screening tool: highlighting the spectrum of substance use. *Subst. Use Misuse* 50, 1668–1677. doi: 10.3109/10826084.2015.1027930

Balsa, A. I., Giuliano, L. M., and French, M. T. (2011). The effects of alcohol use on academic achievement in high school. *Econ. Educ. Rev.* 30, 1–15. doi: 10.1016/j.econedurev.2010.06.015

Birmaher, B., Brent, D. A., Chiappetta, L., Bridge, J., Monga, S., and Baugher, M. (1999). Psychometric properties of the screen for child anxiety related emotional disorders (SCARED): a replication study. *J. Am. Acad. Child Adolesc. Psychiatry* 38, 1230–1236. doi: 10.1097/00004583-199910000-00011

Bøe, T., Øerland, S., Lundervold, A. J., and Hysing, M. (2012). Socioeconomic status and children's mental health: results from the bergen child study. *Soc. Psychiatry Psychiatr. Epidemiol.* 47, 1557–1566. doi: 10.1007/s00127-011-0462-9

Brière, F. N., Fallu, J.-S., Morizot, J., and Janosz, M. (2014). Adolescent illicit drug use and subsequent academic and psychosocial adjustment: an examination of socially-mediated pathways. *Drug Alcohol Depend.* 135, 45–51. doi: 10.1016/j.drugalcdep.2013.10.029

Bukstein, O. G., Brent, D. A., and Kaminer, Y. (1989). Comorbidity of substance abuse and other psychiatric disorders in adolescents. *Am. J. Psychiatry* 146, 1131–1141. doi: 10.1176/ajp.146.9.1131

Busch, V., Loyen, A., Lodder, M., Schrijvers, A. J., van Yperen, T. A., and de Leeuw, J. R. (2014). The effects of adolescent health-related behavior on academic performance a systematic review of the longitudinal evidence. *Rev. Educ. Res.* 84, 245–274. doi: 10.3102/0034654313518441

Chassin, L., Sher, K. J., Hussong, A., and Curran, P. (2013). The developmental psychopathology of alcohol use and alcohol disorders: research achievements and future directions. *Dev. Psychopathol.* 25, 1567–1584. doi: 10.1017/S0954579413000771

Chatterji, P. (2006). Does alcohol use during high school affect educational attainment?: evidence from the national education longitudinal study. *Econ. Educ. Rev.* 25, 482–497. doi: 10.1016/j.econedurev.2005.05.005

Chou, L.-C., Ho, C.-Y., Chen, C.-Y., and Chen, W. J. (2006). Truancy and illicit drug use among adolescents surveyed via street outreach. *Addict. Behav.* 31, 149–154. doi: 10.1016/j.addbeh.2005.04.011

Clark, D. B., Pollock, N., Bukstein, O. G., Mezzich, A. C., Bromberger, J. T., and Donovan, J. E. (1997). Gender and comorbid psychopathology in adolescents with alcohol dependence. *J. Am. Acad. Child Adolesc. Psychiatry* 36, 1195–1203. doi: 10.1097/00004583-199709000-00011

Crosnoe, R. (2006). The connection between academic failure and adolescent drinking in secondary school. *Sociol. Educ.* 79, 44–60. doi: 10.1177/003804070607900103

DeSimone, J. (2010). Drinking and academic performance in high school. *Appl. Econ.* 42, 1481–1497. doi: 10.1080/00036840701721554

Dhalla, S., Zumbo, B., and Poole, G. (2011). A review of the psychometric properties of the CRAFFT instrument: 1999–2010. *Curr. Drug Abuse Rev.* 4, 57–64. doi: 10.2174/1874473711104010057

Ellickson, P. L., Tucker, J. S., and Klein, D. J. (2003). Ten-year prospective study of public health problems associated with early drinking. *Pediatrics* 111, 949–955. doi: 10.1542/peds.111.5.949

Engberg, J., and Morral, A. R. (2006). Reducing substance use improves adolescents' school attendance. *Addiction* 101, 1741–1751. doi: 10.1111/j.1360-0443.2006.01544.x

Folkehelseinstituttet (2010). *The Hordaland Health Study 1997–1999*. Bergen. Available online at: http://husk.b.uib.no/

Hemphill, S. A., Heerde, J. A., Scholes-Balog, K. E., Herrenkohl, T. I., Toumbourou, J. W., and Catalano, R. F. (2014). Effects of early adolescent alcohol use on mid-adolescent school performance and connection: a longitudinal study of students in Victoria, Australia and Washington State, United States. *J. School Health* 84, 706–715. doi: 10.1111/josh.12201

Henry, K. L., and Thornberry, T. P. (2010). Truancy and escalation of substance use during adolescence. *J. Stud. Alcohol Drugs* 71:115. doi: 10.15288/jsad.2010.71.115

Hishinuma, E. S., Chang, J. Y., Goebert, D. A., Nishimura, S. T., Choi-Misailidis, S., and Andrade, N. N. (2006). Substance use as a robust correlate of school outcome measures for ethnically diverse adolescents of Asian/Pacific Islander ancestry. *School Psychol. Q.* 21:286. doi: 10.1521/scpq.2006.21.3.286

Homel, J., Thompson, K., and Leadbeater, B. (2014). Trajectories of marijuana use in youth ages 15–25: implications for postsecondary education experiences. *J. Stud. Alcohol Drugs* 75, 674–683. doi: 10.15288/jsad.2014.75.674

Horwood, L. J., Fergusson, D. M., Hayatbakhsh, M. R., Najman, J. M., Coffey, C., Patton, G. C., et al. (2010). Cannabis use and educational achievement: findings from three Australasian cohort studies. *Drug Alcohol Depend.* 110, 247–253. doi: 10.1016/j.drugalcdep.2010.03.008

Janosz, M., LeBlanc, M., Boulerice, B., and Tremblay, R. E. (1997). Disentangling the weight of school dropout predictors: a test on two longitudinal samples. *J. Youth Adolesc.* 26, 733–762. doi: 10.1023/A:1022300826371

Kelly, A. B., Evans-Whipp, T. J., Smith, R., Chan, G. C., Toumbourou, J. W., Patton, G. C., et al. (2015). A longitudinal study of the association of adolescent polydrug use, alcohol use and high school non-completion. *Addiction* 110, 627–635. doi: 10.1111/add.12829

Kessler, R. C., Adler, L. A., Gruber, M. J., Sarawate, C. A., Spencer, T., and Van Brunt, D. L. (2007). Validity of the world health organization adult ADHD Self-Report Scale (ASRS) screener in a representative sample of health plan members. *Int. J. Methods Psychiatr. Res.* 16, 52–65. doi: 10.1002/mpr.208

King, K. M., Meehan, B. T., Trim, R. S., and Chassin, L. (2006). Marker or mediator? the effects of adolescent substance use on young adult educational attainment. *Addiction* 101, 1730–1740. doi: 10.1111/j.1360-0443.2006.01507.x

Latvala, A., Rose, R. J., Pulkkinen, L., Dick, D. M., Korhonen, T., and Kaprio, J. (2014). Drinking, smoking, and educational achievement: cross-lagged associations from adolescence to adulthood. *Drug Alcohol Depend.* 137, 106–113. doi: 10.1016/j.drugalcdep.2014.01.016

Leach, L. S., and Butterworth, P. (2012). The effect of early onset common mental disorders on educational attainment in Australia. *Psychiatry Res.* 199, 51–57. doi: 10.1016/j.psychres.2012.03.040

Lee, S., Tsang, A., Breslau, J., Aguilar-Gaxiola, S., Angermeyer, M., Borges, G., et al. (2009). Mental disorders and termination of education in high-income and low-and middle-income countries: epidemiological study. *Br. J. Psychiatry* 194, 411–417. doi: 10.1192/bjp.bp.108.054841

Lucas, C. P., Zhang, H., Fisher, P. W., Shaffer, D., Regier, D. A., Narrow, W. E., et al. (2001). The DISC Predictive Scales (DPS): efficiently screening for diagnoses. *J. Am. Acad. Child Adolesc. Psychiatry* 40, 443–449. doi: 10.1097/00004583-200104000-00013

Lundervold, A. J., Breivik, K., Posserud, M.-B., Stormark, K. M., and Hysing, M. (2013). Symptoms of depression as reported by Norwegian adolescents on the short mood and feelings questionnaire. *Front. Psychol.* 4:613. doi: 10.3389/fpsyg.2013.00613

Oesterle, T. S., Hitschfeld, M. J., Lineberry, T. W., and Schneekloth, T. D. (2015). CRAFFT as a substance use screening instrument for adolescent psychiatry admissions. *J. Psychiatr. Pract.* 21, 259–266. doi: 10.1097/PRA.0000000000000083

Olsson, C. A., Romaniuk, H., Salinger, J., Staiger, P. K., Bonomo, Y., Hulbert, C., et al. (2016). Drinking patterns of adolescents who develop alcohol use disorders: results from the victorian adolescent health cohort study. *BMJ Open* 6:e010455. doi: 10.1136/bmjopen-2015-010455

Perini, L., and Marti, J. (2011). *Substance Use And High School Academic Performance*. Neuchâtel: Inst. de Recherches Economiques, Univ. de.

Pilowsky, D. J., and Wu, L.-T. (2013). Screening instruments for substance use and brief interventions targeting adolescents in primary care: a literature review. *Addict. Behav.* 38, 2146–2153. doi: 10.1016/j.addbeh.2013.01.015

Renna, F. (2007). The economic cost of teen drinking: late graduation and lowered earnings. *Health Econ.* 16, 407–419. doi: 10.1002/hec.1178

Roebuck, M. C., French, M. T., and Dennis, M. L. (2004). Adolescent marijuana use and school attendance. *Econ. Educ. Rev.* 23, 133–141. doi: 10.1016/S0272-7757(03)00079-7

Sabia, J. J. (2010). Wastin'away in margaritaville? new evidence on the academic effects of teenage binge drinking. *Contemp. Econ. Policy* 28, 1–22. doi: 10.1111/j.1465-7287.2008.00120.x

Skogen, J. C., Bøe, T., Knudsen, A. K., and Hysing, M. (2013). Psychometric properties and concurrent validity of the CRAFFT among Norwegian adolescents. Ung@ hordaland, a population-based study. *Addict. Behav.* 38, 2500–2505. doi: 10.1016/j.addbeh.2013.05.002

Skogen, J. C., Sivertsen, B., Lundervold, A. J., Stormark, K. M., Jakobsen, R., and Hysing, M. (2014). Alcohol and drug use among adolescents: and the co-occurrence of mental health problems. Ung@ hordaland, a population-based study. *BMJ Open* 4:e005357. doi: 10.1136/bmjopen-2014-005357

StataCorp. (2015). *Stata Statistical Software: Release 14.* College Station, TX: StataCorp, L.P.

Staff, J., Patrick, M. E., Loken, E., and Maggs, J. L. (2008). Teenage alcohol use and educational attainment. *J. Stud. Alcohol Drugs* 69:848. doi: 10.15288/jsad.2008.69.848

Stiby, A. I., Hickman, M., Munafò, M. R., Heron, J., Yip, V. L., and Macleod, J. (2015). Adolescent cannabis and tobacco use and educational outcomes at age 16: birth cohort study. *Addiction* 110, 658–668. doi: 10.1111/add.12827

Thapar, A., and McGuffin, P. (1998). Validity of the shortened mood and feelings questionnaire in a community sample of children and adolescents: a preliminary research note. *Psychiatry Res.* 81, 259–268. doi: 10.1016/S0165-1781(98)00073-0

Van Ours, J. C., and Williams, J. (2009). Why parents worry: initiation into cannabis use by youth and their educational attainment. *J. Health Econ.* 28, 132–142. doi: 10.1016/j.jhealeco.2008.09.001

Williams, J., Powell, L. M., and Wechsler, H. (2003). Does alcohol consumption reduce human capital accumulation? evidence from the college alcohol study. *Appl. Econ.* 35, 1227–1239. doi: 10.1080/0003684032000090735

Windle, M. (2003). Alcohol use among adolescents and young adults. *Population* 45, 19–15. doi: 10.1111/j.1532-7795.2006.00131.x

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Heradstveit, Skogen, Hetland and Hysing. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

HYPOTHESIS AND THEORY
published: 09 June 2017
doi: 10.3389/fpsyg.2017.00928

The Four Causes of ADHD: Aristotle in the Classroom

*Marino Pérez-Álvarez**

Department of Psychology, University of Oviedo, Oviedo, Spain

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most well-established and at the same time controversial disorders to the extreme of being placed in doubt. In the first of two parts, the established position is critically reviewed, beginning with showing fallacious reasoning on which the diagnosis is based, lacking clinical proof. Similarly, a certain rhetoric and metaphysics in genetic and neurobiological research is highlighted, where, for example, a meager accumulation of data is offered as robust conclusions, and correlates and correlations as causes and bases. However, that may be, the controversy is silenced in a dialog of the deaf between "defenders" and "critics." with no way out in sight in empirical and scientific terms. A new meta-scientific position is necessary to analyze the science of ADHD itself and its social uses. In this respect, the second part introduces Aristotle's four causes, material, formal, efficient, final, as an instrument of enquiry. According to this analysis, ADHD is not the pretended clinical entity as presented, but a practical entity providing a variety of functions. The implications would be rather different from the usual.

Keywords: accidental intolerance, ADHD, Aristotle's four causes, Charcot effect, semiotic mediator

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Claudio Longobardi, University of Turin, Italy
Svend Brinkmann, Aalborg University, Denmark
Susan Hawthorne, St. Catherine University, United States

***Correspondence:**
Marino Pérez-Álvarez
marino@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *09 February 2017*
Accepted: *22 May 2017*
Published: *09 June 2017*

Citation:
Pérez-Álvarez M (2017) The Four Causes of ADHD: Aristotle in the Classroom. Front. Psychol. 8:928. doi: 10.3389/fpsyg.2017.00928

INTRODUCTION

This article takes a critical look at the established conception of what is called "Attention-Deficit/Hyperactivity Disorder" (ADHD). The established concept presents ADHD as a neurodevelopment disorder with a highly inheritable genetic origin which begins in infancy and frequently continues into adulthood. This concept forms part of the beginning of most articles on ADHD, as an already familiar *rhetoric* suggestive of something well-established by consensus.

However, the even authors arguing the standard concept recognize the controversy concerning its clinical entity, perhaps just another aspect of *its* rhetoric. The truth is that there is also extensive literature questioning the clinical medical-scientific validity of ADHD. The controversy may be reduced to two opposite positions: the standard, which states its well-established existence, such that denying it would be like denying that the Earth is round, and the critical, which denies its clinical entity, such that those who argue for it would only be pathologizing normal behaviors and problems. A third position, apparently between them, is limited to criticizing overdiagnosis and overmedication, but is still a variant of the standard concept.

Although the controversy is incessant, it does not seem to go any further in the usual terms of whether ADHD exists or not. The critical position cannot just deny its existence under the assumption that it is an "invention" of the pharmaceutical industry or the bio-power that be or whatever. Not because it is an invention would it no longer constitute a factual, practical, and institutional reality. The question would be what *does* exist. However, those who argue for ADHD cannot do so only with ambiguous rhetoric and questionable implicit assumptions. The question here would be *why* they are as genuinely convinced as they are of such a controversial position.

The controversy cannot be resolved in empirical scientific terms, on the plane of facts, as if the facts spoke for themselves, which is where it now stands. A metascientific, philosophical assessment is required, with an ontological scope asking *what* ADHD is, and epistemological scope asking *how* science itself knows and molds what has ended up as the actual "ADHD."

This approach is based on a critical position (not ingenuous) concerning the impressive neuroscientific evidence claimed as support for the established concept. Such an approach is unthinkable for those who assume the standard concept, given their amazement that anyone would deny it. Without denying their data, light will be shed on the *rhetoric* and *metaphysics* that sustain it. If the rhetoric suggests more persuasive than truthful reasoning, metaphysics refers here to implicit assumptions about genetics and the brain which go *beyond* what genomics and brain connectomics really permit. The article has two parts. The first concentrates on revealing the rhetoric and metaphysics of ADHD neuroscience. The second develops the metascientific approach beyond the usual controversy – whether or not it exists – attempting instead to understand what it is that exists and how it came to be that way.

RHETORIC AND METAPHYSICS OF THE ADHD NEUROSCIENCE

Instead of uncritically assuming the standard ADHD concept as if scientific evidence required it, we review its consistency, focusing on the *rhetoric* and *metaphysics* on which it is largely based. Its three basic pillars, diagnosis, genetics, and neurobiology, are specifically reviewed.

How to Make a Diagnosis with Fallacious Reasoning (with Tautologies)

Everything begins and has its basis in the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM; American Psychiatric Association, 2013). For the case in hand, it does not matter whether the International Classification of Diseases (ICD; World Health Organization, 1992) is used. It is the DSM/ICD diagnostic systems themselves which are questioned as a valid basis for making diagnoses. Suffice it to cite in this respect the critical position of two international psychiatric organizations. The first is the statement by Thomas Insel on April 29, 2013, as Director of the National Institute of Mental Health (NIMH), that the Institute was not going to use the DSM-5 criteria at the point of being released, as in fact it was in May the same year, due to its lack of validity. As Insel (2013) states:

> The strength of each of the editions of DSM has been "reliability" – each edition has ensured that clinicians use the same terms in the same ways. The weakness is its lack of validity. Unlike our definitions of ischemic heart disease, lymphoma, or AIDS, the DSM diagnoses are based on a consensus about clusters of clinical symptoms, not any objective laboratory measure.

The Critical Psychiatry Network, an organization of critical psychiatrists who focus on a biomedical approach in psychiatry, has promoted a campaign under the slogan, "No more psychiatric labels" for abolition of the DSM/ICD, also on the basis of its lack of validity (Timimi, 2014).

The DSM may have improved reliability with regard to consistency among those who apply it, but validity is something else: its correctness and robustness for making a diagnosis. A Marcia Angell, ex-director of the *New England Journal of Medicine* says about psychiatric diagnoses:

> If nearly all physicians agreed that freckles were a sign of cancer, the diagnosis would be "reliable," but not valid. The problem with the DSM is that in all of its editions, it has simply reflected the opinions of its writers (Angell, 2011).

The diagnostic criteria are established by consensual opinion. But the consensus reveals that there is no evidence. If there had been scientific evidence, a consensus would not be necessary. What more can be said when many of the experts in the consensus are plagued with conflicts of interest and a laboratory in the field funds the meetings (Kooij et al., 2010)? These statements of consensus are upheld by the superabundant bibliography on ADHD, like someone who grabs hold of a lamppost to keep standing up without using it to see by. One consensus cites over 500 references (Barkley, 2002), like bulk evidence by accumulation, without reviewing it to see if it really is accumulated knowledge. Another uses 320 references to *back* its validity (Kooij et al., 2010), without really being clear, firm evidence. The statements of consensus assume a subtly deceitful argument consisting of citing quantities of studies, without any of them being conclusive, which in the end are taken as convergent, promising support. A collection of promising support turns into evidence. For example, after recognizing the challenge of a "diagnosis being based on reported symptoms alone; there are no biological tests" (Thapar and Cooper, 2016, p. 1241), ADHD becomes in the conclusions a "robust and consistent across design type and sample. There are established assessment methods" (Thapar and Cooper, 2016, p. 1247).

The truth is that the diagnosis of ADHD is established, but based on fallacious reasoning, typically two (Tait, 2009): the *Affirming the Consequent Fallacy* and *Begging the Question Fallacy*. According to the affirming the consequent fallacy, *if* the child "often fails to give close attention to details," "often fidgets with or taps hands or squirms in seat"... (statements in the DSM-5 criteria) *then* he has ADHD. According to the begging the question fallacy it is already known that the child has ADHD because he/she "often fails to give close attention to details," "often fidgets with or taps hands or squirms in seat," and so on. The child does not pay attention and fidgets *because* he/she has ADHD and he/she *has* ADHD because he does not pay attention and fidgets. The symptoms are the guarantee of the diagnostic category, which in turn is invoked to explain the symptoms in an endless loop (Brinkmann, 2014b, p. 128). The diagnostic category is molded in the process of making the diagnosis of the case. In turn, the diagnosis of the case sustains the clinical category without other independent tests or genetic evidence or neurobiology of diagnostic value as discussed below. The *Non-Sequitur Fallacy*, which assumes that if the medication (typically stimulants) reduces hyperactivity, the hyperactivity is a symptom and ADHD is a disorder, also commonly occurs. But

one does not follow the other, not logically and not empirically, since stimulants produce the same effect whether you *have* ADHD or *not*.

The diagnosis is based on fallacious reasoning, not on clinical tests as would be expected in view of how sure the affirmations are. Based on DSM/ICD diagnosis, a series of objective, complementary, and supposedly confirmatory tests are being studied. Among the most objective is the Test of Variables of Attention (TOVA), a continuous performance test (CPT) (Fried et al., 2014; Rodríguez et al., 2016). The TOVA presents a computerized task which evaluates omissions, commissions, reaction times, variability, and post-commission response times. Apart from the scant ecological validity as a task little representative of daily situations, the biggest problem with the TOVA is its inadequate specificity, leading to false positives and false negatives: children not ADHD who "fail" and ADHD children who do well (Zelnik et al., 2012; Fried et al., 2014).

The problem of ecological validity can be reduced with virtual reality tests. However, up to now support is limited (Neguţ et al., 2016). Virtual reality tests, even though they show sensitivity, also lack diagnostic specificity due to variability and overlapping of the measures (Areces et al., 2016; Neguţ et al., 2016). In fact, the TOVA, whether or not in virtual reality, is applied to children already differentiated by the DSM diagnostic criteria: children *with* ADHD or *without* ADHD, not as a diagnostic test itself. These tests can be useful for evaluating attention *skills*, precision or reaction times, which may be relevant in themselves without presupposing ADHD. They measure what they measure, but it could not be said that *the* ADHD is measured.

On the basis of the self-interested consensus that may be assumed from declared conflicts of interest and sponsorship of commissioned work (Barkley, 2002; Kooij et al., 2010; Faraone et al., 2015), inconsistent conclusions (Thapar and Cooper, 2016) and fallacious reasoning (Tait, 2009), surprisingly, or perhaps not, the sentence, as dogmatic as antiscientific, is that doubting ADHD would be like "declaring the Earth flat, the laws of gravity debatable, and the periodic table in chemistry a fraud" (Barkley, 2002, p. 90). According to Timimi et al. (2004) in his comment on this consensus, "It is regrettable that they wish to close down debate prematurely and in a way not becoming of academics. The evidence shows that the debate is far from over" (Timimi et al., 2004, p. 63). Even without assuming intentionality due to conflicts of interest in establishing a consensus, its unintentional influence through default brain-centered thinking cannot be discarded, as mentioned further below.

How to Make Genetics Seem Like Evidence (with Ambiguities)

Beyond the diagnosis, one fundamental aspect of the ADHD rhetoric is its consideration as a highly inheritable genetic disorder (Tarver et al., 2014; Gallo and Posner, 2016; Thapar and Cooper, 2016). If the diagnosis is, as it is, based on a consensus dominated by conflicts of interest more than on tests, lacking in validity and more than anything else tautological, it is going to be hard for there to be specific genetic and neurobiological bases.

The reviews show two things: the non-existence of *real* molecular genetic evidence and the persistence in their affirmation. We refer here to reviews by authors who are not precisely critical of the genetic perspective, but as scientists are compelled to recognize what there is, not without their rhetoric. Thus Cortese, after reviewing the convergence of different approaches (none conclusive), refers to the future, "It is expected that future research will reveal similarly exciting convergent findings" (Cortese, 2012, p. 430). Thapar and Cooper (2016, p. 1242) recognize that "ADHD-associated genomic variants are non-specific." A study by Thapar himself and others found that 14% of children diagnosed with ADHD had a rare chromosomic difference known as "copy number variants" compared to 7% of children not diagnosed with ADHD who also had it (Williams et al., 2010). Although the finding was magnified by emphasizing double the chromosome rarity in ADHD (13.95% over 7.4%) and was even taken as "direct evidence that ADHD is a genetic disorder" (Wellcome Trust, 2010), the truth is that 86% of children with ADHD did not have this rarity and 7% of those without ADHD did.

Tarver et al. (2014, p. 763) likewise acknowledge that "Genomic-wide searches have yet to identify a single candidate gene," although they add that "This is probably due to insufficient sample sizes to date." However, as suggested by Sonuga-Barke (2010, p. 113), "We are now using larger and larger samples of patients to demonstrate smaller and smaller molecular genetic main effects." As Thapar et al. (2013) admit in their conclusions:

> The genetic risks implicated in ADHD generally tend to have small effect sizes or be rare and often increase risk of many other types of psychopathology. Thus, they cannot be used for prediction, genetic testing or diagnostic purposes beyond what is predicted by a family history" (Thapar et al., 2013, p. 3).

Gallo and Posner (2016) also recognize the scant genetic evidence, but not without inconsistent rhetoric between what they affirm and what they really find. They state that "ADHD is a highly heritable disorder" (Gallo and Posner, 2016, p. 558) to continue by saying, "Despite substantial evidence for a genetic origin of ADHD, specific genes or sets of genes causally linked to the disorder have yet to be discovered" (p. 559). This rhetoric of inconsistencies continues when they say, "Substantial progress has been made in clarifying the complex genetic architecture of ADHD, yet the mismatch between the high heritability estimates and weak associations between ADHD and specific genetic markers is puzzling" (p. 560). After all, they feel obliged to admit that "Although candidate genes and neuro transmitter systems have been implicated in ADHD, genome-wide associations between ADHD and individual genetic variants have yet to be found" (p. 563).

The claimed heritability in ADHD is based on statistical data, not on *genetic* data as such. It often refers to ADHD running in the family and to the higher coincidence in monozygotic than in dizygotic twins. Many things run in the family, such as an accent in language or religion without therefore being genetic. Identical twins share more environmental conditions than non-identical twins so this and other "twin method" reasons do not enable the

genetic-environmental knot to be unraveled, much less talk about percentages (Joseph, 2015).

Attention-Deficit/Hyperactivity Disorder may be hereditary, but not therefore genetic. Of the four ways of inheritance, genetic, epigenetic, behavioral, and cultural (Jablonka and Lamb, 2005), genetic is probably the least expectable in transmitting ADHD-type behavioral traits. It is not among the functions of genes to generate behavioral traits. The metaphors "code" and "program" have seduced the imagination of scientists, professionals and people in general so they sound like genes do more than they really do. As development *resources*, more than deterministic "programs," everything related to genes depends on the context, from cellular, extracellular, embryonal, and intrauterine to perinatal and social, from womb to tomb. Recent research in epigenetic and genomic plasticity causes genes to be reconceived beyond their traditional conception as agents instructing traits (González-Pardo and Pérez Álvarez, 2013). The new conception means a change in genes to genome (including non-codifying matter) and of action to reaction referred to genome reactivity as a dynamic system "exquisitely sensitive" to signals in both the organism's immediate intracellular context and external environment as a whole (Keller, 2014, p. 2428). The genome *mediates* adaptation and response to the environment; it does not *cause* response and adaptive action. As Keller (2014, p. 2427) says:

> In addition to providing information required for building and maintaining an organism, the genome also provides a vast amount of information enabling it to adapt and respond to the environment in which it finds itself.

For lack of firm evidence, the defense of ADHD genetics at all costs is served by rhetoric, with two formulas, one consisting of saying that ADHD is a "heterogeneous," "multifactorial," or "complex" disorder, and the other emphasizing "gene–environment interaction."

Talking about "heterogeneous," "multifactorial," or "complex" in psychiatry is synonymous today with lack of specific genetic evidence (Joseph, 2009, p. 72). These expressions sneakily suggest the genetic condition of a disorder by implying a complicated involvement of numerous genes, with no more evidence than thin correlational associations. But an association is not causation. For lack of precise and specific evidence, the genetic argument of ADHD becomes a loop. As Pittelli (2002) says when commenting on a meta-analysis, "The argument that ADHD is "mediated by many genes acting in concert" is rather circular in that it is based primarily on the complete failure of molecular genetic studies to find such genes and replicate those findings" (Pittelli, 2002). ADHD is still "complex" even without thinking about genes.

The commonly referred to gene–environment interaction also insinuates that there is more than there really is: supposed genes interacting with the environment. The formula here is sibylline, as deceitful as it is hard to contradict. Nevertheless, two arguments must be considered.

In the first place, if the ADHD genes are not identified, and they are not, then it is going to be hard to talk sensibly about their interaction. What are we talking about when we discuss interaction? Are the genes active agents able to interact following a "program" or "code" for some behavioral trait? What specific interactions are in play if not even the ADHD phenotype is well-defined? Endophenotypes supposedly closer to genetic influences, such as reaction times, response inhibition or working memory, are also discussed. But research shows that endophenotypes lack specificity for the ADHD phenotype itself (Gallo and Posner, 2016). Endophenotypes are expected to "increase statistical power to identify relevant associations between genes and neurobiological mechanisms," but they remain "a promising route" (Gallo and Posner, 2016, p. 560); the new promise, not cold hard findings.

The second argument says the gene–environment or biology-culture dichotomy itself loses sense in genomic times (Keller, 2012, 2014). It no longer makes sense to talk about interaction as of two preexisting things that enter into interaction (gene–environment) and much less percentages of heritability.

> What research in genomics has shown is that biology itself is constituted by those interactions, and is so constituted at every level, even at the level of genetics. Indeed, one might say that what makes a molecule—any molecule—biological is precisely its capacity to sense and react to its environment (Keller, 2012, p. 139).

The reactivity inherent in biological systems enables development to be understood as a set of cells with their multiple molecules, functioning in mutual concert for a certain result, not thereby executing a central program (Fisher et al., 2011, p. 74). According to this conception of development, it is hard to argue the conception of genes as "instructor agents" or "instructions" of traits which some day, for example, at school age, or in adult life, will be "expressed" as ADHD behavior. What persistent genetic research really underlines is the decisive role of environment in the development of mental disorders (Sonuga-Barke, 2010). It no longer makes sense to talk about percentages. Nature itself, constituting organisms in their continuous interactions, places us beyond typical topical percentages.

The tangled nature of genetics and the environment, even in genetic conditions such as diabetes, keeps heritability from being unpacked, or from there being any interest in doing so (Chaufan, 2008). To begin with, heritability in its technical sense is an attribute of a population, not of individual traits. Furthermore, organisms and phenotypes are *non-additive* products of genes, in an historic sequence of development environments and chance events, so their interdependence impedes any empirical or statistical quantification of the "ingredients" in this mixture. Empirically, the genetic-environmental percentage could be established in breeding animals and in agriculture, from which statistical techniques are derived, enabling quantification that makes sense under controlled conditions. But statistical analyses (typically analysis of variance) are not analyses of *causes,* and therefore do not permit understanding what *caused* a disorder in an individual (Chaufan, 2008, pp. 21, 35). The problem of heritability is not resolved with *larger* samples (Chaufan, 2008, p. 37), as in the promise of the overused genetic perspective (Thapar et al., 2013, p. 7; Tarver et al., 2014, p. 763; Gallo and Posner, 2016, pp. 559–560). It has already seen in schizophrenia, a clinically well-established disorder (Pérez-Álvarez et al., 2016),

unlike ADHD, how larger samples of thousands of patients do not lead to stronger genetic associations (Ross, 2016; Sekar et al., 2016).

While the concept of hereditability is confusing at least, for understanding the category, it lacks application to individuals. Even if there were "ADHD genes," *pre*disposition does not imply availability of the phenotype, according to epigenetic chance (González-Pardo and Pérez Álvarez, 2013; Dillon and Craven, 2014; Mukherjee, 2016).

Quantification of heritability has little to offer for understanding ADHD. According to Chaufan (2008), the genetic emphasis may even be harmful to the extent that it diverts public attention and research funding from the social determinants, which are decisive in the end, even in genetic conditions such as diabetes. There may be more science policy than science itself in pursuance of genetics, concerning interests and status of the authors involved, beginning with the hegemony of the biomedical model.

How to Make Causes Out of Correlations and Correlates (by Calling Them "Bases")

A critical position must also be adopted regarding ADHD as a disorder of neurodevelopment, as presented in its standard packaging, instead of simply assuming it without further consideration. The literature in favor of the neurodevelopment approach is undeniably enormous and the amount of data overwhelming. However, the data do not speak for themselves, but by the perspective in which they are taken. In an uncritical neurodevelopment perspective which places the brain under spotlights as if it were the place the keys to ADHD should be found, data providing feedback for this search are not lacking nor will they be. Things always happen in the brain related to the activities of organisms. It would be of concern if it were not. As more and more sensitive measurements of the brain's functioning become available, neural correlates of the activities selected are found more easily. Another thing is the relevance of the findings and the meaning of the correlation: causal and in what direction, or artefactual due to third factors involved.

A brain-centered approach like the one predominating research and propagated for ADHD incurs easily in two biases: a *tunnel effect* in which one looks in only one direction and a *zoom effect* which magnifies what is seen. A new panoramic and even telescopic approach is necessary which puts the brain in its place: in the body of a subject who behaves within a context and who sees from a distance what is known without becoming "stuck" to the data. Without doubt, more and more is known about the brain due to the new technologies and concepts of its functioning, but not because of this is more known about ADHD, as it has been demonstrated that in spite of everything, its status is still controversial. There is a mountain of data, that is, an enormous amount has been accumulated, but it cannot be said that it is really the solid, accumulative scientific knowledge with which research progresses. After all, there are no "diagnostic neurobiological markers" (Thapar and Cooper, 2016, p. 1243), the "underlying mechanisms" are unknown (Cortese, 2012, p. 2) and in general, "findings from neurobiological research do not have a direct application in daily clinical practice," (Cortese, 2012, p. 9).

The variability and inconsistency of the findings may be reflecting the heterogeneity and lack of entity of the so-called "ADHD." As Beare et al. (2016) say of their own findings:

> Attention-Deficit/Hyperactivity Disorder is an extremely heterogeneous disorder, with few common findings across studies. The variability in findings resulting from methodological decisions in this study illustrates the caution that must be taken in relating network differences to underlying neurobiology.

Neurobiological research is moving from focusing on brain areas toward dysfunctions in circuits distributed throughout the brain, leading to the new concept of "pathoconnectomics" (Cao et al., 2015). Pathoconnectomics assumes that major psychiatric disorders (e.g., ADHD) involve abnormalities of brain networks and that understanding the aberrant organization of brain networks is critical for understanding these brain disorders (Cao et al., 2015, p. 2802). Connectomics combines the study of structural connectivity between regions and functional connectivity consisting of synchronies of remote neuronal activities (Cao et al., 2015). A set of sophisticated mathematical techniques and functional magnetic resonance imaging along with the more conventional electroencephalography/hemoencephalography and infrared spectroscopy, enable a new topology and cartography of the brain (Rodríguez et al., 2011; Cao et al., 2015).

Both regional and general wiring impairments have been found in ADHD. Among the regional impairments, are volumetric reductions in the basal ganglia and abnormalities in cortical thickness in frontal and parietotemporal brain regions (Gallo and Posner, 2016, p. 556). In functional connectivity, one "of the more commonly reported abnormalities is reduced connectivity within the default mode network (DMN)" (Gallo and Posner, 2016, p. 557). DMN is a set of areas in the brain described in 2001 which is associated with mental processes at rest or wandering when one is not busy in some concrete external task (Raichle, 2015).

The hypothesis is that persistent activity of the DMN can interfere with the cognitive control network (CCN) involved in executive functions. Another hypothesis is that individuals with ADHD may have weaker connectivity in DMN when at rest, suggesting immaturity and atypical development. The two networks, DMN/CCN, seem to work in opposite directions in attentional tasks, "As attentional demands increase, activation of the CCN increases, whereas DMN activation decreases; conversely, during periods of internally focused cognitions, activation in the CCN is reduced, and DMN activation increases" (Gallo and Posner, 2016, p. 558). Interplay of correlative transitions would mean normal, mature and typical development.

Four considerations must be made before or instead of taking the neurodevelopment brain-centered perspective automatically, by default, as if there were no other option.

In the first place, the neurodevelopment approach leads to establishing a dichotomy between typical, normal or mature development and atypical, abnormal or immature development

defining a psychiatric disorder (Cao et al., 2015). This dichotomy could be induced by the logic of the approach itself more than anything else, with its tunnel and zoom effects, selecting and magnifying some things and leaving others out. If individuals are selected for certain more or less conspicuous characteristics and taken to extremes with respect to others who do not have them, more or less associated neuronal correlates could appear depending on how well defined those characteristics are. Take the conditions of being a taxi driver or a non-taxi driver, or a musician or non-musician. As studies show, the brains of taxi drivers and musicians show alterations in specific areas and connections associated with their activities compared to those who are not (Maguire et al., 2006; Hyde et al., 2009). Now it could be said that taxi drivers and musicians develop an "atypical" brain compared to non-taxi drivers and non-musicians, who after all, make up the majority of the population, and would develop a "typical" brain. There might also be subtypes: Subtype pianist and subtype violinist and who knows whether subtypes of London, Bombay or small-town taxi drivers.

In fact, as a second consideration, the supposed "neuronal bases" for ADHD do not consist of anything but correlations and correlates. They are "associations," which however, implicitly suggest neuronal causes as "bases" (Rubia et al., 2014, p. 532), when not explicitly (Gallo and Posner, 2016; Rodríguez et al., 2016). Thus, Gallo and Posner (2016), after warning about the "limitations of correlational research" (p. 561) and "caution in imputing causality" (p. 563), in the end are thinking about mapping "causal pathways from genes to neural circuits to symptoms" (p. 564). Rodríguez et al. (2016, p. 8), on the other hand, argue for a "causal model" based on explicit assumptions required by the "structural equation modeling" which they use when they refer to the "direct effect" of cortex activation of variables measured by the TOVA as an ADHD index.

As a third consideration, in a discussion of causal directions, it would be more coherent, both in conceptual terms based on brain plasticity and empirical terms related to correlations and correlates found, to argue for the opposite hypothesis, that behaviors themselves are the causes of the correlates or neuron "alterations" found. It would be more coherent to understand cerebral variations as "dependent variables" of the activities that organisms carry out in their environment than as causal "independent variables." The brain changes and adapts in line with an organism's activities depending on the requirements of the environment. The neuron correlates or brain "alterations" of the taxi drivers and musicians are *not* the cause of driving taxis or playing the piano or the violin. The explanation which Rodríguez et al. (2011) themselves offer in the case of measuring blood flow activated in the brain by cognitive tasks and educational exercises is coherent with this causal direction. After subjects are instructed to make mental calculations, oxygenated hemoglobin in their blood increases. As the authors say:

> This approach, combined with educational exercises as *brain-training*, can maximize blood oxygenation directly in certain areas of the brain (Rodríguez et al., 2011, p. 66).

Beyond the ADHD cortex causal model assumed by "structural equations" (Rodríguez et al., 2016), the *real* causation seems to be from the behaviors to the brain (Rodríguez et al., 2011).

Convergent evidence, to use the rhetoric in vogue, is found in the abundant literature showing that ADHD behavior can be modified by exercises and behavioral training, which is hardly understandable if it has a neurological cause and genetic origin. Furthermore, normalization of the brain, which is usually referred to after medication with stimulants (Rubia et al., 2014, p. 529), could be due to its effect on behavior, and it would really be the change in behavior that is promoting change in the brain, something suggested by the authors themselves when they cite a study in which 4 weeks of training in juggling induced relevant changes in the brain (Rubia et al., 2014, p. 529).

A last consideration concerns how the neurodevelopment model reflects the problem of ADHD in real life in the *brain space,* both scientific related to its entity, and ethical referring to the evaluation involved. Thus the reviews still warn of continuous ambiguities and inconsistencies, no matter how interested they are in finding accumulated knowledge (Rubia et al., 2014, p. 523; Gallo and Posner, 2016, pp. 558, 560). These neurobiological ambiguities and inconsistencies probably reflect the very heterogeneity of "ADHD."

The brain space also reflects ethical evaluation of ADHD, describing the "findings" as volumetric or connectivity "reductions," white matter "deficits," "retarded" maturity, "abnormality" or "atypical" development. Transferring normative values to the brain incurs in three problems. First, components which are no more than normative values are neutralized as natural. Second, maturity is linked to age and environment in a disease. Finally, maturity itself is misunderstood as an autonomous process independent of the setting, ignoring that "maturation" is not merely a question of age, but also of what occurs during one's life.

Conclusion

A critical review of the standard conception of ADHD has underlined the tautological (rhetorical) reasoning and assumptions implicit in the causal-explanatory role of the genome and the brain (metaphysics) which impregnate it. It is understood that this conception cannot be taken uncritically as a starting point. Although this review may seem "demolishing," it is not everything. Up to here the criticism has been *negative* ("demolishing"), not reconstructive (explanatory) of what there is. After all, ADHD does *exist*. It is *real*. Negationist critics must recognize that ADHD does *exist*, since we are even discussing it, though it may be to argue and deny it. The question now is to see *what it is that exists, the way it is real*.

In this respect, we recur to an ontological metascientific and metatheoretical approach, beyond the facts and terms of the controversy itself. A new *radical* approach of this type related to the fundamental nature of something, and *whole* considering the different sides and dimensions of the problem, is found in Aristotle's four causes.

METASCIENCE OF ADHD: ARISTOTLE'S FOUR CAUSES

Aristotle's four causes do not refer to empirical or scientific causes. The terms Aristotle uses in his *Physics and Metaphysics*, in which he deals with causes are *aition,* in plural *aitia,* which is where *etiology* comes from. *Aition* has a wider sense than *cause* in English or Spanish. Aristotle's causes refer to explanatory factors or principles that approach "why-questions" in order to explain why something exists the way it is (van Fraassen, 1980, p. 42). In any case, "cause" remains the best term to capture the meaning of Aristotle (Guthrie, 1981, p. 223). In the 21st century, we can still find refreshing thought in Aristotle for the problems of our times. In particular, the doctrine of the four causes is still useful in the "sublunary world" of human things, so the process of construction (workable materials, shapes, agents, purposes) is not lost from sight and thus does not fall or remain in mechanicist causes. The main Aristotelian causes of why, more than mere empirical causes, enable us to think about how science itself works, from a metascientific perspective.

Application of the four causes is not common in psychology, but neither is it unheard of (Killeen, 2001, 2004; Pérez-Álvarez et al., 2008; Pérez-Álvarez, 2009; Ribes-Iñesta, 2015). In the clinic, the *material cause* asks what psychological disorders are made of, the *formal cause* asks what shape they take, why they are that way, *the efficient cause* asks who makes them that way, and the *final cause* asks what purpose they have or what they are for (Pérez-Álvarez et al., 2008). Even though the typical examples of Aristotle's efficient cause are actors or individual makers (sculptor, potter), here the possibility of collective actors or institutional agents (school, family, clinic) is also considered.

The four causes have been specifically applied to ADHD (Killeen et al., 2012). In spite of being systematic, documented, and well-argued, the application by Killeen et al. (2012) failed in important respects. To begin with, it fails by not fitting better to Aristotle's original concept, which would have made it of greater interest. In the end, their application ends up being a mere reorganization of data from the official neurobiological concept, and ignores that this concept itself is in question.

The greatest contribution of the four causes might be in reconsidering the fundamental question of the way in which ADHD exists. In this article, the application by Killeen et al. (2012) will be briefly discussed first. In continuation, a new, more appropriately Aristotelian application is proposed to find consequences that could reorient the controversy and eventually overcome it.

Causes without Revelation or Rebellion: Aristotle for Nothing

Killeen et al. (2012) applied the four causes in the following order: formal, efficient, material and final, distinguishing in turn, according to Aristotle, close or molecular (proximate) and ultimate or molar (distal) causation. The proximate formal cause of ADHD would be the *formal* DSM/ICD diagnosis itself. The ultimate formal cause would be given by the explanatory theories, typically in terms of executive functions. The proximate efficient cause would consist, according to Killeen et al. (2012), of the symptom triggers. They refer to inadequate reinforcement, processing demand overload (speed, duration, complexity), inadequate control of context (chaotic, stressful, unpredictable), boring environments and repetitive tasks. The ultimate efficient cause refers to the origins of the prenatal syndrome (maternal smoking, alcohol) and perinatal (head injury, malnutrition, stressful environment).

The proximate material cause, according to Killeen et al. (2012), would have to do with neurophysiological substrates, dynamic brain events and neuromodulatory systems. The ultimate material cause concerns genetic and epigenetic conditions, static brain structure and differences in the brain. The final proximate cause was found by Killeen et al. (2012) in negative reinforcement (escape from boredom and escape from mental fatigue) and positive reinforcement (approach novel stimuli, achieve goals more quickly, peer approval). The final ultimate cause would be in evolutionary usefulness referring to historical environmental consequences (new niches) and adaptive advantages (exploitation of opportunities, escape from stressful environments).

The application of Killeen et al. (2012) has several problems, beginning with the order of the causes: formal, efficient, material and final. The order is not indifferent, because it determines the interplay and scope of the causes. The logical, chronological and definitively, ontological would be material, formal, efficient and final as usually expressed. The material and formal causes go first, are interdependent on each other and imply the role of the others. Even when Aristotle gave the most importance to the formal cause as form, *eidos*, pattern, that which defines something as what it is, whether a statue or a bowl, the material as amorphous, unshaped raw material comes first, the marble in the statue or the clay in the bowl.

To begin with, the formal cause, which in ADHD, we could agree with Killeen et al. (2012) is the diagnosis made, means attributing the diagnosis entity in its own right, when the diagnosis itself is in question. Without further questioning, the rest of the causes revolve around the diagnosis, with all its assumptions, as if we were discussing a well-established clinical entity. Thus, the proximate efficient cause then becomes a mere trigger of ADHD symptoms as if it were a natural entity. The distal efficient cause would be in the perinatal antecedents. But the true Aristotelian sense of efficient cause refers to "actors" (individuals or groups) not "factors" or "triggers." The notion of antecedent event does not capture the sense of efficient cause as the builder who builds.

Killeen et al. (2012) found the material cause in the neurophysiological substrates (proximate cause) and in supposedly genetic proneness (distal cause). Nevertheless, this material cause is neither justified by scientific evidence (according to the discussion in the first part) nor is it homogeneous with regard to the formal cause. While the diagnostic form of ADHD is defined by behavior on a molar scale, the material refers here to neurophysiological substrates on a molecular scale, a leap of scale also taken with regard to the efficient cause. While the efficient cause, according to Aristotle is on the operatory scale due to agents, authors or

"actors" (not "factors" or "triggers"), the material cause of Killeen et al. (2012) is on the physicochemical molecular scale. As they themselves admit, the problems met with are hyperactivity and inattention (behaviors), not with "ADHD" (Killeen et al., 2012, p. 415) or in this case, the neurophysiological substrates. The sculptor and potter work with marble and clay as workable, moldable materials, not their atomic molecular substrate, which some may be.

Concerning the final cause, the sense of Killeen et al. (2012) as positive and negative reinforcement may be assumed. However, the ADHD fabric has other actors in addition to the person diagnosed, involving a complex of final causes.

In the end, the application of Killeen et al. (2012) simply reorganizes the data in a certain way, without suggesting their ontological status, scientific epistemology, social practice or political ethics of a complex phenomenon with numerous actors and interests, not without reason controversial. The causes of Killeen et al. (2012) are causes which neither reveal nor rebel. Aristotle's four causes duly applied could reveal the scientific-practical tangle with which most convictions and best intentions sustain ADHD even though lacking in clinical entity and thus having grounds for a rebellion with cause.

Rebellion with Causes: Unmasking the ADHD Tangle

The four Aristotelian causes are related to each other in such a way that it is practically impossible to discuss one without assuming the others. However, for analytical and explanatory reasons, it is advisable to go one by one. Specifically, it is important to begin with the material cause. Not in vain, the material cause is the *raw material* from which something is made (the marble in a statue or the clay in a bowl).

Material Cause

The material cause of ADHD would be the behaviors by which, in fact, it is defined. It refers to some behaviors of children with problems in certain tasks and in certain school, family, and social contexts. These behaviors, typically inattention, hyperactivity or impulsivity, become conspicuous and end up by defining a syndrome and the child itself, but in themselves are not problematic or pathological ("symptoms"), nor do they exhaust what the child is. Such behaviors attract attention and become problematic in terms of norms and values (Hawthorne, 2010; Brinkmann, 2016). But they are not symptoms of any disease, such as a seizure in epilepsy, trembling hands in Parkinson's or the loss of memory in Alzheimer's. They are part of a person's *comportment* which is not reduced to a few behaviors.

A somewhat problematic distinction in the English language between comportment and behavior is introduced. In contrast to the term behavior that usually only captures discrete aspects of the person, typically symptoms, as is the case in ADHD, comportment refers to the whole Gestalt of being engaged with the world. The concept of comportment introduced here captures the "*unifying structure of embodied affective (and cognitive) engagement with the world*, as the most general term to refer to all-encompassing changes," (Jacobs et al., 2015, p. 90). Comportment establishes our *constitutive relationship* with the world. This does not refer to an organism or individual separate from a world they interact with, but a mutually constitutive relationship in which comportment, specifiable in behaviors for practical reasons, is the *soul* and *incarnation* of this relationship.

The structure of comportment constitutes a situated functional corporal unit (Merleau-Ponty, 1942/1963; Thompson, 2007, p. 67). How we are situated is characterized by a phenomenical structure (perceptive and operatory) *from-toward*, *from* what we pay attention to *toward* something and then we operate *on* it. The human biophysical structure itself propels both forward and outward, opening way on a horizon of time and space. As sentient subjects and agents we are embodied, embedded, and enacted subjects (Thompson, 2007; Fuchs, 2011). Belonging to the world in this way means that the essential way we relate to things is neither purely sensory and reflexive, nor cognitive and intellectual, but bodily and practical, articulated by "motor intentionality." This bodily motor intentionality-environment loop constitutes what Merleau-Ponty calls the "intentional arch," which subtends our relationship with the world integrating sensitivity and motility, perception and action (Merleau-Ponty, 1945/1962, p. 136).

In this phenomenological, existential and behavioral perspective, behaviors, including those defining ADHD, are understood according to a circular causality or functional cycles of perception and movement: interplay, feedback or reinforcement. Three cycles have been described (Fuchs, 2011): *cycles of organismic self-regulation* engendering a basic bodily sense of self; *cycles of sensorimotor coupling* between organism and environment, and *cycles of intersubjective interaction*. The problems come up when the functional cycles are somehow altered, but would not therefore be diseases *of* the brain (Fuchs, 2011, 2012).

The behaviors by which ADHD is defined begin to attract attention and even become problematic because they alter functional cycles, starting with the intersubjective interaction cycles. A phenomenological study done with ADHD adults highlighted a certain experience of time and rhythm characterized by a desynchronized way of being-in-the-world (Nielsen, 2016). This desynchronization refers to an accelerated rhythm in thinking, bodily discomfort and even anxiety in movement that is not in time with the rhythms of others, of things, of places or of events. An analysis of the different rhythms of daily life (Lefebvre, 2004) would probably explain many things before pathologizing the different rhythms and styles.

In brief, the material cause ADHD is made of would consist of certain behaviors by which in fact it is diagnosed. Within this, it has been attempted to show that the behaviors forming part of functional cycles constitute the material itself of psychological problems (Pérez-Álvarez et al., 2008; Fuchs, 2012), including so-called ADHD, in which the problem would be a certain desynchronized way of being in the world (Nielsen, 2016).

Formal Cause

The formal cause of ADHD would be the *formal* diagnosis itself made by the diagnostic systems in use (DSM/ICD), in agreement with Killeen et al. (2012). It is no longer important that the diagnosis is more than anything tautological and lacking in

validity, as discussed above. The diagnosis ends up by becoming objectivized and obvious, through the process of selection, definition and magnification of some behaviors over others, appropriately converted into "symptoms." ADHD as it is in common use in school, family, and clinical contexts, as well as in the media, functions as a model, form or "cultural idiom." A cultural idiom is made up of value systems, ways of interpreting, and epistemological assumptions, all of which structure the way in which people experience, give meaning to, and react to the situations they face (Vanthuyne, 2003).

The formal cause includes the theoretical models proposed for explaining ADHD behaviors (Killeen et al., 2012). Among the variety of models existing (Kofler et al., 2016) are those which postulate impaired executive functioning, such as behavioral inhibition (Barkley, 1997) or monitoring attention (Brown, 2005). Within their different emphases, they coincide in understanding the breakdown in executive functioning as some type of disruption in the brain. The attractiveness of an explanation in terms of executive functions may be in the apparent description of neurocognitive mechanisms which supposedly account for the behavior of individuals, something doubtless very much in agreement with the individualist, neuroscientific and biomedical view of our times. However, in spite of all their neuroscientific sophistication, the notion of executive function is still a mechanicist, homunculist explanation, by personifying in an internal *Cartesian* scenario what in fact individuals are doing in the real world scenario where they *execute* their life. After all, neither the intentions are given any place in the brain (Schurger and Uithol, 2015), nor is the supposed breakdown in executive functioning found everywhere (Brinkmann, 2016; Kofler et al., 2016).

The mechanisms which theoreticians and users of executive functions *hypostasize* as if they had a will of their own are only elements in a wider system in the sense of the structure of comportment mentioned above (Merleau-Ponty, 1942/1963) and its patterns of bodily interaction with the environment (Maiese, 2012). In its reconsideration of "central executive," Michelle Maiese emphasizes the essential role of the *affective framework* in which "we interpret persons, objects, facts, states of affairs, and situations in terms of *embodied desiderative feelings.*" "Such framing typically occurs during essentially embodied, spontaneous subjective experience, prior to conceptual and propositional information processing, and yields a pre-reflective, non-conceptual, fine-grained contouring of that world, so that we immediately can target and focus our attention" (Maiese, 2012, p. 901).

There may be different forms of bodily harmony with the surrounding world among individuals and situations and even within the same individual depending on what attracts their attention and interests them. This would place the differences among individuals and within the individual himself more within an affective framework than neurocognitive abstracts of a central executive function. In fact, those who are ADHD are *not* ADHD all of the time nor everywhere, any more than by diagnostic *prescription.* Particular attunement to the environment, rather than a general breakdown, seems to be the problem of ADHD.

In short, the formal cause of ADHD would consist of the diagnosis itself which provides it with entity in its own right. The diagnosis already functions as a "cultural idiom" and counts on theoretical models which support it. It has been attempted to show that the overused model based on executive functions, far from explaining the supposed breakdown, returns ADHD to its reconsideration in contextual affective terms rather than the abstract neurocognitive terms of the model.

Efficient Cause

The efficient cause of ADHD would consist of social practices (scientific, clinical, educational, and family) by which certain behaviors of children or adults (material cause) take the form of a diagnostic category (formal cause). The efficient cause has to do rather with the actions of "actors" (Pérez-Álvarez et al., 2008), than with risk "factors" as usually understood (Killeen et al., 2012). Although clinicians are the main "makers" of diagnoses, they are neither the only *agents* nor the first. ADHD *agency* begins in school and family. But clinicians, parents and educators have scientific institutions of reference, such as the *National Institute of Mental Health* (NIMH) in the USA and the *National Institute for Health and Clinical Excellence* (NICE) in the United Kingdom, and associations such as *Children and Adults with Attention-Deficit/Hyperactivity Disorder* (CHADD) which support their practices. These institutes and associations in turn are based on scientific research. So it is really scientific research which molds ADHD (Hawthorne, 2014).

Clinicians epitomize the efficient cause as "official" providers of the diagnosis. Typically, children referred to them by schools are taken to the doctor by their parents and are given the diagnosis and a prescription (Smith, 2013). What happened? The parents referred to the child's problems which brought them there. The clinician (DSM in hand or in mind) asked questions to confirm that the child had the "symptoms" in the description. Other "complementary" tests may also have been applied. Confirmed: the child *did have* ADHD. In fact, those behaviors really do exist and are observable. The child is from now on observed and defined by ADHD behaviors. Everything else, other behavior, circumstances, contexts or history, remain outside of the description. The clinician believes he has *described* an objective reality, but he has also *created* it this way by selecting some behaviors in detriment to others and elevating them to the category of "symptoms."

There could be a sort of *Charcot effect* here (Pérez-Álvarez and García-Montes, 2007) by which the clinician "generates" the reality he describes to the extent that the subjects end up by seeing themselves according to the diagnosis. This *looping effect* described by Ian Hacking consists of patients internalizing the biomedical view of their diagnosis (Hawthorne, 2014, pp. 160–161). The confirmation the clinicians receive from their patients should not be taken as proof of the objectivity of the diagnosis. There is nothing more objective in psychiatry than the *grande hystérie* ("major hysteria attack") described by Charcot (Didi-Huberman, 2004) and which he himself was really molding with his descriptions, drawings and photographs (the "neuroimaging" of the time). Once the category has

been created, it works like an "*a priori* category" of the clinician's understanding, who through his actions (interviews, tests) reinfluences the patient's understanding, adopting the explanations and definitions offered. The creation of the category itself was already a process of "selection" of the most conspicuous and operative symptoms to which the problem and the individual (decontextualized from his history and circumstances) are reduced, as the Charcot effect suggests (Pérez-Álvarez and García-Montes, 2007). Now each case confirms the category and clinical conviction and at the same time is molded to it as the patient adopts the clinicians point of view if in fact he does not already have it as a "cultural idiom," such as ADHD usually is. Within a dynamic process, the looping effect reaffirms category and clinician and case and patient or user.

The school itself professes the biomedical conception. As already occurred in the origins of ADHD starting at the end of the 1950s with the figure of the school counselor as the intermediary between the classroom and the clinic (Smith, 2013), the school staff still acts as a bridge. Textbooks used to train special education teachers show a strongly biomedical view (Freedman, 2016). Families also tend to see diverse problems even without the ADHD diagnosis, canceling out other possibilities (Lewis-Morton et al., 2014). The influence, if not "pressure" from the school, along with "information" from parents' associations and associations of those affected, beginning with the CHADD, end up inculcating ADHD in the family, which the clinician only confirms.

If teachers, parents, and clinicians consult international reference guidelines such as the NIMH and the NICE, they will have the impression of a *consensus* on the biomedical nature of ADHD which really does not exist (Moncrieff and Timimi, 2013; Erlandsson and Punzi, 2016; Erlandsson et al., 2016). All in all, the ultimate or first efficient cause is how science molds the ADHD which then feeds guidelines and their users. As shown by Hawthorne (2014), science molds ADHD the way it is by certain patterns of reasoning (epistemology) and research methods (methodology) which mutually reinforce each other in a continuous dynamic process.

Although there are a variety of approaches, levels of analysis and sciences in the study of ADHD, all of them have two things in common: the object and the method. The object is the DSM-defined ADHD and the method is some version of the "scientific method" (Hawthorne, 2014, pp. 47–48). ADHD is assumed to be a natural, complex entity which must be objectively described and its mechanisms studied. The proper framework implicitly involves the ADHD/no-ADHD dichotomy (it would be stupid to divide the subjects of research repeatedly without thinking that there are no differences among the groups), as well as generalization from statistical means, reasoning linking genetic, neural and behavioral levels, biological reductionism ("mechanisms") and the final reification of ADHD as an identifiable and treatable species (with its subtypes) (Hawthorne, 2014, p. 70).

The lack of firm evidence is supplemented with rhetoric as already shown above in order to make the reasoning convincing. Thus, "convergence" of a variety of data are discussed even when they are *not* significant and of the need for new more refined studies, giving the impression of being on the right track. As Hawthorne (2014, p. 66) points out, "science builds on previous science; but it is also to say that previous science constrains current science to some extent—novelty is not forbidden, just difficult—by imposing a structure of prior formulation, categorization, and contexts—and tools, techniques, and experimental models—of interest." In scientific practice, a Charcot effect by which research studies what it generates itself (hypotheses and so forth) in a sort of "collective hysteria" would not be unthinkable.

Summarizing, the efficient cause of ADHD would be found in scientific, clinical, educational, and family practices that *make* it the way it is. Without denying that it is *real*, the efficient cause shows how it *becomes* real. If it were a natural entity, as many medical illnesses are (epilepsy, Parkinson's, Alzheimer's), it would make no sense to talk about the efficient cause. But neither because it is not natural is it less real and easier to change. The genome and the brain may be more plastic than the scientific practices themselves with their institutionalization, patterns of reasoning and self-confirmatory methods.

Final Cause

The final cause of ADHD refers to a series of functions which it meets for a variety of actors and institutions, beyond the reinforcement of behaviors of those affected (Killeen et al., 2012). This variety of unintentional functions could explain its expansion, as well as the conviction with which it is argued against the "nay-sayers," in spite of the persistent lack of firm evidence, as reviewed above. In fact, the success of ADHD may be due paradoxically to its *imprecision*: a case of the strength of vague concepts (Löwy, 1992). As this author says, "Imprecise concepts may help to link professional domains and to create alliances between professional groups." 'Fuzzy' terms, continues the author, may last a lifetime and keep functioning (Löwy, 1992, p. 373). This is the case of ADHD.

The "trading zone," which enables imprecise concepts (Löwy, 1992), has its best expression in ADHD as a "semiotic mediator" as defined by Svend Brinkmann. A semiotic mediator referring to a diagnosis is a symbolic linguistic device with three functions: an explanatory function with regard to the problems experienced, a self-affirming function in the sense that a variety of phenomena appear as "symptoms" and a disclaiming function related to responsibility (Brinkmann, 2014b). Semiotic mediation harmonizes the needs, interests and values that make up the ADHD complex. According to Hawthorne (2010, 2014), the solution is reinforced by a positive feedback loop.

A positive feedback loop incorporates values in concepts, methods and scientific conclusions. As the theme of interest chosen, research begins by establishing the division between ADHD and non-ADHD (ADHD versus "controls," "normal," "healthy," "typical development," "unaffected"). Based on this dichotomy, an infinity of topics ("variables") are chosen to observe possible neurocognitive correlates and genetic and behavioral associations. When a "difference" is found, as Hawthorne says, "the observed difference is only relatively value-free, having been arrived at through several value-valenced choices. The slip from "difference" to "dysfunction," which is an

ethical term, intensifies the valuation." Positive results reinforce the decisions and in any case, as they say, more studies are necessary, strengthening the feedback loop (Hawthorne, 2014, p. 136). "Overall, then, the social/scientific feedback loop is self-reinforcing as long as science achieves results that society can take up and support. By this ongoing mutual influence, facts and values are jointly defined and reinforced" (Hawthorne, 2010, p. 28).

Attention-Deficit/Hyperactivity Disorder harmonizes a variety of scientific, medical, educational and family interests besides pharmaceutical industry profits (the most openly shameless and rightly denounced). The only party harmed seems to be the children, with the unintentional effect of "accidental intolerance" of the traits and ADHD-associated behaviors (Hawthorne, 2014, p.142).

Briefly, the final cause of ADHD would be in harmonizing the interests of a variety of actors and institutions, not just the pharmaceutical industry. The particular feedback loop between science and society in which normative values become naturalized and legitimated in research, which is valued and supported by society, has been shown. Perhaps the children are the least benefited due to the resulting "accidental intolerance." Individual differences become dysfunctions, disorder or mental illness.

CONCLUSION

An argument has been developed in three steps. First, the evidence claimed which sustains ADHD was reviewed. It was shown that the diagnosis is based on fallacious reasoning (tautologies), for lack of clinical proof. At this point, the lack of specific genetic and neurobiological evidence should not be surprising, in spite of the enormous amount of literature pointing in that direction. The fact that the science of ADHD seems to be going on the right path is probably due more to the rhetoric and metaphysics of its literature than to accumulated scientific findings. Rhetoric in use seems to convert ambiguous meager data into conclusions presented as "convergent evidence," where the overused expressions "complex" or "heterogeneous" disorder really means that its causes are unknown, even if assumed to be genetic and neurobiological. Implicit metaphysical assumptions are found for example, in correlates and correlations taken as neural "causes" or "bases."

Second, a new metascientific approach to the science of ADHD was proposed, supposing that a mere critical review leaves the controversy between "defenders" and "critics" the same as it was, in a dialog of the deaf. More so, criticism, as demolishing as it is, still recognizes the sense, persuasion, and good faith, not ignorance or simple interests, of the defenders. How are they not going to be convinced if the science they profess directs their path, sheds light on the subject and offers the method? The fact is that the science itself may have blind points and self-confirming methods, without even going down the right path. The new metascientific approach proposed is Aristotle's four causes, material, formal, efficient, and final, as an instrument of enquiry.

Third, the enquiry was carried out using Aristotle's four causes. In addition to a clarifying view, this metascientific focus offers an alternative to the understanding of "ADHD" beyond the dominant biomedical model and its simple denial. According to this analysis, the *material* of which ADHD is made would be some specific behaviors which can be problematic in certain contexts and tasks. These behaviors are easily taken as the *form* of the "ADHD" diagnostic category according to diagnostic criteria in use (typically the DSM). The *efficient cause* with regard to what, or better, who *makes* ADHD the way it is may be found on one hand in the clinicians who make the diagnosis and on the other in scientific research which has molded the established concept. The *final cause* refers to a variety of functions which ADHD meets, *not* in spite of its scientific-clinical vagueness. On the contrary, it would be precisely due to its *imprecision* which makes it useful in a variety of contexts. The positive science-society feedback loop which surreptitiously combines facts and values as the reason for its success in harmonizing varied interests has been shown.

The metascientific perspective makes it possible to see and go beyond the scientific controversy run aground on whether ADHD exists or not. According to this analysis, ADHD would not be sustainable as a clinical entity, although it is still real as a practical entity (Pérez-Álvarez et al., 2008). Far from being a given *natural kind,* out there, ready for its research as a scientific *object*, "ADHD" would be a *practical kind*, constructed on the scientific and clinical practices themselves, fulfilling a variety of functions, who knows for whom or at what cost. Beyond the positivist science framework (typically neuroscience), the "number one recommendation" would be to "establish a pragmatist framework that carefully uses facts *and* values in all decisions and actions relevant to ADHD" (Hawthorne, 2014, p. 176). As a scientifically and ethically coherent derivation, the "ADHD"/non-"ADHD" dichotomy would have to be overcome, and instead of the *essentialist* conception in use, adopt a pragmatic approach with regard to situations and concrete norms where the problem can be enacted according to a cultural, contextual, existential psychology (Brinkmann, 2016, p. 88).

Therefore, the problems to which "ADHD" refers should never have left the family and school educational scope, making them pass through the clinical circuit and come back as "mental disorder." Any problems related to "attention," "activity," and "impulsivity" are not outside learning as aspects of development of self-control. Some children may require additional "training" (not treatment). More precisely, such "training" would be by parents and teachers with a view to promoting the skills children require. Training by parents using common games involving attention and following rules ("Simon says," "frozen dance") as well as behavioral principles (availability of appropriate contexts, positive reinforcement), would "remove" children from (risk of receiving the diagnoses of) "ADHD" (Charach et al., 2013; Laber-Warren, 2014). A study with a careful design showed that behavioral training by parents and teachers was more effective than medication (Pelham et al., 2016). These behavioral "interventions," more than as an alternative to medication (which is no small thing), are referred to here as

an ontological argument demonstrating the practical behavioral nature (non-essentialist) of ADHD. It is already time to overcome the "ADHD"/non-"ADHD" dichotomy without paying attention to the aspect of the problem when necessary without pathologizing it. Since the diagnostic language is not inevitable, only dominant,

> We must supplement the pragmatic interest in action possibilities [afforded by different languages inherent in social practices (e.g., existential, moral, political)] with a hermeneutic interest in interpreting the person and her suffering in her life situation as it presents itself in its "facticity" (Brinkmann, 2014a, p. 645).

AUTHOR CONTRIBUTIONS

The author himself conceived, wrote, reviewed and approved the article.

REFERENCES

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM 5)*, 5th Edn. Washington, DC: American Psychiatric Association. doi: 10.1176/appi.books.9780890425596

Angell, M. (2011). *The Illusions of Psychiatry. The New York Review of Books*. Available at: http://www.nybooks.com/articles/2011/07/14/illusions-of-psychiatry/ [accessed January 12, 2017].

Areces, D., Rodríguez, C., García, T., Cueli, M., and González-Castro, P. (2016). Efficacy of a continuous performance test based on virtual reality in the diagnosis of ADHD and its clinical presentations. *J. Atten. Disord.* doi: 10.1177/1087054716629711

Barkley, R. A. (1997). *ADHD and the Nature of Self-Control*. New York, NY: Guilford Press.

Barkley, R. A. (2002). International consensus statement on ADHD. *Clin. Child Fam. Psychol. Rev.* 5, 89–111. doi: 10.1023/A:1017494719205

Beare, R., Adamson, C., Bellgrove, M. A., Vilgis, V., Vance, A., Seal, M. L., et al. (2016). Altered structural connectivity in ADHD: a network based analysis. *Brain Imaging Behav.* doi: 10.1007/s11682-016-9559-9 [Epub ahead of print].

Brinkmann, S. (2014a). Languages of suffering. *Theory Psychol.* 24, 630–648. doi: 10.1177/0959354314531523

Brinkmann, S. (2014b). Psychiatric diagnoses as semiotic mediators: the case of ADHD. *Nordic Psychol.* 66, 121–134. doi: 10.1080/19012276.2014.926227

Brinkmann, S. (2016). Toward a cultural psychology of mental disorder: the case of attention deficit hyperactivity disorder. *Cult. Psychol.* 22, 80–93. doi: 10.1177/1354067X15621485

Brown, T. (2005). *Attention Deficit Disorder: The Unfocused Mind in Children and Adults*. New Haven, CT: Yale University Press.

Cao, M., Wang, Z., and He, Y. (2015). Connectomics in psychiatric research: advances and applications. *Neuropsychiatr. Dis. Treat.* 11, 2801–2810. doi: 10.2147/NDT.S63470

Charach, A., Carson, P., Fox, S., Ali, M. U., Beckett, J., and Lim, C. G. (2013). Interventions for preschool children at high risk for ADHD: a comparative effectiveness review. *Pediatrics* 131, 1584–1604. doi: 10.1542/peds.2012-0974

Chaufan, C. (2008). Unpacking the heritability of diabetes: the problem of attempting to quantify the relative contributions of nature and nurture. *Data Crítica* 2, 23–38.

Cortese, S. (2012). The neurobiology and genetics of attention-deficit/hyperactivity disorder (ADHD): what every clinician should know. *Eur. J. Paediatr. Neurol.* 16, 422–433. doi: 10.1016/j.ejpn.2012.01.009

Didi-Huberman, G. (2004). *Invention of Hysteria: Charcot and the Photographic Iconography of the Salpêtrière*, Trans. Alisa Hartz. Cambridge, MA: MIT Press.

Dillon, A., and Craven, T. G. (2014). Examining the genetic contribution to ADHD. *Ethical Hum. Psychol. Psychiatry* 16, 20–28. doi: 10.1891/1559-4343.16.1.20

Erlandsson, S., Lundin, L., and Punzi, E. (2016). A discursive analysis concerning information on "ADHD" presented to parents by the National Institute of Mental Health (USA). *Int. J. Qual. Stud. Health Well-Being* doi: 10.3402/qhw.v11.30938

Erlandsson, S., and Punzi, E. (2016). Challenging the ADHD consensus. *Int. J. Qual. Stud. Health Well-Being* 11:31124. doi: 10.3402/qhw.v11.31124

Faraone, S. V., Asherson, P., Banaschewski, T., Biederman, J., Buitelaar, J. K., Ramos-Quiroga, J. A., et al. (2015). Attention-deficit/hyperactivity disorder. *Nat. Rev. Dis. Primers* 1:15020. doi: 10.1038/nrdp.2015.20

Fisher, J., Harel, D., and Henzinger, T. A. (2011). Biology as reactivity. *Commun. ACM* 54, 72–82. doi: 10.1145/2001269.2001289

Freedman, J. E. (2016). An analysis of the discourses on attention deficit hyperactivity disorder (ADHD) in US special education textbooks, with implications for inclusive education. *Int. J. Inclusive Educ.* 20, 32–51. doi: 10.1080/13603116.2015.1073375

Fried, M., Tsitsiashvili, E., Bonneh, Y. S., Sterkin, A., Wygnanski-Jaffe, T., Epstein, T., et al. (2014). ADHD subjects fail to suppress eye blinks and microsaccades while anticipating visual stimuli but recover with medication. *Vision Res.* 101, 62–72. doi: 10.1016/j.visres.2014.05.004

Fuchs, T. (2011). The brain - a mediating organ. *J. Conscious. Stud.* 18, 196–221.

Fuchs, T. (2012). "Are mental illnesses diseases of the brain?," in *Critical Neuroscience: A Handbook of the Social and Cultural Contexts of Neuroscience*, eds S. Choudhury and J. Slaby (Chichester: Wiley), 331–344.

Gallo, E. F., and Posner, J. (2016). Moving towards causality in attention-deficit hyperactivity disorder: overview of neural and genetic mechanisms. *Lancet Psychiatry* 3, 555–567. doi: 10.1016/S2215-0366(16)00096-1

González-Pardo, H., and Pérez Álvarez, M. (2013). Epigenetics and its implications for psychology. *Psicothema* 25, 3–12. doi: 10.7334/psicothema2012.327

Guthrie, W. C. G. (1981). *A History of Greek Philosophy. Aristotle: An Encounter*, Vol. VI. Cambridge: Cambridge University Press.

Hawthorne, S. (2010). Embedding values: how science and society jointly valence a concept—the case of ADHD. *Stud. Hist. Philos. Biol. Biomed. Sci.* 41, 21–31. doi: 10.1016/j.shpsc.2009.12.005

Hawthorne, S. (2014). *Accidental Intolerance: How We Stigmatize ADHD and How We Can Stop*. New York, NY: Oxford University Press.

Hyde, K. L., Lerch, J., Norton, A., Forgeard, M., Winner, E., Evans, A. C., et al. (2009). Musical training shapes structural brain development. *J. Neurosci.* 29, 3019–3025. doi: 10.1523/JNEUROSCI.5118-08.2009

Insel, T. (2013). *Director's Blog: Transforming Diagnosis*. Available at: https://www.nimh.nih.gov/about/director/2013/transforming-diagnosis.shtml [accessed January 12, 2017].

Jablonka, E., and Lamb, M. J. (2005). *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*. Cambridge, MA: MIT Press.

Jacobs, K., Stephan, A., Paskaleva-Yankova, A., and Wilutzky, W. (2015). Existential and atmospheric feelings in depressive comportment. *Philos. Psychiatry Psychol.* 21, 89–110. doi: 10.1353/ppp.2014.0021

Joseph, J. (2009). "ADHD and genetics: a consensus reconsidered," in *Rethinking ADHD: From Brain to Culture*, eds J. Leo and S. Timimi (London: Palgrave MacMillan), 58–91.

Joseph, J. (2015). *The Trouble with Twin Studies: A Reassessment of Twin Research in the Social and Behavioral Sciences*. New York, NY: Routledge.

Keller, E. F. (2012). Genes, genomes, and genomics. *Biol. Theory* 6, 132–140. doi: 10.1007/s13752-012-0014-x

Keller, E. F. (2014). From gene action to reactive genomes. *J. Physiol.* 592, 2423–2429. doi: 10.1113/jphysiol.2014.270991

Killeen, P. R. (2001). The four causes of behavior. *Curr. Dir. Psychol. Sci.* 10, 136–140.

Killeen, P. R. (2004). Minding behavior. *Behav. Philos.* 32, 125–147.

Killeen, P. R., Tannock, R., and Sagvolden, T. (2012). The four causes of ADHD: a framework. *Curr. Top. Behav. Neurosci.* 9, 391–425. doi: 10.1007/7854_2011_160

Kofler, M. J., Raiker, J. S., Sarver, D. E., Wells, E. L., and Soto, E. F. (2016). Is hyperactivity ubiquitous in ADHD or dependent on environmental demands? Evidence from meta-analysis. *Clin. Psychol. Rev.* 46, 12–24. doi: 10.1016/j.cpr.2016.04.004

Kooij, S. J., Bejerot, S., Blackwell, A., Caci, H., Casas-Brugue, M., Carpentier, P. J., et al. (2010). European consensus statement on diagnosis and treatment of adult ADHD: the European network adult ADHD. *BMC Psychiatry* 10:67. doi: 10.1186/1471-244X-10-67

Laber-Warren, E. (2014). Concentrate. *Sci. Am. Mind* 25, 61–65. doi: 10.1038/scientificamericanmind0314-61

Lefebvre, H. (2004). *Rhythmanalysis: Space, Time and Everyday Life*. London: Continuum.

Lewis-Morton, R., Dallos, R., McClelland, L., and Clempson, R. (2014). "There is something not quite right with Brad ...": The ways in which families construct ADHD before receiving a diagnosis. *Contemp. Fam. Ther.* 36, 260–280. doi: 10.1007/s10591-013-9288-9

Löwy, I. (1992). The strength of loose concepts—Boundary concepts, federative experimental strategies and disciplinary growth: the case of immunology. *Hist. Sci.* 30, 371–396. doi: 10.1177/007327539203000402

Maguire, E. A., Woollett, K., and Spiers, H. J. (2006). London taxi drivers and bus drivers: a structural MRI and neuropsychological analysis. *Hippocampus* 16, 1091–1101. doi: 10.1002/hipo.20233

Maiese, M. (2012). Rethinking attention deficit hyperactivity disorder. *Philos. Psychol.* 25, 893–916. doi: 10.1080/09515089.2011.631998

Merleau-Ponty, M. (1942/1963). *The Structure of Behavior,* trans. A. L. Fisher. Boston, MA: Beacon.

Merleau-Ponty, M. (1945/1962). *Phenomenology of Perception*, trans. Colin Smith. London: Routledge.

Moncrieff, J., and Timimi, S. (2013). The social and cultural construction of psychiatric knowledge: an analysis of NICE guidelines on depression and ADHD. *Anthropol. Med.* 20, 59–71. doi: 10.1080/13648470.2012.747591

Mukherjee, S. (2016). *The Gene: An Intimate History*. New York, NY: Scribner Macmillan.

Neguţ, A., Jurma, A. M., and David, D. (2016). Virtual-reality-based attention assessment of ADHD: ClinicaVR: classroom-CPT versus a traditional continuous performance test. *Child Neuropsychol.* doi: 10.1080/09297049.2016.1186617

Nielsen, M. (2016). ADHD and temporality: a desynchronized way of being in the world. *Med. Anthropol.* 36, 260–272. doi: 10.1080/01459740.2016.1274750

Pelham, W. E., Fabiano, G. A., Waxmonsky, J. G., Greiner, A. R., Gnagy, E. M., Pelham, W. E. III, et al. (2016). Treatment sequencing for childhood ADHD: a multiple-randomization study of adptive medication and behavioral interventions. *J. Clin. Child Adolesc. Psychol.* 45, 396–415. doi: 10.1080/15374416.2015.1105138

Pérez-Álvarez, M. (2009). The four causes of behavior: Aristotle and Skinner. *Int. J. Psychol. Psychol. Ther.* 9, 45–57.

Pérez-Álvarez, M., and García-Montes, J. M. (2007). The Charcot effect: the invention of mental illnesses. *J. Constr. Psychol.* 20, 309–336. doi: 10.1080/10720530701503843

Pérez-Álvarez, M., García-Montes, J. M., Vallina-Fernández, O., and Perona-Garcelán, S. (2016). Rethinking schizophrenia in the context of the person and their circumstances: seven reasons. *Front. Psychol.* 7:1650. doi: 10.3389/fpsyg.2016.01650

Pérez-Álvarez, M., Sass, L., and García Montes, J. M. (2008). More Aristotle, less DSM: the ontology of mental disorders in constructivist perspective. *Philos. Psychiatry Psychol.* 15, 211–225. doi: 10.1353/ppp.0.0192

Pittelli, S. J. (2002). Meta-analysis and psychiatric genetics [letter to editor]. *Am. J. Psychiatry* 159, 496–497. doi: 10.1176/appi.ajp.159.3.496

Raichle, M. D. (2015). The brain's default mode network. *Annu. Rev. Neurosci.* 38, 433–447. doi: 10.1146/annurev-neuro-071013-014030

Ribes-Iñesta, E. (2015). El desligamiento funcional y la causalidad Aristotélica: un análisis teórico. [A functional detachment and Aristotelian causality: a theoretical analysis]. *Acta Comportamentalia* 23, 5–15.

Rodríguez, C., González-Castro, P., Álvarez, L., Vicente, L., Núñez, J. C., González-Pienda, J., et al. (2011). Nuevas técnicas de evaluación en el trastorno por déficit de atención e hiperactividad (TDAH). *Eur. J. Educ. Psychol.* 4, 63–73.

Rodríguez, C., González-Castro, P., Cueli, M., Areces, D., and González-Pienda, J. A. (2016). Attention deficit/hyperactivity disorder (ADHD) diagnosis: an activation-executive model. *Front. Psychol.* 7:1406. doi: 10.3389/fpsyg.2016.01406

Ross, C. A. (2016). Extreme exaggeration of the results of genetic research on schizophrenia. *Psychosis* 8, 186–187. doi: 10.1080/17522439.2016.1153702

Rubia, K., Alegria, A., and Brinson, H. (2014). Imaging the ADHD brain: disorder-specificity, medication effects and clinical translation. *Expert Rev. Neurother.* 14, 519–538. doi: 10.1586/14737175.2014.907526

Schurger, A., and Uithol, S. (2015). Nowhere and everywhere: the causal origin of voluntary action. *Rev. Philos. Psychol.* 6, 761–778. doi: 10.1007/s13164-014-0223-2

Sekar, A., Bialas, A. R., de Rivera, H., Davis, A., Hammond, T. R., Kamitaki, N., et al. (2016). Schizophrenia risk from complex variation of complement component 4. *Nature* 530, 177–183. doi: 10.1038/nature16549

Smith, M. (2013). *Hyperactivity: The Controversial History of ADHD*. London: Reaction Books.

Sonuga-Barke, E. J. (2010). Editorial: 'It's the environment stupid!' On epigenetics, programming and plasticity in child mental health. *J. Child Psychol. Psychiatry* 51, 113–115. doi: 10.1111/j.1469-7610.2009.02213.x

Tait, G. (2009). The logic of ADHD: a brief review of fallacious reasoning. *Stud. Philos. Educ.* 28, 239–254. doi: 10.1007/s11217-008-9114-2

Tarver, J., Daley, D., and Sayal, K. (2014). Attention-deficit hyperactivity disorder (ADHD): an updated review of the essential facts. *Child Care Health Dev.* 40, 762–774. doi: 10.1111/cch.12139

Thapar, A., and Cooper, M. (2016). Attention deficit hyperactivity disorder. *Lancet* 387, 1240–1250. doi: 10.1016/S0140-6736(15)00238-X

Thapar, A., Cooper, M., Eyre, O., and Langley, K. (2013). What have we learnt about the causes of ADHD? *J. Child Psychol. Psychiatry* 54, 3–16. doi: 10.1111/j.1469-7610.2012.02611.x

Thompson, E. (2007). *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Cambridge, MA: Harvard University Press.

Timimi, S. (2014). No more psychiatric labels: why formal psychiatric diagnostic systems should be abolished. *Int. J. Clin. Health Psychol.* 14, 208–215. doi: 10.1016/j.ijchp.2014.03.004

Timimi, S., Moncrieff, J., Jureidini, J., Leo, J., Cohen, D., Whitfield, C., et al. (2004). A critique of the international consensus statement on ADHD. A critique of the international consensus statement on ADHD. *Clin. Child Fam. Psychol. Rev.* 7, 59–63. doi: 10.1023/B:CCFP.0000020192.49298.7a

van Fraassen, B. C. (1980). A re-examination of Aristotle's philosophy of science. *Dialogue* 19, 20–45. doi: 10.1017/S0012217300024719

Vanthuyne, K. (2003). Searching for the words to say it: the importance of cultural idioms in the articulation of the experience of mental illness. *Ethos* 31, 412–433. doi: 10.1525/eth.2003.31.3.412

Wellcome Trust (2010). *First Direct Evidence that ADHD is a Genetic Disorder: Children with ADHD more Likely to Have Missing or Duplicated Segments of DNA. ScienceDaily*. Available at: www.sciencedaily.com/releases/2010/09/100929191312.htm [accessed December 20, 2016].

Williams, N. M., Zaharieva, I., Martin, A., Langley, K., Mantripragada, K., Fossdal, R., et al. (2010). Rare chromosomal deletions and duplications in attention-deficit hyperactivity disorder: a genome-wide analysis. *Lancet* 376, 1401–1408. doi: 10.1016/S0140-6736(10)61109-9

World Health Organization (1992). *International Classification of Diseases ICD-10*, 10th Edn. Geneva: WHO.

Zelnik, N., Bennett-Back, O., Miari, W., Goez, H. R., and Fattal-Valevski, A. (2012). Is the test of variables of attention reliable for the diagnosis of attention-deficit hyperactivity disorder (ADHD)? *J. Child Neurol.* 27, 703–707. doi: 10.1177/0883073811423821

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Pérez-Álvarez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 18 May 2017
doi: 10.3389/fpsyg.2017.00821

Childhood Depression: Relation to Adaptive, Clinical and Predictor Variables

Maite Garaigordobil[1], Elena Bernarás[2], Joana Jaureguizar[3] and Juan M. Machimbarrena[1]*

[1] Department of Personality, Assessment and Psychological Treatments, Faculty of Psychology, University of the Basque Country, San Sebastian, Spain, [2] Department of Developmental and Educational Psychology, Faculty of Education, Philosophy and Anthropology, University of the Basque Country, San Sebastián, Spain, [3] Department of Developmental and Educational Psychology, University College of Teaching Training, University of the Basque Country, Bilbao, Spain

The study had two goals: (1) to explore the relations between self-assessed childhood depression and other adaptive and clinical variables (2) to identify predictor variables of childhood depression. Participants were 420 students aged 7–10 years old (53.3% boys, 46.7% girls). Results revealed: (1) positive correlations between depression and clinical maladjustment, school maladjustment, emotional symptoms, internalizing and externalizing problems, problem behaviors, emotional reactivity, and childhood stress; and (2) negative correlations between depression and personal adaptation, global self-concept, social skills, and resilience (sense of competence and affiliation). Linear regression analysis including the global dimensions revealed 4 predictors of childhood depression that explained 50.6% of the variance: high clinical maladjustment, low global self-concept, high level of stress, and poor social skills. However, upon introducing the sub-dimensions, 9 predictor variables emerged that explained 56.4% of the variance: many internalizing problems, low family self-concept, high anxiety, low responsibility, low personal self-assessment, high social stress, few aggressive behaviors toward peers, many health/psychosomatic problems, and external locus of control. The discussion addresses the importance of implementing prevention programs for childhood depression at early ages.

Keywords: child depression, correlations, predictor variables, stress, resilience, self-concept, social skills, psychosomatic problems

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Francisco Javier Méndez, University of Murcia, Spain
Marino Pérez-Álvarez, Universidad de Oviedo, Spain
Efrain Duarte Briceño, Autonomous University of Yucatán, Mexico

****Correspondence:***
Maite Garaigordobil
maite.garaigordobil@ehu.eus

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *04 March 2017*
Accepted: *05 May 2017*
Published: *18 May 2017*

Citation:
Garaigordobil M, Bernarás E, Jaureguizar J and Machimbarrena JM (2017) Childhood Depression: Relation to Adaptive, Clinical and Predictor Variables. Front. Psychol. 8:821. doi: 10.3389/fpsyg.2017.00821

INTRODUCTION

Currently, depression is one of the mental illnesses that produces the greatest concern to health authorities. Its prevalence rate is increasing yearly, according to the World Health Organization (World Health Organization [WHO], 2016), affecting 350 million people worldwide. Depression has very negative consequences in all life areas (family, friends, work. . .) and it is an important public health problem, as well as leading to high health expenditure.

People who suffer depressive symptomatology in childhood and adolescence are more likely to suffer major depression or persistent depressive disorder (dysthymia) in adulthood. In addition, there is a possibility of suicide during major depression (American Psychiatric Association [APA], 2014). Therefore, it is necessary to continue deepening our study of the variables that can predict childhood depression. In this way, early preventive interventions could be implemented that would forestall further negative consequences.

Childhood depression requires special attention due to its influence on children's comprehensive development and to its severe mid- and long-term consequences in adolescence

and adulthood, for example, the risk of developing other mental pathologies. In fact, along with anxiety, depression is one of the most common mental health disorders in children and adolescents (World Health Organization [WHO], 2016).

Many studies alert about the high prevalence of depression at early ages. Studies carried out in schools with child population, using self-reports to appraise severe depression, indicated prevalence rates in Spain close to 4% at early ages (8–12 years) and somewhat higher rates (from 4.3 to 6.5%) in adolescence (for a review, see Jaureguizar et al., 2017). This prevalence is high and shows the need to identify variables that can predict depressive symptomatology at early ages to initiate actions to prevent these symptoms during childhood. Age is a variable that must be taken into account because the onset of major depressive disorders often occurs between 11 and 12 years of age, although the beginning of less severe depressive symptoms is observed mainly around 7–8 years (Del Barrio, 2000).

The quality of the interpersonal relations, anxiety, or self-esteem are some of the variables that appear in studies concerning childhood depressive symptomatology (Bernaras et al., 2013). Human beings need to belong to and interact with social groups because positive social relations are crucial for physical and psychological well-being. Specifically, children with peer relationship problems are more prone to suffer depressive symptoms (Kochenderfer and Ladd, 1996; Brendgen et al., 2002; Hames et al., 2013). Longitudinal studies confirm that difficulties in peer relationships predict childhood depression (Cole, 1991) and even depression in adolescence (Qualter et al., 2010; Katz et al., 2011). Katz et al. (2011) found that childhood loneliness predicted social impairment in adolescence and this, in turn, predicted depression in adulthood.

Anxiety is another variable closely related to depression. Lamers et al. (2011) observed that comorbidity of depressive and anxiety disorders was associated with a more traumatic childhood. In addition, in their study, they observed that, in 57% of the comorbid cases, anxiety preceded depression, and in 18%, depression preceded anxiety. By the other hand, Wu et al. (2016) found that, among other variables, self-esteem and depressive symptoms in childhood predicted high symptoms of social anxiety. In boys, anxiety itself is a good predictor whereas, in girls, the predictors of depression are anxiety, worry, and hypersensitivity (Kovacs and López-Durán, 2010).

Other studies focus on the relation between depressive symptomatology and self-esteem. It seems that children and adolescents who present depressive symptomatology have lower self-esteem (Orth et al., 2008; Bos et al., 2010). By the other hand, Geng-Feng et al. (2016) found that resilience (a positive trait that helps people face adversity and develop good personal adjustment) was negatively associated with depression and could be a positive trait to relieve the harmful effect of isolation.

Socialization contexts, especially, the school environment, deserve special attention due to the great relevance that school maladjustment acquires at this evolutionary stage and to its impact on personal adaptation/maladjustment. In line with this, recent studies have found connections between depression and low academic achievement (Jaureguizar et al., 2017).

Few studies have identified the predictive variables of child depression. Among them, we note the study of Wang et al. (2016), which confirmed problems of health and adaptation, interpersonal relations, and academic achievement as predictors of suffering depressive symptoms between ages 7 and 17. Reinfjell et al. (2016) observed that difficult infant temperament and parental depression predicted an increase in depressive symptoms, whereas social skills predicted their decrease. Lack of social support (Colman et al., 2014), childhood and adolescence behavior problems (Kosterman et al., 2010), adverse experiences in childhood (Poole et al., 2017), and low self-esteem (Babore et al., 2016) also predicted depression.

Goals and Hypotheses

Taking into account previous studies, this research proposed two goals: (1) to study the relationships between self-assessed childhood depression and adaptive (social skills, self-concept-self-esteem, resilience, personal adaptation) and clinical variables (clinical disorder, school maladjustment, emotional symptoms, internalizing/externalizing problems, problem behaviors, childhood stress); and (2) to identify variables that predict childhood depression.

With these goals in mind, the study intends to verify whether children with many depressive symptoms, evaluated with a psychometric instrument, will also have: (1) high scores both in internalizing (withdrawal, somatization, anxiety) and externalizing problems (academic achievement), and school maladjustment (negative attitude to school); as well as (2) low self-concept-self-esteem, poor social skills (communication, cooperation, assertiveness. . .), and low resilience. In addition, this study attempts to confirm whether poor social skills, low self-esteem, and high level of anxiety predict childhood depression.

MATERIALS AND METHODS

Participants

The sample was made up of 420 participants aged 7–10 years, 59.5% were between 7 and 8 years old ($n = 250$) and 40.5% were between 9 and 10 ($n = 170$), and there was a total of 224 boys (53.3%) and 196 girls (46.7%). The participants were selected from schools of the Basque Country (Spain), 53.6% from public schools ($n = 225$) and 46.4% from private/concerted schools ($n = 195$). Public schools are state-funded and associated with middle and low socio-economic levels, whereas private schools are mainly funded by the parents' economic contributions and are associated with high socio-economic levels. Participants studied third ($n = 221$, 52.6%) and fourth grade ($n = 199$, 47.4%) of Primary Education. Of the total sample, 81.9% ($n = 344$) had been born in the province of Gipuzkoa, 1.9% ($n = 8$) in other Spanish provinces, 5.2% ($n = 22$) were aliens and 11% ($n = 46$) did not answer that question. The sample was selected intentionally from the schools of Gipuzkoa, balancing public and private/concerted schools.

Assessment Instruments

To measure the variables under study, we administered the Children's Depression Scale (CDS-self-assessment) and another six assessment instruments with psychometric guarantees of reliability and validity (**Table 1**).

Procedure

The study used a descriptive, correlational, and cross-sectional design. Firstly, a letter was sent to the selected schools, explaining the research project. With the headmasters who agreed to participate, we scheduled an interview in which we explained the project in more detail, and we handed out informed consent forms for parents and/or legal guardians. The members of the research team went to the schools and administered six assessment instruments to the participants, in two 50-min assessment sessions, on successive days. In addition, the teacher filled in another instrument with regard to each child. The study met the ethical values required in research with humans and received the favorable report of the Commission of Research Ethics of the University of the Basque Country (CEISH/266MR/2014).

Data Analysis

Before calculating the correlations between childhood depression and adaptive and clinical variables, we determined possible sex differences, performing descriptive analysis (means and standard deviations) and analysis of variance with the score obtained in depressive symptoms (CDS-self-assessment). Taking into account the absence of sex differences, we calculated the Pearson correlation coefficients for the entire sample. We calculated the correlation between depressive symptoms and the rest of the variables under study. Subsequently, in order to identify variables that predict depression, we conducted stepwise multiple linear regression analysis, first entering the global dimensions and then the subdimensions.

RESULTS

Childhood Depression: Relations to Adaptive and Clinical Variables

The results obtained in the analysis of variance according to sex showed that the mean scores in depressive symptoms were higher in boys ($M = 139.80$, $SD = 32.55$) than in girls ($M = 136.5$, $SD = 31.75$) but these differences were not statistically significant, $F(1,418) = 1.08$, $p = 0.299$. Therefore, we calculated the correlations for the entire sample.

Firstly, when analyzing the global dimensions (**Table 2**), we found positive correlations between self-assessed depression and clinical maladjustment, school maladjustment, emotional symptoms, emotional and behavioral problems (internalizing and externalizing), problem behaviors, emotional reactivity and childhood stress, as well as negative correlations with personal adaptation, global self-concept, social skills, and resilience.

Secondly, when analyzing the subdimensions, the Pearson correlation coefficients (**Table 2**) confirmed positive correlations between self-assessed depression and the following variables: (1) *Negative attitude to school* (feelings of dissatisfaction toward school); (2) *Negative attitude to teachers* (feelings of dislike toward teachers); (3) *Atypicality* (tendency to sudden mood changes, strange ideas, unusual experiences, obsessive thoughts and behaviors considered "weird"); (4) *External locus of control* (belief that the consequences of behavior are controlled by external events or other people); (5) *Social stress* (stress due to interactions with others); (6) *Anxiety* (feelings of nervousness, worry, and fear, tendency to feel overwhelmed by problems); (7) *Depression* (feelings of loneliness and sadness, inability to enjoy life); (8) *Sense of incapacity* (perceptions of not succeeding in school, difficulty to achieve goals and general incapacity); (9) *Internalizing problems assessed by teachers*, such as, *Withdrawal* (shyness, tendency to avoid contact with others, to be alone, not talking much, inhibited social behavior), *Somatization* (numerous physical complaints that do not allow students to work properly, such as headache, stomach ache, back and chest pains... without entirely justifiable medical causes), *Anxiety* (restlessness, nervousness, internal tension, insecurity, fear of problems), *Thought problems* (inappropriate, inconsistent reasoning), *Depression* (sadness, apathy, crying easily, lack of pleasure); (10) *Externalizing problems assessed by teachers* such as *Attention-hyperactivity* (difficulty concentrating and paying attention, easily distracted, active, impulsive, impatient in the face of difficulties, low frustration tolerance), and *Academic achievement* (below average age-appropriate academic achievement not due to intelligence, apathy, lack of motivation to study or to learn); (11) *Self-assessed problematic externalizing behaviors* (physical and verbal aggressive behavior), *Bullying* (aggressive behaviors toward peers), *Inattention-hyperactivity* (easily distracted, impulsivity, excess activity), and *internalizing behaviors* (anxiety, sadness, loneliness); (12) *Emotional reactivity* (sensitivity or intense reactions; recovery or capacity to return from a state of agitation to emotional balance; and *alteration,* occurring when balance is not achieved); and (13) *Childhood stress* in all the assessed dimensions (health/psychosomatic problems, school stress, family stress).

On another hand, the Pearson correlation coefficients (**Table 2**) confirmed negative correlations between depression and the following variables: (1) *Interpersonal relations* (perception of good social relations with peers); (2) *Relations with parents* (positive attitude toward parents and feeling loved); (3) *Self-esteem* (feelings of self-acceptance); (4) *Self-confidence* (confidence in own problem-solving capacity, independence, capacity to make own decisions); (5) *Self-concept* (physical, social, intellectual, family, personal, sense of control); (6) *Social skills* (communication, cooperation, assertiveness, responsibility, empathy, involvement/participation, self-control); and (7) *Resilience*, both regarding a *sense of competence* (optimism, self-efficacy, adaptability) and a *sense of affiliation* (trusting others, perception of social support in adverse situations, or feeling comfortable with others, and tolerance or belief that one can express one's differences within a relationship).

Of the set of variables analyzed, no relations were found between depression and *child-dependent behavioral problems* (behaviors that are more appropriate in smaller children,

TABLE 1 | Assessment instruments, assessed variables, tasks and psychometric data.

Instruments	Assessed variables	Task	Reliability
CDS-self-assessment, Child Depression Scale (Lang and Tisher, 1978; Seisdedos, 2003)	*Depression*	Self-report. 66 statements (e.g., "I often think that nobody cares about me"), rated on a 5-point scale according to the degree of agreement with the content of the sentence (1 = disagree strongly; 5 = strongly agree).	K-R20 = 0.91. Study sample (α = 0.88)
BASC-S2. Behavior Assessment System for Children and Adolescents (Reynolds and Kamphaus, 1992; González et al., 2004)	Clinical scales Negative attitude to school Negative attitude to teachers Atypicality External locus of control Social stress Anxiety Depression Sense of incapacity Adaptive scales Interpersonal relations Relations with parents Self-esteem Self-confidence *Global Indices* *Clinical Maladjustment* *School Maladjustment* *Personal Adaptation* *Emotional Symptoms Index*	Self-report. 146 sentences of adaptive behaviors (e.g., "My parents are often proud of me") and clinical symptoms (e.g., "I often have nightmares"). Respondents indicate the degree to which they can self-apply the content of the statement (thoughts, feelings, behaviors) on a True/False scale.	α = between 0.70 and 0.80 Study sample (α = 0.92)
SPECI. Screening for Children's Emotional and Behavioral Problems (Teacher) (Garaigordobil and Maganto, 2012)	*Internalizing problems* Withdrawal Somatization Anxiety Infantile-dependence Thought problems Depression *Externalizing problems* Attention-hyperactivity Disruptive behavior Academic achievement Violent behavior *Emotional and behavior problems (EBP)*	Teacher's assessment: evaluates 10 EBPs or categories through a series of illustrative examples of the problem (e.g., "Withdrawal: He/she is withdrawn and inhibited, prefers to be alone and seems isolated; not very active and reserved in his/her relation with others"). They indicate the frequency with which they observe these behaviors in each one of their students on a 3-point scale (0 = not at all, 1 = fairly, 2 = very much)	α = 0.82. Study sample (α = 0.89)
CAG. Cuestionario de Autoconcepto [Self-concept Questionnaire] (García, 2001)	*Global self-concept* Physical self-concept Social self-concept Intellectual self-concept Family self-concept Personal self-concept Sense of control	Self-report. 48 statements related to self-concept dimensions (e.g., "I like the way I am"). Respondents rate the degree to which they can self-apply the content of phrases on a 5-point scale (1 = Never, 2 = Not often, 3 = Don't know, 4 = Often, 5 = Always).	α = 0.87. Study sample (α = 0.74)
SSIS. Social Skills Improvement System (Gresham and Elliott, 2008)	*Social skills* Communication Cooperation Assertiveness Responsibility Empathy Involvement/participation Self-control *Problem Behaviors* Externalizing Bullying Inattention-hyperactivity Internalizing	Self-report. 75 items (e.g., "I ask for information when I need it"). Should indicate degree of agreement with content through 4 response options: Not true, Not very true, Fairly true, Very true.	α = 0.80 to 0.90. Study sample: (α = 0.98 to 0.99)

(Continued)

TABLE 1 | Continued

Instruments	Assessed variables	Task	Reliability
RSCA. The Resiliency Scales for Children and Adolescents (Prince-Embury, 2008)	*Sense of competence* Optimism Self-efficacy Adaptability *Sense of affiliation* Self-Confidence Support Comfort Tolerance *Emotional reactivity* Sensitivity Recovery Alteration	Self-report. 64 statements (e.g., "I can adapt when they change plans"). Respondents indicate the frequency with which they have the thought, feeling or behavior on a 4-point scale (0 = *Never*, 1 = *Rarely*, 2 = *Sometimes*, 3 = *Often*, 4 = *Almost always)*.	Competence ($\alpha = 0.85$), Affiliation ($\alpha = 0.90$), Reactivity ($\alpha = 0.90$). Study sample: $\alpha = 0.84$; $\alpha = 0.89$; $\alpha = 0.92$.
IECI. "Inventario de estrés cotidiano infantil" [Inventory of Daily Stress in Children] (Trianes et al., 2011)	*General stress* Health/psychosomatic problems Stress in school setting Stress in family environment	Self-report. 22 dichotomic items (e.g.,"I often feel bad: I get headaches, nausea..."), with Yes-No response option.	$\alpha = 0.81$. Study sample ($\alpha = 0.73$)

α = *Cronbach's alpha.*

dependence on adults, emotional immaturity. . .), *disruptive behavior* (disruptive behavior in the classroom, lack of discipline, disobedience, disturbing others or the class), and *violent behavior* (theft, threats, hitting, making fun, vandalism, cruelty to animals. . .).

Predictor Variables of Childhood Depression

In order to identify the predictor variables of child depression, we performed stepwise multiple linear regression analysis, introducing the global dimensions (clinical maladjustment, school maladjustment, personal adjustment, index of emotional symptoms, externalizing problems, internalizing problems, global self-concept, social skills, problematic social behaviors, sense of competence, affiliation, emotional reactivity, and general stress), the results of which are presented in **Table 3**.

The results (**Table 3**) revealed four significant variables: clinical maladjustment ($\beta = 0.328$), global self-concept ($\beta = -0.263$), general stress ($\beta = 0.243$), and social skills ($\beta = -0.142$). The percentages of explained variance (adjusted determination coefficients) for each of these predictor variables were of medium magnitude. These four variables, which account for 50.6% of the variance, were predictive of depression: high clinical maladjustment, low global self-concept, high level of general stress, and few social skills.

Subsequently, we performed linear regression analysis, introducing all the sub-dimensions, the results of which are presented in **Table 4**. The results revealed nine significant variables: internalizing problems ($\beta = 0.250$), family self-concept ($\beta = -0.183$), anxiety ($\beta = 0.152$), responsibility ($\beta = -0.163$), personal self-assessment ($\beta = -0.130$), social stress ($\beta = 0.103$), bullying ($\beta = -0.122$), health/psychosomatic problems ($\beta = 0.111$), and external locus of control ($\beta = 0.112$). The percentages of explained variance (adjusted determination coefficients) for each of the predictor variables were of medium to high magnitude. Nine variables, which account for 56.4% of the variance, were predictive of depression: many internalizing problems, low family self-concept, high level of anxiety, low responsibility, low personal self-assessment, high social stress, few behaviors of bullying perpetration, many health/psychosomatic problems, and external locus of control.

DISCUSSION

The study aimed to analyze the relationship between childhood depression and a broad range of adaptive and clinical variables, as well as to identify variables that predict depression.

Firstly, the results showed that children with high scores on self-assessed symptoms of depression were more likely to have had *high clinical maladjustment* (anxiety, atypicality, external locus of control), *school maladjustment* (negative attitude toward school and teachers), *emotional symptoms* (anxiety, negative interpersonal relationships, low self-esteem, social stress, sadness-loneliness, sense of incapacity), *many emotional and internalizing and externalizing behavior problems* (withdrawal, somatization, anxiety, thought problems, attention-hyperactivity, low academic performance), *many problem behaviors* (aggressiveness, inattentive-hyperactivity, anxiety, sadness, loneliness), *high emotional reactivity* (vulnerability, agitation, hypersensitivity, alteration, emotional imbalance), and *high childhood stress* (many health/psychosomatic problems, physical symptoms without medical justification, high school stress related to problems with teachers, peers, and poor academic achievement, and high family stress associated with the perception of a lack of parental affection, perceived loneliness at home, perception of squabbles among siblings and high parental demand). The results pointing in the same direction as other studies that found low academic achievement (Wang et al., 2016; Jaureguizar et al., 2017) and health and adaptation problems (Wang et al., 2016) in depressed children.

TABLE 2 | Pearson Coefficients correlation between self-assessed depression and adaptive and clinical variables.

	Depressive symptoms *r* (*p*)
BASC. Clinical Scales	
Negative attitude to school	0.30 (0.001)
Negative attitude to teachers	0.31 (0.001)
Atypicality	0.45 (0.001)
Locus of control	0.49 (0.001)
Social stress	0.53 (0.001)
Anxiety	0.53 (0.001)
Depression	0.48 (0.001)
Sense of incapacity	0.46 (0.001)
BASC. Adaptive scales	
Interpersonal relations	−0.31 (0.001)
Relations with parents	−0.18 (0.001)
Self-esteem	−0.27 (0.001)
Self-Confidence	−0.25 (0.001)
BASC. Global Indices	
Clinical Maladjustment	0.57 (0.001)
School Maladjustment	0.35 (0.001)
Personal Adaptation	−0.36 (0.001)
Emotional Symptoms Index	0.57 (0.001)
SPECI. Emotional/Behavior Problems (Teachers)	
Withdrawal	0.12 (0.012)
Somatization	0.09 (0.044)
Anxiety	0.09 (0.050)
Infantile-dependence	0.08 (0.093)
Thought problems	0.10 (0.029)
Attention-hyperactivity	0.18 (0.007)
Disruptive behavior	0.02 (0.602)
Academic achievement	0.13 (0.007)
Depression	0.14 (0.004)
Violent behavior	0.02 (0.632)
SPECI. Global Scales	
Internalizing problems	0.16 (0.001)
Externalizing problems	0.15 (0.001)
Emotional and Behavioral Problems	0.19 (0.001)
CAG. Self-concept	
Physical self-concept	−0.36 (0.001)
Social self-concept	−0.40 (0.001)
Family self-concept	−0.45 (0.001)
Intellectual self-concept	−0.30 (0.001)
Personal self-concept	−0.49 (0.001)
Sense of control	−0.32 (0.001)
Global Self-concept	−0.53 (0.001)
SSIS. Social skills	
Positive Scales	
Communication	−0.24 (0.001)
Cooperation	−0.30 (0.001)
Assertiveness	−0.29 (0.001)
Responsibility	−0.38 (0.001)
Empathy	−0.16 (0.001)
Involvement/participation	−0.29 (0.001)
Self-control	−0.30 (0.001)
Negative scales	
Externalizing	0.31 (0.001)
Bullying	0.17 (0.001)
Inattention-hyperactivity	0.40 (0.001)
Internalizing	0.58 (0.001)
SSIS. Global Scales	
Social skills	−0.39 (0.001)
Problem Behaviors	0.50 (0.001)
RSCA. Resilience Scales	
Optimism	−0.43 (0.001)
Self-efficacy	−0.37 (0.001)
Adaptability	−0.28 (0.001)
Self-Confidence	−0.43 (0.001)
Support	−0.29 (0.001)
Comfort	−0.34 (0.001)
Tolerance	−0.32 (0.001)
Sensitivity	0.29 (0.001)
Recovery	0.22 (0.001)
Alteration	0.33 (0.001)
RSCA. Global Resilience Indices	
Sense of competence	−0.41 (0.001)
Sense of affiliation	−0.41 (0.001)
Emotional reactivity	0.33 (0.001)
IECI. Childhood stress	
Stress due to health/psychosomatic problems	0.43 (0.001)
Stress in school setting	0.43 (0.001)
Stress in family environment	0.42 (0.001)
IECI. General stress	0.54 (0.001)

Secondly, the results suggest that children with high scores on self-assessed symptoms of depression are more likely to have *low personal adjustment* (shown in difficulties in interpersonal relationships, in relationships with parents, low self-confidence, and low self-esteem), *low global self-concept* (physical, social, intellectual, family, personal...), *poor social skills* (low level of communication, cooperation, assertiveness, responsibility, empathy, involvement/participation, self-control), *low resilience,* that is, *low sense of competence* (low level of optimism, self-efficacy, adaptability) and of *affiliation* (low trust, low social support, feelings of discomfort, and low tolerance for difficulties). The data validate other studies that have shown connections between depressive symptoms and problems in peer relationships (Cole, 1991; Kochenderfer and Ladd, 1996; Brendgen et al., 2002; Katz et al., 2011; Bernaras et al., 2013; Hames et al., 2013), low self-esteem (Orth et al., 2008; Bos et al., 2010), and low resilience (Geng-Feng et al., 2016).

Thirdly, the regression analysis yielded four predictor variables of child depression that account for 50.6% of the variance: *high clinical maladjustment, low global self-concept, high level of general stress,* and *poor social skills*. In addition, when introducing all the sub-dimensions, we confirmed as predictors nine variables that explain 56.4% of the variance: *many internalizing problems* (anxiety, sadness, loneliness); *low family self-concept* (the family provides a low level of satisfaction);

high level of anxiety (nervousness, worry, fear, tendency to feel overwhelmed by problems); *low responsibility* (low interest in school work), *low personal self-assessment,* (low global rating as a person), *high social stress* (due to interactions with others), *few behaviors of peer bullying* (as perpetrator), *health/psychosomatic problems* (physical problems, headaches, stomach ache. . .), and *external locus of control* (attribution of consequences to external factors). Hence, the results confirm the predictions and ratify studies that have found that anxiety (Kovacs and López-Durán, 2010), health and adaptation problems, problems in interpersonal relationships (Wang et al., 2016), poor social skills (Reinfjell et al., 2016), and low self-esteem (Babore et al., 2016) predict childhood depression.

Among the limitations of the study, we note the intentional selection of the sample. Therefore, future studies should use representative samples taken from educational contexts, and also samples of children who consult a psychologist for childhood depression at these early ages. Moreover, we recommend that future research should also obtain information from the parents because, in this study, we only obtained information about self-reported depressive symptoms and symptoms reported by teachers. Finally, as a limitation of this work, we note that the data are correlational, so they contribute little to the causal link between these variables. The methodology used is not experimental, so it does not allow us to categorically rule out the effect of third variables (for example, environmental factors. . .). More investigation with experimental or quasi-experimental designs would help to better determine the existence of connections among these variables.

Despite the limitations, the study makes a significant contribution, providing evidence of the significant connection of childhood depression with thought problems (inappropriate, incoherent reasoning, strange thoughts...), problems of attention-hyperactivity (difficulty concentrating and paying attention, easily distracted, poor task performance, impulsivity, low frustration tolerance...), emotional reactivity (vulnerability, low resilience, high agitation, alteration, emotional imbalance, lack of control...), and high level of general stress (social, school, family...). Few studies have identified predictive variables of child depression, and this work has identified as predictors a high level of general stress (social, school, family...), many health/psychosomatic problems (worries and physical problems that lead to frequent visits to the doctor), and external locus of control (external attribution of the consequences of behaviors).

These findings have relevant practical implications for the design of programs of prevention and psychological treatments for childhood depression. They mainly emphasize the importance of including in interventions to prevent/reduce childhood depression some activities aimed at: (1) *reducing childhood stress* in all contexts (social, school and family), for example, incorporating relaxation activities, cognitive training techniques to control negative thoughts of that generate stress..., which would have positive results in reducing anxiety and problems of attention-hyperactivity; (2) *enhancing self-esteem*, and feelings of self-acceptance; (3) *developing social skills*, the ability to integrate socially, communicate, cooperate, be assertive, empathetic, participatory, self-controlled..., because the increase in social competences will facilitate social interaction, thereby avoiding the situation of isolation and exclusion that many depressed children suffer; (4) *promoting internal locus of control* of life situations and their consequences; and (5) *stimulating resilience*, that is, optimism, self- efficacy, adaptability, self-confidence, feeling comfortable..., a positive factor which helps to cope with

TABLE 3 | Multiple regression analysis for global dimensions predictive of childhood depression.

	R	R^2	ΔR^2	*B*	Error	Constant	β	*t*
BASC. Clinical Maladjustment	0.566	0.321	0.312	0.410	0.049	36.83	0.328	7.19***
CAG. Global self-concept	0.682	0.466	0.463	−0.412	0.076	170.65	−0.263	−5.42***
IECI. Childhood stress	0.707	0.499	0.495	2.418	0.463	171.30	0.243	5.27***
SSIS. Social skills	0.715	0.512	0.506	−0.297	0.098	178.24	−0.142	−3.03**

$^{**}p < 0.01$; $^{***}p < 0.001$.

TABLE 4 | Multiple regression analysis for sub-dimensions predictive of childhood depression.

	R	R^2	ΔR^2	*B*	Error	Constant	β	*t*
SSIS. Internalizing problems	0.581	0.337	0.336	1.502	0.272	107.98	0.250	5.53***
CAG. Family self-concept	0.653	0.426	0.423	−1.255	0.273	182.90	−0.183	−4.60***
BASC. Anxiety	0.705	0.497	0.493	1.254	0.397	180.37	0.152	3.51**
SSIS. Responsibility	0.724	0.523	0.519	−1.789	0.406	200.19	−0.163	−4.41***
CAG. Personal self-assessment	0.733	0.537	0.531	−1.060	0.331	226.31	−0.130	−3.20***
BASC. Social stress	0.740	0.548	0.541	1.606	0.777	219.36	0.103	2.06*
SSIS. Bullying	0.747	0.558	0.550	−1.634	0.486	223.41	−0.122	−3.36***
IECI. Health/Psychosomatic	0.753	0.567	0.558	2.401	0.838	221.73	0.111	2.86**
BASC. Locus of control	0.757	0.573	0.564	1.190	0.500	218.09	0.112	2.38*

$^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

adversity and develop good personal adaptation. Resilience is shown to be a relevant goal to be included in the treatment and prevention of childhood depression.

In the educational context, the results advocate the implementation of programs of socio-emotional development, for example, programs of cooperative play and emotional intelligence, which can promote the development of social and emotional competences that are inversely related to childhood depression. In the clinical setting, the results suggest different goals and therapeutic strategies, such as: (1) teaching techniques to control anxiety (relaxation), (2) using behavioral techniques to develop social/prosocial skills, giving opportunities to practice/try out these behaviors and strengthening them; (3) using cognitive techniques to influence cognitive processes (attributions, expectations, problem-solving strategies and skills, control of negative thoughts...), for example, cognitive restructuring to change irrational beliefs to other more adaptive ways of thinking, self-instruction training (identifying internal negative stimuli, learning how to use reinforcing self-affirmations, positive self-appraisals...); and (4) using emotional techniques such as drawing and playing to facilitate the expression and constructive management of emotions (Garaigordobil et al., 1996; Garaigordobil, 1999, 2003; Del Barrio and Carrasco, 2013).

As has been highlighted in several studies, the prevalence of depression is worthy of consideration, as it is a public health problem that requires multidirectional intervention (family, school, clinic...). Taking into account the findings of the present study, we underline the importance of identifying early symptoms of childhood depression and suggest the implementation of educational programs that promote socio-emotional competences, and the systematized use of evidence-based, efficacious clinical treatments for childhood depression. Intervening in childhood depression will have a positive effect on the emergence of depression during adolescence and adulthood, and their concomitant severe consequences.

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

ACKNOWLEDGMENT

The present study has been financed by the ALICIA KOPLOWITZ Foundation (FP15/62).

REFERENCES

American Psychiatric Association [APA] (2014). *Manual Diagnóstico y Estadístico de los Trastornos Mentales [Diagnostic and Statistical Manual of Mental Disorders] DSM-5*. Madrid: Panamericana.

Babore, A., Trumello, C., Candelori, C., Paciello, M., and Cerniglia, L. (2016). Depressive symptoms, self-esteem and perceived parent–child relationship in early adolescence. *Front. Psychol.* 7:982. doi: 10.3389/fpsyg.2016.00982

Bernaras, E., Jaureguizar, J., Soroa, M., Ibabe, I., and de las Cuevas, M. C. (2013). Evaluación de la sintomatología depresiva en el contexto escolar y variables asociadas [Evaluation of Depressive Symptomatology and the Related Variables in the School Context]. *An. Psicol.* 29, 131–140. doi: 10.6018/analesps.29.1.137831

Bos, A. E. R., Huijding, J., Muris, P., Vogel, L. R. R., and Biesheuvel, J. (2010). Global, contingent and implicit self-esteem and psychopathological symptoms in adolescents. *Pers. Individ. Dif.* 48, 311–316. doi: 10.1016/j.paid.2009.10.025

Brendgen, M., Vitaro, F., Turgeon, L., and Poulin, F. (2002). Assessing aggressive and depressed children's social relations with classmates and friends: a matter of perspective. *J. Abnorm. Child Psychol.* 30, 609–624. doi: 10.1023/A:1020863730902

Cole, D. A. (1991). Preliminary support for a competency-based model of depression in children. *J. Abnorm. Child Psychol.* 100, 181–190. doi: 10.1037/0021-843X.100.2.181

Colman, I., Zeng, Y., McMartin, S. E., Naicker, K., Ataullahjan, A., Weeks, M., et al. (2014). Protective factors against depression during the transition from adolescence to adulthood: findings from a national Canadian cohort. *Prev. Med.* 65, 28–32. doi: 10.1016/j.ypmed.2014.04.008

Del Barrio, V. (2000). *La Depresión Infantil. Factores de Riesgo y Posibles Soluciones [Child Depression. Risk Factors and Possible Solutions]*. Málaga: Aljibe.

Del Barrio, V., and Carrasco, M. A. (2013). *Depresión en Niños y Adolescentes [Depression in Children and Adolescents]*. Madrid: Síntesis.

Garaigordobil, M. (1999). Assessment of a cooperative-creative program of assertive behavior and self-concept. *Span. J. Psychol.* 2, 3–10. doi: 10.1017/S1138741600005400

Garaigordobil, M. (2003). *Programa Juego 8-10 Años. Juegos Cooperativos y Creativos Para Grupos de Niños de 8 a 10 Años [Play Program for 8 to 10-Year-Olds*. Cooperative and Creative Games for Groups of Children Aged 8 to 10], Vol. 3. Madrid: Pirámide

Garaigordobil, M., and Maganto, C. (2012). *SPECI: Screening de Problemas Emocionales y de Conducta Infantil [Screening of Emotional and Behavioral Problems during Childhood]*. Madrid: TEA.

Garaigordobil, M., Maganto, C., and Etxeberria, J. (1996). Effects of a cooperative game program on socio-affective relationships and group cooperation capacity. *Eur. J. Psychol. Assess.* 12, 140–151. doi: 10.1027/1015-5759.12.2.141

García, B. (2001). *CAG. Cuestionario de Autoconcepto: Manual [Self-Concept Questionnaire: Handbook]*. Madrid: EOS.

Geng-Feng, N., Xiao-Jun, S., Yuan, T., Cui-Ying, F., and Zong-Kui, Z. (2016). Resilience moderates the relationship between ostracism and depression among Chinese adolescents. *Pers. Individ. Dif.* 99, 77–80. doi: 10.1016/j.paid.2016.04.059

González, J., Fernández, S., Pérez, E., and Santamaría, P. (2004). *BASC. Sistema de Evaluación de la Conducta en Niños y Adolescentes (Adaptación Española) [Spanish Adaptation of the Behavior Assessment System for Children]*. Madrid: TEA ediciones.

Gresham, F. M., and Elliott, S. N. (2008). *Social Skills Improvement System Rating Scales Manual*. Minneapolis, MN: NCS Pearson.

Hames, J. L., Hagan, C. R., and Joiner, T. E. (2013). Interpersonal processes in depression. *Annu. Rev. Clin. Psychol.* 9, 355–377. doi: 10.1146/annurev-clinpsy-050212-185553

Jaureguizar, J., Bernaras, E., and Garaigordobil, M. (2017). Child depression: prevalence and comparison between self-reports and teacher reports. *Span. J. Psychol.* 20:E17. doi: 10.1017/sjp.2017.14

Katz, S. J., Conway, C. C., Hammen, C. L., Brennan, P. A., and Najman, J. M. (2011). Childhood social withdrawal, interpersonal impairment, and young adult depression: a mediational model. *J. Abnorm. Child Psychol.* 39, 1227–1238. doi: 10.1007/s10802-011-9537-z

Kochenderfer, B. J., and Ladd, G. W. (1996). Peer victimization: cause or consequence of school maladjustment? *Child Dev.* 67, 1305–1317. doi: 10.1111/j.1467-8624.1996.tb01797.x

Kosterman, R., Hawkins, J. D., Mason, W. A., Herrenkohl, T. I., Lengua, L. J., and Mccauley, E. (2010). Assessment of behavior problems in childhood and adolescence as predictors of early adult depression. *J. Psychopathol. Behav. Assess.* 32, 118–127. doi: 10.1007/s10862-009-9138-0

Kovacs, M., and López-Durán, N. (2010). Prodromal symptoms and atypical affectivity as predictors of major depression in juveniles: implications for

prevention. *J. Child Psychol. Psychiatry* 51, 472–496. doi: 10.1111/j.1469-7610.2010.02230.x

Lamers, F., van Oppen, P., Comijs, H., Smit, J., Spinhoven, P., van Balkom, A., et al. (2011). Comorbidity patterns of anxiety and depressive disorders in a large cohort study: the Netherlands study of depression and anxiety (NESDA). *J. Clin. Psychiatry* 72, 341–348. doi: 10.4088/JCP.10m06176blu

Lang, M., and Tisher, M. (1978). *Children's Depression Scale*. Camberwell, VIC: Australian Council for Educational Research.

Orth, U., Robins, R. W., and Roberts, B. W. (2008). Low self-esteem prospectively predicts depression in adolescence and young adulthood. *J. Pers. Soc. Psychol.* 95, 695–708. doi: 10.1037/0022-3514.95.3.695

Poole, J. C., Dobson, K. S., and Pusch, D. (2017). Childhood adversity and adult depression: the protective role of psychological resilience. *Child Abuse Negl.* 64, 89–100. doi: 10.1016/j.chiabu.2016.12.012

Prince-Embury, S. (2008). *Resiliency Scales for Children & Adolescents (RSCA)*. San Antonio, TX: Pearson.

Qualter, P., Brown, S. L., Munn, P., and Rotenberg, K. J. (2010). Childhood loneliness as a predictor of adolescent depressive symptoms: an 8-year longitudinal study. *Eur. Child Adolesc. Psychiatry* 19, 493–501. doi: 10.1007/s00787-009-0059-y

Reinfjell, T., Kårstad, S. B., Berg-Nielsen, T., Luby, J. L., and Wichstrøm, L. (2016). Predictors of change in depressive symptoms from preschool to first grade. *Dev. Psychopathol.* 28, 1517–1530. doi: 10.1017/S0954579415001170

Reynolds, C. R., and Kamphaus, R. W. (1992). *Behavior Assessment System for Children (BASC)*. Circle Pines, MN: American Guidance Services.

Seisdedos, N. (2003). *Cuestionario de Depresión para Niños. Manual. (7ª Edn. Adaptación española del CDS) [Depression Questionnaire for Children. Manual. Spanish adaptation of the CDS]*, 7th Edn. Madrid: TEA.

Trianes, M. V., Blanca, M. J., Fernández-Baena, F. J., Escobar, M., and Maldonado, E. F. (2011). *IECI. Inventario de Estrés Cotidiano Infantil [Inventory of Daily Stress in Children]*. Madrid: TEA.

Wang, L., Feng, Z., Yang, G., Yang, Y., Wang, K., Dai, O., et al. (2016). Depressive symptoms among children and adolescents in western China: an epidemiological survey of prevalence and correlates. *Psychiatry Res.* 246, 267–274. doi: 10.1016/j.psychres.2016.09.050

World Health Organization [WHO] (2016). *Depression*. Available at: http://www.who.int/mediacentre/factsheets/fs369/es/ [accessed February 2017].

Wu, Y. L., Zhao, X., Li, Y. F., Ding, X. X., Yang, H. Y., Bi, P., et al. (2016). The risk and protective factors in the development of childhood social anxiety symptoms among Chinese children. *Psychiatry Res.* 240, 103–109. doi: 10.1016/j.psychres.2015.08.046

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Garaigordobil, Bernarás, Jaureguizar and Machimbarrena. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

HYPOTHESIS AND THEORY
published: 16 May 2017
doi: 10.3389/fpsyg.2017.00745

How Do B-Learning and Learning Patterns Influence Learning Outcomes?

María Consuelo Sáiz Manzanares[1]*, *Raúl Marticorena Sánchez*[2], *César Ignacio García Osorio*[2] and *José F. Díez-Pastor*[2]

[1] Department of Health Sciences, University of Burgos, Burgos, Spain, [2] Department of Civil Engineering, University of Burgos, Burgos, Spain

Learning Management System (LMS) platforms provide a wealth of information on the learning patterns of students. Learning Analytics (LA) techniques permit the analysis of the logs or records of the activities of both students and teachers on the on-line platform. The learning patterns differ depending on the type of Blended Learning (B-Learning). In this study, we analyse: (1) whether significant differences exist between the learning outcomes of students and their learning patterns on the platform, depending on the type of B-Learning [Replacement blend (RB) vs. Supplemental blend (SB)]; (2) whether a relation exists between the metacognitive and the motivational strategies (MS) of students, their learning outcomes and their learning patterns on the platform. The 87,065 log records of 129 students (69 in RB and 60 in SB) in the Moodle 3.1 platform were analyzed. The results revealed different learning patterns between students depending on the type of B-Learning (RB vs. SB). We have found that the degree of blend, RB vs. SB, seems to condition student behavior on the platform. Learning patterns in RB environments can predict student learning outcomes. Additionally, in RB environments there is a relationship between the learning patterns and the metacognitive and (MS) of the students.

Keywords: learning analytics, learning management systems, blended learning, supplemental blend, replacement blend, successful learning, self-regulated learning, learning outcomes

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
Vincenzo Antonio Piccione, Roma Tre University, Italy
Carbonero Martín Miguel Angel, University of Valladolid, Spain

***Correspondence:**
María Consuelo Sáiz Manzanares
mcsmanzanares@ubu.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *29 January 2017*
Accepted: *24 April 2017*
Published: *16 May 2017*

Citation:
Sáiz Manzanares MC, Marticorena Sánchez R, García Osorio CI and Díez-Pastor JF (2017) How Do B-Learning and Learning Patterns Influence Learning Outcomes? Front. Psychol. 8:745. doi: 10.3389/fpsyg.2017.00745

HIGHLIGHTS

- Good teaching designs in Learning Management Systems (LMS) encourage the development of process-oriented feedback.
- Learning Analytics (LA) allow a prediction of the learning patterns of at-risk students.
- Different learning patterns in B-Learning environments, Replacement blend (RB) vs. Supplemental blend (SB).
- Successful learning in the LMS depends on the design of teaching.
- Metacognitive strategies are related with the type of learning pattern in LMS.
- Learning patterns differ in accordance with the type of task.

INTRODUCTION

Learning Management Systems and Improvements to the Learning Process

Over recent years, Learning Management Systems (LMS) have been very effectively used in teaching-learning processes, especially in Higher Education. LMS have been related to improvements in learning outcomes and in information acquisition (Cerezo et al., 2016). These systems have the objective of introducing improvements in the learning process, through the use of new technologies (de Raadt et al., 2009; Xinogalo, 2015), because:

1. They strengthen the development of Self-Regulated Learning (SRL), which increases student motivation. Likewise, the use of LMS reduces abandonment and leads to more successful learning outcomes (Schraw et al., 2007).
2. They allow the teacher to provide the student with more immediate feedback. They also make it possible to register both the teacher's feedback actions and the student's queries about these actions (Sáiz and Marticorena, 2016).
3. They facilitate collaborative and constructive learning (Zacharis, 2015; Yücel and Usluel, 2016).

Also in the context of SRL, LMS provide students with the possibility of developing scaffolding that strengthens planning, monitoring, control and reflection on the object of learning. Likewise, LMS increase understanding and the construction of learning (Azevedo, 2005). Recent investigations (Winne, 2014; Höök and Eckerdal, 2015) have highlighted those individuals who learn with scaffolded tasks of growing difficulty increase autonomy in problem-solving processes. In summary, the stepped structure of learning permits the learner to sequence both goals and the steps needed for task-related problem-solving. LMS not only facilitates the stepped structure of learning, but it also increases motivation toward the object of learning and SRL (Segedy and Biswas, 2015).

An essential aspect in the whole process is the feedback that the teacher provides through the platform. On this point, it is necessary to differentiate two types of feedback: (1) process-oriented feedback, includes the motivational, the cognitive and the metacognitive characteristics of students that are taken into account by the teacher for the design of the feedback; and, (2) grade-oriented feedback, which refers to information on the execution of the learning task or process (incorrect, correct or excellent), but does not descend to the aspects involved in process-oriented feedback (Hattie and Timperley, 2007; Harks et al., 2014). The first type of feedback is more effective, as it facilitates the construction and scaffolding of knowledge (Hattie, 2013; Mentzer et al., 2015).

Well-designed LMS mean that the development of process-oriented feedback is more structured for students, since they can consult the orientations of the teacher, both in real time and afterwards, at any time in the learning process (Sáiz and Marticorena, 2016).

With regard to collaborative learning, this investigation highlights that LMS increase and improve problem-solving routines and increase metacognitive strategies for efficient problem solving (Bernard and Bachu, 2015; Malmberg et al., 2015; Järvelä et al., 2016; Sáiz and Marticorena, 2016). Although, according to Bernard and Bachu (2015), the teacher must start by analyzing students' prior knowledge and clearly formulating the tasks they have to carry out. The teacher also has to provide student with help guides which clearly reflect the objectives, planning of executions and deliveries. These tasks must have an increasing degree of difficulty in order to avoid students' dropouts. Likewise, the teacher should provide accurate feedback of the tasks. All this will increase the motivation of the students.

Nevertheless, the mere use of LMS will not guarantee better results in the teaching-learning process. On the one hand, any such use is conditional upon the design that the teacher makes of the learning activities, as well as the type of feedback that the teacher provides on the evidence of learning. On the other hand, the teacher has to perform an analysis of the patterns of learning behavior of the students. Recent studies have indicated that for a satisfactory development of the teaching-learning process in LMS, training in their use is necessary both for teachers and for students (Yamada and Hirakawa, 2015), given that the mere use of the platforms cannot in itself guarantee the effectiveness of the learning process. Park and Il-Hyun (2016) found significant differences, studying variables, such as the characteristics of teachers, of students, and the structuring and the design of subject modules.

Another relevant aspect in this learning process in LMS is the use of tools for analyzing the log records registered by the platform for the early detection of students at-risk of obtaining poor academic results. Recent studies (Zacharis, 2015; Strang, 2017) have analyzed the relation between the use of the LMS and the behavioral patterns of learning among students. Both successful and at-risk conducts may be detected with regression analysis techniques. Those conducts explain up to 52% of the variance in the learning outcome. The studies are validated through the use of data-mining techniques supported by the use of a well-known tool: Waikato Environment for Knowledge Analysis; better known by its WEKA acronym (Frank et al., 2016). According to, some authors (Zacharis, 2015; Cerezo et al., 2016), the learning behavior that is considered key in the analysis of behavioral patterns of learning are:

1. General effort.
2. Time spent performing the tasks.
3. Working time on theoretical contents.
4. Results in the self-evaluation tests.
5. Time spent in the discussion groups on the forums.
6. Quality of the discussions in the forums (type of message and its length).
7. Time spent analyzing the feedback provided by the teacher.
8. Number and type of messages sent.
9. Frequency of use of the LMS.
10. Accessing the forums to read messages.
11. Contributing to the creation of content.
12. Number of files accessed.
13. Effort required in quizzes.
14. Handing in assignments on time.

Logs, Learning Analytics, and Educational Data Mining

In LMS, the interactions of all user roles (student, teacher and administrator) are recorded in log files. These logs may be analyzed and the use of data-mining techniques allows patterns to be discovered or new information to be extracted from these large datasets. We refer to Learning Analytics (LA) or Educational Data Mining (EDM) when these techniques are employed with data relating to learning. These concepts are closely related between each other, although the first centers more on understanding the learning process, and the second of the two models allows us to analyse these data (Baker and Inventado, 2014).

Moodle is one of the most frequently used within the LMS (Dougiamas and Taylor, 2003). A Learning Management System (LMS) with a modular structure, it allows different resources to be used for different student (individual and group) and teacher profiles. It also means that different learning activities and actions (discussion forums, questionnaires, workshops, wikis, access to repositories) may take place and innovative teaching methods may be used, such as Project-Based Learning (PBL). The interactive behaviors that can be analyzed in this type of LMS, are as follows (Yücel and Usluel, 2016):

1. Student-student interaction.
2. Student-teacher interaction.
3. Student-content interaction.
4. Student-system interaction.
5. Teacher-student interaction.

Yücel and Usluel (2016) pointed out that it is important to consider the type, the quantity and the quality of the interaction. The use of each of these interactive conducts is reflected in the file of records or logs. Moodle permits the extraction of these files, where all of the different events and interactions between the members of the community of learning are stored, in order to facilitate an analysis that will provide a lot of information on the learning behavior of the users.

The information that may be obtained from the Moodle records is very extensive, which is why EDM has to be used to extract what is needed in each case (Iglesias-Pradas et al., 2015). So, there are techniques and models in EDM that will provide records of access: patterns of learning behavior among students and the interactions between them, as well as between the teacher and the students. Likewise, they provide methods for the extraction of information in real time. All of these, records support the processes of educational evaluation by the teacher. EDM can be applied to different roles (Romero and Ventura, 2007; Romero et al., 2013):

1. Oriented toward students: this approach is focused on learning tasks and the objective is the improvement of student learning.
2. Oriented toward educators: the objective is to provide feedback for instruction, to evaluate the course structure and its contents, to analyse elements that have been effective in the learning processes, to classify the type of students and to perceive the needs for guidance and monitoring of learning, the most common patterns in their learning, and the frequency of errors with a view to finding more effective activities.
3. Oriented toward responsible academics and administration: the objective is to provide information to the institution that will help it to improve its learning platforms.
4. At present, importance is given to the use of LA in LMS (Chatti et al., 2012; Agudo-Peregrina et al., 2014). As mentioned earlier, LA are a concept related with EDM, but their focus is more on understanding the learning process (Roberts et al., 2016). It can be used to investigate the responses to such questions as:

1. What data can be used? (*What*) As previously mentioned, an astonishing amount of information is recorded in the LMS, for which purpose the detection of patterns of data analysis is required (LA).
2. For whom is the information provided? (*Who*) It is important to distinguish the group to which the analysis is directed (students, teachers, tutors/mentors, educational administrators, etc.). For example, if we center on the students, the institution could be interested in knowing how to improve its systems to construct more effective areas of learning. Likewise, the teachers might wish to make their teaching practice more effective and to offer the support that their students need. The institutions would therefore be interested in detecting at-risk students and increasing the success of their students, for the purpose of taking administrative decisions on performance. In summary, educational managers increasingly propose the implementation of tools that offer data analysis for non-experts through the application of EDM. These techniques offer goal-oriented feedback that allows the user of the platform to reflect on the data for decision-taking.
3. Why is the information provided? (*Why*) There are different objectives in accordance with the role of the user. LA include: monitoring and analysis, in other words, the follow up of students so as to generate reports for the teacher and/or for the institution. The evaluation of student learning processes by the teacher will improve the learning environment. The prediction of the knowledge of the student and of the results of learning will permit the detection of at-risk students and give students the specific assistance that they need for successful learning. Likewise, tutoring and mentoring will facilitate process-oriented feedback.
4. How is the information provided? (*How*) The methods for the detection of the hidden learning patterns in LMS are:

1. Statistical methods: LMS permit the extraction of reports based on the interaction of the teacher and the students on the platform that analyses time online, total number of visits, number of visits per page, distribution of visits over time, frequency of replies, etc. The statistical analyses that LMS provide are mean (*M*) and standard deviations (*SD*).
2. Visual information: set out reports of the data distributions that are easy to interpret by users.
3. Data mining: the methods are fitted into categories of supervised learning (classification or regression),

non-supervised (clustering) and data association rules.

4. *Classification* (supervised learning): processes of finding a function or a model that distinguishes the data classes. The classes associated with each object are known during the training process. The objective is subsequently to predict the classes of objects with an unknown class label. It includes decision trees, neuronal networks, Bayesian classification and support vector machines together with the k-nearest neighbor classification.
5. *Clustering* in contrast with classification, the membership of a class in each training object or instruction is not well-known. The data are organized into groups from the criterion of inclusion in similar clusters vs. different clusters. The criterion is how the data are situated in the multi-dimensional space defined by the values of attributes and is based on a function of distance. The clustering methods are usually classified by partitioning methods and hierarchical methods. In the first, each participation represents a cluster. The technique begins with an arbitrary partition and then objects are changed from one group to another. Popular heuristic methods are used, such as the k-means algorithm (each cluster is represented from the mean value of the objects in the cluster), and the k-medoids algorithm (each cluster is represented by one of the objects of the cluster). Hierarchical methods create a hierarchy of groups in the form of a tree. The hierarchical clustering algorithms can be of two types: agglomerative and divisive: in the agglomerative algorithms, the hierarchy of groups is organized in an ascendant way (bottom up or by fusion merging): Initially each group is formed by a single observation, then these groups merge to form larger ones and so on, until all observations are in a single group. In the divisive algorithms, the clustering process is organized in a descendent manner (top down or splitting): initially all the observations belong to the same cluster and subsequently they are split in a recursive way.

Educational Data Mining (EDM) is multidisciplinary, in which techniques of algorithm construction, artificial neural networks, instance-based learning, Bayesian learning, programming techniques and statistical techniques all converge and different analytical procedures may also be used. These procedures may be grouped into clustering techniques, outlier detection techniques, association rule mining, sequential pattern mining and text mining (Romero and Ventura, 2007).

In summary, the use of the different techniques in EDM depends on the objectives of the task analysis. Nevertheless, investigators need to find the pedagogical objectives that are needed in the prediction, as well as the recommendations that are pertinent in each case. The challenge of the data analysis techniques centers on the analysis of tasks that allow feedback to be given to the teachers and solutions to be able to intervene in the learning process in an early and effective manner.

Another aspect that has to be considered is that the behavioral patterns on the platform depend on the type of B-Learning (Margulieux et al., 2016). For example, in Replacement blend (RB) (feedback given on the learning production on the platform), participation in the discussion forums is essential, while this aspect is not as important in Supplemental blend (SB) (feedback given on the Face-to-Face (F2F) productions), because the interaction may be done F2F (Cerezo et al., 2016). Another variable is that not all the students have the same learning process in the LMS. Likewise, another relevant indicator is that the teaching on the LMS can be designed in either a traditional or an innovative way (team-based projects, online discussion forums and online quizzes; Park and Il-Hyun, 2016).

In addition, it is necessary to carry out an evaluation of user satisfaction (students and teachers), employing the LMS (Hornbæk, 2006). The e-evaluation models suggest that there are different variables that have an influence: personal factors, behaviors that the students develop, and the environment in which the learning takes place (Harrati et al., 2016). Likewise, different learning patterns have been found, depending on the type of evaluation carried out by the teacher, which is directly related with the learning outcomes.

The use of the methodologies described above allows patterns and new information to be detected on the basis of data sets, such as the log files for example. In this study, we are particularly interested in responding to the following research questions:

RQ1: Will the learning patterns of students on the platform differ depending on the structure of the training program (RB vs. SB)?

RQ2: Will a relation be found between the learning patterns of students on the platform and the learning outcomes?

RQ3: Will a relation exist between the learning outcomes, the patterns of learning of the students on the platform, the metacognitive and the (MS) of students?

RQ4: Will the learning behaviors of the students on the platform offer different learning patterns?

MATERIALS AND METHODS

Participants

We worked with a sample of 129 students, 69 students on the first-year Computer Science Degree (CSD), who were following intermediary subjects on the degree course and 60 students from the branch of Health Sciences, 41 students from the Occupational Therapy Degree (OTD) and 19 on the Nursing Degree (ND) who were studying at intermediary levels on the degree course. In **Table 1**, the gender and the mean age of everybody in the groups may be seen.

Instruments

The following techniques and tools were used in this experimental project.

1. The Moodle platform (version 3.1). It was used to analyse records on: 1. Access to complementary information; 2. Access to theory; 3. Access to practice; 4. Access to self-evaluation; 5. Access to feedback given by the teacher; 6. Participation in the forum; 7. Mean access rate per day.
2. The Scale of learning strategies (ACRAr) by Román and Poggioli (2013). This scale is a highly tested instrument in investigations on learning strategies in Spanish-speaking

TABLE 1 | Descriptive statistics of the variables assigned age and gender.

Degree		Men			Women		
	N	*n*	M_{age}	SD_{age}	*n*	M_{age}	SD_{age}
Computer Science Degree (CSD)	69	60	20.34	1.42	9	21.55	2.5
Nursing Degree (ND)	19	3	26.66	8.19	16	26.26	8.19
Occupational Therapy Degree (OTD)	41	7	23.28	2.92	34	22.58	1.55

N, total number of participants; n, number of participants by variable (sex and degree); M_{age}, Mean age; SD_{age}, Standard deviation by age.

TABLE 2 | Strategies in each one of the ACRAr scales (Román and Poggioli, 2013) and of the different validity coefficients.

ACRAr Scales	Type of strategies	Number of strategies	Inter-judge validity	Construct validity	Content validity
Acquisition of information	Repetition and re-reading	6	$\alpha = 0.78$	$r = 0.75$	$r = 0.85$
Encoding information	Mnemonics, organization and preparation	12	$\alpha = 0.92$	$r = 0.86$	$r = 0.87$
Recovery of information	Search and generation of responses	4	$\alpha = 0.83$	$r = 0.86$	$r = 0.86$
Metacognition	Self-knowledge, self-planning and regulation and self-evaluation	4	$\alpha = 0.90$	$r = 0.88$	$r = 0.88$
Information processing support	Self-instructions, self-control, counter-distractions, social interventions, intrinsic and extrinsic motivation, and escapist motivations	6	$\alpha = 0.90$	$r = 0.88$	$r = 0.88$

populations (Camarero-Suárez et al., 2000; Carbonero et al., 2013) and identifies 32 strategies at different times of processing the information. The list of the scales with the indexes of validity is presented in **Table 2**. In this study, only the metacognitive scales were used and the strategies of motivation within the scale of support for information processing.

3. In this study, the indicators of validity in the scales used in the sample were: Metacognition $\alpha = 0.92$ and Information processing support $\alpha = 0.91$.
4. Learning outcomes among the students with OTD, ND, and CSD. The results of learning theoretical aspects (exam test that in all groups consisted of a multiple choice test-type exam with one true answer) and practical aspects. However, in the two first groups, when working for (PBL) both preparation and defense were considered.

Procedure

Before starting the study, students were passed information and invited to participate in the project, so that their participation was voluntary. In CSD, a pair-based working methodology was used. The subject module on the Moodle platform was structured into: mandatory working material (theory); complementary material; guided practical laboratory sessions; with follow up assignments; self-evaluation activities (questionnaires) and two mandatory practical activities. The teacher returned feedback both on the laboratory assignments and the completion of the practical work through the platform. Likewise, the students had to answer a pair of individual evaluation tests.

In the OTD and ND, the teaching was developed by using the project-based learning methodology (PBL). The Moodle assignment was structured into: Mandatory working material (theory), complementary material, practical activities (five) and the answers to the PBL and self-evaluation activities (questionnaires). Both the practices and the project were done in groups (3 or 5 students). The teacher provided F2F feedback. Likewise, the students had to answer an individual test-type exam.

In all the groups, the teaching methodology was based on self-regulation of learning following a guided structure of the learning process through successive approaches to the goal, facilitating self-evaluation activities and process-oriented feedback, through individualized follow-up of the work of each student.

In all cases, the subject modules had a duration of 14 weeks and the type of teaching was mixed (partly F2F and partly through the Moodle Platform). However, in the CSD Group, the teaching was structured around continuous use of the platform, including the F2F part, the interaction fundamentally taking place through assignments and process-oriented feedback online, and in the Group of Health Sciences, the F2F part was through in-person interaction. When the teaching for all the groups came to an end, they were given the Scale of metacognitive strategies and the ACRAr Scale of process support Strategies.

Design, Variables, and Statistical Analysis

These three elements of the study are defined as follows:

1. Designs: To respond to RQ1, a quasi-experimental design with no control group was used. And to respond to RQ2, RQ3 and RQ4, a descriptive-correlational design was used.
2. Variables: For the first design, the independent variable was the type of B-Learning (RB vs. SB) and the dependent variables were the patterns of learning behavior on the platform. In

the second design, the variables were the patterns of learning behavior on the platform, the metacognitive strategies, the motivational strategies, and the learning outcomes.

3. Statistical analysis: (1) analysis of asymmetry and kurtosis. (2) Discriminant analysis. (3) Single-factor fixed-effect ANOVA (type of B-Learning), value of the effect (eta squared) and Bonferroni test. (4) Pearson correlations matrix. (5) Cluster analysis.

RESULTS

Previous Statistical Analysis

Before starting the study, it was confirmed whether the sample of individuals followed a distribution within the parameters of normality. To do so, the values of asymmetry and kurtosis were found for the selected indicators: in asymmetry, the highest values|2.00| indicate extreme asymmetry and the lowest values indicate a normal distribution (Bandalos and Finney, 2001). With regard to kurtosis, values of between |8| and |20| suggest extreme kurtosis (Arias, 2008; Arias et al., 2013). In asymmetry, values were found within an interval of |0.03| to |1.74| and in kurtosis between |0.02| and |4.40|, which suggests that there is no serious deviation, from normality in the distributions (see **Table 3**).

In view of the results, a parametric statistic was used. The results of each research question are described below.

Will the Learning Patterns of Students on the Platform Differ Depending on the Structure of the Training Program?

In relation to the first research question (Will the learning patterns of students on the platform differ depending on the structure of the training program (RB vs. SB?), a total of 20,217 records were detected for the students from Health Sciences (OTD and ND), 13,847 in the case of OTD and 6,370 in the case of ND and 66,848 records were logged for CSD. These data are already indicative of different patterns of use of the platform by students from the three groups. Subsequently and to test whether the groups behaved in a different way in view of the learning behavior pattern on the platform, a discriminant analysis was performed. The results indicate that the behavior of the three groups differed in relation to all the indicators, except for the records of access to information on the theoretical contents of the subject modules that the students completed. As may be seen in **Table 4**, all of the Wilks' Lambdas are significant for all the indicators except for the records of access to theory. Likewise, the general *Lambda* $(_{14,\ 240}) = 15.29$, $p = 0.000$ was significant with a high effect value $\eta^2_p = 0.47$, which implies that the type of learning behavior pattern on the platform explains 47.1% of the variance among students.

Subsequently, the canonical functions in each of the groups were found. The results show a different pattern in the learning behaviors, as may be confirmed in **Figure 1**. Greater dispersion of the individual students may be seen in the CSD, while student behavior in relation to the variables under analysis in the

TABLE 3 | Analysis of normality in the independent variables before the intervention.

	Group 1 (CSD) $n = 41$							Group 2 (ND) $n = 19$							Group 3 (OTD) $n = 69$						
	Min	*Max*	*M*	*SD*	*AS*	*AE*	*KS*	*KE*	*Min*	*Max*	*M*	*SD*	*AS*	*AE*	*KS*	*KE*	*Min*	*Max*	*M*	*SD*	*AS*	*AE*	*KS*	*KE*
1. Access to complementary information.	0	10	3.76	2.39	0.48	0.37	0.27	0.72	0	22	8.37	6.42	0.85	0.52	0.02	1.01	0	37	9.84	6.97	1.74	0.29	4.24	0.57
2. Access to theory.	0	37	10.39	6.90	1.43	0.37	4.40	0.72	5	31	14.11	7.89	0.85	0.52	−26	1.01	1	69	34.71	14.78	0.26	0.29	0.07	0.57
3. Access to co-evaluation.	0	42	13.15	7.95	1.58	0.37	4.16	0.72	3	37	16.84	8.42	0.95	0.52	0.81	1.01	0	61	17.03	12.40	1.27	0.29	2.33	0.57
4. Access to feedback provided by the teacher.	0	114	23.56	25.58	1.64	0.37	2.93	0.72	0	25	8.05	6.66	0.86	0.52	0.67	1.01	1	71	160.41	170.49	1.56	0.29	2.17	0.57
5. Participation in the forum.	0	87	18.07	23.31	1.56	0.37	1.79	0.72	0	72	25.32	23.35	0.83	0.52	0.36	1.01	0	13	82.94	24.44	−1.03	0.29	2.36	0.57
6. Mean access rate per day.	0	14	5.22	2.91	1.25	0.37	2.21	0.72	0	9	3.89	2.56	0.40	0.52	0.60	1.01	0	54	11.84	14.36	1.48	0.29	1.54	0.57

OTD, Occupational Therapy Degree; ND, Nursing Degree; CSD, Computer Science Degree; Min, minimum value; Max, maximum value; M, Mean; SD, Standard Deviation; AS, Asymmetry Statistic; AE, Asymmetry Error; KS, Kurtosis Statistic; KE, Kurtosis Error.

TABLE 4 | Discriminant analysis between groups (OTD, ND, and CSD).

Discriminant variables	*Wilks' Lambda*	*F*	*Gl1.*	*gl2*	*p*
1. Access to complementary information.	0.82	14.20	2	126	0.000**
2. Access to theory.	0.97	1.83	2	126	0.165
3. Access to practice.	0.51	61.19	2	126	0.000**
4. Access to co-evaluation.	0.76	20.38	2	126	0.000**
5. Access to feedback provided by the teacher.	0.36	110.33	2	126	0.000**
6. Participation in the forum.	0.90	7.02	2	126	0.001**
7. Mean access rate per day.	0.55	51.77	2	126	0.000**

**$p < 0.01$.

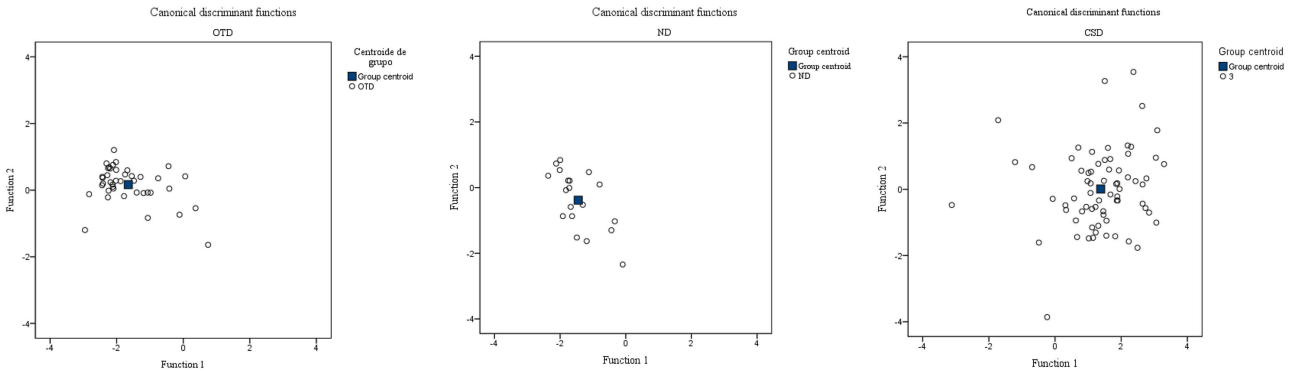


FIGURE 1 | Canonical discriminant functions of the patterns of learning behavior on the platform between the OTD, ND, and CSD groups. OTD, Occupational Therapy Degree; ND, Nursing Degree; CSD, Computer Science Degree.

CSD and OTD is more homogeneous and the similarity of the centroids of the group is greater.

Next, with a view to studying whether significant differences existed between the three groups, a single factor, fixed-effects ANOVA was completed (type degree course). Significant differences were found in all the indicators except in the records of access relating to information on theory by the students (see **Table 5**). Subsequently, a Bonferroni test was carried out to study between which groups and in which indicators those differences were found. As may be appreciated from **Table 6**, the differences are found between students of CSD and ND and OTD in all the variables of behavior on the platform, except for the records of access to complementary information, in which a difference is appreciated between ND and CSD vs. OTD. It may therefore be concluded that the behavior of students of Health Sciences (OTD and ND) differs from the behavior of the CSD.

Interrelations between Learning Behaviors, Metacognitive Skills and Motivation, and Learning Outcomes

Different patterns of learning having been detected on the platform, the results between the group of students of health sciences (OTD and ND) and the group of computer engineering students (CSD) were studied, in order to analyse the second research question (Will a relation be found between the learning patterns of students on the platform and the learning outcomes?) and the third research question (Will a relation exist between the learning outcomes, the patterns of learning of the students on the platform, the metacognitive and the (MS) of students?).

With regard to the group of students studying Health Sciences (OTD and ND), a KMO = 0.74 y χ^2=225.85, $p < 0.001$ was found. As may be seen from **Table 7**, significant correlations were found between the learning outcomes in the different tests ($r = 0.80$, $p < 0.01$, $r = 0.39$, $p < 0.01$, $r = 0.51$, $p < 0.01$). Significant correlations were also found between the learning outcomes, except between SSM (Self-knowledge Metacognitive Skills) and LODPBL (Learning outcomes in the defense of PBL), and the SSM, Planning Metacognitive Skills (PMS), Evaluation Metacognitive Skills (EMS), and Motivational Strategies (MS). But no significant correlations were found between the patterns of learning, the learning outcomes in the different tests, the metacognitive skills and the motivational strategies.

With regard to the analysis in the CSD, in the first place, we found the existence of relationships between variables (*KMO* = 0.80 and χ^2 = 523.76, $p < 0.001$). Likewise, significant correlations were found between the results of performance in the different tests and between those and all of the metacognitive skills. Likewise, the pattern of significant correlations coincided with the type of access to the platform and the type of evaluation test. For example, there was a correlation between access to the practices on the platform and the results that the students obtained in the tests of practices ($r = 0.32$, $p < 0.001$). Likewise, the number of visits by day correlates in a significant way with

TABLE 5 | Single factor fixed-effects ANOVA (Type of group) and value of the effect.

	OTD $n = 41$	ND $n = 19$	CSD $n = 69$			
	M(SD)	*M(SD)*	*M(SD)*	*F*	*p*	η^2
1. Access to complementary information.	3.76 (2.39)	8.37 (6.42)	9.84 (6.40)	14.20	0.00**	0.18
2. Access to theory.	13.15 (7.95)	16.84 (8.42)	17.03 (12.40)	1.83	0.16	0.03
3. Access to practice.	10.39 (6.90)	14.11 (7.89)	34.71 (14.78)	61.19	0.00**	0.49
4. Access to co-evaluation.	23.56 (25.58)	8.05 (6.66)	160.41 (170.49)	20.38	0.00**	0.24
5. Access to feedback provided by the teacher.	18.07 (23.31)	25.32 (23.35)	82.94 (24.44)	110.33	0.00**	0.64
6. Participation in the forum.	5.22 (2.91)	3.88 (2.56)	11.84(14.36)	7.02	0.00**	0.10
7. Mean access rate per day.	1.05 (0.58)	1.296 (0.67)	3.21 (1.48)	51.77	0.00**	0.45

$^{**}p < 0.01$. OTD, Occupational Therapy Degree; ND, Nursing Degree; CSD, Computer Science Degree; M, Mean; SD, Standard deviation; η^2 = eta squared (effect value).

TABLE 6 | Bonferroni test of differences of means between the OTD, ND and CSD.

	OTD vs. ND		OTD vs. CSD		ND vs. CSD	
	DM	*p*	*DM*	*p*	*DM*	*p*
1. Access to complementary information.	−4.61	0.015	−6.08	0.000	–	–
2. Access to theory.	–	–	–	–	–	–
3. Access to practice.			−27.27	0.00**	−25.76	0.00**
4. Access to co-evaluation.	–	–	−136.85	0.00**	−152.35	0.00**
5. Access to feedback provided by the teacher.	–	–	−64.87	0.000**	−57.63	0.00**
6. Participation in the forum.	–	–	−6.62	0.00**	−7.95	0.02*
7. Mean access rate per day.	–	–	−2.16	0.00**	−1.91	0.00**

OTD, Occupational Therapy Degree; ND, Nursing Degree; CSD, Computer Science Degree; DM, Difference of Means; p, Probability. $^{*}p < 0.05$. $^{**}p < 0.01$.

performance in the practices ($r = 0.35$, $p < 0.01$), in the theory ($r = 0.59$, $p < 0.01$) and with the SSM ($r = 0.39$, $p < 0.01$), PMS ($r = 0.33$, $p < 0.01$), EMS ($r = 0.45$, $p < 0.01$), and MS ($r = 0.32$, $p < 0.01$). With regard to participation in the forums, a significant relation was found with the qualification in the theoretical section ($r = 0.27$, $p < 0.05$). Regarding the MS, significant relations were only found with access to feedback actions provided by the teacher (see **Table 8**).

Grouping of Students in Accordance with the Behavioral Patterns

The last research question (Will the learning behaviors of the students on the platform offer different learning patterns?) refers to whether the learning behaviors of students on the platform allow us to differentiate between the different types of students. As different patterns of behavior had been noted on the platform, a separate analysis of the clusters in the groups of students studying Health Sciences (OTD and ND) and CSD was performed to corroborate them. In both cases, an Expectation-Maximization algorithm was used (EM) and to determine the appropriate number of clusters, the Bi-Stage Cluster node (hierarchical algorithm based on BIRCH; Zhang et al., 1996) was used with a mean of 0 and a variance of 1.

In the group of students studying health sciences (OTD and ND), only one cluster was identified, which suggests a similar behavior to the other students on the platform.

With regard to the CSD group of students, 3 clusters were detected: Cluster 1 (C1) defined as low (mean between -1.0 and 0; $n = 36$), Cluster 2 (C2) defined as acceptable (mean between 0 and 0.5; $n = 25$) and Cluster 3 (C3) defined as good (mean between 0.5 and 1; $n = 8$) (see **Table 9**).

The second was to determine whether the variables selected as indicators of good use of LMS are equally sustainable in the configuration of the clusters. The three clusters explained a variance of 67.2% [Wilks' Lambda = 0.11; $F_{(14,\ 120)} = 17.55$, $p < 0.001$, $\eta^2_p = 0.67$], which implies that the students have different patterns of learning behavior in the three clusters in the seven independent variables. However, not all of the learning behaviors have the same degree of discrimination. In the analysis of the inter-group differentiation, the variables that contributed most to the differentiation were: participation in self-evaluation activities [$F_{(2,\ 66)} = 221.18$, $p < 0.000$, $\eta^2_p = 0.87$], mean access rates per day [$F_{(2,\ 66)} = 51.85$, $p = 0.000$, $\eta^2_p = 0.61$] and the records of access to feedback provided by the teacher [$F_{(2,\ 66)} = 11.350$, $p = 0.000$, $\eta^2_p = 0.26$], and to a lesser degree, records of access to complementary information [$F_{(2,\ 66)} = 4.84$, $p = 0.01$, $\eta^2_p = 0.13$], and of access to information on the completion of practices [$F_{(2,\ 66)} = 3.64$, $p = 0.03$, $\eta^2_p = 0.10$]. Likewise, neither were significant differences found in records of student access to information on theoretical contents [$F_{(2,\ 66)} = 32.57$, $p = 0.08$, $\eta^2_p = 0.07$], nor in participation in forums [$F_{(2,\ 66)} = 1.48$, $p = 1.48$, $p = 0.24$, $\eta^2_p = 0.04$].

TABLE 7 | Correlations matrix in the Health Sciences (OTD and ND) and the behaviors on the platform and the metacognitive skills and the motivational strategies.

	1	2	3	4	5	6	7	8	9	10	11	12	13
LOPPBL	–												
LODPLBL	0.80**	–											
TELO	0.39**	0.50**	–										
SMS	0.22	0.26*	0.41**	–									
PMS	0.44**	0.59**	0.52**	0.39**	–								
EMS	0.45**	0.43**	0.51**	0.46**	0.69**	–							
MS	0.38**	0.47**	0.37**	0.18	0.37**	0.41**	–						
ACI	0.16	0.17	0.34**	0.10	0.19	0.19	0.27*	–					
AP	−0.02	−0.09	0.04	0.08	0.001	−0.12	0.19	0.46**	–				
AT	−0.12	−0.16	0.09	0.10	−0.01	−0.03	0.21	0.53**	0.67**	–			
ASA	0.20	0.16	−0.12	−0.007	−0.06	−0.08	−0.03	−0.03	0.10	0.13	–		
AF	0.03	0.04	0.10	0.04	−0.02	−0.04	−0.07	0.33**	0.50**	0.40**	0.17	–	
MVD	0.17	0.18	0.191	0.05	0.08	0.10	0.20	0.52**	0.66**	0.58**	0.48**	0.72**	–
M	2.22	1.76	2.16	20.47	13.25	20.27	12.33	5.22	11.57	14.32	18.65	20.37	1.13
SD	0.178	0.185	0.428	3.41	2.59	2.85	4.24	4.60	7.37	8.212	23.37	23.37	0.618

LOPPBL, Learning outcomes in the preparation of the PBL; LODPBL, Learning outcomes in the defense of PBL; TELO, Test-exam learning outcomes; SMS, Self-knowledge Metacognitive Skills; PMS, Planning Metacognitive Skills; EMS, Evaluation Metacognitive Skills; MS, Motivational Strategies; ACI, Access to Complementary Information; AP, Access to Practices; AT, Access to Theory; ASA, Access to self-evaluation activities; AF, Access to Feedback; MVD, Mean visits per day; M, Mean; SD, Standard Deviation.
*$p < 0.05$. **$p < 0.01$.*

TABLE 8 | Matrix correlations in CSD, the behaviors on the platform and metacognitive skills and motivational strategies.

	1	2	3	4	5	6	7	8	9	10	11	12	13
LOP	–												
TELO	0.57**	–											
SMS	0.62**	0.64**	–										
PMS	0.53**	0.54**	0.76**	–									
EMS	0.64**	0.66**	0.90**	0.79**	–								
MS	0.48**	0.48**	0.55**	0.54**	0.57**	–							
ACI	0.18	0.31**	0.26*	0.35**	0.33**	0.24	–						
AP	0.32**	0.40**	0.32**	0.36**	0.37**	0.23	0.57**	–					
AT	0.21	0.20	0.15	0.20	0.22	0.15	0.45**	0.61**	–				
ASA	0.09	0.43**	0.15	0.29*	0.17	0.19	0.46**	0.30*	0.24*	–			
AF	0.39**	0.62**	0.52**	0.57**	0.54**	0.31*	0.41**	0.48**	0.13	0.52**	–		
MVD	0.35**	0.59**	0.39**	0.53**	0.45**	0.32**	0.61**	0.60**	0.43**	0.81**	0.73**	–	
PF	0.16	0.27*	0.11	0.03	0.08	−0.08	−0.02	0.06	0.02	0.26*	0.27*	0.25	–
M	2.11	3.37	15.17	8.87	14.73	8.48	9.84	34.71	17.03	16.41	82.94	14.09	2.11
SD	0.88	1.53	5.96	4.09	5.91	5.30	6.97	14.78	12.40	17.49	24.44	14.63	0.88

LOP, Learning outcomes in the practices; TELO, Test-exam learning outcomes; SMS, Self-knowledge Metacognitive Skills; PMS, Planning Metacognitive Skills; EMS, Evaluation Metacognitive Skills; MS, Motivational Strategies; ACI, Access to Complementary Information; AP, Access to Practices; AT, Access to Theory; ASA, Access to self-evaluation activities; AF, Access to Feedback; MVD, Mean visits per day; PF, Participation in forums; M, Mean; SD, Standard Deviation.
*$p < 0.05$. **$p < 0.01$.*

In addition, the clusters in which the differences were rooted were studied using the Bonferroni difference of means test (see **Table 10**).

With regard to the relation between the patterns of learning on the platform and the learning outcomes (grades), significant differences were found in the results for theoretical aspects [$F_{(2, 69)} = 5.86$, $p = 0.005$, $\eta_p^2 = 0.15$] and in the final grade [$F_{(2, 69)} = 4.26$, $p = 0.02$, $\eta_p^2 = 0.11$], but not in the grades for practical aspects [$F_{(2, 69)} = 2.89$, $p = 0.06$, η_p^2 =0.08]. Likewise, the Bonferroni test was conducted to analyse the clusters between which the differences were found. Differences were found between the cluster defined as good and the clusters defined as low and acceptable and no differences were found between the latter two (see **Table 11**).

DISCUSSION AND CONCLUSIONS

The analysis of the learning behaviors of students on the platform is related with the teaching design that the teacher devises. The results confirm differences in the learning behaviors in accordance with the type of B-Learning (Cerezo et al., 2016). These results support the hypothesis that the structuring of teaching influences the learning patterns among students and that there are different patterns in accordance with the type of teaching (RB vs. SB). This information is referential in the interpretation of those patterns of behavior. In the B-Learning environments related with SB, in addition to the information in the behavioral patterns of the students on the platform, it is also necessary to analyse the type and quality of the learning behaviors that the students experience in F2F. So, future studies will address the interactions in these contexts using analytical techniques of protocols for thinking out aloud.

With respect to the relation between the learning behaviors of students on the platform and the learning outcomes, it has been confirmed that there are differences in the learning patterns in the RB group and not so in the SB. These differences also support the hypothesis of the difference in the analysis of the learning behaviors depending on the type of B-Learning (Cerezo et al., 2016). In the RB contexts, the relation has been confirmed between the learning outcomes and the learning behavior on the platform. For example, records of access to practical activities are related to the learning outcomes in the practices and with the results from the evaluation of aspects of theory. Likewise, the completion of self-evaluation activities is related with the results in the evaluation of theory. In summary, the type of evaluation test is related with different behaviors of the student on the platform. This result will help predict the at-risk students and, in addition, will help with the differentiation of the results in the different evaluation tests.

However, no relation was found between the patterns of learning behavior and the learning outcomes in SB. This result indicates that there are variables in F2F environment that would have to be isolated to predict the learning patterns of these students. All of the above implies that not all the variables that have been described as determinants of successful learning on the platform have the same weight. Likewise, not all the learning behaviors are related

TABLE 9 | Centers of final clusters in the CSD.

	Cluster		
	C1 (Low)	C2 (Acceptable)	C3 (Good)
1. Access to complementary information.	7.9	10.8	15.6
2. Access to theory.	16.4	15.0	26.0
3. Access to practice.	31.4	35.7	46.3
4. Access to co-evaluation.	42.7	207.8	542.0
5. Access to feedback provided by the teacher.	72.3	90.3	107.9
6. Participation in the forum.	9.50	13.04	18.63
7. Mean access rate per day.	2.26	3.77	5.73

C1, Cluster 1; C2, Cluster 2; C3, Cluster 3.

TABLE 10 | Bonferroni Test of Difference of means between the clusters in the variable learning behaviors of CSD students on the platform.

	C1 vs. C2		C1 vs. C3		C2 vs. C3	
	DM	*p*	*DM*	*p*	*DM*	*p*
1. Access to complementary information.	–	–	−7.72	0.01	–	–
2. Access to theory.	–	–	–	–	–	–
3. Access to practice.			−14.81	0.03*	–	–
4. Access to co-evaluation.	165.11	0.00**	−499.31	0.00**	−334.20	0.00**
5. Access to feedback provided by the teacher.	−17.97	0.006**	35.57	0.00**	–	–
6. Participation in the forum.	–	–	–	–	–	–
7. Mean access rate per day.	−1.51	0.00**	−3.47	0.00**	−1.96	0.00**

*C1, Cluster 1; C2, Cluster 2; C3, Cluster 3. *p < 0.05. **p < 0.01.*

TABLE 11 | Bonferroni test of differences between the means of the Clusters in the learning outcomes for CSD.

	C1 vs. C2		C1 vs. C3		C2 vs. C3	
	DM	*p*	*DM*	*p*	*DM*	*p*
1. Learning outcomes over theoretical aspects.	–	–	−1.92	0.003**	−1.57	0.03*
2. Learning outcomes over practical aspects.	–	–	–	–	–	–
3. Learning outcomes over global grade.	–	–	−2.32	0.03*	−2.49	0.02*

*C1, Cluster 1; C2, Cluster 2; C3, Cluster 3. *p < 0.05. **p < 0.01.*

with success with learning outcomes. Therefore, future investigations will address an analysis of the relation between the learning patterns and the results of students in different evaluation tests. In summary, the procedures for the detection of at-risk students will depend on the B-Learning environment.

Besides, it appears that the pattern of behavior on the platform in the RB model is related with the learning outcomes and with the metacognitive and motivational strategies. In the SB teaching models, a relation has been found between the learning outcomes and the metacognitive responses, but not with the patterns of behavior on the platform, because other F2F learning actions are developed (Cerezo et al., 2016). Likewise, it appears that participation in forums is not a discriminant variable of success at learning, because the teacher takes part in other participative F2F actions in these environments. Therefore, in subsequent investigations, in addition to frequency of participation, its quality will also be analyzed. Also, there are different students' behaviors according to the type of design applied and the degree of virtuality, what could lead to propose different models of platform design depending on the needs of the teacher and the type of teaching (fully virtual, blended or face-to-face). This seems important for the configuration of LMS and for the teacher's approach to the design of the teaching-learning process.

In addition, the relation between learning outcomes, learning behavior on the platform and the metacognitive and the (MS) of students appears to depend on the type of B-Learning (RB vs. SB) and on the type of activity that is proposed to the students. Nevertheless, a relation between the learning outcomes, the planning and EMS and the motivation strategies has been found in the two types of teaching (RB vs. SB). This finding is an important indicator for the teacher in the construction of learning activities on the platform, as the use of these types of strategies can be a predictor of success at learning and can prompt the teacher to conduct training in those areas throughout the instruction process. Future investigations will seek to confirm whether that training produces [e.g., SRL in relation to the execution of the different tasks proposed by the teacher and to the feedback provided through the different evaluation tests designed for learning. For to evaluate self-regulated behaviors, a think aloud protocol (TAP) could be used] improvements in learning outcomes among the students.

With respect to its relation with the behavioral patterns of the students on the platform, there are also differences between RB vs. SB teaching, which supports the results found in the studies of Cerezo et al. (2016) and Zacharis (2015). In RB environments, significant relations have been found between all the metacognitive skills and the learning outcomes, and not in the SB, where no relation has been identified between self-knowledge metacognitive skills and success at learning, which is probably explained by the F2F interaction. With regard to the organization of collaborative forms of teaching, whether in a RB or a SB environment, the use of metacognitive skills has been related with (MS) in students (Bernard and Bachu, 2015; Malmberg et al., 2015; Järvelä et al., 2016; Sáiz and Marticorena, 2016). However, in subsequent studies, an analysis will be conducted to find out whether the type of task that the student has to solve is related to one or another type of metacognitive strategy and what would have to be activated in each case to obtain improvements in learning outcomes.

Likewise, it appears that the learning patterns on the platform discriminate more against at-risk students in RB than in SB. The explained variance in RB teaching was 67.2%. These results are in line with those obtained by Cerezo et al. (2016), Strang (2017), and Zacharis (2015). Nevertheless, not all the variables have the same weight. It appears that the frequency and the systemic approaches of students in their interactions with that platform is a relevant aspect, together with the completion of self-evaluation activities and mean rate of access per day. Hence, as well as frequency, future studies will analyse the type and the quality (actions that the student carries out while accessing the information and how the student processes that information) of the interaction between the learning behaviors of the students on the platform (Yücel and Usluel, 2016).

Another referential aspect is that all of the learning behaviors of the students on the platform are not differentiated by the clusters in a homogenous way. For example, in relation to records of access to complementary information, the distance between the acceptable cluster (C2) and the good cluster (C3) does not differentiate information on theory and feedback provided by the teacher. And in no case, does it differentiate participation in forums. These observations confirm, as we have previously seen, that there is a type of behavior in the learning behavior on the platform that is a function of the type of task that is proposed to the student. This result supports the studies of Park and Il-Hyun (2016) and Harrati et al. (2016) on the differences in behavior on the platform in terms of student characteristics and the structuring of the subject matter by the teachers.

Likewise, the learning behaviors on the platform are not equally well-differentiated, depending on the type of evaluation test that the student is set. This is a referential aspect for future investigations, because it proposes the differentiation of different learning patterns in accordance with the type of evaluation test (Sáiz and Montero, 2016).

In this study, student-teacher, student-content, and student-system interactions have been analyzed. however, in future investigations, student-student and teacher-system relations will be studied, with a view to analyzing whether these behavioral patterns influence the results of student learning (Yücel and Usluel, 2016) and can predict the detection of at-risk students.

All of these conclusions have to be analyzed with prudence in any generalization of the results, as the sample used in this study is not excessively broad and makes reference to students at the same university following three degree courses. Subsequent studies will therefore be directed at enlarging the sample to different populations of university students using the Moodle platform on different degree courses for learning in different B-learning environments. In this study, the variants RB and SB have

been analyzed. Likewise, the results in the Flipped blend modality could be included.

ETHICS STATEMENT

The ethics committee of the University of Burgos approved this study. Written informed consent was obtained from all participants.

AUTHOR CONTRIBUTIONS

MM has been the teacher of two of the intervention groups. She also has done theoretical introduction and data analysis. RS, has done the log extraction on the Moodle platform and he performed the theoretical review. Also, he has been the teacher of one of the intervention groups. CO and JP, have supervised the use of data mining techniques on the extracted logs and completed the theoretical review.

FUNDING

The work was supported by University of Burgos.

ACKNOWLEDGMENTS

Thanks to all the students who participated in this study. Also to the grants for funding the dissemination of research results from the Vice-Rectorate for Research and Knowledge Transfer, 2017 at University of Burgos. We also would like to thank the reviewers for their detailed comments and suggestions to the initial manuscript.

REFERENCES

Agudo-Peregrina, Ã. F., Iglesias-Pradas, S., Conde-Gonzalez, M. Ã., and Hernandez-Garcia, Ã. (2014). Can we predict success from log data in VLEs? Classification of interactions for learning analytics and their relation with performance in VLE-supported F2F and online learning. *Comput. Hum. Behav.* 31, 542–550. doi: 10.1016/j.chb.2013.05.031

Arias, B. (2008). *Desarrollo de un ejemplo de análisis factorial confirmatorio con LISREL. AMOS y SAS. Seminario de Actualización en Investigación sobre Discapacidad SAID 2008. [Development of an example of confirmatory factor analysis with LISREL. AMOS and SAS. Updated Seminar on Disability Research SAID 2008]*. Available online at: http://www.benitoarias.com/articulos/afc.pdf

Arias, B., Verdugo, M. A., Navas, P., and Gómez, L. E. (2013). Factor structure of the construct of adaptive behavior in children with and without intellectual disability. *Int. J. Clin. Health Psychol.* 13, 155–166. doi: 10.1016/S1697-2600(13)70019-X

Azevedo, R. (2005). Using hypermedia as a metacognitive tool for enhancing student learning? The role of self-regulated learning. *Educ. Psychol.* 40, 199–209. doi: 10.1207/s15326985ep4004_2

Baker, R. S., and Inventado, P. S. (2014). "Educational data mining and learning analytics," in *Learning Analytics*, eds J. A. Larusson and B. White (New York, NY: Springer), 61–75.

Bandalos, D. L., and Finney, S. J. (2001). "Item parceling issues in structural equation modeling," in *New Development and Techniques in Structural Equation Modeling*, eds G. A. Marcoulides and R. E. Schumacker (Mahwah, NJ: Lawrence Erlbaum), 269–296.

Bernard, M., and Bachu, E. (2015). "Enhancing the metacognitive skill of novice programmers through collaborative learning," in *Metacognition: Fundaments, Applications, and Trends*, *Vol. 76, Series Intelligent Systems*, ed A. Pe-a-Ayala (Springer Switzerland), 277–298.

Camarero-Suárez, F., Martín del Buey, F., and Herrero-Díez, J. (2000). Estilos y estrategias de aprendizaje en estudiantes universitarios. *Psicothema* 12, 615–622. Available online at: http://www.psicothema.com/pdf/380.pdf

Carbonero, M. A., Román, J. M., and Ferrer, M. (2013). Programa para "aprender estratégicamente"con estudiantes universitarios: diseño y validación experimental. *Anales de Psicología* 29, 876–885. doi: 10.6018/analesps.29.3.165671

Cerezo, R., Sánchez-Santillan, M., Paule-Ruiz, M. P., and Nu-ez, J. C. (2016). Students' LMS interaction patterns and their relationship with achievement: a case study in higher education. *Comput. Educ.* 96, 42–54. doi: 10.1016/j.compedu.2016.02.006

Chatti, M. A., Dyckhoff, A. L., Schroeder, U., and Thüs, H. (2012). A reference model for learning analytics. *Int. J. Technol. Enhanced Learn.* 4, 310–331. doi: 10.1504/ijtel.2012.051815

de Raadt, M., Watson,; R., and Toleman, M. (2009). "Teaching and assessing programming strategies explicitly," in *Proceedings of the Eleventh Australasian Conference on Computing Education 11th Australasian Computing Education Conference (ACE 2009)*, Vol. 95, 45–54. Available online at: http://dl.acm.org/citation.cfm?id=1862723&dl=ACM&coll=DL&CFID=741609144&CFTOKEN=83629355

Dougiamas, M., and Taylor, P. C. (2003). "Moodle: Using learning communities to create an open source course management system," in *Proceedings of the EDMEDIA 2003 Conference*, Vol. 2003 (Honolulu), 171–178.

Frank, E., Hall, M. A., and Witten, I. H. (2016). *The WEKA Workbench. Online Appendix for Data Mining: Practical Machine Learning Tools and Techniques 4th Edn.* Amsterdam: Morgan Kaufmann.

Harks, B., Rakoczy, K., Hattie, J., Besser, M., and Klieme, E. (2014). The effects of feedback on achievement, interest and self-evaluation: the role of feedback's perceived usefulness. *Int. J. Exp. Educ. Psychol.* 34, 269–290. doi: 10.1080/01443410.2013.785384

Harrati, N., Bouchrika, I., Tari, A., and Ladjailia, A. (2016). Exploring user satisfaction for e-learning systems via usage-based metrics and system usability scale analysis. *Comput. Hum. Behav.* 61, 463–471. doi: 10.1016/j.chb.2016.03.051

Hattie, J. (2013). Calibration and confidence: where to next? *Learn. Instr.* 24, 62–66. doi: 10.1016/j.learninstruc.2012.05.009

Hattie, J., and Timperley, H. (2007). The power of feedback. *Rev. Educ. Res.* 77, 81–112. doi: 10.3102/003465430298487

Höök, J. L., and Eckerdal, A. (2015). On the "Bimodality in an Introductory Programming Course: An Analysis of Student Performance Factors," in *Proceedings of the 2015 International Conference on Learning and Teaching in Computing and Engineering* (Taiwan), 79–86. doi: 10.1109/LaTiCE.2015.25

Hornbæk, K. (2006). Current practice in measuring usability: challenges to usability studies and research. *Int. J. Hum. Comput. Stud.* 64, 79–102. doi: 10.1016/j.ijhcs.2005.06.002

Iglesias-Pradas, S., Ruiz-de-Azcarate, C., and Agudo-Peregrina, Ã. F. (2015). Assessing the suitability of student interactions from Moodle data logs as predictors of cross-curricular competencies. *Comput. Hum. Behav.* 47, 81–89. doi: 10.1016/j.chb.2014.09.065

Järvelä, S., Malmberg, J., and Koivuniemi, M. (2016). Recognizing socially shared regulation by using the temporal sequences of online chat and logs in CSCL. *Learn. Instr.* 42, 1–11. doi: 10.1016/j.learninstruc.2015.10.006

Malmberg, J., Järvel,ä, S., Järvenoja, H., and Panadero, E. (2015). Promoting socially shared regulation of learning in CSCL: progress of socially shared regulation among high- and low-performing groups. *Comput. Hum. Behav.* 52, 562–572. doi: 10.1016/j.chb.2015.03.082

Margulieux, L. E., W., McCracken, M., and Catrambone, R. (2016). A taxonomy to define courses that mix face-to-face and online learning. *Educ. Res. Rev.* 19, 104–118. doi: 10.1016/j.edurev.2016.07.001

Mentzer, N., Becker, K., and Sutton, M. (2015). Engineering design thinking: high school students' performance and knowledge. *J. Eng. Educ.* 104, 417–432. doi: 10.1002/jee.20105

Park, Y., and Il-Hyun, J. (2016). Using log variables in a learning management system to evaluate learning activity using the lens of activity theory. *Assess. Eval. High. Educ.* 42, 531–547. doi: 10.1080/02602938.2016.1158236

Roberts, L. D., Howell, J. A., Seaman, K., and Gibson, D. C. (2016). Student attitudes toward learning analytics in higher education: the fitbit version of the learning world. *Front. Psychol.* 7:1959. doi: 10.3389/fpsyg.2016.01959

Román, J. M., and Poggioli, L. (2013). *ACRA (r): Escalas de Estrategias de Aprendizaje [Learning Strategies Scales]*. Caracas: Publicaciones UCAB (Postgraduate: Doctorate in Education).

Romero, C., Espejo, P. G., Zafra, A., Romero, J. R., and Ventura, S. (2013). Web usage mining for predicting final marks of students that use moodle courses. *Comput. Appl. Eng. Educ.* 21, 135–146. doi: 10.1002/cae.20456

Romero, C., and Ventura, S. (2007). Educational data mining: a survey from 1995 to 2005. *Expert Syst. Appl.* 33, 135–146. doi: 10.1016/j.eswa.2006.04.005

Sáiz, M. C., and Marticorena, R. (2016). "Metacognition. Self-Regulation and Feedback for Object-Oriented Programming Problem-Solving," in *Metacognition: Theory. Performance and Current Research*, ed J. Benson (New York, NY: Nova), 43–94.

Sáiz, M. C., and Montero, E. (2016). *Metodologías activas en docencia universitaria: Dise-o de una asignatura de Ciencias de la Salud en la plataforma virtual. [Actives Methodologies at the university: Design of a subject of Health Sciences in the virtual platform]*. Burgos: Servicio de Publicaciones de la Universidad de Burgos.

Schraw, G., Wadkins, T., and Olafson, L. (2007). Doing the Things. We Do: a grounded theory of academic procrastination. *J. Educ. Psychol.* 99, 12–25. doi: 10.1037/0022-0663.99.1.12

Segedy, J. R., and Biswas, G. (2015). "Towards using coherence analysis to scaffold students in open-ended learning environments," in *AIED 2015 Workshop Proceedings*, *Vol. 2*, 49–56. Available online at: http://ceur-ws.org/Vol-1432/iseole_pap7.pdf

Strang, K. D. (2017). Beyond engagement analytics: which online mixed-data factors predict student learning outcomes? *Educ. Inf. Technol.* 22, 917–937. doi: 10.1007/s10639-016-9464-2

Winne, P. H. (2014). Issues in researching self-regulated learning as patterns of events. *Metacogn. Learn.* 9, 229–237. doi: 10.1007/s11409-014-9113-3

Xinogalo, S. (2015). Object-oriented design and programming: an investigation of novices' conceptions on objects and classes. *ACM Trans. Comput. Educ.* 15:13. doi: 10.1145/2700519

Yamada, Y., and Hirakawa, M. (2015). "A case Study of analyzing Logs of LMS in Flipped Classroom," in *2015 IIAI 4th International Congress on Advanced Applied Informatics* (Okayama).

Yücel, Ü. A., and Usluel, Y. K. (2016). Knowledge building and the quantity, content and quality of the interaction and participation of students in an online collaborative learning environment. *Comput. Educ.* 97, 31–48. doi: 10.1016/j.compedu.2016.02.015

Zacharis, N. Z. (2015). A multivariate approach to predicting student outcomes in web-enabled blended learning courses. *Internet High. Educ.* 27, 44–53. doi: 10.1016/j.iheduc.2015.05.002

Zhang, T., Ramakrishnan, R., and Livny, M. (1996). "BIRCH: an efficient data clustering method for very large databases," in *Proceeding SIGMOD '96 Proceedings of the 1996 ACM SIGMOD International Conference on Management of Data*, 25, 103–111. doi: 10.1145/233269.233324

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Sáiz Manzanares, Marticorena Sánchez, García Osorio and Díez-Pastor. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

REVIEW
published: 28 April 2017
doi: 10.3389/fpsyg.2017.00422

A Review of Self-regulated Learning: Six Models and Four Directions for Research

*Ernesto Panadero**

Departamento de Psicología Evolutiva y de la Educación, Facultad de Psicología, Universidad Autónoma de Madrid, Madrid, Spain

Self-regulated learning (SRL) includes the cognitive, metacognitive, behavioral, motivational, and emotional/affective aspects of learning. It is, therefore, an extraordinary umbrella under which a considerable number of variables that influence learning (e.g., self-efficacy, volition, cognitive strategies) are studied within a comprehensive and holistic approach. For that reason, SRL has become one of the most important areas of research within educational psychology. In this paper, six models of SRL are analyzed and compared; that is, Zimmerman; Boekaerts; Winne and Hadwin; Pintrich; Efklides; and Hadwin, Järvelä and Miller. First, each model is explored in detail in the following aspects: (a) history and development, (b) description of the model (including the model figures), (c) empirical support, and (d) instruments constructed based on the model. Then, the models are compared in a number of aspects: (a) citations, (b) phases and subprocesses, (c) how they conceptualize (meta)cognition, motivation and emotion, (d) top–down/bottom–up, (e) automaticity, and (f) context. In the discussion, the empirical evidence from the existing SRL meta-analyses is examined and implications for education are extracted. Further, four future lines of research are proposed. The review reaches two main conclusions. First, the SRL models form an integrative and coherent framework from which to conduct research and on which students can be taught to be more strategic and successful. Second, based on the available meta-analytic evidence, there are differential effects of SRL models in light of differences in students' developmental stages or educational levels. Thus, scholars and teachers need to start applying these differential effects of the SRL models and theories to enhance students' learning and SRL skills.

Keywords: self-regulated learning, self-regulation, metacognition, socially shared regulated learning, shared regulation of learning, motivation regulation, emotion regulation, learning strategies

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
Eva M. Romera, University of Córdoba, Spain
Carlo Magno, De La Salle Araneta University, Philippines

***Correspondence:**
Ernesto Panadero
ernesto.panadero@uam.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *09 January 2017*
Accepted: *06 March 2017*
Published: *28 April 2017*

Citation:
Panadero E (2017) A Review of Self-regulated Learning: Six Models and Four Directions for Research. Front. Psychol. 8:422. doi: 10.3389/fpsyg.2017.00422

INTRODUCTION

Self-regulated learning (SRL) is a core conceptual framework to understand the cognitive, motivational, and emotional aspects of learning. SRL has made a major contribution to educational psychology since the first papers in which scholars began to distinguish between SRL and metacognition (e.g., Zimmerman, 1986; Pintrich et al., 1993a). Since then, publications in the field of SRL theory have increased and expanded in terms of conceptual development, and there are

now several models of SRL (Sitzmann and Ely, 2011). In 2001, a theoretical review was published (Puustinen and Pulkkinen, 2001) that included the most relevant models at that time–those articulated by Boekaerts, Borkowski, Pintrich, Winne, and Zimmerman. However, the field has developed significantly since 2001. A first sign of that evolution is that there are now three meta-analyses of the effects of SRL: Dignath and Büttner (2008), Dignath et al. (2008), and Sitzmann and Ely (2011). A second indicator is that there are now new SRL models in the educational psychology field that did not exist in 2001 (e.g., Efklides, 2011; Hadwin et al., 2011, in press). And lastly, a third aspect is that there is a new handbook[1] (Zimmerman and Schunk, 2011) that presents a variety of established methods to evaluate SRL. Compared to the previous handbook (Boekaerts et al., 2000), the recent handbook has no sections dedicated to presenting new models, being focused on specific aspects of SRL (e.g., basic domains, instructional issues, methodological issues), which shows that the field has evolved and reached a more mature phase.

It is time, then, to reanalyze what is known based on the development of SRL models by comparing them and extracting what are the theoretical and practical implications. Therefore, the aim of this review is to analyze and compare the different SRL models accordingly with the current state of the art and the new empirical data available.

METHODS

Criteria for Inclusion

Only models with a consolidated theoretical and empirical background were considered for inclusion. The criteria to select a model were that (a) it should be published in JCR journals or SRL handbooks, thus peer-reviewed; (b) it should be written in English; and (c) it should have a minimum number of cites. Models published earlier than 2010 should have at least 500 references. If the model was published after 2010, it should at least have 20 cites per year.

Selection Process

As a first step, it was analyzed which of the models included in the 2001 review were still actively used. The models by Boekaerts, Winne, and Zimmerman were included as they are widely used and the authors are active SRL scholars who published in the latest handbook (2011). However, the two other models from the 2001 review–Pintrich and Borkowski–needed further consideration. Pintrich was, unfortunately, not able to develop his work further (Limón et al., 2004), but his model and the questionnaire based on it, the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993b), are still widely used in research (e.g., Moos and Ringdal, 2012). Borkowski et al.'s (2000) model, which has a strong basis in metacognition, has had less of a presence in the development of the SRL field in recent years, and the main author has transferred his research focus to "exceptionality" (e.g., learning disabilities). Therefore, it was excluded.

The second decision was to consider new models. Two actions were taken. First, a literature search was performed in PsycINFO using the term "self-regulated learning model" from 2001 onward. Second, I asked eight SRL colleagues to identify new models. Five new models were identified. Efklides' (2011) model explores how emotion and motivation interact with metacognition, and offers a different interpretation of students' top–down/bottom–up processing in comparison to Boekaerts', thereby broadening our understanding of SRL. Hadwin et al.'s (2011, in press) model addresses the social aspects of the regulation of learning, which has been an emerging line of research within the SRL field (Panadero and Järvelä, 2015). Additionally, three others were considered: (a) Wolters (2003), which has a strong focus on motivation regulation; (b) Azevedo et al. (2004), which builds upon the work of Winne and colleagues (e.g., Azevedo and Cromley, 2004, p. 525, fourth paragraph) and describes a micro-level analysis of SRL; and (c) Schmitz and Wiese (2006), which takes Zimmerman's model as a foundation and proposes some tweaks. While these three models are relevant and the scholars have conducted important empirical research on SRL, it was decided not to include them for two reasons. First, Wolters has a strong focus on motivation and does not cover the whole spectrum of SRL components. Second, Azevedo et al. (2004) and Schmitz and Wiese (2006) have considerable similarities with two other models that were already included (Winne and Zimmerman, respectively).

In sum, the models from Zimmerman, Boekaerts, Winne, and Pintrich, will be analyzed with a new lens based on the research of recent years. Additionally, two new models–those of Efklides and of Hadwin, Järvelä, and Miller–will be compared to those more established models. Next, the models will be discussed in chronological order.

THE SELF-REGULATED LEARNING MODELS

Zimmerman: A Socio-cognitive Perspective of SRL Grounded by Three Models

Zimmerman was one of the first SRL authors (e.g., Zimmerman, 1986). He has developed three different SRL models, being the first one published in 1989 representing what was the first attempt to explain the interactions that influence SRL.

History and Development of the Models

Zimmerman (2013) reviewed his career and the development of his work, framing it into the socio-cognitive theory (i.e., individuals acquire knowledge by observing others and social interaction). Zimmerman's work started from cognitive modeling research in collaboration with Albert Bandura and Ted L. Rosenthal. Later Zimmerman began to explore how individual learners acquire those cognitive models and become experts in different tasks.

[1]A third SRL handbook is under preparation edited by Dale Schunk and Jeffrey Greene.

As one of the most prolific SRL writers, Zimmerman has developed three models of SRL (Panadero and Alonso-Tapia, 2014). The first model (**Figure 1**), known as the Triadic Analysis of SRL, represents the interactions of three forms of SRL: environment, behavior and person level (Zimmerman, 1989). This model describes how SRL could be envisioned within Bandura's triadic model of social-cognition. The second model (**Figure 2**) represents the Cyclical Phases of SRL, which explains at the individual level the interrelation of metacognitive and motivational processes. This model was presented in a chapter in the 2000 handbook, and it is usually known as Zimmerman's model. There the subprocesses that belong to each phase were presented, but it was not until 2003 that these subprocesses were embedded in the figure (Zimmerman and Campillo, 2003). Finally, in Zimmerman and Moylan (2009) the model underwent some tweaks (**Figure 3**), including new metacognitive and volitional strategies in the performance phase. The third model Zimmerman developed (**Figure 4**), which recently has been called the Multi-Level model, represents the four stages in which students acquire their self-regulatory competency (Zimmerman, 2000). In this review, Cyclical Phases model will be analyzed, as it describes the SRL process at the same level as the models from the other authors analyzed here.

Zimmerman's Cyclical Phases Model

Zimmerman's (2000) SRL model is organized in three phases: forethought, performance and self-reflection (see **Figure 3**). In the *forethought* phase, the students analyze the task, set goals, plan how to reach them and a number of motivational beliefs energies the process and influence the activation of learning strategies.

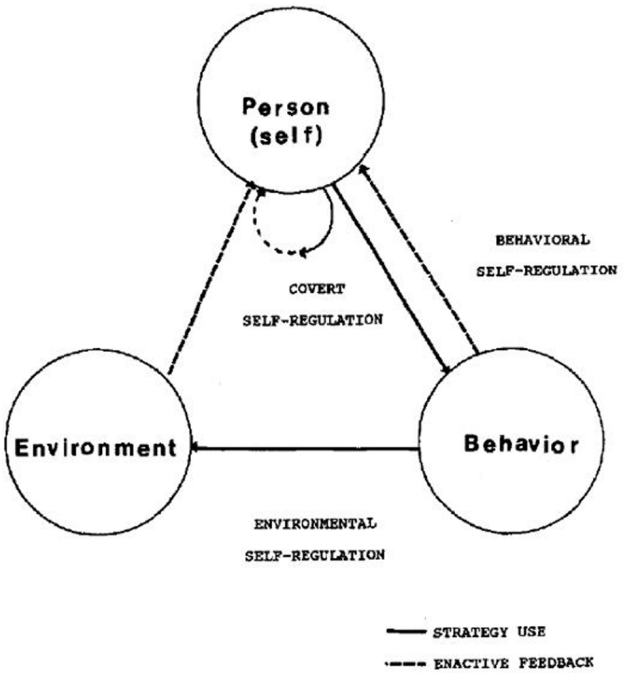


FIGURE 1 | Triadic model of SRL. Adapted from Zimmerman (1989).

In the *performance* phase, the students actually execute the task, while they monitor how they are progressing, and use a number of self-control strategies to keep themselves cognitively engaged and motivated to finish the task. Finally, in the *self-reflection* phase, students assess how they have performed the task, making attributions about their success or failure. These attributions generate self-reactions that can positively or negatively influence how the students approach the task in later performances.

Empirical Evidence Supporting Zimmerman's Cyclical Model

An overview of Zimmerman's empirical evidence can be found in his career review (Zimmerman, 2013). A special feature of Zimmerman's empirical research is the use of athletic skills, along with more typical academic skills. A number of studies have been conducted to test different aspects of Zimmerman's models (Puustinen and Pulkkinen, 2001; Zimmerman, 2013), especially the Multi-level and the Cyclical phase models. Zimmerman conducted work with Kitsantas and Cleary that tested the Multi-level model (Zimmerman and Kitsantas, 1997, 1999, 2002; Kitsantas et al., 2000). Those four studies can be grouped in two types. First, the articles published in 1997 and 1999 studied the differential effect of outcome and process goals with high school students in two different tasks dart throwing and writing, finding support for the model. And second, the articles published in 2000 and 2002 studied the effect of observing different types of models in the development of SRL skills in dart throwing and writing.

The cyclical phase model has been tested in a series of four studies. First, Cleary and Zimmerman (2001) studied the SRL skills showed by adolescent boys who were experts, non-experts and novices in basketball, finding that experts performed more SRL actions. Second, in a similar study, Kitsantas and Zimmerman (2002) compared college women that were experts and non-experts in volleyball, finding that the SRL skills predicted 90% variance in serving skills. Third, Cleary et al. (2006) trained 50 college students in basketball free throws organized in five different conditions: one-phase SRL, two-phases SRL, three-phases SRL, control group practice-only and control group no-practice. The results showed a linear trend: the more phases trained the better the participants' scores. Finally, fourth, DiBenedetto and Zimmerman (2010) studied 51 high school seniors during science courses seniors finding that higher achievers showed more use of subprocesses from Zimmerman's model.

Another important piece of research into Zimmerman's model is the work performed by Bernhard Schmidt and colleagues. As already mentioned, Schmidt has developed a SRL model based on Zimmerman's and influenced by Kuhl's (2000) model with changes in the names of the phases and subprocesses included (Schmitz and Wiese, 2006). This theoretical proposal gives a major emphasis to the role of self-monitoring in SRL (Schmitz et al., 2011). Additionally, Schmitz has developed significant research on how the use of learning diaries and its different data analysis known as time-series analysis. His main results have been that the use of learning diaries enhances all SRL phases being an effective way to impact in students' SRL and performance.

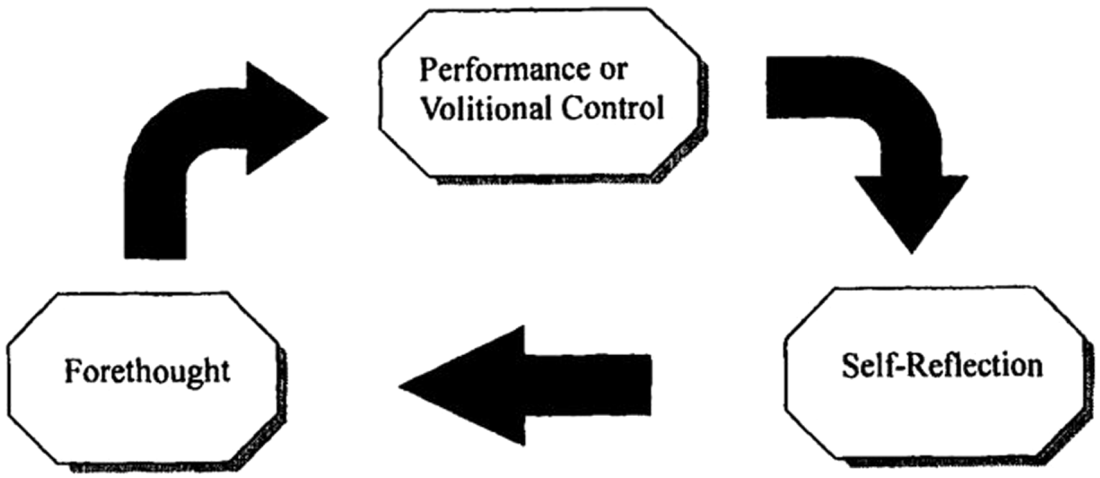


TABLE 1 Phase Structure and Subprocesses of Self-Regulation

Cyclical self-regulatory phases		
Forethought	**Performance/volitional control**	**Self-reflection**
Task analysis	Self-control	Self-judgment
Goal setting	Self-instruction	Self-evaluation
Strategic planning	Imagery	Causal attribution
	Attention focusing	
Self-motivation beliefs	Task strategies	Self-reaction
Self-efficacy		Self-satisfaction/affect
Outcome expectations	Self-observation	Adaptive-defensive
Intrinsic interest/value	Self-recording	
Goal orientation	Self-experimentation	

FIGURE 2 | Cyclical phases model (1st version). Adapted from Zimmerman (2000).

Instruments and Measurement Methods

Under Zimmerman's model umbrella, five instruments and measurements have been developed. First, the subprocesses present in Zimmerman's model are partly based on the results found in the validation process of the Self-Regulated Learning Interview Schedule (SRLIS) (Zimmerman and Martinez-Pons, 1986, 1988). Second, Zimmerman has developed procedures to assess SRL in experimental training settings for writing and dart throwing (Zimmerman and Kitsantas, 1997, 1999). Third, Cleary and Zimmerman (2001, 2012), Kitsantas and Zimmerman (2002), DiBenedetto and Zimmerman (2010) developed microanalytic measures to assess the validity of the Cyclical Phases model. Fourth, Zimmerman has developed different measures of self-efficacy to self-regulate (Zimmerman and Kitsantas, 2005, 2007) and calibration measures of self-efficacy and self-evaluation (Zimmerman et al., 2011). And, fifth, anchored on the framework of SRL by Zimmerman and Martinez-Pons (1986, 1988), Magno (2010) developed the Academic Self-Regulation Scale (A-SRL) which has been validated analyzing its functional correlation against two well-established SRL instruments the MSLQ and the Learning and Study Strategies Inventory (LASSI) (Magno, 2011).

Boekaerts: Different Goal Roadmaps (Top–Down/Bottom–Up) and the Role of Emotions

The work by Boekaerts is also one of the earliest in the SRL literature and can be traced back to the late 1980s (e.g., Boekaerts, 1988). Shortly after she presented her first SRL model (Boekaerts, 1991). Her work has focused in explaining the role of goals (e.g., how students activate different types of goals in relation to SRL), and she was the first to use situation-specific measures to evaluate motivation and SRL. In addition,

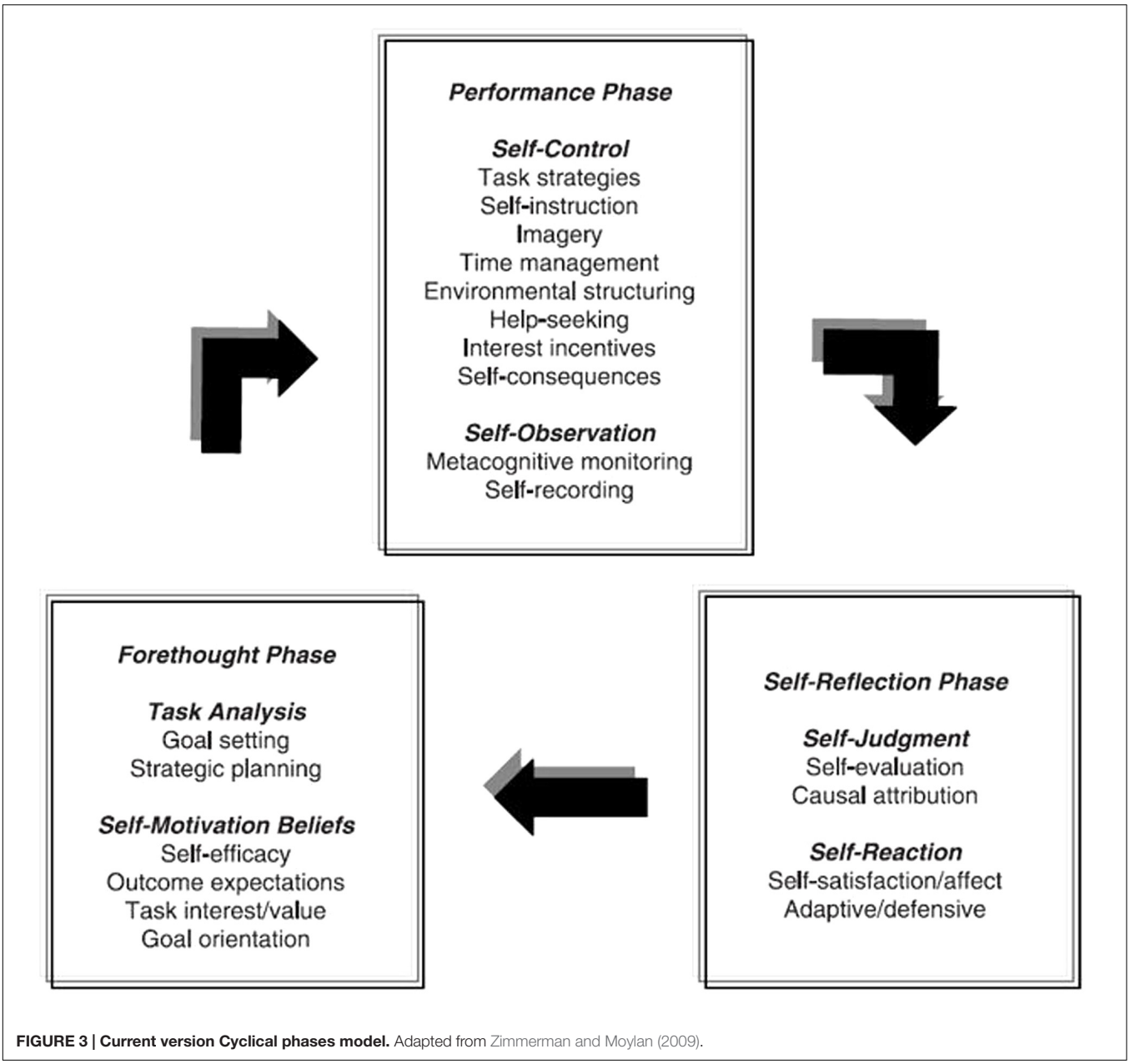


FIGURE 3 | Current version Cyclical phases model. Adapted from Zimmerman and Moylan (2009).

Boekaerts has demonstrated a vast knowledge of the clinical psychology literature on self-regulation and emotion regulation (see Boekaerts, 2011).

History and Development of the Models

Boekaerts has developed two models of SRL. First, she developed a structural model (**Figure 5**) in which self-regulation was divided into six components, which are: (1) domain-specific knowledge and skills, (2) cognitive strategies, (3) cognitive self-regulatory strategies, (4) motivational beliefs and theory of mind, (5) motivation strategies, and (6) motivational self-regulatory strategies (Boekaerts, 1996b). These were organized around, what she then considered to be, the two basic mechanisms of SRL: cognitive and affective/motivational self-regulation. This model has been mainly used to (a) gain more insight into domain-specific components of SRL, to (b) train teachers, to (c) construct new measurement instruments for research, and to (d) design intervention programs (Boekaerts, M. personal communication to author 08/06/2014).

Second, most of Boekaerts' publications were set up to formulate a second SRL model, namely, the Adaptable Learning Model. This model (see **Figure 6**) was presented at the beginning of the 90s (Boekaerts, 1991, 1992). It describes the dynamic aspects of SRL, and later, evolved into the Dual Processing self-regulation model (**Figure 7**). The Adaptable Learning Model offered a theoretical scaffold for understanding the findings from diverse psychological frameworks, including motivation, emotion, metacognition, self-concept, and learning. The model

Level	Name	Description
1	Observation	Vicarious induction of a skill from a proficient model
2	Emulation[a]	Imitative performance of the general pattern or style of a model's skill with social assistance
3	Self-control	Independent display of the model's skill under structured conditions
4	Self-regulation	Adaptive use of skill across changing personal and environmental conditions

FIGURE 4 | Multi-level model. Adapted from Zimmerman (2000).

described two parallel processing modes: (a) a mastery or learning mode and (b) a coping or well-being mode. In a chapter of the 2000 Handbook of self-regulation, Boekaerts and Niemivirta (2000) presented new ideas on goal paths using different figures to visualize how they influence students' behavior (see pp. 434–435). Although, in 2000, Boekaerts had already presented some notions on her vision of top–down and bottom–up theory, it was not until mid-2000 that these theoretical insights were clearly defined in her model, which was then renamed as the Dual Processing self-regulation model (Boekaerts and Corno, 2005; Boekaerts and Cascallar, 2006). In the 2011 SRL handbook of SR, Boekaerts presented an extended version of this model, which pointed to the different purposes of self-regulation during the learning process, namely, (1) expanding one's knowledge and skills, (2) protecting one's commitment to the learning activity, and (3) preventing threat and harm to the self. Boekaerts emphasized the key role that positive and negative emotions play in SRL, and described two different bottom–up strategies, namely, volitional strategies and emotion regulation strategies (**Figure 7**; Boekaerts, 2011).

Boekaerts' Dual Processing Model

In the Dual Processing model (Boekaerts and Cascallar, 2006), the appraisals made by the students are crucial to determine which goal pathway the students will activate. Here, goals are viewed as the "knowledge structures" that guide behavior. For example, if students perceive that the task could be threatening to their well-being, negative cognitions and emotions are triggered. Strategies are then directed to protect the ego from damage, and thereby, students move onto a well-being pathway. On the other hand, if the task is congruent with the students' goals and needs, they will be interested in amplifying their competence, triggering positive cognitions and emotions, and thereby, moving onto the mastery/growth pathway. Boekaerts (2011) also explains that students who have started a task in the mastery/growth pathway may move to the well-being pathway if they detect cues that they might not be successful.

According to Boekaerts (2011), there are three different purposes for self-regulation:

> (a) expanding knowledge and skills. . .(b) preventing threat to the self and loss of resources so that one's well-being is kept within reasonable bounds. . .and (c) protecting one's commitments by using activities that re-route attention from the well-being pathway to the mastery pathway (pp. 410–411).

The first is what she called "top–down," as the pursuit of task goals is driven by the students' values, needs and personal goals (mastery/growth pathway). The second purpose is called "bottom–up," as the strategies try to prevent the self from being damaged (well-being pathway), and students may experience a mismatch between the task goals and their personal goals. The third purpose occurs when students try to redirect their strategies from the well-being to the mastery/growth pathway, which may happen via external (e.g., teacher or peer pressure) or internal (e.g., self-consequating thoughts) forces. Therefore, emotions are essential in Boekaerts' model, because when students experience negative emotions, they will activate the well-being pathway and use bottom–up strategies. Pursuant to this interest, Boekaerts has studied, in depth, the different emotion regulation strategies (see Boekaerts, 2011).

Empirical Evidence Supporting the Dual Processing Model

Most of the empirical support was provided by Boekaerts and her Ph.D. students using the On-line Motivation Questionnaire (OMQ) – next section for more information- and other specific measures. Their work on the Model of Adaptable Learning concentrated on the top half of the model in **Figure 7**. Four main areas of research can be identified using different measurement tools. First, Seegers and Boekaerts (1993, 1996) studied different aspects of cognitive appraisals and how they determine prospective, anticipatory positive and negative emotions and learning intentions; they found gender differences in the types of appraisals activated. In another publication, Boekaerts (1999) demonstrated that these task specific indices of the students' interpretations of the learning activity explain more of the variance in learning intention than domain measures, such as self-concept of ability,

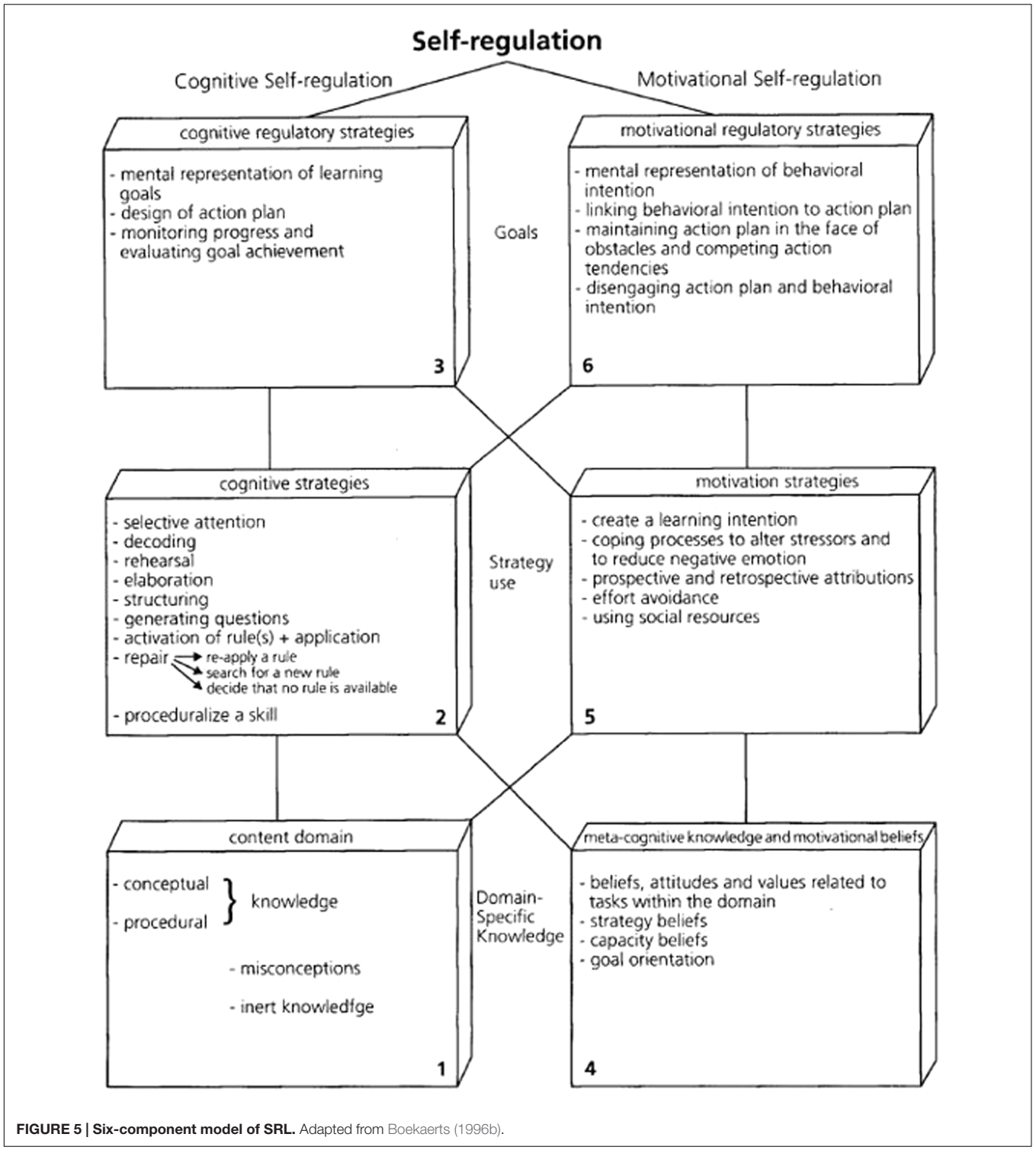


FIGURE 5 | Six-component model of SRL. Adapted from Boekaerts (1996b).

activation of mastery and performance goals, and interest in the domain.

Second, the effect of prospective cognitions and emotions on learning intention was also studied using the OMQ (Boekaerts et al., 1998; Crombach et al., 2003); a confirmatory factor analysis revealed that seven of the eight presupposed factors could be distinguished empirically, as the internal structure of the tested model was invariant over the academic tasks and also seemed stable over a half-year period.

Third, gender differences in prospective cognitions and emotions were studied using the OMQ and the Confidence and Doubt scale -which measures students' feelings of confidence

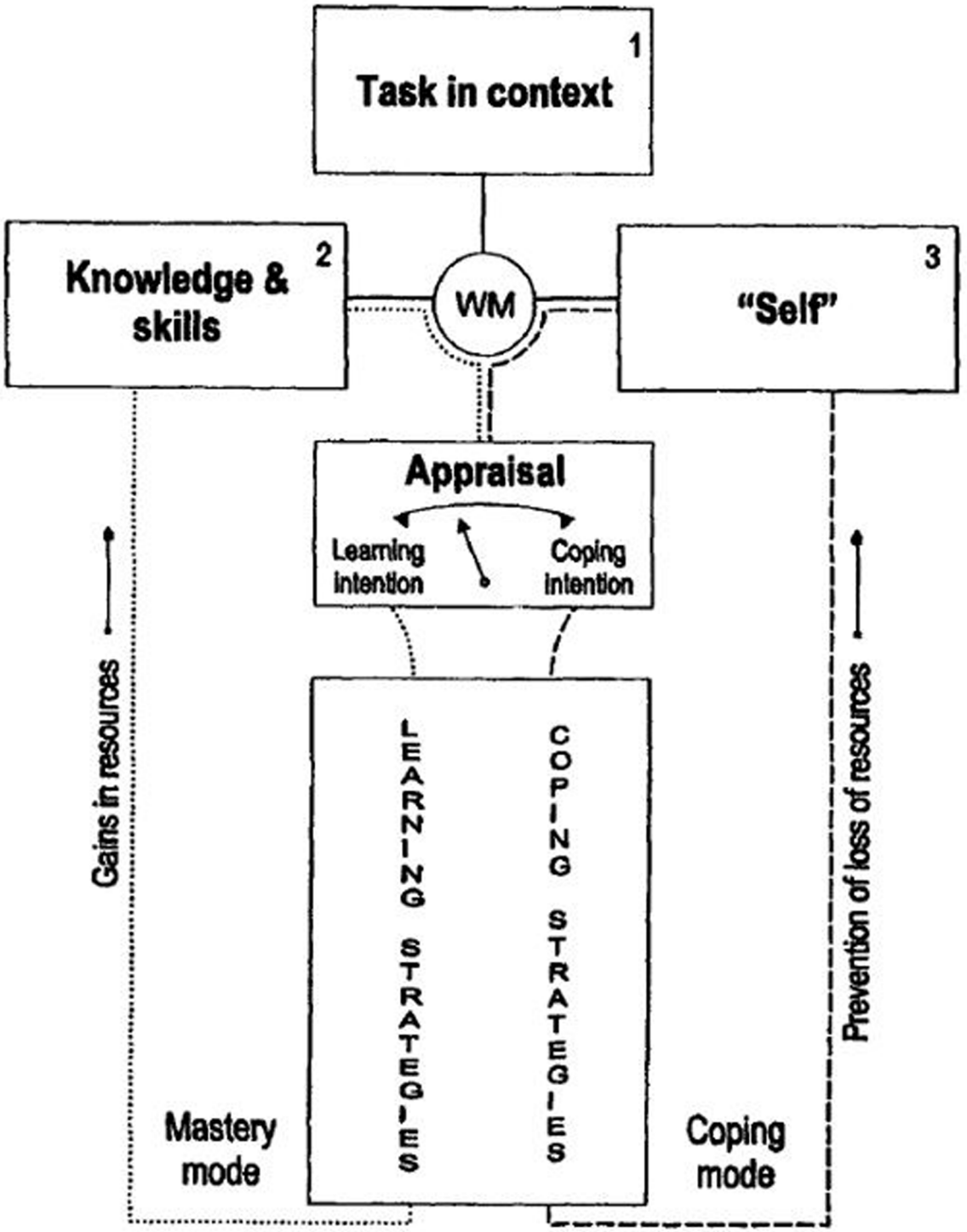


FIGURE 6 | Model of adaptable learning. Extracted from the 2000 handbook but cited there as: the original model of adaptable learning. Adapted from Boekaerts (1996a).

every 40 s while they are performing word problems-, (Boekaerts, 1994; Boekaerts et al., 1995; Vermeer et al., 2001). It was found that boys and girls attend differently to math problems, especially word problems. Boys expressed higher confidence, more liking for the tasks, more positive emotions and more willingness to invest effort than girls. Vermeer et al. (2001) using the Confidence

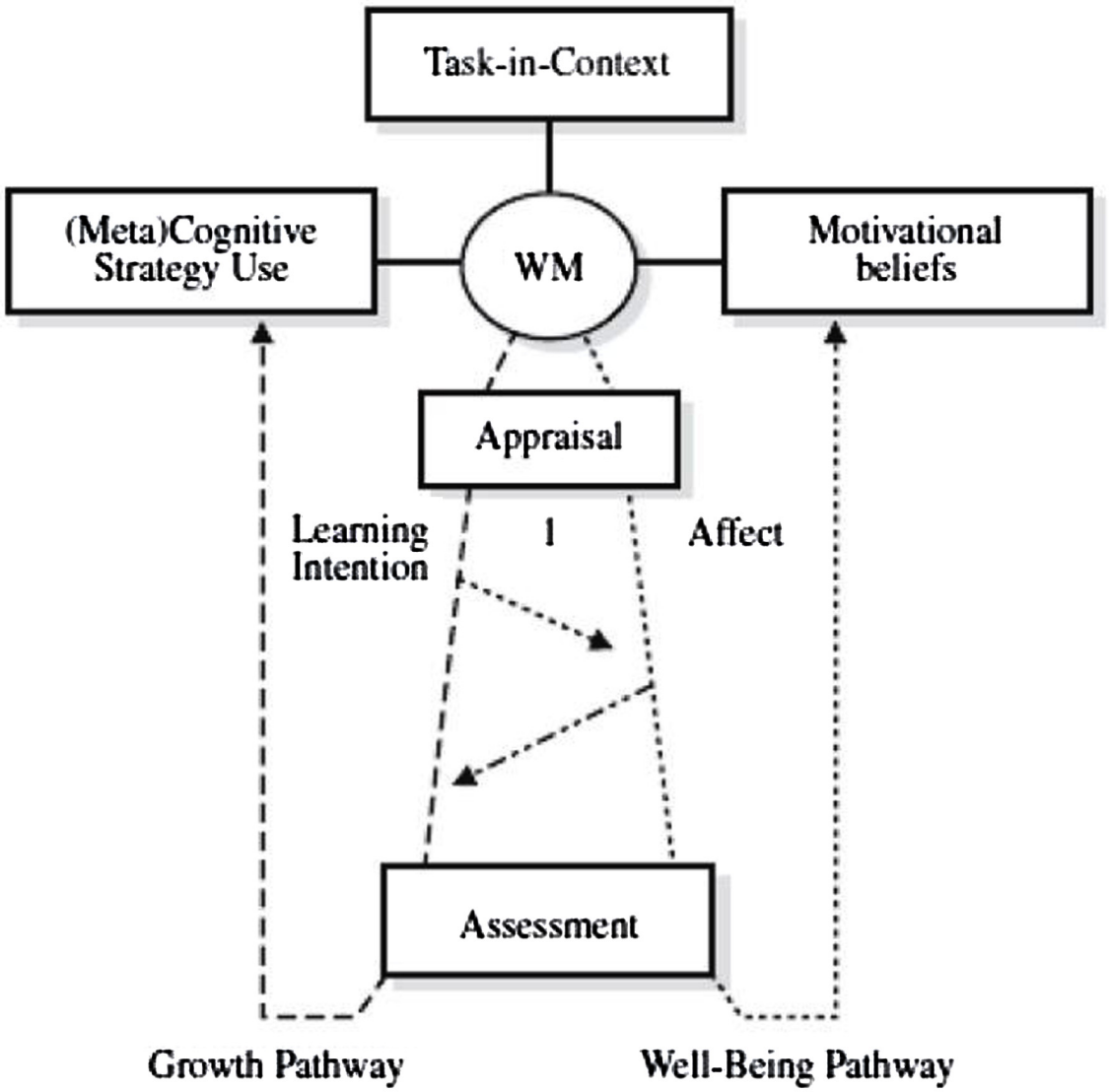


FIGURE 7 | Dual processing self-regulation model. Adapted from Boekaerts (2011).

and Doubt scale, led to the conclusion that girls view solving math problems basically as applying mathematical rules.

Fourth, several interventions in Dutch secondary vocational schools were conducted that focused on building up metacognitive knowledge and creating opportunities to use deep-level processing (Rozendaal et al., 2003; Boekaerts and Rozendaal, 2006). It was found that the intervention worked best for students who were already familiar with (and used) deep-level processing strategies at the beginning of the study.

Boekaerts has also conducted research on the Dual Processing model and the factors that determine students' outcome assessments, their reported effort after a task, and their attributions (bottom part of the model). There are two main lines of research here. First, using structural equation models, Boekaerts (2007) looked more closely at the effect of competence and value appraisals on the students' outcome assessments and reported effort; she also explored the influence that positive and negative emotions during a task have on these outcome variables. She found that students who reported that they had invested effort after doing their mathematics homework, had initially reported that they were competent to do their homework tasks, which produced positive emotions during the task. Valuing a task initially also substantially increased the reported effort. In further research (Boekaerts et al., 2003; Boekaerts, 2007), it was found that outcome assessments after doing homework were positively influenced by both competence and value appraisals. The second line of work, using Neural Network Methodology (family of statistical learning models inspired by the central nervous systems of animals, more specifically biological neural networks) it was examined whether the quality of students' writing performance (poor/mid/high performance group) could be predicted on the basis of characteristics of the SR system

(measured with a specially designed software program based on the OMQ) (Cascallar et al., 2006; Boekaerts and Rozendaal, 2007). It was found that neural networks could predict with high accuracy (ranging 94 and 100%) which students would be in the poor, mid, or high performance groups, based on 56 predictors.

Instruments and Measurement Methods

Boekaerts has written a number of reflection papers about the measurement of SRL (the most known Boekaerts and Corno, 2005), and has participated in the creation of four instruments and assessment methods. First, she developed the OMQ (Boekaerts, 1999), which measures the "sensitivity to learn in concrete situations." It is composed of two parts: (a) students self-report their feelings, thoughts and the effort they want to expend on a concrete task, and (b) after the task, the students report how they feel and their attributions. The validation of her SRL model with the OMQ can be found in Boekaerts (2002). Second, she created an instructional design for secondary vocational schools in the Netherlands based on SRL principles that was called the Interactive Learning Group System (ILGS) innovation (Boekaerts, 1997; Boekaerts and Minnaert, 2003). Third, Boekaerts developed an instrument to record student motivation: the Confidence and Doubt Scale (Vermeer et al., 2001) – explained earlier. And, fourth, she has collaborated with other scholars in the implementation of neural networks for SRL finding high predictive power in such models (e.g., Cascallar et al., 2006).

Winne and Hadwin: Exploring SRL from a Metacognitive Perspective

Winne and Hadwin's model of SRL has a strong metacognitive perspective that recognizes self-regulated students as active and managing their own learning via monitoring and the use of, mainly, (meta)cognitive strategies (Winne, 1995, 1996, 1997; Winne and Hadwin, 1998) while asserting the goal driven nature of SRL and the effects of self-regulatory actions on motivation (Winne and Hadwin, 2008). It has been a widely used model, especially in research implementing computer supported learning settings (Panadero et al., 2015b).

History and Development of the Model

Winne and Hadwin's model is strongly influenced by the Information Processing Theory (Winne, 2001; Greene and Azevedo, 2007), exploring the cognitive and metacognitive aspects of SRL in more detail than the other SRL models with the exception of Efklides'. Some of Phil Winne earliest ideas that led to the model can be traced to his conceptualization of SRL as a fusion of information processing and information processed (Winne, 1995) and Butler and Winne (1995) in their theoretical review of feedback and SRL, in which the concept of internal feedback had a major role and the first version of the model was presented (Figure 1 in Butler and Winne, 1995). Additionally, they presented a second figure in which they explored the different profiles a goal can take and the discrepancy between the goal aims and the current state of work monitoring (Figure 2 in Butler and Winne, 1995). In 1996, Winne presented an updated version of his model (**Figure 8**) in which the two just mentioned figures were fused into one, along with a reflection about the metacognitive aspects that explains the differences in SRL (Winne, 1996). In 1997, he presented the COPES script ideas -see next section- (Winne, 1997). Finally, in 1998, a new version of his model was released (**Figure 9**) including more details and a clearer presentation of COPES (Winne and Hadwin, 1998). It is usually the latter work that is cited when the model is referenced: Winne and Hadwin instead of Winne's model. That denomination is also used in this review for now onward to keep the consistency with the SRL community, but it is important to keep in mind that the model was firstly presented in previous work (Winne, 1996, 1997). Additionally, these two authors, while collaborating in usual basis, have followed different paths within SRL research as signaled by different chapters in the 2011 SRL handbook (Hadwin et al., 2011; Winne, 2011). Winne has continue examining (meta)cognitive aspects of the model, such as his work on gStudy and nStudy (Winne et al., 2010). Furthermore, he performed minor enhancements to the model although the figure that illustrates the process remains the same (Winne, 2011). Hadwin, while continuing collaborating in the empirical evidence of the model (Winne et al., 2010; Winne and Hadwin, 2013) has additionally focused on the situational, contextual and motivational SRL aspects in collaborative learning settings. This line of work has produced the model of Socially Shared Regulated Learning (SSRL) in collaboration with Järvelä and Miller (see Hadwin, Järvelä, and Miller: SRL in the Context of Collaborative Learning). This present section will explore in more detail the work by Winne as the one by Hadwin will have its own section.

Winne and Hadwin's Model of SRL

According to Winne and Hadwin's model (e.g., Winne, 2011), studying is powered by SRL across four linked phases that are open and recursive and are comprehended in a feedback loop. These four phases are (**Figure 9**): (a) *task definition*: the students generate an understanding of the task to be performed; (b) *goal setting and planning*: the students generate goals and a plan to achieve them; (c) *enacting study tactics and strategies*: the use of the actions needed to reach those goals; and (d) *metacognitively adapting studying*: occurs once the main processes are completed and the student decides to make long-term changes in her motivations, beliefs and strategies for the future. Winne especially emphasizes that mistakes can be detected in a posterior phase to the one in which they occurred.

Additionally, SRL deploys five different facets of tasks that can take place in the four phases just mentioned (Winne and Hadwin, 1998). These five facets are identified using the COPES acronym, that was used for the first time in Winne (1997) -i.e., Carla COPES with an arithmetic worksheet- (p. 399). It stands for (a) *Conditions*: resources available to a person and the constrains inherent to a task or environment (e.g., context, time); (b) *Operations*: the cognitive processes, tactics and strategies used by the student that are referred to as SMART -Searching, Monitoring, Assembling, Rehearsing and Translating- (Winne, 2001) (e.g., planning how to perform a task); (c) *Products*: the information created by operations (e.g., new knowledge); (d) *Evaluations*: feedback about the fit between products and

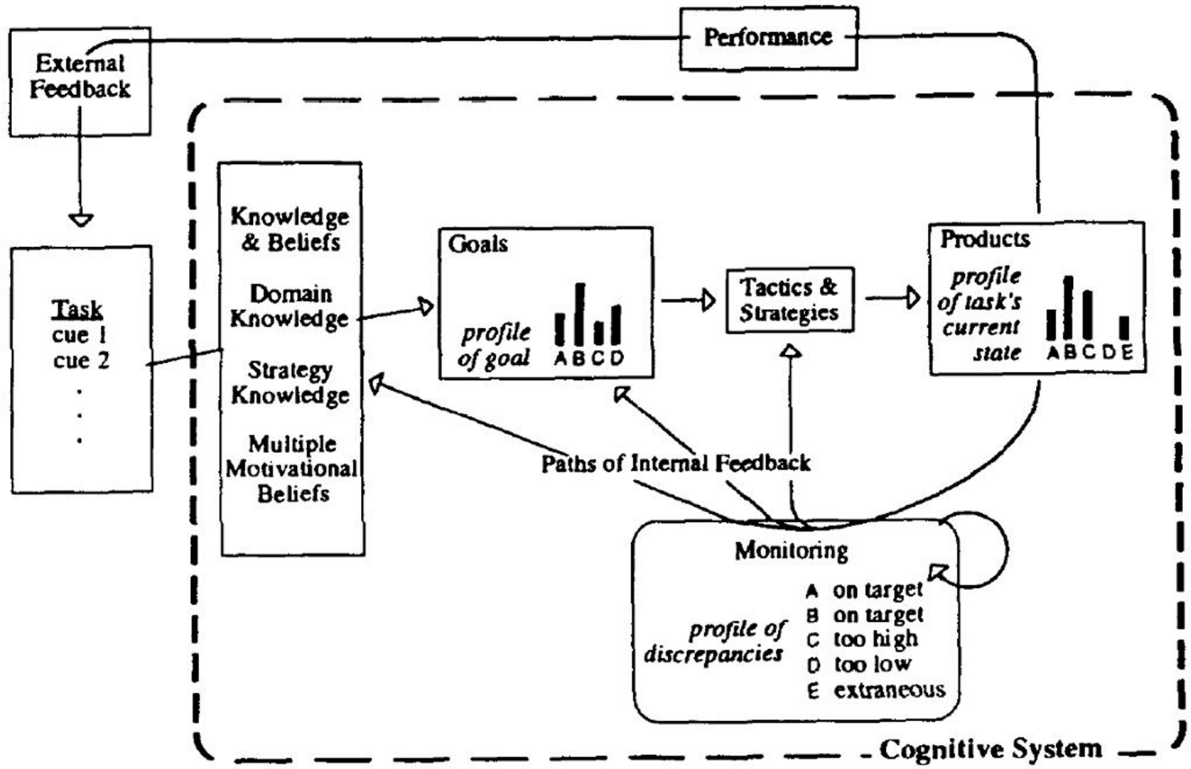


FIGURE 8 | First version of Winne's SRL model. Adapted from Winne (1996).

standards that are either generated internally by the student or provided by external sources (e.g., teacher or peer feedback); and (e) *Standards*: criteria against which products are monitored (definitions taken from Winne and Hadwin, 1998; Greene and Azevedo, 2007) (e.g., assessment criteria).

Furthermore, Winne (2011) model explains in detail how students' cognitive processing operates while planning, performing and evaluating a task. A crucial aspect is the use of criteria and standards to set goals, monitor and evaluate, aspects which are aligned with self-assessment research (Andrade, 2010; Panadero and Alonso-Tapia, 2013). The model describes how students constantly monitor their activities against standards and use tactics to perform tasks (Winne and Hadwin, 1998). One salient feature is that, in the model figure there is no reference to emotions, and there is only an allusion to motivation. Regardless of this Winne and Hadwin also agrees that SRL is goal-driven in nature and has built connections between his model and research by Pintrich (2003) and Wolters (2003) on regulation of motivation (Winne and Hadwin, 2008).

Empirical Evidence Supporting Winne and Hadwin's SRL Model

Greene and Azevedo (2007) reviewed the empirical evidence for the model. Although they presented it as a theoretical review, due to the fact that they did not perform a "*comprehensive review of the empirical literature*" (p. 338), they reviewed a compelling number of studies (113) that provide empirical support for the model. The review covered all the aspects considered in the model, and made inferences that may have been beyond the initial scope of the work (e.g., they included a section for emotion, which is not explicitly mentioned in the original model). In their conclusions, they stated the model's potential for future research and pointed out four challenges that needed additional clarification. First, phase four and external evaluations, especially clarifying long-term changes in the students' SRL and more details on how phase four works (e.g., describing the role of conditions as products of the SRL activity). Second, they made a call for Winne and Hadwin's model to incorporate the regulation of motivation, using Wolters (2003) as a reference to build the connection. Third, Greene and Azevedo recommended a discussion of how SRL skills develop over the life span. And, fourth, they made a call to consider how student characteristics (e.g., learning disabilities) might impact SRL.

In the later years, Winne and his team have been building a basis for gathering solid empirical evidence on the model based on the work with computers that scaffold students' SRL while measuring it at the same time (Panadero et al., 2015b). These will be described in the next section. Additionally, Winne has also been exploring the potential of data mining and learning analytics and their application to SRL (e.g., Winne and Baker, 2013).

Instruments and Measurement Methods

No classical measurement instruments have been constructed based on Winne and Hadwin's model, but there are a number

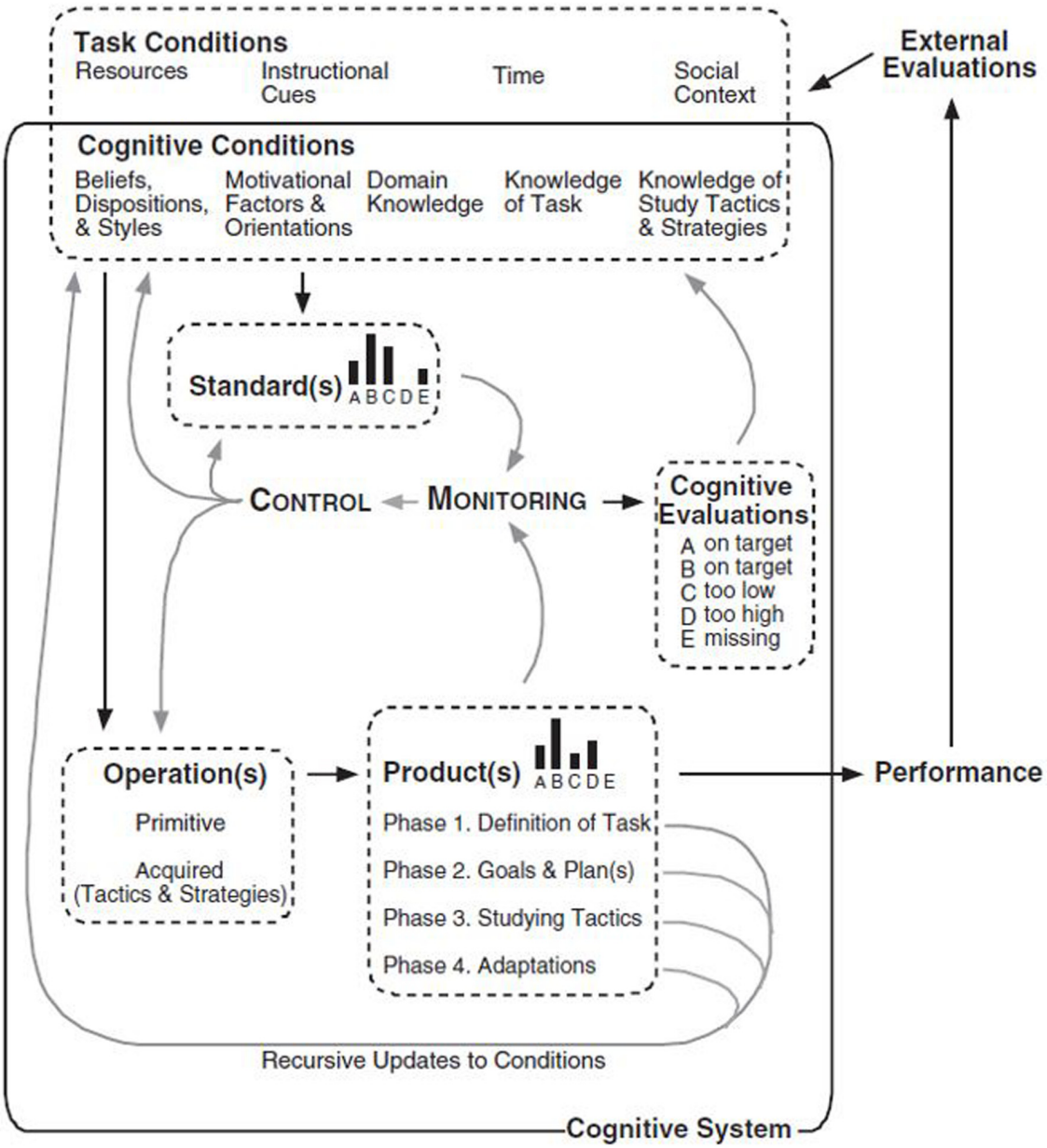


FIGURE 9 | Current version of Winne's SRL model. Adapted from Winne and Hadwin (1998).

of scaffolding tools that measure traces of SRL using the model as theoretical framework (e.g., Winne et al., 2010). They have developed nStudy and gStudy, which are computer-supported learning environments in which the use of SRL is scaffolded while students' activities are recorded for trace and log data (Winne et al., 2010; Winne and Hadwin, 2013). Additionally, trace data which was brought to SRL research via Winne's earlier work (Winne, 1982; Winne and Perry, 2000) has opened up new opportunities for the temporal and sequential analysis of SRL which is showing promising new insights for the field (Azevedo et al., 2010; Malmberg et al., 2013). Furthermore, Winne has written important reflection papers on SRL measurement, especially in Winne and Perry (2000) which emphasized the importance of "on-the-fly" or "online" SRL measures and opened up new approaches to the measurement of SRL (Panadero et al., 2015b); and in Winne et al. (2011) which reviews the SRL methods using trace data.

Pintrich: Grounding the Field and Emphasizing the Role of Motivation in SRL

Pintrich's work continues to be important in the field as he made a major contribution toward clarifying the SRL conceptual

framework (e.g., Pintrich and de Groot, 1990), he conducted crucial empirical work on the relationship of SRL and motivation (Pintrich et al., 1993a), and his questionnaire -MSLQ- (Pintrich et al., 1993b) continues to be widely used (Schunk, 2005; Moos and Ringdal, 2012).

History and Development of the Model

Pintrich was one of the first to analyze the relationship between SRL and motivation empirically (Pintrich and de Groot, 1990), theoretically (Pintrich, 2000), and the lack of connections between motivation and cognition (Pintrich et al., 1993a). Further, he later emphasized and clarified the differences between metacognition and self-regulation (Pintrich et al., 2000) and pointed out the areas of SRL that needed further exploration (Pintrich, 1999). In terms of the model itself, there is only one version of it, the one presented in the first handbook of SRL (Pintrich, 2000).

Pintrich's SRL Model

According to Pintrich (2000) model, SRL is compounded by four phases: (1) Forethought, planning and activation; (2) Monitoring; (3) Control; and (4) Reaction and reflection. Each of them has four different areas for regulation: cognition, motivation/affect, behavior and context. That combination of phases and areas offers a comprehensive picture that includes a significant number of SRL processes (e.g., prior content knowledge activation, efficacy judgments, self-observations of behavior) (see **Figure 10**). Furthermore, in that chapter, Pintrich (2000) explained in great detail how the different SRL components/areas for regulation are deployed in the different phases. Next how the different areas were conceptualized will be shortly presented. First, in terms of regulation of cognition, Pintrich incorporated metacognitive research such as judgments of learning and feelings of knowing. This incorporation emphasizes how important is cognition for Pintrich's. Regarding the second area, regulation of motivation and affect, Pintrich explained that motivation and affect could be regulated by the students based on his own empirical work (Pintrich et al., 1993a; Pintrich, 2004). Three years later, Wolters (2003) continued this line of work finding more empirical evidence. The third area, regulation of behavior, is based on the work by Bandura (1977, 1986, 1997) and the Triadic model by Zimmerman (1989). In this area Pintrich incorporated the "*individual's attempts to control their own overt behavior*" (Pintrich, 2000, p. 466). There is no other SRL model analyzed here that comprehends such area, making Pintrich's in this sense unique. And, fourth area, the regulation of context which Pintrich included because it addresses those aspects of SRL in which the students attempt to "*monitor, control and regulate the* (learning) *context*" (p. 469).

Empirical Evidence Supporting Pintrich's SRL Model

There is no empirical evidence directly addressing Pintrich's model validation. However, there is empirical data on the validation of the MSLQ, questionnaire that is the initial empirical work in which Pintrich based his SRL model. That instrument will be analyzed in the next section. Additionally, in a special issue dedicated to his memory, Schunk (2005) reviewed Pintrich's major contributions to the SRL field identifying six different areas: (a) a conceptual framework and model for SRL (just described in the previous section); (b) the role of motivation in SRL with a special focus on goal orientation; (c) the relationship between SRL, motivation and learning outcomes; (d) the role of classroom contexts in SRL and motivation; (e) the development of SRL through empirical studies; and (f) the development of an instrument to measure SRL (MSLQ).

Instruments and Measurement Methods

One major contribution to the SRL field is the MSLQ (Pintrich et al., 1993b). The MSLQ is composed of 15 scales, divided into a motivation section with 31 items, and a learning strategies (SRL) section with 50 items which are subdivided into three general types of scales: cognitive, metacognitive, and resource management (Duncan and McKeachie, 2005). One of the strengths of the MSLQ is its combination of SRL and motivation, which offers detailed information about students' learning strategies use. Two versions of the questionnaire have been developed for college (Pintrich et al., 1993b) and high school students (Pintrich and de Groot, 1990). For further information on the instrument Duncan and McKeachie (2005) and Moos and Ringdal (2012) provided a list of studies that have used MSLQ. More recently, two reviews have found that the MSLQ is the most used instrument in SRL measurement (Roth et al., 2016) and in self-efficacy measurement (Honicke and Broadbent, 2016). This emphasizes the highly significant impact of Pintrich's work in SRL.

Efklides: The Missing Piece between Metacognition and SRL

Efklides (2011) model has a stronger metacognitive background than the other models, except Winne and Hadwin's which is also metacognitively based. However, when comparing with the latter in Efklides' model motivation and affect occupy a central role in Efklides' figure. The model has been cited a significant number of times despite being recently published.

History and Development of the Model

Efklides (2011) presented the Metacognitive and Affective Model of Self-Regulated Learning (MASRL) in 2011, which extended her ideas previously published in two theoretical articles (Efklides, 2006, 2008). The model is grounded in classic socio-cognitive theory (Bandura, 1986), as stated by the author herself. Efklides has been influenced by the existing SRL models, along with metacognitive models such as those created by Dunlosky and Metcalfe (2008), Ariel et al. (2009), and Koriat and Nussinson (2009). The distinction of Efklides with the metacognitive models mentioned is that hers is theoretically grounded on previous SRL models (e.g., Zimmerman's Winne and Hadwin's, and Pintrich's). Additionally, Efklides' model adds to the other SRL models analyzed here, a thorough presentation of the implications of metacognitive models for SRL.

MASRL Model

In the MASRL, there are two levels (**Figure 11**). First, there is the Person level-also called macrolevel-which is

TABLE 1 Phases and Areas for Self-Regulated Learning

Phases	Areas for regulation: Cognition	Motivation/affect	Behavior	Context
1. Forethought, planning, and activation	Target goal setting	Goal orientation adoption	[Time and effort planning]	[Perceptions of task]
	Prior content knowledge activation	Efficacy judgments	[Planning for self-observations of behavior]	[Perceptions of context]
	Metacognitive knowledge activation	Ease of learning judgements (EOLs); perceptions of task difficulty		
		Task value activation		
		Interest activation		
2. Monitoring	Metacognitive awareness and monitoring of cognition (FOKs, JOLs)	Awareness and monitoring of motivation and affect	Awareness and monitoring of effort, time use, need for help	Monitoring changing task and context conditions
			Self-observation of behavior	
3. Control	Selection and adaptation of cognitive strategies for learning, thinking	Selection and adaptation of strategies for managing motivation and affect	Increase/decrease effort	Change or renegotiate task
			Persist, give up	Change or leave context
			Help-seeking behavior	
4. Reaction and reflection	Cognitive judgments	Affective reactions	Choice behavior	Evaluation of task
	Attributions	Attributions		Evaluation of context

FIGURE 10 | Pintrich's SRL model. Adapted from Pintrich (2000).

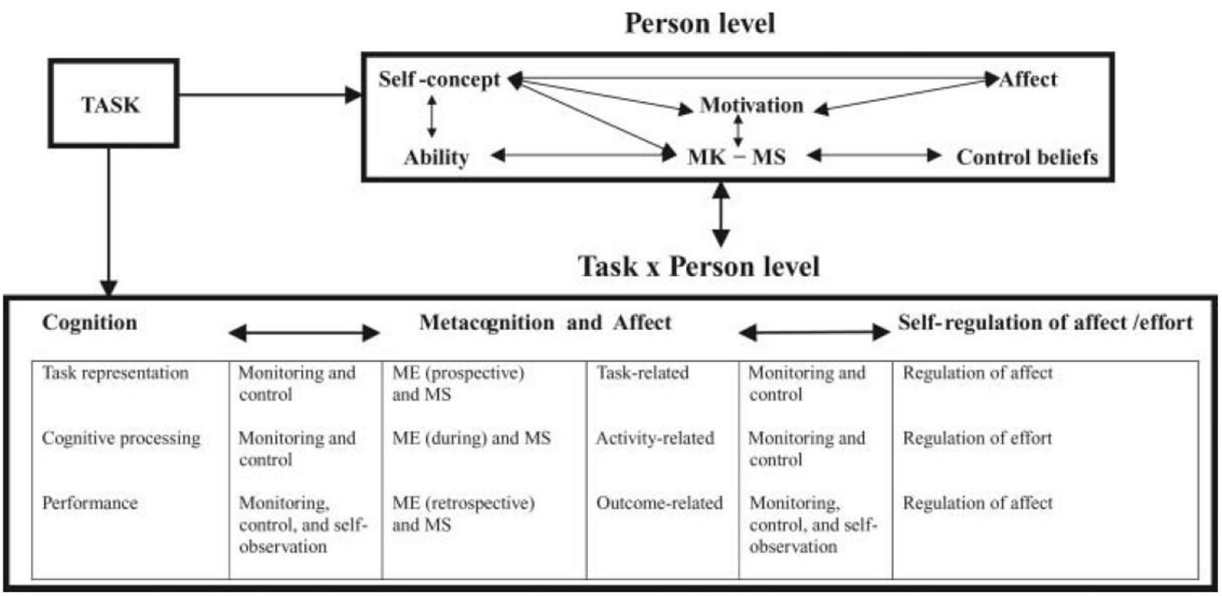


FIGURE 11 | Metacognitive and affective Model of Self-Regulated Learning model (MASRL). Adapted from Efklides (2011).

the most "traditional" view of SRL and comprehends the personal characteristics of the student. In Efklides' own words: "The Person level represents a generalized level of SRL functioning. It is operative when one views a task resorting mainly on memory knowledge, skills, motivational and metacognitive beliefs, and affect" (Efklides, 2011, p. 10). Therefore, it is composed of: (a) cognition, (b) motivation, (c) self-concept, (d) affect, (e) volition, (f) metacognition in the form

of metacognitive knowledge, and (g) metacognition in the form of metacognitive skills. A key aspect is that Efklides considers the Person level to be top–down because it is structured around students' goals for the task. In other words, the thrust of the student's goals "guides cognitive processing and the amount of effort" the student will invest, a decision based "on the interactions of the person's competences, self-concept in the task domain, motivation, and affect, vis-à-vis the perception of the task and its demands" (Efklides, 2011, p. 12).

The second level, the Task × Person level–also known as microlevel–is where the interaction between the type of task and the student's characteristics –i.e., person level–takes place. This level is bottom–up, as the metacognitive activity takes control of the student's actions, which causes activity to be "data-driven" with the focus on addressing the demands of the specific task. To put it more simply, the student's attention moves toward the specific mechanisms of performing the task, and the general learning goal (for example, finishing a summary) is subsumed in a more specific goal (for example, checking for spelling mistakes). Here, the microlevel monitoring is the main process; motivation and affect reactions depend on the evolution of the metacognitive resources and the feedback that comes from the person's performance – i.e., if s/he is progressing appropriately. Finally, Efklides identifies four basic functions at this level: (a) cognition, (b) metacognition, (c) affect, and (d) regulation of affect and effort, which can be conceptualized independently, vertically, or, in an integrative way, horizontally (see **Figure 11**).

This distinction between the Person level and the Task × Person level is probably the most salient feature of the MARSL model. The Person level represents the general trait-oriented features of students' SRL, which are goal-driven and top–down. At this level, the MASRL model is similar to other more person-level-oriented models, such as Zimmerman's (2000). At the Task × Person level, the actions that take place are less conscious and person-oriented: the execution of the task occupies most of the student's attention and processing, and the actions are data-driven and bottom–up, showing similarities with Winne's (2011).

In sum, the MASRL model clarifies, in detail, the relationship among metacognition, motivation, and affect via the interaction of the macro and micro levels, and presents a different conceptualization of the top–down/bottom–up implications from the one provided by Boekaerts and Corno (2005). Importantly, the model also illustrates how students perform during the task execution, the phase with the highest cognitive load where all the cognitive resources are leading the activity.

Empirical Evidence Supporting the MASRL Model

Efklides (2011) explored the basic MASRL features that have received empirical support by reviewing a compelling amount of evidence from the last two decades. First, she presented the three basic tenets of the model that the empirical evidence needs to address: (a) identifying the MASRL's two levels (macro- and microlevel), the effects of the task demands on both levels, and what the interactions among them are; (b) the interaction of motivation and affect in the two levels; and (c) the different forms that metacognition takes at both levels. Then she argued that research showing interactions among metacognition, motivation, and affect at the two levels and their interaction actually supports the model. Finally, she presented a large number of studies addressing some of these aspects, grouped in different sections such as "Relations of cognition, metacognition and motivation/affect at the Task × Person level" or "Effects of affect on metacognitive experiences."

Instruments and Measurement Methods

There are two instruments that reflect aspects of the MASRL model. First, Dermitzaki and Efklides (2000) constructed a questionnaire to measure self-concept for a language task. This instrument compares students' language performance against the four reported categories: self-perception, self-efficacy, self-esteem, and perception of their abilities by others. The interaction of these components is a key aspect of the MASRL model as, for example, these interact at both the Person and the Person × Task levels with metacognition. Secondly, Efklides (2002) created the Metacognitive Experiences Questionnaire, which explores judgments and feelings about cognitive processing. In that paper, the relationship between metacognitive experiences and performance was explored, as well as the effect of task difficulty on metacognitive experiences.

Hadwin, Järvelä, and Miller: SRL in the Context of Collaborative Learning

Hadwin et al. (2011, in press) and Järvelä and Hadwin (2013), together with other colleagues (for a review, see Panadero and Järvelä, 2015), have explored the potential of SRL theory in explaining regulation in social and interactive features of learning, e.g., use of information and communication technology (ICT) and computer-supported collaborative learning (CSCL) settings. The exploration of SRL and metacognition with this particular purpose is relatively recent, with 2003 identified as the year for the first empirical evidence published (Panadero and Järvelä, 2015). Additionally, the model is strongly influenced by Winne and Hadwin's (1998) model, as noted in Section "History and Development of the Model."

History and Development of the Model

One of their premises is that, despite the advantages of collaboration and computer-supported collaboration for learning (Dillenbourg et al., 1996), collaboration poses cognitive, motivational, social, and environmental challenges (Järvelä et al., 2013; Koivuniemi et al., 2017). To collaborate effectively, group members need to commit themselves to group work, establish a shared common ground, and negotiate and share their task perceptions, strategies, and goals (Hadwin et al., 2010); in other words, they need to share the regulation of their learning (SSRL). The key issue in SSRL is that it builds on and merges individual and social processes, and it is not reducible to an individual level. It is explained by the activity of the social entity in a learning situation (Greeno and van de Sande, 2007), including situational affordances that provide opportunities for SSRL to happen (Volet et al., 2009).

As mentioned above, SSRL is a field recently developed within SRL. Because of this, the model proposed by Hadwin, Järvelä, and

Miller (hereinafter referred to as the SSRL model) has changed significantly from their first proposition in the 2011 handbook to the chapter in the forthcoming SRL handbook.[2] The two biggest changes incorporated in the latest are: the authors have clarified their perspective on what is Co-regulated Learning (definition below) and they have incorporated and clarified the influence of COPES (Winne, 1997) in their model (Hadwin et al., in press).

The Model

The SSRL model (Hadwin et al., 2011, in press) proposed the existence of three modes of regulation in collaborative settings: self-regulation (SRL), co-regulation (CoRL), and shared regulation (SSRL) (**Figure 12**). First, SRL in collaboration refers to the individual learner's regulatory actions (cognitive, metacognitive, motivational, emotional, and behavioral) that involve adapting to the interaction with the other group members.

Secondly, CoRL in collaboration "refers broadly to affordances and constraints stimulating the (student's) appropriation of strategic planning, enactment, reflection, and adaptation (occurring when in interaction with other students or group members)" (Hadwin et al., in press, p. 5). This regulatory level is the one that has been in the most dispute in the field, as its use has not been consistent (Panadero and Järvelä, 2015).

Finally, the third type, SSRL in collaboration, occurs when "deliberate, strategic and transactive planning, task enactment, reflection and adaptation" are taken within a group (Hadwin et al., in press, p. 5). The key difference between SSRL and CoRL is that, in the former, the regulatory actions "emerge through a series of transactive exchanges amongst group members" whilst in CoRL they are guided or directed by (a) particular group member/s.

What are the significant changes between the 2011 model version and the forthcoming version? First, the CoRL mode has been reconceptualized based on the empirical evidence (Panadero and Järvelä, 2015). Hadwin et al. (2011) proposed three types of CoRL: (a) temporary mediation (by other than the learner) of regulated learning to promote SRL, (b) distributed regulation of each other's learning in a collaborative task, and (c) a microanalytic approach focusing on interactions through which social environments co-regulate learning. In their forthcoming proposal, they have shifted the focus to the effects of collaborating alone and have not discussed the microanalytic approach in such detail. Another crucial change is that they have considered the reviewed empirical evidence that CoRL and SSRL could both occur "as groups progress through different phases on their collaboration and not always SSRL nor will co-regulation happen in isolation" (Panadero and Järvelä, 2015, p. 199).

Hadwin et al. (2011) conceptualized SSRL as unfolding in four loosely sequenced and recursively linked feedback loops (**Figure 13**) taken from Winne and Hadwin (1998). During the first loop, groups negotiate and construct shared task perceptions based on internal and external task conditions. Through the second loop, groups set shared goals for the task and make plans about how to approach the task together. In the third loop, groups strategically coordinate their collaboration and monitor their progress. Based on this monitoring activity, the groups can change their task perceptions, goals, plans, or strategies in order to optimize their collective activity. Finally, in the fourth loop, groups evaluate and regulate for future performance. In essence, when groups engage in SSRL, they extend regulatory activity from the "I" or "you" level to regulate their collective activity in agreement (Hadwin et al., 2011).

In the forthcoming model proposal, the four-phase cycle remains, but under different labels, now using the ones proposed in Winne and Hadwin's work. Additionally, there is a crucial change: Winne's (1997) COPES architecture is introduced for the first time in the SSRL model. This addition clarifies, especially, the (meta)cognitive processing at the three regulatory modes along with the effects on motivation and emotion (Hadwin et al., in press, **Figure 1**).

Empirical Evidence Supporting the Model

The SSRL authors have been working toward empirical verification of their model (e.g., Järvelä et al., 2013). Meanwhile, other researchers have also conducted a growing number of studies on SSRL. A review on CoRL and SSRL by Panadero and Järvelä (2015) extracted three main conclusions. First, different levels of social regulation were identified: a less balanced type called co-regulation, in which one member of the group takes the lead; and a jointly regulated type, in which goals are negotiated and strategies are shared, known as SSRL. Because of this, those authors proposed to reconceptualize how the CoRL and SSRL modes intertwine, which constitutes one of the main changes in the forthcoming version of the model. Secondly, empirical evidence of the occurrence of SSRL in cognitive, metacognitive, motivational, and emotional shared areas were found. This finding is important, as it shows that shared regulation happens within all SRL areas. And third, there was evidence that SSRL might promote learning and performance. Additionally, new research published after the review has continued strengthening the empirical evidence around the model (e.g., Järvelä et al., 2016a,b).

Instruments

At this time, no classical measurement instruments (e.g., questionnaires) have been developed under the SSRL model, even though there is research in the field using self-reported data (e.g., Panadero et al., 2015a). Because of the contextual nature of interpersonal regulation of learning (Vauras and Volet, 2013), new methodologies have been developed to investigate SSRL. Current instruments combine scaffolding and measures in context as, for example, a computer-supported environment to promote group awareness, planning, and evaluation (e.g., Järvelä et al., 2015). Additionally, the joint effort of the model authors has been in developing multi-modal data collections including objective data (e.g., eye tracking, physiological responses) triangulated with subjective data, such as students' conceptions and intent (Hadwin et al., in press).

[2]An early draft of the chapter was provided by the authors for this review. The estimated year of publication for the handbook is 2018.

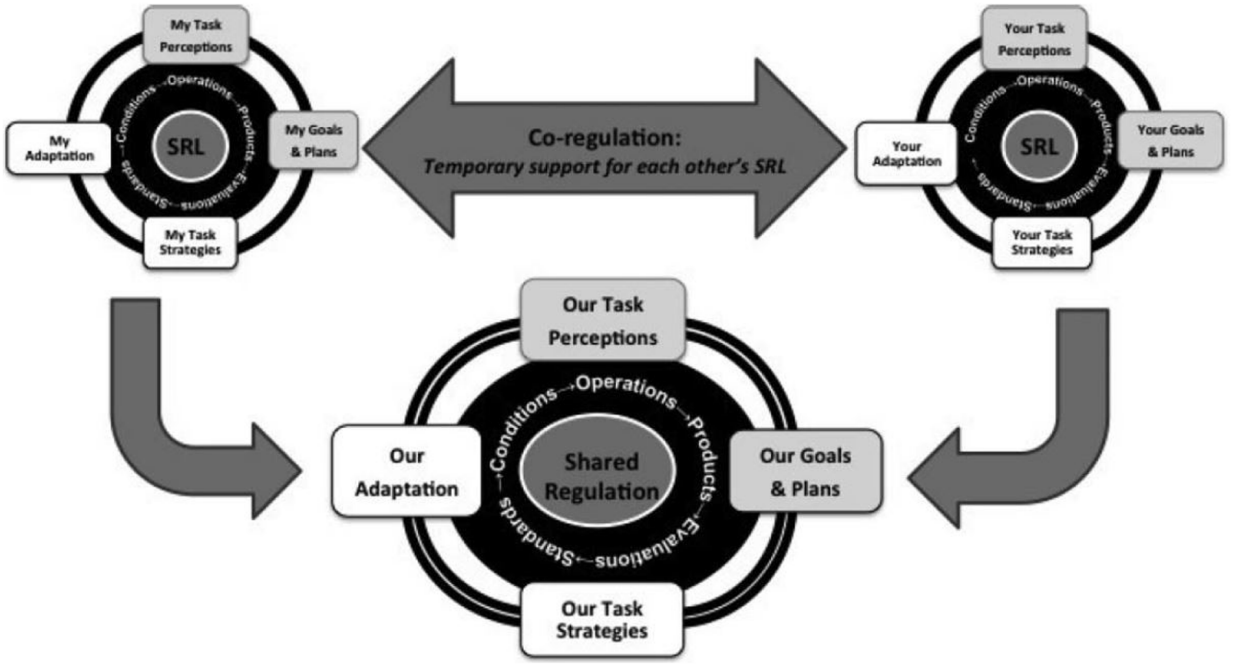


FIGURE 12 | Socially shared regulated learning model 1. Adapted from Järvelä and Hadwin (2013).

COMPARING SELF-REGULATED LEARNING MODELS

Next, the models will be compared in the following categories. First, the models' number of cites. Second, all the models are divided into different SRL phases and subprocesses. They are compared here, to extract conclusions. Thirdly, there are three main areas that SRL explores; (meta)cognition, motivation, and emotion; therefore, their positioning in each of the six models is analyzed. And, fourth, the SRL models present significant differences in three major aspects of conceptualization: top–down/bottom–up, automaticity, and context.

Citations and Importance in the Field

One word of advice before starting this section: the number of citations garnered is an indicator that can be influenced by aspects not related exclusively to the quality of the model. Important innovations can actually be made by models that have not received so many cites. Nevertheless, it is an interesting indicator to extract some conclusions from.

In **Table 1**, the number of citations per model is presented. The Efklides and SSRL models have a lower total number, as they were published recently. Nevertheless, they show promising numbers in citations per year, which indicates their relevance. The models of Boekaerts and of Winne and Hadwin's models form a second group according to their number of citations. It is important to point out that Boekaerts and Corno's (2005) study includes not only Boekaerts' model, but also information about Corno's and Kuhl's models and, especially, a reflection on SRL measurement. Therefore, it is only a partial representation of citations of Boekaerts' model, but it is her most cited paper where her model is presented. Winne and Hadwin's (1998) book is the most cited work regarding their model, but it is not the original presentation of their work, as earlier discussed. Finally, Pintrich's and Zimmerman's models, both presented in the 2000 handbook, have the highest number of citations, with Zimmerman as the most cited.

If we compare the number of the four older models, Pintrich's and Zimmerman's models have been more widely used in comparison to Boekaerts' and that of Winne and Hadwin. There are two probable causes. One is that the first ones are more comprehensive and easier to understand and apply in classrooms (Dignath et al., 2008). With regards to the first cause, both Pintrich's and Zimmerman's models include a more complete vision of different types of subprocesses. If we compare these four models figures, it is salient that Zimmerman and Pintrich (a) present more specific subprocesses than Boekaerts and (b) include motivational and emotional aspects that are not directly presented by Winne and Hadwin. The second cause is that Boekaerts' model and Winne and Hadwin's are slightly less intuitive, and a deeper understanding of the underpinning theory is needed for a correct application. This is not to say that these two models are less relevant than the others; on the contrary, both cover in depth two critical aspects for SRL: emotion regulation and metacognition. To finalize, Moos and Ringdal's (2012) review of the teacher's role in SRL in the classroom found that Zimmerman's model has been the predominant in that line of research, as it offers "a robust explanatory lens" which might help the most when working with teachers as proposed by these authors.

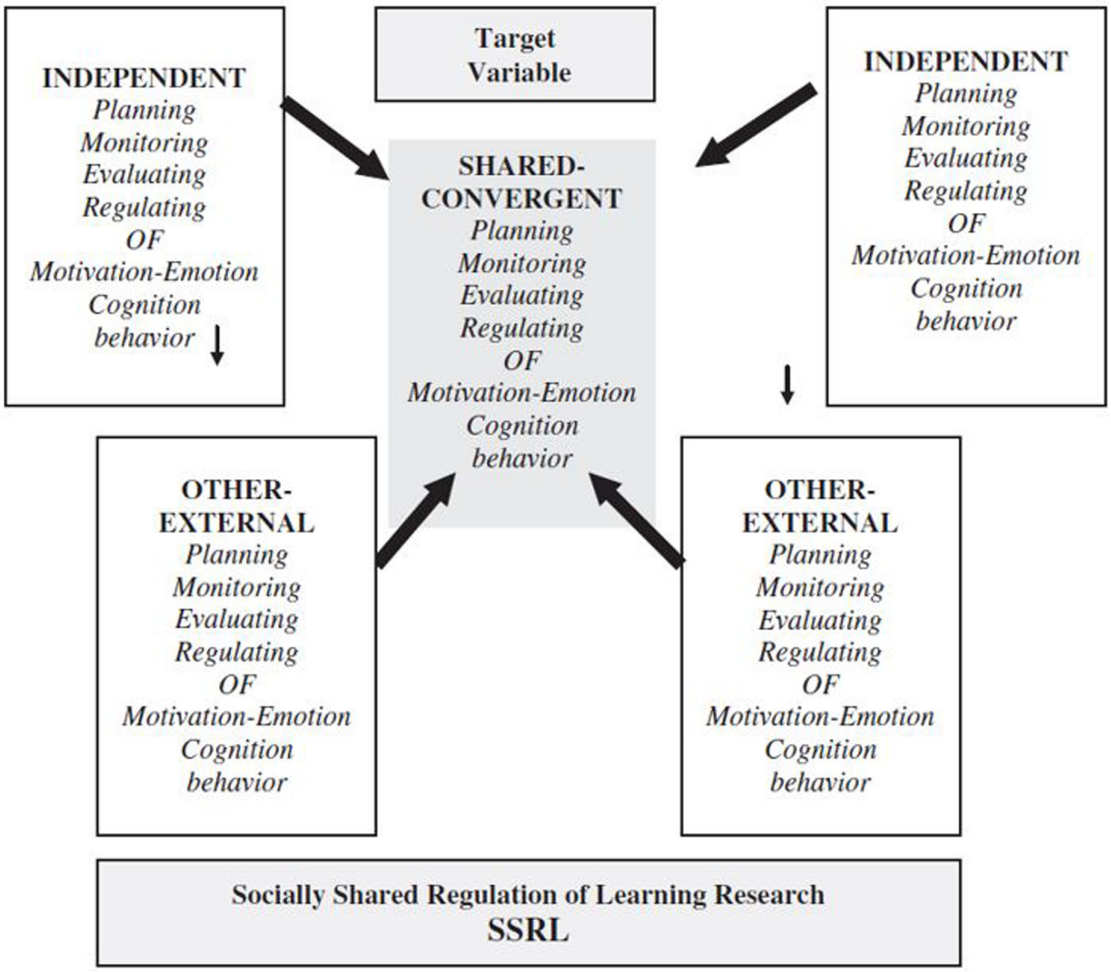


FIGURE 13 | Socially shared regulated learning model 2. Adapted from Hadwin et al. (2011).

Phases and Subprocesses

All of the model authors agree that SRL is cyclical, composed of different phases and subprocesses. However, the models present different phases and subprocesses, and by identifying them we can extract some conclusions. In general terms, Puustinen and Pulkkinen's (2001) review concluded that the models they analyzed had three identifiable phases: (a) preparatory, which includes task analysis, planning, activation of goals, and setting goals; (b) performance, in which the actual task is done while monitoring and controlling the progress of performance; and (c) appraisal, in which the student reflects, regulates, and adapts for future performances. What is the conceptualization of SRL phases in the two added models? (see **Table 2**). First, Efklides (2011) does not clearly state an appraisal phase in her model, although she considers that the Person level is influenced after repeated performances of a task. Second, the SSRL model in its version from 2011, although strongly influenced by Winne and Hadwin's, presents four phases that are similar to Pintrich's but using different labels. Therefore, the SSRL model classification in the table is the same one that Puustinen and Pulkkinen (2001) proposed for Pintrich's.

TABLE 1 | Number of citations of the different SRL models main publication.

Model	Publication	Total citations	Citations year*
Boekaerts	Boekaerts and Corno, 2005	1011	84.25
Efklides	Efklides, 2011	251	41.83
Hadwin et al.	Hadwin et al., 2011	196	32.67
Pintrich	Pintrich, 2000	3416	200.94
Winne and Hadwin	Winne and Hadwin, 1998	1037	54.58
Zimmerman	Zimmerman, 2000	4169	245.24

*Data as in 20th of March 2017. Search performed via Google Scholar. *The average citation per year was calculated dividing the total number of citation by the resulting number of subtracting to 2017 -the current year- the year of publication of the reference.*

What can be concluded? Even if all of the models considered here except Efklides', can be conceptualized around those three phases proposed by Puustinen and Pulkkinen, two

TABLE 2 | Models' phases.

Models	SRL phases		
	Preparatory phase	**Performance phase**	**Appraisal phase**
Boekaerts	Identification, interpretation, primary and secondary appraisal, goal setting	Goal striving	Performance feedback
Efklides	Task representation	Cognitive processing, performance	
Hadwin et al., 2011	Planning	Monitoring, control	Regulating
*Hadwin et al. (in press)**	*Negotiating and awareness of the task*	*Strategic task engagement*	*Adaptation*
Pintrich	Forethought, planning, activation	Monitoring, control	Reaction and reflection
Winne and Hadwin	Task definition, goal setting and planning	Applying tactics and strategies	Adapting metacognition
Zimmerman	Forethought (task analysis, self-motivation)	Performance (self-control self-observation)	Self-reflection (self-judgment, self-reaction)

**The early draft provided by the authors did not provide the exact names for the phases but it could be implied the phases are similar to Winne and Hadwin's. Therefore, this review comparison will be based on their 2011 publication.*

conceptualizations of the SRL phases can be distinguished. First, some models emphasize a clearer distinction among the phases and the subprocesses that occur in each of them. Zimmerman's and Pintrich's models belong to this group, each having very distinct features for each phase. Those in the second group-the Winne and Hadwin, Boekaerts, Efklides, and SSRL (in its forthcoming version) models-transmit more explicitly that SRL is an "open" process, with recursive phases, and not as delimited as in the first group. For example, Winne and Hadwin's figure does not make a clear distinction between the phases and the processes that belong to each: SRL is presented as a feedback loop that evolves over time. It is only through the text accompanying the figure that Winne and Hadwin (1998) clarified that they were proposing four phases.

One implication from this distinctive difference could be in how to intervene according to the different models. The first group of models might allow for more specific interventions because the measurement of the effects might be more feasible. For example, if a teacher recognizes that one of her students has a motivation problem while performing a task, applying some of the subprocesses presented by Zimmerman at that particular phase (e.g., self-consequences) might have a positive outcome. On the other hand, the second group of models might suggest more holistic interventions, as they perceive the SRL as a more continuous process composed of more inertially related subprocesses. This hypothesis, though, would need to be explored in the future.

(Meta)cognition, Motivation, and Emotion

Next, the three main areas of SRL activity and how each model conceptualizes them will be explored. The interpretation is guided by the models' figures as they reveal the most important SRL aspects for each author. A classification based on different levels for the three aforementioned areas is proposed (**Table 3**). It is important to clarify that the levels were conceptualized, not as being close in nature, but rather, as being positions on a continuum.

(Meta)cognition

Three levels are considered with regard to (meta)cognition. The first level includes models with a strong emphasis on (meta)cognition. The first model at this level is Winne and Hadwin's, in which the predominant processes are metacognitive: "Metacognitive monitoring is the gateway to self-regulating one's learning" (Winne and Perry, 2000, p. 540). Efklides' model includes motivational and affective aspects, but the metacognitive ones are defined in more detail at the Task × Person level and are the ones with more substance. Finally, the SSRL model includes in the forthcoming version the COPES architecture from Winne and Hadwin. However, due to the fact that the SSRL 2011 version did not emphasize (meta)cognition, it was decided to locate it after the two more metacognitive models. At the second level are Pintrich's and Zimmerman's models. Pintrich (2000) incorporates the "regulation of cognition," which has a central role along with aspects of metacognitive theory such as FOKs and FOLs. Zimmerman (2000) presents a number of leading cognitive/metacognitive strategies, but they are not emphasized over the motivational ones, as is the case for the models just discussed. At the third level, Boekaerts includes the use of (meta)cognitive strategies in her figures, but does not explicitly refer to specific strategies.

Motivation

A two-level classification is proposed. The Zimmerman, Boekaerts, and Pintrich models are at the first level. Zimmerman's own definition of SRL explicitly states the importance of goals

TABLE 3 | Models figures comparison on cognition, motivation, and emotion.

Levels of relevance	Cognition	Motivation	Emotion
First (more emphasis)	Winne Efklides SSRL	Zimmerman Boekaerts Pintrich	Boekaerts
Second	Pintrich Zimmerman	SSRL Efklides Winne	Zimmerman/ Pintrich SSRL
Third (less emphasis)	Boekaerts		Efklides Winne

Note from the author: these levels should be read as a continuum.

and presents SRL as a goal-driven activity. In his model, in the forethought phase, self-motivation beliefs are a crucial component; the performance phase was originally described (Zimmerman, 2000) as performance/volitional control, which indicates how important volition is; and at the self-reflection phase, self-reactions affect the motivation to perform the task in the future. According to Boekaerts, the students "interpret" the learning task and context, and then activate two different goal paths. Those pathways are the ones that lead the regulatory actions that the students do (or do not) activate (e.g., Boekaerts and Niemivirta, 2000). In addition, Boekaerts also included motivational beliefs in her models as a key aspect of SRL (see **Figure 7**). Finally, Pintrich (2000) also included a motivation/affect area in his model that considers aspects similar to those in Zimmerman's, but Pintrich's places a greater emphasis on metacognition. It is also important to mention that Pintrich conducted the first research that explored the role of goal orientation in SRL (Pintrich and de Groot, 1990).

The second level includes the SSRL, Efklides, and Winne and Hadwin models. SSRL included motivation in the 2011 version figure and emphasized its role in collaborative learning situations, but without differentiating motivational components in detail. Nevertheless, the authors have conducted a significant amount of research regarding motivation and its regulation at the group level (e.g., Järvelä et al., 2013). Finally, Winne and Hadwin (1998) and Efklides (2011) included motivation in their models, but it is not their main focus of analysis.

Emotion

Three levels are proposed. In the first one (Boekaerts, 1991; Boekaerts and Niemivirta, 2000) emphasizes the influence of emotions in students' goals and how this activates two possible pathways and different strategies. For Boekaerts, ego protection plays a crucial role in the well-being pathway, and for that reason it is essential for students to have strategies to regulate their emotions, so that they will instead activate the learning pathway. At the second level, Pintrich (2000) and Zimmerman (2000) shared similar interpretations of emotions. They both put the most emphasis on the reactions (i.e., attributions and affective reactions) that occur when students self-evaluate their work during the last SRL phase. In addition, both mentioned strategies to control and monitor emotions during performance: Pintrich discusses "awareness and monitoring" and "selection and adaptation of strategies to manage" (Pintrich, 2000), and Zimmerman stated that imagery and self-consequences can be used by students to self-induce positive emotions (Zimmerman and Moylan, 2009). Nevertheless, in the preparatory phases, neither of them mentions emotions directly. Yet, Zimmerman argues that self-efficacy, which is included in his forethought phase, is a better predictor of performance at that phase than emotions or emotion regulation (Zimmerman, B. J. personal communication with the author, 28/02/2014). The SSRL model includes emotion in its 2011 version figure (Hadwin et al., 2011), but the subprocesses that underlie the regulation of emotion are not specified. Nonetheless, these authors clearly argue that collaborative learning situations present significant emotional challenges, and they have conducted empirical studies exploring this matter (e.g., Järvenoja and Järvelä, 2009; Koivuniemi et al., 2017). Finally, Efklides (2011) and Winne and Hadwin (e.g., Winne, 2011) mention the role of emotions in SRL [e.g., "affect may directly impact metacognitive experiences as in the case of the mood" (Efklides, 2011, p. 19, and she included it in her model at two levels]. However, they do not place a major emphasis on emotion-regulation strategies.

Three Additional Areas for a Comparison

As mentioned earlier, three additional areas in which the models present salient differences were identified.

Top–Down/Bottom–Up (TD/BU)

The first model that included this categorization of self-regulation was Boekaerts and Niemivirta (2000). Top–down is the mastery/growth pathway in which the learning/task goals are more relevant for the student. On the other hand, bottom–up is the well-being pathway in which students activate goals to protect their self-concept (i.e., self-esteem) from being damaged, also known as ego protection. Efklides (2011) also uses this categorization, but with different implications. For her, top–down regulation occurs when goals are set in accordance with the person's characteristics (e.g., cognitive ability, self-concept, attitudes, emotions, etc.), and self-regulation is guided based on those personal goals. Bottom–up occurs when the regulation is data-driven, i.e., when the specifics of performing the task (e.g., the monitoring of task progress) direct and regulate the student's actions. In other words, the cognitive processes are the main focus when the student is trying to perform a task.

The other models do not explore this categorization explicitly, although some implicit interpretations can be extracted. This way, there could be a third vision of TD/BU that is based on the interactive nature of Zimmerman's model and Winne and Hadwin's. Zimmerman (personal communication to author 27/02/2014) explained:

> *Historically, top–down theories have been cognitive and have emphasized personal beliefs and mental processes as primary (e.g., Information Processing theories). By contrast, bottom–up theories have been behavioral and have emphasized actions and environments as primary (e.g., Behavior Modification theories). When Bandura (1977) developed social cognitive theory, he concluded that both positions were half correct: both were important. His theory integrates both viewpoints using a triadic depiction. I contend that his formulation is neither top–down [n]or bottom–up but rather interactionist where cognitive processes bi-directionally cause and are caused by behavior and environment. My cyclical model of SRL elaborates these triadic components and describes their interaction in repeated terms of cycles of feedback. Thus, any variable in this model (e.g., a student's self-efficacy beliefs) is subject to change during the next feedback cycle. . .. There are countless examples of people without goals who experience success in sport, music, art, or academia and subsequently develop strong goals in the process. Interactionist theories emphasize developing one's goals as much as following them.*

Winne (personal communication to the author 27/02/2014) stated:

> *I didn't introduce this terminology because it is limiting. A vital characteristic of SRL is cycles of information flow rather than one-directional flow of information. Some cycles are internal to the person and others cross the boundary between person and environment.*

In sum, Zimmerman and Winne do not consider TD/BU to be applicable to their models, as the recursive cycles of feedback during performance generate self-regulation and changes in the specificity of the goals.

As Pintrich's (2000) model is goal-driven, it could be assumed that it conceptualizes top–down motivation as coming from personal characteristics, as proposed by Efklides (2011). Nevertheless, Pintrich also included goal orientation, which implicates performance and avoidance goals, which has a connection to Boekaerts' well-being pathway, especially avoidance goals. Therefore, it is difficult to discern with any precision what the interpretation of TD/BU would be for his model. The SSRL model (Hadwin et al., 2011) has not yet clarified this issue, though a stance similar to that of Winne and Hadwin could be presupposed.

Automaticity

In SRL, automaticity usually refers to underlying processes that have become an automatic response pattern (Bargh and Barndollar, 1996; Moors and De Houwer, 2006; Winne, 2011). It is frequently used to refer to (meta)cognitive processes: some authors maintain that, for SRL to occur, some processes must become automatic so that the student can have less cognitive load and can then activate strategies (e.g., Zimmerman and Kitsantas, 2005; Winne, 2011). However, it can also refer to motivational and emotional processes that occur without student's awareness (e.g., Boekaerts, 2011). Next, some quotations from the models on this topic will be presented to illustrate the different perspectives of automaticity. Winne (2011) stated:

> Most cognition is carried out without learners needing either to deliberate about doing it or to control fine-grained details of how it unfolds. . .Some researchers describe such cognition as "unconscious" but I prefer the label implicit. . .Because so much of cognitive activity is implicit, learners are infrequently aware of their cognition. There are two qualifications. First, cognition can change from implicit to explicit when errors and obstacles arise. But, second, unless learners trace cognitive products as tangible representations -"notes to self" or underlines that signal discriminations about key ideas, for example-the track [of] cognitive of events across time can be unreliable, a fleeting memory (p. 18).

In addition, Efklides (2011) indicated:

> This conception of the SRL functioning at the Task × Person level presupposes a cognitive architecture in which there are conscious analytic processes and explicit knowledge as well as non-conscious automatic processes and implicit knowledge that have a direct effect on behavior (p. 13).

Boekaerts also assumed that automaticity can play a crucial role in the different pathways that students might activate: "Bargh's (1990) *position is that goal activation can be automatic or deliberate and* Bargh and Barndollar (1996) *demonstrated that some goals may be activated or triggered directly by environmental cues, outside the awareness of the individual*" (Boekaerts and Niemivirta, 2000, p. 422). Pintrich (2000) specified: "*At some level, this process of activation of prior knowledge can and does happen automatically and without conscious thought*" (p. 457). Finally, Zimmerman and Moylan (2009) asserted:

> In terms of their impact on forethought, process goals are designed to incorporate strategic planning-combining two key task analysis processes. With studying and/or practice, students will eventually use the strategy automatically. Automization occurs when a strategy can be executed without close metacognitive monitoring. At the point of automization, students can benefit from outcome feedback because it helps them to adapt their performance based on their own personal capabilities, such as when a basketball free throw shooter adjusts their throwing strategy based on the results of their last shot[3]. However, even experts will encounter subsequent difficulties after a strategy becomes automatic, and this will require them to shift their monitoring back from outcomes to processes (p. 307).

Thus, automaticity is an important aspect in the majority of the models. Here, there are three aspects for reflection. First, there are automatic actions that affect SRL; for example, Pintrich (2000) mentioned access to prior knowledge and Boekaerts (2011) discussed goal activation. Second, we can assume that even self-regulation, when it is understood to be the enactment of a number of learning strategies to reach students' goals, can happen implicitly, as proposed by Winne (2011). This means that students can be so advanced in their use of SRL strategies that they do not need an explicit, conscious, purposive action to act strategically. Nevertheless, this takes practice. Third, some automatic reactions, particularly some emotions, and even some complex emotion-regulation strategies may not be positive for learning (Bargh and Williams, 2007). For example, Boekaerts (2011) mentions that the well-being pathways can be activated even when students are not aware. Therefore, assisting students to become aware of those negative automatic processes could have the potential to enhance self-regulation that is oriented toward learning.

Context

The SSRL model emphasizes not only the role of context, but also the ability of different external sources (group members, teachers, etc.) to promote individual self-regulation by exerting social influence (CrRL) or of groups of students to regulate jointly while they are collaborating (SSRL) (Järvelä and Hadwin, 2013). Zimmerman (2000) did not include context in his Cyclical Phases model, only a minor reference to the specific strategy "environmental structuring." However, in his Triadic and Multi-level models, the influence of context and vicarious learning is key to the development of self-regulatory skills (Zimmerman, 2013). Boekaerts and Niemivirta (2000) posits that students' interpretation of the context activates different goal pathways and that previous experiences affect the different roles that students adopt in their classrooms (e.g., joker, geek). For Winne

[3]This was edited by Zimmerman in a personal communication. The original quote was: "on their height."

(1996), Pintrich (2000), and Efklides (2011) models, context is: (1) important to adapt to the task demands, and (2) part of the loops of feedback as students receive information from the context and adapt their strategies accordingly. In sum, all of the models include context as a significant variable to SRL. Nevertheless, with the exception of Hadwin, Järvelä, and Miller's work, not much research has been conducted by the others in exploring how significantly other contexts or the task context affect SRL.

DISCUSSION

The aim of this review was to compare educational psychology models of SRL. To achieve this goal, the included models have been presented and compared. Next, some final conclusions will be presented.

Meta-Analytical Empirical Evidence for the Models

All of the models have empirical evidence that supports the validity to some of their main aspects. However, because the SRL models share a high number of processes, there is a significant overlap in the empirical evidence. For example, self-efficacy is a crucial variable for some SRL models (e.g., Pintrich, 2000; Zimmerman, 2000). Thus, if we consider van Dinther et al. (2010) review on factors affecting self-efficacy in higher education students, it has implications for all those models that emphasize self-efficacy as a crucial SRL process. For this reason, trying to disentangle each individual empirical contribution tailored to a specific SRL model and applying it to the other five models would be very complex. As a consequence, the analysis will focus on more transversal findings, which stem from the meta-analyses conducted in the SRL field.

Three meta-analyses have been conducted with the main aim to study SRL effects (Dignath and Büttner, 2008; Dignath et al., 2008; Sitzmann and Ely, 2011) and a fourth meta-analysis have explored *learning skills interventions* with direct implications for SRL research (Hattie et al., 1996). First, regarding Hattie et al. (1996), they did not explore differential effects of SRL theories or models. Despite this limitation, one interesting conclusion was that: "it is recommended that training (a) be in context, (b) use tasks within the same domain as the target content, (c) and promote a high degree of learner activity and metacognitive awareness" (Hattie et al., 1996, p. 131). Secondly, Dignath's work explored the effects of SRL interventions in primary-school students (Dignath et al., 2008), while Dignath and Büttner (2008) added secondary-education students. As extracted from the latter, regarding primary school results, effects size on academic performance were higher if "the intervention was based on social-cognitive theories ($B = 0.33$) rather than on metacognitive theories (reference category)" plus "if interventions also included the instruction of metacognitive ($B = 0.39$) and motivational strategies ($B = 0.36$)" (p. 246). In the same study, effects sizes for secondary education results about the same variables were found to be higher:

> "if the intervention was based on metacognitive theoretical background (reference category) rather than on social-cognitive ($B = -1.41$) or motivational theories ($B = -0.97$)" plus "if the intervention focused on metacognitive reflection ($B = 0.82$) or motivation strategies ($B = 0.56$) rather than on cognitive strategies (reference category), but higher for interventions promoting cognitive rather than metacognitive strategies ($B = -0.64$)" (p. 246).

The last meta-analysis, by Sitzmann and Ely (2011), focused on how adults regulate their learning in two settings: higher education and the workplace. These authors did not include the SRL theoretical background as a moderator, as Dignath and colleagues did. However, they extracted three key results that apply to the aim of this review. First, the authors found that the constructs that there were included in more SRL theories were the ones that had stronger effects on learning (p. 433). Second, the overlap of the empirical results indicates that significant relationships exists between the different models. Third, "most of the self-regulatory processes exhibited positive relationships with learning, goal level, persistence, effort, and self-efficacy having the strongest effects. Together these four constructs accounted for 17% of the variance in learning after controlling for cognitive ability and pre-training knowledge" (p. 438).

Three main conclusions can be extracted from these four meta-analyses. First, SRL is a powerful umbrella to anchor crucial variables that affect learning, offering, at the same time, a comprehensive framework that explains their interactions. Second, SRL interventions are successful ways to improve students' learning, if properly designed. Third, SRL interventions have differential effects based on the students' educational level.

Self-regulated learning interventions that are grounded in socio-cognitive theory (Bandura, 1986) have a higher impact when used at earlier educational stages (e.g., primary), and when a framework is provided for students and teachers (Dignath et al., 2008). It has been hypothesized that this probably happens because socio-cognitive models (e.g., Zimmerman, 2000) are more comprehensive and easier to understand (Dignath et al., 2008). In addition, these models contain motivational and emotional aspects, which are more salient for academic performance during primary education (Dignath et al., 2008). When it comes to more mature students (i.e., those in secondary-education), they benefit more from interventions including more metacognitive aspects (Dignath and Büttner, 2008). This is probably due to the increased performance of cognitively demanding tasks in which it is necessary to use more specific strategies (Dignath and Büttner, 2008). Therefore, it could be hypothesized that metacognitive models (e.g., Efklides, Winne, and Hadwin) would have a higher impact at this educational level. Finally, the results from higher education and workplace trainees (Sitzmann and Ely, 2011) show that the four biggest predictors that were found—goal level, persistence, effort, and self-efficacy—have a significant motivational value and are all comprehended in the socio-cognitive theory. These results align with those of Richardson et al. (2012), who found that (a) self-efficacy was the highest predictor, (b) goal-setting strategy boosts effort regulation, and (c) multifaceted interventions may be more effective (pp. 375–376); and with the results of

Robbins et al. (2004), where the best predictors for GPA were academic self-efficacy and achievement motivation. Therefore, there seems to be a tendency for higher education students to have better results if the interventions are aiming at motivational and emotional aspects—i.e., self-efficacy and goal setting. It could, thus, be hypothesized that models with an emphasis on motivation and emotion (e.g., Boekaerts, Pintrich, and Zimmerman) might have a higher impact. Nevertheless, it is important to emphasize that the conclusions regarding higher education students are not build on meta-analyses that explicitly compared different SRL models (i.e., theoretical backgroud) interventions as are the ones for primary and secondary education.

Finally, there was another interesting finding from Dignath and colleagues meta-analyses. They found that SRL interventions, including group work, were detrimental for primary students but that they had positive impact in secondary education students (Dignath and Büttner, 2008). This finding implies that the implementation of SSRL model interventions should be carefully conducted in primary education to try to maximize positive effects. Additionally, SSRL interventions might be needed in secondary and higher education, where the amount of group work increases.

Educational Implications

Four educational implications will be discussed. First, if we examined the psychological correlates (e.g., self-efficacy, effort regulation, procrastination) that influence academic performance (Richardson et al., 2012), the conclusion is that the vast majority of these correlates are included in the SRL models. Additionally, SRL interventions promote students' learning (Dignath et al., 2008; Rosário et al., 2012). Therefore, a first implication is that teachers need to receive training on SRL theory and models to understand how they can maximize their students' learning (Paris and Winograd, 1999; Moos and Ringdal, 2012; Dignath-van Ewijk et al., 2013). There are three ways of intervening. First, pre-service teachers should receive pedagogical training for their future adaptation to the workplace. There is a significant number of studies conducted with pre-service teachers (e.g., Kramarski and Michalsky, 2009; Michalsky and Schechter, 2013), however, there is need for longitudinal studies exploring the final outcomes of such training when they start working. Second, in-service teachers also need to receive training on SRL, as they most probably did not receive any during their pre-service preparation (Moos and Ringdal, 2012). Third, teachers should gain SRL expertize themselves as learners, as this will impact their knowledge and pedagogic skills (Moos and Ringdal, 2012).

A second implication relates to how to teach SRL at different educational levels. Different models work better at different educational levels (Dignath and Büttner, 2008). Furthermore, another review shows that teachers at different educational levels used different approaches to SRL (Moos and Ringdal, 2012), but not in the expected direction. These authors found that: (a) higher education teachers tend to focus on the course content, providing limited opportunities for scaffolding SRL; (b) secondary teachers offer more of those opportunities but do not formulate explicit instructions in terms of SRL; and (c) primary teachers implement more SRL practices. There is, therefore, a misalignment between what SRL research says about its implementation at different educational levels (Dignath and Büttner, 2008), and what teachers actually do in their classroom (Moos and Ringdal, 2012). This brings us back to the previous implication: more teacher training is then needed, however, it needs to be tailored so that the interventions take the differential effects of SRL models into account.

A third implication is related to creating environments that leads students' actions toward learning. All of the models consider SRL as goal-driven, so students' goals direct their final self-regulatory actions. However, as Boekaerts (2011) argues, students also activate goals not oriented to learning (well-being pathway) and, as a consequence, students might self-regulate toward avoidance goals (e.g., pretending they are sick to miss an exam) (Alonso-Tapia et al., 2014). There is a line of research that explores how teachers can create a classroom environment that is conducive toward learning goals (Meece et al., 2006; Alonso-Tapia and Fernandez, 2008). Educators need to maximize the learning classroom climate for SRL to promote learning.

Fourth, a SRL skill developmental approach is more beneficial for learning. We already know that SRL skills develop over time with practice, feedback, and observation (Zimmerman and Kitsantas, 2005). We also know that students experience a high cognitive load when performing novel tasks, as claimed by cognitive load theory (Sweller, 1994). If we consider what we know on how to design instructional environments to minimize the impact of cognitive load (Kirschner, 2002), then a SRL skill developmental approach should be chosen. Such an approach would consider the four stages for acquisition of SRL, formulated in Zimmerman's Multi-Level model (Zimmerman and Kitsantas, 2005): observation, emulation, self-control (including automaticity), and self-regulation. This approach will maximize SRL skill development and has been proposed for self-assessment, which is a crucial process for SRL (Panadero et al., 2016).

Future Research Lines

Four future lines will be discussed. First, a call for a connection between the empirical evidence on SRL and meta-analytic evidence of correlates of learning and academic performance should be issued (e.g., Hattie et al., 1996; Richardson et al., 2012). As already argued, SRL models are comprehensive models. Therefore, the validation of the models becomes complex, as it requires either (a) conducting one study with a very large number of variables, or (b) conducting a number of studies with a narrower approach. However, if future research combines conclusions from previous meta-analyses (e.g., Hattie, 2009) and SRL models validational studies, we could advance our understanding of SRL and test even more specific SRL models' differential effects. This attempt to combine meta-analytic and primary research studies should lead to the construction of a meta-model of SRL, including all SRL areas and interconnecting the existing models. A preliminary attempt can be found in Sitzmann and Ely (2011), however, it needs to be developed further.

Second, more fine-grained studies should also be conducted to understand how the specifics of SRL work. Although SRL models provide a quite specific picture of their processes, there is still much needed to understand SRL mechanisms more precisely (e.g., how self-reflection works, interactions that leads to attributions). This could be achieved through solid experimental designs controlling for strange variables.

Third, longitudinal research on the development of SRL skills throughout the life span is needed, especially regarding how SRL applies to adults in their workplace (Sitzmann and Ely, 2011). There is a compelling amount of research on SRL development during formal education years (Paris and Newman, 1990; Ley and Young, 1998; Núñez et al., 2013). However, we need to further implement longitudinal studies that cover a significant amount of years, and emphasize the role of SRL in adult life. In terms of the latter, our call would be to first test if the available models are valid, rather than developing a new SRL model (Sitzmann and Ely, 2011). Additionally, more longitudinal research on SRL, which focuses on its development during more specific and shorter periods of time, is needed. For example, studies that focus on one specific crucial academic year (e.g., first year of university). The research on learning diaries (Schmitz et al., 2011) is a very promising stream of research that allows for extraction of information in a longitudinal manner.

Fourth, new insights into SRL processes will come from recent developments in SRL measurement (Panadero et al., 2015b). The introduction of computers in SRL research, not only to measure but also to scaffold SRL, is showing promising results. This will provide more tailored interventions and learning environments over the coming years, which should be integrated into the existent body of knowledge.

CONCLUSION

Self-regulated learning is a broad field that provides an umbrella to understand variables that influence students' learning. Over the last two decades, SRL has become one of the major areas of research in educational psychology, and the current advances in the field are a signal that its relevance will continue. One conclusion from this review is that the SRL models are beneficial for interventions under different circumstances and populations, an aspect that need to be further considered by researchers and practitioners. Additionally, SRL models address a variety of research areas (e.g., emotion regulation, collaborative learning) and, therefore, researchers can utilize those that better suit their research goals and focus. Having a repertoire of models is enriching because researchers and teachers can tailor their interventions more effectively. Finally, I would like to issue a call for a new generation of researchers to take the lead in developing new approaches, measures, and, of course, SRL models—or to continue validating the ones that already exist. These future advances should promote changes in our understanding of SRL and the means through which research is conducted.

AUTHOR CONTRIBUTIONS

EP has acted as only author and lead the writing and editorial process of this submission.

FUNDING

Research funded by personal grant to EP under Ramón y Cajal framewok (RYC-2013-13469) and Fundación BBVA call Investigadores y Creadores Culturales 2015 (project name Transición a la educación superior id. 122500) for publishing cost. Additionally funding by the Finnish Academy, project name PROSPECTS (PI: Sanna Järvelä).

ACKNOWLEDGMENTS

I would like to thank Monique Boekaerts, Anastasia Efklides, Allyson Hadwin, Mariel Miller, Phil Winne, and Barry Zimmerman for their efforts in replying to my questions, access to their earlier work and providing insights and feedback. Additional thanks to Charlotte Dignath for her help in the interpretation of her meta-analyses results and to my "usual suspect" Gavin Brown. Finally, very special thanks to Sanna Järvelä for her support.

REFERENCES

Alonso-Tapia, J., and Fernandez, B. (2008). Development and initial validation of the classroom motivational climate questionnaire (CMCQ). *Psicothema* 20, 883–889.

Alonso-Tapia, J., Panadero, E., and Ruiz, M. A. (2014). Development and validity of the emotion and motivation self-regulation questionnaire (EMSR-Q). *Span. J. Psychol.* 17:e55. doi: 10.1017/sjp.2014.41

Andrade, H. (2010). "Students as the definitive source of formative assessment: academic self-assessment and the self-regulation of learning," in *Handbook of Formative Assessment*, eds H. J. Andrade and G. J. Cizek (New York, NY: Routledge), 90–105.

Ariel, R., Dunlosky, J., and Bailey, H. (2009). Agenda-based regulation of study-time allocation: when agendas override item-based monitoring. *J. Exp. Psychol. Gen.* 138, 432–447. doi: 10.1037/a0015928

Azevedo, R., and Cromley, J. G. (2004). Does training on self-regulated learning facilitate students' learning with hypermedia? *J. Educ. Psychol.* 96, 523–535. doi: 10.1037/0022-0663.96.3.523

Azevedo, R., Cromley, J. G., and Seibert, D. (2004). Does adaptive scaffolding facilitate students' ability to regulate their learning with hypermedia? *Contemp. Educ. Psychol.* 29, 344–370. doi: 10.1016/j.cedpsych.2003.09.002

Azevedo, R., Johnson, A., Chauncey, A., and Burkett, C. (2010). "Self-regulated learning with MetaTutor: advancing the science of learning with metacognitive tools," in *New Science of Learning*, eds M. S. Khine and I. M. Saleh (New York, NY: Springer), 225–247.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychol. Rev.* 84, 191–215. doi: 10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. New York, NY: W. H. Freeman and Company.

Bargh, J. A. (1990). "Auto-motives: preconcious determinants of social interaction," in *Handbook of Motivation and Cognition. Foundations of Social Behavior*, eds E. T. Higgins and R. M. Sorrentino (New York, NY: Guilford), 93–103.

Bargh, J. A., and Barndollar, K. (1996). "Automaticity in action: the unconscious as repository of chronic goals and motives," in *The Psychology of Action: Linking Cognition and Motivation to Behavior*, eds P. M. Gollwitzer and J. A. Bargh (New York, NY: Guilford), 457–481.

Bargh, J. A., and Williams, L. E. (2007). "The nonconscious regulation of emotion," in *Handbook of Emotion Regulation*, ed. J. J. Gross (New York, NY: The Guilford Press), 429–445.

Boekaerts, M. (1988). Motivated learning: bias in appraisals. *Int. J. Educ. Res.* 12, 267–280. doi: 10.1016/0883-0355(88)90005-5

Boekaerts, M. (1991). Subjective competence, appraisals and self-assessment. *Learn. Instr.* 1, 1–17. doi: 10.1016/0959-4752(91)90016-2

Boekaerts, M. (1992). The adaptable learning process: initiating and maintaining behavioural change. *Appl. Psychol.* 41, 377–397. doi: 10.1111/j.1464-0597.1992.tb00713.x

Boekaerts, M. (1994). Confidence and doubt in relation to mathematics. *Sci. Paedagog. Exp.* 31, 287–304.

Boekaerts, M. (1996a). "Coping with stress in childhood and adolescence," in *Handbook of Coping: Theories, Research, Application*, eds M. Zeidner and N. S. Endler (New York, NY: Wiley), 452–484.

Boekaerts, M. (1996b). Self-regulated learning at the junction of cognition and motivation. *Eur. Psychol.* 2, 100–112. doi: 10.1027/1016-9040.1.2.100

Boekaerts, M. (1997). Self-regulated learning: a new concept embraced by researchers, policy makers, educators, teachers, and students. *Learn. Instr.* 7, 161–186. doi: 10.1016/S0959-4752(96)00015-1

Boekaerts, M. (1999). Motivated learning: studying student situation transactional units. *Eur. J. Psycholo. Educ.* 14, 41–55. doi: 10.1007/bf03173110

Boekaerts, M. (2002). "The on-line motivation questionnaire: a self-report instrument to assess students' context sensitivity," in *Advances in Motivation and Achievement: New Directions in Measures and Methods*, Vol. 12, eds P. R. Pintrich and M. L. Maehr (New York, NY: JAI/Elsevier Science), 77–120.

Boekaerts, M. (2007). "Understanding students' affective processes in the classroom," in *Emotion in Education*, eds P. Schutz and R. Pekrun (San Diego, CA: Academic Press), 37–56.

Boekaerts, M. (2011). "Emotions, emotion regulation, and self-regulation of learning," in *Handbook of Self-Regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 408–425.

Boekaerts, M., and Cascallar, E. (2006). How far have we moved toward the integration of theory and practice in self-regulation? *Educ. Psychol. Rev.* 18, 199–210. doi: 10.1007/s10648-006-9013-4

Boekaerts, M., and Corno, L. (2005). Self-regulation in the classroom: a perspective on assessment and intervention. *Appl. Psychol.* 54, 199–231. doi: 10.1111/j.1464-0597.2005.00205.x

Boekaerts, M., Crombach, M. J., and Voeten, M. J. M. (1998). *Task Attraction as a Determinant of Intended Effort on Curricular Tasks*, Vol. 35. Gent: Rijksuniversiteit Gent.

Boekaerts, M., and Minnaert, A. (2003). "Measuring behavioral change processes during an ongoing innovation program: scope and limits," in *Powerful Learning Environments: Unravelling Basic Components and Dimensions*, eds E. De Corte, L. Verschaffel, M. Boekaerts, N. Entwistel, and J. van Merriënboer (New York, NY: Pergamon), 71–81.

Boekaerts, M., and Niemivirta, M. (2000). "Self-regulated learning: finding a balance between learning goals and ego-protective goals," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 417–451. doi: 10.1016/b978-012109890-2/50042-1

Boekaerts, M., Otten, R., and Voeten, R. (2003). Examination performance: Are student's causal attributions school-subject specific? *Anxiety Stress Coping* 16, 331–342. doi: 10.1080/1061580031000095470

Boekaerts, M., Pintrich, P. R., and Zeidner, M. (2000). *Handbook of Self-Regulation*. San Diego, CA: Academic Press.

Boekaerts, M., and Rozendaal, J. S. (2006). "Self-regulation in Dutch secondary vocational education: need for a more systematic approach to the assessment of self-regulation," in *Zeitschrift für Berufs- und Wirtschaftspädagogik, Beiheft 20, Selbstgesteuertes Lernen in der beruflichen Bildung*, eds D. Euler, M. Lang, and G. Pätzold (Stuttgart: Franz Steiner), 49–77.

Boekaerts, M., and Rozendaal, J. S. (2007). New insights into the self-regulation of writing skills in secondary vocational education. *Z. Psychol.* 215, 152–163. doi: 10.1027/0044-3409.215.3.164

Boekaerts, M., Seegers, G., and Vermeer, H. (1995). Solving math problems: Where and why does the solution process go astray? *Educ. Stud. Math.* 28, 241–262. doi: 10.1007/BF01274175

Borkowski, J. G., Chan, L. K. S., and Muthukrishna, N. (2000). "A process-oriented model of metacognition: links between motivation and executive functioning," in *Issues in the Measurement of Metacognition*, eds G. Schraw and J. Impara (Lincoln, NE: University of Nebraska–Lincoln).

Butler, D. L., and Winne, P. H. (1995). Feedback and self-regulated learning: a theoretical synthesis. *Rev. Educ. Res.* 65, 245–281. doi: 10.3102/00346543065003245

Cascallar, E., Boekaerts, M., and Costigan, T. (2006). Assessment in the evaluation of self-regulation as a process. *Educ. Psychol. Rev.* 18, 297–306. doi: 10.1007/s10648-006-9023-2

Cleary, T., and Zimmerman, B. J. (2012). "A cyclical self-regulatory account of student engagement: theoretical foundations and applications," in *Handbook of Research on Student Engagement*, eds S. L. Christenson and W. Reschley (New York, NY: Springer Science), 237–257.

Cleary, T., Zimmerman, B. J., and Keating, T. (2006). Training physical education students to self-regulate during basketball free throw practice. *Res. Q. Exerc. Sport* 77, 251–262. doi: 10.1080/02701367.2006.10599358

Cleary, T. J., and Zimmerman, B. J. (2001). Self-regulation differences during athletic practice by experts, non-experts, and novices. *J. Appl. Sport Psychol.* 13, 185–206. doi: 10.1080/104132001753149883

Crombach, M. J., Boekaerts, M., and Voeten, M. J. M. (2003). Online measurement of appraisals of students faced with curricular tasks. *Educ. Psychol. Meas.* 63, 96–111. doi: 10.1177/0013164402239319

Dermitzaki, I., and Efklides, A. (2000). Aspects of self-concept and their relationship to language performance and verbal reasoning ability. *Am. J. Pschol.* 113, 621–637. doi: 10.2307/1423475

DiBenedetto, M. K., and Zimmerman, B. J. (2010). Differences in self-regulatory processes among students studying science: a microanalytic investigation. *Int. J. Educ. Psychol. Assess.* 5, 2–24.

Dignath, C., and Büttner, G. (2008). Components of fostering self-regulated learning among students. a meta-analysis on intervention studies at primary and secondary school level. *Metacogn. Learn.* 3, 231–264. doi: 10.1007/s11409-008-9029-x

Dignath, C., Büttner, G., and Langfeldt, H. (2008). How can primary school students learn self-regulated learning strategies most effectively? A meta-analysis on self-regulation training programmes. *Educ. Res. Rev.* 3, 101–129. doi: 10.1016/j.edurev.2008.02.003

Dignath-van Ewijk, C., Dickhäuser, O., and Büttner, G. (2013). Assessing how teachers enhance self-regulated learning: a multiperspective approach. *J. Cogn. Educ. Psychol.* 12, 338–358. doi: 10.1891/1945-8959.12.3.338

Dillenbourg, P., Baker, M., Blaye, A., and O'Malley, C. (1996). "The evolution of research on collaborative learning," in *Learning in Humans and Machine: Towards an Interdisciplinary Learning Science*, eds E. Spada and P. Reiman (Oxford: Elsevier).

Duncan, T. G., and McKeachie, W. J. (2005). The making of the motivated strategies for learning questionnaire. *Educ. Psychol.* 40, 117–128. doi: 10.1207/s15326985ep4002_6

Dunlosky, J., and Metcalfe, J. (2008). *Metacognition*. New York, NY: Sage Publications.

Efklides, A. (2002). Feelings and judgments as subjective evaluations of cognitive processing: How reliable are they? *Psychology* 9, 163–184.

Efklides, A. (2006). Metacognition and affect: What can metacognitive experiences tell us about the learning process? *Educ. Res. Rev.* 1, 3–14. doi: 10.1016/j.edurev.2005.11.001

Efklides, A. (2008). Metacognition: defining its facets and levels of functioning in relation to self-regulation and co-regulation. *Eur. Psychol.* 13, 277–287. doi: 10.1027/1016-9040.13.4.277

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: the MASRL model. *Educ. Psychol.* 46, 6–25. doi: 10.1080/00461520.2011.538645

Greene, J. A., and Azevedo, R. (2007). A theoretical review of Winne and Hadwin's model of self-regulated learning: new perspectives and directions. *Rev. Educ. Res.* 77, 334–372. doi: 10.3102/003465430303953

Greeno, J. G., and van de Sande, C. (2007). Perspectival understanding of conceptions and conceptual growth in interaction. *Educ. Psychol.* 42, 9–23. doi: 10.1080/00461520709336915

Hadwin, A. F., Järvelä, S., and Miller, M. (2011). "Self-regulated, co-regulated, and socially shared regulation of learning," in *Handbook of Self-Regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 65–84.

Hadwin, A. F., Järvelä, S., and Miller, M. (in press). "Self-regulation, co-regulation and shared regulation in collaborative learning environments," in *Handbook of Self-Regulation of Learning and Performance*, eds D. H. Schunk and J. A. Greene (New York, NY: Routledge).

Hadwin, A. F., Oshige, M., Gress, C. L. Z., and Winne, P. H. (2010). Innovative ways for using *gStudy* to orchestrate and research social aspects of self-regulated learning. *Comput. Hum. Behav.* 26, 794–805. doi: 10.1016/j.chb.2007.06.007

Hattie, J. (2009). *Visible Learning: A Synthesis of over 800 Meta-Analyses Relating to Achievement*. London: Routledge.

Hattie, J., Biggs, J., and Purdie, N. (1996). Effects of learning skills interventions on student learning: a meta-analysis. *Rev. Educ. Res.* 66, 99–136. doi: 10.3102/00346543066002099

Honicke, T., and Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: a systematic review. *Educ. Res. Rev.* 17, 63–84. doi: 10.1016/j.edurev.2015.11.002

Järvelä, S., and Hadwin, A. F. (2013). New frontiers: regulating learning in CSCL. *Educ. Psychol.* 48, 25–39. doi: 10.1080/00461520.2012.748006

Järvelä, S., Järvenoja, H., Malmberg, J., and Hadwin, A. F. (2013). Exploring socially-shared regulation in the context of collaboration. *J. Cogn. Educ. Psychol.* 12, 267–286. doi: 10.1891/1945-8959.12.3.267

Järvelä, S., Järvenoja, H., Malmberg, J., Isohätälä, J., and Sobocinski, M. (2016a). How do types of interaction and phases of self-regulated learning set a stage for collaborative engagement? *Learn. Instr.* 43, 39–51. doi: 10.1016/j.learninstruc.2016.01.005

Järvelä, S., Kirschner, P., Panadero, E., Malmberg, J., Phielix, C., Jaspers, J., et al. (2015). Enhancing socially shared regulation in collaborative learning groups: designing for CSCL regulation tools. *Educ. Technol. Res. Dev.* 63, 125–142. doi: 10.1007/s11423-014-9358-1

Järvelä, S., Malmberg, J., and Koivuniemi, M. (2016b). Recognizing socially shared regulation by using the temporal sequences of online chat and logs in CSCL. *Learn. Instr.* 42, 1–11. doi: 10.1016/j.learninstruc.2015.10.006

Järvenoja, H., and Järvelä, S. (2009). Emotion control in collaborative learning situations: do students regulate emotions evoked by social challenges. *Br. J. Educ. Psychol.* 79, 463–481. doi: 10.1348/000709909x402811

Kirschner, P. A. (2002). Cognitive load theory: implications of cognitive load theory on the design of learning. *Learn. Instr.* 12, 1–10. doi: 10.1016/S0959-4752(01)00014-7

Kitsantas, A., and Zimmerman, B. J. (2002). Comparing self-regulatory processes among novice, non-expert, and expert volleyball players: a microanalytic study. *J. Appl. Sport Psychol.* 14, 91–105. doi: 10.1080/10413200252907761

Kitsantas, A., Zimmerman, B. J., and Cleary, T. (2000). The role of observation and emulation in the development of athletic self-regulation. *J. Educ. Psychol.* 92, 811–817. doi: 10.1037/0022-0663.92.4.811

Koivuniemi, M., Panadero, E., Malmberg, J., and Järvelä, S. (2017). Higher education students' learning challenges and regulatory skills in different learning situations. *Infancia Aprendizaje* 40, 19–55. doi: 10.1080/02103702.2016.1272874

Koriat, A., and Nussinson, R. (2009). Attributing study effort to data-driven and goal-driven effects: implications for metacognitive judgments. *J. Exp. Psychol. Learn. Mem. Cogn.* 35, 1338–1343. doi: 10.1037/a0016374

Kramarski, B., and Michalsky, T. (2009). Investigating preservice teachers' professional growth in self-regulated learning environments. *J. Educ. Psychol.* 101, 161–175. doi: 10.1037/a0013101

Kuhl, J. (2000). "A functional-design approach to motivation and self-regulation," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 111–169.

Ley, K., and Young, D. B. (1998). Self-regulation behaviors in underprepared (developmental) and regular admission college students. *Contemp. Educ. Psychol.* 23, 42–64. doi: 10.1006/ceps.1997.0956

Limón, M., Mason, L., Sinatra, G. M., Winne, P. H., Montero Garcia-Celay, I., de Dios, M. J., et al. (2004). A tribute to Paul R. Pintrich's contributions to psychology and education. *Electron. J. Res. Educ. Psychol.* 2, 159–162.

Magno, C. (2010). Assessing academic self-regulated learning among Filipino college students: the factor structure and item fit. *Int. J. Educ. Psychol. Assess.* 5, 61–76.

Magno, C. (2011). Validating the academic self-regulated learning scale with the motivated strategies for learning questionnaire (MSLQ) and learning and study strategies inventory (LASSI). *Int. J. Educ. Psychol. Assess.* 7, 56–73.

Malmberg, J., Järvenoja, H., and Järvelä, S. (2013). Patterns in elementary school students' strategic actions in varying learning situations. *Instr. Sci.* 41, 933–954. doi: 10.1007/s11251-012-9262-1

Meece, J. L., Anderman, E. M., and Anderman, L. H. (2006). Classroom goal structure, student motivation, and academic achievement. *Annu. Rev. Psychol.* 57, 487–503. doi: 10.1146/annurev.psych.56.091103.070258

Michalsky, T., and Schechter, C. (2013). Preservice teachers' capacity to teach self-regulated learning: integrating learning from problems and learning from successes. *Teach. Teach. Educ.* 30, 60–73. doi: 10.1016/j.tate.2012.10.009

Moors, A., and De Houwer, J. (2006). Automaticity: a theoretical and conceptual analysis. *Psychol. Bull.* 132, 297–326. doi: 10.1037/0033-2909.132.2.297

Moos, D. C., and Ringdal, A. (2012). Self-regulated learning in the classroom: a literature review on the teacher's role. *Educ. Res. Int.* 2012:423284. doi: 10.1155/2012/423284

Núñez, J. C., Rosário, P., Vallejo, G., and González-Pienda, J. A. (2013). A longitudinal assessment of the effectiveness of a school-based mentoring program in middle school. *Contemp. Educ. Psychol.* 38, 11–21. doi: 10.1016/j.cedpsych.2012.10.002

Panadero, E., and Alonso-Tapia, J. (2013). Self-assessment: theoretical and practical connotations. When it happens, how is it acquired and what to do to develop it in our students. *Electron. J. Res. Educ. Psychol.* 11, 551–576. doi: 10.14204/ejrep.30.12200

Panadero, E., and Alonso-Tapia, J. (2014). How do students self-regulate? Review of Zimmerman's cyclical model of self-regulated learning. *Anal. Psicol.* 30, 450–462. doi: 10.6018/analesps.30.2.167221

Panadero, E., Brown, G. T. L., and Strijbos, J. W. (2016). The future of student self-assessment: a review of known unknowns and potential directions. *Educ. Psychol. Rev.* 28, 803–830. doi: 10.1007/s10648-015-9350-2

Panadero, E., and Järvelä, S. (2015). Socially shared regulation of learning: a review. *Eur. Psychol.* 20, 190–203. doi: 10.1027/1016-9040/a000226

Panadero, E., Kirschner, P., Järvelä, S., Malmberg, J., and Järvenoja, H. (2015a). How individual self-regulation affects group regulation and performance: a shared regulation intervention. *Small Group Res.* 46, 431–454. doi: 10.1177/1046496415591219

Panadero, E., Klug, J., and Järvelä, S. (2015b). Third wave of measurement in the self-regulated learning field: when measurement and intervention come hand in hand. *Scand. J. Educ. Res.* 60, 723–735. doi: 10.1080/00313831.2015.1066436

Paris, S. G., and Newman, R. S. (1990). Developmental aspects of self-regulated learning. *Educ. Psychol.* 25, 87–102. doi: 10.1207/s15326985ep2501_7

Paris, S. G., and Winograd, P. (1999). *The Role of Self-Regulated Learning in Contextual Teaching: Principles and Practices for Teacher Preparation*. Available at: http://www.ciera.org/library/archive/2001-04/0104parwin.htm

Pintrich, P. R. (1999). Taking control of research on volitional control: challenges for future theory and research. *Learn. Individ. Differ.* 11, 335–354. doi: 10.1016/S1041-6080(99)80007-7

Pintrich, P. R. (2000). "The role of goal orientation in self-regulated learning," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 452–502.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *J. Educ. Psychol.* 95, 667–686. doi: 10.1037/0022-0663.95.4.667

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educ. Psychol. Rev.* 16, 385–407. doi: 10.1007/s10648-004-0006-x

Pintrich, P. R., and de Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *J. Educ. Psychol.* 82, 33–40. doi: 10.1037/0022-0663.82.1.33

Pintrich, P. R., Marx, R. W., and Boyle, R. A. (1993a). Beyond cold conceptual change: the role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Rev. Educ. Res.* 63, 167–199. doi: 10.3102/00346543063002167

Pintrich, P. R., Smith, D. A. F., Garcia, T., and Mckeachie, W. J. (1993b). Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ). *Educ. Psychol. Meas.* 53, 801–813. doi: 10.1177/0013164493053003024

Pintrich, P. R., Wolters, C. A., and Baxter, G. P. (2000). "Assessing metacognition and self-regulated learning," in *Issues in the Measurement of Metacognition*, eds G. Schraw and J. Impara (Lincoln, NE: University of Nebraska), 43–97.

Puustinen, M., and Pulkkinen, L. (2001). Models of self-regulated learning: a review. *Scand. J. Educ. Res.* 45, 269–286. doi: 10.1080/00313830120074206

Richardson, M., Abraham, C., and Bond, R. (2012). Psychological correlates of university students' academic performance: a systematic review and meta-analysis. *Psychol. Bull.* 138, 353–387. doi: 10.1037/a0026838

Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., and Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychol. Bull.* 130, 261–288. doi: 10.1037/0033-2909.130.2.261

Rosário, P., Núñez, J. C., Valle, A., González-Pienda, J., and Lourenço, A. (2012). Grade level, study time, and grade retention and their effects on motivation, self-regulated learning strategies, and mathematics achievement: a structural equation model. *Eur. J. Psychol. Educ.* 28, 1311–1331. doi: 10.1007/s10212-012-0167-9

Roth, A., Ogrin, S., and Schmitz, B. (2016). Assessing self-regulated learning in higher education: a systematic literature review of self-report instruments. *Educ. Assess. Eval. Account.* 28, 225–250. doi: 10.1007/s11092-015-9229-2

Rozendaal, J. S., Minnaert, A., and Boekaerts, M. (2003). Motivation and self-regulated learning in secondary vocational education: information-processing type and gender differences. *Learn. Individ. Differ.* 13, 273–289. doi: 10.1016/S1041-6080(03)00016-5

Schmitz, B., Klug, J., and Schmidt, M. (2011). "Assessing self-regulated learning using diary measures with university students," in *Handbook of Self-regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 251–266.

Schmitz, B., and Wiese, B. S. (2006). New perspectives for the evaluation of training sessions in self-regulated learning: time-series analyses of diary data. *Contemp. Educ. Psychol.* 31, 64–96. doi: 10.1016/j.cedpsych.2005.02.002

Schunk, D. H. (2005). Self-regulated learning: the educational legacy of Paul R. Pintrich. *Educ. Psychol.* 40, 85–94. doi: 10.1207/s15326985ep4002_3

Seegers, G., and Boekaerts, M. (1993). Task motivation and mathematics achievement in actual task situations. *Learn. Instr.* 3, 133–150. doi: 10.1016/0959-4752(93)90012-O

Seegers, G., and Boekaerts, M. (1996). Gender-related differences in self-referenced cognitions in relation to mathematics. *J. Res. Math. Educ.* 27, 215–240. doi: 10.2307/749601

Sitzmann, T., and Ely, K. (2011). A meta-analysis of self-regulated learning in work-related training and educational attainment: what we know and where we need to go. *Psychol. Bull.* 137, 421–442. doi: 10.1037/a0022777

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learn. Instr.* 4, 295–312. doi: 10.1016/0959-4752(94)90003-5

van Dinther, M., Dochy, F., and Segers, M. (2010). Factors affecting students' self-efficacy in higher education. *Educ. Res. Rev.* 6, 95–108. doi: 10.1016/j.edurev.2010.10.003

Vauras, M., and Volet, S. (2013). "The study of interpersonal regulation in learning and its challenge to the research methodology," in *Interpersonal Regulation of Learning and Motivation*, eds S. Volet and M. Vauras (London: Routledge).

Vermeer, H., Boekaerts, M., and Seegers, G. (2001). Motivational and gender differences: sixth-grade students' mathematical problem-solving behavior. *J. Educ. Psychol.* 92, 308–315. doi: 10.1037/0022-0663.92.2.308

Volet, S., Vauras, M., and Salonen, P. (2009). Self- and social regulation in learning contexts: an integrative perspective. *Educ. Psychol.* 44, 215–226. doi: 10.1080/00461520903213584

Winne, P. H. (1982). Minimizing the black box problem to enhance the validity of theories about instructional effects. *Instr. Sci.* 11, 13–28. doi: 10.1007/BF00120978

Winne, P. H. (1995). Inherent details in self-regulated learning. *Educ. Psychol.* 30, 173–187. doi: 10.1207/s15326985ep3004_2

Winne, P. H. (1996). A metacognitive view of individual differences in self-regulated learning. *Learn. Individ. Differ.* 8, 327–353. doi: 10.1016/S1041-6080(96)90022-9

Winne, P. H. (1997). Experimenting to bootstrap self-regulated learning. *J. Educ. Psychol.* 89, 397–410. doi: 10.1037/0022-0663.89.3.397

Winne, P. H. (2001). "Self-regulated learning viewed from models of information processing," in *Self-Regulated Learning and Academic Achievement*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Lawrence Erlbaum Associates), 153–190.

Winne, P. H. (2011). "A cognitive and metacognitive analysis of self-regulated learning," in *Handbook of Self-Regulation of Learning and Performance*, eds B. J. Zimmerman and D. H. Schunk (New York, NY: Routledge), 15–32.

Winne, P. H., and Baker, R. S. J. D. (2013). The potentials of educational data mining for researching metacognition, motivation and self-regulated learning. *J. Educ. Data Mining* 5, 1–8.

Winne, P. H., and Hadwin, A. F. (1998). "Studying as self-regulated engagement in learning," in *Metacognition in Educational Theory and Practice*, eds D. Hacker, J. Dunlosky, and A. Graesser (Hillsdale, NJ: Erlbaum), 277–304.

Winne, P. H., and Hadwin, A. F. (2008). "The weave of motivation and self-regulated learning," in *Motivation and Self-Regulated Learning: Theory, Research and Applications*, eds D. H. Schunk and B. J. Zimmerman (New York, NY: Lawrence Erlbaum Associates), 297–314.

Winne, P. H., and Hadwin, A. F. (2013). "nStudy: tracing and supporting self-regulated learning in the internet," in *International Handbook of Metacognition and Learning Technologies*, eds R. Azevedo and V. Aleven (New York, NY: Springer), 293–308.

Winne, P. H., Hadwin, A. F., and Gress, C. (2010). The learning kit project: software tools for supporting and researching regulation of collaborative learning. *Comput. Human Behav.* 26, 787–793. doi: 10.1016/j.chb.2007.09.009

Winne, P. H., and Perry, N. E. (2000). "Measuring self-regulated learning," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (Orlando, FL: Academic Press), 531–566.

Winne, P. H., Zhou, M., and Egan, R. (2011). "Designing assessments of self-regulated learning," in *Assessment of Higher-order Thinking Skills*, eds G. Schraw and D. H. Robinson (Charlotte, NC: Information Age Publishing), 89–118.

Wolters, C. A. (2003). Regulation of motivation: evaluating an underemphasized aspect of self-regulated learning. *Educ. Psychol.* 38, 189–205. doi: 10.1207/S15326985EP3804_1

Zimmerman, B. J. (1986). Becoming a self-regulated learner: which are the key subprocesses? *Contemp. Educ. Psychol.* 11, 307–313. doi: 10.1016/0361-476x(86)90027-5

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *J. Educ. Psychol.* 81, 329–339. doi: 10.1037/0022-0663.81.3.329

Zimmerman, B. J. (2000). "Attaining self-regulation: a social cognitive perspective," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 13–40. doi: 10.1016/b978-012109890-2/50031-7

Zimmerman, B. J. (2013). From cognitive modeling to self-regulation: a social cognitive career path. *Educ. Psychol.* 48, 135–147. doi: 10.1080/00461520.2013.794676

Zimmerman, B. J., and Campillo, M. (2003). "Motivating self-regulated problem solvers," in *The Nature of Problem Solving*, eds J. E. Davidson and R. J. Sternberg (New York, NY: Cambridge University Press), 233–262.

Zimmerman, B. J., and Kitsantas, A. (1997). Developmental phases in self-regulation: shifting from process goals to outcome goals. *J. Educ. Psychol.* 89, 29–36. doi: 10.1037/0022-0663.89.1.29

Zimmerman, B. J., and Kitsantas, A. (1999). Acquiring writing revision skill: shifting from process to outcome self-regulatory goals. *J. Educ. Psychol.* 91, 241–250. doi: 10.1037/0022-0663.91.2.241

Zimmerman, B. J., and Kitsantas, A. (2002). Acquiring writing revision and self-regulatory skill through observation and emulation. *J. Educ. Psychol.* 94, 660–668. doi: 10.1037/0022-0663.94.4.660

Zimmerman, B. J., and Kitsantas, A. (2005). "The hidden dimension of personal competence: self-regulated learning and practice," in *Handbook of Competence and Motivation*, eds A. J. Elliot and C. S. Dweck (New York, NY: Guilford Press), 509–526.

Zimmerman, B. J., and Kitsantas, A. (2007). Reliability and validity of Self-Efficacy for Learning Form (SELF) scores of college students. *Z. Psychol.* 215, 157–163. doi: 10.1027/0044-3409.215.3.157

Zimmerman, B. J., and Martinez-Pons, M. (1986). Development of a structured interview for assessing student use of self-regulated learning-strategies. *Am. Educ. Res. J.* 23, 614–628. doi: 10.3102/00028312023004614

Zimmerman, B. J., and Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *J. Educ. Psychol.* 80, 284–290. doi: 10.1037/0022-0663.80.3.284

Zimmerman, B. J., and Moylan, A. R. (2009). "Self-regulation: where metacognition and motivation intersect," in *Handbook of Metacognition in Education*, eds D. J. Hacker, J. Dunlosky, and A. C. Graesser (New York, NY: Routledge), 299–315.

Zimmerman, B. J., Moylan, A. R., Hudesman, J., White, N., and Flugman, B. (2011). Enhancing self-reflection and mathematics achievement of at-risk urban technical college students. *Psychol. Test Assess. Model.* 53, 141–160.

Zimmerman, B. J., and Schunk, D. H. (2011). *Handbook of Self-Regulation of Learning and Performance*. New York, NY: Routledge.

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Panadero. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 April 2017
doi: 10.3389/fpsyg.2017.00583

Using Exponential Random Graph Models to Analyze the Character of Peer Relationship Networks and Their Effects on the Subjective Well-being of Adolescents

*Can Jiao[1], Ting Wang[1], Jianxin Liu[2], Huanjie Wu[1], Fang Cui[1] and Xiaozhe Peng[1]**

[1] College of Psychology and Sociology, Shenzhen University, Shenzhen, China, [2] The Faculty of Humanities and Social Sciences, City University of Macau, Macau, Macau

The influences of peer relationships on adolescent subjective well-being were investigated within the framework of social network analysis, using exponential random graph models as a methodological tool. The participants in the study were 1,279 students (678 boys and 601 girls) from nine junior middle schools in Shenzhen, China. The initial stage of the research used a peer nomination questionnaire and a subjective well-being scale (used in previous studies) to collect data on the peer relationship networks and the subjective well-being of the students. Exponential random graph models were then used to explore the relationships between students with the aim of clarifying the character of the peer relationship networks and the influence of peer relationships on subjective well being. The results showed that all the adolescent peer relationship networks in our investigation had positive reciprocal effects, positive transitivity effects and negative expansiveness effects. However, none of the relationship networks had obvious receiver effects or leaders. The adolescents in partial peer relationship networks presented similar levels of subjective well-being on three dimensions (satisfaction with life, positive affects and negative affects) though not all network friends presented these similarities. The study shows that peer networks can affect an individual's subjective well-being. However, whether similarities among adolescents are the result of social influences or social choices needs further exploration, including longitudinal studies that investigate the potential processes of subjective well-being similarities among adolescents.

Keywords: peer relationships, subjective well-being, exponential random graph models, social network analysis

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo, Spain

Reviewed by:
Ana Miranda, Universitat de València, Spain
Mercedes Inda-Caro, University of Oviedo, Spain

****Correspondence:***
Xiaozhe Peng
pengxz@szu.edu.cn

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *22 December 2016*
Accepted: *29 March 2017*
Published: *13 April 2017*

Citation:
Jiao C, Wang T, Liu J, Wu H, Cui F and Peng X (2017) Using Exponential Random Graph Models to Analyze the Character of Peer Relationship Networks and Their Effects on the Subjective Well-being of Adolescents. Front. Psychol. 8:583. doi: 10.3389/fpsyg.2017.00583

INTRODUCTION

In adolescence, and with increasing physical and cognitive development, a child's psychological awareness begins to resemble that of an adult. Adolescents spend more and more time with their contemporaries, especially their peers. A peer relationship is the relationship of a common activity and mutual cooperation among children in the same or similar age group, but mainly refers to a relationship between peers or individuals at a similar level of psychological development, which

is built and developed through communication (Yang, 2008). And peer relationships are the main sources of social support for adolescents and the main driving force in enhancing an adolescent's self-concept and well-being (Furman and Buhrmester, 1992). Good peer relationships cannot only promote the development of an adolescent's social cognition and social skills, but also improve their physical and mental health and enhance their subjective well-being. Negative peer relationships not only hinder an adolescent's academic performance and personality development, but might lead to emotional problems such as anxiety, depression, and mental illness (Chen and Zhou, 2007). Adolescent school-based networks are important for developing these peer relationships (Haas et al., 2010). Researchers have argued that peer relationships may promote the development of an adolescent's self-identity through social comparison and symbolic evaluation (Brown and Lohr, 1987). Adolescents see their peer groups as typical models for their views and behaviors, and use the identity of the peer groups to regulate their own behavior. In this way, adolescents develop similarities to others in their groups. According to social communication theory, in a social network, a person's emotions, opinions, and behaviors are like an epidemic and can spread by social interaction (Kiuru et al., 2012). And according to similarity theory, individual similarities in values, characteristics and behaviors increase predictably, which enables them to share the same feelings and develop a sense of belonging, and makes them easy to get along with (Batool and Malik, 2010).

The developmental literature has long emphasized the strong role of peer groups in determining our inclination toward social behaviors (Brown, 2004). Many researchers have carried out a social network analysis of adolescents especially in relation to their social behaviors. Researchers have studied the relationship between peer-related physical activity social networks (Voorhees et al., 2005) and peer aggression (Low et al., 2013); health (Haas et al., 2010); obesity (Marqués et al., 2015); smoking (Ennett and Bauman, 1993; Lakon et al., 2013; Lambert, 2014); substance use (Ennett et al., 2006); and drinking (Mundt, 2011; Deutsch et al., 2014). However, whether they like their lives is rarely explored through this method. Our investigation aims to satisfy curiosity about a child's inner state.

Subjective well-being is a personal evaluation of an individual's overall living conditions. In other words, subjective well-being is how much a person likes his or her life (Veenhoven, 2013) and in colloquial terms is sometimes labeled "happiness." This is a multidisciplinary research field. The social psychologist Diener, one of the few internationally recognized academic authorities in this area, pointed out that the subjective well-being of the individual produces a positive attitude and positive feelings by comparing the actual state of life with ideal life. Subjective well-being is characterized by subjectivity, initiative and comprehensiveness (Diener, 2000). The evaluation criteria are made by an individual's own standards without reference to any external evaluation criteria. The evaluation criteria have the characteristics of subjectivity, stability and integrity. External factors such as gender, age, income and life events, as well as internal factors such as personality, self-esteem, self-efficacy, and self-concept, all have an impact on subjective well-being (Diener et al., 1995, 1999; McCullough et al., 2000; Schimmack and Diener, 2003; Ferrer-i-Carbonell, 2005; Gutiérrez et al., 2005; Gilman and Huebner, 2006; Karademas, 2006; Zhou et al., 2012; Ulloa et al., 2013). Since subjective well-being is the main aspect of living quality and has a close relationship with mental health, studies of subjective well-being have been highly valued (Diener, 1984). Meanwhile, various studies have shown that peer/interpersonal relationships and subjective well-being are related to a certain degree (Hussong, 2000; Liu and Gong, 2000; Dai, 2005; Demir and Weitekamp, 2007; Litwin and Shiovitz-Ezra, 2010). In addition, the former has a strong predictive ability on the latter (Dai, 2005; Chen, 2006; Demir et al., 2007; Xia, 2007; Wu, 2008; Zhang and Zhu, 2012).

The period known as adolescence is a critical period for psychological development. Psychological symptoms such as low subjective well-being have been recognized as being common (La Greca and Lopez, 1998). These obstacles can last a long time, often beginning in adolescence and extending to adulthood (Devine et al., 1994), and are likely to become risk factors for adult mental disorders (Devine et al., 1994; Aalto-Setälä et al., 2002). Therefore, studies of the relationship between adolescent peer relationships and subjective well-being have a certain practical significance.

Although there has been much fruitful research on the relationship between peer relationships and subjective well-being, as outlined above, there is a common problem with these studies; that is, their methodological premise in applying statistical analysis. Specifically, researchers have presented relational data in a simplified form as attribute data. Peer relationships in essence are relational attributes and reflect interpersonal relationships as well as interdependencies between individuals. However, if peer relationships are regarded as attribute data, then the methods used to conduct statistical analysis on the basis of this assumption would be those that are relevant to attribute data only, such as correlation analysis and regression analysis. The statistic type is clearly against the premise of these methods in this context, and the conclusions drawn from such research may not be valid (Jiao et al., 2014).

Social network analysis is an effective method of solving this problem. As a method for dealing with relational data, social network analysis fully considers the impacts of the social situation on individual behaviors and focuses on the relationship between individuals. The social context is constituted by the relationship between individuals. Relationships constitute a network. In social networks, the points (or nodes) represent the units such as individuals, families, organizations, and social groups. The edges represent whether a relationship between points exists and its strength. By network analysis, the relationships between individuals can be described and measured. Additionally, the resources and information within the relationship can also be described and measured. Furthermore, a model can be built for these relationships, which can be used to study the interactions between these relationships and individual behaviors (Liu, 2004).

Exponential Random Graph Models (ERGMs) are a method of social network analysis for building complex social network structures (Robins et al., 2007). The model assumes that the emergence of a relationship might be influenced by the presence

or absence of other relationships and/or individual attributes (Robins et al., 2007). Compared with other social network analysis models, an ERGM focuses on the interaction between the structures of a relationship network (such as reciprocity, transitivity, and popularity) and individual attributes (such as gender and education level). In order to understand the inner mechanism of peer relationships and subjective well-being more clearly, this study used an ERGM model to explore the relationships between network structures in adolescent peer relationships and the individual's subjective well-being.

Our purpose is to clarify the character of a peer relationship network and the mechanism of the peer relationship influence on subjective well-being. Studies have shown that there are effects of reciprocal structure, transitivity structure, popularity structure and expansiveness structure in peer networks (Schaefer et al., 2010; Daniel et al., 2013). Thus, this study assumes the following.

- Hypothesis 1: There are significant reciprocal structure effects in adolescent peer networks.
- Hypothesis 2: There are significant transitivity structure effects in adolescent peer networks.
- Hypothesis 3: There are significant popularity structure effects in adolescent peer networks.
- Hypothesis 4: There are significant expansiveness structure effects in adolescent peer networks.

Adolescents and their friends might have similarities in a variety of social, behavioral, and psychological characteristics (Prinstein and Dodge, 2008). Numerous studies have found that adolescent friends have similarities in externalizing problems such as attacks (Sijtsema et al., 2010); internalizing problems such as depression (Van Zalk et al., 2010); health risk behaviors such as smoking (Mercken et al., 2010); "happy" emotions (Fowler and Christakis, 2008); and prosocial behaviors (Barry and Wentzel, 2006). Thus, this study also assumes the following.

- Hypothesis 5: Adolescents show similar levels among peers in each dimension of subjective well-being (satisfaction with life, positive affects and negative affects).

Receiver effects build relationships between individual attribute variables and popularity. Popularity refers to the nominated numbers that individuals receive from other individuals in their network class. More nominated numbers indicate that the individual is more popular. Studies have shown that popular individuals prefer interactions with their peers and have more positive attitudes. They are seldom isolated, refused or repelled by peers. They experience more positive affects and have fewer negative experiences (LaFontana and Cillessen, 2002; Wen, 2011). Thus, this study further assumes:

- Hypothesis 6: There is a significant positive receiver effect in the positive affective dimension of subjective well-being; namely, individuals who have higher levels of positive affect will have more friends and be more popular, and vice versa.
- Hypothesis 7: There is a significant negative receiver effect in the negative affective dimension of subjective well-being, namely, individuals who have higher levels of negative affect will have fewer friends and be less popular, and vice versa.

MATERIALS AND METHODS

Participants

Nine junior middle schools were selected at random from Shenzhen, China. Twenty-nine classes were then selected at random from these nine schools (mean classes 3.22, standard deviation 0.44). There were 1,497 students altogether. All students were given questionnaires which were handled as follows. First, the questionnaires that did not meet requirements were excluded from the study. These included cases of: (a) multiple answers (a participant provided more than one option for an item); (b) no answers (a participant failed to provide an option for an item); and (c) regular answers (a participant provided the same option or a regular array of options for a series of items). Secondly, the subjects that obtained subjective well-being (SWB) scores exceeding three standard deviations were removed from the study, by which the influence of extreme values was eliminated. Thirdly, the subjects who were at the edge or on the periphery of a class network were excluded from the study as these subjects did not associate with other members in their class network and became isolated points. Finally, there were 1,279 subjects remaining, including 678 boys and 601 girls. The study was conducted in accordance with the Declaration of Helsinki and was approved by the Academic Committee of the College of Psychology and Sociology, Shenzhen University. All participants (or the parents of participants who were under the age of 16) provided written informed consent of participation in the study.

Research Tools

The Questionnaire: Peer Nomination

The questions in the questionnaire were designed as follows. As regards peer nomination, participants were asked: "Please write the name of your best friends in the class (at least three)" (Lubbers and Snijders, 2007). In measuring peer relationships, if a member nominated another member it meant there was a relationship between them, which was then recorded as 1 in the relationship matrix; otherwise it was recorded as zero.

Subjective Well-being Scale

The SWB scale was built from two constituents: the Satisfaction with Life Scale (SWLS) and the Affect Balance Scale (ABS). The SWLS scale was compiled by Diener et al. (1985). It has been used to measure the cognitive dimension of subjective well-being (Zhu et al., 2012). The scale contains five items, each of which employs 7 score grades from "strongly disagree" to "strongly agree." Strongly disagree is recorded with a score of 1, while strongly agree is recorded with a score of 7, the scores increasing in sequence. Higher scores indicate a higher satisfaction with life (SWL), whilst a low score means a low SWL. The Alpha coefficient of the scale is 0.78. The split-half reliability is 0.70. The fit index of confirmatory factor analysis is, respectively, the ratio of (chi-square/degrees of freedom) that is 6.71, RMSEA = 0.071, GFI = 0.97, and CFI = 0.96, which shows that the structure of the scale has a good validity (Xiong and Xu, 2009). The internal homogeneity coefficient α of the measurement is 0.77 and meets metrological standards.

The ABS scale was compiled by Bradburn and Noll (1969). The reliability estimates of Bradburn's original study showed acceptable reliability coefficients (Bradburn and Noll, 1969). ABS has been used to measure the affective dimension of subjective well-being such as positive affect and negative affect (Yue et al., 2006). Our study uses the Chinese version of the Mental Health Assessment Scale, which was collected by Wang et al. (1999). The scale contains 10 items, which are used to describe a person's feelings in the past few weeks. Among them, five items describe positive affects and five items describe negative effects. The answer "Yes" is recorded with a score of 1; the answer "No" with a score of 0. A higher score indicates a higher frequency of experiencing positive or negative effects (Zhang et al., 2007). In the scale, the retest reliability of positive affects and negative effects are both above 0.80; additionally, the correlation values between these two subscales is less than 0.10, which indicates the validity of the scale and its reliability (Ou et al., 2009). In the measurement, the internal homogeneity coefficient α of the positive affective dimension is 0.60, and the internal homogeneity coefficient α of the negative affective dimension is 0.63. The ABS has been translated into many languages including Cantonese, Vietnamese, and Laotian, and a cultural equivalence has been found (Devins et al., 1997). The original version of ABS and the Chinese version have both been shown to be reliable, and the measurement meets metrological standards.

Exponential Random Graph Models

Exponential Random Graph Models (ERGMs), also known as P^* models, were proposed by Frank and Strauss (1986) to explain a series of statistical models in social networks. An ERGM can infer how network relationships are formed. The model does not focus on predicting individual outcome variables in the network but focuses on the formation of deductive relations. It takes the network as a graph constituted by nodes (actors) and edges (relationships). It inspects the probability distribution of the set of all graphs with a fixed number of points (or nodes) (Ma et al., 2011). The model assumes that the network was generated at random. The probability of the observed graph depends on the number of occurrences of various structures in the model (Wang et al., 2009). Its basic form is as follows:

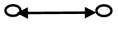
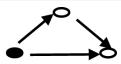
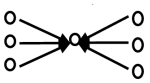
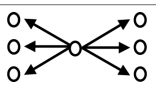
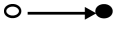
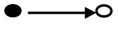
$$\Pr(X = x) = \frac{\exp\{\theta' z(x)\}}{k(\theta)} = \frac{\exp\{\theta_1 z_1(x) + \ldots + \theta_r z_r(x)\}}{k(\theta)}$$

In the above formula, the meaning of each expression is as follows (Ma et al., 2011). $\Pr(X = x)$ is the probability of some actual relationship between individuals. θ is a series of network structure parameter vectors, including reciprocal structure parameters, transitivity structure parameters and star-shaped structure parameters. $z(x)$ is a series of network statistic vectors. The series contains not only particular network structure parameters (such as reciprocal parameters, transitivity parameters and star-shaped structure parameters), but also attribute parameters of the actors in the network (such as grade, gender, and attitudes). k is a constant and guarantees that the probability distribution is a normal distribution.

The dependence assumption is the basic theoretical assumption of ERGMs. "My friend's friend is my friend" is a typical dependence assumption in a social network. The assumption is that the existence of some relationships will produce, maintain or destroy other relationships (Robins, 2011). If a relationship does not rely on other relationships, it can be said that the existence of some relationships will affect the existence of other relationships to some extent, and that they have no incentive to form the structure. The dependence assumption is presented by specific structures which reflect how relationships are generated in the network. The network structure is a small network mode, which is constituted by points (or nodes) and the relationships among points (Brughmans et al., 2014). **Table 1** presents the common structural parameters of ERGMs for a directed network.

The reciprocity assumption is that if actor A selects actor B, then actor B will also select actor A. Reciprocity is a basic characteristic of social life and has been proved in peer groups (Snyder et al., 1996; Strayer and Santos, 1996). Popularity means that an individual has a higher "in-degree" compared with other individuals in the network ("in-degree" counts the total number of actors who select a particular individual). Higher in-degrees show that some people are more attractive than others, and the popularity assumption is that an individual will select the one actor that others have all selected to make friends (Barabási and Albert, 1999; Gould, 2002). Transitivity measures triangular closure trends in the network; namely, "my friend's friend is also my friend." If transitivity appears in peer groups, the reason might be that more and more individuals are willing to share each other's friends, or might be due to a psychological need for balance (Daniel et al., 2013).

TABLE 1 | The common structural parameters of exponential random graph models for a directed network.

Parameter	Structure of point	Description of structure
Reciprocity		Two points select each other as friends, which creates a reciprocal relationship.
Transitivity		My (black point) friend's (white point) friend (white point) is also my friend.
Popularity		The points on both sides all select the central point as a friend. The central point is the most popular one.
Expansiveness		The central point selects the points on both sides as friends. The central point is actively making friends with other points.
Receiver		The relationship is sent from any point (white point) to some specific attribute point (black point).
Sender		The relationship is sent from some specific attribute point (black point) to any point (white point).

The point represents an "actor"; the directed line represents a "directed relationship from sender to receiver."

Based on various dependence assumptions, ERGMs contain several kinds of models. The simplest one is the Bernoulli Graph Model, which assumes that the edges and binary relations are independent in all networks. Therefore, there are only edges and no other structures in a Bernoulli Graph Model. A Dyadic Model assumes that the dyadic relations in a directed network graph are all independent. If the relationship between actor A and actor B is irrelevant to the relationship between actor B and actor C, there are two structures in the model: edges and reciprocated edges (Wang et al., 2009). A reciprocated edge means that if actor A selects actor B, then actor B will also select actor A.

However, the two models above are unrealistic, both from a theoretical standpoint and from practical experience. Therefore, Markov independence was introduced by Frank and Strauss (1986); this assumes that the relationship between actor A and actor B depends on any other relationships related to A or B. Under this condition, if there is a common actor in two relationships, then the relationships should be considered as conditionally independent (Robins et al., 2007). The Markov Random Graph Model was proposed based on this Markov dependence assumption. A Markov Random Graph Model contains not only the structural parameters of edges and reciprocated edges, but also various "two-star" structural parameters (where two actors both have relationships with a third actor). The structural parameters of "two-out-star" (an actor simultaneously selects two other actors as friends) are related by expansiveness. The structural parameters of "two-in-star" (an actor is selected by two other actors simultaneously as a friend) involves popularity. The simplest Markov Random Graph Model is a two-star model, which has only edges and two-stars within its structure. Researchers subsequently noted the importance of transitivity and cyclicity, and brought further structural parameters into the Markov Random Graph Model (Newman, 2003). The expanded model contains higher star-shaped statistics such as three-star structures (where three actors all have relationships with a fourth actor).

However, this model can only fit the data in quite limited circumstances. Additionally, many studies have shown that the model will have gradual degradation problems when it is estimated and simulated. A Markov Random Graph Model was therefore not considered to be a good model for observing social networks (Pattison et al., 2007). Researchers then introduced the concept of partial conditional dependence and proposed a Realization-Dependent Model (e.g., Snijders et al., 2006). This model assumes that if there is a relationship between two actors, then it can be regarded as partially conditionally dependent. The model has three new statistics: namely, alternating k-star (k actors all have a relationship at the same time with actor $k + 1$); alternating k-triangles (two actors with a relationship build triangular relationships with k actors); and alternating independent two-paths (two independent actors build two-path relationships with multiple third party actors). The convergence of the model is effectively improved with these additions.

In summary, the Bernoulli assumption is unsuitable for real network data. Although the Markov independent assumption broadens the network structure, the model might degrade for smaller networks. Partial conditional dependence assumptions enable us to build network aggregation effects and are closer to real social networks. Consequently, the realization-dependent model has been widely applied by scholars.

The common parametric estimation methods of ERGMs are the Maximum Pseudo-Likelihood Estimation (MPLE) method and the Markov chain Monte Carlo maximum likelihood estimation (MCMC MLE) method. The MPLE method transfers the model into logit form, and then applies logistic regression techniques to conduct likelihood fit tests. The core of MCMC MLE is designed to simulate random graph distribution from a set of parameter values. It adjusts parameter values by comparing the distributions of corresponding random graphs and observed graphs, and then repeats the process until the estimated value becomes stable. Studies have shown that the MCMC MLE method works better than the MLE method, especially when the network has a strong dyadic dependence.

Statistical Analyses

Statnet's ERGM R software package was used to conduct statistical analysis. The study applied MCMC MLE to conduct parameter estimations. First, peer relationship networks in each class were built according to the measurement of peer networks (Lubbers and Snijders, 2007). They were then stored in relational data files by matrix form. To build a relationship network, each student in the class was regarded as a network actor; the connections between them formed the relationships in the network. The relationship network in each class was composed of a square matrix, in which the rows and columns were all students in the network. The elements/data in the square matrix represented whether there were connections between students. If a student nominated another student, this indicated they had a connection which was recorded as 1; otherwise, it would be recorded as 0. The square matrix was not symmetrical; that is, although A nominated B, B might not nominate A. The attribute data files for each network were then built according to demography variables. The data files were in SPSS format. A list of data corresponded to an attribute variable. Having built an attribute data file, all individual attribute variables needed to be standardized in order to compare the data. For the initial ERGM model, the effects of each attribute variable were assessed separately. Finally, the three dimensions of subjective well-being were brought into the model to build the final ERGM, and the effects of multiple attribute variables assessed simultaneously.

In order to control structure effects when inspecting attribute variables effects, the model contained both attribute variables effects and structure effects. To further explore the mode of peer relationships in the network, the study incorporated four common structure effects: namely, reciprocal structure, transitivity structure, popularity structure and expansiveness structure. With regard to attribute variables effects, in order to test Hypothesis 5 the study considered differential effects. Differential effects were based on the absolute difference in some attribute variables between individuals who had relations with each other. If the estimated result of the differential effects parameter was negative and had statistical significance, it showed that, under the invariable condition of other effects in the model, individuals with relations tended to have similarities

in their attribute variables. In order to test Hypotheses 6 and 7, the study also estimated receiver effect parameters, which were based on the interactions between attribute variables and network structures. The study also analyzed the relationship between subjective well-being and popularity structure. If there was a positive correlation between them, it indicated that an individual with high scores in SWB would be more popular.

STATISTICAL RESULTS

Model Fitting Degree

The *t-ratio* is defined as the estimate of a parameter divided by its standard error, with reference to a standard normal null distribution (Snijders, 2001), and it is often applied to balance the fitting degree of each parameter, which is calculated by taking the observed values minus the sample mean, then dividing by the standard error. **Table 2** shows the estimated *t-ratio* of each parameter in our ERGMs, which were based on the relationship networks in each class. Every parameter of the ERGM in the 15 networks was between −1 and 1, which indicates that the model built from the 15 classes was an acceptable fit that reflected the features of the network.

Structure Effects

The estimated values and standard errors of network structure effects are presented in **Table 3**. The results show the following:

(1) *Reciprocal effect*: The 15 networks all had obvious reciprocal effects, which meant individuals tended to select each other as friends.
(2) *Transitivity effect*: The transitivity parameters of the 15 relationship networks were all greater than 0.05 and had statistical significance, which meant a friend's friend tended to be a friend.
(3) *Popularity effect*: The popularity effects in most classes were not obvious, which meant the in-degree (the total number of actors selecting an individual) of individuals in the class networks had little difference. The distribution of relationships was average. Among them, the parameters of popularity effects in classes D, G, L, and M were negative and had statistical significance, which showed that the actual appearance probability of popularity structure was lower than that of a random level in the four networks.
(4) *Expansiveness effect*: All classes presented obvious negative expansiveness effects, which showed that an individual's social circle was stationary in the network; i.e., an individual would not take the initiative to make friends with people outside the circle.

Differential Effects

Absolute differential effect parameters were applied to inspect the assumption "Adolescent peers have similarities in subjective well-being." If the estimated results were negative and had statistical significance, then they supported the assumption. The estimated results of differential effect parameters for the initial model (the effects of each attribute variable were separately assessed) and the final model (the effects of multiple attribute variables were simultaneously assessed) are shown in **Table 4**. The final model shows adolescent friends had some obvious similarity tendencies in each dimension of subjective well-being.

In the initial model which only considered satisfaction with life, the differential effect parameters of eight networks A, B, E, G, H, K, L, and M were negative and had statistical significances. Among them, when considering the three dimensions of subjective well-being in the final model, the differential effects of five classes E, G, H, K, and L were negative and had statistical significances, which shows that there was a similar satisfaction with life among friends in five networks. A, B, and M did not have statistical significances in the final model, although the initial model showed a similar satisfaction with life among friends in the three networks. The observation that they did not have similarities when affected by other variables in the final model shows that individuals in the networks might not form friendships based on the similarity of satisfaction with life but on other correlated variables. The differential effects in the other seven networks were not obvious.

For positive affective dimensions, only the differential effect parameters of eight networks A, B, E, G, K, L, M, and O in the initial model were negative and had statistical significances. Among them, when simultaneously considering three dimensions of subjective well-being in the final model, the differential effects of five classes A, B, E, L, and M were also negative and had statistical significances, which showed that there were similar positive affects among friends in five networks. G, K, and O did not have statistical significances in the final model although, in the initial model, there were similar positive affective levels among friends in these three networks. The observation that they did not have similarities when affected by other variables in the final model shows that individuals in these networks might not form friendships based on the similarity of positive affects but on other correlated variables. The differential effects in the other seven networks were not significant.

For negative affective dimensions, the differential effect parameters of seven networks B, E, H, K, L, M, and N in the initial model were negative and had statistical significances. Among them, when simultaneously considering three dimensions of subjective well-being in the final model, the differential effects of all seven classes B, E, H, K, L, M, and N were also negative and had statistical significances, which shows that there were similar negative affects among friends in these seven networks. The differential effects in the other eight networks were not significant.

Receiver Effects

Receiver effects are based on the relationship between subjective well-being and the popularity of individual attribute variables. The results of receiver effects in each relationship network are shown in **Table 5**. Only life satisfaction and popularity in class D and class M had significantly positive correlations ($r = 0.39$, $p < 0.05$; $r = 0.41$, $p < 0.05$), which showed that an individual with higher satisfaction with life would be more popular.

TABLE 2 | The estimated *t-ratio* of each parameter in the exponential random graph model.

Class	Reciprocity	Popularity	Expansiveness	Transitivity	Life Satisfaction	Positive Affection	Negative Affection
Class A	0.47	0.04	−0.44	−0.11	0.08	−0.02	0.20
Class B	0.95	0.05	0.05	0.60	−0.07	−0.24	0.08
Class C	0.58	−0.18	−0.25	0.04	−0.13	−0.05	−0.24
Class D	0.18	−0.33	−0.55	−0.55	−0.21	0.02	−0.08
Class E	0.26	−0.38	−0.28	−0.30	0.11	0.02	0.10
Class F	0.54	−0.16	−0.33	−0.01	−0.38	−0.09	0.03
Class G	0.70	−0.01	−0.04	0.15	−0.33	−0.17	0.16
Class H	0.92	−0.23	−0.41	0.17	−0.20	−0.06	−0.10
Class I	0.76	−0.33	−0.65	−0.23	−0.10	−0.25	−0.19
Class J	0.98	0.00	−0.08	0.20	−0.02	0.15	0.17
Class K	0.36	−0.14	−0.49	−0.31	−0.42	−0.04	0.03
Class L	0.89	−0.16	−0.16	0.09	−0.22	−0.18	−0.17
Class M	0.45	−0.33	−0.42	−0.20	−0.03	−0.08	−0.18
Class N	1.00	−0.04	−0.25	0.33	−0.13	−0.15	−0.02
Class O	0.79	0.02	−0.13	0.09	−0.13	−0.06	−0.01

TABLE 3 | The estimated values (standard errors) of network structure effects.

Class	Reciprocity	Transitivity	Popularity	Expansiveness
Class A	4.14 (0.27)**	2.04 (0.15)**	0.02 (0.03)	−2.14 (0.19)**
Class B	4.07 (0.20)**	1.46 (0.10)**	−0.03 (0.02)	−0.67 (0.06)**
Class C	3.31 (0.24)**	1.02 (0.16)**	−0.04 (0.02)	−0.43 (0.06)**
Class D	3.73 (0.33)**	1.41 (0.14)**	−0.11 (0.06)*	−0.85 (0.13)**
Class E	3.05 (0.30)**	1.14 (0.13)**	−0.03 (0.03)	−0.47 (0.08)**
Class F	3.42 (0.30)**	1.29 (0.14)**	0.02 (0.01)	−0.76 (0.09)**
Class G	3.31 (0.28)**	1.29 (0.11)**	−0.08 (0.04)*	−0.47 (0.07)**
Class H	3.12 (0.36)**	0.78 (0.38)*	−0.24 (0.13)	−1.01 (0.26)**
Class I	3.75 (0.33)**	1.29 (0.22)**	−0.01 (0.04)	−1.18 (0.18)**
Class J	3.50 (0.31)**	1.37 (0.21)**	0.02 (0.02)	−1.31 (0.15)**
Class K	2.74 (0.25)**	1.09 (0.07)**	−0.01 (0.01)	−0.30 (0.03)**
Class L	3.13 (0.33)**	1.04 (0.17)**	−0.24 (0.08)**	−0.18 (0.08)*
Class M	2.84 (0.26)**	0.85 (0.13)**	−0.11 (0.03)**	−0.12 (0.03)**
Class N	3.56 (0.28)**	1.90 (0.18)**	−0.03 (0.05)	−1.92 (0.21)**
Class O	3.45 (0.33)**	1.42 (0.16)**	−0.00 (0.03)	−0.86 (0.13)**

*$p < 0.05$, **$p < 0.01$.

CONCLUSION AND DISCUSSION

This study examined the network features of adolescent peer relationships and then applied ERGMs to inspect the impacts of adolescent peer relationships on subjective well-being. As regards reciprocal effects, transitivity effects and expansiveness effects, the findings were in line with previous research on peer relationship networks. However, the findings on receiver effects and differential effects show interesting differences from previous studies. We discuss each of these in turn.

Reciprocal Effects

All the peer relationship networks in our study showed positive reciprocal effects. Reciprocity is the most fundamental and common behavior in human activities (Blau, 1964). It is also a significant part of friendship and plays a significant role in friends' selections (Snyder et al., 1996). Adolescents are no exception. Mutual friends have more opportunities to influence each other and form similarities between each other (Mercken et al., 2010). A reciprocal relationship also improves the quality of friendship and enhances intimacy (Hinde et al., 1985; Dishion et al., 1996). Reciprocity is a major feature of adolescent friendship (Rubin et al., 1998), and a reciprocal relationship between friends is the significant factor in adolescent peer groups (Pearson and Michell, 2000).

Transitivity Effects

All the peer relationship networks in our study showed positive transitivity effects: that is, my friend's friend might become my friend. The results confirm previous findings on adolescent friend networks (Espelage et al., 2007). The main reason why transitivity exists in a network is that the actors attempt to reduce the contradictions and uncertainties in social and cognitive situations and make efforts to establish a balance in interpersonal relationships. In a tripartite relation between friends, for instance, unbalanced relations occur when actor E likes actor R, actor R likes actor V, but actor E does not like actor V. This might cause emotional stress and uncertainty (Batjargal, 2007). Therefore, adolescents might tend to build transitive relations with other peers to establish an equilibrium in a tripartite relationship.

Expansiveness Effects

All the peer relationship networks in our study showed negative expansiveness effects. The network circles in a class are relatively stationary. The reason is because adolescence is a psychologically sensitive period and adolescents fear rejection, so they have a lower initiative to make friends. Meanwhile, in order to maintain a stable friendship and optimize groups, the individual relationship circles are often exclusive, which makes it difficult for people outside the circle to enter and leads to less volatility for each circle.

TABLE 4 | The estimated values of differential effects parameters.

Class	Life satisfaction		Positive affection		Negative affection	
	Initial	Final	Initial	Final	Initial	Final
Class A	**−0.16**	−0.12	**0.75**	**−0.15**	−0.10	−0.08
Class B	**−0.18**	−0.10	**−0.14**	**−0.13**	**−0.26**	**−0.25**
Class C	−0.09	−0.04	−0.13	−0.12	−0.06	−0.05
Class D	0.14	0.15	−0.08	−0.07	−0.02	0.10
Class E	**−0.32**	**−0.30**	**−0.18**	**−0.15**	**−0.20**	**−0.18**
Class F	−0.09	−0.10	−0.14	−0.13	−0.13	−0.12
Class G	**−0.22**	**−0.20**	**−0.18**	−0.14	−0.10	−0.08
Class H	**−0.34**	**−0.30**	−0.10	−0.03	**−0.30**	**−0.24**
Class I	−0.16	−0.14	−0.07	−0.07	0.01	0.03
Class J	0.02	0.02	−0.01	0.01	0.03	0.03
Class K	**−0.21**	**−0.15**	**−0.16**	−0.11	**−0.22**	**−0.21**
Class L	**−0.34**	**−0.26**	**−0.25**	**−0.20**	**−0.24**	**−0.24**
Class M	**−0.25**	−0.15	**−0.44**	**−0.35**	**−0.25**	**−0.17**
Class N	−0.12	−0.12	−0.10	−0.06	**−0.19**	**−0.17**
Class O	−0.12	−0.07	**−0.18**	−0.16	−0.18	−0.12

The black font indicates that the results of parameter estimations are obvious.

Leaders and Receiver Effects

The analysis of popularity effects indicates that the peer relationship networks in our study have no leaders and have no significant receiver effects. No leader emergence might be due to the fact that the adolescents surveyed in our investigation all came from urban schools and do not live in the school (as is the case with boarding schools). Learning is the main task for adolescents and they have little distractions beyond learning, which means there is little ground for the emergence and growth of adolescent leaders. Besides, the generations after 2000 have grown into adolescence in the Internet age. Social media networks expand their social horizons and enhance their cognitive levels which, to a certain extent, would obviously hinder the emergence of leaders in adolescent peer networks.

Meanwhile, whilst our study found that receiver effects were not significant, there were no correlations between popularity in the network and each dimension of subjective well-being among most friends. There might be two reasons for this. Firstly, popularity was the result of evaluation from others, while subjective well-being was self-evaluated. Secondly, subjective well-being has multiple sources, while the classroom environment is only one factor.

TABLE 5 | The estimated results of receiver effect parameters.

Class	Life satisfaction	Positive affection	Negative affection
Class A	0.08	0.07	0.06
Class B	0.18	0.20	0.11
Class C	0.26	0.22	0.29
Class D	0.39*	0.25	0.27
Class E	0.15	0.15	0.19
Class F	0.14	0.07	0.08
Class G	0.25	0.23	0.28
Class H	0.28	0.26	0.24
Class I	0.19	0.20	0.22
Class J	0.17	0.13	0.14
Class K	0.01	0.19	0.04
Class L	0.28	0.27	0.27
Class M	0.41*	0.21	0.28
Class N	0.13	0.11	0.09
Class O	0.21	0.16	0.16

*$p < 0.05$.

Differential Effects

The results of differential effects show that adolescents in partial peer networks in our study exhibit similar levels in SWB dimensions (satisfaction with life, positive affects and negative affects), which is consistent with the results of previous studies (Ryan, 2001), but not all network friends presented such similarities. The possible reasons for these mixed results are as follows.

(1) Our study overcame the lack of peer self-reports in previous studies which increases the objectivity and credibility of the results. In previous studies, participants were only required to report the attribute variables of their friends. Adolescents might overestimate the similarities among friends. In our study, all individuals in the network were required to do self-reporting so that the results would be more reliable.

(2) The structural features in this study were different from previous studies, and therefore different results are to be expected. Previous studies have been based on binary relationship structures (such as reciprocal structures) while this study was based on structural features such as transitivity, expansiveness, and popularity. These ternary or multiple structures were constituted by the interdependence of multiple dual structures which are closer to real situations and have a greater practical significance. The results therefore are more reliable and have a greater accuracy.

(3) This investigation studied the variables of peer relationships only and did not take into account other factors which could affect the conclusions (see below).

Subjective Well-being and Future Research

Studies have shown that subjective well-being among friends will lead to an effect on each other and tends to reach a similar level (Fowler and Christakis, 2008). Social Communication Theory and Similarity Theory could explain the similarities among friends. For instance, these similarity effects might be the result of social influences: that is, adolescents are affected by their friends and take on similar behaviors. But they might also be the result of social choice: that is, forming friendships based on similar attitudes and behaviors such as a similar SWB. Whether the similarities among adolescents are the result of social communication and influences or social choices needs further exploration, and future research could investigate the potential processes of SWB similarities among adolescents by longitudinal studies.

This study shows that peer networks can affect an individual's subjective well-being. The peer environment in school plays a role in the process of maintaining groups of friends. However, individual behaviors in the groups tend to promote each individual and tend to be consistent. Since similar friends gather together into smaller peer groups, so we could apply group counseling to intervene in specific groups of friends. We could also through influential individuals to intervene with other peer in the network, by which we could promote the healthy development of the individual and ultimately promote social progress.

From the methodological point of view, this study adds to the current literature on ERGMs, and also provides a platform for future research. As one of our social network analysis models, ERGMs are concerned not only with the relationship between individual and individual, but also with a more in-depth study of the dependent relationships between individuals. One advantage of an ERGM is the ability to apply a simple graphical structure to present selected local structure variables. Additionally, the selection of structure variables is quite flexible and can easily be corrected. A further advantage is that the potential statistics in an ERGM enables a more in-depth exploration of the dependent relationships between individuals compared to other network models. (Hossain et al., 2015). In future, it could be extended from binary random variables to classified relational variables or multiple relational variables. It could also be put into use in the fields of sociology, economics, and psychology and promote interdisciplinary collaboration in the study of peer relationships.

LIMITATIONS

There are some aspects of our study that need to be improved: Firstly, we did not measure other variables that could influence the results such as age, gender and social economic level. Secondly, we cannot completely exclude the possibility that the lack of a relationship between popularity and subjective well-being (the receiver effect) is related to the lack of a popularity structure effect. Thirdly, longitudinal research is needed to explore the potential changes in the similarity effect of peers' subjective well-being. The similarity effect may be the result of social influence, as adolescents can be influenced by their friends and act out similar behaviors and performance; but it may also be the result of social choice, as adolescents can select friends on the basis of similar behaviors and attitudes such as subjective well-being.

AUTHOR CONTRIBUTIONS

CJ, FC, JL, and XP developed the concepts for the study. HW collected the data. CJ, TW, JL, XP, and HW analyzed the data. CJ, JL, XP, and HW wrote the manuscript. All authors contributed to the manuscript and approved the final version of the manuscript for submission.

FUNDING

This research was supported by the Outstanding Young Faculty Award of Guangdong province: YQ2014149.

REFERENCES

Aalto-Setälä, T., Marttunen, M., Tuulio-Henriksson, A., Poikolainen, K., and Lönnqvist, J. (2002). Depressive symptoms in adolescence as predictors of early adulthood depressive disorders and maladjustment. *Am. J. Psychiatry* 159, 1235–1237. doi: 10.1176/appi.ajp.159.7.1235

Barabási, A. L., and Albert, R. (1999). Emergence of scaling in random networks. *Science* 286, 509–512. doi: 10.1126/science.286.5439.509

Barry, C. M., and Wentzel, K. R. (2006). Friend influence on prosocial behavior: the role of motivational factors and friendship characteristics. *Dev. Psychol.* 42, 153–163. doi: 10.1037/0012-1649.42.1.153

Batjargal, B. (2007). Network triads: transitivity, referral and venture capital decisions in China and Russia. *J. Int. Bus. Stud.* 38, 998–1012. doi: 10.1057/palgrave.jibs.8400302

Batool, S., and Malik, N. I. (2010). Role of attitude similarity and proximity in interpersonal attraction among friends. *Int. J. Innov. Manag. Technol.* 1, 142–146.

Blau, P. M. (1964). *Exchange and Power in Social Life*. Piscataway, NJ: Transaction Publishers.

Bradburn, N. M., and Noll, C. E. (1969). *The Structure of Psychological Well-Being*. Chicago, IL: Aldine.

Brown, B. B. (2004). Adolescents' relationships with peers. *Handb. Adolesc. Psychol.* 2, 363–394. doi: 10.1002/9780471726746.ch12

Brown, B. B., and Lohr, M. J. (1987). Peer-group affiliation and adolescent self-esteem: an integration of ego-identity and symbolic-interaction theories. *J. Pers. Soc. Psychol.* 52, 47–55. doi: 10.1037/0022-3514.52.1.47

Brughmans, T., Keay, S., and Earl, G. (2014). Introducing exponential random graph models for visibility networks. *J. Archaeol. Sci.* 49, 442–454. doi: 10.1016/j.jas.2014.05.027

Chen, S. H., and Zhou, Z. K. (2007). The influence of peer relationship on adolescents' mental health. *Hunan Norm U. J. Edu. Sci.* 6, 76–79.

Chen, Y. Y. (2006). A study on the relationship between peer relationship and happiness of middle school students. *Med. Soc.* 19, 42–43. doi: 10.3233/THC-140804

Dai, Q. Y. (2005). *The Relationship between Adolescents Friendship and Subjective Well-Being*. Master's dissertation, Chongqing: East China Normal University.

Daniel, J. R., Santos, A. J., Peceguina, I., and Vaughn, B. E. (2013). Exponential random graph models of preschool affiliative networks. *Soc. Networks* 35, 25–30. doi: 10.1016/j.socnet.2012.11.002

Demir, M., Ozdemir, M., and Weitekamp, L. A. (2007). Looking to happy tomorrows with friends: best and close friendships as they predict happiness. *J. Happiness Stud.* 8, 243–271. doi: 10.1007/s10902-006-9025-2

Demir, M., and Weitekamp, L. A. (2007). I am so happy cause today i found my friend: friendship and personality as predictors. *J. Happiness Stud.* 8, 181–211. doi: 10.1007/s10902-006-9012-7

Deutsch, A. R., Steinley, D., and Slutske, W. S. (2014). The role of gender and friends' gender on peer socialization of adolescent drinking: a prospective multilevel social network analysis. *J. Youth Adolesc.* 43, 1421–1435. doi: 10.1007/s10964-013-0048-9

Devine, D., Kempton, T., and Forehand, R. (1994). Adolescent depressed mood and young adult functioning: a longitudinal study. *J. Abnorm. Child Psychol.* 22, 629–640. doi: 10.1007/BF02168942

Devins, G. M., Beiser, M., Dion, R., Pelletier, L. G., and Edwards, R. G. (1997). Cross-cultural measurements of psychological well-being: the psychometric equivalence of cantonese, vietnamese, and laotian translations of the affect balance scale. *Am. J. Public Health* 87, 794–799. doi: 10.2105/AJPH.87.5.794

Diener, E. (1984). Subjective well-being. *Psychol. Bull.* 95, 542–575. doi: 10.1037/0033-2909.95.3.542

Diener, E. (2000). Subjective well-being: the science of happiness and a proposal for a national index. *Am. Psychol.* 55, 34–43. doi: 10.1037/0003-066X.55.1.34

Diener, E., Diener, M., and Diener, C. (1995). Factors predicting the subjective well-being of nations. *J. Pers. Soc. Psychol.* 69, 851–864. doi: 10.1037/0022-3514.69.5.851

Diener, E., Emmons, E. A., Larsen, R. J., and Griffin, S. (1985). The satisfaction with life scale. *J. Pers. Assess.* 49, 71–75. doi: 10.1207/s15327752jpa4901_13

Diener, E., Suh, E., Lucas, R. E., and Smith, H. L. (1999). Subjective well-being: three decades of progress. *Psychol. Bull.* 125, 276–302. doi: 10.1037/0033-2909.125.2.276

Dishion, T. J., Spracklen, K. M., Andrews, D. W., and Patterson, G. R. (1996). Deviancy training in male adolescent friendships. *Behav. Ther.* 27, 373–390. doi: 10.1016/S0005-7894(96)80023-2

Ennett, S. T., and Bauman, K. E. (1993). Peer group structure and adolescent cigarette smoking: a social network analysis. *J. Health Soc. Behav.* 34, 226–236. doi: 10.2307/2137204

Ennett, S. T., Bauman, K. E., Hussong, A., Faris, R., Foshee, V. A., and DuRant, R. H. (2006). The peer context of adolescent substance use: findings from social network analysis. *J. Res. Adolesc.* 16, 159–186. doi: 10.1111/j.1532-7795.2006.00127.x

Espelage, D. L., Green, H., and Wasserman, S. (2007). Statistical analysis of friendship patterns and bullying behaviors among youth. *New Dir. Child Adolesc. Dev.* 118, 61–75. doi: 10.1002/cd.201

Ferrer-i-Carbonell, A. (2005). Income and well-being: an empirical analysis of the comparison income effect. *J. Public Econ.* 89, 997–1019. doi: 10.1016/j.jpubeco.2004.06.003

Fowler, J. H., and Christakis, N. A. (2008). Dynamic spread of happiness in a large social network, longitudinal analysis over 20 years in the framingham heart study. *Brit. Med. J.* 337, 1–9. doi: 10.1136/bmj.a2338

Frank, O., and Strauss, D. (1986). Markov graphs. *J. Am. Stat. Assoc.* 81, 832–842. doi: 10.2307/2289017

Furman, W., and Buhrmester, D. (1992). Age and sex differences in perceptions of networks of personal relationships. *Child Dev.* 63, 103–115. doi: 10.1111/j.1467-8624.1992.tb03599.x

Gilman, R., and Huebner, E. S. (2006). Characteristics of adolescents who report very high life satisfaction. *J. Youth Adolesc.* 35, 293–301. doi: 10.1007/s10964-006-9036-7

Gould, R. V. (2002). The origins of status hierarchies: a formal theory and empirical Test1. *Am. J. Sociol.* 107, 1143–1178. doi: 10.1086/341744

Gutiérrez, J. L. G., Jiménez, B. M., Hernández, E. G., and Pcn, C. (2005). Personality and subjective well-being: big five correlates and demographic variables. *Pers. Indiv. Differ.* 38, 1561–1569. doi: 10.1016/j.paid.2004.09.015

Haas, S. A., Schaefer, D. R., and Kornienko, O. (2010). Health and the structure of adolescent social networks. *J. Healh Soc. Behav.* 51, 424–439. doi: 10.1177/0022146510386791

Hinde, R. A., Titmus, G., Easton, D., and Tamplin, A. (1985). Incidence of friendship and behavior toward strong associates versus non-associates in preschoolers. *Child Dev.* 56, 234–245. doi: 10.2307/1130190

Hossain, L., Hamra, J., Wigand, R. T., and Carlsson, S. (2015). Exponential random graph modeling of emergency collaboration networks. *Knowl. Based Syst.* 77, 68–79. doi: 10.1016/j.knosys.2014.12.029

Hussong, A. M. (2000). Perceived peer context and adolescent adjustment. *J. Res. Adoles.* 10, 391–415. doi: 10.1207/SJRA1004_02

Jiao, C., Wu, H. J., Huang, Y. N., Huang, F. F., and Zhang, M. Q. (2014). Application of network autocorrelation models in psychological studies: taking the impact of peer effect, learning motivation on adolescents' academic performance as examples. *Acta Psychol. Sin.* 12, 1933–1945. doi: 10.3724/sp.j.1041.2014.01933

Karademas, E. C. (2006). Self-efficacy, social support and well-being: the mediating role of optimism. *Pers. Indiv. Differ.* 40, 1281–1290. doi: 10.1016/j.paid.2005.10.019

Kiuru, N., Burk, W. J., Laursen, B., Nurmi, J., and Salmela-Aro, K. (2012). Is depression contagious? a test of alternative peer socialization mechanisms of depressive symptoms in adolescent peer networks. *J. Adolesc. Health* 50, 250–255. doi: 10.1016/j.jadohealth.2011.06.013

La Greca, A. M., and Lopez, N. (1998). Social anxiety among adolescents: linkages with peer relations and friendships. *J Abnorm. Child Psychol.* 26, 83–94. doi: 10.1023/A:1022684520514

LaFontana, K. M., and Cillessen, H. N. (2002). Children perceptions of popular and unpopular peers: a multi-method assessment. *Dev. Psychol.* 38, 635–647. doi: 10.1037/0012-1649.38.5.635

Lakon, C. M., Butts, C., Hipp, J., Jose, R., Timberlake, D., and Wang, C. (2013). A systems perspective on adolescent smoking: relationships between social network characteristics, peer influence, and adolescent smoking. *Paper Presented at the Society for Prevention Research 21st Annual Meeting*, San Francisco, CA.

Lambert, G. (2014). *Social Network Analysis of Peer Influence on Adolescent Smoking*. Doctoral dissertation, Albuquerque, NM: University of New Mexico.

Litwin, H., and Shiovitz-Ezra, S. (2010). Social network type and subjective well-being in a national sample of older americans. *Gerontologist* 51, 379–388. doi: 10.1093/geront/gnq094

Liu, J. (2004). *An Introduction to Social Network Analysis*. Beijing: Social Sciences Academic Press, 5–13.

Liu, R. G., and Gong, Y. X. (2000). The subjective well-being of the elderly and its influential factors. *Chin. J. Clin. Psychol.* 2, 73–78.

Low, S., Polanin, J. R., and Espelage, D. L. (2013). The role of social networks in physical and relational aggression among young adolescents. *J. Youth Adolesc.* 42, 1078–1089. doi: 10.1007/s10964-013-9933-5

Lubbers, M. J., and Snijders, T. A. B. (2007). A comparison of various approaches to the exponential random graph model: a reanalysis of 102 student networks in school classes. *Soc. Networks* 29, 489–507. doi: 10.1016/j.socnet.2007.03.002

Ma, S. Q., Jiao, C., and Zhang, M. Q. (2011). Application of social network analysis in psychology. *Adv. Psychol. Sci.* 5, 755–764.

Marqués, P., Arias, N., Calvo, M. D., Sánchez, A. B., Quiroga, E., and Rosa, G. (2015). Adolescents' social networks: the influence of friendship on the development of obesogenic habits. *Enfermería Glob.* 38, 263–272. doi: 10.13140/RG.2.1.4277.3923

McCullough, G., Huebner, E. S., and Laughlin, J. E. (2000). Life events, self-concept, and adolescents positive subjective well-being. *Psychol. Sch.* 37, 281–290. doi: 10.1002/(SICI)1520-6807(200005)37:3<281::AID-PITS8>3.0.CO;2-2

Mercken, L., Snijders, T. A., Steglich, C., Vartiainen, E., and De Vries, H. (2010). Dynamics of adolescent friendship networks and smoking behavior. *Soc. Networks* 32, 72–81. doi: 10.1016/j.socnet.2009.02.005

Mundt, M. P. (2011). The impact of peer social networks on adolescent alcohol use initiation. *Acad Pediatr.* 11, 414–421. doi: 10.1016/j.acap.2011.05.005

Newman, M. E. (2003). The structure and function of complex networks. *SIAM Rev.* 45, 167–256. doi: 10.1137/S003614450342480

Ou, Y. Y., Wu, M. X., Zhang, D. J., Hu, S. S., and Zhu, Y. (2009). The relationship between self-complexity and subjective well-being in college students. *Psychol. Dev. Edu.* 2, 97–102.

Pattison, P., Robins, G., Kalish, Y., and Lusher, D. (2007). An introduction to exponential random graph (p*) models for social networks. *Soc. Networks* 29, 173–191. doi: 10.1016/j.socnet.2006.08.002

Pearson, M., and Michell, L. (2000). Smoke rings, social network analysis of friendship groups, smoking and drug-taking. *Drugs Edu. Prev. Policy* 7, 21–37. doi: 10.1080/713660095

Prinstein, M. J., and Dodge, K. A. (eds) (2008). *Understanding Peer Influence in Children and Adolescents*. New York, NY: Guilford Press.

Robins, G. (2011). "Exponential random graph models for social networks," in *Handbook of Social Network Analysis*, eds J. Scott and P. Carrington (Thousand Oaks, CA: Sage).

Robins, G., Snijders, T., Wang, P., Handcock, M., and Pattison, P. (2007). Recent developments in exponential random graph (p*) models for social networks. *Soc. Networks* 29, 192–215. doi: 10.1016/j.socnet.2006.08.003

Rubin, K. H., Bukowski, W. M., and Parker, J. G. (1998). "Peer interactions, relationships, and groups," in *Handbook of Children's Psychology*, ed. N. Eisenberg (New York, NY: Wiley).

Ryan, A. M. (2001). The peer group as a context for the development of young adolescent motivation and achievement. *Child Dev.* 72, 1135–1150. doi: 10.1111/1467-8624.00338

Schaefer, D. R., Light, J. M., Fabes, R. A., Hanish, L. D., and Martin, C. L. (2010). Fundamental principles of network formation among preschool children. *Soc. Networks* 32, 61–71. doi: 10.1016/j.socnet.2009.04.003

Schimmack, U., and Diener, E. (2003). Predictive validity of explicit and implicit self-esteem for subjective well-being. *J. Res. Pers.* 37, 100–106. doi: 10.1016/S0092-6566(02)00532-9

Sijtsema, J. J., Ojanen, T., Veenstra, R., Lindenberg, S., Hawley, P. H., and Little, T. D. (2010). Forms and functions of aggression in adolescent friendship selection and influence: a longitudinal social network analysis. *Soc. Dev.* 19, 515–534. doi: 10.1111/j.1467-9507.2009.00566.x

Snijders, T. A., Pattison, P. E., Robins, G. L., and Handcock, M. S. (2006). New specifications for exponential random graph models. *Soc. Methodol.* 36, 99–153. doi: 10.1111/j.1467-9531.2006.00176.x

Snijders, T. A. B. (2001). The statistical evaluation of social network dynamics. *Soc. Methodol.* 31, 361–395. doi: 10.1111/0081-1750.00099

Snyder, J., West, L., Stockemer, V., Gibbons, S., and Almquist-Parks, L. (1996). A social learning model of peer choice in the natural environment. *J. Appl. Dev. Psychol.* 17, 215–237. doi: 10.1016/S0193-3973(96)90026-X

Strayer, F. F., and Santos, A. J. (1996). Affiliative structures in preschool peer groups. *Soc. Dev.* 5, 117–130. doi: 10.1111/j.1467-9507.1996.tb00075.x

Ulloa, B. F. L., Møller, V., and Sousa-Poza, A. (2013). How does subjective well-being evolve with age? a literature review. *J. Popul. Ageing* 6, 227–246. doi: 10.1007/s12062-013-9085-0

Van Zalk, M., Kerr, M., Branje, S., Stattin, H., and Meeus, W. (2010). It takes three: selection, influence, and de-selection processes of depression in adolescent friendship networks. *Dev. Psychol.* 46, 927–938. doi: 10.1037/a0019661

Veenhoven, R. (2013). *Conditions of Happiness*. Berlin: Springer Science and Business Media.

Voorhees, C. C., Murray, D., Welk, G., Birnbaum, A., Ribisl, K. M., Johnson, C. C., et al. (2005). The role of peer social network factors and physical activity in adolescent girls. *Am. J. Health Behav.* 29, 183–190. doi: 10.5993/AJHB.29.2.9

Wang, P., Sharpe, K., Robins, G., and Pattison, P. (2009). Exponential random graph models for affiliation networks. *Soc. Networks* 31, 12–25. doi: 10.1016/j.socnet.2008.08.002

Wang, X. D., Wang, X. L., and Ma, H. (1999). *Rating Scales for Mental Health*. Beijing: Chinese Journal of Mental Health.

Wen, X. (2011). *Study on Children Cheeper Peer Relationship Intervention*. Master's dissertation, Inner Mongolia: Inner Mongolia Normal University.

Wu, C. (2008). *Relationship between Interpersonal Relationship and Subjective Well-being of Middle School Students*. Master's dissertation, Chongqing: Southwest University.

Xia, J. L. (2007). The research of high school students interpersonal relationship and subjective well-being. *Nercous Dis. Ment. Health* 7, 40–42.

Xiong, C. Q., and Xu, Y. L. (2009). The reliability and validity of the satisfaction with life scale for Chinese people. *Chin. J. Health Psychol.* 8, 948–949.

Yang, H. B. (2008). A new perspective of the research on peer relationship influence on primary school children's academic achievement. *Psychol. Sci.* 31, 648–651.

Yue, S. H., Zhang, W., Huang, H. Q., and Li, D. P. (2006). The adolescents' subjective well-being and mental health and relationships with stress coping. *Psychol. Dev. Edu.* 3, 93–98.

Zhang, J. H., and Zhu, X. M. (2012). Relationship between peer relations and subjective well-being among rural senior middle school students. *Chin. J. Health Psychol.* 11, 1717–1719.

Zhang, L., Zheng, X., Yan, B. B., Wen, J. J., and Shi, Y. C. (2007). Researches on the relationship between interpersonal disturbances and subjective well-being in college students. *Psychol. Dev. Edu.* 2, 116–121.

Zhou, T., Wu, D., and Lin, L. (2012). On the intermediary function of coping styles: between self-concept and subjective well being of adolescents of Han, Qiang and Yi Nationalities. *Sci. Res.* 3, 136–142. doi: 10.4236/psych.2012.32021

Zhu, W., Chen, G. F., Wu, M., and Wu, X. C. (2012). Relationships among college students' attachment, core self evaluation and subjective well-being. *Mod. Prev. Med.* 39, 6204–6209.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer MI-C and handling Editor declared their shared affiliation, and the handling Editor states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2017 Jiao, Wang, Liu, Wu, Cui and Peng. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 12 April 2017
doi: 10.3389/fpsyg.2017.00540

The Impact of Inattention, Hyperactivity/Impulsivity Symptoms, and Executive Functions on Learning Behaviors of Children with ADHD

Carla Colomer[1], Carmen Berenguer[2], Belén Roselló[2,3], Inmaculada Baixauli[3] and Ana Miranda[2]*

[1] Departamento de Educación, Universidad Jaume I, Castellón, Spain, [2] Departamento de Psicología Evolutiva y de la Educación, Universidad de Valencia, Valencia, Spain, [3] Departamento de Psicología Evolutiva y de la Educación, Universidad Católica de Valencia San Vicente Mártir, Valencia, Spain

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
María Rosa Elosúa, Universidad Nacional de Educación a Distancia, Spain
Lina Marcela Cómbita Merchán, University of Granada, Spain

****Correspondence:***
Carla Colomer
colomerc@uji.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *07 December 2016*
Accepted: *24 March 2017*
Published: *12 April 2017*

Citation:
Colomer C, Berenguer C, Roselló B, Baixauli I and Miranda A (2017) The Impact of Inattention, Hyperactivity/Impulsivity Symptoms, and Executive Functions on Learning Behaviors of Children with ADHD. Front. Psychol. 8:540. doi: 10.3389/fpsyg.2017.00540

Children diagnosed with attention deficit/hyperactivity disorder (ADHD) are at risk of experiencing lower academic achievement compared to their peers without ADHD. However, we have a limited understanding of the mechanisms underlying this association. Both the symptoms of the disorder and the executive functions can negatively influence learning behaviors, including motivation, attitude toward learning, or persistence, key aspects of the learning process. The first objective of this study was to compare different components of learning behaviors in children diagnosed with ADHD and typically developing (TD) children. The second objective was to analyze the relationships among learning behaviors, executive functioning, and symptoms of hyperactivity/impulsivity in both groups. Participants were 35 children diagnosed with ADHD and 37 with TD (7–11 years old), matched on age and IQ. The teachers filled out the Behavior Rating Inventory of Executive Function (BRIEF) and the Learning Behaviors Scale, which evaluates Competence/motivation, Attitude toward learning, Attention/persistence, and Strategy/flexibility. In addition, parents and teachers filled out the DSM-5 diagnostic criteria for ADHD. ANOVAs showed significant differences between children with ADHD and TD children on all the learning behaviors. Moreover, in both the ADHD and TD groups, the behavioral regulation index of the BRIEF predicted the search for strategies, and the metacognition index was a good predictor of motivation. However, attitude toward learning was predicted by metacognition only in the group with ADHD. Therefore, the executive functions had greater power than the typical symptoms of inattention and hyperactivity/impulsivity in predicting learning behaviors of children with ADHD. The findings are in line with other studies that support the influence of the executive functions on performance, highlighting the importance of including their development as a top priority from early ages in the school setting in order to strengthen learning behaviors.

Keywords: ADHD, Executive functions, inattention, hyperactivity, learning behaviors, school

INTRODUCTION

Children diagnosed with attention deficit hyperactivity disorder (ADHD) are at risk of school failure. Specifically, ADHD is associated with poor grades, grade retention, and low academic achievement, compared to their peers without ADHD (Loe and Feldman, 2007). In a recent study (Fried et al., 2016), participants with ADHD were significantly more likely to have repeated a grade or dropped out of high school, compared to participants without ADHD, even after adjusting for social status, IQ, and learning disabilities. Whereas there is a large amount of research on ADHD and academic achievement, there is a need for a greater focus on modifiable factors that may contribute to academic success.

The causes of good or poor academic achievement are multifactorial. Academic competence is a multidimensional construct comprised of academic skills and academic enablers (attitudes and behaviors) that facilitate school success (DiPerna and Elliott, 2002). This means that observable and modifiable learning behaviors related to motivation, positive attitudes toward learning, the ability to maintain attention, flexibility in problem solving, and persistence on academic tasks play an important role in academic achievement. These characteristics that facilitate academic success are referred to by Stott et al. (1988) as "approaches toward learning" or "learning behaviors", and by DiPerna and Elliott (2002) as some of the "academic enablers". Specifically, McDermott et al. (2016, p. 60) states that "define the effortful and goal-directed means by which children go about classroom learning processes, as distinguished from the cognitive skills and socio-behavioral adaptations that might emerge from those learning processes".

The importance of these behaviors has been shown in the research carried out with children from the general population. Several studies demonstrate the link between learning behaviors and academic readiness (Fantuzzo et al., 2007; Vitiello et al., 2011), success in reading (Jenkins and Demaray, 2015), and the prediction of eventual good classroom adjustment, school attendance, and future socio-behavioral adjustment (Sasser et al., 2015; McDermott et al., 2016), or as a protective factor mitigating the negative effect of lower levels of classroom quality on dictation/spelling (Meng, 2015). In fact, these learning behaviors have also been found to predict achievement beyond intelligence (Yen et al., 2004).

Although less numerous, other studies have focused on symptoms of different disorders, especially behavioral problems or learning disabilities. The most significant conclusions stemming from this line of research indicate that behavioral problems predict approaches to learning (Domínguez et al., 2011) and mediate in the relationship between early behavior problems and future academic achievement (Domínguez and Greenfield, 2009). In addition, higher competence motivation may especially lead to reducing the risk of learning disabilities in elementary and secondary education (McDermott et al., 2006).

Most of the research conducted in children with a clinical diagnosis of ADHD has focused on academic achievement, but learning behaviors have not yet been comprehensively studied and understood in this group. However, some studies have used variables that, although not referred to as learning behaviors or enablers, are related to them or form part of them. For example, when comparing children with and without ADHD, children with ADHD demonstrated lower levels of motivation and lower levels of task persistence (Hoza et al., 2001; Carlson et al., 2002). These differences exist in children with high levels of inattention, hyperactivity and impulsivity symptomatology, assessed through the Academic Competence Evaluation Scales (ACES), which measure academic enablers (Demaray and Jenkins, 2011). Given the importance of learning behaviors in competences related to school and general development, it would be essential to understand the explanatory role played by ADHD symptoms and executive functions (EF) in this domain.

Attention and hyperactivity/impulsivity symptoms are negatively related to academic achievement in community and clinical samples, even after controlling for intelligence, comorbidity, and socioeconomic status (Polderman et al., 2010). In children with ADHD, academic impairment is related primarily to inattention symptoms (Langberg et al., 2013; Plamondon and Martinussen, 2015). Furthermore, high levels of hyperactive–impulsive symptoms in childhood have been associated with school dropout and fewer years of attained education (Fredriksen et al., 2014), indicating an increased risk of unfavorable educational outcomes related to these symptoms in childhood. More specifically, the few studies investigating the relationship between ADHD symptoms and learning behaviors show a significant relationship between high levels of inattention, hyperactivity and impulsivity, and lower competence motivation, attention/persistence (Fantuzzo et al., 2005), and academic enabler levels (Volpe et al., 2006; Demaray and Jenkins, 2011). Nonetheless, it is important to highlight that the direction of these relationships is not clear, as one study suggested that learning behavior problems can signal later attention-deficit hyperactivity (McDermott et al., 2016).

Difficulties in learning behaviors could also be a manifestation of deficits in *executive function*s, which are defined as a set of higher order, self-regulatory, cognitive processes required to direct behavior toward the attainment of a goal (Barkley, 1997). Prior research has found that EF are fundamental to individuals' academic achievement in the general population (Blair and Diamond, 2008; Sasser et al., 2015) and in children with ADHD (Biederman et al., 2004; Miranda et al., 2012; Langberg et al., 2013). EF could be one of the cognitive regulatory processes that underlie and facilitate learning-related behaviors in the classroom, predicting teacher ratings of learning-related behaviors in kindergarteners and elementary school children (Brock et al., 2009; Neuenschwander et al., 2012). Specifically, Brock et al. (2009) found that cool EF predicted learning-related classroom behaviors in kindergarteners. Along these lines, Vitiello et al. (2011) reported that cognitive flexibility is related to the ability to pay attention and persist in the classroom in preschool children at risk of school failure. Miller et al. (2006) also found an association between observed classroom emotion dysregulation and teacher-rated school adjustment, particularly with motivation. In this context, studies with ADHD samples are needed because EF may have a strong impact on academic variables.

Finally, few studies have analyzed the combined influence of EF and ADHD symptoms on academic variables. Langberg et al. (2013) evaluated the relationship between EF ratings on the Behavior Rating Inventory of Executive Function (BRIEF) and academic functioning, above and beyond the ADHD symptoms in adolescents with ADHD. They developed different prediction models that included combinations of EF and ADHD symptoms depending on the variable to predict (school grades, or homework problems). One of the most complete models was related to the prediction of homework problems, and it included symptoms of inattention and hyperactivity/impulsivity, as well as the EF of planning and organization. However, as mentioned above, only symptoms of inattention and the ability to plan ahead and organize time and materials consistently predicted academic outcomes.

In summary, prior research on learning behaviors has mainly employed community samples. Some studies have been developed in the context of the Head Start program for preschoolers from low-income families (McDermott et al., 2011). As learning behaviors are often associated with higher levels of academic and social achievement, it is important to analyze the similarities and differences observed in children with ADHD compared to TD children. Taking a step forward, it is important to identify the factors that can influence learning behaviors, and determine whether the relationships established among them are different in children with ADHD and TD children, due to the limited existing research on this topic.

The first objective of this study was to compare different components of learning behaviors in children with ADHD and TD children. Our hypothesis is that children with ADHD will have lower scores on learning behaviors than TD children, as occurs with academic achievement. The second objective was to analyze the relationships among learning behaviors, EF, and symptoms of inattention and hyperactivity/impulsivity in both groups and identify which aspects of EF and/or ADHD symptoms have greater relevance in predicting different indicators of learning behaviors in children with ADHD and TD children: Competence Motivation, Attitude Toward Learning Attention/Persistence, and Strategy/Flexibility. Based on theoretical arguments and empirical findings, our hypothesis is that ADHD symptoms, and especially inattention, will be related to learning behaviors in both groups, whereas EF will be more related to learning behaviors in the ADHD group because of their strong influence on the disorder. The results can be relevant in helping students with and without ADHD to achieve academic success, and lead to more effective, targeted intervention strategies.

MATERIALS AND METHODS

Participants

Seventy-two children participated in this study, 35 with a clinical diagnosis of ADHD and 37 TD children, all between the ages of 7 and 11.

Children with ADHD had a previous clinical diagnosis of ADHD by mental health services that was confirmed before their participation in the study: all of them met the strict diagnostic criteria for ADHD from the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), based on information from parents and teachers. Specifically, 77.14% of the participants had an ADHD combined presentation, and 22.86% had an ADHD inattentive presentation. Moreover, 71.4% of the children in the ADHD sample were receiving psychostimulant medication.

Typically developing children were attending school in regular classrooms in the same schools as the clinical sample in the research. They had no history of psychopathology or referral to children's mental health units, according to the information from school records, and they did not meet the DSM-5 criteria for ADHD before beginning the evaluation. The exclusion criteria for all the participants were: an overall IQ below 80, measured with the K-BIT (Kaufman and Kaufman, 2000); neurological or sensorial damage, psychosis, visual, auditory, motor, or sensorial deficits; or autism spectrum disorder, evaluated through an extensive prior anamnesis carried out with the families.

Table 1 shows the socio-demographic characteristics of the participants and their families. Both groups were matched on age [$t(70) = 1.90$, $p = 0.062$], IQ [$t(70) = -1.24$, $p = 0.218$] and level of semantic language [$t(70) = -1.49$, $p = 0.140$], assessed with the vocabulary subtest of the WISC-IV (Wechsler, 2003). There were statistically significant differences in their symptoms of inattention and hyperactivity/impulsivity, according to parents' and teachers' ratings of DSM-5 criteria (severity of each item from 0 to 3). In addition, 91.42% of the individuals with ADHD and 64.86% of the individuals with TD were male. Regarding the school modality, all children in the TD group were attending school in regular classrooms full time, whereas 94.3% of the children with ADHD attended regular classrooms but received educational support for their specific needs in the school. Regarding the family's socio-cultural status, there were differences between the two groups in the parents' education level [$t(70) = -5.39$, $p < 0.001$]. Specifically, the parents of the children in the ADHD sample had significantly less education than the parents of the children in the TD group.

Procedure

This study respected the principles outlined in the current legislation on clinical investigation, and it was approved by the Research Ethics Committee of the University of Valencia, which is regulated by Ethical Principles for Medical Research Involving Human Subjects (Declaration of Helsinki 1964, World Medical Association, 2013).

The official and written authorization of the Board of Education and School Management (Consellería de Educación de la Generalitat Valenciana) was obtained to locate children who had received a previous diagnosis of ADHD by professionals in specialized childhood mental health services. A total of 42 schools from the Valencian Community participated in a larger research about neurodevelopmental disorders that included the sample in this study.

Oral permission from the children and written informed consent from their parents and schools were obtained before beginning the evaluation. The intelligence test was administered

TABLE 1 | Descriptive characteristics of children and families.

	Attention deficit/hyperactivity disorder (ADHD) ($n = 35$)		Typically developing (TD) ($n = 37$)		Statistic	
Continuous Measures	***M***	***SD***	***M***	***SD***	***t/F***	***p***
Age	9.14	1.42	8.54	1.26	1.90	0.062
IQ	99.03	9.87	101.70	8.36	−1.24	0.218
Vocabulary	29.74	8.24	32.86	9.43	−1.49	0.140
DSM-Ina (Parent r)	21.29	3.37	3.72	2.76	579.02	0.000
DSM-H/I (Parent r)	16.11	4.46	3.61	3.17	185.83	0.000
DSM-Ina (Teacher r)	20.03	4.90	3.22	3.81	260.99	0.000
DSM-H/I (Teacher r)	15.43	6.80	2.31	2.71	115.22	0.000
Parental education	1.77	1.26	3.27	1.10	5.39	0.000
Ordinal Measures	***N***	**%**	***N***	**%**	$\chi^2_{(N=72)}$	***p***
Male	32	91.42	24	64.86	7.34	0.007
Repeat grade	4	11.41	0	0	4.48	0.034
Educational support	33	94.30	0	0	63.42	0.000

Parental education measured as highest level of mother or father (0 = elementary school, 1 = Compulsory secondary school, 2 = Medium level vocational training, 3 = Upper secondary education (Bachiller) or Superior level vocational training, 4 = University degree).

to all the children individually by doctoral-level psychologists or highly trained psychologists in suitable classrooms in the different schools. Teachers and parents filled out questionnaires on ADHD criteria from the DSM-5, and teachers-tutors filled out the questionnaires selected to assess EF and learning behaviors.

Measures

Learning Behaviors

The Learning Behaviors Scale (McDermott et al., 2001) is a teacher-report questionnaire designed to measure student behaviors related to effective and efficient learning. The Learning Behaviors Scale contains 29 items, six items with positive wording and the remaining items with relatively negative wording in order to reduce response sets. Items are rated on a 3-point Likert scale (0 = Does not apply, 1 = Sometimes applies, 2 = Most often applies). High scores indicate good learning behavior, and low scores are interpreted as faulty learning behavior. Based on the manual, 25 of the 29 items were used to produce a Total score and four subscales: Competence Motivation ("Says task is too hard without making much effort to attempt it"), Attitude Toward Learning ("Shows a lively interest in learning activities"), Attention/Persistence ("Sticks to a task with no more than minor distractions"), and Strategy/Flexibility ("Follows peculiar and inflexible procedures in tackling tasks"). Total and subscale raw scores are converted to normalized T scores ($M = 50$, $SD = 10$). In our sample the internal consistency coefficient is high for the total score ($\alpha = 0.93$) and for the subscales ($\alpha = 0.76$–0.86). Moreover, studies present supportive psychometric evidence for the Learning behaviors scale scores in different contexts (McDermott, 1999; Canivez and Beran, 2011).

ADHD Symptoms

Parents and teachers provided information about the 18 ADHD criteria from the DSM-5, rating the severity of each item from 0 to 3. A score of 2 or 3 on an item was regarded as presence of the symptom. The means of the items assessed by parents and teachers were included in the analyses.

Executive Functions

The Behavior Rating Inventory of Executive Function (BRIEF, Gioia et al., 2000). The teacher version of the BRIEF was used in this study to assess the children's EF through the observation of their behavior in the school context. It consists of 86 items rated on a Likert-type scale with three levels (never, sometimes, often). The items are grouped in two indexes: The Behavioral Regulation Index is composed of the following scales: Inhibit, Shift, and Emotional Control scales, assessing the child's capacity to make cognitive changes and adjust his/her emotions and behavior through appropriate inhibitory control. The Metacognition Index is composed of the scales of Initiation, Working Memory, Planning/Organization, Organization of Materials, and Monitor. This index reflects the child's ability to initiate, plan, organize, self-monitor, and maintain information in working memory. It could be interpreted as the ability to self-manage cognitive tasks and supervise their performance. This index is related to the capacity to actively solve problems in a variety of contexts. Direct scores can be transformed into T-scores, with higher scores indicating worse EF. In our sample the internal consistency coefficient is high for the total score ($\alpha = 0.98$), for the indices ($\alpha = 0.96$–0.97) and for the subscales ($\alpha = 0.78$–0.94).The instrument has good psychometric properties in Spanish samples (García Fernández et al., 2014).

Statistical Analyses

Data analysis was conducted with the Statistical Package for the Social Sciences (SPSS), version 23. To compare the ADHD and TD learning behaviors, Multivariate Analysis of Covariance (MANCOVA) was used. The parents' educational level and children's gender were included as covariates, as research suggests that girls have higher approaches to learning than boys (Vitiello

et al., 2011). The proportion of total variance accounted for by the independent variables was calculated using partial eta squared (according to Cohen (1988): eta squared, 0.06 = small; 0.06–0.14 = medium, 0.14 = large).

Partial correlations, controlling for parents' educational levels and children's gender, were conducted to examine relationships among EF, ADHD symptomatology, and learning behavior dimensions. Finally, four multiple linear regression analyses were conducted to test the effect of the two EF indices (Behavioral regulation and Metacognition) and the DSM-5 inattention and hyperactivity/impulsivity scores (independent variables – simultaneously entered) on the four learning behavior dimensions (dependent variables).

RESULTS

Differences in Learning Behaviors of Children Diagnosed with ADHD and TD

According to teachers' ratings, 54.3% of the children diagnosed with ADHD exhibited learning behavior problems ($T < 35$), whereas none of the TD children presented these problems.

The two groups were compared on their learning behaviors, using parental education and children's gender as covariates. The results of the first MANCOVA showed a statistically significant difference between the two groups on learning behaviors (Wilks Lambda = 0.54, $F_{5,64} = 10.81$, $p < 0.001$, $\eta_p^2 = 0.458$). The differences were statistically significant on all the subscales: Competence Motivation ($F_{1,68} = 31.62$; $p < 0.001$; $\eta_p^2 = 0.317$), Attitude Toward Learning ($F_{1,68} = 28.39$; $p < 0.001$; $\eta_p^2 = 0.295$), Attention/Persistence ($F_{1,68} = 37.68$; $p < 0.001$; $\eta_p^2 = 0.357$), Strategy/Flexibility ($F_{1,68} = 29.39$; $p < 0.001$; $\eta_p^2 = 0.302$), and Total Score ($F_{1,68} = 35.82$; $p < 0.001$; $\eta_p^2 = 0.345$). In all cases, the ADHD group presented significantly higher scores than the TD group (**Table 2**).

Relationships Among EF, Inattention, Hyperactivity/Impulsivity, and Learning Behaviors in ADHD and TD Groups

Table 3 presents the correlations among EF, ADHD symptoms, and learning behaviors in children with ADHD and children with TD. In the TD group, correlation analyses showed that both EF indexes and the inattention symptoms were significantly correlated with all the learning behaviors ($p < 0.05$), and correlations were moderate to large in magnitude, ranging from $r = -0.400$ to $r = -0.799$. However, in this group, hyperactivity/impulsivity symptoms presented significantly low correlations only with Competence/motivation, Strategy/Flexibility, and the Total Score.

In the ADHD group, both EF indexes were significantly correlated with Attitude toward learning, Strategy/flexibility, and the Total score, with moderate correlations ranging from $r = -0.427$ to $r = -0.677$. The Metacognition index additionally presented a moderate to high correlation with Competence/motivation ($r = -0.664$). Inattention symptoms presented significant correlations with all the learning behaviors, except Strategy/Flexibility ($r = -0.428$ to $r = -0.518$), whereas the Hyperactivity/impulsivity symptoms were significantly correlated with Attention/persistence ($r = -0.353$).

Predictors of Learning Behaviors in ADHD and TD groups

Four separate multiple regressions for each group were conducted to study whether EF and ADHD symptoms are differentially related to learning behaviors (Competence/Motivation, Attitude Toward Learning, Attention/Persistence and Strategy/Flexibility) in the ADHD and TD groups. All the regressions models were significant (See **Table 4**).

The regressions conducted with the ADHD group indicated that the Metacognition index was a significant individual predictor of Competence/motivation ($\beta = -0.66$, $t = -3.76$, $p = 0.001$) and Attitude Toward Learning ($\beta = -0.46$, $t = -2.46$, $p = 0.020$). All the predictors collectively explained 50 and 44% of the variance of Competence/ motivation and Attitude Toward Learning, respectively. The Behavioral regulation index was an individual predictor ($\beta = -0.42$, $t = -2.30$, $p = 0.029$) of Strategy/Flexibility, with 44% of the variance explained by all the predictor variables. There was no unique individual predictor of Attention/Persistence, but collectively, EF and ADHD symptoms, explained 27% of its variance.

Regarding the TD group analyses, Inattention was a significant individual predictor of Attitude Toward Learning ($\beta = -0.61$, $t = -3.63$, $p = 0.001$) and Attention/Persistence ($\beta = -0.46$, $t = -2.44$, $p = 0.020$). All the predictors collectively explained 51 and 40% of their variance, respectively. Inattention ($\beta = -0.56$, $t = -4.77$, $p < 0.001$) and the Metacognition index ($\beta = -0.48$, $t = -3.93$, $p < 0.001$) were significant predictors of Competence/Motivation and, along with the other predictor variables, explained 77% of its variance. Finally, the Behavioral regulation index ($\beta = -0.61$, $t = -3.64$, $p = 0.001$) was the only significant predictor of Strategy/Flexibility, with 44% of the variance explained by all the predictor variables.

DISCUSSION

This study examined learning behaviors in children diagnosed with ADHD. To date, research related to school failure has primarily focused on academic achievement using mainly standardized test scores or school grades. However, this study expands on previous work demonstrating that children with ADHD have poorer learning behaviors than TD children. The results of our first objective showed differences between the two groups in all the learning behaviors measured, even after controlling for gender and parents' education. Thus, children with ADHD had less competence motivation, that is, less tendency to engage in challenging tasks or work independently at tasks; less attention/persistence, that is, less ability to focus on tasks, resist distractions, and persist appropriately; less attitude toward learning, that is, less ability to tolerate frustration, cooperate, and accept help when needed; and less strategy/flexibility, for example, by following peculiar and inflexible procedures in tackling tasks.

TABLE 2 | Comparisons of learning behaviors in ADHD and TD.

	ADHD ($n = 35$)		TD ($n = 37$)		Statistic	
Learning behaviors	***M***	***SD***	***M***	***SD***	$F_{(1,68)}$	η_p^2
Competence Motivation	35.91	10.47	53.11	9.75	31.62*	0.317
Attitude Toward Learning	36.09	10.60	50.57	7.87	28.39*	0.295
Attention/Persistence	29.89	14.24	52.13	8.30	37.68*	0.357
Strategy/Flexibility	32.09	13.04	50.43	8.13	29.39*	0.302
Total Score	30.51	13.72	51.84	8.77	35.82*	0.345

*$p < 0.001$.

TABLE 3 | Partial Correlations between executive functions (EF), ADHD symptoms, and learning behaviors in ADHD and TD groups.

		Competence motivation	Attitude toward learning	Attention/ persistence	Strategy/ flexibility	Total score
TD	BRI	−0.400*	−0.471**	−0.416*	−0.747**	−0.676**
	MI	−0.776**	−0.647**	−0.652**	−0.552**	−0.799**
	Inatt.	−0.798**	−0.660**	−0.541**	−0.402*	−0.717*
	H/I	−0.340*	−0.206	0.117	−0.410*	−0.382*
ADHD	BRI	−0.180	−0.427*	−0.272	−0.606**	−0.618**
	MI	−0.664**	−0.575**	−0.322	−0.543**	−0.677**
	Inatt.	−0.518**	−0.458*	−0.436*	−0.268	−0.428*
	H/I	−0.106	−0.229	−0.353*	−0.321	−0.313

*$p < 0.05$, **$p < 0.01$. *Controlling for parental education and gender. BRI, Behavioral Regulation Index; MI, Metacognition Index; Inatt, Inattention symptoms; H/I, Hyperactivity/Impulsivity symptoms.*

TABLE 4 | Multiple regression analysis of EF and ADHD symptoms predicting learning behaviors in ADHD and TD groups.

	ADHD group				TD group			
	B	***SE***	β	***t***	***B***	***SE***	β	***T***
Comp. Motivation		$F(4,30) = 7.48^{**}$; $R^2 = 0.50$				$F(4,32) = 26.25^{**}$; $R^2 = 0.77$		
BRI	0.18	0.14	0.22	1.24	0.17	0.18	0.11	0.91
MI	−0.60	0.16	−0.66	−3.76*	−0.72	0.18	−0.48	−3.93**
Inattention	−0.33	0.22	−0.21	−1.46	−1.08	0.23	−0.56	−4.77**
H/I	−0.16	0.16	−0.15	−1.01	−0.07	0.24	−0.03	−0.30
Attitude TL		$F(4,30) = 5.79^{*}$; $R^2 = 0.44$				$F(4,32) = 8.35^{**}$; $R^2 = 0.51$		
BRI	−0.13	0.15	−0.16	−0.85	−0.34	0.22	−0.27	−1.56
MI	−0.42	0.17	−0.46	−2.46*	−0.12	0.21	−0.10	−1.56
Inattention	−0.30	0.24	−0.20	−1.26	−0.96	0.26	−0.61	−3.63*
H/I	−0.04	0.17	−0.04	−0.25	0.53	0.28	0.31	1.90
Att./Persistence		$F(4,30) = 2.78^{*}$; $R^2 = 0.27$				$F(4,32) = 5.30^{*}$; $R^2 = 0.40$		
BRI	−0.06	0.24	−0.05	−0.25	−0.28	0.25	−0.21	−1.10
MI	−0.25	0.26	−0.20	−0.96	−0.25	0.25	−0.20	−1.00
Inattention	−0.61	0.37	−0.29	−1.65	−0.75	0.31	−0.46	−2.44*
H/I	−0.33	0.26	−0.23	−1.28	0.55	0.33	0.31	1.69
Strategy/Flex.		$F(4,30) = 5.96^{*}$; $R^2 = 0.44$				$F(4,32) = 9.03^{**}$; $R^2 = 0.47$		
BRI	−0.43	0.19	−0.42	−2.30*	−0.80	0.22	−0.61	−3.64*
MI	−0.28	0.21	−0.25	−1.34	−0.14	0.22	−0.11	−0.65
Inattention	−0.18	0.29	−0.09	−0.60	−0.19	0.27	−0.12	−0.70
H/I	−0.17	0.21	−0.13	−0.84	0.03	0.28	0.02	0.10

*$p < 0.001$; **$p < 0.005$. *MI, Metacognition Index; BRI, Behavioral Regulation Index; H/I, Hyperactivity/Impulsivity.*

Our results are similar to other studies that compared motivation and task persistence or academic enablers in children with ADHD and TD, finding lower performance in children with ADHD (Hoza et al., 2001; Carlson et al., 2002; Demaray and Jenkins, 2011). Moreover, the motivation deficits are in line with explanatory models of ADHD that point to disturbances in motivational processes, involving frontoventral striatal reward circuits and mesolimbic branches (Sonuga-Barke, 2005), and structural and functional neuroimaging studies that suggest dysfunctions in motivational neural networks and systems that mediate the control of cognition and motivation (Cubillo et al., 2012).

These findings highlight the importance of examining a range of indicators that can be related to poor learning behaviors. Consequently, the second objective of this study was to examine the relationships between ratings of EF and ADHD symptoms and learning behaviors. Correlation analyses revealed significant moderate to large correlations between most of the learning behaviors and both EF and ADHD symptoms, although the patterns of these relationships were slightly different in the TD group and the ADHD group. In the TD group, all the learning behaviors presented a negative correlation with the metacognition index, the behavioral regulation index, and inattention symptoms, whereas hyperactivity/impulsivity symptoms presented lower correlations that were only significant with Competence/motivation and Strategy/flexibility. The ADHD group presented a less uniform pattern: Attention/persistence significantly correlated with ADHD symptoms (inattention and hyperactivity/impulsivity); Strategy/flexibility significantly correlated with EF indicators and Competence/motivation; and Attitude toward learning mainly correlated with inattention and the metacognition index. Consistent with previous research conducted on achievement (Papaioannou et al., 2016), results demonstrated a close link between EFs, inattention symptoms, and learning behaviors. Inattention symptoms were more related to learning behaviors than hyperactivity symptoms were in both groups, supporting the results of other studies on academic impairments (Langberg et al., 2013). Moreover, our results confirmed the high correlation between motivation and inattention ($r = -0.80$), with a similar value found in previous research (Volpe et al., 2006; Plamondon and Martinussen, 2015).

To further explore the relations among the constructs, we conducted multiple regressions to determine whether deficits in learning behaviors are mainly driven by EF or by the effects of the ADHD symptoms. The results showed some similarities between children with ADHD and TD children. The model with the highest percentage of explained variance in both cases was Competence/Motivation, so that EF and ADHD symptoms are the best predictors of engagement on learning tasks, even reaching 77% in the case of the TD group. Behavioral regulation, defined as the capacity to make cognitive changes and adjust emotions and behaviors through appropriate inhibitory control, has an important weight in the flexible use of strategies, that is, the capacity to modify task execution procedures in both children with ADHD and TD children. However, the models also present some differences between the groups. In the ADHD group, metacognition (which encompasses the EF of initiation, working memory, planning/organization, organization of materials, and monitor), was the only significant predictor of Competence/motivation and Attitudes toward learning, whereas in the TD group, inattention was the main predictor of Competence/motivation, Attitude toward learning and Attention/Persistence, suggesting that attention plays an important role in the learning behaviors of children without ADHD.

One aspect that should be highlighted is that EF deficits, which are frequently related to ADHD (Barkley, 1997), appear to play a role in the learning behaviors of children with ADHD, predicting them beyond the typical symptoms of inattention and hyperactivity/impulsivity, whereas inattentive symptoms (alone or with EF) were the main predictor of most of the learning behaviors in the TD group. There are similarities between our study using learning behaviors and other studies using other academic functioning outcomes. Langberg et al. (2013) found that, among different facets of executive functions and ADHD symptoms, inattention symptoms and two main subscales of the Metacognition index (Organization of materials and Planning organization), rated by both parents and teachers, were the main predictors of school grades and homework problems. As in our results, it seems that the metacognition index plays a more important role than the behavioral regulation index in academic-related areas. Moreover, Langberg et al. (2013) found a greater relationship between inattention symptoms and academic outcomes. There can be various reasons for this. First, their main objective was to evaluate associations between EF and multiple academic outcomes, using ADHD symptoms to determine whether their predictions are verified above and beyond the role of these symptoms. For this reason, their regression method was different from ours. Langberg et al. (2013) controlled for the ADHD symptoms in the first block of the hierarchical regression, whereas in our analyses all the predictor variables were simultaneously introduced (however, main results do not change using their methodology). The differences can also be due to the ages of the participants in the two studies (children and adolescents), as well as the use of performance tasks instead of learning behaviors, where EF may be more influential.

Moreover, there seems to be a unique contribution of specific aspects of EF in predicting different learning behaviors, with behavioral regulation being more related to Strategy/Flexibility and metacognition being more related to Competence/motivation and Attitudes toward learning. Our results suggest that EF may be involved in selecting and activating positive, appropriate approaches to learning (Vitiello et al., 2011), so that a child with strong EF (especially related to metacognition) may be better able to select and activate motivated responses to a specific learning situation, such as voluntarily engaging in an activity that was previously found to be challenging.

Implications

According to our results, children with ADHD present poor learning behaviors, which are modifiable risk factors that have been consistently associated with educational deficits in the

general population. The first practical implication of our results refers to the importance of early identification of learning behaviors within the classroom context. These variables can be assessed with rating scales or direct observations that will help to identify a student's strengths and weaknesses. Specific evaluations may be useful in providing insight into where to focus additional support or in recommending learning-related interventions. As learning behaviors are potentially teachable through modeling or programmed instruction (McDermott et al., 2016), a key factor for children with ADHD would be to strengthen the way they engage in learning and their enthusiasm for learning. Some effective teaching practices that promote learning behaviors use modeling to foster positive learning attitudes and behaviors by elaborating and expanding children's ideas and actions, praising children's effort, or scaffolding learning (Hyson, 2008). According to DiPerna (2006), many different intervention strategies can be employed to promote the development of the academic enablers, including modeling, coaching, behavioral rehearsal, and reinforcement.

This study also provides evidence that EF strongly predicts learning behaviors of elementary school children with ADHD and TD children, suggesting that professionals attempting to improve learning behaviors should also focus on children's EF and inattention symptoms. It is important to consider programs that focus on developing strategies to improve real world aspects of EF or school-based interventions that target executive function to improve academic achievement (Jacob and Parkinson, 2015). Moreover, motivation has a direct connection with persistence on learning goals. Even though more research is needed on programs designed to set realistic learning goals and self-monitoring their achievement, executive processes should be taught and scaffolded in programs that put students in charge of their own motivation.

Limitations and Future Directions

The current study has a number of limitations that need to be addressed. First, the small sample size may have limited the power of the analyses, hiding some possible effects that may have been evident with a larger sample and more complex statistical analyses. Moreover, most of the ADHD participants were male, so studies with female participants should be conducted. Second, EF have been defined broadly; in the future, a more specific approach using tasks related to single constructs, such as inhibition and working memory, should be used. Furthermore, this study used teacher ratings of EF, and future studies should be conducted using neuropsychological measures. Fourth, there may be a degree of overlap between ratings of EF, and ratings of ADHD symptoms and learning behaviors; therefore, the relationships with more direct assessments of these skills should be examined in future studies. Fifth, other factors that may influence learning behaviors can be behavioral problems, social relationships, or more contextual factors such as teaching styles. Future studies should include these factors in order to better understand learning behaviors in children with ADHD. Lastly, the relationships among ratings of EF, ADHD symptoms, and learning behaviors may change throughout development. Longitudinal studies are needed to address the importance of these relationships over time because approaches to learning develop as the grade level increases in ways that are consistent with school socialization effects (Chen et al., 2011).

AUTHOR CONTRIBUTIONS

CC, CB, BR, IB, and AA each made substantial contributions to the conception or design of the work, or the acquisition, analysis, or interpretation of data for the work, drafting the work or revising it critically for important intellectual content, final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FUNDING

This work is supported by the Spanish State Research Agency (Agencia Española de Investigación, AEI) and the European Regional Development Fund (Fondo Europeo de Desarrollo Regional, FEDER) through the Project PSI2016-78109 (AEI/FEDER, UE) and by the University of Valencia (UV-INV-PREDOC15-265889).

REFERENCES

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders*. Washinton, DC: American Psychiatric Association. doi: 10.1176/appi.books.9780890425596

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: constructing a unifying theory of ADHD. *Psychol. Bull.* 121, 65–94. doi: 10.1037/0033-2909.121.1.65

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., et al. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *J. Consult. Clin. Psychol.* 72, 757–766. doi: 10.1037/0022-006X.72.5.757

Blair, C., and Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Dev. Psychopathol.* 20, 899–911. doi: 10.1017/S0954579408000436

Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L., and Grimm, K. J. (2009). The contributions of 'hot' and 'cool' executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. *Early Child. Res. Q.* 24, 337–349. doi: 10.1016/j.ecresq.2009.06.001

Canivez, G. L., and Beran, T. N. (2011). Learning Behaviors Scale and Canadian youths: factorial validity generalization and comparisons to the U.S. standardization sample. *Can. J. Sch. Psychol.* 26, 193–208. doi: 10.1177/0829573511416440

Carlson, C. L., Booth, J. E., Shin, M., and Canu, W. H. (2002). Parent-, teacher-, and self-rated motivational styles in ADHD subtypes. *J. Learn. Disabil.* 35, 104–113. doi: 10.1177/002221940203500202

Chen, J. Q., Masur, A., and McNamee, G. (2011). Young children's approaches to learning: a sociocultural perspective. *Early Child Dev. Care* 181, 1137–1152. doi: 10.1080/03004430.2010.520160

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*, 2nd Edn. Hillsdale, NJ: Erlbaum.

Cubillo, A., Halari, R., Smith, A., Taylor, E., and Rubia, K. (2012). A review of fronto-striatal and fronto-cortical brain abnormalities in children and adults with Attention Deficit Hyperactivity Disorder (ADHD) and new evidence for dysfunction in adults with ADHD during motivation and attention. *Cortex* 48, 194–215. doi: 10.1016/j.cortex.2011.04.007

Demaray, M. K., and Jenkins, L. N. (2011). Relations among academic enablers and academic achievement in children with and without high levels of parent-related symptoms of inattention, impulsivity, and hyperactivity. *Psychol. Sch.* 48, 573–586. doi: 10.1002/pits.20578

DiPerna, J. C. (2006). Academic enablers and student achievement: Implications for assessment and intervention services in the schools. *Psychol. Sch.* 43, 7–17. doi: 10.1002/pits.20125

DiPerna, J. C., and Elliott, S. N. (2002). Promoting academic enablers to improve student achievement: an introduction to the miniseries. *Sch. Psychol. Rev.* 31, 293–297.

Domínguez, X., and Greenfield, D. (2009). Learning behaviors mediating the effects of behavior problems on academic outcomes. *NHSA Dialog* 12, 1–17. doi: 10.1080/15240750802590768

Domínguez, X., Vitiello, V. E., Fuccillo, J. M., Greenfield, D. B., and Bulotsky-Shearer, R. J. (2011). The role of context in preschool learning: a multilevel examination of the contribution of context-specific problem behaviors and classroom process quality to low-income children's approaches to learning. *J. Sch. Psychol.* 49, 175–195. doi: 10.1016/j.jsp.2010.11.002

Fantuzzo, J., Bulotsky-Shearer, R., McDermott, P. A., and McWayne, C. (2007). Investigation of dimensions of social-emotional classroom behavior and school readiness for low-income urban preschool children. *Sch. Psychol. Rev.* 36, 44–62.

Fantuzzo, J. W., Bulotsky-Shearer, R., Fusco, R. A., and McWayne, C. (2005). An investigation of preschool classroom behavioral adjustment problems and social–emotional school readiness competencies. *Early Child. Res. Q.* 20, 259–275. doi: 10.1037/0012-1649.44.1.139

Fredriksen, M., Dahl, A. A., Martinsen, E. W., Klungsoyr, O., Faraone, S. V., and Peleikis, D. E. (2014). Childhood and persistent ADHD symptoms associated with educational failure and long-term occupational disability in adult ADHD. *Atten. Defic. Hyperact. Disord.* 6, 87–99. doi: 10.1007/s12402-014-0126-1

Fried, R., Petty, C., Faraone, S. V., Hyder, L. L., Day, H., and Biederman, J. (2016). Is ADHD a risk factor for high school dropout? a controlled study. *J. Atten. Disord.* 20, 383–389. doi: 10.1177/1087054712473180

García Fernández, T., González-Pienda, J. A., Rodríguez Pérez, C., Álvarez García, D., and Álvarez Pérez, L. (2014). Psychometric characteristics of the BRIEF scale for the assessment of executive functions in Spanish clinical population. *Psicothema* 26, 47–52. doi: 10.7334/psicothema2013.149

Gioia, G. A., Isquith, P. K., Guy, S. C., and Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function*. Odessa, FL: Psychological Assessment Resources, Inc.

Hoza, B., Waschbusch, D. A., Owens, J. S., Pelham, W. E., and Kipp, H. (2001). Academic task persistence of normally achieving ADHD and control boys: performance, self-evaluations, and attributions. *J. Consult. Clin. Psychol.* 69, 271–283. doi: 10.1037/0022-006X.69.2.271

Hyson, M. (2008). *Enthusiastic and Engaged Learners: Approaches to Learning in the Early Childhood Classroom*. New York, NY: Teachers College Press.

Jacob, R., and Parkinson, J. (2015). The potential for school-based interventions that target executive function to improve academic achievement: a review. *Rev. Educ. Res.* 85, 512–552. doi: 10.3102/0034654314561338

Jenkins, L. N., and Demaray, M. K. (2015). An investigation of relations among academic enablers and reading outcomes. *Psychol. Sch.* 52, 379–389. doi: 10.1002/pits.21830

Kaufman, A. S., and Kaufman, N. I. (2000). *K-BIT, Test Breve de Inteligencia de Kaufman*. Madrid: Pearson.

Langberg, J. M., Dvorsky, M. R., and Evans, S. W. (2013). What specific facets of executive function are associated with academic functioning in youth with attention-deficit/hyperactivity disorder? *J. Abnorm. Child Psychol.* 41, 1145–1159. doi: 10.1007/s10802-013-9750-z

Loe, I. M., and Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *J. Pediatr. Psychol.* 32, 643–654. doi: 10.1093/jpepsy/jsl054

McDermott, P. A. (1999). National scales of differential learning behaviors among American children and adolescents. *Sch. Psychol. Rev.* 28, 280–291.

McDermott, P. A., Goldberg, M. M., Watkins, M. W., Stanley, J. L., and Glutting, J. J. (2006). A nationwide epidemiologic modeling study of LD risk, protection, and unintended impact. *J. Learn. Disabil.* 39, 230–251. doi: 10.1177/00222194060390030401

McDermott, P. A., Green, L. F., Francis, J. M., and Stott, D. H. (2001). *Learning Behaviors Scale*. Philadelphia, PA: Edumetric and Clinical Science.

McDermott, P. A., Rikoon, S. H., and Fantuzzo, J. W. (2016). Transition and protective agency of early childhood learning behaviors as portents of later school attendance and adjustment. *J. Sch. Psychol.* 54, 59–75. doi: 10.1016/j.jsp.2015.10.003

McDermott, P. A., Rikoon, S. H., Waterman, C., and Fantuzzo, J. W. (2011). The preschool learning behaviors scale: dimensionality and external validity in head start. *Sch. Psychol. Rev.* 41, 66–81.

Meng, C. (2015). Classroom quality and academic skills: approaches to learning as a moderator. *Sch. Psychol. Q.* 30, 553–563. doi: 10.1037/spq0000108

Miller, A. L., Seifer, R., Stroud, L., Sheinkopf, S. J., and Dickstein, S. (2006). Biobehavioral indices of emotion regulation relate to school attitudes, motivation, and behavior problems in a low-income preschool sample. *Ann. N. Y. Acad. Sci.* 1094, 325–329. doi: 10.1196/annals.1376.043

Miranda, A., Colomer, C., Fernández, I., and Presentación, M. J. (2012). Executive functioning and motivation of children with attention deficit hyperactivity disorder (ADHD) in problem solving and calculation tasks. *Rev. Psicodidáct.* 17, 51–72.

Neuenschwander, R., Röthlisberger, M., Cimeli, P., and Roebers, C. M. (2012). How do different aspects of self-regulation predict successful adaptation to school? *J. Exp. Child Psychol.* 113, 353–371. doi: 10.1016/j.jecp.2012.07.004

Papaioannou, S., Mouzaki, A., Sideridis, G. D., Antoniou, F., Padeliadu, S., and Simos, P. G. (2016). Cognitive and academic abilities associated with symptoms of attention-deficit/hyperactivity disorder: a comparison between subtypes in a Greek non-clinical sample. *Educ. Psychol.* 36, 138–158. doi: 10.1080/01443410.2014.915931

Plamondon, A., and Martinussen, R. (2015). Inattention symptoms are associated with academic achievement mostly through variance shared with intrinsic motivation and behavioral engagement. *J. Atten. Disord.* doi: 10.1177/1087054715587098 [Epub ahead of print].

Polderman, T. J. C., Boomsma, D. I., Bartels, M., Verhulst, F. C., and Huizink, A. C. (2010). A systematic review of prospective studies on attention problems and academic achievement. *Acta Psychiatr. Scand.* 122, 271–284. doi: 10.1111/j.1600-0447.2010.01568.x

Sasser, T. R., Bierman, K. L., and Heinrichs, B. (2015). Executive functioning and school adjustment: the mediational role of pre-kindergarten learning-related behaviors. *Early Child. Res. Q.* 30, 70–79. doi: 10.1016/j.ecresq.2014.09.001

Sonuga-Barke, E. J. (2005). Causal models of attention-deficit/hyperactivity disorder: from common simple deficits to multiple developmental pathways. *Biol. Psychiatry* 57, 1231–1238. doi: 10.1016/j.biopsych.2004.09.008

Stott, D. H., McDermott, P. A., Green, L. F., and Francis, J. M. (1988). *Learning Behaviors Scale and Study of Children's Learning Behaviors Research Edition Manual*. San Antonio, TX: The Psychological Corporation.

Vitiello, V. E., Greenfield, D. B., Munis, P., and George, J. L. (2011). Cognitive flexibility, approaches to learning, and academic school readiness in head start preschool children. *Early Educ. Dev.* 22, 388–410. doi: 10.1080/10409289.2011.538366

Volpe, R. J., DuPaul, G. J., DiPema, J. C., Jitendra, A. K., Lutz, G., Tresco, K., et al. (2006). Attention deficit hyperactivity disorder and scholastic achievement: a model of mediations via academic enablers. *Sch. Psychol. Rev.* 35, 47–61.

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children (WISC-IV)*, 4th Edn. San Antonio, TX: The Psychological Corporation.

World Medical Association (2013). World medical association declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA* 310, 2191–2194. doi: 10.1001/jama.2013.281053

Yen, C., Konold, T. R., and McDermott, P. A. (2004). Does learning behavior augment cognitive ability as an indicator of academic achievement? *J. Sch. Psychol.* 42, 157–169. doi: 10.1016/j.jsp.2003.12.001

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Colomer, Berenguer, Roselló, Baixauli and Miranda. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 04 April 2017
doi: 10.3389/fpsyg.2017.00462

Understanding Rejection between First-and-Second-Grade Elementary Students through Reasons Expressed by Rejecters

Francisco J. García Bacete[1,2], Virginia E. Carrero Planes[1], Ghislaine Marande Perrin[1,2] and Gonzalo Musitu Ochoa[3]*

[1] Department of Developmental, Educational and Social Psychology and Methodology, Universitat Jaume I, Castellón de la Plana, Spain, [2] GREI Interuniversity Research Group, Universitat Jaume I, Castellón de la Plana, Spain, [3] Department of Education and Social Psychology, Pablo de Olavide Universit, Sevilla, Spain

Objective: The aim of this research was to obtain the views of young children regarding their reasons for rejecting a peer.

Method: To achieve this goal, we conducted a qualitative study in the context of theory building research using an analysis methodology based on Grounded Theory. The collected information was extracted through semi-structured individual interviews from a sample of 853 children aged 6 from 13 urban public schools in Spain.

Results: The children provided 3,009 rejection nominations and 2,934 reasons for disliking the rejected peers. Seven reason categories emerged from the analysis. Four categories refer to behaviors of the rejected children that have a cost for individual peers or peer group such as: direct aggression, disturbance of wellbeing, problematic social and school behaviors and dominance behaviors. A further two categories refer to the identities arising from the preferences and choices of rejected and rejecter children and their peers: personal identity expressed through preferences and disliking, and social identity expressed through outgroup prejudices. The "no-behavior or no-choice" reasons were covered by one category, unfamiliarity. In addition, three context categories were found indicating the participants (interpersonal–group), the impact (low–high), and the subjectivity (subjective–objective) of the reason.

Conclusion: This study provides researchers and practitioners with a comprehensive taxonomy of reasons for rejection that contributes to enrich the theoretical knowledge and improve interventions for preventing and reducing peer rejection.

Keywords: reasons for peer rejection, grounded theory, norms, group, preferences, identity, unfamiliarity, early elementary education

OPEN ACCESS

Edited by:
José Carlos Núñez, Universidad de Oviedo Mieres, Spain

Reviewed by:
Eva M. Romera, Universidad de Córdoba, Spain
Fuensanta Cerezo, University of Murcia, Spain
Jose-Maria Roman, University of Valladolid, Spain
Isabel Hombrados-Mendieta, University of Málaga, Spain

****Correspondence:***
Francisco J. García Bacete
fgarcia@uji.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *02 January 2017*
Accepted: *13 March 2017*
Published: *04 April 2017*

Citation:
García Bacete FJ, Carrero Planes VE, Marande Perrin G and Musitu Ochoa G (2017) Understanding Rejection between First-and-Second-Grade Elementary Students through Reasons Expressed by Rejecters. Front. Psychol. 8:462. doi: 10.3389/fpsyg.2017.00462

INTRODUCTION

Maintaining a minimum number of meaningful, positive and lasting interpersonal relationships (Baumeister and Leary, 1995), and belonging to groups (Nesdale, 2007) are persistent motivations for people. During early elementary school children make new relationships and start being actively involved in various peer networks (Ladd, 2005). However, whereas some children are accepted and included in different groups, other children are rejected and excluded by their peers (Gifford-Smith and Brownell, 2003; Abrams et al., 2005; Asher and McDonald, 2009; Killen et al., 2009). Peer rejection is a common peer experience that predicts maladjustment

outcomes, mood disorders and victimization in childhood and adulthood (Leary, 2001; McDougall et al., 2001; Saarento et al., 2013). Knowing what drives some children to reject/dislike others is therefore a question of interest (Mikami et al., 2010).

This study aims to understand the reasons given by first-and-second-grade children for rejecting some of their peers. Most studies using peer assessment, attributional approach or social exclusion have been descriptive of children aged 8 or older, as younger children's assessments of their classmates have been considered little reliable (Nesdale and Duffy, 2011). In contrast, we think that, instead of asking the reasons why one thinks that others are rejected or oneself is rejected, which is the information collected by the aforementioned techniques, it is more suitable to ask the rejecters themselves the reasons why they dislike some peers. Selman (2003), in his interpersonal coordination theory, stated that most children aged 6–8 years are cognitively aware of their own thoughts, motives and feelings in social interactions. Besides, the sociometric methods have shown to be useful to assess the "attractions" and "repulsions" between children as young as three (Cillessen, 2009). We used open-ended questions to collect the reasons given by the rejecters. Then, in order to analyze these reasons we chose a qualitative theory building approach to seize the whole richness of the responses, avoiding pre-established categories. Working with 6-and-7-year old children will provide valuable information to implement specific actions designed to prevent and reduce peer rejection at early ages (García Bacete et al., 2014).

McDougall et al. (2001, p. 214) referred to peer rejection as "dislike on the part of one's peers which may or may not be accompanied by varying degree of victimization, exclusion, or intentional isolation from peer activities." This definition includes the three characteristics of peer rejection: (1) Rejection is based on dislikes, which are attitudes and not necessarily behaviors (Leary, 2005). In this study we use indistinctly dislike and rejection. (2) Rejection occurs between peers who know each other in the context of a group, which indicates a common history (Doosje et al., 2002). The often private character of disliking requires focusing on who rejects, and the fact that disliking occurs between known peers requires conducting the study in the ecological settings where the peer interactions take place, like classrooms. (3) When rejection is perpetrated by a significant number of peers, it is conceptualized as peer rejection.

However, for many years the predominant conceptualization in rejection research has been based on the deficits of the rejected child that contribute to her/his social difficulties (Asher, 1990; Bierman, 2004). Thus, most studies have focused on the rejected person, largely by examining the correlates and consequences of rejection (Coie et al., 1990; Bierman, 2004), and other questions such as perceptions of being rejected (Guerra et al., 2004), reactions to rejection (Sandstrom and Zakriski, 2004), or problematic social situations for peer-rejected students (Martín-Antón et al., 2016). When attention is given to the rejecter, the focus has generally been on explicit rejection behaviors (Asher et al., 2001; Lev-Wiesel et al., 2013). It is therefore unsurprising that research into the reasons for rejection has also focused on the rejected person and on behavioral correlates of rejection as the causes of rejection (Rubin et al., 2006). In contrast, few studies directly asked rejecters to give their reasons for rejecting known peers in real situations (Monjas et al., 2008).

Correlates of Rejection and Other Reasons for Rejection

For many years scholars have been keen to learn about which behavioral characteristics lead children and adolescents to be accepted or rejected by their peers (Asher and McDonald, 2009). This is what is known as the correlates of rejection (Coie et al., 1990; Bierman, 2004; Rubin et al., 2006). Newcomb et al. (1993) found that high levels of aggression and withdrawal and low levels of sociability and cognitive abilities are associated with rejected peer status. Bierman (2004) summarized this set of reasons as she stated that rejected children can be more argumentative, disruptive, and aggressive, more socially awkward and insensitive, less skillful in engaging in prosocial play, and/or have more negative interactions with teachers than their peers. In general, the rejected person's characteristics and behaviors are considered to invite rejection from others (Asher, 1990; Newcomb et al., 1993; McDougall et al., 2001; Mikami et al., 2010). However, correlates cannot be interpreted so readily as causes (McDougall et al., 2001), and can frequently be better understood as consequences of the rejection itself (Orue and Calvete, 2011). Chang (2004) found that some rejected children are popular and central members of their group, which suggests that rejection is a function of those who reject rather than of the rejected person's behaviors. Thus, rejection is not a property of the rejected child or a characteristic of her/his behavior (Dirks et al., 2007).

Alongside, other studies presented children with hypothetical situations or experimental designs and asked them else to select or rate causes of social failure or peer rejection, as did social attribution studies (Elig and Frieze, 1975; Goetz and Dweck, 1980; Earn and Sobol, 1984), or to reason the legitimacy of social exclusion behaviors in manipulated hypothetical situations, as did studies on social exclusion based in the social-cognitive domains (Abrams et al., 2005; Smetana, 2006; Killen, 2007; Abrams and Rutland, 2008; Killen et al., 2009). In the attributional studies, children's responses are usually interpreted in accordance with the three dimensions proposed by Weiner, locus, stability, and control (e.g., "She played better," external, unstable, controllable). But above all the attributional approach emphasizes the success/failure of the rejected child's behavior in a specific social situation (e.g., managing to "play with," "get on well with"), whereas peer rejection cannot be interpreted in terms of the failure neither of the rejected child, because "not being liked" does not depend on the child her/himself but on the other, nor of the rejecter because nobody can accept everyone (Leary, 2001). In the social exclusion studies, the reasons for exclusion are classified according to moral reasons such as treating the ingroup and the outgroup members in the same fair and equitable way, social-conventional reasons such as identification with the group and the way it functions, and personal reasons such as preferences and attributions of intentions to others (Horn, 2006;

Killen et al., 2009). These contributions are valuable; however, the focus of these studies is the behavior of rejection or exclusion, and not the rejection as an attitude. In addition, in this type of studies, the reasons are derived from interpretation of situations and evaluation of behaviors (Turiel, 1998; Smetana, 2006). Both approaches use strongly structured designs in which the children are asked to explain why a certain event and behavior occur and the presented situations and reasons may have little meaning for the children. Moreover, the analysis of children's responses is based on pre-established dimensions or categories.

Evaluation by the Rejecters and Group Context

So far, little is known about the reasons that may explain the process of rejection as a result of an interpersonal interaction in a social group, as proposed by Bierman (2004). This perspective implies two relevant issues: First, research on the reasons for rejection must focus on the rejecter child; and second, the social context in which peer interactions occur influences rejection.

The first question is related to the principle of relational evaluation put forward by Leary (2001, 2005). According to this principle, any form of rejection, regardless of the behaviors or traits of the rejecters or rejected child, is a state of relatively low relational evaluation in which a person does not consider his/her relationship with another individual as valuable. Many of our decisions to reject reflect personal preferences based on our attitudes, interests, abilities, goals, and previous social experiences (Leary, 2001; Nucci, 2001; Scandroglio et al., 2008). Similarly, Asher and McDonald (2009) stated that the basis for peer rejection is not the behavior of the rejected child but rather the others' interpretation that the relationship with that child does not properly satisfy their needs (e.g., "Does this child seek to have influence in ways that are not acceptable for me?").

As for the second issue, it is important to recognize that neither the rejecter nor the rejected student are on their own, but they are members of groups (class group, class subgroups, social categorization groups as gender, birth place, etc. . .) (Bourdieu, 1985; Nesdale, 2011). Several authors have concluded that a complete model of peer rejection could be obtained only through the understanding of social context influences (García Bacete et al., 2014; Mulvey et al., 2014). Killen et al. (2013) suggested that what seems to be interpersonal rejection might actually reflect group rejection.

Mikami et al. (2010) described the processes by which groups influence peer rejection: cognitive biases held by the accepted peer group, deviation from peer group norms; and social dominance hierarchy in the peer group. Abrams and Rutland (2008) found that individuals who do not fit well into their own group are highly likely to be rejected. Poor adaptation to a group can occur either because the person does not maintain typical relationships with her peers (e.g., "being shy," see Rubin et al., 2006), or because she contributes little or nothing, or harms the group (e.g., "violate the natural tendency to cooperate within the group," see Levine and Moreland, 1994). In turn, Nesdale (2007, 2011) found that belonging to other groups entailed greater probability of rejection, either due to preference for one's own group, or due to prejudice toward other groups (gender, ethnic group etc.) (Brown and Bigler, 2005; Scandroglio et al., 2008; Mulvey et al., 2010).

In summary neither the rejection nor the reasons for rejection can be understood as a characteristic of a person or of a behavior, or as an attribution or cause, or as an evaluation of behaviors, social situations, or social failures. Peer rejection is an attitude or a feeling, a negative or low relational evaluation, and the reasons are an attempt to explain this relational evaluation in the group context. We agree with Asher and McDonald (2009, p. 235) in that "scholars who study the behavioral correlates of acceptance and rejection rarely discuss the ways that the behaviors they study are powerful because they speak to peoples' fundamental needs,. . . that it might suggest other characteristics that are relevant to acceptance and rejection but have not yet been studied."

Open–Ended Question and Qualitative Method

It is therefore important to include open–ended questions to study reasons for rejection since, as pointed out by Elig and Frieze (1979), they are more meaningful and allow for greater spontaneity than the aforementioned approaches, and they do not hint at any reasons that children have not even thought about.

This strategy has been used in a few studies. Smith (1950), a teacher, asked her fourth-grade class open-ended questions about the reasons for their positive and negative sociometric choices. The children's responses showed that verbal abusiveness, rule violations, and bullying were associated with negative nominations. Monjas et al. (2008), using the responses of fifth-and-sixth-grade children to the questions "Which of your classmates do you not like and why," developed a taxonomy of 15 reasons for peer rejection ranging from unfriendliness and lack of companionship to aggressive, dominating and antisocial behaviors. Feinberg et al. (1958) asked sixth-and-seventh-grade students to describe the classmates with whom they felt uncomfortable or annoyed, found that the traits fighting, disruptive, conceited, and silly were associated with negative status. These studies represented a contribution since they analyzed the reasons in situations where rejected children and rejecters interacted on a daily basis, which were highly meaningful and very different from the hypothetical situations and anonymous protagonists with no background history nor future exposed in the aforementioned more structured methods (Doosje et al., 2002). However, the reasons for rejection in these studies are still presented in a descriptive way without going deeper into the interconnections between categories, they are largely interpreted in terms of the behavior of the rejected child without taking into consideration the rejecter and rejected children's group context.

A qualitative approach is needed to understand the reasons that prompt children to reject or dislike some peers. Grounded Methodology developed by Glaser and Strauss (1967), has proved capable of generating basic conceptual categories from data that explain the processes that occur in complex social situations (Carrero et al., 2012). From this perspective neither a predetermined taxonomy of possible reasons nor an explanatory

framework to interpret them is necessary. Instead of that, the Grounded Theory starts from the data provided by the social participants and, by applying the constant comparison of the incidents found (the reasons given by the rejecters), makes emerge substantive categories which are compared to new incidents. These successive comparisons continue until achieving the theoretical saturation of the data given by the participants. This process yields an underlying structure that explains the variability of the elicited reasons. Data collection, coding process, integration of categories, and construction of theory are thus guided by methodology as it emerges.

This study aims to understand the reasons given by first-and-second-grade children for rejecting some of their peers. In order to analyze these reasons the conducted study focuses on: (1) Defining peer rejection as an attitude or a feeling, a negative or low relational evaluation. (2) Asking the rejecters themselves the reasons why they dislike some peers. (3) Including the influence of social context in which peer interactions occur. (4) Applying a qualitative theory building approach to seize the whole richness of the responses and avoid pre-established categories.

MATERIALS AND METHODS

Design and Participants

In this study we used a theory building qualitative approach with a methodology of analysis based on Grounded Theory (Glaser and Strauss, 1967) consisting of analyzing the information provided by a sample of children through the codification, comparison, and conceptualization of data coming from their speech to form categories and establish relationships between them (Strauss and Corbin, 2007). The sample has been selected by applying *master selection criteria* (age, sociometric type) and *heterogeneity-homogeneity criteria* (sex, education level, place of residence, and socioeconomic status) according to the objectives of the research (Valles, 2000; Suárez et al., 2013, 2016) (**Table 1**). An incidental sampling was used to select public elementary schools situated in urban districts with average socioeconomic level close to the four universities where the researchers were conducting a broader study that included a large intervention later on. These criteria and the extend of the sample was designed taking into account the need to ensure the *point of redundancy* (Lincoln and Guba, 1985) where the new information analyzed is redundant with the previous data and could be integrated into the existing categories.

Finally, to guarantee the validity of the results and the consistency of the emergent categories several procedures, based on the recommendations claimed by Glaser (1978, 1992) and Thomas (2006), were applied in this study: first, to find a way to avoid bias in the researcher during the process of coding without losing his theoretical sensitivity and, second, to verify the consistency of the final categories. To achieve the first goal, the *substantive coding* phase (Strauss and Corbin, 2007) was developed by a researcher who was trained previously in coding technique but who was not an expert in peer rejection (third author) while for the *selective* and *theoretical coding* phases, three experts in peer rejection and qualitative methodology joined the analysis work (first, second, and fourth author). Secondly, to verify the consistency of the final categories we applied a *coding consistency check* (Valles, 2000; Thomas, 2006) by consulting two experts in rejection and bullying and then calculated the interrater agreement (Dubé, 2008) using Cohen's kappa statistic (κ) in accordance with the guidelines proposed by Landis and Koch (1977).

Participants were 939 pupils of both sexes, aged 5–7 years, who were studying in 40 first-and-second-grade classrooms of 13 schools in four Spanish cities: Valencia, Palma de Mallorca, Sevilla and Valladolid.

Of the 939 initial subjects 86 pupils (9.2%) did not respond. Forty-six of them because they did not have the parental permission, were not at school during the assessment, or left the school during the study (although they continued to be nominated by their classmates). The other 40 children gave nominations of acceptation but not of rejection. The final

TABLE 1 | Description of the sample of respondents (*n* = 853) according to place of residence, education level, age, gender, sociometric type, number of classrooms, number of schools, and socioeconomic status.

Cities		Valencia *n*[a] = 244 (28.6)	Palma *n* = 272 (31.9)	Sevilla *n* = 243 (28.5)	Valladolid *n* = 94 (11.0)	Total *n* = 853
Education level	First	244 (100)	147 (54.0)	107 (44.0)	94 (100)	592 (69.4)
	Second	–	125 (46.0)	136 (56.0)	–	261 (30.6)
Age	5	22 (9.0)	16 (5.9)	12 (4.9)	6 (6.4)	56 (9.5)
	6	222 (91.0)	233 (85.7)	215 (88.5)	88 (93.6)	497 (84.0)
	7	–	23 (8.5)	16 (6.6)	–	39 (6.5)
Gender	Boy	129 (52.9)	131 (48.2)	120 (49.4)	50 (53.2)	430 (50.4)
	Girl	115 (47.1)	141 (51.8	123 (50.4)	44 (46.8)	423 (49.6)
Sociometric Type	Average	172 (70.5)	164 (60.3)	180 (74.1)	73 (77.7)	589 (69.0)
	Preferred	29 (11.9)	28 (10.3)	20 (8.2)	8 (8.5)	85 (10.0)
	Rejected	29 (11.9)	31 (11.4)	31 (12.8)	11 (11.7)	102 (12.0)
	Neglected	6 (2.5)	38 (14.2)	6 (2.5)	1 (1.1)	51 (6.0)
	Controversial	8 (3.3)	11 (4.0)	6 (2.5)	1 (1.1)	26 (3.0)
School SES[b]		M2	M2	M2	M2	M2

[a]*n = sample (%).* [b]*SES = Socioeconomic status: M1 = Medium-low; M2 = Medium; M3 = Medium-high.*

sample of respondents consisted of 853 pupils (49.6% girls) ($M_{age} = 6.76$ years, $SD = 0.67$).

Data Collection

In each city, two trained evaluators (research collaborators graduate in educational psychology) gathered the data by means of 20-min individual interviews in which they asked two questions extracted from the sociometric questionnaire (García Bacete and González, 2010): (1) Who in your class do you like least? (2) Why don't you like (classmate's name)? To answer the first question, the child identified all the classmates he or she did not like on the class photographs. After that, the researcher asked the student the second question for each of the classmates nominated negatively and wrote down verbatim the child's reasons. The information gathered in the interviews allowed compiling a list of reasons verbalized by the pupils to explain the rejection toward their peers. To ensure that all students provide a comparative number of reasons, only a maximum of five reasons were used per student.

Each school left a private room at disposal for carrying out the interviews. The present study was conducted in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards, with the approval of the management board of schools, the educational inspection services, the Department of Education of the Regional Government of Valencia (Spain), the Childhood Observatory of the Regional Government of Andalusia (Spain), the Socio-Educational Institute Foundation s'Estel of the Government of the Balearic Islands (Spain); and the Observatory School Coexistence of the Autonomous Government of Castilla y León (Spain). Review and approval from an ethics committee was not required as per the institutional and national requirements. Participation in the study was voluntary. All subjects gave written informed consent. The required authorizations from the education authorities, the schools, and the children's families were obtained.

Analytic Strategy

First, the list of reasons given by the participants was read in detail by the researchers to familiarize themselves with the content and to approach a first understanding of the "themes" and details of the subject. After that, in the first step of the analysis we used the *substantive coding*. The substantive codes break down (fracture the data) and then conceptually grouping it into codes that then become the theory which explains what is happening in the data (Glaser, 1978). During substantive coding the data are examined, and compared for similarities and differences. The researcher compares incident to incident with the purpose of establishing the underlying uniformity and its varying conditions (Glaser, 1978). In our study we grouping under the same label the reasons exposed by the children that use common key words used by the participants (e.g., friend, "She doesn't want to be my friend," "He is Rob's friend"), or that had a certain similarity (e.g., lack of hygiene, "He's always got a runny nose"; "she doesn't clean her teeth"). This process yielded 10 groups of reasons or categories (**Table 2**).

Applying the constant comparison method (Glaser, 1978; Carrero et al., 2012), we then created subgroups within the same category. Depending on the frequency and distinctive meaning of the reasons that appeared under the same label, they form a subcategory within the existent category or a new independent category. After this first categorization the resulting categories still needed to be refined, therefore we continue applying the constant comparative technique to the data (**Table 3**).

As the reader can see on **Table 3**, during this continuous process of open coding, the configuration and definition of the list of categories suffered constant changes. For example, in the second categorization, the *bad behavior/disruptive conduct* category divided into two categories: Bad ("stupid," "He's a cheat," "She steals") and *disruptive behavior in class* ("He doesn't keep quiet in classroom," "He gets punished"). In the third categorization, these two new categories combined with the category *poor academic skills* and gave way to two categories: *bad pupil* and *antisocial behavior*.

TABLE 2 | Initial grouping of reasons for rejection.

- **NO FRIENDSHIP**: She isn't my friend; he doesn't want to be my friend; he's Rob's friend;. . .
- **NO RELATIONSHIP**: I don't talk to her much; he never sits next to me; when I come she goes away; he doesn't come any more; we don't play; she plays with other children;. . .
- **I DON'T LIKE. . .**: I don't like her at all; I don't like being with her much; I don't get on with her; there's something about him I don't like; I don't like the way he runs;. . .
- **PERSONAL CHARACTERISTICS**: She's really bad tempered; he's mad; he gets angry; she spends all day crying; he gets anxious; he acts cocky; she never keeps her promises; she isn't friendly; he isn't much fun; he's really tedious; she's boring; she doesn't leave me in peace; he doesn't share; she's bossy; she thinks she's the boss; he tells lies;. . .
- **PHYSICAL CHARACTERISTICS/PHYSICAL APPEARANCE**: She's a gypsy; he's got horrible teeth; he's a boy; she's got big ears; I don't like her hair; he walks funny; I don't like his face; she wears glasses; she wears horrible clothes;. . .
- **LACK OF HYGIENE**: He's always got a runny nose; he's really dirty; she doesn't clean her teeth;. . .
- **POOR ACADEMIC SKILLS**: she doesn't do her homework; he doesn't understand anything; he's thick; she copies; he reads really badly; she doesn't know much about school stuff;. . .
- **BAD BEHAVIOR/DISRUPTIVE CONDUCT**: She takes my things; she breaks my friends' things; the teacher always gets cross with him; he gets told off; she spits; he throws sand; he's very naughty; she's bad; he's very rough; she threatens us; she cheats; she insults; he shouts; he makes fun of me; she doesn't shut up in class; he swears; he talks nonsense;. . .
- **PHYSICAL AGGRESSION**: She pinches; he fights; he pushes us; she pulls our hair; he throws juice at us; he hits;. . .
- **OTHERS**: I don't know; I don't remember;. . .

TABLE 3 | Evolution of the categorization.

First categorization	Second categorization	Third categorization	Fourth categorization	Fifth categorization (FINAL)
			Supracategory: PREFERENCE	***Supracategory: Preference (IDENTITY)***
Cat 1: No friendship ***Cat 2:*** No relationship ***Cat 3:*** Do not play together (N) – ***Subcat 3.1:*** Play as a tool of exclusion	***Cat 1:*** NO friendship/relationship/play – ***Subcat 1.1:*** No friendship – ***Subcat 1.2:*** No relationship – ***Subcat 1.3:*** Do not play together	***Cat 1:*** NO friendship/relationship/play	***Cat 1***: Preference ***Cat 2***: Aversion – ***Subcat 2.1:*** Personal dislike (N) – ***Subcat 2.2:*** Group dislike. Social prejudices (N)*	***Cat 1***: Personal identity (N) – **Subcat 1.1:** Preferences – **Subcat 1.2:** Dislike ***Cat 2***: Social identity. Prejudices**
				Supracategory: Unfamiliarity (INERTIA/SELFPROTECTION) ***Cat 3***: Unfamiliarity (N)***
			Supracategory: BEHAVIOR	***Supracategory: Behavior (COST)***
Cat 4: Poor academic skills	***Cat 4:*** Poor academic skills	***Cat 2:*** Bad pupil (N) ***Cat 3:*** Antisocial Behavior	***Cat 3***: Problematic social and school behaviors	***Cat 4***: Problematic social and school behaviors
Cat 5: Bad behavior/Disruptive conduct	***Cat 3:*** Disruptive behavior in class ***Cat 2:*** Bad (N)			
	Cat 5: Annoying/nuisance/boring/silly (N)	***Cat 4:*** Annoying/nuisance/boring/silly	***Cat 4***: Disturbance of wellbeing	***Cat 5***: Disturbance of wellbeing
Cat 6: Relational aggression (N) – ***Subcat 7.1.:*** Lies	***Cat 6:*** Bossy/dominant (N)	***Cat 5:*** Dominance	***Cat 5***: Dominance	***Cat 6***: Dominance
Cat 7: Verbal aggression (N) ***Cat 8:*** Physical aggression	***Cat 7:*** Verbal aggression ***Cat 8:*** Physical aggression	***Cat 6:*** Direct aggression – ***Subcat 6.1:*** Verbal aggression – ***Subcat 6.2:*** Physical aggression	***Cat 6***: Aggression/intimidation (N) – ***Subcat 6.1:*** Verbal aggression – ***Subcat 6.2:*** Physical aggression	***Cat 7***: Aggression – ***Subcat 7.1***. Verbal aggression – ***Subcat 7.2***. Physical aggression – ***Subcat 7.3***. Intimidation
Cat 9: Physical appearance	***Cat 9:*** Physical appearance	***Cat 7:*** Appearance: prejudices and physical appearance		

*The original order of the categories in the categorizations First, Second, and Third has been changed to make visible the parallelism with the FINAL categorization. N = New; *it includes Cat 7 of Third categorization; **it coincides with Cat 7 of Third categorization; ***it comes from Cat 1 of Fourth categorization.*

With each new category configuration or change to labels or definitions, we revised each reason one by one, and the number of unclassified reasons gradually disappeared. By this point (third categorization), practically all the main reasons were present: *aggression, dominance, annoyance, antisocial behavior, bad pupil, no friendship/relationship/play, appearance*.

At this point of the analysis, relationships between concepts were analyzed, identifying the position of the actors (rejecter or rejected child) as regard their disliking or liking referring to friendship, relationship or play, and defining the links between categories and subcategories hierarchically, establishing a series of main categories or supracategories (*selective coding*). In this way, we first distinguished between preference and aversion and then gradually differentiated two principal sets of reasons for rejection: *behavior* (supracategory of rejection because of what the rejected child does, says, or tries to do), *preference* (supracategory of rejection because of what the rejected child s/he likes).

The last step in the analysis consisted in validating the final theoretical scheme, confirming the relationships between categories, removing data and filling in categories that still needed further refinement and development (*theoretical coding*). For example, from the *preference* category we decided to remove reasons that expressed little or no contact between rejecter and rejected child because above all they revealed an absence of preference (choice) or of shared activity (behavior), for which they could not be in the *preference* nor in the *behavior* supracategories, thus forming a third independent supracategory, *unfamiliarity*. Simultaneously it became clear that *preference* is a positive choice and *dislike* is a negative choice and that both would underlie personal identity, whereas prejudices against people belonging to or representing certain social categories would account for the base of social identity, which led to the categories *personal identity* and *social identity*.

In this theoretical phase another important aspect had gained relevance. It is observed that all the reasons exposed contain information concerning the children who participate ("She hits me," "He hits us"), the different times or intensity of the event ("Sometimes she does not play with me," "He never plays with me"), and the different levels of subjectivity-objectivity of what is said ("I don't like him," "She didn't invite me to her birthday party"). From these observations, three context categories emerged: *participants*, *impact,* and *subjectivity–objectivity*. The context categories can be represented as transversal axes to each reason category.

Finally, to calculate the interrater agreement we sent the definition of each category to the two expert raters and asked them to assign a list of 500 reasons randomly to the final set of categories.

RESULTS

The pupils provided 3,009 rejection nominations, of which 2.5% contained no reasons for rejection, or the respondent claimed not to know the reasons for the rejection. The analysis of the remaining 2,934 reasons produced seven reason categories, arranged in three supracategories, and three context categories. The interrater agreement reached with the two expert raters was strong ($\kappa = 0.90$ with rater 1, and $\kappa = 0.81$ with rater 2).

Reason Supracategories and Categories

Supracategory: Behavior (Cost) (74.1%)

The reasons of this category express rejection of the other because of what s/he does, says, or tries to do and these behaviors represent threats to or attacks on social and school expectations and norms ("She takes things away," "He's bad at reading"), personal and group wellbeing ("He bothers", She speaks when we're working"), autonomy ("He bosses people about," "She pushes me around"), and physical and emotional safety ("He hits," "She makes fun of everybody"). Only when these behaviors are interpreted as costs for the personal and groups norms and functioning, or do not contribute to satisfy the individual and group needs, the child becomes the object of rejection.

Problematic social and school behaviors category (17.4%)

This category highlights simultaneously antinormative and abnormal social and school behaviors of the rejected child. On one hand, such behaviors go against what is considered appropriate and desirable, against general or specific social and school expectations and norms, which reflect the breach of social and school rules norms ("She steals things," "She makes the teacher angry"). On the other hand, they refer to deficits in the social and school skills necessary for relational and educational success or a deficiency in fulfilling expectations and achieving goals ("He doesn't leave me anything," "He reads really badly").

Disturbance of wellbeing category (18.4%)

This category refers to the rejected child's behaviors that make people feel uncomfortable and angry and obstruct people to achieve their objectives ("He says silly things," "She is always interrupting"). The reasons in this category are characterized by frequent behaviors of low intensity that interfere with what one wants, when and how one wants, and in the end cause personal or group discomfort.

Dominance category (4.5%)

Dominance is understood as behaviors of the rejected child that aim to impose what is to be done, influence others for one's own advantage or strengthen one's own ego at the expense of others ("He bosses people about," "He acts cocky with me").

Aggressive category (33.8%)

This category is defined by direct behaviors of the rejected child that cause personal or physical harm, or insecurity. They may be verbal and gestural aggressive aimed to humiliate others or damage their reputation (4.7%) ("He insults," "She shouts at me"), physical aggression aimed to cause physical damage (23.1%) ("He hits," "He spits"), or intimidation aimed to frighten the person through threats or abuse (6.0%) ("She treats me badly," "He threatens"). All these behaviors share the purpose of harming, but in the case of intimidation, it is the fear of what may occur that makes feel the harm beforehand.

Supracategory: Preference (Identity) (18.6%)

This supracategory refers to what the rejecter or the rejected child likes and is. It consists of two categories, *personal identity* and *social identity*, which are based on two different attraction processes: personal attraction, which derives from the idiosyncratic preferences arising in interpersonal relationships; and social attraction, which derives from the degree to which an individual represents the prototype of his or her group.

In this supracategory the reason are firstly situated in the affective frame of likings/dislikes of the rejecter or of the rejected child (in fact, the rejecter's perception of the rejected child's preferences). In a second moment, the preferences become cognitive or/and behavioral choices, which can involve direct rejection ("I don't want to be his friend") or indirect ("I play with my friends"). Finally, when the preferences and choices are systematically used and based on exclusion norms the personal identity becomes reinforced. Moreover, when these systematical preferences are based on negative reputations and social prejudices, then the social identity becomes strengthened. This identity process may lead to situations where differences strongly clash, people forget about ethics and egalitarian treatment, and rejection settles down. Here too the influence of the peer context or the group is present.

Personal identity category (14.5%)

In this category the subject shows that her/his likings are different from those of the people s/he rejects. This category has two subcategories: preference and dislike.

Preference subcategory (3.7%). This subcategory expresses the rejecter's likings, enjoyments or choices (I like it/him/her) or those of the rejected child (s/he likes it/him/her) referring to a person, relationship, friendship, activity or play, that extends to the group (we like it/him/her, I like them, they like me, s/he likes us). In the reasons of this category, the rejecter affirms her/his preferences or those of others ("I like playing football," "He plays with his friends").

Dislike subcategory (10.8%). This category expresses the rejecter's volition (I don't want/like) or the rejected child's volition as perceived by the rejecter (s/he doesn't want/like) not to establish a relationship or share friendship and play. This intention can also be extended to their groups (we don't want, they don't want). In this subcategory the rejecter shows her/his own dislikes or those of his/her group, or reacts to the dislikes of other or others ("I don't like their games," "She doesn't let me play," "He doesn't want to play with me").

Social identity category (4.1%)

In this category the dislike of other children is based on their belonging to a social group or category ("She's a girl") or on their doing activities typical of those same groups ("He plays girls' games"), in the absence of other more specific reasons. These reasons actually express stereotypes and prejudices against those who are not like me or us, or belong to other group ("She's Romanian," "He's new").

Supracategory: Unfamiliarity (Inertia/Self-protection) (7.4%)

This supracategory is a set of reasons that express little or absence of choices-sharing and of activities-sharing (We aren't. . ., we don't go. . ., we don't play. . .), for which they cannot be in the *preference* nor can they be in the *behavior* supracategories. This supracategory is formed by a unique category, unfamiliarity. It includes reasons that reflect low interest in little known others, or hesitation to make new relationships, which are manifested in not searching for contacts and shared activities ("I don't know him/her," "We don't play together").

Figure 1 describes the final map of categories where three paths to the motivation for peer rejection can be observed: first path to rejection lies in the rejected children's deviant behavior (What s/he does, says, tries) in the context of their personal and group relationships (costs of the behavior); second path to rejection is built on the preferences and choices of the rejecters and rejected children, defining what they are (identities). The third path to rejection consists of the absence of behavioral interactions and choices (unfamiliarity).

Context Categories

The context categories are referred to conditions in which rejection occurs. These categories modify as well as increase the diversity of reasons given by the rejecters. The context must be considered to deeply understand the reasons given by the interviewed children about why they reject or dislike some peers.

The *participants* context distinguishes between interpersonal rejection and group rejection. The interpersonal rejection occurs when the participants are the rejecter–rejected pair (33.7%) ("He hits me") or trios in which in the rejection between rejecter and rejected a third pupil is included (4.1%) ("She hits my friend"). The group rejection occurs when the rejecter or the rejected child or both are in a group. The groups can be number-limited or formed by known peers (5.7%) ("He hits my friends"), or be larger collectives, or relate to general statements (56.5%) ("He hits everybody").

The *impact* context includes frequency and intensity of the event and distinguishes between low, medium and high impact. Low impact (8.6%) refers to single or occasional cases ("He pushed me once"), or low intensity ("He's a little bad"). Medium impact occurs when there are no intensity or frequency indicators, or is expressed in indefinite or third person (66.1%) ("She doesn't let others play"). High impact refers to maximum frequency or intensity (25.2%) ("He doesn't lend things to anybody").

The third context category relates to the *subjectivity–objectivity* feature of the reason, whether the meaning of the reason is a function of the subject who rejects or a function of the event or object for which rejection occurs. We use the term subjectivity when the rejecter's feeling and thinking are part of the reason and the rejecter acts as a judge or interpreter. In this way, the valence of the reason can be different (positive, negative, or neutral), depending on the evaluator. Subjective reasons may be: total when referring to the whole rejected person (8.7%) ("I don't like her") or partial when referring to only one aspect (21.9%) ("He's annoying"). On the contrary, other reasons focus

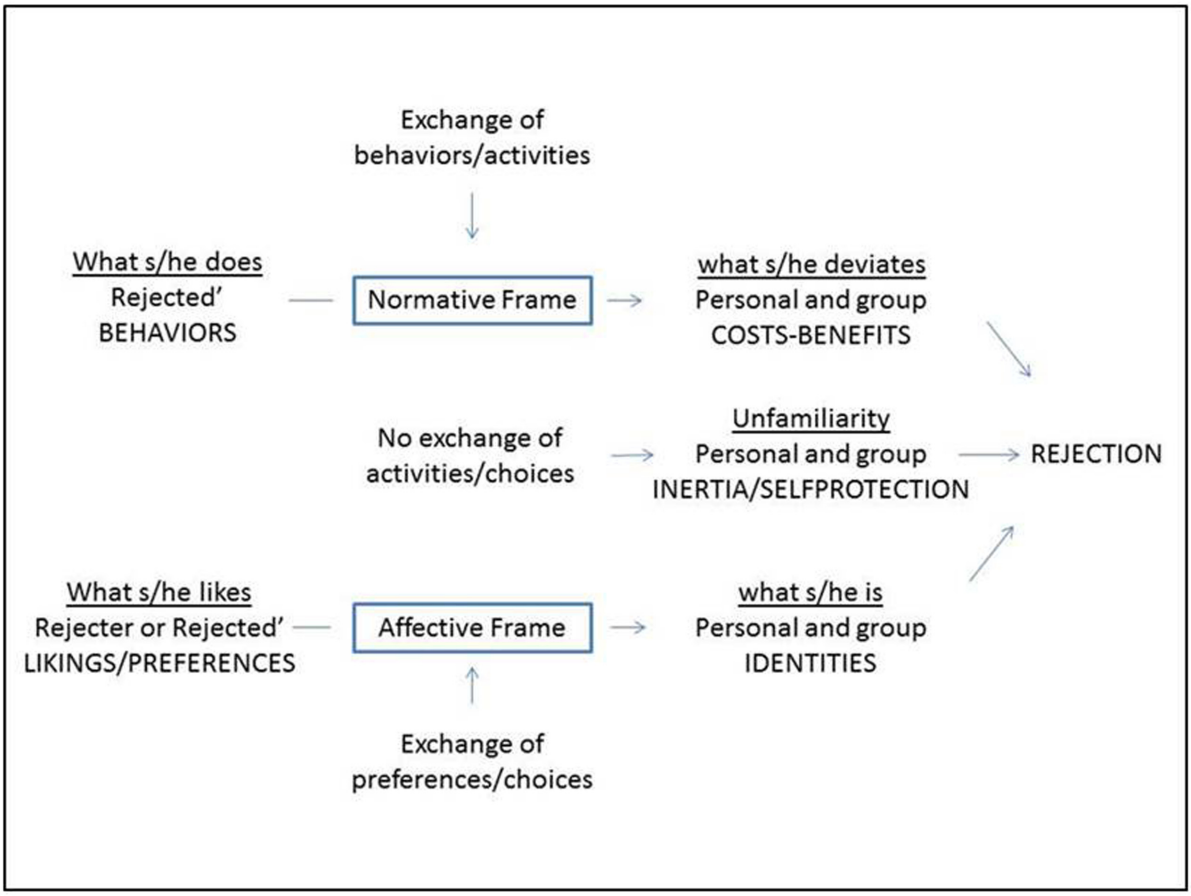


FIGURE 1 | Sources and paths of motivation for peer rejection.

on the rejected child as something external, and the rejecter only describes the reason as a narrator or observer of an event in which the rejected child participated. The descriptive reasons can be: general and imprecise (45.8%) ("She calls names") or specific or precise (23.7%) ("She plays with Danny").

DISCUSSION

From the above said several contributions of this study can be deduced. First of all, it major part of reasons refers to what the rejected does, in line with the studies of the correlates of rejection and the social attribution (Earn and Sobol, 1984; Coie et al., 1990; Bierman, 2004). However, in contrast to those studies, rejection here does not appear to be the direct result of what the rejected does, but of the relational evaluation of this behavior done by the rejecters (Leary, 2001), of how they interpret that this behavior affects their needs and the group functioning (Levine and Moreland, 1994; Asher and McDonald, 2009), and its degree of typicality in comparison to the behavior of the own group or of other groups (Nesdale, 2007; Abrams and Rutland, 2008). This path of rejection highlights the power of the behavioral interactions and the deviation from the norms to provoke peer rejection, since the classmates interpret them as costs to the interpersonal relationships and the group functioning (Levine and Moreland, 1994; Ladd, 2005). The information provided by the context categories strengthens the utility of using the rejecter and the group approaches in the study of peer rejection.

Secondly, the rejecters provided two types of reasons that do not usually appear in the traditional studies on rejection (e.g., Bierman, 2004), -namely the reasons for rejection due to *preference* and to *unfamiliarity*-, because the classic studies focus mainly on the rejected children's behavior (what they do, say or try to do). The second path highlights the power of the preferences both in the personal domain and in the social categorization to provoke peer rejection (Smetana, 2006; Nesdale, 2007; Abrams and Rutland, 2008; Mikami et al., 2010), since the children interpret them as likings and choices that crystallize in personal and group identities (Scandroglio et al., 2008; Nesdale, 2011). The third path highlights that the social inertia toward choosing and doing what has already been preferred and done (Bourdieu, 1985), or the fear and mistrust to what is unknown or unfamiliar (Gifford-Smith and Brownell, 2003), may also lead to rejection (Allport, 1954). The reasons included in those two supracategories are external to the rejected children's behavior since they focus on the rejecters' attractions and choices, (or those

that the rejecters attribute to the rejected), and on what does not befall (not sharing activities, not making choices). These new reasons could appear owing to having put the interest on the rejecter, and because rejecters and rejected children are known peers, members of the same classroom. The rejecters' answers "I don't know" or "no response" are other examples of reasons external to the rejected child's behavior.

Thirdly, the fact that children at this age, in their explaining their reasons for peer rejection, turn to arguments simultaneously referring to the self, the group, and stereotypes, confirm the results of the theory of social-cognitive domain to explain the exclusion (Turiel, 1998; Smetana, 2006; Killen, 2007), and strengthen the idea that the social judgments are not a characteristic of one stage but emerge simultaneously in development, unlike to Kohlberg's (1984) model. In fact, the reasons for peer rejection show a parallelism with the three social-cognitive domains: The reasons based on *personal identity* match with personal domain (Nucci, 2001; Gifford-Smith and Brownell, 2003), the reasons based on the rejected child's *behavior* with the social normative domain (Abrams et al., 2005; Ladd, 2005), the reasons based on *social identity* with the moral domain (Brown and Bigler, 2005; Mulvey et al., 2010; Hatfield and Rapson, 2011), and the reasons based on *unfamiliarity* with both personal and social domains.

Fourthly, the content and the form of the reasons reflect the three characteristics of peer rejection: private evaluation, group influence, context of known peers.

Private evaluation: Rejection is above all a private and attitudinal evaluation (Leary, 2001, 2005). The presence of reasons that make it difficult for the observer to identify certain situations as rejection puts in evidence this private character. This is the case of reasons under the heading *do not know/no response*; of reasons expressed in past tense that refer to a memory and not a present reality; and of reasons included in the *unfamiliarity* category. The private evaluative nature is also present in the reasons where the rejecter's opinion is an inseparable part of the content, where the rejection is not so much due to the behavior or the event but rather to the interpretation the rejecter makes of it, since the same behavior ("he's always singing") may be evaluated as positive, negative, or neutral by different evaluators. In other reasons, like those in the *social identity* category, the content itself of the reason includes the evaluation, in this case discriminatory or prejudiced. Thus, the rejecter's perspective becomes indispensable to know the reasons for peer rejection, because since rejection is essentially a private evaluation, the reasons are arguments for rejection only if the rejecter feels and thinks like it.

Group influence: Although the methodology used for the data collecting had an interpersonal basis, the analysis methodology allowed the emergence of clear indicators of the influence of the others and of the group in the reasons, showing that reasons can also be based on the group and/or norms (Horn, 2006). The influence of the group in the interpersonal system mentioned by Mikami et al. (2010) is observed in the transversal and majority presence in all the categories of group reasons, reasons in which groups act as spokespersons or recipients (62.2% of the *participants context*). Even though interpersonal and group reasons overlap in all categories and permit tracking this group basis (Killen et al., 2013), some categories reflect the group influence with more clarity, as in the cases of the *problematic social and school behaviors* category that reports on ingroup dynamics (Abrams and Rutland, 2008) and the *social identity* category on outgoup dynamics (Nesdale, 2007, 2011).

Context of known peers: Finally, the fact that peer rejection occurs between known peers who share identity or history is corroborated by the constant references in the reasons to particular classmates or relatives, terms such as 'friends' or 'us,' and known situations and norms. This condition of known peers in peer rejection has two implications. Precisely the fact that the children share a classroom and will probably continue to do so for some time makes rejection a highly socially significant situation, strongly stable and with negative outcomes (McDougall et al., 2001; García Bacete et al., 2014). Simultaneously this condition requires the reasons for peer rejection to be studied in their context (García Bacete et al., 2014; Mulvey et al., 2014).

Limitations and Future Directions

Some limitations of this study would refer to the studied populations, other to the use of data collecting techniques and other to group influence. Differential analyses need to be performed on the reason and context categories according to gender (Sureda et al., 2009), broadening the study to other ages (8–10, 11–13, and older), examining the differences in the reasons for rejection between minority and majority groups (e.g., children from minority/majority ethnic group, with/without special educational needs, rejected/average).

As seen above, many of the reasons are expressed briefly and imprecisely, with no type of indicator. It may be possible that children do not need more precise or detailed arguments; however, it would be interesting to carry out in-depth interviews to allow the children to explain what they do not like about their classmates in a broader and more precise way. It may be a potentially useful method for finding out whether they think the rejected child knows s/he is not liked, whether they do or say anything to make him or her know that they dislike him/her, whether children have criteria that they use consistently when thinking about how they feel about another child, and other similar questions.

Finally, we need to progress in the study of the influence of the classroom and the others. As discussed, our study has provided indicators, but it remains far from systematically undertaking this goal. Two alternatives: first, through the realization of multilevel studies in which being a member of a classroom represents the higher level, this study will help to know whether the motivational structure of rejection in a given classroom differs from the one in another classroom. Secondly, by examining if there is consensus across children on what they say about a particular child.

CONCLUSION

The present study reinforces that rejection is part of children's daily life. Only 4.5% of the participants did not name negatively

any children. Moreover, 94% of the rejecters express reasons for rejection. The richness of reasons for rejection as well as the subsequent comprehensive taxonomy could have been obtained only through the conceptual and methodological decisions adopted in this study, namely: understanding rejection as a relational evaluation, focusing on the rejecters as informants, studying rejection in its ecological context, and using qualitative methodology in the data collection and analysis.

In brief, main contributions of this study are: (a) Peer rejection is external to the rejected child; that is, what the rejected child does or says does not lead directly or inevitably to rejection. (b) Rejection occurs during the exchange of activities/behaviors and preferences/choices in a group context, or even in the absence of exchange, between a rejecter or group of rejecters and a rejected child or group of rejected children. (c) The sources and pathways that lead to rejection are the rejecters' interpretations of these exchanges in terms of interpersonal and group costs, negative personal and social identities, personal or group inertia or self-protection, evidencing a great interdependence between the interpersonal and the group levels. (d) Through the study of the reasons we could observe that peer rejection is a heterogeneous social reality, in the number of participants and the link between them, the frequency or intensity of it, and the degree of objectivity/subjectivity with which the rejecter refers to the exchanges. (e) The development of children at age 6 already displays a rich knowledge of the socio-cognitive domains used to explain the peer relationships, so that our findings revealed personal reasons, normative or socio-conventional reasons and moral reasons.

In summary, peer rejection at this age can be understood as a negative relational evaluation, expressed by individual or group rejecters, toward individually or group rejected children, in the form of a specific or general description, or a partial or total judgment, both unidirectionally and bidirectionally, and with a variable impact. Such evaluation operates simultaneously in the personal, social and moral domains (Mulvey et al., 2014), as an exercise of personal autonomy (Nucci, 2001), or in response to attacks or threats (Ladd, 2005), or as a prejudicial aversion (Mulvey et al., 2010), or even in the absence of interactions and arguments (Williams and Zadro, 2001). In definitive, the study provides researchers and practitioners with a comprehensive taxonomy of reasons for rejection that contributes to the theoretical construct of peer rejection and the design of interventions for preventing and reducing peer rejection.

AUTHOR CONTRIBUTIONS

FG: Led and designed the study, coordinated data collection, performed the analysis and interpretation of the data, and drafted the manuscript. VC: Revised the analytic strategies, participated in the analysis and interpretation of the data, and helped to draft the manuscript. GMD: Participated in data collection, participated in the analysis and interpretation of the data, and helped to draft the manuscript. GMO: Contributed to the analysis and interpretation of the data, revised critically the study, and participated in drafting the manuscript. All authors approved the final manuscript as submitted.

ACKNOWLEDGMENTS

This work was supported by grant EDU2012-35930 from the Spanish Ministry of Education and grant P1-1A2012-04 from the Jaume I University. We thank all the students, teachers, and families for their participation.

REFERENCES

Abrams, D., Hogg, M. A., and Marques, J. M. (2005). "A social psychological framework for understanding social inclusion and exclusion," in *The Social Psychology of Inclusion and Exclusion*, eds D. Abrams, J. M. Marques, and M. A. Hogg (Philadelphia, PA: Psychology Press), 1–26.

Abrams, D., and Rutland, A. (2008). "The development of subjective group dynamics," in *Intergroup Relations and Attitudes in Childhood through Adulthood*, eds S. R. Levy and M. Killen (Oxford: Oxford University Press), 47–65.

Allport, G. W. (1954). *The Nature of Prejudice*. Reading, MA: Addison–Wesley.

Asher, S. R. (1990). "Recent advances in the study of peer rejection," in *Peer Rejection in Childhood*, eds S. R. Asher and J. D. Coie (Cambridge: Cambridge University Press), 3–14.

Asher, S. R., and McDonald, K. L. (2009). "The behavioral basis of acceptance, rejection, and perceived popularity," in *Handbook of Peer Interactions, Relationships, and Groups: Social, Emotional, and Personality Development in Context*, eds K. H. Rubin, W. M. Bukowski, and B. Laursen (New York, NY: Guilford), 232–249.

Asher, S. R., Rose, A. J., and Gabriel, S. W. (2001). "Peer rejection in everyday life," in *Interpersonal Rejection*, ed. M. Leary (New York, NY: Oxford University Press), 105–142.

Baumeister, R. F., and Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychol. Bull.* 117, 497–529. doi: 10.1037/0033-2909.117.3.497

Bierman, K. L. (2004). *Peer Rejection: Developmental Processes and Intervention Strategies*. New York, NY: The Guilford Press.

Bourdieu, P. (1985). The social space and the genesis of groups. *Theory Soc.* 14, 723–744. doi: 10.1007/bf00174048

Brown, C. S., and Bigler, R. S. (2005). Children's perceptions of discrimination: a developmental model. *Child Dev.* 76, 533–553. doi: 10.1111/j.1467-8624.2005.00862.x

Carrero, V. E., Soriano, R., and Trinidad, A. (2012). *Teoría Fundamentada "Grounded Theory": El Desarrollo de la Teoría desde la Generalización Conceptual [Grounded Theory": The Construction of Theory from Conceptual Generalization]*. Madrid: Centro de Investigación Sociológica, 37.

Chang, L. (2004). The role of classroom norms in contextualizing the relations of children's social behaviors to peer acceptance. *Dev. Psychol.* 40, 691–702. doi: 10.1037/0012-1649.40.5.691

Cillessen, A. H. N. (2009). "Sociometric methods," in *Handbook of Peer Interactions, Relationships, and Groups*, eds K. H. Rubin, W. M. Bukowski, and B. Laursen (New York, NY: Guilford), 82–99.

Coie, J. D., Dodge, K. A., and Kupersmidt, J. (1990). "Peer group behavior and social status," in *Peer Rejection in Childhood*, eds S. R. Asher and J. D. Coie (Cambridge: Cambridge University Press), 17–58.

Dirks, M. A., Treat, T. A., and Weersing, R. (2007). Integrating theoretical, measurement, and intervention models of youth social competence. *Clin. Psychol. Rev.* 27, 327–347. doi: 10.1016/j.cpr.2006.11.002

Doosje, B., Spears, R., and Ellemers, N. (2002). Social identity as both cause and effect: the development of group identification in response to anticipated and

actual changes in the intergroup status hierarchy. *Br. J. Soc. Psychol.* 41, 57–76. doi: 10.1348/014466602165054

Dubé, J. E. (2008). Evaluación del acuerdo interjueces en investigación clínica. Breve introducción a la confiabilidad interjueces [Evaluation of interrater reliability in clinical research. A brief introduction to interrater reliability]. *Rev. Argent. Clin. Psicol.* 17, 75–80.

Earn, B. M., and Sobol, M. P. (1984). A categorical analysis of children's attributions for social experience. *Psychol. Rec.* 40, 173–186.

Elig, T. W., and Frieze, I. H. (1975). *A Multi-Dimensional Scheme for Coding and Interpreting Perceived Causality for Success and Failure Events/Coding Scheme of Perceived Causality, CSPC*. Washington, DC: American Psychological Association.

Elig, T. W., and Frieze, I. H. (1979). Measuring causal attributions for success and failure. *J. Pers. Soc. Psychol.* 37, 621–634. doi: 10.1037/0022-3514.37.4.621

Feinberg, M. R., Smith, M., and Schmidt, R. (1958). An analysis of expressions used by adolescents of varying economic levels to describe accepted and rejected peers. *J. Genet. Psychol.* 93, 133–148. doi: 10.1080/00221325.1958.10532411

García Bacete, F. J., and González, J. (2010). *Evaluación de la Competencia Social Entre Iguales [Assessment of the Peer Social Competence: the Sociometry and Other Measures]*. Madrid: TEA Ediciones.

García Bacete, F. J., Marande Perrin, G., Sanchiz Ruiz, M. L., Sureda García, I., Ferrá Coll, P., Jiménez Lagares, I., et al. (2014). *El Rechazo Entre Iguales en su Contexto Interpersonal: Una Investigación con Niños y Niñas de Primer Ciclo de Educación Primaria [Peer Rejection in its Interpersonal Context: A Research Work on Children in First and Second Grades of Elementary Education]*. Castellón: Fundación Dávalos–Fletcher.

Gifford-Smith, M. E., and Brownell, C. A. (2003). Childhood peer relationships: social acceptance, friendships, and peer networks. *J. Sch. Psychol.* 41, 235–284. doi: 10.1016/S0022-4405(03)00048-7

Glaser, B. G. (1978). *Theoretical Sensitivity: Advances in the Methodology of Grounded Theory*. Mill Valley, CA: Sociology Press.

Glaser, B. G. (1992). *Basic of Grounded Theory Analysis: Emergence vs. Forcing*. Mill Valley, CA: Sociology Press.

Glaser, B. G., and Strauss, A. L. (1967). *The Discovery of Grounded Theory*. Aldine de Gruyter, CA: Sociology Press.

Goetz, T. E., and Dweck, C. (1980). Learned helplessness in social situations. *J. Pers. Soc. Psychol.* 39, 246–255. doi: 10.1037/0022-3514.39.2.246

Guerra, V. S., Asher, S. R., and DeRosier, M. E. (2004). Effect of children's perceived rejection on physical aggression. *J. Abnorm. Child Psychol.* 32, 551–563. doi: 10.1023/B:JACP.0000037783.88097.69

Hatfield, E., and Rapson, R. L. (2011). "Equity theory in close relationships," in *Handbook of Theories of Social Psychology*, eds P. A. M. van Lange, A. W. Kruglanski, and E. T. Higgins (London: Glyph International), 200–217.

Horn, S. (2006). Group status, group bias, and adolescents' reasoning about treatment of others in school contexts. *Int. J. Behav. Dev.* 30, 208–218. doi: 10.1177/0165025406066721

Killen, M. (2007). Children's social and moral reasoning about exclusion. *Curr. Dir. Psychol. Sci.* 16, 32–36. doi: 10.1111/j.1467-8721.2007.00470.x

Killen, M., Mulvey, K. L., and Hitti, A. (2013). Social exclusion: a developmental intergroup perspective. *Child Dev.* 84, 772–790. doi: 10.1111/cdev.12012

Killen, M., Rutland, A., and Jampol, N. S. (2009). "Social exclusion in childhood and adolescence," in *Handbook of Peer Interactions, Relationship, and Groups*, eds K. H. Rubin, W. M. Bukowski, and B. Laursen (New York, NY: Guilford Press), 249–266.

Kohlberg, L. (1984). *Essays on Moral Development: The Psychology of Moral Development–The Nature and Validity of Moral Stages*, Vol. Vol. 2. San Francisco: Harper and Row.

Ladd, G. W. (2005). *Children's Peer Relations and Social Competence*. New Haven, CT: Yale University Press.

Landis, J. R., and Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics* 33, 159–174. doi: 10.2307/2529310

Leary, M. R. (2001). "Toward a conceptualization of interpersonal rejection," in *Interpersonal Rejection*, ed. M. R. Leary (New York, NY: Oxford University Press), 3–20.

Leary, M. R. (2005). "Varieties of interpersonal rejection," in *The Social Outcast: Ostracism, Social Exclusion, Rejection, and Bullying*, eds K. D. Williams, J. P. Forgas, and W. von Hippel (New York, NY: Psychology Press), 35–51.

Levine, J. M., and Moreland, R. L. (1994). "Group socialization: theory and research," in *European Review of Social Psychology*, Vol. 5, eds W. Stroebe and M. Hewstone (New York, NY: John Wiley and Sons), 305–336.

Lev-Wiesel, R., Sarid, M., and Sternberg, R. (2013). Measuring social peer rejection during childhood: development and validation. *J. Aggress. Maltreat. Trauma* 22, 482–492. doi: 10.1080/10926771.2013.785456

Lincoln, Y. S., and Guba, E. G. (1985). *Naturalistic Inquiry*. Beverly Hills, CA: Sage Publications, Inc.

Martín-Antón, L. J., Monjas, M. I., García Bacete, F. J., and Jiménez-Lagares, I. (2016). Problematic social situations for peer-rejected students in the first year of elementary school. *Front. Psychol.* 7:1925. doi: 10.3389/fpsyg.2016.01925

McDougall, P., Hymel, S., Vaillancourt, T., and Mercer, L. (2001). "The consequences of childhood peer rejection," in *Interpersonal Rejection*, ed. M. R. Leary (New York, NY: Oxford University Press), 213–247.

Mikami, A. Y., Lerner, M. D., and Lun, J. (2010). Social context influences on children's rejection by their peers. *Child Dev. Perspect.* 4, 123–130. doi: 10.1111/j.1750-8606.2010.00130.x

Monjas, M. I., Sureda, I., and García Bacete, F. J. (2008). ¿Por qué los niños y niñas se aceptan y se rechazan? [Why do children accept and reject each other?]. *Cult. Educ.* 20, 479–492. doi: 10.1174/113564008786542181

Mulvey, K. L., Hitti, A., and Killen, M. (2010). The development of stereotyping and exclusion. *Wires. Cogn. Sci.* 1, 597–606. doi: 10.1002/wcs.66

Mulvey, K. L., Hitti, A., Rutland, A., Abrams, D., and Killen, M. (2014). Context differences in children's ingroup preferences. *Child Dev.* 50, 1507–1519. doi: 10.1037/a0035593

Nesdale, D. (2007). "The development of ethnic prejudice in early childhood: theories and research," in *Contemporary Perspectives on Social Learning in Early Childhood Education*, eds O. Saracho and B. Spodek (Charlotte, NC: Information Age Publishing), 213–240.

Nesdale, D. (2011). Social groups and children's intergroup prejudice: just how influential are social group norms? *An. Psicol.* 27, 600–610.

Nesdale, D., and Duffy, A. (2011). Social identity, peer group rejection, and young children's reactive, displaced, and proactive aggression. *Br. J. Dev. Psychol.* 29, 823–841. doi: 10.1111/j.2044-835X.2010.02012.x

Newcomb, A. F., Bukowski, W. M., and Pattee, L. (1993). Children's peer relations: a meta-analytic review of popular, rejected, neglected, controversial, and average sociometric status. *Psychol. Bull.* 113, 99–128. doi: 10.1037/0033-2909.113.1.99

Nucci, L. P. (2001). *Education in the Moral Domain*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511605987

Orue, I., and Calvete, E. (2011). Reciprocal relationships between sociometric indices of social status and aggressive behavior in children: gender differences. *J. Soc. Pers. Relat.* 28, 963–982. doi: 10.1177/0265407510397982

Rubin, K., Bukowski, W., and Parker, J. G. (2006). "Peer interactions, relationships, and groups," in *Handbook of Child Psychology: Social, Emotional, and Personality Development*, Vol 3, eds N. Eisenberg, W. Damon, and R. M. Lerner (Hoboken, NJ: John Wiley and Sons Inc), 571–645.

Saarento, S., Kärnä, A., Hodges, E. V. E., and Salmivalli, C. (2013). Student–classroom–and school-level risk factors for victimization. *J. Sch. Psychol.* 51, 421–434. doi: 10.1016/j.jsp.2013.02.002

Sandstrom, M. J., and Zakriski, A. L. (2004). "Understanding the experience of peer rejection," in *Children's Peer Relations: From Development to Intervention*, eds J. B. Kupersmidt and K. A. Dodge (Washington, DC: American Psychological Association), 101–118. doi: 10.1037/10653-006

Scandroglio, B., López, J., and San José, M. C. (2008). La teoría de la identidad social: una síntesis crítica de sus fundamentos, evidencias y controversias [social identity theory: a critical synthesis of its bases, evidence and controversies.]. *Psicothema* 20, 80–89.

Selman, R. (2003). *The Promotion of Social Awareness: Powerful Lesson from Partnership of Developmental Theory and Classroom Practice*. New York, NY: Russell Sage Foundation.

Smetana, J. G. (2006). "Social-cognitive domain theory: consistencies and variations in children's moral and social judgments," in *Handbook of Moral Development*, eds M. Killen and J. G. Smetana (Mahwah, NJ: Lawrence Erlbaum Associate), 119–154.

Smith, G. D. (1950). Sociometric study of best-liked and least-liked children. *Elem. Sch. J.* 51, 77–86. doi: 10.1086/459206

Strauss, A. L., and Corbin, J. (2007). *Basics of Qualitative Research*, 3rd Edn. Thousand Oaks, CA: Sage.

Suárez, C., del Moral, G., and González, M. T. (2013). Consejos prácticos para escribir un artículo cualitativo publicable en Psicología [Tips for writing a publishable qualitative article in Psycho]. *Psychosoc. Interv.* 22, 71–79. doi: 10.5093/in2013a9

Suárez, C., Del Moral, G., Martínez, B., John, B., and Musitu, G. (2016). El patrón de consumo de alcohol en adultos desde la perspectiva de los adolescentes [Adult pattern of alcohol use as perceived by adolescents]. *Gac. Sanit.* 30, 11–17. doi: 10.1016/j.gaceta.2015.06.004

Sureda, I., García Bacete, F. J., and Monjas, M. I (2009). Razones de niños y niñas de diez y once años para preferir o rechazar a sus iguales [Reasons why ten and eleven years old children prefer or reject their peers]. *Rev. Lat. Am. Psicol.* 41, 305–321. doi: 10.14349/rlp.v41i2.382

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *Am. J. Eval.* 27, 237–246. doi: 10.1177/1098214005283748

Turiel, E. (1998). Cultural practices, oppression, and morality. *Hum. Dev.* 41, 166–171. doi: 10.1159/000022576

Valles, M. (2000). *Técnicas Cualitativas de Investigación Social*. Madrid: Síntesis.

Williams, K. D., and Zadro, L. (2001). "Ostracism: on being ignored," in *Interpersonal Rejection*, ed. M. R. Leary (New York, NY: Oxford University Press), 21–53.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 García Bacete, Carrero Planes, Marande Perrin and Musitu Ochoa. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 22 March 2017
doi: 10.3389/fpsyg.2017.00441

Risk and Protective Factors Associated to Peer School Victimization

Inmaculada Méndez[1], Cecilia Ruiz-Esteban[1] and J. J. López-García[2]*

[1] Department of Developmental Psychology and Education, University of Murcia, Murcia, Spain, [2] Department of Basic Psychology and Methodology, University of Murcia, Murcia, Spain

The main objective of this study is to analyze the relationship between peer school victimization and some risk and protection factors and to compare the differences by role in victimization with those of non-involved bystanders. Our participants were 1,264 secondary students ($M = 14.41$, $SD = 1.43$) who participated voluntarily, although an informed consent was requested. A logistic regression model (LR) was used in order to identify the victim's potential risks and protective factors related to non-involved bystanders. A multiple LR and a forward stepwise LR (Wald) were used. The results showed the variables related to the victim profile were: individual features (to be male, to be at the first cycle of compulsory Secondary Education and a few challenging behaviors), school environments (i.e., school adjustment), family environment (parental styles like authoritarianism) and social environment (i.e., friends who occasionally show a positive attitude toward drug consumption and easy access to drugs, access to drugs perceived as easy, rejection by peers or lack of social acceptance and social maladjustment). The results of the study will allow tackling prevention and intervention actions in schools, families, and social environment in order to improve coexistence at school and to assist the victimized students in the classroom.

Keywords: bullying, secondary education, adolescence, drug consumption, peers, family

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Eva M. Romera, Universidad de Córdoba, Spain
Thomas James Lundy, Cuttlefish Arts, USA
Esther Maria Secanilla, Universitat Autònoma de Barcelona, Spain

****Correspondence:***
Inmaculada Méndez
inmamendez@um.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *09 November 2016*
Accepted: *09 March 2017*
Published: *22 March 2017*

Citation:
Méndez I, Ruiz-Esteban C and López-García JJ (2017) Risk and Protective Factors Associated to Peer School Victimization. Front. Psychol. 8:441. doi: 10.3389/fpsyg.2017.00441

INTRODUCTION

Among the problems that arise at school ages, there may appear situations of harassment or bullying (Ortega-Ruiz, 2015), that is, an aggressive and intentional attack carried out repeatedly and overtime by a group or an individual against a victim who cannot easily fight back; or in other words, a power imbalance (Olweus, 1993, 2013). This problem makes no distinctions between geographic location, social status, public or private schools, etc. The report issued by Save the Children in Spain (Sastre, 2016) reveals that 9.3% of students have ever been bullying victims. Moreover, 5.4% of them admitted to have been bullied. There are three groups of key actors involved in bullying: aggressor, victim, provocative victim (Olweus, 2013). Literature also reinforces the key role of non-involved bystanders in bullying dynamics. Bystanders not involved in the action can take on different roles (Sullivan et al., 2005): accomplices, boosters, non-involved bystanders and defenders). Out of fear of clashing with the aggressor, some students become morally involved in false rules of silence (Ortega, 2000; Armas, 2007). Thus, the main objective of this study is to analyze the relationship between peer school victimization and some risk and protection factors and the differences by role in victimization comparing them with those of the non-involved bystanders in the action. There are different

risks or protective factors, both personal and contextual or environmental, that accelerate victimization or make it more likely to happen.

With regards to social environment, examples of risk factors that can be associated with peers include at interpersonal level: peer group as pattern of submission and need of acceptance (Sullivan et al., 2005); modeling (Sánchez et al., 2007; Alfonso et al., 2009; Pérez-Fuentes and Gázquez, 2010; Delegación del Gobierno para el Plan Nacional sobre Drogas [DGPNSD], 2014), especially through the best friend (Espada et al., 2008); promoting access to drug use (Cerezo et al., 2013); the existence of drugs in the social environment which implies their accessibility, their visibility and their availability together with the attitude of society toward drugs (Delegación del Gobierno para el Plan Nacional sobre Drogas [DGPNSD], 2007).

Several studies have found that victimization is related to multiple variables related to individual features too. For instance, it has been observed that the possibility of becoming a victim depends on some variables. Some personal features are: to be younger than the aggressors and the average classmate (Astor et al., 2001; Cerezo, 2009; Dinkes et al., 2009), to be at the first cycle of secondary studies (Serrano and Iborra, 2005); males as more likely to become victims, shyness, little self-control, low self-esteem, high anxiety, etc. (Cerezo, 2009); provocative victim involved in other risky behaviors such as drugs/consumption (Kaltiala-Heino et al., 2000; Cerezo and Méndez, 2009; Tharp-Taylor et al., 2009).

As family protective factors against victimization, some studies underline that adolescents may perceive an over protective family environment, organization and control. Such an over protection would imply a great difficulty to face arrogant or abuse attitudes (Ortega, 2000; Samper-García et al., 2015). Studies have shown that sibling relationships are considered a source of risk or of protection against violence or victimization depending on the sibling size (Piñero-Ruiz et al., 2012).

Traditionally, literature on bullying points out that it is school adaptation what predicts the role of victim. Some studies have evidenced that failure to adapt to school promotes aggressive behaviors as opposed to victimization (Cerezo, 2009; Méndez and Cerezo, in press). As far as the child's interaction with the peer group diminishes, the child may become more and more isolated and socially rejected (Armas, 2007; Cerezo, 2009; Cerezo and Ato, 2010). Even peer acceptance is recognized as a protection factor against peer victimization (Demaray and Malecki, 2003; Schmidt and Bagwell, 2007).

Thus, the main objective of this study is to analyze the relationship between peer victimization and some risk and protection factors and to identify the differences by role in victimization and compare them with the ones of non-involved bystanders. Some risk and protection factors (personal and environmental) as well as the level of comprehensive maladjustment (personal, at school, in society and with family), often favor or prevent other risk behaviors (consumption of legal drugs and challenging behavior) that shape the victim profile involved in bullying. To this purpose, this research identifies victims' potential risk and protective factors and compares them with those of non-involved bystanders.

MATERIALS AND METHODS

Participants

Participants in this study were 1.264 students (50.8% female). Age range: 11–18 years old, $M = 14.41$, $SD = 1.43$ (0.2% 11 years old, 11.3% 12 years old,15.7% 13 years old, 22.3% 14 years old, 27.9% 15 years old, 15.7% 16 years old, 5.9% 17 years old and 0.9% 18 years old) in 13 compulsory secondary education institutions. The participants attended public (66.2%) and private/semi-private (33.8%) secondary schools in different geographical areas of the Region of Murcia (72.8% urban and 27.2% rural areas). 83.5% of them were Spanish and 16.5% were foreigners. Distribution by grade: 45.1% ($n = 557$) at first level and 54.9% ($n = 679$) at second level.

Design and Procedure

This research work is transversal and descriptive. The selection of the participant schools was determined by their acceptance to take part in the study. The participant students were selected from secondary schools in the Region of Murcia, Spain. After obtaining the corresponding permission, students were approached in their own classrooms at school. Researchers explained the objectives of the study and the instruments that would be used. Participation was voluntary and anonymous. The inclusion criteria used were: students in compulsory secondary education, aged between 11 and 18 years. They were requested to attend the school and sit a test that classified them as victims or non-involved bystanders by their own classmates, according to the test Bull-S (Cerezo, 2012). On the other hand, the exclusion criteria were: non-attendance the day the test was passed out, language problems to fully understand the instruments, to be considered an aggressor or a provocative victim by their peers according to the test Bull-S (description in instrument). After obtaining the sample, the selection of individuals was based on the inclusion criteria mentioned above, as it was necessary to focus on the roles of victim and non-involved bystander.

This study was carried out in accordance with the recommendations of the Oviedo Agreement and it was reviewed and approved by the Ethic Committee for clinic research of the University of Murcia. All participants were requested a written informed consent. Parents also gave written informed consent in accordance with the Declaration of Helsinki.

Two sessions of 50 min were used to complete the tests (20 min the Bull-S Test, 20–25 min the second scale, 15–20 min the FRIDA and 30–40 min the TAMAI).

Data Analysis

In this paper we used a logistic regression (LR) procedure to relate a dichotomous variable (bullying victim/non-involved bystanders) to a set of categorical and continuous variables, which enabled us to identify potential risks and protective factors. In order to analyze the effect of each variable separately, a simple LR (crude odds ratio) was performed. In addition, with the purpose of identifying the variables related to the victim role, a multiple LR and a forward stepwise LR (Wald) were applied. The Odds Ratio (OR) and the 95% confidence interval were calculated

in each case. In these multiple models, we have weighted the fit to the model (Hosmer-Lemeshow Test), the significance of coefficients (Omnibus test) as well as an estimation of the (pseudo) determination coefficient (CoxSnell and Nagelkerke). All analyses were run with SPSS 19.0.

Instruments

Students were requested to fill in the following instruments:

First of all, the Bull-S test (version 3.3) Assessment Test of Aggressiveness was used (Cerezo, 2012). It consisted of 15 direct choice Likert items and was addressed to all individuals in the group-class. The test had three dimensions:

- Dimension 1: Sociometric status (four items by peer nominations). It included a nominal variable that measured individual social status in the group (leader, popular, very rejected, rejected, isolated, controversial, and average). It also included two quantitative variables: the social impact (ISI) indicates the percentage of peers related to each student and the social preference (SPS), which represents the difference between the peers who have assessed a student positively and those who have done so negatively. It also provides information on the level of cohesion in the group-class.
- Dimension 2: Bullying dynamic (six items by peer nominations). It provided information on the students who stood out in at least 25% of each profile linked to bullying dynamics. The features associated to the aggressor profile were related to continuous items: physical strength, aggressiveness and provoking behavior; and those associated with the victim role: cowardice, victimization and fixation. Individuals who scored significantly high in victimization and fixation were classified as provocative victim. In addition, we obtained a qualitative variable reporting on the role assumed in bullying: aggressor, victim, provocative victim or non-involved students (non-involved bystanders).
- Dimension 3: Situational perception (5 Likert scale items). It analyzed the situational aspects in aggressive relationships among peers: type of aggression (insults and threats, physical abuse, rejection and others), place of the aggression (classroom, playground, corridors, and others), frequency of the attacks (never, once or twice a week, rarely or everyday), seriousness of the attacks (not serious at all, hardly serious, serious, quite serious or very much serious), security at school (not safe at all, hardly safe, average, quite safe or very much safe).

The test included socio-demographic variables too. Gender (male/female), age, grade, origin (Spanish/foreigner), course repetition (yes/no), nature of the school (public/private/semi-private) and geographical location (urban/rural) were also collected as variables. Cronbach's alpha coefficient was 0.68 for total scale scores (73 for aggressors and 0.84 for victims) (Cerezo, 2012). In this study, the coefficient was 0.68 for total scale scores (0.83 for aggressors and 0.84 for victims). Example of items: Whom would you choose as a classmate in the classroom?

The second scale we applied (Méndez et al., unpublished) was based on the "National Survey on Drug Consumption in Secondary School Students" (ESTUDES), issued by the Government Delegation for the National Drug Plan –Delegación del Gobierno para el Plan Nacional sobre Drogas [DGPNSD] (2008) to detect substance use among adolescents in educative contexts. It included 19 dichotomous items about drug consumption and other behaviors. The scale consisted of two factors. Factor I – "Substance Abuse and Health Consequences" – was based on the use of illegal drugs; a higher score indicated a greater possibility of health risk behaviors (have you either participated in any fighting or suffered or initiated any physical attack?, have you been arrested by the police, expelled from school for one or more full days or carry out activities that put your health at risk?) and illegal drug consumption. And Factor II – "Legal Drug Consumption and Challenging Behavior" –, where a higher score indicated a greater possibility of challenging behaviors (Have you had a major conflict or argument with parents or siblings? have you run away from home for more than a day?) and legal drug consumption. Cronbach's alpha reliability coefficient for total scale scores was 0.64 (0.63 for Factor I and 0.64 for Factor II). The Bartlett statistics were good indicators that a matrix of tetrachoric correlations could be subject to EFA Bartlett $(190) = 4269.1$, $p < 0.001$, and KMO index, KMO = 0.82. Each factor consisted of different items with a factorial loading > 0.30. The total variance explained by two factors was 58.3%. Example of items: Have you ever smoked a cigarette? Yes/No.

In the third place, we used FRIDA – Interpersonal Risk Factors for Drug Consumption in Adolescence (Secades et al., 2006). It consisted of 90 items in a Likert scale (3 or 5 points), providing a global index of vulnerability or risk and measuring seven factors. Factor 1 ($\alpha = 0.88$) – "Family Reaction against Drug Consumption" – higher values indicate lower family reaction; for example, the family does not get annoyed if the child is discovered to be smoking. Factor 2 ($\alpha = 0.86$) – "Peers" – it evaluates friends' attitude toward drug consumption, friends' drug consumption and risk activities; higher levels indicate friends have a higher permissive attitude toward drugs and may even be drug consumers. Factor 3 ($\alpha = 0.89$) – "Access to drugs" – it evaluates how easily adolescents access drugs; the higher the value, the easier the access; Factor 4 ($\alpha = 0.64$) – "Family Risks" – it inquiries into family relationships, drug consumption and family conflicts; higher values indicate more family conflicts and drug consumption. Factor 5 ($\alpha = 0.85$) – "Family Education about Drugs" – evaluates the amount of information adolescents receive from their families about drugs; high values indicate a lack of rules about drug consumption. Factor 6 ($\alpha = 0.74$) – "Family Protective Activities" – includes leisure and sport activities and measures the quality of relationships and academic achievement; higher values indicate less protective activities. Factor 7 ($\alpha = 0.70$) – "Parental Educational Styles" – it reports on how authoritarian or permissive the parenting style is (higher scores indicate more permissiveness, while lower scores indicate a democratic style and moderate scores an authoritative one). Cronbach's alpha reliability coefficient was 0.925 for total scale scores (Secades et al., 2006). In this study, the reliability coefficient was 0.81 and in each dimension: Factor 1 ($\alpha = 0.88$), Factor 2 ($\alpha = 0.80$), Factor 3 ($\alpha = 0.90$), Factor 4 ($\alpha = 0.79$),

Factor 5 (α = 0.71), Factor 6 (α = 0.85), and Factor 7 (α = 0.83). Example of item: My best friend smokes. A Not at all, B Occasionally, C Sometimes, D Often.

The fourth scale we used was the Multifactorial Self-evaluation Child Adaptation Test -TAMAI- (Hernández- Guanir, 2015); it consists of 175 dichotomous items that measure five factors. Factor P (α = 0.85) – "Personal Maladjustment," a high score reports a lack of self-acceptance. Factor E (α = 0.86) – "School Maladjustment," a high score indicates a lack of satisfaction at school, the appearance of disruptive behavior in the classroom and negative attitudes toward learning. Factor S (α = 0.75) – "Social Maladjustment," a high score means poor social abilities showing apprehension or distrust. Factor F (α = 0.75) – "Family Maladjustment" – a high score implies a lack of satisfaction with home environment and parents relationship. Factor IH (α = 0.70) – "Sibling Maladjustment" – a high score indicates a lack of satisfaction with sibling interaction. Cronbach's alpha reliability coefficient was 0.92 for the total scale scores (Hernández- Guanir, 2015). In this study, the reliability coefficient was 0.80 and in each dimension: Factor P (α = 0.71), Factor E (α = 0.83), Factor S (α = 0.70), Factor F (α = 0.70) Factor IH (α = 0.64). Example of item: I have few friends (A) YES (B) NO.

RESULTS

The distribution of roles in bullying issues among the 1,264 adolescents we studied was as follows: 125 (9.9%) victims, 109 (8.6%) aggressors 7 (0.6%) provocative victim and 1,023 (80.9%) non-involved bystanders. In order to identify possible risk and protection factors in the victim role, a LR analysis was conducted. We compared 125 young victims with 1023 non-involved bystanders. **Table 1** shows the categorical and quantitative variables used for the LR procedure. Firstly, a simple LR analysis (crude) enabled us to detect the individual effect of each variable in the role of victim. The variables in the table proved to be significant in the simple LR (crude). The following risk factors resulted statistically significant: (1) Perceived attitude in friends toward access to drugs (OR = 1.879): students who perceive that their friends would have a moderate easy access to drugs are more likely to be victims than those who perceive little facility; (2) a difficult access to drugs (OR = 2.667): students with easy access to drugs are more likely to fit the profile than those who perceive it as difficult; (3) Parenting style (OR: 2.995): an authoritarian education style can result in three times more risk than a democratic style; (4) Compulsory Secondary Education level (OR = 1.531): undergraduate students (youth) are more likely to become victims than students in the second cycle; (5) Sex (OR = 4.066): being male multiplied the risk by 4 when compared to females; (6) Student social status (OR = 8.280): students 'rejected' by their peers have eight times more risk of becoming a victim than other students; (7) Social maladjustment (OR = 1.062): students with higher social maladjustment show a higher risk of becoming victims; (8) Challenging behaviors (OR = 0.848): lower challenging behavior increases the possibilities of becoming a victim; (9) School maladjustment (OR = 0.968): students with higher school adjustment are more likely to become victims. On the other hand, there were significant protection factors: (1) Being popular among peers (OR = 0.218), compared to average students; (2) Age (OR = 0.848): the older peers take a lower risk; and (3) Social Preference (OR = 0.872): those elected by fellow students show a lower risk.

Subsequently, a multiple LR analysis (Adjusted) was accomplished, aiming to identify risk/no protection or non-redundant factors. With this procedure, the following simultaneous risk factors to become a victim were identified: being male, school adapted, socially maladjusted and slightly preferred by their peers.

Last, aiming at the exclusion of irrelevant or redundant factors, some variables were selected with a Forward LR (Wald statistics) procedure (Forward selection), which confirmed the aforementioned factors, including an additional one: Perception of the friends' attitude toward access to drugs. Students who perceive that their friends would have a moderate or easy access to drugs are more likely to become victims.

These results are similar if analyzed separately for boys and girls.

DISCUSSION

Understanding the factors that predict peer victimization at school requires a close examination of the complex inter-relationships between the individual and his/her environment. In this study, a number of factors related to victimization in secondary education adolescents have been identified.

Concerning social environment, the results of our study show that adolescents who have less drug-friendly friends are more likely to be potential victims than those who show a higher tolerance. The results obtained in relation to social environment are consistent with other research works that show adolescents can be influenced by their group of friends on drugs consumption (Sánchez et al., 2007; Alfonso et al., 2009; Pérez-Fuentes and Gázquez, 2010; Delegación del Gobierno para el Plan Nacional sobre Drogas [DGPNSD], 2014), especially through best friend (Espada et al., 2008), and even promote the perception of easy access to its consumption (Cerezo et al., 2013).

In this sense, our findings point out that those adolescents who perceive easier access to drugs might be at greater risk of becoming victims. Nevertheless, the victim profile is not usually involved in challenging behaviors (i.e., legal drug consumption, have you had a major conflict or argument with parents or siblings, run away from home for more than a day?), unlike studies on the aggressor profile, provocative victim or non-involved bystanders (Kaltiala-Heino et al., 2000; Cerezo and Méndez, 2013). Probably, this difference between group values and individual's behavior makes perception become a risk factor to become a victim.

In relation to family environment, the results obtained regarding the parenting style support revealed that children exposed to peer victimization have a different home environment than those who are not. Children whose parents show an

TABLE 1 | Logistic regression for victim role.

Categorical variable				Logistic regression: B/OR (95% CI)		
	Category	***N***	**%**	**Crude**	**Adjusted**	**Forward selection**
Peers	Low	33	9.1	Ref***	Ref	Ref**
	Moderate	512	15.8	0.631/1.879 (0.560–6.304)	0.272/1.313 (0.242–7.114)	1.104/3.018 (0.756–12.046)
	High	603	6.8	−0.315/0.615 (0.214–2.492)	−0.243/0.785 (0.143–4.293)	0.381/1.523 (0.371–6.264)
Access to drugs	Low	175	7.4	Ref***	Ref	
	Moderate	643	8.4	0.133 / 1.142 (0.608–2.145)	0.386/1.471 (0.692–3127)	
	High	329	17.6	0.981/2.667** (1.417–5.018)	0.754/2.126 (0.986–4.584)	
Parental educational styles	Democratic	50	6.0	Ref**	Ref	
	Authoritative	334	15.9	1.083/2.995 (0.887–9.845)	0.906/2.473 (0.606–10.096)	
	Permissive	764	9.0	0.442/1.555 (0.472–5.128)	0.804/2.235 (0.554–9.021)	
Grade	Second	621	9.2	Ref*	Ref	
	First	500	13.4	0.426/1.531* (1.053–2.227)	−0.103/0.902 (0.463–1.758)	
Gender	Female	617	5.0	Ref***	Ref***	Ref***
	Male	531	17.7	1.403/4.066*** (2.660–6.216)	1.380/3.974*** (2.449–6.427)	1.416/4.157*** (2.573–6.715)
Status	Average	778	9.3	Ref***	Ref	
	Leader	24	0	−18.920/0	−17.210/0	
	Popular	92	2.2	−1.524/0.218*(0.053–0.903)	−0.308/0.735 (0.180–4.259)	
	Rejected	83	45.8	2.114/8.280*** (5.046–13.587)	−0.342/0.710 (0.292–1.727)	
	Isolated	171	7.6	−0.215/0.807(0.436–1.493)	−0.086/0.917 (0.476–1.767)	
Continous Variable	**Victim(125)**	**Non-involved (1023)**				
Age	14.10 (1.45)[a]	14.44 (1.43)[a]		−0.165/0.848* (0.744–0.966)	−0.132/0.876 (0.697–1.101)	
Legal drug consumption and challenging behavior (Factor II)	1.74 (1.64)	2.36 (2.12)		−0.163/0.850** (0.767–0.942)	0.010/1.010 (0.884–1.154)	
School maladjustment	9.86 (6.03)	11.31 (6.87)		−0.032/0.968* (0.941–0.996)	−0.052/0.949* (0.910–0.990)	−0.061/0.943** (0.905–0.982)
Social maladjustment	9.74 (5.09)	8.23 (4.90)		0.060/1.062*** (1.023–1.101)	0.093/1.103*** (1.050–1.159)	0.099/1.105*** (1.053–1.160)
Social preference (SPS)	−7.14 (11.62)	2.47 (6.32)		−0.137/0.872*** (0.850–0.895)	−0.132/0.877*** (0.839–0.916)	−0.121/0.885*** (0.862–0.910)
					HLT = 8.793; $p = 0.360$ OT = 212.262; $p < 0.001$ R^2Cox-Snell = 0.173 R^2Nagelkerke = 0.344	HLT = 6.566; $p = 0.584$ OT = 208.842; $p < 0.001$ R^2Cox-Snell = 0.164 R^2Nagelkerke = 0.327

N: Total cases. %: Victim percent. B/OR (95% CI): Regression coefficient/Odds Ratio (95% confidence interval). [a]*Mean (standard deviation).*
**p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001. HLT, Hosmer Lemeshow Test. OT, Omnibus test. Ref, Reference value. Ref*, Significance level of categorical variable.*

authoritarian style run a greater risk to become a victim than those coming from permissive and democratic family environments. In contrast, some studies showed that permissive parental style predicts the experience of victimization while the authoritarian parental style best predicts bullying behavior (Baldry and Farrington, 2000; Georgiou and Stavrinides, 2013). Therefore, it will promote victimization and inhibit the attachment to peers (Ortega, 2000; Samper-García et al., 2015).

Regarding personal features, our data show that students at the first cycle of secondary school are more likely to be at risk than those at the second, which also confirms the decreasing risk associated to the variable age. Older students are more likely to experience bullying than younger school students and perceive school as unsafe as a number of studies have shown (Astor et al., 2001; Cerezo, 2009; Dinkes et al., 2009). Serrano and Iborra (2005) consider the probability to become a victim is more likely to happen during the 1st years of secondary studies while it tends to decrease in the following years. These studies are coherent with our data that point out age as a protective factor. The protection and social skills that adolescents develop with age explained data presented in this study.

Researchers are careful about conclusions on gender differences in bullying behavior (Hong and Espelage, 2012). Previous findings indicated that boys are usually either victims or authors of direct forms of bullying while girls experience indirect bullying (Olweus, 1993; Varjas et al., 2009). Cerezo (2009) points out males as more likely to become victims. Our study indicates that males are four times more likely than females to become victims.

Regarding student social status, other studies prove that non-involved children are better placed in their social networks than those involved in bullying dynamics (García-Bacete et al., 2010). According to our results, adolescents rejected by their peers are at higher risk, up to 45 times higher, than the average student is. Among involved children, aggressors get more support and are more accepted by their peers than victims (Estévez et al., 2007; Salmivalli, 2010; Van der Schoot et al., 2010). Victims are rejected, when not ignored, by most of the group members

(Cerezo and Ato, 2010) which certainly contributes to their helplessness (Ortega, 2000). This finding supports the results obtained in this study.

Cerezo and Ato (2010) point out that victim were worse placed than aggressors in the network of interpersonal relationships. That is, both victims and aggressors are rejected but victims are also considered cowards. Regarding social perception, victims reported to be lonely, nobody caring about them, because the rest is not concerned about the seriousness of the situation, and that could encourage the persistence of bullying. In this line, this research consistently shows that students rejected by their peers run 8 times more risk of becoming a victim than average students.

The data we have obtained show that social maladjustment increases the risk of victimization while school maladjustment reduces it (therefore, adolescents with a higher level of school adjustment are also at higher risk). High achievement is usually linked to school adjustment. Students with the highest achievement are more rejected than average students. This may help to interpret our data. In addition, at school environments, the victim role shows a higher academic achievement than the aggressor role, being similar to the average achievement of the peer group/classroom (non-involved bystanders) (Cerezo, 2009; Méndez and Cerezo, in press).

The last related variable is social preference. The risk adolescents run diminishes as they are more socially accepted. Preference by peers, popularity, and friendship are very important for adolescents (Espelage, 2002). Besides our findings, other studies found friendship to be a protection against victimization (Demaray and Malecki, 2003; Schmidt and Bagwell, 2007).

Both adjusted LR and forward selection procedures identify the same subgroup of significant variables in relation to the victimization and can define the test type features in the sample under study: to be male, to perceive that friends are not at high risk of drug consumption, low school maladjustment, high social maladjustment and low social acceptance by peers. The identified variables, however, explain only 34%, at the most, of the variation on victimization. This moderated percentage underlines the complexity of the issue. Other studies point to different risk factors that were not studied but should be considered in future studies. Some personal factors are shyness, little self-control, low self-esteem, high anxiety, depression, race or ethnicity, handicaps, learning disabilities (Cerezo, 2009), challenging victim involvement in other risky behaviors (Kaltiala-Heino et al., 2000; Cerezo and Méndez, 2009; Tharp-Taylor et al., 2009); some contextual factors as: (a) over protective family environment (Ortega, 2000), hierarchical relationships among siblings (Piñero-Ruiz et al., 2012); negative peer relationships (Salmivalli, 2010); (b) school environment features, such as the lack of resources or little experienced teachers (Serrano and Iborra, 2005), inter-parental violence (Corvo and deLara, 2010); and (c) social environment, for instance exposure to violence in the media (David-Ferdon and Hertz, 2007).

These results should have consequences for educational policy and practice. It is necessary to promote inclusion (Llorent et al., 2016). It is also necessary to strengthen emotional education and acquisition of social skills (Sastre, 2016). At school level, it is recommended to provide teachers with resources (Serrano and Iborra, 2005). It is important that society as a whole breaks the law of silence or helplessness (Ortega, 2000), giving an active role to non-involved bystanders. Kärnä et al. (2010) suggest that non-involved behaviors in bullying situations moderate the effects of individual and interpersonal risk factors for victimization. Influence on these behaviors might be an effective way to protect vulnerable children from victimization.

It is convenient to take into account teachers and family's perspectives and even gather information on other behaviors that may be influencing victimization, such as personality, self-esteem, or self-concept, and to collaborate with specialists when dealing with medical problems or psychological consequences of victimization.

There have been several meta-analyses and studies on bullying prevention and intervention programs. Results indicated moderate effect sizes on self-reported victimization that students experienced from aggressors (Smith et al., 2004). Hong and Espelage's (2012, p. 2012) social-ecological approach considered that *responses to aggressors, rather than rely on traditional punitive measures, should approach both aggressors and victims patterns of behavior, with particular attention to non-involved bystanders at school, as well as the classroom-social climate and other influences such as family, community and society. Maybe, intervention programs have been too focused on aggressors and rarely on victims and non-involved bystanders.*

Researchers also noted that anti-bullying programs were more efficient when implemented with older students (i.e., 11 and older) (Smith et al., 2004). In spite of the large number of prevention programs implemented in our country: "Educating in harmonious coexistence in order to prevent violence" (Ortega, 2000); "Aid between peers Program" (Cowie and Fernández, 2006); KiVa antibullying program (Kärnä et al., 2011); "System to detect racial-based Bullying through Gamification" (Álvarez-Bermejo et al., 2016), "Using a 3D simulation Instrument in educational settings" (Cangas et al., 2016). We must insist in prevention programs based on ecological approach that take into account risk and protection factors. Furthermore, intervention programs should address victims and non-involved bystanders instead of only aggressors. In addition, it should include risky behaviors related to bullying dynamics, like the consumption of drugs.

Like many of the existing studies on the topic of bullying and peer victimization, the present study used a standard cross-sectional methodology. Even though this is an established method in social sciences, it also shows limitations, such as significant constraints in unfolding cause and effect relationships. Our conclusions are limited because they are based on correlational relationships. Additional research on these variables with longitudinal data is needed.

AUTHOR CONTRIBUTIONS

IM: Fieldwork, theoretical development and writing. CR: Theoretical development and writing. JL: Fieldwork and methodological treatment.

REFERENCES

Alfonso, J. P., Huedo-Medina, T. B., and Espada, J. P. (2009). Factores de riesgo predictores del patrón de consumo de drogas durante la adolescencia [Risk factors predictors of the pattern of substance use during the adolescence]. *Anal. Psicol.* 25, 330–338.

Álvarez-Bermejo, J. A., Belmonte-Ureña, L. J., Martos-Martínez, A., Barragán-Martín, A. B., and Simón-Marquez, M. D. M. (2016). System to detect racial-based bullying through gamification. *Front. Psychol.* 7:1791. doi: 10.3389/fpsyg.2016.01791

Armas, M. (2007). *Prevención e Intervención ante Problemas de Conducta. Estrategias para Centros Educativos y Familias. [Prevention and Intervention to Behavior Problems. Strategies for Educational Centers and Families]*. Madrid: Wolters Kluwer.

Astor, R. A., Meyer, H. A., and Pitner, R. O. (2001). Elementary and middle school students' perceptions of violence-prone school subcontexts. *Elem. Sch. J.* 101, 511–528.

Baldry, A. C., and Farrington, D. P. (2000). Bullies and delinquents: personal characteristics and parental styles. *J. Commun. Appl. Soc. Psychol.* 10, 17–31.

Cangas, A. J., Carmona-Torres, J. A., Gallego, J., Aguilar-Parra, J. M., and Langer, A. (2016). Bullying, drug use, and eating disorders: an assessment by using a 3D simulation Instrument in educational settings. *Ment. Health Prevent.* 4, 130–137. doi: 10.1016/j.mhp.2016.09.001

Cerezo, F. (2009). Bullying: análisis de la situación en las aulas españolas [Bullying: analysis of the situation in the Spanish classroom]. *Int. J. Psychol. Psychol. Ther.* 9, 383–394.

Cerezo, F. (2012). *Bull-S. Test de Evaluación de la Agresividad Entre Escolares [Bull-S. Assessment Test of Aggressiveness Among Students]*. Madrid: Albor-Cohs.

Cerezo, F., and Ato, M. (2010). Social status, gender, classroom climate and bullying among adolescents pupils. *Anal. Psicol.* 26, 137–144.

Cerezo, F., and Méndez, I. (2009). Adolescentes, agresividad y conductas de riesgo de salud: análisis de variables relacionadas [Adolescents, aggression and risk behaviour: associated variables analysis]. *Int. J. Dev. Psychol.* 1, 217–226.

Cerezo, F., and Méndez, I. (2013). Agresores en bullying y conductas antisociales [Aggressors in bullying and disocial behaviours]. *Euro. J. Invest. Health Psychol. Educ.* 3, 5–14.

Cerezo, F., Méndez, I., and Ato, M. (2013). Moderating role of family and friends' factors between dissocial behavior and consumption in adolescents. *Int. J. Clin. Health Psychol.* 13, 171–180.

Corvo, K., and deLara, E. (2010). Towards an integrated theory of relational violence: is bullying a risk factor for domestic violence? *Aggress. Violent Behav.* 15, 181–190.

Cowie, H., and Fernández, F. (2006). Ayuda entre iguales en las escuelas: desarrollo y retos [Aid between peers in shools: development and challenges]. *Rev. Electrón. Invest. Psicoeduc.* 9, 291–310.

David-Ferdon, C., and Hertz, M. F. (2007). Electronic media, violence, and adolescents: an emerging public health problem. *J. Adolesc. Health* 41, S1–S5.

Delegación del Gobierno para el Plan Nacional sobre Drogas (DGPNSD) (2007). *Guía sobre drogas, 2007 [Drug Guide, 2007]*. Madrid: Ministerio de Sanidad y Consumo. Available at: http://www.pnsd.msssi.gob.es/

Delegación del Gobierno para el Plan Nacional sobre Drogas [DGPNSD] (2008). *Encuesta estatal sobre uso de drogas (ESTUDES) 2008 [National Survey on Drug Use in Secondary School Students (ESTUDES)]*. Madrid: Secretaría de Estado de Servicios Sociales e Igualdad. Available at: http://www.pnsd.msssi.gob.es/Categoria2/observa/pdf/CuestionarioEstudes2008.pdf

Delegación del Gobierno para el Plan Nacional sobre Drogas [DGPNSD] (2014). *Encuesta Estatal Sobre Uso de Drogas (ESTUDES) 2012/2013 [National Survey About Drugs Use (ESTUDES) 2012/2013]*. Madrid: Secretaría de Estado de Servicios Sociales e Igualdad.

Demaray, M. K., and Malecki, C. K. (2003). Perceptions of the frequency and importance of social support by students classified as victims, bullies, and bully/victims in an urban middle school. *Sch. Psychol. Rev.* 32, 471–490.

Dinkes, R., Kemp, J., Baum, K., and Snyder, T. (2009). *Indicators of School Crime and Safety: 2009 (NCES 2010-012)*. Washington, DC: Institute of Education Sciences.

Espada, J. P., Pereira, J. R., and García-Fernández, J. M. (2008). Influencia de los modelos sociales en el consumo de alcohol de los adolescentes [Influence of social models on alcohol use among adolescents]. *Psicothema* 20, 531–537.

Espelage, D. L. (2002). *Bullying in Early Adolescence: The Role of the Peer Group*. Champaign, IL: ERIC Digest.

Estévez, E., Murgui, S., Moreno, D., and Musitu, G. (2007). Estilos de comunicación familiar, actitud hacia la autoridad y conducta violenta de los adolescentes en la escuela [Family communication styles, attitude towards institutional authority and adolescents' violent behaviour at school]. *Psicothema* 19, 108–113.

García-Bacete, F. J., Sureda, I., and Monjas, I. (2010). El rechazo ente iguales en la educación primaria: una panorámica general [Peer rejection in elementary school: a general outlook]. *Anal. Psicol.* 26, 123–136.

Georgiou, S. N., and Stavrinides, P. (2013). Parenting at home and bullying at school. *Soc. Psychol. Educ.* 16, 165–179.

Hernández- Guanir, P. (2015). *TAMAI. Test Autoevaluativo Multifactorial de Adaptación Infantil. TAMAI. [Test Multifactorial Child Self-Evaluative Adaptation]*, 7th Edn. Madrid: TEA Ediciones.

Hong, J. S., and Espelage, D. L. (2012). A review of research on bullying and peer victimization in school: an ecological system analysis. *Aggress. Violent Behav.* 17, 311–322.

Kaltiala-Heino, R., Rimpelä, M., Rantanen, P., and Rimpelä, A. (2000). Bullying at school: an indicator of adolescents at risk for mental disorders. *J. Adolesc.* 23, 661–674.

Kärnä, A., Voeten, M., Little, T. D., Poskiparta, E., Kaljonen, A., and Salmivalli, C. (2011). A large-scale evaluation of the. KiVa antibullying program: grades 4–6. *Child Dev.* 82, 311–330.

Kärnä, A., Voeten, M., Poskiparta, E., and Salmivalli, C. (2010). Vulnerable children in varying classroom contexts: bystanders' behaviors moderate the effects of risk factors on victimization. *Merrill Palmer Q.* 56, 261–282.

Llorent, V. J., Ortega-Ruiz, R., and Zych, I. (2016). Bullying and cyberbullying in minorities: are they more vulnerable than the majority group? *Front. Psychol.* 7:1507. doi: 10.3389/fpsyg.2016.01507

Méndez, I., and Cerezo, F. (in press). *La Repetición Escolar en Educación Secundaria y Factores de Riesgo Asociados [Grade Repetition in Secondary Education and Associated Risk Factor]*. Available at: http://revistas.uned.es/index.php/educacionXX1/index

Olweus, D. (1993). *Bullying at School. What We Know and What We Can Do*. Oxford: Blackwell.

Olweus, D. (2013). School bullying: development and some important challenges. *Annu. Rev. Clin. Psychol.* 9, 751–780. doi: 10.1146/annurev-clinpsy-050212-185516

Ortega, R. (2000). *Educar la Convivencia Para Prevenir la Violencia [Educating in Harmonious Coexistence in Order to Prevent Violence]*. Madrid: Antonio Machado Libros.

Ortega-Ruiz, R. (2015). *Convivencia y Ciberconvivencia. Un Modelo Educativo para la Prevención del Acoso y el Ciberacoso Escolar [Coexistence and Cibercoexistence. An Educational Model for the Prevention of Harassment and cyberbullying]*. Madrid: Machado Libros.

Pérez-Fuentes, M. C., and Gázquez, J. J. (2010). Variables relacionadas con la conducta violenta en la escuela según los estudiantes [Variables related to violent behavior at school according to students]. *Int. J. Psychol. Psychol. Ther.* 10, 427–437.

Piñero-Ruiz, E., López-Espín, J. J., Cerezo, F., and Torres-Cantero, A. (2012). Tamaño de la fratría y victimización escolar. [Number of siblings and school victimization]. *An. Psicol.* 28, 842–847. doi: 10.6018/analesps.28.3.156091

Salmivalli, C. (2010). Bullying and the peer group: a review. *Aggress. Violent Behav.* 15, 112–120.

Samper-García, P., Mestre-Escrivá, V., Malonda, E., and Mesurado, B. (2015). Victimización en la escuela: relación de la crianza y variables funcionales-disfuncionales del desarrollo [Victimization at school: relationship of parenting and functional-dysfunctional developmental variables]. *Anal. Psicol.* 31, 849–858.

Sánchez, M. I., Moreno, M. C., Muñoz, M. V., and Pérez, J. P. (2007). Adolescencia, grupo de iguales y consumo de sustancias. Un estudio descriptivo relacional [Adolescence, peer groups and substance. A relational descriptive study]. *Apunt. Psicol.* 25, 305–324.

Sastre, A. (2016). *Yo a Eso no Juego. Bullying y Ciberbullying en la Infancia [I Do Not Play to that. Bullying and Cyberbullying in Childhood]*. Madrid: Save the Children España.

Schmidt, M. E., and Bagwell, C. L. (2007). The protective role of friendships in overtly and relationally victimized boys and girls. *Merrill Palmer Q.* 53, 439–460. doi: 10.1353/mpq.2007.0021

Secades, R., Carballo, J. L., Fernández-Hermida, J. R., García, O., and García, E. (2006). *Cuestionario de Factores de Riesgo Interpersonales Para el Consumo de Drogas en Adolescentes (FRIDA) [Interpersonal Risk Factors for Drug Use in Adolescence-FRIDA]*. Madrid: TEA.

Serrano, A., and Iborra, I. (2005). *Violencia entre Compañeros en la Escuela [Violence between Peers at School]*. Valencia: Centro Reina Sofía para el estudio de la violencia.

Smith, J. D., Schneider, B. H., Smith, P. K., and Ananiadou, K. (2004). The effectiveness of whole-school antibullying programs: a synthesis of evaluation research. *Sch. Psychol. Rev.* 33, 547–560.

Sullivan, K., Cleary, M., and Sullivan, G. (2005). *Bullying en la Enseñanza Secundaria. El Acoso escolar: Cómo se Presenta y Cómo Afrontarlo [Bullying in Secondary School]*. Barcelona: CEAC.

Tharp-Taylor, S., Haviland, A., and D'Amico, E. J. (2009). Victimization from mental and physical bullying and substance use in early adolescence. *Addict. Behav.* 34, 561–567. doi: 10.1016/j.addbeh.2009.03.012

Van der Schoot, R., Van der Velden, F., Bomb, J., and Brugman, D. (2010). Can at risk young adolescent be popular and antisocial? Sociometric status groups, antisocial behaviour, gender and ethnic background. *J. Adolesc.* 33, 583–592. doi: 10.1016/j.adolescence.2009.12.004

Varjas, K., Henrich, C. C., and Meyers, J. (2009). Urban middle school students' perceptions of bullying, cyberbullying, and school safety. *J. Sch. Violence* 8, 159–176. doi: 10.1007/s10464-009-9240-1

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Méndez, Ruiz-Esteban and López-García. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 14 March 2017
doi: 10.3389/fpsyg.2017.00372

Verbal Emotional Disclosure of Traumatic Experiences in Adolescents: The Role of Social Risk Factors

*Silvia Pérez, Wenceslao Peñate, Juan M. Bethencourt and Ascensión Fumero**

Psicología Clínica, Psicobiología y Metodología, Universidad de La Laguna, La Laguna, Spain

It is well-known that traumatic events and adverse life situations are very important in both physical and psychological health. Prevalence studies suggested that adolescents experience at least one potentially traumatic event before reaching age 18. The paradigm of research centered on expressive writing has evidenced the beneficial effects that the emotional disclosure of previous traumas produces on physical health and psychological adjustment. The aims of the study are threefold: determining the prevalence of adverse or traumatic events; examining the extent to which psychopathological symptoms developed in those exposed to traumatic events; and exploring an verbal emotional disclosure (VED) paradigm in which variations on time spent talking about traumatic experiences to others resulted in a reduction of the psychological impact of trauma in a sample of Spanish adolescents. 422 volunteer adolescents participated, 226 boys and 192 girls, from 10 to 19 years old, all of them living in Tenerife. The mean age was 14.8 years (SD = 1.83). All of them completed the instruments used to assess the psychological impact of traumatic experiences and VED. The main results indicated that 77% of the participants had suffered a traumatic situation. The participants who have been exposed to traumatic events scored significantly higher in measures of post-traumatic stress, disorder, intrusive thoughts, avoidance behaviors, anxiety and depression, compared to those without trauma. Furthermore, results show a decrease in symptomatology scores as a function of time spent disclosing emotional experiences to others, particularly when disclosure occurred several times. In conclusion, stressful events or traumatic experiences and their concomitant emotional effects are highly prevalent in adolescents, and repeated VED to others appears to ameliorate their impact. VED shows greater therapeutic benefits when adolescents narrate the experience on several occasions and in an extensive way.

Keywords: verbal emotional disclosure, traumatic experiences, psychopathological symptoms, adolescents at risk, social exclusion

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Juan Preciado, York College – The City University of New York, USA
Sonia Zambrano Hernandez, Universidad Catolica de Colombia, Colombia

****Correspondence:***
Ascensión Fumero
afumero@ull.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *06 December 2016*
Accepted: *27 February 2017*
Published: *14 March 2017*

Citation:
Pérez S, Peñate W, Bethencourt JM and Fumero A (2017) Verbal Emotional Disclosure of Traumatic Experiences in Adolescents: The Role of Social Risk Factors. Front. Psychol. 8:372. doi: 10.3389/fpsyg.2017.00372

INTRODUCTION

The experiencing of traumatic, painful, or stressing situations in a person's life is not harmless, and may cause serious difficulties in psychological adjustment (Walter and Bates, 2012). When these experiences become part of everyday life, the probability of suffering a psychological disorder is very high (Campo-Arias et al., 2014). The impact of the traumatic situations or adverse life events

during childhood and adolescence may be much more significant. Adolescence is a potentially significant period in developing stress and coping processes (Hollenstein and Lougheed, 2013). It is well-documented that exposure to multiple traumatic events, as well as other risk behavior, such as gambling or substance use, are common among juvenile offenders (Lee et al., 2012). The importance of the adverse events in adolescence may be due to several reasons. First, change is viewed as an inherent component of stress, and adolescence is characterized by changes in biological functioning, cognitive development, social roles, and social environments. Second, because adolescence is a period of transition, change and adaptation. Third, cognitive and social development during adolescence may make it an optimal time for learning new coping skills to reduce the adverse effects of stressful events (Compas et al., 1985).

Adolescents at risk of social exclusion constitute a population especially sensitive to traumatic experiences. They lacked the necessary moral or material assistance which must be provided by those who are supposed to take care of them; they suffered abandonment, physical and/or psychological abuse, regular alcoholism or drug addiction in members of the family, sexual abuse, serious violent behavior or attitudes by relatives or third parties in the family unit, incitement to mendicancy, delinquency, prostitution, or to any other form of economic or sexual exploitation.

Studies about prevalence of exposure to trauma suggest that many children and adolescents experience at least a potentially traumatic event before reaching 18 years of age (Alisic et al., 2014). It is estimated that approximately 1 in 4 youths will experience some type of substantive trauma, such as physical abuse, sexual abuse or domestic violence during his or her developmental years (Duke et al., 2010). Adolescents are considered an at-risk population due to the serious negative consequences associated with exposure to trauma, from PTSD (post-traumatic stress disorder) to other anxiety disorders, behavior issues, depression, substance abuse, and risk behavior for health (Shi et al., 2016; Zhen et al., 2016). It has been demonstrated that a greater number of adverse events during childhood result in worse health in adults (Barboza Solis et al., 2015). With four or more adverse events in childhood, the risk of suffering several medical conditions increased exponentially (Perry, 2014).

The importance of language in the processing of trauma and subsequent health outcomes has been recognized. There is empirical support for a relationship between emotional disclosure about traumatic events and health outcomes (Pennebaker et al., 1988; Pennebaker, 1989). Specifically, verbal disclosure in comparison with writing achieved the greatest improvements in cognitive change, self-esteem, and adaptive coping strategies (Esterling et al., 1994). Also, most forms of psychotherapy include trauma disclosure. The reason should be in using language to label an emotion, and an experience creates a structure, which facilitates the assimilation and understanding of the event, and thus the reduction of emotional arousal that is detrimental to physical and psychological health (Pennebaker et al., 1997).

There is evidence of significant benefits in emotional health, physical health, positive changes in the immune system, and in the general psychological functioning after emotional self-disclosure or communication to others (Frattaroli, 2006; Lumley et al., 2014). However, results are less consistent for participants with psychological difficulties (Baikie et al., 2012; Travagin et al., 2015). While some studies have supported written emotional disclosure in students with a history of trauma (Ironson et al., 2013), benefits appear to be limited in samples of participants with a negative image of their own body (O'Connor et al., 2011; Lafont and Oberle, 2014), adults who suffered child abuse, exhibit symptoms of depression and post-traumatic stress, or had lost a relative (Baikie et al., 2012; Meston et al., 2013; Unterhitzenberger and Rosner, 2014). There have been significant effects on positive affect, negative affect, and level of depression, after an intervention based on expressive writing. However, anxiety, intrusive thoughts, and avoidance behaviors did not change (Del Pino et al., 2016).

In spite of the promising results with the adult population, there is scant evidence about the effectiveness of emotional disclosure in the adolescents. Findings indicate the beneficial effects of the use of emotional disclosure in children and adolescents on the symptoms of internalizing and externalizing behaviors (Zajac et al., 2015), a significant increase in optimism, a decrease in negative affect, the development of better coping strategies, such as positive reframing, and optimistic thinking (Margola et al., 2010; Graham-Bermann et al., 2011), and the strengthening of the academic self-concept (Facchin et al., 2014). Travagin et al. (2015) carried out a meta-analysis that evaluated the effects of expressive writing on adolescents; results suggest that emotional disclosure may help reduce internalization problems, behavior issues, somatic complaints, as well as improve social adjustment, school participation and performance. Briefly, emotional disclosure tends to produce significant improvements in the well-being of adolescents.

The effect of emotional disclosure on adolescent aggressive behavior and emotional lability has also been shown (Kliewer et al., 2011). Results suggest that emotional disclosure was an effective way of helping students deal with the stress factors they experienced, with those adolescents most exposed to violence being the most benefited. Furthermore, the adolescents who reported body dissatisfaction, and disclosed their emotional experiences through expressive writing showed a reduction in thin ideal internalization, personal dissatisfaction, and psychosocial deterioration (Graham-Bermann et al., 2011). Besides, adolescents who regarded problems with classmates as a stress factor improved their personal well-being and social adjustment in the long term, after emotional disclosure (Travagin et al., 2015).

This study is aimed at establishing to what an extent a population of adolescents is at high risk of experiencing traumatic situations, and whether psychopathological symptoms, such as PTSD, intrusive thoughts, avoidance behaviors, anxiety, and depression developed in a sample of adolescents exposed to traumatic events. The study also explores the extent to which variations on time spent talking about traumatic experiences to others modulates the psychological impact of trauma.

MATERIALS AND METHODS

Participants

The sample consisted of 422 volunteer adolescents who were recruited from different Tenerife schools; 101 of them were under the Child Protection System, declared by the Dirección General de Dependencia, Infancia y Familia (DGDIF) (Dependency, Childhood and Family Department) of the Government of the Canary Islands, to be unquestionably abandoned, and admitted to Protection Centers, and 321 were enrolled at Secondary Education Institutes. 228 (54%) males, and 194 (46%) females, aged between 10 and 19 years. The mean age of the total sample was 14.8 years ($SD = 1.83$). The sample includes volunteers with various levels of education, from 4th grade Primary School to 2nd year High School or Intermediate Professional Education, the most common being 2nd year Compulsory Middle School. The study was approved by the Research and Ethics Committee at Universidad de La Laguna.

Procedure

The collection of information started with the recruitment of the sample, which was carried out through the following procedure: in the first place, for the participation of adolescents under the Child Protection System, authorization was sought from the Unidad Orgánica de Infancia y Familia (Organic Childhood and Family Unit), a competent body in Foster Care, of the Island Council of Tenerife. After the authorization to conduct the study was granted, every participant voluntarily agreed to participate, and the collection of information started at the Protection System centers. Secondly, for the collection of data from adolescents enrolled at secondary education institutes, appointments were arranged with educational centers in the island. Following submission of the study to the directors in charge of each educational center, all the participants individually completed every assessment instrument in their classrooms. Different groups were used. The first one included those participants who reported any traumatic situation; the purpose was to detect the existence of symptoms compared to those who had not been exposed to this kind of situations. From the second sample, information was collected about whether they had narrated the experience, and for how long; the purpose was to know whether the psychological impact of the stressing event was lesser in participants who disclosed their emotional experiences.

Measures

The socio-demographic questionnaire records the age, sex, and educational level of the study participants.

The verbal emotional disclosure (VED) scale is a self-report as a semi-structured interview, developed to determine the experience of stressing, painful and/or traumatic situations, composed of questions in which adolescents reported (i) their traumatic experience; (ii) whether they spoke with somebody about it; (iii) who those persons were (teachers, parents, psychologists, etcetera); and the duration of disclosure These questions were developed according to the recommendations of systemic reviews and meta-analyses (Frattaroli, 2006), which indicated an increase in the effectiveness of emotional disclosure when it occurs repeatedly, and spending more time talking about the adverse or traumatic event to others. In that sense, no psychometric data are available and every question was considered an autonomous variable.

The Child Post-Traumatic Stress Disorder Symptom Scale (CPSS; Foa et al., 2001) assesses the presence of post-traumatic stress symptoms in children from 8 to 18 years of age, with a known trauma history. The scale is based on the DSM-IV diagnostic criteria, and consists of 17 Likert-type items referring to how frequently symptoms of this disorder appear. This instrument can be used as a self-report, or as a structured clinical interview. It is composed of three subscales: re-experiencing (five items), avoidance (seven items), and arousal (five items). Meyer et al. (2015) reported that the the Spanish version of the total symptom scale demonstrated excellent internal consistency ($\alpha = 0.88$), and moderate to good consistency within the sub-scale symptom categories (i.e., re-experiencing, avoidance, and hyper-arousal) (range: $\alpha = 0.71$–0.84).

The Impact of Event Scale, Revised (IES-R; Weiss and Marmar, 1997) consists of 15 dichotomous items; seven evaluate answers relating to intrusion, and eight relating to avoidance, about the most stressing recent life event. The scale assesses two factors: intrusive thoughts as regards the experienced event, and the avoidance answers associated with the presence of those events. The Spanish version of this scale showed adequate psychometric adjustments; Cronbach's alpha for the overall scale 0.94, intrusion 0.95, and avoidance 0.87; test–retest reliability coefficients = 0.35, 0.36, 0.28 for total scores, intrusive thoughts, and avoidance behaviors, respectively (Báguena et al., 2001).

The Hospital and Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983) consists of 14 items (seven for anxiety, and seven for depression) distributed in two subscales. It is centered on the emotional and cognitive aspects of these two disorders. The Spanish version of the scale has shown adequate psychometric adjustments; Cronbach's alpha 0.74, 0.59, y 0.76 for anxiety, depression, and overall scale, respectively (Gil et al., 2015).

Data Analysis

A descriptive design was made ex post facto. The predictor variables used were the presence or non-presence of traumas, whether VED occurred, and the time spent making the disclosure, and the criterion variables analyzed: PTSD, anxiety, depression, intrusive thoughts, and avoidance behaviors.

A descriptive analysis of traumatic experiences was made, which was followed by a contrast of means to examine the symptomatology associated with exposure to the traumatic event.

Multivariate analysis of variances (MANOVAs) were conducted to analyze the effect of the emotional trauma re-experiencing on the psychopathological variables, and to check whether differences appeared in the psychopathological variables according to the time the adolescents spent on VED, whether they talked about it for a moment, more than half an hour, or on several occasions.

RESULTS

Table 1 shows the descriptive statistics of the variables analyzed in the study. The results about prevalence indicated that 77% of the participants ($n = 324$) had suffered a traumatic situation.

The comparison between groups showed that the participants who have been exposed to traumatic events scored significantly higher in PTSD, intrusive thoughts, avoidance behaviors and anxiety, compared to those without exposure to traumatic events but not in depression (**Table 2**).

The MANOVA tests conducted with the adolescents' information about their VED, showed statistically significant differences in depression between the group who disclosed their emotional experiences and the group who did not, that is, levels of depression decreased when VED had occurred [$F(1,219) = 4.63$, $p = 0.03$]. **Table 3** contains the descriptive statistics of PTSD symptoms, intrusive thoughts, avoidance behaviors, anxiety, and depression in both the group who disclosed their emotional experiences, and the group who did not.

Of the total sample that reported to have suffered a traumatic experience (324), cases with missing values have been taken away, resulting in a sample made up of 309 (233 with VED and 76 without VED). A new MANOVA was conducted to check whether there were significant differences in the psychopathological variables as a function of time participants spent disclosing their stressful or traumatic events to others, that is, whether they had only made a comment, had spent more than half an hour, or had done so several times. **Table 4** shows the means and the standard deviations of measures of PTSD symptoms, intrusive thoughts, avoidance behaviors, anxiety and depression. Results show a decrease in symptomatology scores as a function of time spent disclosing emotional experiences to others, particularly when disclosure occurred several times; however, reductions were not statistically significant.

TABLE 1 | Descriptive statistics of groups with and without trauma experience.

	With trauma experience ($n = 324$)		Without trauma experience ($n = 98$)	
	M_1	SD_1	M_2	SD_2
PTSD	25.11	13.98	16.01	12.28
Intrusion	8.34	5.69	5.14	5.48
Avoidance	9.58	5.60	6.18	5.91
Anxiety	7.40	4.30	5.02	3.60
Depression	5.81	3.81	5.81	3.55

M_1, group 1 mean; SD_1, group 1 standard deviation; M_2, group 2 mean; SD_2, group 2 standard deviation; PTSD, post-traumatic stress disorder.

TABLE 2 | Difference in symptomatology between groups with or without trauma experience.

	Without trauma experience ($n = 98$)		With trauma experience ($n = 324$)		$t(p)$
	M_1	SD_1	M_2	SD_2	
PTSD	14.21	13.19	25.49	15.15	−6.43***
Intrusion	4.67	5.88	8.39	5.90	−5.06***
Avoidance	5.60	6.40	9.68	5.93	−5.34***
Anxiety	4.79	3.76	7.45	4.47	−5.04***
Depression	5.80	3.83	5.81	3.98	−0.11 n.s.

*M_1, group 1 mean; SD_1, group 1 standard deviation; M_2, group 2 mean; SD_2, group 2 standard deviation; PTSD, post-traumatic stress disorder. ***$p < 0.001$; n.s., non-significant.*

TABLE 3 | Descriptive statistics of groups based on whether verbal emotional disclosure has taken place or not.

	With VED ($n = 233$)		Without VED ($n = 76$)	
	M_1	SD_1	M_2	SD_2
PTSD	25.85	14.75	26.11	15.43
Intrusion	8.30	5.76	8.62	6.13
Avoidance	9.59	5.90	10.37	5.76
Anxiety	7.80	4.61	7.16	4.50
Depression	5.56	3.84	6.60	4.27

M_1, group 1 mean; SD_1, group 1 standard deviation; M_2, group 2 mean; SD_2, group 2 standard deviation; PTSD, post-traumatic stress disorder; VED, verbal emotional disclosure.

DISCUSSION

This study was aimed at getting to know to what an extent an adolescent population is at a higher risk of experiencing traumatic situations, on the assumption that going through traumas or highly stressing situations occurs with relative frequency. Our findings indicate that a great number of adolescents have experienced traumatic situations. Results show that three out of four adolescents in the sample have undergone some sort of traumatic experience. Different studies about prevalence of exposure to trauma in adolescents found similar results (Duke et al., 2010; Alisic et al., 2014).

Additionally, the study focused on determining to what an extent the experience of traumatic events in adolescence was associated with vulnerability to certain psychological

TABLE 4 | Descriptive statistics of groups based on the time used for verbal emotional disclosure.

	Only a comment ($n = 69$)		More than half an hour ($n = 42$)		Several times ($n = 122$)	
	M_1	SD_1	M_2	SD_2	M_3	SD_3
PTSD	28.48	17.29	24.95	13.42	25.31	14.67
Intrusion	8.93	6.47	8.40	4.87	8.22	5.68
Avoidance	10.85	6.38	10.52	5.51	9.08	5.77
Anxiety	8.02	4.52	8.42	5.53	7.28	4.33
Depression	6.04	4.03	6.14	4.63	5.24	3.75

M_1, group 1 mean; SD_1, group 1 standard deviation; M_2, group 2 mean; SD_2, group 2 standard deviation; M_3, group 3 mean; SD_3, GROUP 3 standard deviation; PTSD, post-traumatic stress disorder.

problems, such as post-traumatic stress, intrusive thoughts, avoidance behaviors, anxiety, and depression. In connection with the impact of those experiences on mental health. It was observed that those who experienced traumatic events have higher psychopathological scores (post-traumatic stress, intrusive thoughts, avoidance behaviors, anxiety, and depression) than those who did not. These findings are in agreement with the results found in other comparable research studies (Perry, 2014; Barboza Solis et al., 2015; Shi et al., 2016; Zhen et al., 2016).

Furthermore, we explored whether VED helped to reduce the psychological impact of those experiences. The major feature of the present study was that verbal disclosure can play a relevant role in reducing depressive symptoms. Because traumatic events can play a role in depression vulnerability, with long-term effects (Mandelli et al., 2015), and depressive symptoms represent an important aftermath of traumatic experience (Kaltman and Bonanno, 2003), our data can be clinically relevant. In this regard, though the effect of VED on the sequels of the traumatic experience was limited, it seems to reduce depressive symptoms. As reported in other research studies about the benefits of emotional disclosure in psychological functioning and physical health, the adolescents who talked to someone about their traumatic experience showed a reduction of depressive symptoms (Peñate et al., 2010; Baikie et al., 2012; Ironson et al., 2013; Lumley et al., 2014; Blasio et al., 2015; Travagin et al., 2015; Del Pino et al., 2016).

As regards the time spent on VED results reveal a decrease in symptoms primarily when VED occurred on several occasions. The adolescents with less psychopathological symptoms were those who had talked about their traumatic experiences several times, compared to those who disclosed those experiences sporadically, or who spent little time doing so. Our results on the effectiveness of VED were mixed. There were no significant differences in symptomatology. However, improvement was observed when adolescents disclosed their traumatic experiences in an extensive way and on several occasions. These results are in line with previous studies that highlighted the modulating effects of emotional disclosure, particularly the benefits of writing repeatedly about the same event (Peñate et al., 2010; Jones, 2016).

This research study has certain limitations; we worked with a sample of volunteer adolescents without knowing about either their personal history of post-traumatic events, or the consequences that the recalled events could have for their adequate personal adjustment. It would be advisable to collect more precise information about the type, intensity, and time of the traumatic experiences, so that we can previously know the history of traumas and psychological problems, if any, and therefore have more information in order to be able to understand and explain the data.

On the other hand, in the present study there was no VED application protocol available. In this study, a formal and rigorous procedure of the VED paradigm was not carried out, but the effect of emotional expression and its intensity as a process of normalization on adverse experience was evaluated. For future research, it would be advisable to create a protocol for the procedure, characterized by its rigorous, detailed and precise application, taking into account the degree of privacy, place of sessions, instructions given to adolescents about the type of event narrated, duration and number of sessions, with the aim of implementing an experimental design with adolescents contrasting results about health and psychological well-being. Finally, as indicated by the specialized literature, the use of emotional disclosure should only be used as adjunctive therapy to other empirically supported treatments (Sloan et al., 2015).

CONCLUSION

It has been demonstrated that adolescents at risk of social exclusion constitute a population vulnerable to traumatic situations, and these events may trigger serious difficulties in their psychological adjustment. Furthermore, VED by adolescents who have suffered trauma helps to reduce psychopathological symptoms, mainly depression, when adolescents repeatedly disclosed their stressful or traumatic experiences to others. In any case, findings from our descriptive data could be further explored by examining the therapeutic effects of an emotional writing disclosure procedure with a similar population in future studies.

ETHICS STATEMENT

All children that participated had been given permission to participate by the director of their primary school, and by their parents via a signed consent form. Before data collection, children were given an oral description of the task, plus an explanation that they were free to stop the testing at any given point. The measures that were going to be used were explained. This study was carried out in accordance with the recommendations of The Ethics Committee for Research and Animal Welfare (CEIBA) of the Universidad de La Laguna, with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the CEIBA Committee.

AUTHOR CONTRIBUTIONS

WP was involved in study design. SP was involved in data collecting, analysis and manuscript drafting and revises. WP, JB, and AF were involved in data analysis, manuscript drafting and revises. We have read and approved the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

Alisic, E., Zalta, A. K., Van Wesel, F., Larsen, S. E., Hafstad, G. S., Hassanpour, K., et al. (2014). Rates of post-traumatic stress disorder in trauma-exposed children and adolescents: meta-analysis. *Br. J. Psychiatry* 204, 335–340. doi: 10.1192/bjp.bp.113.131227

Báguena, M. J., Villarroya, E., Beleña, A., Díaz, A., and Reig, R. (2001). Propiedades psicométricas de la versión española de la escala revisada de impacto del estresor (EIE-R). *Anál. Modif. Conducta* 27, 581–604.

Baikie, K. A., Geerligs, L., and Wilhelm, K. (2012). Expressive writing and positive writing for participants with mood disorders: an online randomized controlled trial. *J. Affect. Disord.* 136, 310–319. doi: 10.1016/j.jad.2011.11.032

Barboza Solis, C., Kelly-Irving, M., Fantin, R., Darnaudery, M., Torrisani, J., Lang, T., et al. (2015). Adverse childhood experiences and physiological wear-and-tear in midlife: findings from the 1958 British birth cohort. *Proc. Natl. Acad. Sci. U.S.A.* 112, E738–E746. doi: 10.1073/pnas.1417325112

Blasio, P. D., Camisasca, E., Caravita, S. C. S., Ionio, C., Milani, L., and Valtolina, G. G. (2015). The effects of expressive writing on postpartum depression and posttraumatic stress symptoms. *Psychol. Rep.* 117, 856–882. doi: 10.2466/02.13.PR0.117c29z3

Campo-Arias, A., Celina Oviedo, H., and Herazo, E. (2014). Prevalence of mental symptoms, possible cases and disorders in victims displaced by the internal armed conflict in Colombia: a systematic review. *Rev. Colomb. Psiquiatr.* 43, 177–185. doi: 10.1016/j.rcp.2014.07.003

Compas, B. E., Davis, G. E., and Forsythe, C. J. (1985). Characteristics of life events during adolescence. *Am. J. Community Psychol.* 13, 677–691. doi: 10.1007/BF00929795

Del Pino, T., Penþate, W., Fumero, A., Bethencourt, J. M., and Zambrano, S. (2016). La eficacia de la reexperimentacioìn emocional: el papel del optimismo y la alexitimia. *Eur. J. Invest. Health Psychol. Educ.* 6, 167–179. doi: 10.1989/ejihpe.v6i3.179

Duke, N. N., Pettingell, S. L., McMorris, B. J., and Borowsky, I. W. (2010). Adolescent violence perpetration: associations with multiple types of adverse childhood experiences. *Pediatrics* 125, e778–e786. doi: 10.1542/peds.2009-0597

Esterling, B. A., Antoni, M. H., Fletcher, M. A., Margulies, S., and Schneiderman, N. (1994). Emotional disclosure through writing or speaking modulates latent Epstein-Barr virus antibody titers. *J. Consult. Clin. Psychol.* 62, 130–140. doi: 10.1037/0022-006X.62.1.130

Facchin, F., Margola, D., Molgara, S., and Revenson, T. A. (2014). Effects of benefit-focused versus standard expressive writing on adolescents' self-concept during the high school transition. *J. Res. Adolesc.* 24, 131–144. doi: 10.1111/jora.12040

Foa, E. B., Johnson, K. M., Feeny, N. C., and Treadwell, K. R. H. (2001). The Child PTSD symptom scale: a preliminary examination of its psychometric properties. *J. Clin. Psychol.* 30, 376–384. doi: 10.1207/s15374424jccp3003_9

Frattaroli, J. (2006). Experimental disclosure and its moderators: a meta-analysis. *Psychol. Bull.* 132, 823–865. doi: 10.1037/0033-2909.132.6.823

Gil, F., Oberst, U., Del Valle, G., and Chamarro, A. (2015). Nuevas tecnologías Nuevas patologías? l'El smartphone y el fear of missing out. *Aloma* 33, 77–83.

Graham-Bermann, S. A., Kulkarni, M. R., and Kanukollu, S. (2011). Is disclosure therapeutic for children following exposure to traumatic violence? *J. Interpers. Violence* 26, 1056–1076. doi: 10.1177/0886260510365855

Hollenstein, T., and Lougheed, J. P. (2013). Beyond storm and stress: typicality, transactions, timing, and temperament to account for adolescent change. *Am. Psychol.* 68, 444–454. doi: 10.1037/a0033586

Ironson, G., O'Cleirigh, C., Leserman, J., Stuetzle, R., Fordiani, J., Fletcher, M., et al. (2013). Gender-specific effects of an augmented written emotional disclosure intervention on posttraumatic, depressive, and HIV-disease-related outcomes: a randomized, controlled trial. *J. Consult. Clin. Psychol.* 81, 284–298. doi: 10.1037/a0030814

Jones, C. J. (2016). How to... Conduct a trial using written emotional disclosure. *Health Psychol. Update* 25, 19–24.

Kaltman, S., and Bonanno, G. A. (2003). Trauma and bereavement: examining the impact of sudden and violent deaths. *J. Anxiety Disord.* 17, 131–147. doi: 10.1016/S0887-6185(02)00184-6

Kliewer, W., Lepore, S. J., Farrell, A. D., Allison, K. W., Meyer, A. L., Sullivan, T. N., et al. (2011). A school-based expressive writing intervention for at-risk urban adolescents' aggressive behavior and emotional lability. *J. Clin. Child Adolesc. Psychol.* 40, 693–705. doi: 10.1080/15374416.2011.597092

Lafont, J., and Oberle, C. D. (2014). Expressive writing effects on body image: symptomatic versus asymptomatic women. *Psychology* 5, 431–440. doi: 10.4236/psych.2014.55053

Lee, G. P., Storr, C. L., Ialongo, N. S., and Martins, S. S. (2012). Association between adverse life events and addictive behaviors among male and female adolescents. *Am. J. Addict.* 21, 516–523. doi: 10.1111/j.1521-0391.2012.00285.x

Lumley, M. A., Keefe, F. J., Mosley-Williams, A., Rice, J. R., McKee, D., Waters, S. J., et al. (2014). The effects of written emotional disclosure and coping skills training in rheumatoid arthritis: a randomized clinical trial. *J. Consult. Clin. Psychol.* 82, 644. doi: 10.1037/a0036958

Mandelli, L., Petrelli, C., and Serretti, A. (2015). The role of specific early trauma in adult depression: a meta-analysis of published literature. Childhood trauma and adult depression. *Eur. Psychiatry* 30, 665–680. doi: 10.1016/j.eurpsy.2015.04.007

Margola, D., Facchin, F., Molgora, S., and Revenson, T. A. (2010). Cognitive and emotional processing through writing among adolescents who experienced the death of a classmate. *Psychol. Trauma* 2, 250–260. doi: 10.1037/a0019891

Meston, C. M., Lorenz, T. A., and Stephenson, K. R. (2013). Effects of expressive writing on sexual dysfunction, depression, and PTSD in women with a history of childhood sexual abuse: results from a randomized clinical trial. *J. Sex. Med.* 10, 2177–2189. doi: 10.1111/jsm.12247

Meyer, R. M. L., Gold, J. I., Beas, V. N., Young, C. M., and Kassam-Adams, N. (2015). Psychometric evaluation of the child PTSD symptom scale in spanish and english. *Child Psychiatry Hum. Dev.* 46, 438–444. doi: 10.1007/s10578-014-0482-2

O'Connor, D. B., Hurling, R., Hendrickx, H., Osborne, G., Hall, J., Walklet, E., et al. (2011). Effects of written emotional disclosure on implicit self-esteem and body image. *Br. J. Health Psychol.* 16, 488–501. doi: 10.1348/135910710X523210

Peñate, W., Del Pino, T., and Bethencourt, J. (2010). The differential effect of writing about a same trauma or about different traumas on both the psychological well-being and the self-reported health state. *Univ. Psychol.* 9, 433–445.

Pennebaker, J. W. (1989). Confession, Inhibition, and Disease. *Adv. Exp. Soc. Psychol.* 22, 211–244. doi: 10.1016/S0065-2601(08)60309-3

Pennebaker, J. W., Kiecolt-Glaser, J., and Glaser, R. (1988). Disclosure of traumas and immune function. Health implications for psychotherapy. *J. Consult. Clin. Psychol.* 56, 239–245. doi: 10.1037/0022-006X.56.2.239

Pennebaker, J. W., Mayne, T., and Francis, M. E. (1997). Linguistic predictors of adaptive bereavement. *J. Pers. Soc. Psychol.* 72, 863–871. doi: 10.1037/0022-3514.72.4.863

Perry, B. D. (2014). *The Cost of Caring Secondary Traumatic Stress and the Impact of Working with High-Risk Children and Families*. Houston, TX: The Child Trauma Academy.

Shi, X., Yu, N. X., Zhou, Y., Geng, F., and Fan, F. (2016). Depressive symptoms and associated psychosocial factors among adolescent survivors 30 months after 2008 Wenchuan earthquake: a follow-up study. *Front. Psychol.* 7:467. doi: 10.3389/fpsyg.2016.00467

Sloan, D. M., Sawyer, A. T., Lowmaster, S. E., Wernick, J., and Marx, B. P. (2015). Efficacy of narrative writing as an intervention for PTSD: does the evidence support its use? *J. Contemp. Psychother.* 45, 215–225. doi: 10.1007/s10879-014-9292-x

Travagin, G., Margola, D., and Revenson, T. A. (2015). How effective are expressive writing interventions for adolescents? A meta-analytic review. *Clin. Psychol. Rev.* 36, 42–55. doi: 10.1016/j.cpr.2015.01.003

Unterhitzenberger, J., and Rosner, R. (2014). Lessons from writing sessions: a school-based randomized trial with adolescent orphans in Rwanda. *Eur. J. Psychotraumatol.* 5:24917. doi: 10.3402/ejpt.v5.24917

Walter, M., and Bates, G. (2012). "Posttraumatic growth and recovery from post-traumatic stress disorder," in *Essential Notes in Psychiatry*, ed. V. Olisah (Manhattan, NY: InTech), 143–186.

Weiss, D. S., and Marmar, C. R. (1997). "The impact of event scale-revised," in *The Impact of Event Scale-Revised*, eds J. Wilson and T. M. Keane (New York, NY: Guilford Press), 399–411.

Zajac, K., Ralston, M. E., and Smith, D. W. (2015). Maternal support following childhood sexual abuse: associations with children's adjustment post-disclosure and at 9-month follow-up. *Child Abuse Negl.* 44, 66–75. doi: 10.1016/j.chiabu.2015.02.011

Zhen, R., Quan, L., Yao, B., and Zhou, X. (2016). Understanding the relationship between rainstorm-related experiences and PTSD among Chinese adolescents after rainstorm disaster: the roles of rumination and social support. *Front. Psychol.* 7:1407. doi: 10.3389/fpsyg.2016.01407

Zigmond, A. S., and Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatr. Scand.* 67, 361–370. doi: 10.1111/j.1600-0447.1983.tb09716.x

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Pérez, Peñate, Bethencourt and Fumero. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 07 March 2017
doi: 10.3389/fpsyg.2017.00286

Students' Achievement and Homework Assignment Strategies

Rubén Fernández-Alonso[1,2], *Marcos Álvarez-Díaz*[2], *Javier Suárez-Álvarez*[3]* and *José Muñiz*[3]

[1] Department of Education Sciences, University of Oviedo, Oviedo, Spain, [2] Department of Education, Principality of Asturias Government, Oviedo, Spain, [3] Department of Psychology, University of Oviedo, Oviedo, Spain

The optimum time students should spend on homework has been widely researched although the results are far from unanimous. The main objective of this research is to analyze how homework assignment strategies in schools affect students' academic performance and the differences in students' time spent on homework. Participants were a representative sample of Spanish adolescents (N = 26,543) with a mean age of 14.4 (±0.75), 49.7% girls. A test battery was used to measure academic performance in four subjects: Spanish, Mathematics, Science, and Citizenship. A questionnaire allowed the measurement of the indicators used for the description of homework and control variables. Two three-level hierarchical-linear models (student, school, autonomous community) were produced for each subject being evaluated. The relationship between academic results and homework time is negative at the individual level but positive at school level. An increase in the amount of homework a school assigns is associated with an increase in the differences in student time spent on homework. An optimum amount of homework is proposed which schools should assign to maximize gains in achievement for students overall.

Keywords: homework time, equity, compulsory secondary education, hierarchical modeling, adolescents

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Trude Nilsen, University of Olso, Norway
Eva M. Romera, University of Córdoba, Spain

***Correspondence:**
Javier Suárez-Álvarez
suarezalvarezj@gmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *16 November 2016*
Accepted: *14 February 2017*
Published: *07 March 2017*

Citation:
Fernández-Alonso R, Álvarez-Díaz M, Suárez-Álvarez J and Muñiz J (2017) Students' Achievement and Homework Assignment Strategies. Front. Psychol. 8:286. doi: 10.3389/fpsyg.2017.00286

The role of homework in academic achievement is an age-old debate (Walberg et al., 1985) that has swung between times when it was thought to be a tool for improving a country's competitiveness and times when it was almost outlawed. So Cooper (2001) talks about the *battle over homework* and the debates and rows continue (Walberg et al., 1985, 1986; Barber, 1986). It is considered a *complicated subject* (Corno, 1996), *mysterious* (Trautwein and Köller, 2003), *a chameleon* (Trautwein et al., 2009b), or *Janus-faced* (Flunger et al., 2015). One must agree with Cooper et al. (2006) that homework is a practice full of contradictions, where positive and negative effects coincide. As such, depending on our preferences, it is possible to find data which support the argument that homework benefits all students (Cooper, 1989), or that it does not matter and should be abolished (Barber, 1986). Equally, one might argue a compensatory effect as it favors students with more difficulties (Epstein and Van Voorhis, 2001), or on the contrary, that it is a source of inequality as it specifically benefits those better placed on the social ladder (Rømming, 2011). Furthermore, this issue has jumped over the school wall and entered the home, contributing to the polemic by becoming a common topic about which it is possible to have an opinion without being well informed, something that Goldstein (1960) warned of decades ago after reviewing almost 300 pieces of writing on the topic in *Education Index* and finding that only 6% were empirical studies.

The relationship between homework time and educational outcomes has traditionally been the most researched aspect (Cooper, 1989; Cooper et al., 2006; Fan et al., 2017), although conclusions have evolved over time. The first experimental studies (Paschal et al., 1984) worked from the hypothesis that time spent on homework was a reflection of an individual student's commitment and diligence and as such the relationship between time spent on homework and achievement should be positive. This was roughly the idea at the end of the twentieth century, when more positive effects had been found than negative (Cooper, 1989), although it was also known that the relationship was not strictly linear (Cooper and Valentine, 2001), and that its strength depended on the student's age- stronger in post-compulsory secondary education than in compulsory education and almost zero in primary education (Cooper et al., 2012). With the turn of the century, hierarchical-linear models ran counter to this idea by showing that homework was a multilevel situation and the effect of homework on outcomes depended on classroom factors (e.g., frequency or amount of assigned homework) more than on an individual's attitude (Trautwein and Köller, 2003). Research with a multilevel approach indicated that individual variations in time spent had little effect on academic results (Farrow et al., 1999; De Jong et al., 2000; Dettmers et al., 2010; Murillo and Martínez-Garrido, 2013; Fernández-Alonso et al., 2014; Núñez et al., 2014; Servicio de Evaluación Educativa del Principado de Asturias, 2016) and that when statistically significant results were found, the effect was negative (Trautwein, 2007; Trautwein et al., 2009b; Lubbers et al., 2010; Chang et al., 2014). The reasons for this null or negative relationship lie in the fact that those variables which are positively associated with homework time are antagonistic when predicting academic performance. For example, some students may not need to spend much time on homework because they learn quickly and have good cognitive skills and previous knowledge (Trautwein, 2007; Dettmers et al., 2010), or maybe because they are not very persistent in their work and do not finish homework tasks (Flunger et al., 2015). Similarly, students may spend more time on homework because they have difficulties learning and concentrating, low expectations and motivation or because they need more direct help (Trautwein et al., 2006), or maybe because they put in a lot of effort and take a lot of care with their work (Flunger et al., 2015). Something similar happens with sociological variables such as gender: Girls spend more time on homework (Gershenson and Holt, 2015) but, compared to boys, in standardized tests they have better results in reading and worse results in Science and Mathematics (OECD, 2013a).

On the other hand, thanks to multilevel studies, systematic effects on performance have been found when homework time is considered at the class or school level. De Jong et al. (2000) found that the number of assigned homework tasks in a year was positively and significantly related to results in mathematics. Equally, the volume or amount of homework (mean homework time for the group) and the frequency of homework assignment have positive effects on achievement. The data suggests that when frequency and volume are considered together, the former has more impact on results than the latter (Trautwein et al., 2002; Trautwein, 2007). In fact, it has been estimated that in classrooms where homework is always assigned there are gains in mathematics and science of 20% of a standard deviation over those classrooms which sometimes assign homework (Fernández-Alonso et al., 2015). Significant results have also been found in research which considered only homework volume at the classroom or school level. Dettmers et al. (2009) concluded that the school-level effect of homework is positive in the majority of participating countries in PISA 2003, and the OECD (2013b), with data from PISA 2012, confirms that schools in which students have more weekly homework demonstrate better results once certain school and student-background variables are discounted. To put it briefly, homework has a multilevel nature (Trautwein and Köller, 2003) in which the variables have different significance and effects according to the level of analysis, in this case a positive effect at class level, and a negative or null effect in most cases at the level of the individual. Furthermore, the fact that the clearest effects are seen at the classroom and school level highlights the role of homework policy in schools and teaching, over and above the time individual students spend on homework.

From this complex context, this current study aims to explore the relationships between the strategies schools use to assign homework and the consequences that has on students' academic performance and on the students' own homework strategies. There are two specific objectives, firstly, to systematically analyze the differential effect of time spent on homework on educational performance, both at school and individual level. We hypothesize a positive effect for homework time at school level, and a negative effect at the individual level. Secondly, the influence of homework quantity assigned by schools on the distribution of time spent by students on homework will be investigated. This will test the previously unexplored hypothesis that an increase in the amount of homework assigned by each school will create an increase in differences, both in time spent on homework by the students, and in academic results. Confirming this hypothesis would mean that an excessive amount of homework assigned by schools would penalize those students who for various reasons (pace of work, gaps in learning, difficulties concentrating, overexertion) need to spend more time completing their homework than their peers. In order to resolve this apparent paradox we will calculate the optimum volume of homework that schools should assign in order to benefit the largest number of students without contributing to an increase in differences, that is, without harming educational equity.

METHODS

Participants

The population was defined as those students in year 8 of compulsory education in the academic year 2009/10 in Spain. In order to provide a representative sample, a stratified random sampling was carried out from the 19 autonomous regions in Spain. The sample was selected from each stratum according to a two-stage cluster design (OECD, 2009, 2011, 2014a; Ministerio de Educación, 2011). In the first stage, the primary units of the sample were the schools, which were selected with a probability proportional to the number of students in the 8th grade. The more 8th grade students in a given school, the higher the likelihood of the school being selected. In the second

stage, 35 students were selected from each school through simple, systematic sampling. A detailed, step-by-step description of the sampling procedure may be found in OECD (2011). The subsequent sample numbered 29,153 students from 933 schools. Some students were excluded due to lack of information (absences on the test day), or for having special educational needs. The baseline sample was finally made up of 26,543 students. The mean student age was 14.4 with a standard deviation of 0.75, rank of age from 13 to 16. Some 66.2% attended a state school; 49.7% were girls; 87.8% were Spanish nationals; 73.5% were in the school year appropriate to their age, the remaining 26.5% were at least 1 year behind in terms of their age.

Procedure

Test application, marking, and data recording were contracted out via public tendering, and were carried out by qualified personnel unconnected to the schools. The evaluation, was performed on two consecutive days, each day having two 50 min sessions separated by a break. At the end of the second day the students completed a context questionnaire which included questions related to homework. The evaluation was carried out in compliance with current ethical standards in Spain. Families of the students selected to participate in the evaluation were informed about the study by the school administrations, and were able to choose whether those students would participate in the study or not.

Instruments

Tests of Academic Performance

The performance test battery consisted of 342 items evaluating four subjects: Spanish (106 items), mathematics (73 items), science (78), and citizenship (85). The items, completed on paper, were in various formats and were subject to binary scoring, except 21 items which were coded on a polytomous scale, between 0 and 2 points (Ministerio de Educación, 2011). As a single student is not capable of answering the complete item pool in the time given, the items were distributed across various booklets following a matrix design (Fernández-Alonso and Muñiz, 2011). The mean Cronbach α for the booklets ranged from 0.72 (mathematics) to 0.89 (Spanish). Student scores were calculated adjusting the bank of items to Rasch's IRT model using the ConQuest 2.0 program (Wu et al., 2007) and were expressed in a scale with mean and standard deviation of 500 and 100 points respectively. The student's scores were divided into five categories, estimated using the plausible values method. In large scale assessments this method is better at recovering the true population parameters (e.g., mean, standard deviation) than estimates of scores using methods of maximum likelihood or expected a-posteriori estimations (Mislevy et al., 1992; OECD, 2009; von Davier et al., 2009).

Homework Variables

A questionnaire was made up of a mix of items which allowed the calculation of the indicators used for the description of homework variables. *Daily minutes spent on homework* was calculated from a multiple choice question with the following options: (a) Generally I don't have homework; (b) 1 h or less; (c) Between 1 and 2 h; (d) Between 2 and 3 h; (e) More than 3 h. The options were recoded as follows: (a) = 0 min.; (b) = 45 min.; (c) = 90 min.; (d) = 150 min.; (e) = 210 min. According to Trautwein and Köller (2003) the average homework time of the students in a school could be regarded as a good proxy for the amount of homework assigned by the teacher. So the mean of this variable for each school was used as an estimator of *Amount or volume of homework assigned*.

Control Variables

Four variables were included to describe sociological factors about the students, three were binary: *Gender* (1 = *female*); *Nationality* (1 = *Spanish; 0 = other*); School type (1 = *state school; 0 = private*). The fourth variable was *Socioeconomic and cultural index* (SECI), which is constructed with information about family qualifications and professions, along with the availability of various material and cultural resources at home. It is expressed in standardized points, *N(0,1)*. Three variables were used to gather educational history: *Appropriate School Year* (1 = *being in the school year appropriate to their age*; 0 = *repeated a school year)*. The other two adjustment variables were *Academic Expectations* and *Motivation* which were included for two reasons: they are both closely connected to academic achievement (Suárez-Álvarez et al., 2014). Their position as adjustment factors is justified because, in an ex-post facto descriptive design such as this, both expectations and motivation may be thought of as background variables that the student brings with them on the day of the test. *Academic expectations for finishing education* was measured with a multiple-choice item where the score corresponds to the years spent in education in order to reach that level of qualification: compulsory secondary education (10 points); further secondary education (12 points); non-university higher education (14 points); University qualification (16 points). *Motivation* was constructed from the answers to six four-point Likert items, where 1 means strongly disagree with the sentence and 4 means strongly agree. Students scoring highly in this variable are agreeing with statements such as "at school I learn useful and interesting things." A Confirmatory Factor Analysis was performed using a Maximum Likelihood robust estimation method (MLMV) and the items fit an essentially unidimensional scale: CFI = 0.954; TLI = 0.915; SRMR = 0.037; RMSEA = 0.087 (90% CI = 0.084–0.091).

As this was an official evaluation, the tests used were created by experts in the various fields, contracted by the Spanish Ministry of Education in collaboration with the regional education authorities.

Data Analyses

Firstly the descriptive statistics and Pearson correlations between the variables were calculated. Then, using the HLM 6.03 program (Raudenbush et al., 2004), two three-level hierarchical-linear models (student, school, autonomous community) were produced for each subject being evaluated: a null model (without predictor variables) and a random intercept model in which adjustment variables and homework variables were introduced at the same time. Given that HLM does not return standardized coefficients, all of the variables were standardized around the general mean, which allows the interpretation of the results as

classical standardized regression analysis coefficients. Levels 2 and 3 variables were constructed from means of standardized level 1 variables and were not re-standardized. Level 1 variables were introduced without centering except for four cases: study time, motivation, expectation, and socioeconomic and cultural level which were centered on the school mean to control composition effects (Xu and Wu, 2013) and estimate the effect of differences in homework time among the students within the same school. The range of missing variable cases was very small, between 1 and 3%. Recovery was carried out using the procedure described in Fernández-Alonso et al. (2012).

The results are presented in two ways: the tables show standardized coefficients while in the figures the data are presented in a real scale, taking advantage of the fact that a scale with a 100 point standard deviation allows the expression of the effect of the variables and the differences between groups as percentage increases in standardized points.

RESULTS

Table 1 shows the descriptive statistics and the matrix of correlations between the study variables. As can be seen in the table, the relationship between the variables turned out to be in the expected direction, with the closest correlations between the different academic performance scores and socioeconomic level, appropriate school year, and student expectations. The nationality variable gave the highest asymmetry and kurtosis, which was to be expected as the majority of the sample are Spanish.

Table 2 shows the distribution of variance in the null model. In the four subjects taken together, 85% of the variance was found at the student level, 10% was variance between schools, and 5% variance between regions. Although the 10% of variance between schools could seem modest, underlying that there were large differences. For example, in Spanish the 95% plausible value range for the school means ranged between 577 and 439 points, practically 1.5 standard deviations, which shows that schools have a significant impact on student results.

Table 3 gives the standardized coefficients of the independent variables of the four multilevel models, as well as the percentage of variance explained by each level.

The results indicated that the adjustment variables behaved satisfactorily, with enough control to analyze the net effects of the homework variables. This was backed up by two results, firstly, the two variables with highest standardized coefficients were those related to educational history: academic expectations at the time of the test, and being in the school year corresponding to age. Motivation demonstrated a smaller effect but one which was significant in all cases. Secondly, the adjustment variables explained the majority of the variance in the results. The percentages of total explained variance in **Table 2** were calculated with all variables. However, if the strategy had been to introduce the adjustment variables first and then add in the homework variables, the explanatory gain in the second model would have been about 2% in each subject.

The amount of homework turned out to be positively and significantly associated with the results in the four subjects. In a 100 point scale of standard deviation, controlling for other variables, it was estimated that for each 10 min added to the daily volume of homework, schools would achieve between 4.1 and 4.8 points more in each subject, with the exception of mathematics where the increase would be around 2.5 points. In other words, an increase of between 15 and 29 points in the school mean is predicted for each additional hour of homework volume of the school as a whole. This school level gain, however, would only occur if the students spent exactly the same time on homework as their school mean. As the regression coefficient of student homework time is negative and the variable is centered on the level of the school, the model predicts deterioration in results for those students who spend more time than their class mean on homework, and an improvement for those who finish their homework more quickly than the mean of their classmates.

Furthermore, the results demonstrated a positive association between the amount of homework assigned in a school and the differences in time needed by the students to complete their homework. **Figure 1** shows the relationship between volume of homework (expressed as mean daily minutes of homework by school) and the differences in time spent by students (expressed as the standard deviation from the mean school daily minutes). The correlation between the variables was 0.69 and the regression gradient indicates that schools which assigned 60 min of homework per day had a standard deviation in time spent by students on homework of approximately 25 min, whereas in those schools assigning 120 min of homework, the standard deviation was twice as long, and was over 50 min. So schools which assigned more homework also tended to demonstrate greater differences in the time students need to spend on that homework.

Figure 2 shows the effect on results in mathematics of the combination of homework time, homework amount, and the variance of homework time associated with the amount of homework assigned in two types of schools: in type 1 schools the amount of homework assigned is 1 h, and in type 2 schools the amount of homework 2 h. The result in mathematics was used as a dependent variable because, as previously noted, it was the subject where the effect was smallest and as such is the most conservative prediction. With other subjects the results might be even clearer.

Looking at the first standard deviation of student homework time shown in the first graph, it was estimated that in type 1 schools, which assign 1 h of daily homework, a quick student (one who finishes their homework before 85% of their classmates) would spend a little over half an hour (35 min), whereas the slower student, who spends more time than 85% of classmates, would need almost an hour and a half of work each day (85 min). In type 2 schools, where the homework amount is 2 h a day, the differences increase from just over an hour (65 min for a quick student) to almost 3 h (175 min for a slow student). **Figure 2** shows how the differences in performance would vary within a school between the more and lesser able students according to amount of homework assigned. In type 1 schools, with 1 h of homework per day, the difference in achievement between quick and slow students would be around 5% of a standard deviation, while in schools assigning 2 h per day the difference would be

TABLE 1 | Descriptive statistics and Pearson correlation matrix between the variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Mathematics	–														
2. Spanish	0.45	–													
3. Sciences	0.48	0.61	–												
4. Citizenship	0.42	0.59	0.55	–											
5. SEC	0.29	0.36	0.34	0.29	–										
6. Female	−0.05	0.11	−0.05	0.13	−0.01	–									
7. Spanish national	0.12	0.16	0.14	0.12	0.18	−0.01	–								
8. Appropriate school year	0.26	0.34	0.32	0.28	0.31	0.08	0.15	–							
9. Expectations	0.26	0.38	0.33	0.35	0.36	0.13	0.07	0.42	–						
10. Motivation	0.02	0.06	0.06	0.11	−0.02	0.12	−0.04	0.06	0.16	–					
11. Homework time	0.03	0.07	0.05	0.07	0.13	0.14	0.02	0.14	0.19	0.16	–				
12. State school	−0.15	−0.21	−0.17	−0.19	−0.29	−0.01	−0.09	−0.12	−0.16	−0.01	−0.09	–			
13.School SEC	0.25	0.31	0.28	0.24	0.55	0.01	0.11	0.21	0.23	−0.06	0.09	−0.53	–		
14. HWTIME_mean	0.09	0.12	0.11	0.13	0.15	0.04	0.08	0.06	0.11	0.07	0.34	−0.26	0.27	–	
15. AC SEC	0.17	0.16	0.16	0.11	0.24	0.01	−0.04	0.10	0.05	−0.13	−0.04	−0.17	0.44	−0.10	–
Mean	506.47	509.65	509.37	508.10	0.06	0.50	0.88	0.74	14.06	2.87	91.26	0.66	0.06	91.26	0.06
Standard deviation	99.44	95.69	96.37	97.08	1,00	0.50	0.33	0.43	2,34	0.49	42.40	0.48	0.55	14.35	0.24
Asymmetry	0.17	−0.14	−0.05	−0.18	−0.18	−0.03	−2.34	−1.19	−0.54	−0.39	1.26	−0.65	0.01	0.67	−0.11
Kurtosis	0.13	0.11	0.05	−0.07	−0.53	−2.00	3.46	−0.59	−1.48	0.62	1.87	−1.58	−0.01	1.20	−0.55

TABLE 2 | Distribution of the variance in the null model.

Variance	Mathematics	Sciences	Spanish	Citizenship
Level 1	0.8754	0.8521	0.8191	0.8391
Level 2	0.0771	0.1048	0.1353	0.1259
Level 3	0.0482	0.0508	0.0572	0.0430

12%. On the other hand, the slow student in a type 2 school would score 6 points more than the quick student in a type 1 school. However, to achieve this, the slow student in a type 2 school would need to spend five times as much time on homework in a week (20.4 weekly hours rather than 4.1). It seems like a lot of work for such a small gain.

DISCUSSION AND CONCLUSIONS

The data in this study reaffirm the multilevel nature of homework (Trautwein and Köller, 2003) and support this study's first hypothesis: the amount of homework (mean daily minutes the student spends on homework) is positively associated with academic results, whereas the time students spent on homework considered individually is negatively associated with academic results. These findings are in line with previous research, which indicate that school-level variables, such as amount of homework assigned, have more explanatory power than individual variables such as time spent (De Jong et al., 2000; Dettmers et al., 2010; Scheerens et al., 2013; Fernández-Alonso et al., 2015). In this case it was found that for each additional hour of homework assigned by a school, a gain of 25% of a standard deviation is expected in all subjects except mathematics, where the gain is around 15%. On the basis of this evidence, common sense would dictate the conclusion that frequent and abundant homework assignment may be one way to improve school efficiency.

However, as noted previously, the relationship between homework and achievement is paradoxical- appearances are deceptive and first conclusions are not always confirmed. Analysis demonstrates another two complementary pieces of data which, read together, raise questions about the previous conclusion. In the first place, time spent on homework at the individual level was found to have a negative effect on achievement, which confirms the findings of other multilevel-approach research (Trautwein, 2007; Trautwein et al., 2009b; Chang et al., 2014; Fernández-Alonso et al., 2016). Furthermore, it was found that an increase in assigned homework volume is associated with an increase in the differences in time students need to complete it. Taken together, the conclusion is that, schools with more homework tend to exhibit more variation in student achievement. These results seem to confirm our second hypothesis, as a positive covariation was found between the amount of homework in a school (the mean homework time by school) and the increase in differences within the school, both in student homework time and in the academic results themselves. The data seem to be in line with those who argue that homework is a source of inequity because it affects those less academically-advantaged students and students with greater limitations in their home environments (Kohn, 2006; Rømming, 2011; OECD, 2013b).

This new data has clear implications for educational action and school homework policies, especially in compulsory education. If quality compulsory education is that which offers the best results for the largest number (Barber and Mourshed, 2007; Mourshed et al., 2010), then assigning an excessive volume of homework at those school levels could accentuate differences, affecting students who are slower, have more gaps in their knowledge, or are less privileged, and can make them feel overwhelmed by the amount of homework assigned to them (Martinez, 2011; OECD, 2014b; Suárez et al., 2016). The data show that in a school with 60 min of assigned homework, a quick student will need just 4 h a week to finish their homework, whereas a slow student will spend 10 h a week, 2.5 times longer, with the additional aggravation of scoring one twentieth of a standard deviation below their quicker classmates. And in a school assigning 120 min of homework per day, a quick student will need 7.5 h per week whereas a slow student will have to triple this time (20 h per week) to achieve a result one eighth worse, that is, more time for a relatively worse result.

It might be argued that the differences are not very large, as between 1 and 2 h of assigned homework, the level of inequality increases 7% on a standardized scale. But this percentage increase has been estimated after statistically, or artificially, accounting for sociological and psychological student factors and other variables at school and region level. The adjustment variables influence both achievement and time spent on homework, so it is likely that in a real classroom situation the differences estimated here might be even larger. This is especially important in comprehensive education systems, like the Spanish (Eurydice, 2015), in which the classroom groups are extremely heterogeneous, with a variety of students in the same class in terms of ability, interest, and motivation, in which the aforementioned variables may operate more strongly.

The results of this research must be interpreted bearing in mind a number of limitations. The most significant limitation in the research design is the lack of a measure of previous achievement, whether an *ad hoc* test (Murillo and Martínez-Garrido, 2013) or school grades (Núñez et al., 2014), which would allow adjustment of the data. In an attempt to alleviate this, our research has placed special emphasis on the construction of variables which would work to exclude academic history from the model. The use of the repetition of school year variable was unavoidable because Spain has one of the highest levels of repetition in the European Union (Eurydice, 2011) and repeating students achieve worse academic results (Ministerio de Educación, 2011). Similarly, the expectation and motivation variables were included in the group of adjustment factors assuming that in this research they could be considered background variables. In this way, once the background factors are discounted, the homework variables explain 2% of the total variance, which is similar to estimations from other multilevel studies (De Jong et al., 2000; Trautwein, 2007; Dettmers et al., 2009; Fernández-Alonso et al., 2016). On the other hand, the statistical models used to analyze the data are correlational, and as such, one can only speak of an association between variables

TABLE 3 | Multilevel models for prediction of achievement in four subjects.

	Mathematics	Sciences	Spanish	Citizenship
	β (SE)	β (SE)	β (SE)	β (SE)
CONTROL VARIABLES				
Level 1 (student)				
SECI	0.126 (0.010)***	0.144 (0.008)***	0.151 (0.009)***	0.116 (0.007)***
Women	−0.072 (0.007)***	−0.089 (0.007)***	0.068 (0.007)***	0.089 (0.008)***
Country: Spain	0.060 (0.008)***	0.069 (0.008)***	0.088 (0.007)***	0.060 (0.007)***
Appropriate school year	0.129 (0.008)***	0.162 (0.008)***	0.158 (0.008)***	0.127 (0.007)***
Expectations	0.146 (0.009)***	0.191 (0.011)***	0.211 (0.008)***	0.204 (0.007)***
Motivation	0.026 (0.007)**	0.058 (0.008)***	0.035 (0.006)***	0.066 (0.007)***
Level 2 (school)				
State school	−0.021 (0.014)	−0.027 (0.012)*	−0.054 (0.013)***	−0.077 (0.013)***
School SECI	0.163 (0.013)***	0.177 (0.013)***	0.192 (0.020)***	0.132 (0.013)***
Level 3 (AC)				
AC SECI	0.370 (0.123)**	0.261 (0.247)	0.224 (0.225)	0.131 (0.237)
HW Variables				
HW Time (student)	−0.050 (0.008)***	−0.053 (0.006)***	−0.055 (0.006)***	−0.055 (0.007)***
HW Amount (school)	0.046 (0.011)***	0.075 (0.009)***	0.068 (0.011)***	0.083 (0.011)***
Percentage of variance explained				
Level 1	9.7	15.9	18.7	15.0
Level 2	57.1	58.7	59.3	47.7
Level 3	67.3	53.0	50.1	36.2
Total	16.1	22.2	25.9	20.0

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

β, Standardized weight; SE, Standard Error; SECI, Socioeconomic and cultural index; AC, Autonomous Communities.

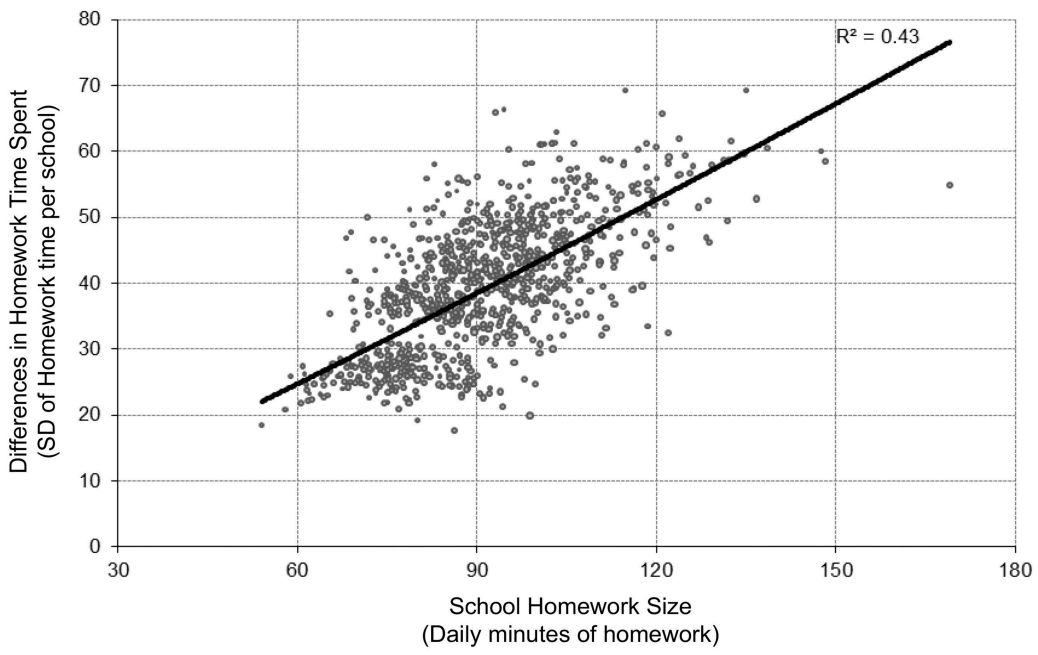


FIGURE 1 | Relationship between school homework volume and differences in time needed by students to complete homework.

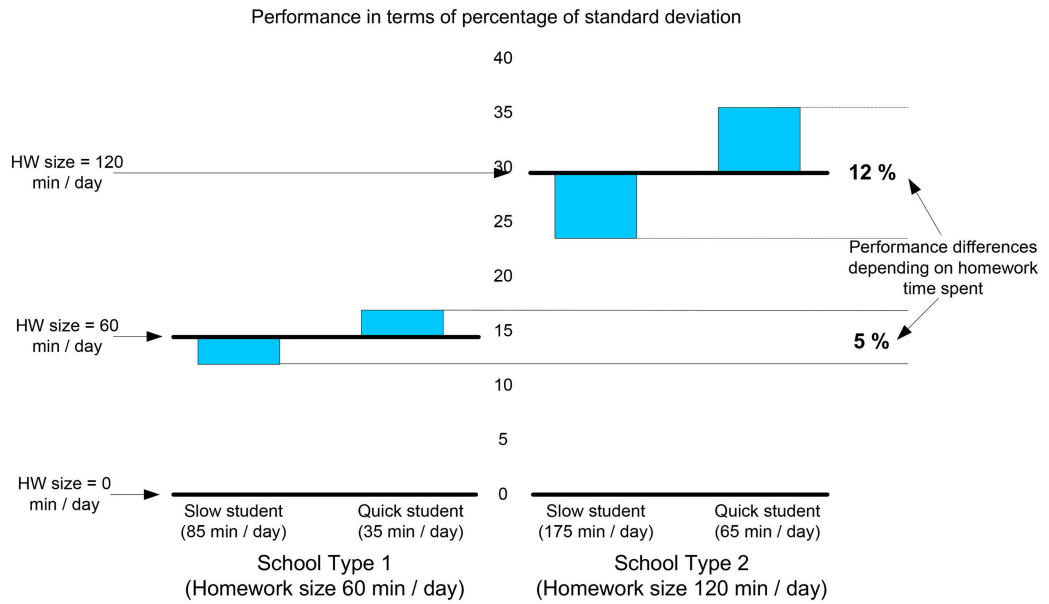


FIGURE 2 | Prediction of results for quick and slow students according to school homework size.

and not of directionality or causality in the analysis. As Trautwein and Lüdtke (2009) noted, the word "effect" must be understood as "predictive effect." In other words, it is possible to say that the amount of homework is connected to performance; however, it is not possible to say in which direction the association runs. Another aspect to be borne in mind is that the homework time measures are generic -not segregated by subject- when it its understood that time spent and homework behavior are not consistent across all subjects (Trautwein et al., 2006; Trautwein and Lüdtke, 2007). Nonetheless, when the dependent variable is academic results it has been found that the relationship between homework time and achievement is relatively stable across all subjects (Lubbers et al., 2010; Chang et al., 2014) which leads us to believe that the results given here would have changed very little even if the homework-related variables had been separated by subject.

Future lines of research should be aimed toward the creation of comprehensive models which incorporate a holistic vision of homework. It must be recognized that not all of the time spent on homework by a student is time well spent (Valle et al., 2015). In addition, research has demonstrated the importance of other variables related to student behavior such as rate of completion, the homework environment, organization, and task management, autonomy, parenting styles, effort, and the use of study techniques (Zimmerman and Kitsantas, 2005; Xu, 2008, 2013; Kitsantas and Zimmerman, 2009; Kitsantas et al., 2011; Ramdass and Zimmerman, 2011; Bembenutty and White, 2013; Xu and Wu, 2013; Xu et al., 2014; Rosário et al., 2015a; Osorio and González-Cámara, 2016; Valle et al., 2016), as well as the role of expectation, value given to the task, and personality traits (Lubbers et al., 2010; Goetz et al., 2012; Pedrosa et al., 2016). Along the same lines, research has also indicated other important variables related to teacher homework policies, such as reasons for assignment, control and feedback, assignment characteristics, and the adaptation of tasks to the students' level of learning (Trautwein et al., 2009a; Dettmers et al., 2010; Patall et al., 2010; Buijs and Admiraal, 2013; Murillo and Martínez-Garrido, 2013; Rosário et al., 2015b). All of these should be considered in a comprehensive model of homework.

In short, the data seem to indicate that in year 8 of compulsory education, 60–70 min of homework a day is a recommendation that, slightly more optimistically than Cooper's (2001) "10 min rule," gives a reasonable gain for the whole school, without exaggerating differences or harming students with greater learning difficulties or who work more slowly, and is in line with other available evidence (Fernández-Alonso et al., 2015). These results have significant implications when it comes to setting educational policy in schools, sending a clear message to head teachers, teachers and those responsible for education. The results of this research show that assigning large volumes of homework increases inequality between students in pursuit of minimal gains in achievement for those who least need it. Therefore, in terms of school efficiency, and with the aim of improving equity in schools it is recommended that educational policies be established which optimize all students' achievement.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the University of Oviedo with written informed consent from all subjects. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the University of Oviedo.

AUTHOR CONTRIBUTIONS

RF and JM have designed the research; RF and JS have analyzed the data; MA and JM have interpreted the data; RF, MA, and JS have drafted the paper; JM has revised it critically; all authors have provided final approval of the version to be published and have ensured the accuracy and integrity of the work.

FUNDING

This research was funded by the Ministerio de Economía y Competitividad del Gobierno de España. References: PSI2014-56114-P, BES2012-053488. We would like to express our utmost gratitude to the Ministerio de Educación Cultura y Deporte del Gobierno de España and to the Consejería de Educación y Cultura del Gobierno del Principado de Asturias, without whose collaboration this research would not have been possible.

REFERENCES

Barber, B. (1986). Homework does not belong on the agenda for educational reform. *Educ. Leadersh.* 43, 55–57.

Barber, M., and Mourshed, M. (2007). *How the World's Best-Performing School Systems Come Out on Top*. McKinsey and Company. Available online at: http://mckinseyonsociety.com/downloads/reports/Education/Worlds_School_Systems_Final.pdf (Accessed January 25, 2016).

Bembenutty, H., and White, M. C. (2013). Academic performance and satisfaction with homework completion among college students. *Learn. Individ. Differ.* 24, 83–88. doi: 10.1016/j.lindif.2012.10.013

Buijs, M., and Admiraal, W. (2013). Homework assignments to enhance student engagement in secondary education. *Eur. J. Psychol. Educ.* 28, 767–779. doi: 10.1007/s10212-012-0139-0

Chang, C. B., Wall, D., Tare, M., Golonka, E., and Vatz, K. (2014). Relations of attitudes toward homework and time spent on homework to course outcomes: the case of foreign language learning. *J. Educ. Psychol.* 106, 1049–1065. doi: 10.1037/a0036497

Cooper, H. (1989). Synthesis of research on homework. *Educ. Leadersh.* 47, 85–91.

Cooper, H. (2001). *The Battle Over Homework: Common Ground for Administrators, Teachers, and Parents*. Thousand Oaks, CA: Sage.

Cooper, H., Robinson, J. C., and Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Rev. Educ. Res.* 76, 1–62. doi: 10.3102/00346543076001001

Cooper, H., Steenbergen-Hu, S., and Dent, A. L. (2012). "Homework," in *APA Educational Psychology Handbook,* Vol. 3: *Application to Learning and Teaching*, eds K. R. Harris, S. Graham, and T. Urdan (Washington, DC: American Psychological Association), 475–495.

Cooper, H., and Valentine, J. C. (2001). Using research to answer practical questions about homework. *Educ. Psychol.* 36, 143–153. doi: 10.1207/S15326985EP3603_1

Corno, L. (1996). Homework is a complicated thing. *Educ. Res.* 25, 27–30. doi: 10.3102/0013189X025008027

De Jong, R., Westerhof, K. J., and Creemers, B. P. M. (2000). Homework and student math achievement in junior high schools. *Educ. Res. Eval.* 6, 130–157. doi: 10.1076/1380-3611(200006)6:2;1-E;F130

Dettmers, S., Trautwein, U., Lüdtke, M., Kunter, M., and Baumert, J. (2010). Homework works if homework quality is high: using multilevel modeling to predict the development of achievement in mathematics. *J. Educ. Psychol.* 102, 467–482. doi: 10.1037/a0018453

Dettmers, S., Trautwein, U., and Lüdtke, O. (2009). The relationship between homework time and achievement is not universal: evidence from multilevel analyses in 40 countries. *Sch. Eff. Sch. Improv.* 20, 375–405. doi: 10.1080/09243450902904601

Epstein, J. L., and Van Voorhis, F. L. (2001). More than minutes: teachers' roles in designing homework. *Educ. Psychol.* 36, 181–193. doi: 10.1207/S15326985EP3603_4

Eurydice (2015). *The Structure of the European Education Systems 2015/16: Schematic Diagrams*. Luxembourg: Publications Office of the European Union. Available online at: https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Publications:The_Structure_of_the_European_Education_Systems_2015/16:_Schematic_Diagrams (Accessed January 25, 2016).

Eurydice (2011). *Grade Retention during Compulsory Education in Europe: Regulations and Statistics*. Luxembourg: Publications Office of the European Union.

Fan, H., Xu, J., Cai, Z., He, J., and Fan, X. (2017). Homework and students' achievement in math and science: a 30-year meta-analysis, 1986-2015. *Educ. Res. Rev.* 20, 35–54. doi: 10.1016/j.edurev.2016.11.003

Farrow, S., Tymms, P., and Henderson, B. (1999). Homework and attainment in primary schools. *Br. Educ. Res. J.* 25, 323–341. doi: 10.1080/0141192990250304

Fernández-Alonso, R., and Muñiz, J. (2011). Diseños de cuadernillos para la evaluación de competencias básicas. *Aula Abierta* 39, 3–34.

Fernández-Alonso, R., Suárez-Álvarez, J., and Muñiz, J. (2012). Imputación de datos perdidos en las evaluaciones diagnósticas educativas [Imputation methods for missing data in educational diagnostic evaluation]. *Psicothema* 24, 167–175.

Fernández-Alonso, R., Suárez-Álvarez, J., and Muñiz, J. (2014). Tareas escolares en el hogar y rendimiento en matemáticas: una aproximación multinivel con estudiantes de enseñanza primaria [Homework and academic performance in mathematics: A multilevel approach with primary school student]. *Rev. Psicol. Educ.* 9, 15–30.

Fernández-Alonso, R., Suárez-Álvarez, J., and Muñiz, J. (2015). Adolescents' homework performance in mathematics and science: personal factors and teaching practices. *J. Educ. Psychol.* 107, 1075–1085. doi: 10.1037/edu0000032

Fernández-Alonso, R., Suárez-Álvarez, J., and Muñiz, J. (2016). Homework and performance in mathematics: the role of the teacher, the family and the student's background. *Rev. Psicod.* 21, 5–23. doi: 10.1387/RevPsicodidact.13939

Flunger, B., Trautwein, U., Nagengast, B., Lüdtke, O., Niggli, A., and Schnyder, I. (2015). The Janus-faced nature of time spent on homework: using latent profile analyses to predict academic achievement over a school year. *Lear. Instr.* 39, 97–106. doi: 10.1016/j.learninstruc.2015.05.008

Gershenson, S., and Holt, S. B. (2015). Gender gaps in high school students' homework time. *Educ. Res.* 44, 432–441. doi: 10.3102/0013189X15616123

Goetz, T., Nett, U. E., Martiny, S. E., Hall, N. C., Pekrun, R., Dettmers, S., et al. (2012). Students' emotions during homework: structures, self-concept antecedents, and achievement outcomes. *Learn. Individ. Differ.* 22, 225–234. doi: 10.1016/j.lindif.2011.04.006

Goldstein, A. (1960). Does homework help? A review of research. *Elementary Sch. J.* 60, 212–224. doi: 10.1086/459804

Kitsantas, A., Cheema, J., and Ware, H. (2011). The role of homework support resources, time spent on homework, and self-efficacy beliefs in mathematics achievement. *J. Adv. Acad.* 22, 312–341. doi: 10.1177/1932202X1102200206

Kitsantas, A., and Zimmerman, B. J. (2009). College students homework and academic achievement: the mediating role of self-regulatory beliefs. *Metacognition Learn.* 4, 1556–1623. doi: 10.1007/s11409-008-9028-y

Kohn, A. (2006). Abusing research: the study of homework and other examples. *Phi Delta Kappan* 88, 9–22. doi: 10.1177/003172170608800105

Lubbers, M. J., Van Der Werf, M. P. C., Kuyper, H., and Hendriks, A. A. J. (2010). Does homework behavior mediate the relation between personality and academic performance? *Learn. Individ. Differ.* 20, 203–208. doi: 10.1016/j.lindif.2010.01.005

Martinez, S. (2011). An examination of Latino students' homework routines. *J. Latinos Educ.* 10, 354–368. doi: 10.1080/15348431.2011.605688

Mislevy, R. J., Beaton, A. E., Kaplan, B., and Sheehan, K. M. (1992). Estimating population characteristics from sparse matrix samples of item responses. *J. Educ. Meas.* 29, 133–161. doi: 10.1111/j.1745-3984.1992.tb00371.x

Ministerio de Educación (2011). *Evaluación General de Diagnóstico 2010. Educación Secundaria Obligatoria. Informe de Resultados*. Madrid: Instituto de Evaluación. Available online at: http://www.mecd.gob.es/dctm/ievaluacion/informe-egd-2010.pdf?documentId=0901e72b80d5ad3e (Accessed January 25, 2016).

Mourshed, M., Chijioke, C., and Barber, M. (2010). *How the World's Most Improved School Systems Keep Getting Better*. McKinsey and Company. Available online at: http://mckinseyonsociety.com/downloads/reports/Education/How-the-Worlds-Most-Improved-School-Systems-Keep-Getting-Better_Download-version_Final.pdf (Accessed January 25, 2016).

Murillo, F. J., and Martínez-Garrido, C. (2013). Homework influence on academic performance. A study of iberoamerican students of primary education. *J. Psychodidactics* 18, 157–171. doi: 10.1387/RevPsicodidact.6156

Núñez, J. C., Vallejo, G., Rosário, P., Tuero, E., and Valle, A. (2014). Student, teacher, and school context variables predicting academic achievement in biology: analysis from a multilevel perspective. *J. Psychodidactics* 19, 145–171. doi: 10.1387/RevPsicodidact.7127

OECD (2009). *PISA Data Analysis Manual: SPSS, 2nd Edn*. Paris: OECD Publishing.

OECD (2011). *School Sampling Preparation Manual. PISA 2012 Main Survey*. Paris: OECD Publishing. Available online at: https://www.oecd.org/pisa/pisaproducts/PISA2012MS-SamplingGuidelines-.pdf (Accessed January 6, 2017).

OECD (2013a). *PISA 2012 Results: What Students Know and Can Do. Student Performance in Mathematics, Reading and Science (Volume I)*. Paris: OECD Publishing.

OECD (2013b). *PISA 2012 Results: What Makes Schools Successful? Resources, Policies and Practices (Volume IV)*. Paris: OECD Publishing.

OECD (2014a). *PISA 2012 Technical Report*. Paris: OECD Publishing. Available online at: http://www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf (Accessed January 25, 2016).

OECD (2014b). *Does Homework Perpetuate Inequities in Education? PISA in Focus*. Paris: OECD Publishing.

Osorio, A., and González-Cámara, M. (2016). Testing the alleged superiority of the indulgent parenting style among Spanish adolescents. *Psicothema* 28, 414–420. doi: 10.7334/psicothema2015.314

Paschal, R. A., Weinstein, T., and Walberg, H. J. (1984). The effects of homework on learning: a quantitative synthesis. *J. Educ. Res.* 78, 97–104. doi: 10.1080/00220671.1984.10885581

Patall, E. A., Cooper, H., and Wynn, S. R. (2010). The effectiveness and relative importance of providing choices in the classroom. *J. Educ. Psychol.* 102, 896–915. doi: 10.1037/a0019545

Pedrosa, I., Suárez-Álvarez, J., García-Cueto, E., and Muñiz, J. (2016). A computerized adaptive test for enterprising personality assessment in youth. *Psicothema* 28, 471–478. doi: 10.7334/psicothema2016.68

Ramdass, D., and Zimmerman, B. J. (2011). Developing self-regulation skills: the important role of homework. *J. Adv. Acad.* 22, 194–218. doi: 10.1177/1932202X1102200202

Raudenbush, S. W., Bryk, A. S., Cheong, Y. F., and Congdon, R. T. (2004). *HLM6: Hierarchical Linear and Nonlinear Modeling*. Chicago: Scientific Software International.

Rømming, M. (2011). Who benefits from homework assignments? *Econ. Educ. Rev.* 30, 55–64. doi: 10.1016/j.econedurev.2010.07.001

Rosário, P., Núñez, J. C., Vallejo, G., Cunha, J., Nunes, T., Mourão, R., et al. (2015a). Does homework design matter? The role of homework's purpose in student mathematics achievement. *Contemp. Educ. Psychol.* 43, 10–24. doi: 10.1016/j.cedpsych.2015.08.001

Rosário, P., Núñez, J. C., Vallejo, G., Cunha, J., Nunes, T., Suárez, N., et al. (2015b). The effects of teachers' homework follow-up practices on students' EFL performance: a randomized-group design. *Front. Psychol.* 6:1528. doi: 10.3389/fpsyg.2015.01528

Servicio de Evaluación Educativa del Principado de Asturias (2016). *La relación entre el tiempo de deberes y los resultados académicos [The Relationship between Homework Time and Academic Performance]. Informes de Evaluación, 1*. Oviedo: Consejería de Educación y Cultura del Gobierno del Principado de Asturias.

Scheerens, J., Hendriks, M., Luyten, H., Sleegers, P., and Cees, G. (2013). *Productive Time in Education. A Review of the Effectiveness of Teaching Time at School, Homework and Extended Time Outside School Hours*. Enschede: University of Twente. Available online at: http://doc.utwente.nl/86371/ (Accessed January 25, 2016).

Suárez-Álvarez, J., Fernández-Alonso, R., and Muñiz, J. (2014). Self-concept, motivation, expectations and socioeconomic level as predictors of academic performance in mathematics. *Learn. Indiv. Diff.* 30, 118–123. doi: 10.1016/j.lindif.2013.10.019

Suárez, N., Regueiro, B., Epstein, J. L., Piñeiro, I., Díaz, S. M., and Valle, A. (2016). Homework involvement and academic achievement of native and immigrant students. *Front. Psychol.* 7:1517. doi: 10.3389/fpsyg.2016.01517

Trautwein, U. (2007). The homework–achievement relation reconsidered: differentiating homework time, homework frequency, and homework effort. *Learn. Instr.* 17, 372–388. doi: 10.1016/j.learninstruc.2007.02.009

Trautwein, U., and Köller, O. (2003). The relationship between homework and achievement: still much of a mystery. *Educ. Psychol. Rev.* 15, 115–145. doi: 10.1023/A:1023460414243

Trautwein, U., Köller, O., Schmitz, B., and Baumert, J. (2002). Do homework assignments enhance achievement? A multilevel analysis in 7th grade mathematics. *Contemp. Educ. Psychol.* 27, 26–50. doi: 10.1006/ceps.2001.1084

Trautwein, U., Lüdtke, O., Schnyder, I., and Niggli, A. (2006). Predicting homework effort: support for a domain-specific, multilevel homework model. *J. Educ. Psychol.* 98, 438–456. doi: 10.1037/0022-0663.98.2.438

Trautwein, U., and Lüdtke, O. (2007). Students' self-reported effort and time on homework in six school subjects: between-student differences and within-student variation. *J. Educ. Psychol.* 99, 432–444. doi: 10.1037/0022-0663.99.2.432

Trautwein, U., and Lüdtke, O. (2009). Predicting homework motivation and homework effort in six school subjects: the role of person and family characteristics, classroom factors, and school track. *Learn. Instr.* 19, 243–258. doi: 10.1016/j.learninstruc.2008.05.001

Trautwein, U., Niggli, A., Schnyder, I., and Lüdtke, O. (2009a). Between-teacher differences in homework assignments and the development of students' homework effort, homework emotions, and achievement. *J. Educ. Psychol.* 101, 176–189. doi: 10.1037/0022-0663.101.1.176

Trautwein, U., Schnyder, I., Niggli, A., Neumann, M., and Lüdtke, O. (2009b). Chameleon effects in homework research: the homework–achievement association depends on the measures used and the level of analysis chosen. *Contemp. Educ. Psychol.* 34, 77–88. doi: 10.1016/j.cedpsych.2008.09.001

Valle, A., Pan, I., Regueiro, B., Suárez, N., Tuero, E., and Nunes, A. R. (2015). Predicting approach to homework in primary school students. *Psicothema* 27, 334–340. doi: 10.7334/psicothema2015.118

Valle, A., Regueiro, B., Núñez, J. C., Rodríguez, S., Piñero, I., and Rosário, P. (2016). Academic goals, student homework engagement, and academic achievement in elementary school. *Front. Psychol.* 7:463. doi: 10.3389/fpsyg.2016.00463

von Davier, M., Gonzalez, E., and Mislevy, R. J. (2009). *What are Plausible Values and Why are They Useful?*. IERI Monograph Series. Issues and Methodologies in Large-Scale Assessments. Available online at: http://www.ierinstitute.org/fileadmin/Documents/IERI_Monograph/IERI_Monograph_Volume_02.pdf (Accessed January 15, 2017).

Walberg, H. J., Paschal, R. A., and Weinstein, T. (1985). Homework's powerful effects on learning. *Educ. Leadersh.* 42, 76–79.

Walberg, H. J., Paschal, R. A., and Weinstein, T. (1986). Walberg and colleagues reply: effective schools use homework effectively. *Educ. Leadersh.* 43, 58.

Wu, M. L., Adams, R. J., Wilson, M. R., and Haldane, S. A. (2007). *ACER ConQuest 2.0: Generalised Item Response Modelling Software*. Camberwell, VIC: Australian Council for Educational Research.

Xu, J. (2008). Models of secondary school students' interest in homework: a multilevel analysis. *Am. Educ. Res. J.* 45, 1180–1205. doi: 10.3102/0002831208323276

Xu, J. (2013). Why do students have difficulties completing homework? The need for homework management. *J. Educ. Train. Stud.* 1, 98–105. doi: 10.11114/jets.v1i1.78

Xu, J., and Wu, H. (2013). Self-regulation of homework behavior: homework management at the secondary school level. *J. Educ. Res.* 106, 1–13. doi: 10.1080/00220671.2012.658457

Xu, J., Yuan, R., Xu, B., and Xu, M. (2014). Modeling students' time management in math homework. *Learn. Individ. Differ.* 34, 33–42. doi: 10.1016/j.lindif.2014.05.011

Zimmerman, B. J., and Kitsantas, A. (2005). Homework practices and academic achievement: the mediating role of self-efficacy and perceived responsibility beliefs. *Contemp. Educ. Psychol.* 30, 397–417. doi: 10.1016/j.cedpsych.2005.05.003

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Fernández-Alonso, Álvarez-Díaz, Suárez-Álvarez and Muñiz. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 14 February 2017
doi: 10.3389/fpsyg.2017.00170

Antisocial Behavior and Interpersonal Values in High School Students

María del Mar Molero Jurado[1], María del Carmen Pérez Fuentes[1], José J. Carrión Martínez[1], Antonio Luque de la Rosa[1], Anabella Garzón Fernández[1], África Martos Martínez[1], Maria del Mar Simón Márquez[1], Ana B. Barragán Martín[1] and José J. Gázquez Linares[1,2]*

[1] Department of Psychology, University of Almería, Almería, Spain, [2] Department of Psychology, Universidad Autónoma de Chile, Chile, Chile

This article analyzes the characteristics of antisocial behavior and interpersonal values of high school students (*Compulsory Secondary Education*) (CSE), the profile of students with high levels of antisocial behavior with regard to interpersonal values, and possible protection from antisocial behavior that interpersonal values could provide. The Interpersonal Values Questionnaire was used to assess interpersonal values, and the Antisocial-Delinquent Behaviors Questionnaire was employed to assess antisocial behaviors. The sample was made up of 885 CSE students aged 14–17. The results revealed a greater prevalence of antisocial behaviors among males and fourth-year CSE students. Moreover, antisocial behaviors were more frequent among participants with high scores in Stimulation, Recognition, Independence, and Leadership and low scores in Conformity and Benevolence. Lastly, logistic regression analyses showed that low scores in Conformity and Benevolence and high scores in Independence predicted high scores in antisocial behavior. The possibility of identifying certain interpersonal values which could positively or negatively affect the appearance of antisocial behavior during adolescence is discussed.

Keywords: antisocial behavior, interpersonal values, high school students, convivence, profile of subjects

OPEN ACCESS

Edited by:
Jason C. Immekus, University of Louisville, USA

Reviewed by:
Pablo Miñano, University of Alicante, Spain
David Álvarez-García, University of Oviedo, Spain

****Correspondence:***
María del Carmen Pérez Fuentes
mpf421@ual.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *31 July 2016*
Accepted: *25 January 2017*
Published: *14 February 2017*

Citation:
Molero Jurado MdM, Pérez Fuentes MdC, Carrión Martínez JJ, Luque de la Rosa A, Garzón Fernández A, Martos Martínez Á, Simón Márquez MdM, Barragán Martín AB and Gázquez Linares JJ (2017) Antisocial Behavior and Interpersonal Values in High School Students. Front. Psychol. 8:170. doi: 10.3389/fpsyg.2017.00170

INTRODUCTION

According to Farrington (2005), antisocial behavior is characterized by a style of interpersonal relations seeking group value and recognition, is manipulative and deceitful, lacks empathy, is socially insensitive, impulsive, irresponsible and disobedient. It thus includes "a wide variety of behaviors which reflect violation of societal norms and/or aggression against others" (Kazdin and Buela-Casal, 1996, p. 19). Most authors agree on a series of characteristics that define this type of behavior, such as lack of respect of social norms and the rights of others (Martínez and Gras, 2007), its multifactorial origin (López and Rodríguez-Arias, 2012), and its manifestation linked to the influence of personal variables (such as gender, age, or personality traits) (Pahlavan and Andreu, 2009; Calvete and Orue, 2010; Peña, 2010). As antisocial behavior reaches its maximum expression during adolescence, it becomes of great interest to research on this developmental stage (Pérez-Fuentes et al., 2011; Light et al., 2013; Inglés et al., 2014; Gázquez et al., 2015). Other authors refer to problems in conceptualizing antisocial behavior, differentiating between aggressive forms and

rule-breaking (Burt, 2013), since they correlate with different factors, such as proactive aggression (Andreu and Peña, 2013). To the extent that this type of behavior constitutes a risk, not only for the person him/herself, but also for those he/she relates with, effective intervention strategies are necessary not only for its elimination, but also for its prevention (Fernández-Cabezas et al., 2011). Achievement of these goals of intervention and prevention goes through knowledge of antisocial behavior risk and protection factors (López and Rodríguez-Arias, 2012).

THE ORIGIN OF ANTISOCIAL BEHAVIOR AND SOCIALIZATION CONTEXTS

The early beginning of antisocial behavior (Loeber and Burke, 2011) makes the family, as the child's first socialization context, of special relevance and importance in the presence of risk and protection factors (Antolín et al., 2009; Álvarez et al., 2015). Some authors suggest childhood abuse or exposure of minors to domestic violence as risk factors for antisocial behavior in adolescence (Sousa et al., 2011), as well as the presence of antisocial behavior of parents, which has a negative impact on the mental and emotional health of their children (Silberg et al., 2012). Murray et al. (2012) found that sudden changes in family structure, such as incarceration of one of the parents, increased the probability of antisocial behavior in their children by 10%.

Furthermore, regarding the family context as a source of possible protective factors against antisocial behavior, Jaureguizar and Ibabe (2012) suggest that the promotion of prosocial attitudes and acquisition of values in the family maintains an inverse relationship with development of antisocial attitudes in children and adolescents. These benefits are also confirmed in the meta-analysis by Piquero et al. (2009), in which the reduction in problematic behavior, including antisocial and delinquent behaviors, was outstanding after application of several types of family intervention going from training in parenting to house visits. Family support not only has positive effects on children who grow up in socially adequate environments, but also performs a protective function in marginal and disfavored environments (Schofield et al., 2012).

Nor should it be forgotten that the educational context provides opportunities for interaction with the peer group, which can be both a system for protection of and risk to young people developing antisocial and delinquent behaviors, and is therefore also relevant to their study (Gázquez et al., 2011). The presence of a positive school environment is therefore a protective factor against both acquisition and maintenance of problematic behavior (Wu et al., 2010). On the other hand, a negative school climate is characterized by the presence of problems with coexistence and bullying, presents higher prevalence of antisocial behaviors and more motivation problems are observed (Rodríguez and Mora-Merchán, 2014; Rodríguez et al., 2014; Regueiro et al., 2015; Valle et al., 2015a,b). Thus the "aggressive victim" responds to harassment by projecting a self-image as rebellious and antisocial (Emler, 2009), while the aggressor is characterized by being highly impulsive (López et al., 2008) and rejecting norms (Povedano et al., 2012). Finally, some authors find a positive correlation between the role of aggressor and antisocial behavior (Cerezo and Méndez, 2013).

DIFFERENCES IN MANIFESTATION OF ANTISOCIAL BEHAVIOR: GENDER, AGE, AND SCHOOL YEAR

Much of the research on prevalence of antisocial behavior which has analyzed the differences in gender suggests that males show higher rates of antisocial behavior than females (López and Rodríguez-Arias, 2010; Hasking et al., 2011; Viñas et al., 2012). However, although men show more aggressiveness than women (Muñoz et al., 2010), this trend may be changing, since female involvement in violent situations is growing (Pozo, 2012).

Martí and Palma (2010) thought that sex and age have a significant effect on adolescent preferences for values: Girls prefer more abstract, interiorized values and are prone to instrumental values with a more egocentric and material load. As age advances, adolescents prefer values more in harmony with personal dignity and equality rather than those focusing on oneself or on confrontation with others. More recently, Garaigordobil et al. (2014) observed that males involved in bullying tend toward domination and are more aggressive than women.

Regarding the age variable, no one moment has been agreed upon for either appearance of antisocial behavior or its prevalence during an individual's development. Some have placed its appearance at around 13 years of age (Rechea, 2008), while others like Tresgallo (2011) have suggested that first manifestations appear at 6–7 years, intensifying in late adolescence (Cifuentes and Londoño, 2011), and still others have suggested that it is relatively stable through adulthood (Estévez et al., 2007). More recently, findings in a sample of adolescents aged 13–18 showed that older adolescents exhibit antisocial behavior more often than younger adolescents. Thus the stage of psychological development, and not just age, is of especial importance in the analysis of origin and maintenance of antisocial behavior.

Finally, another of the aspects analyzed is the school year, which is of interest for studying transitions, since this is where the appearance of behavior negative to the school climate becomes most likely (Pellegrini et al., 2010). The prevalence of such behavior in each school year is also studied, because there is a positive correlation between its prevalence and subject age, and also with school year. And the older they are, that is, in higher school years, student justification of violence decreases and is there is more of it among males (Garaigordobil et al., 2013).

ANTISOCIAL BEHAVIOR AND INTERPERSONAL VALUES

Interpersonal values are defined as factors determining human behavior, aspects by which each person behaves one way or another when relating to others, depending on their system of values (Gordon, 1979). Thus, throughout development, and especially during adolescence, where interpersonal relations start

to become more important, decisions made in different moral dilemmas are of significant importance (Paciello et al., 2013). Therefore, in recent years, several studies associated with this stage of development have analyzed the protective variables avoiding the appearance of antisocial behavior (Inglés et al., 2013) and those which could attenuate its manifestations once they have appeared (Loeber and Farrington, 2012). Thus attitudes and values, such as social sensitivity, prosocial leadership, or security in interpersonal relationships, have been related to social competency in adolescents (Jiménez and López-Zafra, 2011). Other studies have found association of certain interpersonal values and aggressive behavior in the school. Fossati et al. (2012) suggested that low scores in friendliness/benevolence are closely related to participation in violence against schoolmates. According to Georgiou et al. (2013), individualism as a cultural value could be related to an authoritarian style and proneness to intimidation.

After reviewing the literature on the subject in the study in hand, the following research hypotheses were posed: H_1: More antisocial behavior in males in higher grades; H_2: Antisocial behavior differs depending on the higher/lower interpersonal value scores; and H_3: Interpersonal values have different weights on the scale as predictors of antisocial behavior.

In spite of the history of research in antisocial behavior in its role as a predictor of other repertoires of problematic behavior, such as substance abuse (Clark et al., 2002) and its clinical applications (Yakeley and Williams, 2014), this study attempts to clarify the weight of other variables, such as interpersonal values, susceptible to early intervention. Better understanding of these variables during adolescence is essential to progress in research on the causes of these behaviors and for the development of prevention programs addressing antisocial behavior at the youngest ages. Acquisition of interpersonal values is therefore presented as a tool for the prevention of violent behaviors, but unlike the traditional trend of research on the subject, in this case, from a more positive focus. Work is therefore concentrated on identifying those values which make the adolescent a competent social being (Oliva et al., 2010).

This study pursues a better explanation in this regard by analyzing the characteristics of antisocial behavior and interpersonal values based on gender and school year, describing the interpersonal value profile of individuals with high levels of antisocial behavior, and finally, to what extent interpersonal values protect against antisocial behavior.

MATERIALS AND METHODS

Participants

The sample was acquired by random cluster sampling by the different geographic areas [Center, *Levante* (East), and *Poniente* (West)] in the province of Almeria (Spain) from which five public high schools in rural and urban areas were selected at random. Each zone had at least one high school and four classes per school, two in third and two in fourth year of high school, *Educación Secundaria Obligatoria* (*Compulsory Secondary Education*) (ESO), and the sample from each area was over 200 students.

The total sample was made up of 1055 students from 3rd and 4th year of high school of whom 120 were disqualified (11.37%) because they did not finish the questionnaires in time due to their poor mastery of the Spanish language. Another 50 (4.74%) were disqualified due errors or omissions or not having attended one of the two sessions it was given in. Thus the final sample was comprised of a total of 885 students ranging from 14 to 17 years of age, with a mean age of 15.2 years ($SD = 0.90$). Of the total sample, 49.8% ($n = 441$) were males and 50.2% ($n = 444$) were females, with a mean age of 15.22 ($SD = 0.92$) and 15.19 ($SD = 0.89$), respectively. Sample distribution by geographic areas was 212 students (24%) from the center of the province, 333 students from *Levante* (37.6%), and from *Poniente* 340 students (38.4%).

Distribution of the sample by school year was as follows: 3rd year ESO ($n = 475$; 241 males and 234 females) and 4th year ESO ($n = 410$; 200 males and 210 females). The chi-square test for homogeneous distribution of frequencies showed absence of statistically significant differences in gender and school year among the four groups ($\chi^2_{(1,885)} = 0.34$; $p = 0.56$).

Instruments

Survey of Interpersonal Values (SIV; Gordon, 1977). Ninety yes/no items measuring six aspects of the subject's relations with others:

- Stimulation: Is treated kindly, with consideration and understanding and perceives support from others.
- Conformity: Following the rules, doing what is socially correct, conforming and acting in conformity with what is accepted and suitable.
- Recognition: Being recognized by others, admired and looked up to, attracting positive attention.
- Independence: Doing and considering it one's right to do whatever one wants, decide for oneself using own criteria and being free.
- Benevolence: Being generous, helping others and doing things for and sharing with them.
- Leadership: Exerting authority over others from a position of command or power.

The Cronbach's alpha is from 0.78 to 0.89 (Gordon, 1993).

Antisocial-Delinquent Behaviors Questionnaire (*A-D*; Seisdedos, 1995). It is comprised of 40 items which assess antisocial (trespassing, littering, etc.) and delinquent behaviors (taking drugs, stealing, etc.). Its reliability and validity are adequate ($\alpha = 0.88$), as they are in our sample, with a total Cronbach's alpha slightly above ($\alpha = 0.92$). In this study, only the antisocial behavior scale was used ($\alpha = 0.90$).

Procedure

First, a meeting was held with the directors or counselors at the various schools selected to explain the research goals and inform them of the instruments to be used, as well as to request the permission and cooperation necessary to implement the

study. This study was exempt from ethical approval, because the study did not involve any potential risk for the participants. All participants provided written consent. Then the counselors met with and informed the parents of the purpose of the study and requested their consent for the participation of their children. The questionnaires were then administered in two 50-min sessions with an interval between which varied with the school and the class, but was always over 20 min. The questionnaires were coded for their identification by students and to keep them otherwise anonymous. They were administered by groups, voluntarily and anonymously in the classroom or other space at the school if several classes were grouped together. The researchers responsible for the study were present at both the parents meeting and during administration of the questionnaires, to answer questions or resolve doubts, etc.

Data Analysis

A cross-sectional descriptive design was used for this study in order to analyze the antisocial behavior and interpersonal values by gender and school year and find any relationships between students' interpersonal values (stimulation, conformity, recognition, independence, benevolence, and leadership) and antisocial behavior.

The Student's *t*-test was used for the first objective and to find out the mean scores of males and females as well as students in third and fourth year high school on antisocial behavior and interpersonal values (Are there any statistically significant differences in antisocial behavior and interpersonal values between men and women? Are there any statistically significant differences in antisocial behavior and interpersonal behavior between students in 3rd and 4th year?). In addition, to find out the magnitude or effect size of those significant differences indicated by the *t*-test, the Cohen's *d* was calculated Cohen's (1988) and interpreted as $d \leq 0.20$ minimum effect size, $d = 0.21$ a $d = 0.50$ means a small effect size, $d = 0.51$ a $d = 0.79$ means a medium effect size, and when $d \geq 0.80$ the effect is large.

Identification of the sample on the *SIV Questionnaire* interpersonal value scales (Gordon, 1977) was done when the normal distribution of each had been tested. The thresholds of the scales were differentiated after their normal distribution had been checked. Two groups were formed from the total sample ($N = 885$) for each of the scales: (a) students with low scores in Stimulation, Conformity, Recognition, Independence, Benevolence, and Leadership, that is, those who scored the same or below the 25th percentile (scores equal to or over 14, 11, 8, 13, 14, and 7, respectively) ($N_{2S} = 233$, 26.3%; $N_{2C} = 235$, 26.6%; $N_{2R} = 218$, 24.6%; $N_{2I} = 237$, 26.8%; $N_{2B} = 262$, 29.6%, and $N_{2L} = 240$, 27.1%); (b) students with high scores in Stimulation, Conformity, Recognition, Independence, Benevolence, and Leadership, that is, those who scored the same or over 20, 19, 15, 21, 22, and 14, respectively) ($N_{1S} = 291$, 32.9%; $N_{1C} = 227$, 25.6%; $N_{1R} = 238$, 26.9%; $N_{1I} = 268$, 30.3%; $N_{1B} = 248$, 28%, and $N_{1L} = 246$; 27.8%). This procedure, commonly used in evolutionary psychology, provides two groups with high and low levels. This is also along the same line as other authors who discuss how various facets of antisocial behavior are related to the individual's social development (Espinosa and Clemente, 2011), so it is important to analyze the scores in antisocial behavior from a group criterion. Subjects with intermediate levels did not form part of the sample analyzed.

The Student's *t*-test was used to analyze the differences in antisocial behavior between students with high and low scores

TABLE 1 | Difference in means in antisocial behavior and interpersonal values by gender and school year.

	Males			Females			Statistical significance		
	N	***M***	***DE***	***N***	***M***	***DE***	***t***	***p***	***d***
AB	441	9.76	5.69	444	8.45	5.26	3.56	0.00	0.24
SIV-S	433	17.25	4.44	437	17.54	4.37	−0.96	0.34	n.s.
SIV-C	426	14.46	5.21	436	15.23	5.38	−2.15	0.03	0.15
SIV-R	431	12.74	4.60	436	10.75	4.42	6.53	0.00	0.44
SIV-I	430	17.27	5.76	434	17.41	5.79	−0.33	0.74	n.s.
SIV-B	429	16.39	5.97	437	19.06	5.48	−6.86	0.00	0.47
SIV-L	430	11.72	5.14	429	9.85	4.64	5.60	0.00	0.38
	3rd year			**4th year**			**Statistical significance**		
	N	***M***	***DE***	***N***	***M***	***DE***	***t***	***p***	***d***
AB	475	8.50	5.29	410	9.81	5.69	−3.54	0.00	0.24
SIV-S	471	16.97	4.38	399	17.90	4.40	−3.12	0.01	0.21
SIV-C	468	15.93	5.08	394	13.57	5.29	6.65	0.00	0.46
SIV-R	471	11.28	4.42	396	12.29	4.78	−3.22	0.01	0.22
SIV-I	466	17.00	5.88	398	17.74	5.63	−1.87	0.06	n.s.
SIV-B	468	18.34	5.84	398	17.04	5.85	3.26	0.01	0.22
SIV-L	465	10.39	4.77	394	11.25	5.18	−2.50	0.01	0.17

AB, Antisocial Behavior; SIV-S, support; SIV-C, conformity; SIV-R, recognition; SIV-I, independence; SIV-B, benevolence; SIV-L, leadership; n.s., not significant.

on the *SIV Questionnaire* scales (Are there any statistically significant differences in antisocial behavior between students with higher/lower scores on each of the interpersonal values scales?). And again, the Cohen's *d* (Cohen's, 1988) was calculated to find out the magnitude or effect size of the significant differences shown by the *t*-test.

Aside from this, for the purpose of analyzing the ability of interpersonal values to predict students' antisocial behavior, a binary logistic regression analysis was performed using forward stepwise regression based on the Wald statistic (What is the predictive value of interpersonal values on antisocial behavior?). Thus two groups were formed, one for the six predictive variables (Stimulation, Conformity, Recognition, Independence, Benevolence, and Leadership) and one for the criterion variable (antisocial behavior), maintaining the one used for the previous test for the predictive variables. For classifying the sample for antisocial behavior, the same criterion was used as in the *SIV Questionnaire* scales, using the following procedure to find out who had high and low scores: (a) students with high Antisocial Behavior, those who scored in the 75th percentile or over (scores the same or over 13) ($N_1 = 238$, 26.9%); (b) students with low Antisocial Behavior, those who scored in the 25th percentile

TABLE 2 | Difference in means in antisocial behavior in students with low and high scores on interpersonal values.

SIV		Low			High			Statistical significance		
Total		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{522}	***p***	***d***
Antisocial Behavior	*SIV – S*	233	8.25	5.67	291	9.71	5.12	−3.09	0.01	0.27
	SIV – C	235	11.64	5.08	227	7.52	5.23	8.57	0.00	0.80
	SIV – R	218	8.83	5.48	238	10.03	5.78	−2.27	0.02	0.21
	SIV – I	237	7.23	5.07	268	11.08	5.31	−8.32	0.00	0.74
	SIV – B	262	10.50	5.68	248	7.50	5.04	6.31	0.00	0.56
	SIV – L	240	8.49	5.24	246	10.02	5.72	−3.07	0.01	0.28
Hombre		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{251}	***p***	***d***
Antisocial Behavior	*SIV – S*	115	9.27	6.01	138	10.13	4.98	−1.21	*n.s.*	–
	SIV – C	127	12.21	4.83	105	8.31	5.94	5.40	0.00	0.73
	SIV – R	82	9.37	5.80	151	10.31	5.72	−1.19	*n.s.*	–
	SIV – I	111	7.87	5.45	133	11.46	5.40	−5.15	0.00	0.66
	SIV – B	167	10.56	5.80	91	8.42	5.42	2.89	0.01	0.38
	SIV – L	94	9.31	5.67	161	10.40	5.85	−1.45	*n.s.*	–
Mujer		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{269}	***p***	***d***
Antisocial Behavior	*SIV – S*	118	7.25	5.15	153	9.33	5.23	−3.27	0.01	0.40
	SIV – C	108	10.97	5.30	122	6.85	4.43	6.34	0.00	0.85
	SIV – R	136	8.51	5.27	87	9.56	5.90	−1.37	*n.s.*	–
	SIV – I	126	6.66	4.65	135	10.71	5.20	−6.60	0.00	0.82
	SIV – B	95	10.41	5.49	157	6.97	4.74	5.25	0.00	0.68
	SIV – L	146	7.95	4.88	85	9.29	5.42	−1.92	*n.s.*	–
Curso 3º		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{279}	***p***	***d***
Antisocial Behavior	*SIV – S*	141	7.28	5.37	140	9.54	5.01	−3.65	0.00	0.44
	SIV – C	94	11.90	4.71	150	7.26	4.96	7.23	0.00	0.96
	SIV – R	131	8.26	5.23	112	9.51	5.63	−1.79	*n.s.*	–
	SIV – I	143	6.91	4.87	140	10.86	5.17	−6.61	0.00	0.79
	SIV – B	125	9.80	5.78	153	6.73	4.36	4.89	0.00	0.61
	SIV – L	143	8.00	4.75	116	8.83	5.70	−1.24	*n.s.*	–
Curso 4º		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{241}	***p***	***d***
Antisocial Behavior	*SIV – S*	92	9.73	5.83	151	9.87	5.23	−0.18	*n.s.*	–
	SIV – C	141	11.46	5.32	77	8.03	5.71	4.43	0.00	0.63
	SIV – R	87	9.69	5.75	126	10.50	5.91	−0.98	*n.s.*	–
	SIV – I	94	7.71	5.34	128	11.33	5.46	−4.91	0.00	0.67
	SIV – B	137	11.15	5.53	95	8.73	5.79	3.20	0.01	0.43
	SIV – L	97	9.20	5.83	130	11.08	5.54	−2.47	0.01	0.33

SIV-S, support; SIV-C, conformity; SIV-R, recognition; SIV-I, independence; SIV-B, benevolence; SIV-L, leadership; n.s., not significant.

or below (scores equal to or over 5) (N_2 = 260, 29.4%). This model enables the probability of occurrence of a certain fact or event (e.g., highly aggressive behavior) in the presence of one or several predictors (e.g., high Stimulation, Conformity, Recognition, Independence, Benevolence, or Leadership). This probability is estimated by the odd ratio statistic (OR), both in the total sample and in the samples formed by gender and school year. Statistical analyses were done with the SPSS 20 statistical package.

RESULTS

Antisocial Behavior and Interpersonal Values as a Function of Gender and School Year

Observing the mean scores in both Antisocial Behavior and the various interpersonal values by gender, males are observed to have had higher mean scores on the presence of Antisocial Behaviors, Recognition and Leadership, and these were significantly higher than for females, with small effects of gender ($d \leq 0.50$) on Antisocial Behavior ($d = 0.24$), on Recognition ($d = 0.44$), and Leadership ($d = 0.38$). On the contrary, in Conformity and Benevolence, females showed significantly higher mean scores than males, and again in this case, the effects of gender were small ($d \leq 0.50$) for Conformity ($d = 0.15$) and Benevolence ($d = 0.47$) values (**Table 1**).

With regard to school year, the students in the fourth year scored significantly higher than those in third year on Antisocial Behavior, and Stimulation, Recognition and Leadership values, with small effects of the school year variable ($d \leq 0.50$). On the contrary, students in the third year scored significantly higher in Conformity and Benevolence values than the fourth year, again with small effects of the school year variable ($d \leq 0.50$).

Antisocial Behavior in Subjects with High and Low Scores on Interpersonal Values

Table 2 shows the differences between students with low and high scores on the SIV scales with respect to the presence of Antisocial Behavior for the whole sample and for gender and school year. In the total sample, all the variables are observed to have had significant differences in Antisocial Behavior means. High SIV Stimulation, Recognition, Independence, or Leadership were associated with the presence of higher Antisocial Behavior,

TABLE 3 | Logistic regression for the probability of high antisocial behavior.

Total	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**R^2 Nagelkerke**	**% Correct**
SIV-S	0.63	0.24	6.86	0.01	1.87	1.17 – 3.00	0.03	57.7
SIV-C	−1.95	0.28	49.57	0.00	0.14	0.08 – 0.24	0.26	72.6
SIV-R	0.52	0.24	4.59	0.03	1.68	1.04 – 2.71	0.02	56.5
SIV-I	1.92	0.27	51.12	0.00	6.81	4.02 – 11.52	0.25	72.1
SIV-B	−1.34	0.25	29.11	0.00	0.26	0.16 – 0.43	0.13	65.9
SIV-L	0.53	0.24	4.67	0.03	1.69	1.05 – 2.72	0.02	56.5
Male	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**R^2 Nagelkerke**	**% Correct**
SIV-C	−1.93	0.38	25.79	0.00	0.14	0.07 – 0.31	0.24	71.9
SIV-I	1.71	0.36	22.12	0.00	5.55	2.72 – 11.34	0.21	70.3
SIV-B	−0.96	0.35	7.79	0.01	0.38	0.19 – 0.75	0.07	62.0
Female	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**R^2 Nagelkerke**	**% Correct**
SIV-S	0.83	0.35	5.83	0.02	2.30	1.17 – 4.53	0.05	59.2
SIV-C	−2.07	0.42	23.81	0.00	0.13	0.05 – 0.29	0.28	73.5
SIV-I	2.20	0.41	29.06	0.00	9.04	4.06 – 20.14	0.30	74.1
SIV-B	−1.60	0.38	17.37	0.00	0.20	0.09 – 0.43	0.17	70.4
3rd year	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**R^2 Nagelkerke**	**% Correct**
SIV-S	0.87	0.33	6.80	0.01	2.38	1.24 – 4.56	0.06	61.1
SIV-C	−2.34	0.43	29.56	0.00	0.10	0.04 – 0.22	0.31	75.4
SIV-I	1.98	0.36	30.16	0.00	7.28	3.58 – 14.78	0.26	72.8
SIV-B	−1.57	0.36	18.75	0.00	0.21	0.10 – 0.42	0.17	68.6
4th year	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**R^2 Nagelkerke**	**% Correct**
SIV-C	−1.51	0.40	14.22	0.00	0.22	0.10 – 0.48	0.15	69.8
SIV-I	1.78	0.40	19.38	0.00	5.93	2.68 – 13.09	0.21	71.3
SIV-B	−0.95	0.36	7.03	0.01	0.39	0.19 – 0.78	0.07	62.9

SIV-S, support; SIV-C, conformity; SIV-R, recognition; SIV-I, independence; SIV-B, benevolence; SIV-L, leadership; B, coefficient; SE, standard error; p, probability; OR, odd ratio; IC, interval of confidence at 95%.

while higher Antisocial Behavior means were present in students with low levels of Conformity and Benevolence. The effects of the Conformity ($d = 0.80$), Independence ($d = 0.74$) and Benevolence ($d = 0.56$) scales on Antisocial Behavior were medium ($d \geq 0.51$), while the Stimulation ($d = 0.27$), Recognition ($d = 0.21$) and Leadership ($d = 0.28$) scales had small effects ($d \leq 0.50$) on Antisocial Behavior.

Gender analysis shows significant differences in mean scores on Antisocial Behavior for the Conformity, Independence and Benevolence scales, and also on the Stimulation scale in females, although its effects were small ($d = 0.40$). In both male and female groups, students with low Conformity and Benevolence showed higher means in Antisocial Behavior, with medium effects of both scales ($d \geq 0.51$), except in males, where high or low values in Benevolence had small effects ($d = 0.38$) on Antisocial Behavior.

In the analysis of third and fourth years of high school, significant differences are also observed in the mean score on Antisocial Behavior depending on whether the scores on the Conformity, Independence and Benevolence scales were high or low, all of them with a medium effect ($d \geq 0.51$), except in the fourth year for the last scale, Benevolence ($d = 0.43$), where the effect was small. Furthermore, only in the third year of high school were there differences in the Stimulation scale, and these also had a small effect ($d = 0.44$).

Are Interpersonal Values Predictors of Antisocial Behavior?

Table 3 presents the probability of high Antisocial Behavior derived from the binary logistic regression in both the total sample and by gender and school year. It is observed that percentages correctly classified in the total sample vary from 56.5% of the Recognition and Leadership scales to 72.6% of the Conformity scale. The percentages of correct classification by gender go from 62% and 59.2% to 71.9% and 74.1% in males and females, respectively. Finally, in the analysis of the sample by school year, percentages go from 61.1% and 62.9% to 75.4% and 71.3% in the third and fourth year, respectively. In fourth year of high school, the Leadership scale did not form part of the model. The Nagelkerke R^2 varied from 0.02 for the total sample on Recognition and Leadership scales to 0.32 for the third year on the Conformity scale.

The Odd Ratio's interpretation of the data from the whole sample shows that the probability of Antisocial Behavior is: (a) 1.87 times higher in students with high Stimulation, (b) 0.14 times lower in students with high Conformity, (c) 1.68 times higher in students with high Recognition, (d) 6.81 times higher in students with high Independence, (e) 0.26 times lower in students with high Benevolence, and (f) 1.69 times higher in students with high Leadership.

In the analysis by gender and school year, the probability of having antisocial behavior is: (a) 0.14 (males), 0.13 (females), 0.10 (third year high school), and 0.22 (fourth year high school) times lower in students with high Conformity, (b) 0.38 (males), 0.20 (females), 0.21 (third year high school), and 0.39 (fourth year high school) times lower in students with high Benevolence, (c) 5.55 (males), 9.04 (females), 7.28 (third year high school), and 5.93 (fourth year high school) times higher in students with high independence, (d) 2.30 (females), and 2.38 (third year high school) times higher in students with high Stimulation.

DISCUSSION

With regard to the first of the goals of this study, it is observed that males showed higher mean scores on antisocial behavior, coinciding with previous results (López and Rodríguez-Arias, 2010; Hasking et al., 2011; Viñas et al., 2012). Furthermore, in the analysis of interpersonal values, females showed significantly higher mean scores than males in conformity and benevolence with small effects of gender ($d \leq 0.50$) in both cases.

In the analysis of the influence of school year, its effect was also small, and it was the fourth year students who showed significantly higher scores in Antisocial Behavior, which suggests an increase in frequency of negative, violent or antisocial behavior with year (Cifuentes and Londoño, 2011; Pérez-Fuentes et al., 2011; Garaigordobil et al., 2013). Moreover, in interpersonal values, students in fourth year scored significantly higher in the Stimulation, Recognition and Leadership values than those in third year, while those in third showed higher means in Conformity and Benevolence.

With respect to the study's second goal, the results show that students who had the highest Antisocial Behavior means, regardless of gender and school year, were those who are treated with kindness, consideration, understanding, etc., who are recognized by others, admired and looked up to, who do what they want and decide for themselves, those who exert authority over those under them, show low conformity (often do not obey the rules or do what is socially correct) and low benevolence (are not generous or do not help others).

Finally, with respect to the third goal, high Stimulation, Recognition, Independence and Leadership values are statistically significant positive predictors of the probability of high scores on Antisocial Behavior, while low scores on Conformity and Benevolence are statistically significant negative predictors of the probability of high scores on Antisocial Behavior.

Logistic regressions by gender and school year were only done for those values in which there were differences in the results of mean interpersonal value scores between the high and low level groups. So low scores on Conformity and Benevolence values and high scores on Independence predict high scores on Antisocial Behavior for both males and females, and both years of high school analyzed. Furthermore, when the Stimulation value was analyzed for females in third year high school, it was also found to be a statistically significant positive predictor of the probability of high scores on Antisocial Behavior.

Limitations of the study are that: (1) It is a sample, which although representative, is comprised only of high school students and cannot be generalized to other grade levels, and therefore, one of the future lines of research is the replication of this study in other years, adapting the questionnaires to be used. (2) The questionnaire used to measure antisocial behavior only gives a total assessment, so it is not possible to find out whether these relationships with interpersonal values are also given for

the various different aspects that construct includes, and future research should use a questionnaire such as the Antisocial and Delinquent Behavior Scale (Andreu and Peña, 2013) which allows various factors to be differentiated (predelinquent behavior, vandalism, violence, crimes against property, use of alcohol and drugs). (3) Finally, another of the limitations refers to the biases typical of self-report techniques, such as social desirability. Some cases (Soubelet and Salthouse, 2011) have been found of association of the effects of social desirability, which with age show positive relations with certain desirable characteristics of the self-report and negative with those undesirable.

However, although this study does have some limitations which should be kept in mind for future research, it may be considered a precursor, and is of great interest for the relevant data it contributes to the design of interventions which make it possible to work on reducing risk factors and strengthening those which protect against antisocial behavior at the same time (López and Rodríguez-Arias, 2012). It is recommended that future lines of research include other variables of interest to grouping, such as sociocultural diversity, above all, if that characteristic is representative of the sample. The possibility of adding variables gradually for their analysis makes possible a systematic approach for in-depth study of the subject. The need to continue progressing in the study of the variables involved in antisocial behavior in adolescence therefore emerges from our results.

AUTHOR CONTRIBUTIONS

JC, AL, and AB (review scientific language); AM, MS, and JG (writing and literature search); MM (analysis of data); MP and JG (design and review); and AG (changes requested by the reviewers).

FUNDING

This work is the result of Research Project P08-SEJ-04305, co-financed by the Consejería de Innovación, Ciencia y Empresa (Council of Innovation, Science and Enterprise) of the Junta of Andalucía and FEDER.

REFERENCES

Álvarez, A., Suárez, N., Tuero, E., Núñez, J. C., Valle, A., and Regueiro, B. (2015). Implicación familiar, autoconcepto del adolescente y rendimiento académico [Family involvement, adolescent self-concept and academic achievement]. *Eur. J. Investig. health Psychol. Educ.* 5, 293–311. doi: 10.1989/ejihpe.v5i3.133

Andreu, J. M., and Peña, M. E. (2013). Propiedades psicométricas de la escala de conducta antisocial y delictiva en adolescentes [Psychometrical properties of the antisocial and criminal behavior scale in adolescents]. *Anal. Psicol.* 29, 516–522.

Antolín, L., Oliva, A., and Arranz, E. B. (2009). Contexto familiar y conducta antisocial infantil [Family and childhood antisocial behavior]. *Anu. Psicol.* 40, 313–327.

Burt, S. A. (2013). Do etiological influences on aggression overlap with those on rule breaking? A meta-analysis. *Psychol. Med.* 43, 1801–1812. doi: 10.1017/S0033291712001894

Calvete, E., and Orue, I. (2010). Cognitive schemas and aggressive behavior in adolescents: the mediating role of social information processing. *Span. J. Psychol.* 1, 189–200.

Cerezo, F., and Méndez, I. (2013). Agresores en bullying y conductas antisociales [Aggressors in bullying and disocial behaviours]. *Eur. J. Investig. Health Psychol. Educ.* 3, 5–14.

Cifuentes, J. J., and Londoño, N. H. (2011). Perfil cognitivo y psicopatológico asociados a la conducta antisocial [Cognitive and Psychopathologycal profile associated with antisocial behavior]. *Int. J. Psychol. Res.* 4, 58–69. doi: 10.1590/S1413-294X2003000100003

Clark, D. B., Vanyukov, M., and Cornelius, J. (2002). Childhood antisocial behavior and adolescent alcohol use disorders. *Alcohol Res. Health* 26, 109–115.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioural Sciences*, 2nd Edn. Hillsdale, NJ: Erlbaum.

Emler, N. (2009). "Delinquents as a minority group: accidental tourists in forbidden territory or voluntary émigrés?," in *Coping with Minority Status: Responses to Exclusion and Inclusion*, eds F. Butera and J. Levine (New York, NY: Cambridge University Press), 127–154.

Espinosa, P., and Clemente, M. (2011). La medida del comportamiento antisocial en adolescentes y jóvenes: desarrollo del inventario de comportamientos antisociales (ICA) [Measurement of antisocial behaviour in adolescents and young peopel: development of the antisocial behaviour inventory -ABI/ICA-]. *Rev. Psicol. Soc.* 26, 223–240.

Estévez, E., Murgui, S., Moreno, D., and Musitu, G. (2007). Estilos de comunicación familiar, actitud hacia la autoridad institucional y conducta violenta del adolescente en la escuela [Family communication styles, attitude towards institutional authority and adolescents' violent behaviour at school]. *Psicothema* 19, 108–113.

Farrington, D. P. (2005). The importance of child and adolescent psychopathy. *J. Abnorm. Child Psychol.* 33, 489–497. doi: 10.1007/s10802-005-5729-8

Fernández-Cabezas, M., Benítez, J. L., Fernández, E., Justicia, F., and Justicia-Arráez, A. (2011). Desarrollo de la competencia social y prevención del comportamiento antisocial en niños de 3 años [Development of social competence and prevention of antisocial behaviour in 3-year-old children]. *Infancia Aprendizaje* 34, 337–347. doi: 10.1174/021037011797238603

Fossati, A., Borroni, S., and Maffei, C. (2012). Bullying as a style of personal relating: personality characteristics and interpersonal aspects of self-reports of bullying behaviours among Italian adolescent high school students. *Pers. Ment. Health* 6, 325–339. doi: 10.1002/pmh.1201

Garaigordobil, M., Aliri, J., and Martínez-Valderrey, V. (2013). Justificación de la violencia durante la adolescencia: diferencias en función de variables sociodemográficas [Justification of violence during adolescence: differences as a function of sociodemographic variables]. *Eur. J. Educ. Psychol.* 6, 83–93.

Garaigordobil, M., Martínez-Valderrey, V., and Aliri, J. (2014). Victimization, perception of violence, and social behaviour. *Infancia Aprendizaje* 37, 90–116. doi: 10.1080/02103702.2014.881651

Gázquez, J. J., Pérez-Fuentes, M. C., Lucas, F., and Fernández, M. (2011). Análisis de la convivencia escolar por los docentes europeos [Analysis by european teachers of the school coexistence]. *Aula Abierta* 39, 51–58.

Gázquez, J. J., Pérez-Fuentes, M. C., Molero, M. M., Martos, A., Cardila, F., Barragán, A. B., et al. (2015). Adaptación española del cuestionario de expectativas del alcohol en adolescentes [Spanish adaptation of the alcohol expectancy-adolescent questionnaire, brief]. *Eur. J. Investig. Health Psychology Educ.* 5, 357–369. doi: 10.1989/ejihpe.v5i3.138

Georgiou, S. N., Fousiani, K., Michaelides, M., and Stavrinides, P. (2013). Cultural value orientation and authoritarian parenting as parameters of bullying and victimization at school. *Int. J. Psychol.* 48, 69–78. doi: 10.1080/00207594.2012.754104

Gordon, L. V. (1977). *Cuestionario de Valores Interpersonales (SIV) [Interpersonal Values Questionnaire]*. Madrid: TEA.

Gordon, L. V. (1979). *Manual Inventory of Interpersonal Values*. Paris: Evangelical Christian Publishers Association.

Gordon, L. V. (1993). *Survey of Interpersonal Values, SRA, Examiners Manual*, 3rd Edn. Londres: MacMillan.

Hasking, P. A., Scheier, L. M., and Abdallah, A. B. (2011). The three latent antisocial classes of adolescent delinquency and the risk factors for membership in each class. *Aggress. Behav.* 37, 19–35. doi: 10.1002/ab.20365

Inglés, C. J., Martínez-González, A. E., and García-Fernández, J. M. (2013). Conducta prosocial y estrategias de aprendizaje en una muestra de estudiantes españoles de educación secundaria obligatoria [Prosocial behavior and learning strategies in a sample of Spanish students of compulsory secondary education]. *Eur. J. Educ. Psychol.* 6, 33–53.

Inglés, C. J., Torregrosa, M. S., García-Fernández, J. M., Martínez-Monteagudo, M. C., Estévez, E., and Delgado, B. (2014). Conducta agresiva e inteligencia emocional en la adolescencia [Aggressive behavior and emotional intelligence in adolescence]. *Eur. J. Educ. Psychol.* 7, 29–41. doi: 10.1989/ejep.v7i1.150

Jaureguizar, J., and Ibabe, I. (2012). Conductas violentas de los adolescentes hacia las figuras de autoridad: el papel mediador de las conductas antisociales [Adolescents' violent behaviours toward authority: the mediating effect of antisocial behaviours]. *Rev. Psicol. Soc.* 27, 7–24. doi: 10.1174/021347412798844088

Jiménez, M. I., and López-Zafra, E. (2011). Actitudes sociales y adaptación social en adolescentes españoles: el papel de la inteligencia emocional percibida [Social attitudes and social adaptation among spanish adolescents: the role of perceived emotional intelligence]. *Rev. Psicol. Soc.* 26, 105–117. doi: 10.1174/021347411794078417

Kazdin, A., and Buela-Casal, G. (1996). *Conducta Antisocial: Evaluación, Tratamiento y Prevención en la Infancia y Adolescencia [Antisocial Behavior: Evaluation, Treatment and Prevention in Childhood and Adolescence]*. Madrid: Pirámide.

Light, J. M., Rusby, J. C., Nies, K. M., and Snijders, T. A. (2013). Antisocial behavior trajectories and social victimization within and between school years in early adolescence. *J. Adolesc. Res.* 24, 322–336. doi: 10.1111/jora.12055

Loeber, R., and Burke, J. D. (2011). Developmental pathways in juvenile externalizing and internalizing problems. *J. Adolesc. Res.* 21, 34–46. doi: 10.1111/j.1532-7795.2010.00713.x

Loeber, R., and Farrington, D. P. (2012). Advancing knowledge about direct protective factors that may reduce youth violence. *Am. J. Prev. Med.* 43, 24–25. doi: 10.1016/j.amepre.2012.04.031

López, C., Sánchez, A., Pérez-Nieto, M. A., and Poveda, M. (2008). Impulsividad, autoestima y control cognitivo en la agresividad del adolescente [Impulsiveness, self-esteem and cognitive control of the aggressiveness of adolescent]. *EduPsykhé Rev. Psicol. Educ.* 7, 81–99.

López, S., and Rodríguez-Arias, J. L. (2010). Factores de riesgo y de protección en el consumo de drogas en adolescentes y diferencias según edad y sexo [Risk and protective factors in adolescents' drug use, and differences by age and sex]. *Psicothema* 22, 568–573.

López, S., and Rodríguez-Arias, J. L. (2012). Factores de riesgo y de protección en el consumo de drogas y la conducta antisocial en adolescentes y jóvenes españoles [Risk and protective factors for drug use and antisocial behavior in Spanish adolescents and young people]. *Int. J. Psychol. Res.* 5, 25–33. doi: 10.21500/20112084.746

Martí, M., and Palma, J. (2010). Jerarquización y preferencia de valores en los estudiantes de secundaria [Hierarchical structuring and preference of values in secondary students]. *Rev. Española Orientación Psicopedagogía* 21, 603–616. doi: 10.5944/reop.vol.21.num.3.2010.11545

Martínez, G., and Gras, M. (2007). La conducta antisocial percibida por adolescentes de Enseñanza secundaria obligatoria: frecuencia, contexto y atribución causal [The perceived antisocial behavior by adolescents of Secondary Education: frequency, context and causal attribution]. *Apuntes Psicol.* 25, 285–304.

Muñoz, A. P., de Los Fayos, E. J. G., and Chirivella, E. C. (2010). Estudio de conductas prosociales y antisociales: comparación entre niños y adolescentes que practican y no practican deporte [Study of prosocial and antisocial behavior: comparison among children and adolescents who practice and not practice sport]. *Inf. Psicol.* 99, 64–78.

Murray, J., Farrington, D. P., and Sekol, I. (2012). Children's antisocial behavior, mental health, drug use, and educational performance after parental incarceration: a systematic review and meta-analysis. *Psychol. Bull.* 138, 175. doi: 10.1037/a0026407

Oliva, A., Ríos, M., Antolín, L., Parra, A., Hernando, A., and Pertegal, M. A. (2010). Más allá del déficit: construyendo un modelo de desarrollo positivo adolescente [Beyond the deficit: building a model of positive youth development]. *Infancia Aprendizaje* 33, 223–234. doi: 10.1174/021037010791114562

Paciello, M., Fida, R., Tramontano, C., Cole, E., and Cerniglia, L. (2013). Moral dilema in adolescence: the role of values, prosocial moral reasoning and moral disengagement in helping decision making. *Eur. J. Dev. Psychol.* 10, 190–205. doi: 10.1080/17405629.2012.759099

Pahlavan, F., and Andreu, J. M. (2009). Sex-specific effects of sociocultural changing on aggression: fact or artefact? *J. Organ. Transform. Soc. Change* 6, 106–131. doi: 10.1386/jots.6.2.103_1

Pellegrini, A. D., Long, J. D., Solberg, D., Roseth, C., Dupuis, D., Bohn, C., et al. (2010). "Bullying and social status during School Transitions," in *Handbook of Bullying in Schools: An International Perspective,* eds S. R. Jimerson, S. M. Swearer, and D. L. Speleage (New York, NY: Routledge), 199–210.

Peña, M. E. (2010). *Conducta Antisocial en Adolescentes: Factores de Riesgo y de Protección [Antisocial Behavior in Adolescents: Risk Factors and Protective]*. Madrid: Editorial Complutense.

Pérez-Fuentes, M. C., Gázquez, J. J., Mercader, I., Molero, M. M., and García, M. M. (2011). Rendimiento académico y conductas antisociales y delictivas en alumnos de Educación Secundaria Obligatoria [Academic Achievement and Antisocial Behavior in Public Secondary Education Students]. *Int. J. Psychol. Psychol. Ther.* 11, 401–412.

Piquero, A. R., Farrington, D. P., Welsh, B. C., Tremblay, R., and Jennings, W. G. (2009). Effects of early family/parent training programs on antisocial behavior and delinquency. *J. Exp. Criminol.* 5, 83–120. doi: 10.1007/s11292-009-9072-x

Povedano, A., Estévez, E., Martínez, B., and Monreal, M. C. (2012). Un perfil psicosocial de adolescentes agresores y víctimas en la escuela: análisis de las diferencias de género [A psychosocial profile of adolescent aggressors and school victims: analysis of gender differences]. *Rev. Psicol. Soc.* 27, 169–182. doi: 10.1174/021347412800337906

Pozo, R. (2012). La violencia de las mujeres jóvenes que delinquen: ¿violentas o violentadas? [Girls violence ¿violent girls or girls abused?]. *Rev. Educ. Soc.* 15, 1–12.

Rechea, C. (2008). *Conductas Antisociales y Delictivas de los Jóvenes en España [Antisocial and Criminal Behavior of Young People in Spain]*. Castilla-La Mancha: Centro de Investigación en Criminología.

Regueiro, B., Rodríguez, S., Piñeiro, I., Estévez, I., Ferradás, M. M., and Suárez, N. (2015). Diferencias en la percepción de la implicación parental en los deberes escolares en función del nivel de motivación de los estudiantes [Differences in the perception of parental involvement in homework depending on the level of student motivation]. *Eur. J. Investig. Health Psychol. Educ.* 5, 513–523. doi: 10.1989/ejihpe.v5i3.134

Rodríguez, L. N., and Mora-Merchán, J. A. (2014). El uso de estrategias de afrontamiento y habilidades metacognitivas ante situaciones de bullying y cyberbullying. *Eur. J. Educ. Psychol.* 7, 121–129. doi: 10.1989/ejep.v7i2.184

Rodríguez, S., Regueiro, B., Blas, R., Valle, A., Piñeiro, I., and Cerezo, R. (2014). Teacher self-efficacy and its relationship with students' affective and motivational variables in higher Education. *Eur. J. Educ. Psychol.* 7, 107–120. doi: 10.1989/ejep.v7i2.183

Schofield, T. J., Conger, R. D., Conger, K. J., Martin, M. J., Brody, G., Simons, R., et al. (2012). Neighborhood disorder and children's antisocial behavior: the protective effect of family support among Mexican American and African American families. *Am. J. Commu. Psychol.* 50, 101–113. doi: 10.1007/s10464-011-9481-7

Seisdedos, N. (1995). *A-D. Cuestionario de Conductas Antisociales-Delictivas [Antisocial-Delinquent Behaviors Questionnaire]*. Madrid: TEA.

Silberg, J. L., Maes, H., and Eaves, L. J. (2012). Unraveling the effect of genes and environment in the transmission of parental antisocial behavior to children's conduct disturbance, depression and hyperactivity. *J. Child Psychol. Psychiatry* 53, 668–677. doi: 10.1111/j.1469-7610.2011.02494.x

Soubelet, A., and Salthouse, T. A. (2011). Influence of social desirability on age differences in self-reports of mood and personality. *J. Pers.* 79, 741–762. doi: 10.1111/j.1467-6494.2011.00700.x

Sousa, C., Herrenkohl, T. I., Moylan, C. A., Tajima, E. A., Klika, J. B., Herrenkohl, R. C., et al. (2011). Longitudinal study on the effects of child abuse and children's exposure to domestic violence, parent-child attachments, and antisocial behavior in adolescence. *J. Interpers. Violence* 26, 111–136. doi: 10.1177/0886260510362883

Tresgallo, E. (2011). El acoso escolar y las actitudes psicológicas defensivas en el primer ciclo de Educación Primaria [Bullying and defensive psychological attitudes in the first cycle of Primary Education]. *Rev. Española Orientación Psicopedagogía* 22, 28–37. doi: 10.5944/reop.vol.22.num.1.2011.75

Valle, A., Regueiro, B., Estévez, I., Piñeiro, I., Rodríguez, S., and Freire, C. (2015a). Implicación y motivación hacia los deberes escolares en los estudiantes de Primaria según el rendimiento académico y el curso [Homework involvement and motivation in elementary school students according to academic achievement and grade]. *Eur. J. Investig. health Psychol. Educ.* 5, 345–355. doi: 10.1989/ejihpe.v5i3.137

Valle, A., Regueiro, B., Rodríguez, S., Piñeiro, I., Freire, C., Ferradás, M. M., et al. (2015b). Perfiles motivacionales como combinación de expectativas de autoeficacia y metas académicas en estudiantes universitarios [Motivational profiles as a combination of self-efficacy expectations and academic goals in university students]. *Eur. J. Educ. Psychol.* 8, 1–8. doi: 10.1016/j.ejeps.2015.10.001

Viñas, F., González, M., García, Y., Jane, M. C., and Casas, F. (2012). Comportamiento perturbador en la adolescencia y su relación con el temperamento y los estilos de afrontamiento [Disruptive behavior in adolescence and its relationship with temperament and coping styles]. *Psicothema* 24, 567–572.

Wu, J. Y., Hughes, J. N., and Kwok, O. M. (2010). Teacher-student relationship quality type in elementary grades: effects on trajectories for achievement and engagement. *J. Sch. Psychol.* 48, 357–387. doi: 10.1016/j.jsp.2010.06.004

Yakeley, J., and Williams, A. (2014). Antisocial personality disorder: new directions. *Adv. Psychiatr. Treat.* 20, 132–143. doi: 10.1192/apt.bp.113.011205

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Molero Jurado, Pérez Fuentes, Carrión Martínez, Luque de la Rosa, Garzón Fernández, Martos Martínez, Simón Márquez, Barragán Martín and Gázquez Linares. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 19 January 2017
doi: 10.3389/fpsyg.2017.00022

Self-Regulation, Cooperative Learning, and Academic Self-Efficacy: Interactions to Prevent School Failure

Javier Fernandez-Rio[1], Jose A. Cecchini[1], Antonio Méndez-Gimenez[1], David Mendez-Alonso[2] and Jose A. Prieto[2]*

[1] Department of Educational Science, University of Oviedo, Oviedo, Spain, [2] Facultad Padre Ossó, University of Oviedo, Oviedo, Spain

Learning to learn and learning to cooperate are two important goals for individuals. Moreover, self regulation has been identified as fundamental to prevent school failure. The goal of the present study was to assess the interactions between self-regulated learning, cooperative learning and academic self-efficacy in secondary education students experiencing cooperative learning as the main pedagogical approach for at least one school year. 2.513 secondary education students (1.308 males, 1.205 females), 12–17 years old (M = 13.85, SD = 1.29), enrolled in 17 different schools belonging to the National Network of Schools on Cooperative Learning in Spain agreed to participate. They all had experienced this pedagogical approach a minimum of one school year. Participants were asked to complete the cooperative learning questionnaire, the strategies to control the study questionnaire and the global academic self-efficacy questionnaire. Participants were grouped based on their perceptions on cooperative learning and self-regulated learning in their classes. A combination of hierarchical and κ-means cluster analyses was used. Results revealed a four-cluster solution: cluster one included students with low levels of cooperative learning, self-regulated learning and academic self-efficacy, cluster two included students with high levels of cooperative learning, self-regulated learning and academic self-efficacy, cluster three included students with high levels of cooperative learning, low levels of self-regulated learning and intermediate-low levels of academic self-efficacy, and, finally, cluster four included students with high levels of self-regulated learning, low levels of cooperative learning, and intermediate-high levels of academic self-efficacy. Self-regulated learning was found more influential than cooperative learning on students' academic self-efficacy. In cooperative learning contexts students interact through different types of regulations: self, co, and shared. Educators should be aware of these interactions, symmetrical or asymmetrical, because they determine the quality and quantity of the students' participation and achievements, and they are key elements to prevent school failure.

Keywords: secondary education, students at risk, clusters, academic self-efficacy, learning

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Yang-Hsueh Chen, National University of Tainan, Taiwan
Ricardo Tejeiro, University of Liverpool, UK

****Correspondence:***
Javier Fernandez-Rio
javier.rio@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *31 October 2016*
Accepted: *04 January 2017*
Published: *19 January 2017*

Citation:
Fernandez-Rio J, Cecchini JA, Méndez-Gimenez A, Mendez-Alonso D and Prieto JA (2017) Self-Regulation, Cooperative Learning, and Academic Self-Efficacy: Interactions to Prevent School Failure. Front. Psychol. 8:22. doi: 10.3389/fpsyg.2017.00022

INTRODUCTION

Research has showed that individuals are able to monitor, control and regulate their behaviors in learning contexts, but all depends on the resources and the pedagogical approach used by the educators (Agina et al., 2011). Students' active role in their own learning process begins very early, and continues along their lifetime (Zimmerman, 1989). Several elements have been identified as fundamental in this growth: cognition, metacognition, motivation, behavior and context (Pintrich, 2000; Dembo et al., 2006). Among them, context is considered a key factor to promote or mislead self-regulated learning (Agina et al., 2011). This concept refers to a "proactive process that students use to acquire academic skills, such as setting goals, selecting and developing strategies, and self-monitoring one's effectiveness" (Zimmerman, 2008, p. 166).

Individuals are usually focused on regulating their own knowledge and behavior, with no intentions of influencing other students. Therefore, it is considered intra-personal (Grau and Whitebread, 2012). However, students are constantly challenged to work in pairs to learn. In this case, individuals must move into the inter-personal concept of regulation, *co-regulation*, which "means regulation directed toward a specific member of a group in a collective activity" (Hayes et al., 2015, p. 3). Students are forced to work with a class-mate (on a one-to-one basis) and interact with him/her to solve a learning task. Finally, students are also faced with cooperative and/or collaborative learning contexts where they have to relate with several other students to learn. *Shared-regulation* is referred as "processes by which multiple others regulate their collective activity" (Hadwin and Oshige, 2011, p. 254). In this context, group members "collectively set goals, track their progress, use strategies, and consider their effectiveness in the service of a shared outcome" (Hayes et al., 2015, p. 3). There is general consensus of the efficacy of self-regulated learning on academic success (Pintrich, 2000; Winne, 2005; Zimmerman, 2008). The question that this research brings is: how do cooperative learning contexts affect students' self-regulated learning?

Cooperative learning has been associated to the development of cognitive, metacognitive and motivational skills in students, which can promote self-regulated learning (Efklides, 2008; Järvelä et al., 2008; Arjanggi and Setiowati, 2014). Among its basic elements positive interdependence can be considered very significant (the other ones are: promotive interaction, individual accountability, group processing, and interpersonal skills). It refers to the idea that students must help each other learn, because one's success is dependent on others' success (Johnson and Johnson, 2014). This is the basis of cooperative learning, but what types of relations are established between group members in this context? Does individuals' personality influence them? Chamorro-Premuzic et al. (2007) believe that students' personality traits have an effect on their learning in cooperative contexts. Individuals' personality has been organized around five basic dimensions (Goldberg, 1990): extraversion (i.e., sociable, active), neuroticism (i.e., anxious, pessimistic), openness to experience (i.e., imaginative, curious), agreeableness (i.e., empathic, compassionate), and conscientiousness (i.e., organized, hard-working). The dimension extraversion/introversion has been associated to a preference for cooperative learning (Ramsay et al., 2000), but all of them can play a role in this type of contexts.

Within cooperative learning groups, the regulation processes can shift from one person providing all the information and adopting a leading instructional role, to a more co-regulatory and balanced situation where different group members provide information and instruction (Salonen et al., 2005). Moreover, within a group, there are individuals who adopt active roles (more participative), while others adopt passive roles (less participative). Unfortunately, many times, the most active ones are not always the better qualified, but they can become the most influential (Menges and Svinicki, 1991). Therefore, at times, cooperative learning contexts can negatively affect individuals' self-regulated learning. Learn to learn is important, but also learn to cooperate. For researchers and scholars, cooperative learning is considered a pedagogical approach capable of successfully promote academic achievement (Johnson and Johnson, 2014; Slavin, 2014). The question that this study brings is: do all students in a cooperative learning context improve their self-regulated learning skills? And how both influence academic self-efficacy?

Self-regulated learning has long been associated to self-efficacy (Schunk, 1990; Zimmerman, 1990), since the first one depends on personal perceptions of efficacy, among other things. Self-efficacy has been defined as the belief in one's ability to conduct the actions needed to achieve one's goals (Bandura, 1997). Learners high on self-regulation, both high and low-achieving, tend to exhibit a high sense of efficacy in their own capabilities (Duckworth et al., 2009). In this same trend, one of the three motivational components with the highest influence on academic achievement is considered to be self-efficacy. It refers to the beliefs about one's capacity to perform a class task. Its influence on students' motivation is so important that it is considered the most powerful predictor of academic performance, effort and persistence (Pintrich and Schunk, 2002). Therefore, schools should try to improve both, self-regulation and self-efficacy, to prevent school failure, because every student needs to feel the support to develop the belief that he/she can improve his/her knowledge and skills and learn.

Self-efficacy, among other elements, can help at risk students overcome their at-risk conditions and have a positive impact in their academics (Cooper, 2015). School failure or individual's progress in school have been related to different factors such as child characteristics, family background and contextual factors (i.e., school, teachers...) (Blair and Raver, 2015). Historically, they have been associated to general intelligence (Duckworth and Carlson, 2013). Not until recently, researchers have turned their eyes to a dimension of temperament linked to success in school: self-regulation (Blair and Raver, 2015). Learning to organize information and to engage in goal-directed tasks, to focus and maintain attention, to reflect on information and experience, to regulate emotions and to engage in positive social interactions have been shown instrumental to prevent school failure (Blair and Razza, 2007; McEwen and Gianaros, 2011; Blair and Raver, 2015).

As mentioned above, cooperative learning contexts demand students to self, co, and share-regulate their learning, and not all students know how to do it. Moreover, Leinonen

et al. (2003) identified four types of knowledge construction based on students' interactions: (i) active co-construction: these individuals frequently bring information to the group, actively collaborating with others; (ii) non-active co-construction: these individuals less frequently bring information to the group, but they access other's information; (iii) comment receiver: these individuals receive information from others, providing feedback; and (iv) isolate receiver: these individuals receive little information from others with no reciprocal interaction. Therefore, students in cooperative learning groups play different roles to regulate their and others' knowledge. Moreover, in these groups, individuals' self-efficacy can significantly impact their feelings of collective efficacy (Fernandez-Ballesteros et al., 2002), influencing the group's functioning and achievements. The question that this research brings is: how do cooperative learning, self-regulation and academic self-efficacy relate to each other? And how they connect to have an effect on students' at risk of academic failure?

Previous research works have studied the interactions between self-regulation and self-efficacy (Schunk, 1990; Zimmerman, 1990), between self-regulation and cooperative learning (Arjanggi and Setiowati, 2014), and between self-efficacy and collaborative learning (Wang and Lin, 2007). However, no previous works have assessed the three elements at the same time.

Based on the aforementioned, the main goal of the present study was to assess the interactions between self-regulated learning, cooperative learning and academic self-efficacy in secondary education students experiencing cooperative learning as the main pedagogical approach for at least one school year. The initial hypothesis was that some students will perceive high levels of self-regulated learning and cooperative learning (**Figure 1**, CA), other students will perceive low levels of both variables (**Figure 1**, CB), a third group will show high levels of cooperative learning and low levels of self-regulation (**Figure 1**, CC), and a fourth group will show high levels of self-regulated learning and low levels of cooperative learning (**Figure 1**, CD). A second hypothesis was that these groups will show different levels of academic self-efficacy: the higher the students' self-regulation, the higher their self-efficacy; this means that group B will show the lowest scores on both variables, followed by groups C, D, and A (**Figure 2**).

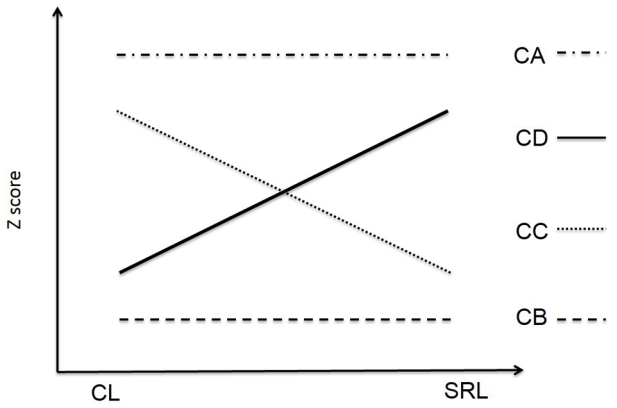


FIGURE 1 | Students' groups in the initial hypothesis.

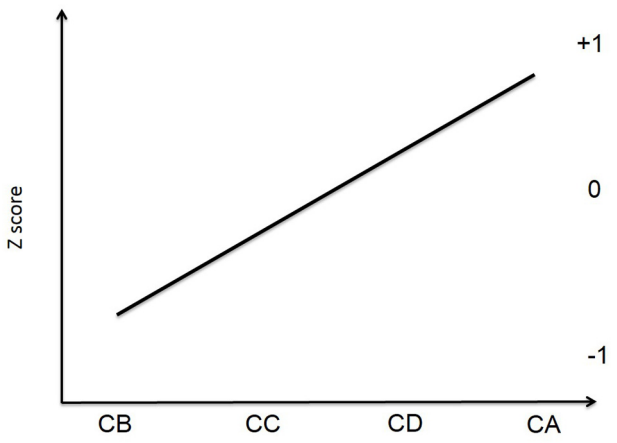


FIGURE 2 | Hypothesized relationship between academic self-efficacy and students' groups.

MATERIALS AND METHODS

Participants

2.513 secondary education students (1.308 males, 1.205 females), 12–17 years old ($M = 13.85$, $SD = 1.29$), enrolled in 17 different schools belonging to the National Network of Schools on Cooperative Learning in Spain agreed to participate. The main goal of this network is to use this methodology on a daily basis as one of its pillars. 411 students were considered at risk of academic failure (they had low grades in at least three school subjects), and 71 were immigrants. All participants had experienced cooperative learning a minimum of one school year. Based on the accessibility of their teachers, schools selected different subjects to implement this pedagogical approach (i.e., Maths, History, Science, Literature, Arts, Music, and Physical Education). They had to use, at least, one cooperative learning technique a week in their classes; for example: Think-Pare-Share (Kagan, 1992), Collective Score (Orlick, 1978), Student-Teams-Achievement-Division (Slavin, 1990), Learning Together (Johnson and Johnson, 1987), Co-op Co-op (Kagan, 1992), or Jigsaw (Aronson, 2010).

Instruments

Cooperative Learning

The Cooperative Learning Questionnaire (Fernandez-Río et al., 2017), validated for secondary education and baccalaureate students, was used. It includes five subscales (four items each): interpersonal and small group skills (i.e., "We listen to groupmates' ideas and perspectives"), Group processing (i.e., "Ideas are discussed among group members"), Positive interdependence (i.e., "My groupmates' help is important to finish the tasks), Promotive interaction (i.e.,

"Group members interact during tasks"), and Individual accountability (i.e., "Each group member must participate in the tasks"). The following stem was added: "In class..." Each item was rated in a five-point likert scale from 1 "*corresponds not at all*" to 5 "*corresponds exactly.*" Cronbach's alphas were adequate (original scores are presented between quotation marks): interpersonal and small group skills = 0.77 (0.74), Group processing = 0.79 (0.75), Positive interdependence = 0.74 (0.72), Promotive interaction 0.81 (0.76), and Individual accountability 0.79 (0.79). A global cooperative learning factor can also be obtained from the questionnaire.

Self-Regulated Learning

The Strategies to Control the Study Questionnaire (Hernández and García, 1995) was used to assess participants' self-regulated learning. It includes three subscales: prior to the study period or the learning task (seven items: i.e., "I divide the task in parts to make it easier"), during the study period or learning task (six items: i.e., "If there is something I don't understand, I do not continue until I understand it"), and after the study period or learning task (four items: i.e., "I review the whole task to see if I have any mistakes"). Cronbach's alphas can be considered adequate (original scores are presented in parenthesis): prior to the study period or the learning task = 0.85 (0.82), during the study period or learning task = 0.72 (0.73), and after the study period or learning task = 0.78 (0.79).

Academic Self-Efficacy

The Global Academic Self-Efficacy Questionnaire (Torre, 2006) was used. It is a nine-item, one factor instrument (i.e., I feel that I have the capacity to pass all the subjects this year"). It has been validated for university students (Cronbach's $\alpha = 0.90$). In our study, it was validated for secondary education students, and it obtained an adequate Cronbach's $\alpha = 0.90$.

Procedure

Project implementation involved several steps. Prior to data collection an informed written consent, approved by the researchers' university Ethical Committee, was signed by all participants' parents. Schools' administrators were contacted to fully explain the research project. Near the end of the school year, each school was informed of all the necessary procedures to guarantee adequate data collection. In one session (45 min), all participants were granted access to the questionnaire through an online link provided by the research team (it was "open" only during 1 week for all the schools to obtain data at the same time of the year). Participating students were informed that their participation was voluntary, data obtained would be kept confidential, and it will not affect their grades. To minimize the tendency of participants to provide socially desirable answers, they were asked to be totally honest, guarantying complete anonymity and confidentiality. School administrators and not teachers were in charge of data collection to avoid any influence on the students' responses. Questionnaire completion lasted an average of 20–25 min.

Statistical Analyses

First, two confirmatory factor analyses were conducted using the program EQS 6.2. (Bentler, 2006). The first one produced a self-regulated learning index from the self-regulated learning questionnaire. The second one validated the academic self-efficacy questionnaire in secondary education students. Since preliminary data showed a substantial multivariate kurtosis, analyses were based on the Satorra-Bentler scaled chi-square statistic (S-Bχ^2; Satorra and Bentler, 1988). The sample's goodness-of-fit was performed using multiple criteria (Byrne, 2008): the Comparative Fit Index (*CFI; Bentler, 1990), the Root Mean-Square Error of Approximation (*RMSEA; Browne and Cudeck, 1993), and the Standardized Root Mean Square Residual (SRMR). The *CFI represents the CFI robust version calculated on the S-Bχ^2 statistical basis. It is ranged from 0 to 1.00. Hu and Bentler (1999) suggested a value of 0.95 as indicative of good model fit. The *RMSEA is considered the robust version of the RMSEA and it considers the population's approximation error (Browne and Cudeck, 1993). *RMSEA's discrepancy is expressed in degrees of freedom, and it is sensitive to the model's complexity. Values lower than 0.05 indicate a good fit, and values as high as 0.08 represent reasonable errors of approximation. To complete the analysis, the 90% confidence interval provided by the *RMSEA was also included (Steiger, 1990). Finally, the SRMR is the average standardized residual value. It is derived from fitting the hypothesized variance covariance matrix to the sample data. Its values range from 0 to 1.00. Values lower than 0.08 indicate a proper fit to the model (Hu and Bentler, 1999).

Second, descriptive and correlational analyses were conducted. To assess the initial hypotheses, participants were grouped based on their perceptions on cooperative learning and self-regulated learning in their classes. A combination of hierarchical and κ-means cluster analyses was used in different steps: (1) to identify the number of clusters and provide the necessary information for the next analysis (*k*-means), a hierarchical cluster analysis using Ward's method and the squared Euclidian distance was conducted (variables' scores were standardized using z-transformation; Huberty et al., 2005); (2) a κ-means cluster analysis was conducted in the groups obtained in the previous step to find the final cluster solution; and (3) this solution's stability was tested and re-examined on a random sample (50%) of the total number of participants. In addition, Cohen's κ was used to measure the degree of agreement (stability) of the subjects' classification using data from the entire sample and the subsamples. Differences among clusters in all behavioral variables were estimated using analysis of variance *post hoc* Tukey's HSD test.

RESULTS

Confirmatory factor analyses showed a good fit to the model (**Table 1**). **Table 2** shows means and standard deviations of all variables. Cooperative learning and self-regulated learning's levels were similar. Correlations between these variables and academic self-efficacy were positive and significant ($p < 0.001$), and the highest one was found between self-regulated learning

TABLE 1 | Confirmatory factor analyses.

	S-Bx2	*df*	*CFI	SRMR	*RMSEA (90% CI)	
Self-regulated learning						
M_1	434.75	116	0.971	0.035	0.033	(0.030–0.036)
Academic self-efficacy						
M_2	170.35	27	0.978	0.024	0.046	(0.039–0.053)

TABLE 2 | Mean, standard deviation, and correlations among variables.

	α	*M*	*SD*	1	2	3
(1) Cooperative learning	0.92	3.72	0.65	1		
(2) Self-regulated learning	0.90	3.70	0.71	0.38***	1	
(3) Academic self-efficacy	0.90	3.89	0.75	0.29***	0.60***	1

****p < 0.001.*

and academic self-efficacy. Cronbach's alphas were also very high in all variables (≥0.90).

A second correlation analysis was conducted among all the cooperative learning subscales (interpersonal and small group skills, group processing, positive interdependence, promotive interaction, and individual accountability), all the self-regulated learning subscales (pre, in, and post) and academic self-efficacy. They all were positive and significant ($p < 0.01$). The highest ones were found between the different subscales of each scale, and also between academic self-efficacy and the different subscales of self-regulated learning (**Table 3**).

Based on the cooperative learning and self-regulated learning factors, participants were grouped in clusters. An exploratory multivariate data reduction technique was used to place students into relatively homogenous groups, maximizing similarities within students belonging to a particular cluster and dissimilarities between students belonging to different clusters. Significant changes were observed from the two-cluster to the three-cluster solution, and from this one to the four-cluster solution. Therefore, three solutions with two, three and four clusters were considered. The two-cluster solution produced two groups: (a) high self-regulated learning and cooperative learning, and (b) low self-regulated learning and cooperative learning. The three-cluster solution produced three groups: the previous two, and (c) low self-regulated learning and high cooperative learning. Finally, the four-cluster solution produced four groups: (a) high self-regulated learning and cooperative learning; (b) low self-regulated learning and cooperative learning; (c) low self-regulated learning and high cooperative learning; and (d) high self-regulated learning and low cooperative learning. Significant differences were obtained among the four clusters in both grouping variables ($p < 0.001$). Balancing parsimony and explanatory power, the four-cluster solution was selected based on the following criteria: (i) the agglomeration coefficients yielded a relatively large change, (ii) statistically significant differences were identified between clusters; and (iii) differences among groups were more consistent from a theoretical and an empirical point of view. This solution's stability was tested through a *k*-means cluster analysis in 50% of the original sample, randomly selected, and similar values were obtained (Kappa Cohen = 0.81; Landis and Koch, 1977).

Figure 3 shows the four different groups identified, and **Table 4** presents their characteristics. Cluster one included 395 students with a low profile on both clustering variables: cooperative learning and self-regulation. The majority were males (64.1%), 25.36% were students "at risk of academic failure" (the highest), and 3.5% were immigrants. Cluster two included 888 students with a high profile on both variables. The majority were females (53.6%), 11.1% were students "at risk of academic failure" (the lowest percentage), and 2.5% were immigrants. Cluster three included 735 students with a profile high on cooperative learning and low on self-regulated learning. The highest percentage were males (53.6%), 20.7% were students "at risk of academic failure" (20.7%), and 2.9% were immigrants. Finally, cluster four included 495 students with a profile high on self-regulated learning and low on cooperative learning. It contained similar number of males (50.9%) and females, a low percentage of students "at risk of failure" (11.9%), and immigrants (2.8%).

An univariate analysis of variance was conducted using academic self-efficacy as the dependent variable and cluster and gender as independent variables. A significant main effect emerged for cluster: $F(3,2505) = 299.14$, $p < 0.001$, $\eta^2 = 0.26$, and its interaction with gender: $F(3,2505) = 5.32$, $p < 0.01$, $\eta^2 = 0.01$. Tukey's HSD *post hoc* tests were conducted to compare groups (**Figure 4**). Statistically significant differences ($p < 0.001$) were found among all groups (clusters) in academic self-efficacy. Finally, **Figure 5** shows the interaction cluster*gender. In all clusters, males' scores were higher than females, except in cluster four, where females scored higher.

DISCUSSION

The goal of the present study was to assess the interactions between self-regulated learning, cooperative learning and academic self-efficacy in secondary education students experiencing cooperative learning as the main pedagogical approach for at least one school year. The initial hypothesis was that one group of students will perceive high levels of self-regulated learning and cooperative learning, other group will perceive low levels of both variables, a third group will show high levels of cooperative learning and low levels of self-regulation, and a fourth group will show high levels of self-regulated learning and low levels of cooperative learning. A second hypothesis was that these groups will show different levels of academic self-efficacy: the higher the students' self-regulation, the higher their self-efficacy; this means that group B will show the lowest, followed by groups C, D, and A. Results obtained support both hypothesis, and they revealed four clusters: cluster 1: low levels of cooperative learning, self-regulated learning and academic self-efficacy; cluster 2: high levels of cooperative learning, self-regulated learning and academic self-efficacy; cluster 3: high levels of cooperative learning, low levels of self-regulated learning

TABLE 3 | Correlations among all subscales.

	1	2	3	4	5	6	7	8	9
(1) Interpersonal and small group skills	1								
(2) Group processing	0.77**	1							
(3) Positive interdependence	0.55**	0.58**	1						
(4) Promotive interaction	0.60**	0.63**	0.65**	1					
(5) Individual accountability	0.54**	0.55**	0.59**	0.56**	1				
(6) Pre-self-regulated learning	0.32**	0.33**	0.28**	0.26**	0.24**	1			
(7) In-self-regulated learning	0.35**	0.33**	0.29**	0.31**	0.26**	0.67**	1		
(8) Post-self-regulated learning	0.28**	0.28**	0.23**	0.21**	0.22**	0.64**	0.66**	1	
(9) Academic self-efficacy	0.29**	0.28**	0.18**	0.25**	0.21**	0.53**	0.56**	0.49**	1

**$p < 0.01$ (bilateral).

and intermediate-low levels of academic self-efficacy, and cluster 4: high levels of self-regulated learning, low levels of cooperative learning, and intermediate-high levels of academic self-efficacy.

Regarding the first hypothesis, four groups of students were obtained, supporting it. Cluster 2 was the largest one (888 students) and it included students who perceived high levels of self-regulated, cooperative learning and academic self-efficacy. This is consistent with previous studies that showed that cooperative learning can foster cognitive, metacognitive, and motivational skills (Pintrich, 2000; Dembo et al., 2006), with those which observed that cooperative learning can promote self-regulated learning (Järvelä et al., 2008; Arjanggi and Setiowati, 2014) and with the ones which have linked self-regulation and self-efficacy (Pintrich and Schunk, 2002; Duckworth et al., 2009). Cluster 2 could be considered the most adaptive group, since students high on self-regulated learning have been found to be more proactive, and they tend to show initiative, persistence and adaptive skills, originated from positive metacognitive and motivational skills (Zimmerman, 2008). Plan, guide and monitor one's personal conduct seem to allow individuals to self-regulate their participation in the cooperative work, increasing group processing, which can lead to improved results (Jermann and Dillenbourg, 2008; Mauri et al., 2009). Cooperative learning has been found effective when different perspectives were confronted. This can help activate different interactive processes: attention, metacognition, motivation, emotion, action, and volitional control (Boekaerts and Niemivirta, 2000; Boekaerts and Corno, 2005). When this happens, the context allows regulation among group members, which tends to favor self-regulated learning in all of them (Monereo, 2007). In the present study, data obtained in cluster 2 could be considered very positive: individuals in this group showed the highest levels of academic self-efficacy, cooperative learning and self-regulation and the lowest percentage of students at risk of academic failure (11.1%). Previous studies have showed that individuals' self-efficacy can significantly impact a groups' feelings of collective efficacy (Fernandez-Ballesteros et al., 2002), influencing its functioning and its achievements. Fortunately, it was the biggest group (888 students), which is consistent with the background of the targeted sample: schools belonging to the National Network of Schools on Cooperative Learning, who had been integrating this pedagogical model on a regular basis during the whole school year.

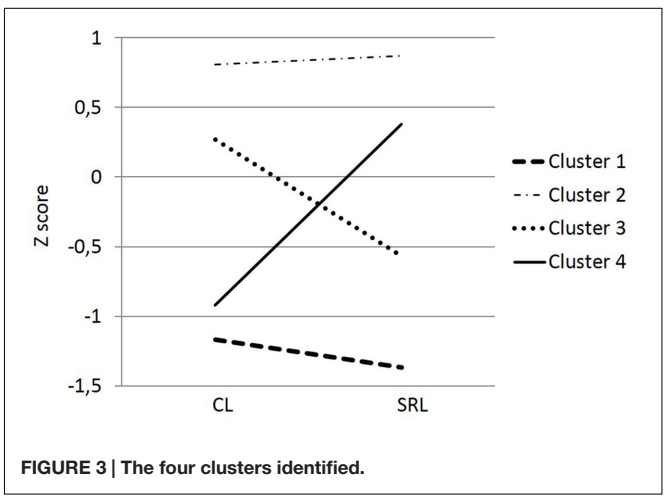


FIGURE 3 | The four clusters identified.

Opposite to the previous group, cluster 1 could be considered the least adaptive one. It included students who showed low levels of cooperative learning, self-regulated learning and academic self-efficacy. This is consistent with the findings of the previous group. Students who feel that the different features linked to self-regulation described in the previous paragraph do not refer to them are expected to produce opposite results. If these individuals feel that the educational context does not allow them to confront ideas or perspectives, it will not force these students to adapt and reach agreements, helping them regulate theirs and others' behaviors. These students probably felt that the learning contexts did not allow for co and shared regulation, creating unbalanced situations where, maybe, only a few group members provided information and instruction, taking a dominant role in the group (Salonen et al., 2005). Students in this cluster probably felt that the relationships created in their groups were asymmetrical, affecting their self-regulation processes. These students' probably behaved as isolated receivers of knowledge (received little information from others with no reciprocal interaction) (Leinonen et al., 2003). The end result could be considered very negative: the lowest levels of self-regulated learning, cooperative learning and academic self-efficacy. Fortunately, it was the smallest

TABLE 4 | Clusters' characteristics.

Clustering variable	Cluster 1 ($n = 395$)		Cluster 2 ($n = 888$)		Cluster 3 ($n = 735$)		Cluster 4 ($n = 495$)	
	Mean (z)	*SD*	Mean (z)	*SD*	Mean (z)	*SD*	Mean (z)	*SD*
(1) Cooperative learning	2.95^{d} (−1.17)	0.53	4.25^{a} (0.81)	0.35	3.90^{b} (0.27)	0.47	3.12^{c} (−0.92)	0.49
(2) Self-regulated learning	2.73^{d} (−1.37)	0.52	4.32^{a} (0.87)	0.33	3.30^{c} (−0.57)	0.51	3.97^{b} (0.38)	0.71
(3) Academic self-efficacy	3.24^{d} (−0.81)	0.83	4.30^{a} (0.55)	0.50	3.64^{c} (−0.33)	0.55	4.04^{b} (0.19)	0.75
Characteristics								
Males *n* (%)	253 (64.1%)		409 (46.1%)		394 (53.6%)		252 (50.9%)	
Females *n* (%)	142 (35.9%)		479 (53.9%)		341 (46.4%)		243 (49.1%)	
Risk of failure *n* (%)	101 (25.6%)		99 (11.1%)		152 (20.7%)		59 (11.9%)	
Immigrants *n* (%)	14 (3.5%)		22 (2.5%)		21 (2.9%)		14 (2.8%)	

Means in the same row which do not share superscripts differ at $p < 0.01$.

group (395 participants), which is also consistent with the background of the targeted sample: schools belonging to the National Network of Schools on Cooperative Learning. It was also the cluster with the highest percentage of students at risk of academic failure (25.6%). This is consistent with the scores obtained by these students in the other variables: low self-regulated learning and academic self-efficacy. These results are supported by previous studies which showed that group members' personal self-efficacy beliefs can significantly impact the group's feelings of collective efficacy (Fernandez-Ballesteros et al., 2002), influencing its functioning and its achievements. Educators should be aware that learning contexts that promote self-regulation imply choice and consistency (Sheldon and Elliot, 1998), "clarity and pace of instruction, student autonomy, teacher enthusiasm, humor, fairness, and teacher expectations about students' capacity" (Boekaerts and Cascallar, 2006, p. 204). If teachers want to promote self-regulation in their students, they must create specific class structures to incorporate these ideas.

Cluster 3 included students who scored high on cooperative learning, but low on self-regulated learning, showing a negative correlation between both variables. The first impression is that cooperative learning seemed to distort student's self-regulated learning. Previous studies have showed that cooperative learning can promote or hinder self-regulated learning, depending on the relations created among group members (Agina et al., 2011). Asymmetrical relations in working groups can lead to unbalanced instruction, failure in co-regulation, and negative feelings and behaviors among group members (Salonen et al., 2005). In cooperative learning contexts, some individuals adopt active roles (more participative), forcing other group members to adopt passive roles (less participative). These individuals tend to non-actively co-construct their knowledge, probably behaving as comment receivers (received information from others and providing feedback) or even isolated receivers (received little information from others with no reciprocal interaction) (Leinonen et al., 2003). The first students usually

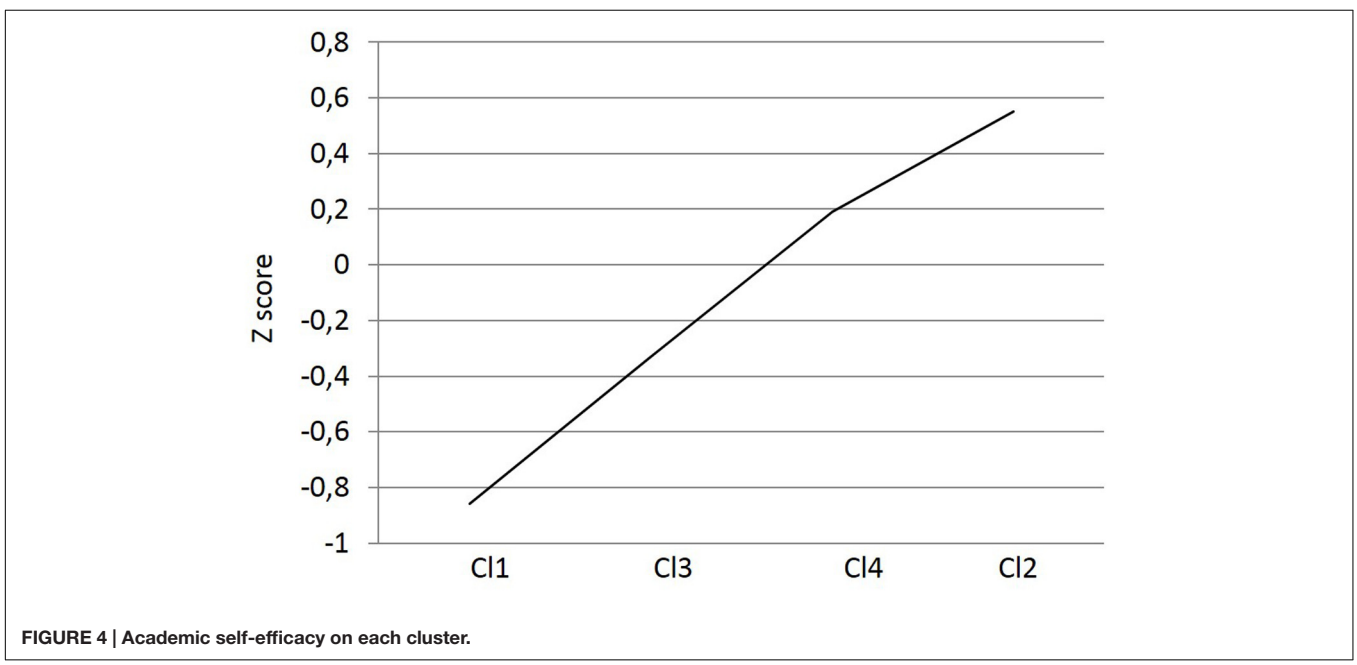


FIGURE 4 | Academic self-efficacy on each cluster.

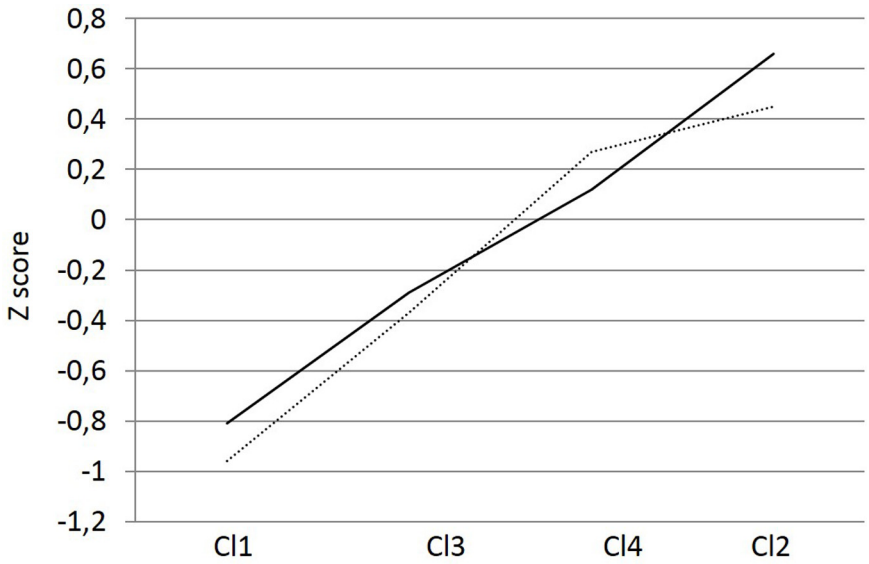


FIGURE 5 | Interaction cluster × gender.

dominate the group, adopting the role of instructors, and hindering their groupmates' self-regulatory processes (Menges and Svinicki, 1991; Ramsay et al., 2000). Results from the present study indicated that in cluster 3, group members' roles were not balanced. Educators should be aware of the relations that can emerge among group members in cooperative learning contexts, because some of them can negatively affect students' self-regulated learning and knowledge construction. They should behave as activators of the teaching-learning process and prevent asymmetrical relations among groupmates (Fernández-Río, 2016). When these appear, cooperative learning does not positively correlate to self-regulated learning. Results seem to indicate that this was the case in cluster 3, and the end result was negative: intermediate-low levels of academic self-efficacy. This cluster included the second highest percentage of students at risk of school failure (20.7%), which is consistent with the scores obtained in the other variables. Previous studies have showed that low levels of self-regulated learning tend to produce low levels of academic self-efficacy, which can lead to academic failure (Pintrich and Schunk, 2002).

The final cluster, number 4, included students with high levels of self-regulation and low levels of cooperative learning, showing a negative correlation between both variables. However, unlike in cluster 3, it produced high levels of academic self-efficacy. This is noteworthy, because it shows that self-regulated learning was more influential than cooperative learning on students' academic self-efficacy (results also showed the highest correlation between these two variables). This is consistent with previous research works which showed that high levels of self-regulation have been linked to high levels of academic self-efficacy efficacy (Duckworth et al., 2009). Students in this cluster probably behaved as active co-constructors of knowledge (providing large amounts of information to the groupmates), non active co-constructors of knowledge (providing some information to the groupmates) and/or comment receivers (receiving information from others and providing feedback) (Leinonen et al., 2003). Their scores indicated that they perceived low levels of cooperative learning in their groups, and consequently, asymmetrical relationships among group members. They probably thought that other group members did not cooperate, becoming active and dominant or passive or non-dominant members; in both cases taking advantage of the work of others. In any case, they showed high levels of self-regulated learning. The end result could be considered positive: intermediate-high levels of academic self-efficacy. This cluster included the second lowest percentage of students at risk of school failure (11.9%), which is consistent with the scores obtained in the other variables. Previous studies indicated that low achieving students can also show high levels of self-efficacy (Duckworth et al., 2009), they just need help form the teachers to avoid school failure and the different issues associated (Cooper, 2015).

Regarding the second hypothesis, results showed that the higher the students' self-regulation, the higher their academic self-efficacy. Cluster 2 scored higher in both variables, followed by cluster 4, cluster 3, and cluster 1. The same trend was observed in the correlational analyses: the highest score was obtained between these two variables, both when they were assessed globally (**Table 2**), and when the three subscales of self-regulated learning (pre, in, and post) were used in the analysis (**Table 3**). As previously mentioned, preceding studies have showed that learners high on self-regulation, both high and low-achieving, tend to exhibit high feelings of effectiveness in their own capabilities (Duckworth et al., 2009). Teachers can help their students develop self-regulation skills and have a positive impact in their self-efficacy showing them that they must: orient themselves before starting a task, collect relevant resources, integrate different viewpoints, monitor for comprehension and assess one's progress (Boekaerts and Cascallar, 2006). Teachers

must also help all students learn to persist on the class' tasks, to work to overcome the difficulties that they face daily, to invest enough effort to be successful, and to try increasingly demanding tasks. If teachers focus on these ideas their students will develop their self-efficacy and, consequently, it will have an impact in the students' self-regulation or vice versa. It is an extremely important goal and schools should try to improve both skills in all their students to prevent school failure.

Finally, results also showed significant differences in the interaction between clusters and gender. Males scored higher in all cluster except cluster 4. To our knowledge, there are no published studies that have addressed this connection to compare our results.

CONCLUSION

Students experiencing cooperative learning as the main pedagogical approach model for at least one school year were grouped in four clusters: (1): low levels of cooperative learning, self-regulated learning and academic self-efficacy; (2): high levels of cooperative learning, self-regulated learning, and academic self-efficacy; (3): high levels of cooperative learning, low levels of self-regulated learning, and intermediate-low levels of academic self-efficacy; and (4): high levels of self-regulated learning, low levels of cooperative learning, and intermediate-high levels of academic self-efficacy. Self-regulated learning was found more influential than cooperative learning on students' academic self-efficacy. In cooperative learning contexts students interact through different types of regulations: self, co, and shared. Educators should be aware of these interactions, symmetrical or asymmetrical, because they determine the quality and quantity of their participation and their achievements, and they are key elements to prevent school failure.

The present study also holds some limitations. First, its cross-sectional design does not allow to establish any causal relationship between the variables assessed. Longitudinal studies should assess the impact of purposely designed interventions. Second, the participants' cooperative learning exposure was not fully controlled. All students had a minimum of 1 year experience, but the numbers of hours per week or years that the students have been following this method were not considered. Future studies should assess the impact of different hours, academic subjects, and techniques.

ETHICS STATEMENT

The study was carried in accordance with the recommendations of the University of Oviedo Ethics Committee with written informed consent from all participants. All subjects gave written informed consent in accordance with the Declaration of Helsinki. The protocol was approved by the University of Oviedo Ethics Committee.

AUTHOR CONTRIBUTIONS

JF-R: study design, manuscript preparation; JC: study design, statistical analysis; AM-G: study design; DM-A: study design, data collection; JP: study design, data collection.

REFERENCES

Agina, A. M., Kommers, P. A., and Steehouder, F. (2011). The effect of the external regulator's absence on children's speech use, manifested self-regulation, and task performance during learning tasks. *Comput. Hum. Behav.* 27, 1118–1128. doi: 10.1016/j.chb.2010.10.007

Arjanggi, R., and Setiowati, E. A. (2014). "The effectiveness of student team-achievement division to increase self-regulated learning," in *Proceedings of the 8th International Technology, Education and Development Conference (INTED)*, Valencia, 2379–2383.

Aronson, E. (2010). *Cooperation in the Classroom: The Jigsaw Method*. London: Pinter & Martin Limited.

Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. New York, NY: W.H. Freeman and Company.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychol. Bull.* 107, 238–246. doi: 10.1037/0033-2909.107.2.238

Bentler, P. M. (2006). *EQS 6 Structural Equations Program Manual*. Encino, CA: Multivariate Software.

Blair, C., and Raver, C. C. (2015). School readiness and self-regulation: a developmental psychobiological approach. *Annu. Rev. Psychol.* 66, 711–731. doi: 10.1146/annurev-psych-010814-015221

Blair, C., and Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Dev.* 78, 647–663. doi: 10.1111/j.1467-8624.2007.01019.x

Boekaerts, M., and Cascallar, E. (2006). How far have we moved toward the integration of theory and practice in self-regulation? *Educ. Psychol. Rev.* 18, 199–210. doi: 10.1007/s10648-006-9013-4

Boekaerts, M., and Corno, L. (2005). Self-regulation in the classroom: a perspective on assessment and intervention. *Appl. Psychol.* 54, 199–231. doi: 10.1111/j.1464-0597.2005.00205.x

Boekaerts, M., and Niemivirta, M. (2000). "Self-regulated learning. Finding a balance between learning goals and ego-protective goals," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 417–449.

Browne, M. W., and Cudeck, R. (1993). "Alternative ways of assessing model fit," in *Testing Structural Equation Models*, eds K. A. Bollen and J. S. Long (Newbury Park, CA: Sage), 136–162.

Byrne, B. M. (2008). Testing for multigroup equivalence of a measuring instrument: a walk through the process. *Psicothema* 20, 872–882.

Chamorro-Premuzic, T., Furnham, A., and Lewis, M. (2007). Personality and approaches to learning predict preference for different teaching methods. *Learn. Individ. Differ.* 17, 241–250. doi: 10.1016/j.lindif.2006.12.001

Cooper, C. L. (2015). *Students at Risk: The Impacts of Self-Efficacy and Risk Factors on Academic Achievement*. Doctoral dissertation, University of Texas at Arlington, Arlington, TX.

Dembo, M. H., Junge, L. G., and Lynch, R. (2006). "Becoming a self-regulated learner: implications for web-based education," in *Web-Based Learning: Theory, Research, and Practice*, eds H. F. O'Neil and R. S. Perez (Mahwah, NJ: Lawrence Erlbaum Associates), 185–202.

Duckworth, A. L., and Carlson, S. M. (2013). "Self-regulation and school success," in *Self-regulation and autonomy: Social and Developmental Dimensions of Human Conduct*, eds B. W. Sokol, F. M. E. Grouzet, and U. Müller (New York, NY: Cambridge University Press), 208–230.

Duckworth, K., Akerman, R., MacGregor, A., Salter, E., and Vorhaus, J. (2009). *Self-Regulated Learning: A Literature Review*. London: Institute of Education, Centre for Research on the Wider Benefits of Learning.

Efklides, A. (2008). Metacognition: defining its facets and levels of functioning in relation to self-regulation and co-regulation. *Eur. Psychol.* 13, 277–287. doi: 10.1027/1016-9040.13.4.277

Fernandez-Ballesteros, R., Dıez-Nicolas, J., Caprara, G. V., Barbaranelli, C., and Bandura, A. (2002). Determinants and structural relation of personal efficacy to collective efficacy. *Appl. Psychol.* 51, 107–125. doi: 10.1111/1464-0597.00081

Fernández-Río, J. (2016). Student-teacher-content-context: indissoluble ingredients in the teaching-learning process. *J. Phys. Educ. Recreation Dance* 87, 3–5. doi: 10.1080/07303084.2016.1110476

Fernandez-Río, J., Cecchini, J. A., Méndez-Giménez, A., Méndez-Alonso, D., and Prieto, J. A. (2017). Diseño y validación de un cuestionario de medición del aprendizaje cooperativo en contextos educativos [Design and validation of a questionnaire to assess cooperative learning in educational contexts]. *Ann. Psychol.*

Goldberg, L. R. (1990). An alternative description of personality: the big five factor structure. *J. Pers. Soc. Psychol.* 59, 1216–1229. doi: 10.1037/0022-3514.59.6.1216

Grau, V., and Whitebread, D. (2012). Self and social regulation of learning during collaborative activities in the classroom: the interplay of individual and group cognition. *Learn. Instr.* 22, 1–12. doi: 10.1016/j.learninstruc.2012.03.003

Hadwin, A., and Oshige, M. (2011). Self-regulation, coregulation, and socially shared regulation: exploring perspectives of social in self-regulated learning theory. *Teach. Coll. Rec.* 113, 240–264.

Hayes, S., Uzuner-Smith, S., and Shea, P. (2015). Expanding learning presence to account for the direction of regulative intent: self-, co-and shared regulation in online learning. *J. Interact. Online Learn* 19, 1–19.

Hernández, P., and García, L. A. (1995). *Cuestionario de Estrategias de Control en el Estudio (ECE) [The Strategies to Control the Study Questionnaire]*. Departamento de Psicología Educativa, Evolutiva y Psicobiología, Universidad de La Laguna, San Cristóbal de La Laguna.

Hu, L. T., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ. Modeling* 6, 1–55. doi: 10.1080/10705519909540118

Huberty, C. J., Jordan, E. M., and Brandt, W. C. (2005). "Cluster analysis in higher education research," in *Higher Education: Handbook of Theory and Research*, ed. J. C. Smart (Dordrecht: Springer), 437–457.

Järvelä, S., Järvenoja, H., and Veermans, M. (2008). Understanding the dynamics of motivation in socially shared learning. *Int. J. Educ. Res.* 47, 122–135. doi: 10.1348/000709909X402811

Jermann, P., and Dillenbourg, P. (2008). Group mirrors to support interaction regulation in collaborative problem solving. *Comput. Educ.* 51, 279–296. doi: 10.1016/j.compedu.2007.05.012

Johnson, D. W., and Johnson, R. T. (1987). *Learning Together and Alone: Cooperative, Competitive, and Individualistic Learning*. New York, NY: Prentice-Hall, Inc.

Johnson, D. W., and Johnson, R. T. (2014). Cooperative learning in 21st century. *Ann. Psychol.* 30, 841–851.

Kagan, S. (1992). *Cooperative Learning*. San Juan Capistrano, CA: Resources for Teachers Inc.

Landis, J. R., and Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics* 33, 159–174. doi: 10.2307/2529310

Leinonen, P., Järvelä, S., and Lipponen, L. (2003). Individual students' interpretations of their contribution to the computer-mediated discussions. *J. Interact. Learn. Res.* 14, 99–122.

Mauri, T., Colomina, R., and Gispert, I. (2009). Diseño de propuestas docentes con TIC para la enseñanza de la autorregulación en la Educación Superior [Desing of teacher proposals through TIC to teach self-regulation in higher education]. *Rev. Educ.* 348, 377–399.

McEwen, B. S., and Gianaros, P. J. (2011). Stress and allostasis-induced brain plasticity. *Annu. Rev. Med.* 62, 431–445. doi: 10.1146/annurev-med-052209-100430

Menges, R. J., and Svinicki, M. D. (1991). *College Teaching, from Theory to Practice*. San Francisco, CA: Jossey-Bass.

Monereo, C. (2007). Hacia un nuevo paradigma del aprendizaje estratégico: el papel de la mediación social, del self y de las emociones [Towards a new paradigm of strategic learning: the role of social mediation, self and emotions]. *Rev. Investig. Educ.* 5, 239–265.

Orlick, T. (1978). *The Cooperative Sports and Games Book*. New York, NY: Pantheon.

Pintrich, P. R. (2000). "The role of goal orientation in self-regulated learning," in *Handbook of Self-Regulation*, eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 452–502.

Pintrich, P. R., and Schunk, D. H. (2002). *Motivation in Education: Theory, Research, and Applications*, 2nd Edn. Columbus, OH: Merrill-Prentice Hall.

Ramsay, A., Hanlon, D., and Smith, D. (2000). The association between cognitive style and accounting students' preference for cooperative learning: an empirical investigation. *J. Account. Educ.* 18, 215–228. doi: 10.1016/S0748-5751(00)00018-X

Salonen, P., Vauras, M., and Efklides, A. (2005). Social interaction-what can it tell us about metacognition and coregulation in learning? *Eur. Psychol.* 10, 199–208. doi: 10.1027/1016-9040.10.3.199

Satorra, A., and Bentler, P. M. (1988). *Scaling Corrections for Statistics in Covariance Structure Analysis (UCLA Statistics Series 2)*. Los Angeles, CA: University of California, Department of Psychology.

Schunk, D. H. (1990). Goal setting and self-efficacy during self-regulated learning. *Educ. Psychol.* 25, 71–86. doi: 10.1207/s15326985ep2501_6

Sheldon, K. M., and Elliot, A. J. (1998). Not all personal goals are personal: comparing autonomous and controlled reasons for goals and predictors of effort and attainment. *Pers. Soc. Psychol. Bull.* 24, 546–557. doi: 10.1177/0146167298245010

Slavin, R. (1990). *Cooperative Learning: Theory, Research and Practice*. Englewood Cliffs, NJ: Prentice Hall.

Slavin, R. E. (2014). Cooperative learning and academic achievement: Why does groupwork work? *Ann. Psychol.* 30, 785–791.

Steiger, J. H. (1990). Structural model evaluation and modification: an interval estimation approach. *Multivariate Behav. Res.* 25, 173–180. doi: 10.1207/s15327906mbr2502_4

Torre, J. (2006). *La Autoeficacia, la Autorregulación y Los Enfoques de Aprendizaje en Estudiantes Universitarios [Self-Efficacy, Self-Regulation and Learning Focus in University Students]*. Ph.D. thesis, Universidad Pontificia Comillas, Madrid.

Wang, S. L., and Lin, S. S. J. (2007). The effects of group composition of self-efficacy and collective efficacy on computer-supported collaborative learning. *Comput. Hum. Behav.* 23, 2256–2268. doi: 10.1016/j.chb.2006.03.005

Winne, P. H. (2005). A perspective on state-of-the-art research on self-regulated learning. *Instr. Sci.* 33, 559–565. doi: 10.1007/s11251-005-1280-9

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *J. Educ. Psychol.* 81, 329–339. doi: 10.1037/0022-0663.81.3.329

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: an overview. *Educ. Psychol.* 25, 3–17. doi: 10.1207/s15326985ep2501_2

Zimmerman, B. J. (2008). Investigating self-regulation and motivation: historical background, methodological developments, and future prospects. *Am. Educ. Res. J.* 45, 166–183. doi: 10.3102/0002831207312909

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2017 Fernandez-Rio, Cecchini, Méndez-Gimenez, Mendez-Alonso and Prieto. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 26 December 2016
doi: 10.3389/fpsyg.2016.01993

Risk Factors for School Dropout in a Sample of Juvenile Offenders

Asunción Fernández-Suárez[1], Juan Herrero[1], Beatriz Pérez[2], Joel Juarros-Basterretxea[1] and Francisco J. Rodríguez-Díaz[1]*

[1] Department of Psychology, University of Oviedo, Oviedo, Spain, [2] Núcleo en Ciencias Sociales y Humanidades, Universidad de la Frontera, Temuco, Chile

Backgrounds: The high rates of school dropout worldwide and their relevance highlight the need for a close study of its causes and consequences. Literature has suggested that school dropout might be explained by multiple causes at different levels (individual, family, school, and neighborhood). The aim of the current study is to examine the relation between individual (defiant attitude, irresponsibility, alcohol abuse, and illegal drugs use), family (educational figure absent and parental monitoring), school factors (truancy and school conflict) and school dropout.

Method: Judicial files of all juvenile offenders (218 males and 46 females) with a judicial penal measure in Asturias (Spain) in the year 2012 were examined. Multivariate logistic regression analyses were performed to estimate the relationships between school dropout and individual, family and school variables.

Results: As for the individual characteristics, results showed that school dropouts were more irresponsible than non-dropouts. Also they had higher rates of illegal drug use and alcohol abuse. Moreover, lack of parental monitoring emerged as a key predictive factor of school dropout, beyond the type of family structure in terms of the presence of both or only one educational figure. Finally, school factors did not show a significant relationship to school dropout.

Conclusions : These findings indicate that school dropout is a multidimensional process. School and family policies that emphasize the role of parental monitoring and prevent alcohol and substance abuse are recommended.

Keywords: school dropout, juvenile delinquency, judicial records, risk factors, parental monitoring, irresponsibility, alcohol abuse, substances use

OPEN ACCESS

Edited by:
Ann X. Huang,
Duquesne University, USA

Reviewed by:
Claudio Longobardi,
University of Turin, Italy
María Del Carmen Pérez Fuentes,
University of Almería, Spain

****Correspondence:***
Juan Herrero
olaizola@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *12 July 2016*
Accepted: *08 December 2016*
Published: *26 December 2016*

Citation:
Fernández-Suárez A, Herrero J, Pérez B, Juarros-Basterretxea J and Rodríguez-Díaz FJ (2016) Risk Factors for School Dropout in a Sample of Juvenile Offenders. Front. Psychol. 7:1993. doi: 10.3389/fpsyg.2016.01993

INTRODUCTION

School dropout has been defined as leaving education without obtaining a minimal credential, most often a higher secondary education diploma (De Witte et al., 2013). Estimates of dropout rates seem to be higher in South and West Asia (43%) and sub-Saharian Africa (36%), while other geopolitical areas such as East Asia, and Europe show similar lower dropout rates (between 4 and 12%) (United Nations Educational,Scientific and Cultural Organization, 2012; European Commission Education Training, 2013). In Spain, where the present study is conducted, dropout rates are estimated as high as 22% (Andrei et al., 2012; Korhonen et al., 2014) with a greater incidence among males (26.6%). Although there is great diversity of standards by which school dropout and completion are measured across various studies (Cataldi et al., 2009), these figures illustrate the relevance of school dropout worldwide and ask for a close study of its causes and consequences.

Although it is often difficult to differentiate causes from consequences, youth who drop out from school are at increased risk for displaying socioemotional problems and engaging in delinquent and criminal behavior (Prevatt and Kelly, 2003; Lochner and Moretti, 2004; Bradshaw et al., 2008). Literature has also suggested that school dropout might be regarded as the last stage of a dynamic, cumulative and multidimensional process of school disengagement (Andrei et al., 2012; Bjerk, 2012; Fortin et al., 2013; Korhonen et al., 2014) in which multiple causes at different levels (individual, family, school, and neighborhood) might be explaining this phenomenon (Bronfenbrenner and Morris, 1998; Jimerson et al., 2000; Bradshaw et al., 2008; De Witte et al., 2013).

Among the individual risk factors, both internalizing and externalizing disorders have been claimed to have an influence on school dropout. Among the externalizing disorders, disruptive behavior seems to be the most impeding for educational attainment (Esch et al., 2014) whereas depression and anxiety are among the most studied internalizing problems (Tramontina et al., 2001; Kearney, 2008; Fortin et al., 2013; Quiroga et al., 2013). Patterson et al. (1989) suggested that children with early behavioral problems are at risk for developing academic problems and experiencing rejection from their prosocial peers, probably leading to connections with deviant peers and in turn engage in other maladjusted acts such as truancy, substance use, or possibly violent behavior (Bradshaw et al., 2008). Alternatively, students who conform to school rules tend to perform better in the classroom setting and are less likely to leave school early (Bradshaw et al., 2008). Moreover, disruptive behavior at school also influences parents' involvement and guidance (Dishion et al., 2004), as well as teachers' relationships with students (Hughes et al., 2001; Lewis et al., 2005; Settanni et al., 2015; Prino et al., 2016), thus exacerbating its effects on school performance (Tramontina et al., 2001; McGrath and Van Bergen, 2015).

Of special interest among the individual risk factors is substance abuse. The relationship between substance abuse and school dropout is among the most studied in official records (Esch et al., 2014), suggesting that students who are involved in drug or alcohol abuse are more likely to drop out from school (Battin-Pearson et al., 2000; Bradshaw et al., 2008; Patrick et al., 2016). For instance, Esch et al. (2014) found that students who continued their academic career had lower risk of becoming current drinkers than their peers who had dropped out from school. Likewise, those adolescents who began to use cannabis before the age of 16 were up to five times more likely to drop out of secondary school than their peers who did not consume any drugs (see also Harford et al., 2006; Crosnoe and Riegle-Crumb, 2007). However, possible mechanisms linking substance use with school dropout are unclear, ranging from cognitive and neurobiological deficits to learning difficulties and low academic performance (Townsend et al., 2007; DuPont et al., 2013; Goldberg-Looney et al., 2016; Park and Kim, 2016).

Among the family factors, socioeconomic status, family structure (De Witte et al., 2013), and the importance parents place on academic success (Bradshaw et al., 2008) have been related to school dropout. From a family socialization theoretical point of view, school performance and home environment are closely related (Battin-Pearson et al., 2000). For instance, stressful events such as parental divorce or family conflict might influence how a student behaves in and outside the classroom (Bradshaw et al., 2008). Beyond the existence of stressful events, family structure may also influence school dropout (De Witte et al., 2013). The empirical evidence show how children from single-parent households are more likely to dropout from school (Bridgeland et al., 2006; Román, 2013; Torres et al., 2015) and there is literature suggesting that family structure might influence socialization process (i.e., lack of rules) which in turn exacerbate its influence on school dropout. As Bridgeland et al. (2006) found, 38% of school dropouts believed that they did not have enough rules, making too easy to skip class or engage in activities outside of school. This lack of rules seemed to relate both to lack of order and discipline at school as to substance use and juvenile antisocial behavior (Cutrín et al., 2015). In this regard, Park and Kim (2016) found that living with parents has a protective effect against substance use, while low parental education level was associated with substance use, thus emphasizing the importance of family parental monitoring to reduce also the likelihood of substance use. Likewise, Guillén et al. (2015), in a sample of 1023 young students, found that parental monitoring would be able to strengthen resistance to peer pressure and therefore it can be expected to reduce alcohol consumption.

Regarding school factors, truancy has been identified in several studies as a risk factor for school dropout (Tramontina et al., 2001; Kearney, 2008; Ekstrand, 2015). According to Wilkins and Bost (2016), truancy might indicate that students are potentially disengaged from school and that a trajectory toward dropping out is likely. Truancy has been regarded as a resistance to the school culture (Zhang, 2007) which results in negative developmental outcomes such as deviant behaviors, crime and delinquency (Henry, 2007; Huck, 2011).

Of special interest for the current study is the fact that the literature has empirically linked school dropout and involvement with the justice system (De Witte et al., 2013). In this sense, literature has suggested that the reasons behind dropout are key to understand further engagement to delinquency: those who leave education early for personal reasons are probably more prone to display offending behavior than those leaving for economic reasons (Weerman, 2010).

The literature has traditionally analyzed dropout and delinquency in adult samples, mostly penitentiary samples, where crime has been studied as a result of school dropout and other school factors, such as school belonging (Lucero et al., 2015), learning-disabilities, attitudes toward school and scholastic experiences (Einat and Einat, 2015), school expulsion (Jaggers et al., 2016) or school mobility (Ou and Reinolds, 2010). For instance, Dianda (2008) found that 41% of inmates in state and federal prisons in the United States had less than a high school education, indicating that inmates who were dropouts were more likely to have served a prior sentence in prison and were more likely to have been sentenced when they were young. Similarly, Herrero et al. (2016), in a sample of 110 imprisoned males in Spain, found that most of them (60%) did not have secondary studies. Likewise, Einat and Einat (2015), in a sample of 89 adult inmates in Israel, found that those who dropped out

of school early began their criminal activity at an earlier stage, suggesting that completing high school reduces the probability of incarceration (Lochner and Moretti, 2004).

To date, few studies have analyzed school dropout among juvenile offenders, despite its alarming rates of school dropout as compared to the juvenile general population (Andrei et al., 2012; Kim, 2012; Korhonen et al., 2014). Drawing from the reviewed literature, the current study examined the relation between individual (defiant attitude, irresponsibility, alcohol abuse and illegal drugs use), family (educational figure absent and parental monitoring), school factors (truancy and school conflict) and school dropout among juvenile offenders. The research question that motivated the present research was: do school dropouts and non-dropouts differ in their characteristics in the individual, family, and school contexts? Specifically, we analyze the presence of school dropout (defined as leaving school before or during their criminal career) among juvenile offenders taking into account individual, family, and school correlates that have been empirically found to be related to school dropout.

METHODS

Participants

Participants of the study were 264 young offenders drawn from the population of convicted young offenders 14–18 years-old with a judicial penal measure in Asturias (Spain). The population consisted in 270 young offenders (218 males and 46 females). Six of them, however, did not have information about school dropout in their criminal records so they were not retained for further analyses. All participants had committed at least one criminal offense in the year 2012. Participants varied considerably in terms of the type of offense: 42.8% were generalist offenders—different type of offenses on various occasions—and 57.2% were specialist offenders—tendency to repeat the same offense over time—. Offenses committed most frequently were property offenses (73.9%), injuries (45.5%), offenses against public security (17%), offenses against public order (12.9%), threats (11.4%), and child to parent violence/bullying/dating violence (11.4%).

Procedure

The researchers contacted the Juvenile Prosecutor of Asturias (Spain) and explained the objectives of the study. After access for the official records was granted, confidentiality of participants was guaranteed, according to the Organic Law 15/1999 on the Protection of Personal Data in Spain as well as the Declaration of Helsinki. The official records provided not only information about the criminal history of all participants but, also, their forensic evaluation. This evaluation was conducted by health professionals. The psychological, family, and school correlates were assessed through an in-depth evaluation of the multidisciplinary team of psychologists and counselors for each participant. The present paper is an empirical study, which was conducted with a quantitative methodology and a retrospective design.

Measures

Outcome Variable

Participants were divided into two groups: school dropouts (n = 128; 48.5%)—juvenile offenders who had left school before or during their criminal career—and non-dropouts (n = 136; 51.5%)—juvenile offenders who remain at school by the time they committed their last offense in 2012—. Response categories were 0 for non-dropout, and 1 for dropout.

Individual Variables

Psychological characteristics of respondents were retrieved from official records. For this study, information about two individual characteristics was used: defiant attitude and irresponsibility. Defiant attitude measures whether the participant regularly rejected authority and showed trouble in compliance with rules, limits, schedules and orders or not (n = 120; 45.5% of them). Irresponsibility measures whether the participant was responsible for his/her behavior or not (n = 86; 32.6% of them was described by professionals as irresponsible). *Substance use and abuse*. Substance use and abuse (including cannabis, cocaine, heroin, inhalants, amphetamines, etc.) was assessed as present if participant reported having use substances 4 or more times a week. While 15.9% (n = 42; 12 missing cases) of juvenile delinquents abuse alcohol, 61.4% (n = 162; 12 missing cases) of them use illegal drugs.

Family Variables

Family structure and parental monitoring were family variables of the study. *Family structure* was measured as the presence of both parents in child-rearing or not. In 183 cases (69.3%) the father/mother had been absent. *Parental monitoring* was measured as the presence of clear limits and rules about the behavior of participants at home. In 112 cases (42.4%) there were not clear rules.

School Variables

Truancy and conflict at school were the school variables of the study. *Truancy* was measured as the tendency observed for each participant of missing school. Truancy was considered to be present if the student was absent from class without informed consent for 3 or more days within a 4-week period, or for 10 or more days within a 6-month period. In 146 participants (55.3%) it was found a tendency to miss school regularly. *School conflict* measured whether there was a history of conflict with teachers, peers or school equipment or not. In 110 participants (41.7%) it was observed a history of conflict.

Statistical Procedures

Multivariate logistic regressions were conducted to determine the relationship between school dropout and individual, family and school variables. Chi-squared tests were first conducted for each set of variables (individual, family, and school) to analyze their bivariate associations with dropouts, and Cramer's V was used as a measure of effect size for this association.

TABLE 1 | Multivariate logistic regression analysis for individual (psychological and alcohol/drugs abuse), family and school variables predicting school dropout.

	Model 1 Nagelkerke $R^2 = 0.098$		Model 2 Nagelkerke $R^2 = 0.182$		Model 3 Nagelkerke $R^2 = 0.220$		Model 4 Nagelkerke $R^2 = 0.223$	
	Exp. (b)	IC 95%	Exp. (b)	IC 95%	Exp. (b)	IC 95%	Exp. (b)	IC 95%
Irresponsibility	2.116**	1.204–3.718	1.972*	1.100–3.535	2.019*	1.101–3.701	1.981*	1.075–3.652
Defiant attitude	2.082**	1.229–3.525	1.488	0.846–2.616	1.276	0.711–2.293	1.199	0.652–2.207
Alcohol abuse			2.371*	1.108–5.072	2.142^{+}	0.986–4.654	2.180*	1.003–4.739
Illegal drugs use			2.639***	1.467–4.745	2.442***	1.346–4.431	2.373**	1.288–4.370
Educational figure absent					1.663^{+}	0.910–3.039	1.585	0.858–2.930
Parental monitoring					0.505*	0.285–0.895	0.522*	0.290–0.940
Truancy							1.148	0.610–2.162
School conflict							1.191	0.663–2.140

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.01$; $^{+}p < 0.10$.

RESULTS

Multivariate logistic regression analyses tested whether dropouts showed statistically significant differences compared to non-dropouts in the variables of the study. To do so, individual, family, and school variables were entered into the equation in a sequential fashion to further analyze the joint contribution of each variable of the study. Model 1 incorporated individual psychological variables. Model 2 jointly analyzed all the individual variables, including alcohol and drugs abuse to Model 1. Model 3 incorporated family variables to the previous Model 2. Final Model 4, included school variables to Model 3. For model fit evaluation, Nagelkerke R^2 was estimated for each model. Odds ratios [Exp. (b)] and their 95% confidence intervals were used to test for statistical significance of each variable of the study on the outcome variable. Results for all models are presented in **Table 1**. Also, sample size, percentage, Chi-squared and Cramer's V tests for each set of variables (individual, family, and school) in each group of juvenile delinquents are presented in **Tables 2**–**4**.

Results for Model 1, which incorporated only individual psychological variables, showed that both being irresponsible and defiant increased the odds ratios of having dropped out from school. The inclusion of substance use and abuse variables in Model 2, however, removed the statistical significance of defiant attitude and school dropout, in spite of Chi squared test showed that dropouts display significantly a more defiant attitude than non-dropouts (see **Table 2**). In this Model 2, having being described as irresponsible by professionals and reporting heavy alcohol consumption and illegal drugs use were positively related to having dropped out from school. The effect of defiant attitude on school dropout seemed to be completely explained by the presence of alcohol abuse and illegal substance consumption. As for results of Model 3, which incorporated family variables, the existence of parental monitoring in the family was negatively related to school dropout, suggesting that those participants with clear limits and rules at home presented lower odds ratio of dropping out from school, regardless their individual characteristics and patterns of substance use and abuse. The absence of a family educational figure did not seem to have an effect beyond the existence of parental monitoring in the family. Finally, Model 4 showed that school variables did not influence school dropout beyond individual and family variables. Although both truancy and school conflict showed a bivariate positive relationship with school dropout (see **Table 4**), this relationship was non-significant after taking into account the individual and family variables of the study.

Overall, results from final Model 4 suggested that individual characteristics such as being irresponsible, substance use and alcohol abuse, and lack of parental monitoring in the family were key to understand the existence of school dropout among participants. Otherwise stated, juvenile delinquents of the study who stayed at school during the compulsory years of education were assessed by professionals as more responsible, low on substances consumption and alcohol abuse, and more supervised in their family.

DISCUSSION

In the present study school dropout was examined from a multidimensional approach, where individual, family and school (Andrei et al., 2012; Bjerk, 2012; Fortin et al., 2013; Korhonen et al., 2014) correlates of school dropout were analyzed among juvenile offenders, a population with a high risk of school dropout (Lochner and Moretti, 2004; Dianda, 2008; Ou and Reinolds, 2010; Andrei et al., 2012; De Witte et al., 2013; Korhonen et al., 2014; Einat and Einat, 2015; Lucero et al., 2015; Herrero et al., 2016; Jaggers et al., 2016). The official records of 264 juvenile delinquents were used to analyze the individual, family, and school correlates of school dropout.

As for the differences in their individual characteristics, the school dropouts seemed to be more irresponsible than non-dropouts. Students who did not comply with rules, limits, schedules and orders (i.e., they arrive late at school or return late from playtime) were at risk for school dropout. This finding would support the idea that a disruptive behavior is the most impeding for educational attainment (Patterson et al., 1989; Bradshaw et al., 2008; Esch et al., 2014). Although school

TABLE 2 | Sample size, percentage, χ^2 and Cramer's V test on individual variables and drugs use.

Individual variables	Dropouts ($n = 128$)	Non-dropouts ($n = 136$)	χ^2	Cramer's V
Defiant attitude			12.540***	0.23***
Yes (n)	73	47		
Yes (%)	57	34.6		
Irresponsibility			11.318***	0.21***
Yes (n)	55	31		
Yes (%)	43	22.8		
Alcohol abuse^			9.971***	0.21***
Yes (n)	30	12		
Yes (%)	24.8	9.2		
Illegal drugs use^			19.345***	0.28***
Yes (n)	95	67		
Yes (%)	78.5	51.1		

*^12 missing cases; ***p < 0.001.*

TABLE 3 | Sample size, percentage, χ^2 and Cramer's V test on family variables.

Family variables	Dropouts ($n = 128$)	Non-dropouts ($n = 136$)	χ^2	Cramer's V
Educational figure absent			3.271+	0.12+
Yes (n)	96	87		
Yes (%)	75	64		
Parental monitoring			15.505***	0.25***
Yes (n)	38	74		
Yes (%)	29.7	54.4		

****p < 0.001; +p < 0.10.*

TABLE 4 | Sample size, percentage, χ^2 and Cramer's V test on School variables.

School factors	Dropouts ($n = 128$)	Non-dropouts ($n = 136$)	χ^2	Cramer's V
Truancy			7.040**	0.17***
Yes (n)	82	64		
Yes (%)	64.1	47.1		
School conflict			3.205+	0.12+
Yes (n)	61	49		
Yes (%)	47.7	36		

****p < 0.001; **p < 0.01; +p < 0.10.*

dropouts and non-dropouts differ in their defiant attitudes, the effect of this psychological characteristic on school dropout seemed to be completely explained by the presence of alcohol abuse and illegal drugs consumption. This result support the idea that substances use is associated with deviant behaviors (Townsend et al., 2007) and externalizing symptoms (Meier et al., 2015).

Also, alcohol abuse and substance use were predictive of higher rates of school dropout. This finding would be consistent with research showing that both alcohol and substance dependence may increase the likelihood of school dropout (Battin-Pearson et al., 2000; Harford et al., 2006; Crosnoe and Riegle-Crumb, 2007; Townsend et al., 2007; Bradshaw et al., 2008; Esch et al., 2014; Patrick et al., 2016). Alcohol abuse and substance use have direct consequences on individual characteristics that relate to deviant behaviors, externalizing symptoms, psychological problems and risky behaviors (Townsend et al., 2007; Meier et al., 2015; Park and Kim, 2016), on cognitive process leading poor planning, impaired executive functioning or attention deficits (DuPont et al., 2013), and even on academic motivation (Park and Kim, 2016), being their effects incompatibles with keeping in school. Likewise, adolescent alcohol and drug users often reduce the number of hours committed to studying, completing homework assignments, and attending school, engaging in a vicious cycle which cause loss of interest in pursuing academic goals (DuPont et al., 2013).

Regarding family variables, lack of parental monitoring emerged as a key predictive factor of school dropout, beyond the type of family structure (absence of educational figures). These results suggest that, indeed, there would be family socialization differences in each group: parents of school dropouts seem to not clearly put limits and rules (i.e., they do not control the arrival time from school, or do not know about recreational activities of adolescents). This finding would be consistent both with family socialization theory (Battin-Pearson et al., 2000) and with the empirical evidence linking lack of rules and school dropout (Bridgeland et al., 2006; Bradshaw et al., 2008; De Witte et al., 2013; Román, 2013; Torres et al., 2015). The existence of family parental monitoring, however, seems to be more relevant than the absence of parents in child rearing, according to our data. Thus, parental monitoring seemed to be associated with a reduction of school dropout rates, whether both parents of these participants were present or not.

Once individual and family variables were taken into account, school-related variables such as truancy and the presence of conflicts with teachers and peers at school did not show a significant relationship with school dropout. This result contradicts research showing truancy as a risk factor for school dropout (Tramontina et al., 2001; Kearney, 2008; Ekstrand, 2015); however, it could be explained because most of these studies do not take into account other potentially relevant influences in the psychological and family realms, as our study shows.

Implications for Practice

Results from our study clearly highlight the role that the individual and family characteristics play on the explanation of school dropout thus pointing out where prevention and intervention efforts should put the accent on. In this sense, it seems that school dropouts of our study would benefit from both school and family policies that emphasize the role of supervision of adolescents. For instance, dealing with the irresponsible nature of participants would probably reduce school dropout rates (i.e., a closer control of time schedules, monitoring the homework or their recreational activities). Likewise, a greater

prevention and intervention effort aimed to provide parents with educational and communicational tools that allow them to better monitor adolescents would probably lead to a reduction in school dropout rates. In addition, parents and teachers might play a key role on prevention of substance abuse, in so far as they promote alternative recreational activities which are incompatibles with consumption (such as sport) and develop tools that help them to early detection of substance abuse. For instance, prevention efforts directed to address substance use and related problems among students who are experiencing academic difficulties would be needed. Also, continued care monitoring systems to track their progress and to provide more intensive supports are warranted while strategies such as punitive methods (i.e., student expulsion) should be avoided (DuPont et al., 2013). Rather, parents should monitor and supervise adolescent activities, expressing disapproval of drinking and other drug use and communicating a zero-tolerance message (Prevatt and Kelly, 2003; Dick and Hancock, 2015).

Strengths and Limitations

The study presents strengths and potential limitations. Among the strengths, participants of the study were representative of the population of juvenile offenders of Asturias (Spain), which might add generalizability of the study findings. As for the potential limitations, given the cross-sectional nature of the data used other alternative explanations of the observed relationships in our study are also possible. Thus, although we claimed that individual, family, and school variables were predictive of school dropout, the reverse might also be true: school dropout influenced individual, family and school variables. In this sense, the variables used in our study might be seen both as causes and consequences of school dropout thus warranting new research that takes into account the temporal dimension (i.e., follow-up studies). Also, participants of the study were mainly male (about 80%), so generalization of results across sex might not be tenable. Although participants of the study were almost the population of convicted young offenders 14–18 years-old with a judicial penal measure in Asturias (98% of those convicted), future research would benefit from a greater representation of female participants to analyze different potential paths for female school dropout.

Results of the present study, however, are in line with previous research about the role that individual, family and school variables have on school dropout, so we are confident that our findings might help to a better understanding of school dropout among juvenile offenders.

AUTHOR CONTRIBUTIONS

All authors jointly co-authored the content.

ACKNOWLEDGMENTS

Support for this research was provided by grant Severo Ochoa (BP13-134 and BP14-153) from Foundation for the Promotion in Asturias of Applied Scientific Research and Technology (FICYT, Asturias, Spain), and grants for predoctoral contracts for Teacher Training University (FPU 13/04310) from the Ministry of Education, Culture and Sport (Spain). This work was also supported by grant number SV-16-GRUPUO-CJS from The Government of the Principado of Asturias (Spain). We are especially thankful to the Juvenile Prosecutor of Asturias (Spain) for granting us access to official records.

REFERENCES

Andrei, T., Teodorescu, D., and Oancea, B. (2012). Quantitative methods used to identify the causes of school dropout in EU countries. *Proc. Soc. Behav. Sci.* 31, 188–192. doi: 10.1016/j.sbspro.2011.12.039

Battin-Pearson, S., Newcomb, M. D., Abbott, R. D., Hill, K. G., Catalano, R. F., and Hawkins, J. D. (2000). Predictors of early high school dropout: a test of five theories. *J. Educ. Psychol.* 92, 568–582. doi: 10.1037/0022-0663.92.3.568

Bjerk, D. (2012). Re-examining the impact of dropping out on criminal and labor outcomes in early adulthood. *Econ. Educ. Rev.* 31, 110–122. doi: 10.1016/j.econedurev.2011.09.003

Bradshaw, C. P., O'Brennan, L. M., and McNeely, C. A. (2008). Core competencies and the prevention of school failure and early school leaving. *New Dir. Child Adolesc. Dev.* 122, 19–32. doi: 10.1002/cd.226

Bridgeland, J. M., DiIulio, J. J., and Morison, K. B. (2006). *The Silent Epidemic. Perspectives of High School Dropouts*. Washington, DC: Civic Enterprises, L.L.C. Available online at: https://docs.gatesfoundation.org/Documents/TheSilentEpidemic3-06Final.pdf

Bronfenbrenner, U., and Morris, P. (1998). "The ecology of developmental processes," in *Handbook of Child Psychology,* Vol. 1. *Theoretical Models of Human Development*, ed W. Damon (Hoboken, NJ: Wiley), 993–1028.

Cataldi, E. F., Laird, J., and KewalRamani, A. (2009). *High School Dropout and Completion Rates in the United States: 2007*. Washington, DC: National Center for Education Statistics. Available onlie at: http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2009064

Crosnoe, R., and Riegle-Crumb, C. (2007). A life course model of education and alcohol use. *J. Health Soc. Behav.* 48, 267–282. doi: 10.1177/002214650704800305

Cutrín, O., Gómez-Fraguela, J. A., and Luengo, M. A. (2015). Peer-group mediation in the relationship between family and juvenile antisocial behavior. *Eur. J. Psychol. Appl. Legal Context* 7, 59–65. doi: 10.1016/j.ejpal.2014.11.005

De Witte, K., Cabus, S., Thyssen, G., Groot, W., and van den Brink, H. M. (2013). A critical review of the literature on school dropout. *Educ. Res. Rev.* 10, 13–28. doi: 10.1016/j.edurev.2013.05.002

Dianda, M. R. (2008). *Preventing Future High School Dropouts. An Advocacy and Action Guide for NEA State and Local Affiliates*. Washington, DC: National Education Association. Availabe online at: http://www.nea.org/assets/docs/HE/dropoutguide1108.pdf

Dick, D. M., and Hancock, L. C. (2015). Integrating basic research with prevention/intervention to reduce risky substance use among college students. *Front. Psychol.* 6:544. doi: 10.3389/fpsyg.2015.00544

Dishion, T. J., Nelson, S. E., and Bullock, B. M. (2004). Premature adolescent autonomy: parent disengagement and deviant peer process in the amplification of problem behavior. *J. Adolesc.* 27, 515–530. doi: 10.1016/j.adolescence.2004.06.005

DuPont, R. L., Caldeira, K. M., DuPont, H. S., Vincent, K. B., Shea, C. L., and Arria, A. M. (2013). *America's Dropout Crisis: The Unrecognized Connection to Adolescent Substance Use.* Rockville, MD: Institute for Behavior and Health, Inc. Availabe online at: http://www.preventteendruguse.org/pdfs/AmerDropoutCrisis.pdf

Einat, T., and Einat, A. (2015). To learn or not to learn—this is the question: learning- disabled inmates' attitudes toward school, scholastic experiences, and the onset of criminal behavior. *Prison J.* 95, 423–448. doi: 10.1177/0032885515596509

Ekstrand, B. (2015). What it takes to keep children in school: a research review. *Educ. Rev.* 67, 459–482. doi: 10.1080/00131911.2015.1008406

Esch, P., Bocquet, V., Pull, C., Couffignal, S., Lehnert, T., Graas, M., et al. (2014). The downward spiral of mental disorders and educational attainment: a systematic review on early school leaving. *BioMed. Central Psychiatry* 14:237. doi: 10.1186/s12888-014-0237-4

European Commission Education and Training (2013). *Reducing Early School Leaving: Key Messages and Policy Support*. Final report of the thematic working group on early school leaving. November 2013. Availabe online at: http://ec.europa.eu/education/policy/strategic-framework/doc/esl-group-report_en.pdf

Fortin, L., Marcotte, D., Diallo, T., Potvin, P., and Royer, E. (2013). A multidimensional model of school dropout from an 8-year longitudinal study in a general high school population. *Eur. J. Psychol. Educ.* 28, 563–583. doi: 10.1007/s10212-012-0129-2

Goldberg-Looney, L. D., Sánchez-SanSegundo, M., Ferrer-Cascales, R., Albadalejo-Blazquez, N., and Perrin, P. B. (2016). Adolescent alcohol use in Spain: connections with friends, school, and other delinquent behaviors. *Front. Psychol.* 7:269. doi: 10.3389/fpsyg.2016.00269

Guillén, N., Roth, E., Alfaro, A., and Fernández, E. (2015). Youth alcohol drinking behavior: associated risk and protective factors. *Rev. Iberoam. Psicol. Salud* 6, 53–63. doi: 10.1016/j.rips.2015.03.001

Harford, T. C., Yi, H. Y., and Hilton, M. E. (2006). Alcohol abuse and dependence in college and noncollege samples: a ten-year prospective follow-up in a national survey. *J. Stud. Alcohol Drugs* 67, 803–809. doi: 10.15288/jsa.2006.67.803

Henry, K. L. (2007). Who's skipping school: characteristics of truants in 8th and 10th grade. *J. Sch. Health* 77, 29–35. doi: 10.1111/j.1746-1561.2007.00159.x

Herrero, J., Torres, A., Fernández-Suárez, A., and Rodríguez-Díaz, F. J. (2016). Generalists versus specialists: toward a typology of batterers in prison. *Eur. J. Psychol. Appl. Legal Context* 8, 19–26. doi: 10.1016/j.ejpal.2015.09.002

Huck, J. L. (2011). Truancy programs: are the effects too easily washed away? *Educ. Urban Soc.* 43, 499–516. doi: 10.1177/0013124510380716

Hughes, J. N., Cavell, T. A., and Willson, V. (2001). Further support for the developmental significance of the quality of the teacher-student relationship. *J. Sch. Psychol.* 39, 289–301. doi: 10.1016/S0022-4405(01)00074-7

Jaggers, J. W., Robison, S. B., Rhodes, J. L. F., Guan, X., and Church, W. T. (2016). Predicting adult criminality among Louisiana's urban youth: poverty, academic risk, and delinquency. *J. Soc. Soc. Work Res.* 7, 2334–2315. doi: 10.1086/685089

Jimerson, S. R., Egeland, B., Sroufe, L. A., and Carlson, B. (2000). A prospective longitudinal study of high school dropouts: examining multiple predictors across development. *J. Sch. Psychol.* 38, 525–549. doi: 10.1016/S0022-4405(00)00051-0

Kearney, C. A. (2008). School absenteeism and school refusal behavior in youth: a contemporary review. *Clin. Psychol. Rev.* 28, 451–471. doi: 10.1016/j.cpr.2007.07.012

Kim, S. A. (2012). Individual, social factors, and experience after school dropout: differences between delinquent and non-delinquent dropout youth. *J. Korea Contents Assoc.* 12, 216–226. doi: 10.5392/JKCA.2012.12.10.216

Korhonen, J., Linnanmäki, K., and Aunio, P. (2014). Learning difficulties, academic well-being and educational dropout: a person-centred approach. *Learn. Individ. Differ.* 31, 1–10. doi: 10.1016/j.lindif.2013.12.011

Lewis, R., Romi, S., Qui, X., and Katz, Y. J. (2005). Teachers' classroom discipline and student misbehavior in Australia, China and Israel. *Teach. Teach. Educ.* 21, 729–741. doi: 10.1016/j.tate.2005.05.008

Lochner, L., and Moretti, E. (2004). The effect of education on crime: evidence from prison inmates, arrests, and self-reports. *Am. Econ. Rev.* 94, 155–189. doi: 10.1257/000282804322970751

Lucero, J. L., Barrett, C., and Jensen, H. (2015). An examination of family and school factors related to early delinquency. *Child. Sch.* 37, 165–173. doi: 10.1093/cs/cdv013

McGrath, K. F., and Van Bergen, P. (2015). Who, when, why and to what end? Students at risk of negative student-teacher relationships and their outcomes. *Educ. Res. Rev.* 14, 1–17. doi: 10.1016/j.edurev.2014.12.001

Meier, M. H., Hill, M. L., Small, P. J., and Luthar, S. S. (2015). Associations of adolescent cannabis use with academic performance and mental health: a longitudinal study of upper middle class youth. *Drug Alcohol Depend.* 156, 207–212. doi: 10.1016/j.drugalcdep.2015.09.010

Ou, S., and Reinolds, A. J. (2010). Childhood predictors of young adult male crime. *Child Child. Youth Serv. Rev.* 32, 1097–1107. doi: 10.1016/j.childyouth.2010.02.009

Park, S., and Kim, Y. (2016). Prevalence, correlates, and associated psychological problems of substance use in Korean adolescents. *BioMed. Central Public Health* 16, 79. doi: 10.1186/s12889-016-2731-8

Patrick, M. E., Schulenberg, J. E., and O'Malley, P. M. (2016). High school substance use as a predictor of college attendance, completion, and dropout: a national multicohort longitudinal study. *Youth Soc.* 48, 425–447. doi: 10.1177/0044118X13508961

Patterson, G. R., DeBaryshe, B. D., and Ramsey, E. (1989). A developmental perspective on antisocial behavior. *Am. Psychol.* 44, 329–335. doi: 10.1037/0003-066X.44.2.329

Prevatt, F., and Kelly, F. D. (2003). Dropping out of school: a review of intervention programs. *J. Sch. Psychol.* 41, 377–395. doi: 10.1016/S0022-4405(03)00087-6

Prino, L. E., Pasta, T., Giovanna, F., Gastaldi, M., and Longobardi, C. (2016). The effect of autism spectrum disorders, Down syndrome, specific learning disorders and hyperactivity and attention deficits on the student-teacher relationship. *Elect. J. Res. Educ. Psychol.* 14, 89–106. doi: 10.14204/ejrep.38.15043

Quiroga, C. V., Janosz, M., Bisset, S., and Morin, A. J. S. (2013). Early adolescent depression symptoms and school dropout: mediating processes involving self-reported academic competence and achievement. *J. Educ. Psychol.* 105, 552–560. doi: 10.1037/a0031524

Román, M. C. (2013). Factores asociados al abandono y la deserción escolar en América Latina: Una mirada en conjunto. *Rev. Iberoam. Sobre Calidad Efic. Cambio Educ.* 11, 33–59.

Settanni, M., Longobardi, C., Sclavo, E., Fraire, M., and Prino, L. E. (2015). Development and psychometric analysis of the student–teacher relationship scale–short form. *Front. Psychol.* 6:898. doi: 10.3389/fpsyg.2015.00898

Torres, J., Acevedo, D., and Gallo, L. (2015). Causas y consecuencias de la deserción y repitencia escolar: Una visión general en el contexto Latinoamericano. *Cult. Educ. Soc.* 6, 157–187.

Townsend, L., Flisher, A. J., and King, G. (2007). A systematic review of the relationship between high school dropout and substance use. *Clin. Child Family Psychol.* 10, 295–317. doi: 10.1007/s10567-007-0023-7

Tramontina, S., Martins, S., Michalowski, M. B., Ketzer, C. R., Eizirik, M., Biederman, J., et al. (2001). School dropout and conduct disorder in Brazilian elementary school students. *Can. J. Psychiatry* 46, 941–947. doi: 10.1177/070674370104601006

United Nations Educational, Scientific and Cultural Organization (2012). *Opportunities Lost: The Impact of Grade Repetition and Early School Leaving*. UNESCO Institute for Statistics. Available online at: http://www.uis.unesco.org/Education/Documents/ged-2012-en.pdf

Weerman, F. M. (2010). Delinquency after Secondary school: exploring the consequences of schooling, working and dropout. *Eur. J. Criminol.* 7, 339–355. doi: 10.1177/1477370810373729

Wilkins, J., and Bost, L. W. (2016). Dropout prevention in middle and high schools: from research to practice. *Interv. Sch. Clin.* 51, 267–275. doi: 10.1177/1053451215606697

Zhang, M. (2007). School absenteeism and the implementation of truancy-related penalty notices. *Past. Care Educ.* 25, 25–34. doi: 10.1111/j.1468-0122.2007.00422.x

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Fernández-Suárez, Herrero, Pérez, Juarros-Basterretxea and Rodríguez-Díaz. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 23 December 2016
doi: 10.3389/fpsyg.2016.01988

Student-Teacher Relationships As a Protective Factor for School Adjustment during the Transition from Middle to High School

*Claudio Longobardi *, Laura E. Prino, Davide Marengo and Michele Settanni*

Department of Psychology, University of Turin, Turin, Italy

A robust body of research has identified school transitions during adolescence, and in particular the transition from middle to high school, as one of the riskiest phases for school failure, being characterized by significant social, emotional and behavioral changes. This transition is critical even with respect to academic achievement: in Italy, the highest frequency of school dropout can be observed in the 9th and 10th grades, partly as a consequence of poor adjustment to the new school context. The impact of students' relationships with their teachers may be particularly relevant during critical developmental periods. Indeed, student-teacher relationships have been widely recognized as protective factors in school adjustment and, in case of negative relationships, also as a factor that increases the risk of maladjustment. Positive and affective student-teacher relationships may play an important role in students' adaptation to the school environment, favoring both academic achievement and adaptive behaviors. The aim of this study was to investigate the effects of the quality of teacher-student relationships, as perceived by pupils, on academic achievement, and problem and prosocial behaviors during the relevant school transition. The sample consisted of 122 students (55% female). We employed a self-report questionnaire to collect information on: demographic characteristics, quality of the relationship with teachers, problem and prosocial behaviors, and academic achievement. Students filled in the questionnaires twice: once during the 8th grade and 1 year later, during their first year of high school (9th grade). Regression analyses indicated that both average and varying levels of closeness with teachers significantly predicted changes in academic achievement: A perceived increase in closeness in 9th grade, as well as a higher mean closeness level, was associated with an increase in academic achievement. In turn, an increase in the level of perceived conflict with teachers significantly predicted an increase in conduct problems and hyperactive behaviors. This study supports the significance of student-teacher relationships as a protective factor during students' transition to high-school. Our findings also highlight the importance of relationship quality in preventing students' risk of school failure.

Keywords: student-teacher relationship, school transition, longitudinal study, academic achievement, middle school, high school

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Hyemin Han, University of Alabama, USA
Fiorenzo Laghi, Sapienza University of Rome, Italy
Martina Smorti, University of Pisa, Italy

****Correspondence:***
Claudio Longobardi
claudio.longobardi@unito.it

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *24 June 2016*
Accepted: *06 December 2016*
Published: *23 December 2016*

Citation:
Longobardi C, Prino LE, Marengo D and Settanni M (2016) Student-Teacher Relationships As a Protective Factor for School Adjustment during the Transition from Middle to High School. Front. Psychol. 7:1988. doi: 10.3389/fpsyg.2016.01988

INTRODUCTION

It is well established that one of the most demanding phases for children is that of school transition, especially the one from middle to high school (Gazelle and Druhen, 2009; Shell et al., 2014). Entering a new learning context requires students to adapt to harder tasks and to achieve different goals, therefore placing great pressure on their emotional well-being (Scalera and Alivernini, 2010).

The first empirical research studies on this theme date back to the end of the 1900s in the United States and, since the 1980s, a substantial line of international and inter-disciplinary research interested has developed (Neild, 2009). In 2000, the International Journal of Educational Research (Galton et al., 2000) presented a monographic issue on normative school transitions, discussing literature from an increasingly large number of geographic areas (Darmody, 2008; Cueto et al., 2010; Jindal-Snape, 2010), and in particular Germany (Van Ophuysen, 2009), Switzerland (Neuenschwander and Garrett, 2008), and Belgium (Dang Kim and Pelleriaux, 2006). Unlike other countries, in Italy research on school transitions is scarce (Scalera and Alivernini, 2010). Among the few existing studies are those by Pombeni and D'Angelo (1994) on the theme of motivation in learning and scholastic orientation, the study by Scalera and Alivernini (2010) on the transition to high school, as well as researches on the transition from primary to middle school by Zanobini and Usai (2002) and Tomada et al. (2005).

The transition to high school has been described as being the most critical when compared to other school transitions (Southern Regional Education Board, 2002; Barber and Olsen, 2004; Scalera and Alivernini, 2010; Ellerbrock and Kiefer, 2013; Roybal et al., 2014), especially because of its high dropout and failure rate (National Center for Education Statistics, 2008). In Italy, for example, 20.3% of new enrolments in the first year of high school fail (ISTAT, 2011). Such high failure rates highlight the importance of risk assessment for teachers, educators, school psychologists, and policy makers. In light of these considerations, the present study aims to investigate student-teacher relationships (STRs) as factor in promoting students' psychosocial adjustment during the transition from middle to high school. More in detail, the aim of this work is to assess, in the transition from middle school to high school, whether there is a link between the quality of the relationship with teachers as perceived by their students, academic achievement and problem or prosocial behavior. We hypothesize that STR quality may be an important emotional resource for school transitions, favoring the scholastic adjustment of the students (e.g., limiting problems behavior and promoting academic achievement).

Transitioning to High-School: Risk and Protective Factors

There are numerous factors that make it difficult to adapt to high school, chiefly the fact that students are simultaneously entering adolescence, which involves a complex redefinition of their personalities (Erikson, 1968; Blos, 1988), alongside difficulties in maintaining positive emotional well-being (Akos, 2002; Frey et al., 2009; Neild, 2009). Risk factors include, but are not limited to: larger, more chaotic rooms; school organization marked by a greater deal of bureaucracy; and a heavier workload, requiring increased cognitive effort on behalf of students (Akos and Galassi, 2004; Scalera and Alivernini, 2010; Eccles and Roeser, 2011; Waters et al., 2012). An additional relevant factor is the change that occurs in students' relationships with teachers and peers. New teachers tend to be perceived as cold, impersonal, and unreceptive to their developmental needs. Furthermore, students face relevant changes in their friendship networks (Cushman and Rogers, 2008; National Middle School Association, 2010; Scalera and Alivernini, 2010; Eccles and Roeser, 2011). Students have to reconsider their position in a new peer group, conscious of losing the security they have developed in a familiar classroom. For particularly anxious children, fitting into a new peer group may be a problem and could call for specific interventions (Gazelle, 2006; Oh et al., 2008).

The transition causes a series of changes, making it necessary for students to reorganize their social lives, and requiring them to cope with the new adaptation and development tasks. In the new school environment, students may perceive a lack of support from teachers and peers, and face difficulties in regulating their behavior. A reduction of emotional support in the transition to high school may result in a significant increase in the number of students who suffer from some form of exclusion (Avant et al., 2011). More specifically, if students needing more protection than others in this transition phase lack emotional support, their process of integration is hindered and they may also be exposed to experiences of victimization (Gazelle, 2008). Conversely, many studies have documented that a warm classroom climate, fostered by the social support of teachers, parents and peers, promotes lower conduct problems (Wang and Eccles, 2012). Furthermore, the transition to a new class may also provide students with positive opportunities to establish more satisfying and gratifying relationships with peers (Li and Lerner, 2011), especially for students with a previous history of victimization (Gazelle et al., 2005).

Alongside peer support, teachers' willingness and ability to support their students during developmental transitions remains a crucial factor in favoring their adaptation to the new environment. Students who experience some form of support from their teachers show increased academic commitment and motivation to learn (Fraire et al., 2013), as well as higher positive social and emotional well-being. In spite of this, it is often the case that teachers' management style, in an effort to maintain discipline and control over school activities, may compromise students' successful adaptation to the new requirements (Eccles and Roeser, 2011). In particular, this happens in cases where great importance is given to formal assessment. Students with low marks may perceive their teachers as unsupportive and ill-disposed toward them. At the same time, schools as institutions will be perceived as an unpleasant, pointless and, at times, hostile places (Bru et al., 2010).

In sum, it can certainly be argued that the teaching ability and relational skills of teachers are important to stimulate and promote students' motivation to learn while at school (Wentzel, 1998; Chen, 2008). Teachers who are able to regulate

classroom activities, while also highlighting students' progresses and achievements, significantly help their students during the transition and adaptation to the new school environment (Ryan and Deci, 2000).

Student-Teacher Relationship and Behavioral Problems

Alongside being a place for learning, classrooms are living environments in which many significant interpersonal relationships are developed. In this setting, teachers are central, and the quality of their relationships with students is fundamental to many aspects of school life. Children experiencing positive relationships with their teacher develop interest in school activities, are more motivated and willing to learn (Baumeister and Leary, 1995; Wentzel et al., 2010; Prino et al., 2016), and show higher academic achievement (Hughes, 2011; Pasta et al., 2013). Additionally, a positive link exists between the emotional support provided by student-teacher interactions and students' development of relational and social skills (Pianta et al., 2008b). Therefore, students' perception of emotional support is essential for their correct development, favoring learning and the creation of a wider network of friends (Pianta et al., 2008a).

Studies investigating the role of STRs in promoting students' well-being and academic achievement in the perspective of attachment theory, have shown that teachers which act as a "secure base"—that is, being available, responsive and accepting of students' needs—improve their students' commitment (Hughes et al., 2008; Myers and Pianta, 2008; Gastaldi et al., 2015), competence (Baker, 2006), and favor the development of their learning interests (Hughes et al., 2008; Quaglia et al., 2013). Low-conflict relationships with teachers favor an increase in positive classroom climate and students' perceived teacher support, and a decrease in students' negative experiences (Hamre et al., 2008; O'Connor, 2010). Teachers who share a warm relationship with their students tend to develop a positive sense of community in the classroom, as well as to promote cooperation among students by favoring their sharing of skills and ideas. Students seem to interiorize the interactions they have with their teachers and reproduce them with their classmates. In other words, if teachers behave in a consistent, accessible manner with their students, the latter tend to behave in the same way with their classmates (Mikami et al., 2011; Settanni et al., 2015). Conversely, children who are more isolated tend to relate less with their teachers (Wu et al., 2010). Similarly, aggressive children and those with low interest for school activities tend to relate very little with their teachers (Gest and Rodkin, 2011). The quality of friendships between peers is often compromised in children that show aggressiveness or lack of respect for others (O'Connor, 2010). Therefore, improving children's relationships with their teachers and peers is essential, not just to promote motivation and commitment, and to support the resilience of vulnerable students, but also to avoid or interrupt behaviors that threaten positive psychological growth (Bronfenbrenner and Morris, 2006).

Current Study

In Italy, schools are organized in a way that continuity of the class group is maintained within school cycles. Each class is formed by a group of students who normally stay together for the whole length of the school cycle, that is, for three consecutive years in middle school, and 5 years in high schools. Within-cycle changes in the class composition are rare, as there is much less mobility in Italy as compared, for example, to the United States or the United Kingdom. Teachers are also generally quite stable in the class: in some cases, they teach the same group of students for the whole school cycle. The continuity of the class group is significant in psychological terms, since with the passing of time students develop a sense of belonging, share ideas and visions of schooling, teaching, and learning. Moreover, and differently from other countries, no curricular flexibility is allowed to the students in Italian middle and high schools. By the end of middle school, at the age of 13–14 years, students are required to choose the track they intend to follow the next 5 years of high school.

The aim of this study is to investigate the effects of the quality of teacher-student relationships, as perceived by students, on their academic achievement and problem and prosocial behaviors during this important school transition. Regarding behaviors, we consider problematic ones as possible risk factors for school dropout. Indeed, as posited by many authors, dropping out of school is the culmination of cumulative risk factors over time, including poor academic achievement, school disengagement, and a variety of childhood behavior problems. In this study we examine whether students' individual relationship with their teachers during the transition from 8th to 9th grade predicts a change in academic achievement and in other behavioral difficulties related to the risk of school failure. Based on previous considerations about the protective role of student-teacher relationship quality in improving students' academic success and psychosocial adjustment, we hypothesize that positive transition-related changes in STR quality will have a positive impact on students' academic achievement and behavioral outcomes.

METHODS

Participants and Procedure

Sample consists of 181 Italian 8th grade students recruited from different middle schools in Northern Italy. After 1 year, participants were contacted in their new schools. However 59 participants were lost to follow-up given that some of the new schools did not give consent for the research to continue. The final sample consists of 122 students (of which 55% female). We employed a self-report questionnaire to collect information regarding demographic characteristics (age, gender), quality of relationship with teachers (using the Student Perception of Affective Relationships with Teacher Scale—SPARTS, Koomen and Jellesma, 2015), problematic and prosocial behavior (Strenghts and Difficulties Questionnaire, SDQ, Goodman, 1997) and academic achievement (as the average grade across all the school subjects).

Students filled in the questionnaires twice: first during the 8th grade and then 1 year later during their first year of high school (9th grade).

Ethical Considerations

School principals gave their consent for the participation of both teachers and students in our study. Individual informed consent to take part in the research was also collected from teachers, children and their parents, along with written consent describing the nature and objective of the study according to the ethical code of the Italian Association for Psychology (AIP). The consent stated that data confidentiality would be assured and that participation was voluntary. For the pupils, both parents were asked to sign the consent form in order to have their child participate in our study. The study was approved by the IRB of the University of Turin (approval number: 42345).

Instruments

After collecting data about students' age and gender, both students and teachers were asked to fill in a questionnaire including the following instruments.

Strengths and Difficulties Questionnaire (SDQ)

Teachers were asked to fill in the SDQ (Goodman, 1997, 1999; for the Italian validation, see Tobia et al., 2011), which is a brief behavioral screening questionnaire for children and adolescents aged 3–16. It consists of 25 items investigating 5 different dimensions: Emotional symptoms, Conduct problems, Hyperactivity/inattention, Peer relationship problems and Prosocial behavior. Teachers evaluated the degree to which each item (such as: "Considerate of other people's feelings"; "Has at least one good friend") described the student, using a 3-point Likert scale (0: Not true, 1: A little true, 2: Certainly true). Subscales' Cronbach's α for this study ranged from 0.65 to 0.86; the average α was 0.74.

Academic Achievement

Teachers were asked to report the average grade obtained by each student across all the school subjects. Each school subject was graded on a 1–10 scale.

Student Perception of Affective Relationship with Teacher Scale (SPARTS)

We examined students' perceptions of the student–teacher relationship quality using the Student Perception of Affective Relationship with Teacher Scale (SPARTS; Koomen and Jellesma, 2015). It consists of 25 items investigating three dimensions, namely Closeness, Conflict, and Negative expectations. The Closeness scale (8 items) assesses the students' positive feelings toward and reliance on their teacher (e.g., "I feel most at ease when my teacher is near"). Conflict dimension (10 items) measures the pupils' perception of the extent of negative behavior, and attitudes experimented with their teacher (e.g., "I guess my teacher gets tired of me in class"). Negative expectations scale (7 items) measures the lack of confidence in teacher's responsiveness and availability, (e.g., "I wish my teacher knew me better"). Children evaluated the extent to which they believed each of the 25 statements applied to their relationship with the teacher on a 5-point response scale, ranging from 1 ("no, that is not true"), to 5 ("yes, that is true"). Cronbach's alphas for this study were adequate, ranging from 0.66 to 0.84, the average α was 0.77.

Data Analysis

As a first step, study measures were inspected for univariate outliers using *Z-scores* ($-3.29 < Z < 3.29$). Analyses revealed presence of outliers on the SDQ subscales (T2) assessing emotional symptoms (3), conduct problems (1) and peer-relationship problems (1). Comparison of mean scores of these variables with corresponding means after removing outliers showed that none of these outliers significantly influenced mean scores on the variables at a nominal alpha level of 0.05. Consequently, univariate outliers were retained within further analyses (Pallant, 2001).

Then, descriptive statistics (mean, standard deviation, range) were computed on the study variables, both in the overall sample and by gender group. Independent samples *t*-tests were performed to investigate significance of gender differences on study measures. In order to investigate the significance of mean changes over time on the study measures, a set of paired-samples *t*-tests were performed in the overall sample. A measure of effect size (Cohen's *d*) was used to convey the size of difference in study measures between the two time points.

In order to investigate univariate relationships between study measures, Pearson's correlation coefficients were computed on measures as assessed at T1.

Descriptive statistics (mean, standard deviation, range) were computed on the study variables. In order to investigate the significance of mean changes over time on the study measures, a set of paired-samples *t*-tests were additionally performed.

A set of multiple linear regression models was utilized to investigate the link between students' relationship quality with teachers and 1-year follow-up measures of achievement and emotional and behavioral difficulties. Potential collinearity among IVs was controlled by mean-centering the variables (Aiken and West, 1991). Predictors were then entered in the regressions in the form of both time-averaged levels and change scores. More in detail, t1 and t2 measures of achievement and emotional and behavioral difficulties (X1, X2) were entered into the analyses both as an average level $(X1 + X2)/2$ and as a difference $(X2 - X1)$. We choose to use this specific parameterization approach as to determine in the analyses the presence of participants who have either stably low or high scores on the predictor variables included in the models (Labouvie et al., 1991). Thus, we investigated the associations between mean and difference scores for the conflict, negative expectations and closeness facets of student's relationship quality with teachers over a 1-year time lapse and 1-year follow-up measures of students' achievement and emotional and behavioral difficulties. Students' outcome measures at baseline (t1) and gender were added as covariates in the analyses.

RESULTS

Descriptive Statistics

Table 1 reports the descriptive statistics computed on the study variables as measured at baseline (T1) and follow-up (T2) in the overall sample, and by gender group. On average, participants showed low levels of emotional symptoms and problematic behaviors, conflict and negative expectations with teachers.

TABLE 1 | A study variable in the overall sample and by gender.

	Female					Male					Overall sample				Mean change	Cohen's *d*
	T1		T2		Normative data	T1		T2		Normative data	T1		T2			
	M	*SD*	*M*	*SD*	*M (SD)*	*M*	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*		
SDQ Emotional symptoms	1.40	2.05	1.29	1.69	1.98 (2.32)	1.88	2.28	1.18	1.54	1.74 (2.07)	1.53	2.02	1.23	1.65	−0.30	0.161
SDQ Conduct problems	1.04	1.43	.98	1.51	1.25 (1.79)	1.85**	2.10	1.31	1.84	1.82 (2.00)	1.47	1.79	1.15	1.70	−0.32	0.185
SDQ Hyperactivity/Inattention	2.19	2.12	1.96	1.62	2.65 (2.82)	3.89**	2.59	3.21**	2.43	3.84 (3.02)	3.08	2.30	2.67	2.16	−0.41*	0.184
SDQ Peer relationship problems	1.50	1.59	1.38	1.33	2.03 (2.11)	2.11*	1.84	1.71	1.55	2.21 (1.89)	1.68	1.64	1.55	1.49	−0.13	0.084
SDQ Prosocial behaviors	7.60	2.49	6.89	2.03	7.28 (2.52)	6.07**	2.91	5.73*	2.08	5.86 (2.64)	6.88	2.77	6.26	2.18	−0.62*	0.244
SPARTS-Closeness	15.52	6.86	16.62	7.36		15.30	6.47	15.26	6.59		15.61	6.88	15.99	7.03	0.38	−0.055
SPARTS-Conflict	8.68	6.38	5.62	4.70		12.21**	8.54	9.53*	10.58		10.11	7.41	7.49	8.26	−2.62**	0.322
SPART-Negative expectations	8.75	4.37	6.40	4.25		8.43	4.35	6.26	5.56		8.25	4.12	6.41	4.83	−1.84**	0.403
Academic achievement	7.30	2.02	7.84	1.60		6.36**	2.08	7.24*	1.74		7.02	2.02	7.54	1.68	0.52*	−0.204

Normative data were available for SDQ only (Tobia et al., 2011).
**p < 0.01 *p < 0.05.*

In turn, they reported medium levels of prosocial behaviors, closeness with teachers and academic achievement. Paired-sample *t*-tests indicated significant negative transition-related changes in hyperactivity/inattention, prosocial behaviors, the conflict and negative expectations facets of students' relationship quality with teachers, as well a significant increase in academic achievement. Based on widely accepted thresholds for Cohen's *d* (Cohen, 1988), although associated with statistically significant changes, effect sizes for conflict, negative expectations, prosocial behaviors and academic achievement, were only small ($d > 0.20$), while change in hyperactivity/inattention was negligible.

A few gender differences emerged. At T1, males reported higher scores on conduct problems, hyperactivity/inattention, peer relationship problems and student-teacher conflict, and lower prosocial behaviors and academic achievement than female students. A similar pattern emerged at T2, with the exception of conduct problems, which showed no difference between the groups.

Correlation Analyses

Table 2 shows the correlations between study measures as assessed at T1. Academic achievement showed negative correlations with SDQ subscales assessing conduct problems, hyperactivity/inattention, and peer relationship problems, and with SPARTS conflict subscale. In turn, positive correlations emerged between academic achievement and both SDQ prosocial behaviors and SPARTS closeness subscales.

SDQ subscales showed many significant inter-correlations: Subscales assessing emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems were all positively inter-correlated, and with the exception of the emotional symptoms subscale, all revealed significant negative correlations with the prosocial behaviors subscale. SPARTS subscales were also significantly inter-correlated: Closeness negatively correlated with conflict and negative expectations, which in turn showed a positive inter-correlation.

SDQ and SPARTS subscales also showed the many significant correlations: SPARTS Closeness subscale negatively correlated with the SDQ subscales assessing conduct problems and hyperactivity/inattention, and positively correlated with prosocial behaviors; the SPARTS conflict subscale showed an opposite correlation pattern, while no correlations emerged between the SPARTS negative expectations subscale and the SDQ subscales.

Regression Analyses

Results of the regressions models, reported in **Table 3**, indicated transition-related changes in relationship quality between students and teachers (i.e., closeness, negative expectations, and conflict with teachers) as significant predictors of changes in both students' academic achievement and two of the five behavioral dimensions measured by SDQ (conduct problems, hyperactivity/inattention). Specifically, an increase in the level of perceived conflict with teachers significantly predicted an increase in both conduct problems and hyperactivity/inattention symptoms across the two considered time points. Concerning academic achievement, both varying and average levels of

TABLE 2 | Correlations among study variables (T1).

	AA	ES	CP	HI	PP	PS	CL	CO
Academic achievement								
SDQ Emotional symptoms	−0.17							
SDQ Conduct problems	−0.53**	0.36**						
SDQ Hyperactivity/Inattention	−0.68**	0.40**	0.66**					
SDQ Peer relationship problems	−0.28**	0.29**	0.27**	0.27*				
SDQ Prosocial behaviors	0.48**	−0.07	−0.60**	−0.49**	−0.40**			
SPARTS-Closeness	0.23*	0.12	−0.28**	−0.26**	−0.03	0.27*		
SPARTS-Conflict	−0.31**	−0.09	0.40**	0.35**	0.14	−0.42**	−0.53**	
SPARTS-Negative expectations	−0.18	0.16	0.19	0.19	0.10	−0.15	−0.31**	0.52**

*Variable labels: AA, Academic achievement; ES, emotional symptoms; CP, conduct problems; HI, hyperactivity/inattention; PP, peer relationship problems; PS, prosocial behaviors; CL, Closeness; CO, Conflict; NE, Negative expectations. **p < 0.01 *p < 0.05.*

TABLE 3 | Regression models: SDQ behavioral dimensions and academic achievement (T2) on student-teacher relationship quality (T1-T2 change and average scores).

	ES	CP	HI	PP	PS	AA
Negative expectations (Change)	0.08	0.15	−0.04	0.10	0.08	−0.06
Closeness (Change)	−0.06	0.13	−0.02	−0.04	0.09	0.34**
Conflict (Change)	−0.14	0.24*	0.33**	0.01	0.06	−0.01
Negative expectations (Mean)	0.06	0.15	0.15	0.23	−0.19	0.18
Closeness (Mean)	0.02	−0.06	0.05	−0.06	0.09	0.24*
Conflict (Mean)	0.01	−0.00	0.03	0.02	−0.02	−0.03
Gender (1 = Female; 0 = Male)	−0.01	−0.05	−0.14	−0.08	0.24*	0.08
T1 score	0.09	0.22*	0.42**	0.03	0.05	0.11
R^2 (*Adj.* R^2)	0.02 (0.00)	0.23 (0.16)	0.35 (0.29)	0.12 (0.04)	0.14 (0.05)	0.25 (0.18)

Standardized coefficients are reported. Variable labels: ES, emotional symptoms; CP, conduct problems; HI, hyperactivity/inattention; PP, peer relationship problems; PS, prosocial behaviors; AA, Academic achievement.
***p < 0.01 *p < 0.05.*

closeness with teachers significantly predicted change over time: A perceived increase in closeness in 9th grade, as well as a higher mean closeness level, was associated with an increase in achievement.

DISCUSSION

The first analyses conducted were aimed to identify the behavioral characteristics of the adolescents that took part in the research, as evaluated by their teachers using SDQ. Examination of the normative data (Tobia et al., 2011) did not reveal substantial differences in behavioral outcomes between our sample and the Italian population. The variations recorded in the transition to high school show a small reduction in prosocial behaviors and a significant, but weaker, decrease in hyperactivity/attention. Concerning hyperactivity, the weakness of the transition-related effect may be partly due to normative developmental changes in the executive functions linked with self-regulation, which appear to plateau during in early to mid-adolescence (Ng-Knight et al., 2016), and the relatively short time-span in which observations took place. For the other dimensions examined by the SDQ, instead, there were no significant variations.

Academic achievement reached average scores in third year of middle school and was improved by half a point in the first year of high school. The improvement in academic achievement recorded for the participants of our study is not in line with that reported by literature (Akos and Galassi, 2004; Barber and Olsen, 2004; Benner and Graham, 2009).

Relationship with teachers is perceived by 3rd year middle school pupils as not particularly conflictual, and is characterized by low levels of negative expectations and average levels of closeness in terms of the range of the scales. In the transition to high school, there are variations in the relationship with teachers as perceived by students. In high school, said relationship is marked by lower levels of conflict and negative expectations, while the dimension of closeness shows no significant variation. Therefore, in the transition to high school the quality of the relationship with the teacher, as perceived by the students, is higher. This improvement is not linked to a variation in the level of closeness and sharing with the teacher, but to a reduction in the dimension of conflict and negative expectations. This datum is also in contrast with some of the literature, which reports that high school students tend to describe the relationship with their teachers as being detached, impersonal, oriented to learning and not interested in their individual needs for emotional support or

encouragement to be autonomous (Seidman et al., 1996; Barber and Olsen, 2004; Cushman and Rogers, 2008; National Middle School Association, 2010; Scalera and Alivernini, 2010; Eccles and Roeser, 2011).

The regression model underlines the importance of the relationship with teachers as both as a risk or a protection factor, depending on its features. In accordance with the literature, we have found that variations in STR quality affect both academic achievement and some of the students' problem behaviors, namely: conduct problems and Hyperactivity (Lynch and Cicchetti, 1992; Birch and Ladd, 1997; Roeser et al., 1998; Wentzel, 1998; Saft and Pianta, 2001; Henricsson and Rydell, 2004; Ahnert et al., 2006; Murray et al., 2008). More specifically, in the transition we have analyzed, the closeness dimension was linked to the improvement of academic achievement, while the conflict dimension is linked to increases in students' problem behavior.

CONCLUSIONS

The transition to high school is described in the literature as being the most critical, difficult and worrying of all developmental transitions (Southern Regional Education Board, 2002; Barber and Olsen, 2004; Roybal et al., 2014), even though some students report positive feelings and successful integration following their transition to the new school (Zeedyk et al., 2003; NSW Department of Education and Training, 2006; Anderman and Leake, 2007; Turner, 2007; Neild, 2009; Hamm et al., 2010; Rice et al., 2011; Waters et al., 2012). The transition to high school requires special consideration, since it coincides with puberty and with the psychophysical changes that entails and, therefore, can place great pressure on the emotional well-being of adolescents (Akos, 2002; Frey et al., 2009; Neild, 2009). The relationship with teachers plays an important role in this particular development phase by favoring scholastic adaptation and, therefore, affecting the dropout rate, which has been found to rise in the first year of high school. Consequently, given the importance of the educational relationship, the analysis of a student's situation in class should also look closely at the quality of the relationship with teachers, and not just at academic results in individual subjects, since these results too are related to the quality of the relationship. Our results show that both the closeness and the conflict dimensions, as perceived by students, are influential and can affect behavior, individual adaptation in class and academic achievement. Therefore, we hope that future interventions will be designed to improve the quality of the STR at middle and high school, so that said relationship may become a protective factor for students. The STR is one of the main factors that influence the degree to which students feel a bond with their school community, and determines their scholastic well-being (Libbey, 2004; Noddings, 2005; Schussler and Collins, 2006; Nichols, 2008; Suldo et al., 2009). Furthermore, it favors a reduction of problem behaviors and an increase in positive and prosocial attitudes in the classroom (Wentzel, 1994; Garnefski and Diekstra, 1996; Birch and Ladd, 1997; Hughes and Kwok, 2007; Close and Solberg, 2008), as well as fewer absences and a lower risk of dropping out and engaging in criminal activity (Finn, 1993; Blum and Rinehart, 1997; Hamre and Pianta, 2005).

Our study suffers from some limitations. First of all, it suffers from sample mortality and from a non-representative sample: it would be useful to plan new longitudinal research studies, expanding sample size and diversifying the territorial and scholastic settings. For example, this would enable the creation of a study on the possible differences linked to a school's territorial localization (i.e., urban or rural) or to the type of high school attended (lyceum, technical or vocational school, etc.). Subsequently, it would be possible to investigate whether the STR plays the same role in these cases, or whether, in some scholastic or territorial contexts, it may have a different influence on students' adaptation to school and their behavior. Finally, another fruitful line of research could focus exclusively on situations that are more at-risk, by designing interventions to improve STRs in order to assess whether this can reduce student dropout rate.

AUTHOR CONTRIBUTIONS

CL was involved with the design and interpretation of this work as well as writing and revising the manuscript. LP were involved in the acquisition of the data and discuss it. DM and MS were involved in methodology and analysis of the data.

REFERENCES

Ahnert, L., Pinquart, M., and Lamb, M. E. (2006). Security of children's relationships with nonparental care providers. A meta-analysis. *Child Dev.* 77, 664–679. doi: 10.1111/j.1467-8624.2006.00896.x

Aiken, L. S., and West, S. G. (1991). *Multiple Regression: Testing and Interpreting Interactions*. Newbury Park, CA: Sage.

Akos, P. (2002). Student perceptions of the transition from elementary to middle school. *Prof. School Couns.* 5, 339–345.

Akos, P., and Galassi, J. (2004). Middle and high school transitions as viewed by students, parents, and teachers. *Prof. School Couns.* 7, 212–221.

Anderman, L. H., and Leake, V. S. (2007). "The interface of school and family in meeting the belonging needs of early adolescents," in *Handbook of Research in Middle Level Education, Vol. 6, The Young Adolescent and Middle School,* eds S. Mertens, V. Anfara, and M. Caskey (Charlotte, NC: Information Age Publishing), 163–182.

Avant, T. S., Gazelle, H., and Faldowski, R. (2011). Classroom emotional climate as a moderator of anxious solitary children's longitudinal risk for peer exclusion: a child environment model. *Dev. Psychol.* 47, 1711–1727. doi: 10.1037/a0024021

Baker, J. A. (2006). Contributions of teacher-child relationships to positive school adjustment during elementary school. *J. Sch. Psychol.* 44, 211–229. doi: 10.1016/j.jsp.2006.02.002

Barber, B. K., and Olsen, J. A. (2004). Assessing the transitions to middle and high school. *J. Adolesc. Res.* 19, 3–30. doi: 10.1177/0743558403258113

Baumeister, R. F., and Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychol. Bull.* 117, 497–529.

Benner, A. D., and Graham, S. (2009). The transition to high school as a developmental process among multiethnic urban youth. *Child Dev.* 80, 356–376. doi: 10.1111/j.1467-8624.2009.01265.x

Birch, S. H., and Ladd, G. W. (1997). The teacher-child relationship and children's early school adjustment. *J. Sch. Psychol.* 35, 61–79. doi: 10.1016/S0022-4405(96)00029-5

Blos, P. (1988). *The Adolescent Passage. Developmental Issue*. New York, NY: International University Press.

Blum, R. W., and Rinehart, P. M. (1997). *Reducing the Risk: Connections That Make a Difference in the Lives of Youth*. Bethesda, MD: Add Health.

Bronfenbrenner, U., and Morris, P. A. (2006). "The bioecological model of human development," In *Handbook of Child Psychology, Vol. 1, Theoretical Models of Human Development, 6th Edn*., ed R. M. Lerner (Hoboken, NJ: Wiley), 793–828.

Bru, E., Stornes, T., Munthe, E., and Thuen, E. (2010). Student's perceptions of teacher support across the transition from primary to secondary school. *Scand. J. Educ. Res.* 54, 519–533. doi: 10.1080/00313831.2010.522842

Chen, J. J.-L. (2008). Grade-level differences: relations of parental, teacher and peer support to academic engagement and achievement among Hong Kong students. *Sch. Psychol. Int.* 29, 183–198. doi: 10.1177/0143034308090059

Close, W., and Solberg, S. (2008). Predicting achievement, distress, and retention among Lower Income Latino Youth. *J. Vocat. Behav.* 72, 31–42. doi: 10.1016/j.jvb.2007.08.007

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences, 2nd Edn*. Hillsdale, NJ: Erlbaum.

Cueto, S., Guerrero, G., Sugimaru, C., and Zevallos, A. M. (2010). Sense of belonging and transition to high schools in Peru. *Int. J. Educ. Dev.* 30, 277–287. doi: 10.1016/j.ijedudev.2009.02.002

Cushman, K., and Rogers, L. (2008). *Fires in the Middle School Bathroom: Advice for Teachers from Middle Schoolers*. New York, NY: The New Press.

Dang Kim, T., and Pelleriaux, K. (2006). *Equity in Education Thematic Review – Flanders*. Antwerp: University of Antwerp.

Darmody, M. (2008). Mapping barriers to successful school transitions in comparative perspective – Irish and Estonian experiences. *Trames* 12, 51–72. doi: 10.3176/tr.2008.1.04

Eccles, J. S., and Roeser, R. W. (2011). Schools as developmental contexts during adolescence. *J. Res. Adolesc.* 21, 225–241. doi: 10.1111/j.1532-7795.2010.00725.x

Ellerbrock, C. R., and Kiefer, S. M. (2013). The interplay between adolescent needs and secondary school structures: fostering developmentally responsive middle and high school environments across the transition. *High School J.* 96, 170–194. doi: 10.1353/hsj.2013.0007

Erikson, E. H. (1968). *Identity: Youth and Crisis*, *Vol. 19*. New York, NY: Norton.

Finn, J. D. (1993). *School Engagement and Students at Risk*. Washington, DC: National Center for Education Statistics.

Fraire, M., Longobardi, C., Prino, L. E., Sclavo, E., and Settanni, M. (2013). Examining the student-teacher relationship scale in the Italian context: a factorial validity study. *Electron. J. Res. Educ. Psychol.* 11, 649–664. doi: 10.14204/ejrep.31.13064

Frey, A., Ruchkin, V., Martin, A., and Schwab-Stone, M. (2009). Adolescents in transition: school and family characteristics in the development of violent behaviors entering high school. *Child Psychiatry Hum. Dev.* 40, 1–13. doi: 10.1007/s10578-008-0105-x

Galton, M., Morrison, I., and Pell, T. (2000). Concluding comments: transfer and transition: the next steps. *Int. J. Educ. Res.* 33, 443–449. doi: 10.1016/S0883-0355(00)00027-6

Garnefski, N., and Diekstra, R. (1996). Perceived social support from family, school, and peers: relationship with emotional and behavioral problems among adolescents. *J. Am. Acad. Child Adoles. Psychiatry* 35, 1657–1664. doi: 10.1097/00004583-199612000-00018

Gastaldi, F. G. M., Longobardi, C., Quaglia, R., and Settanni, M. (2015). Parent-teacher meetings as a unit of analysis for parent-teacher interactions. *Cult. Psychol.* 21, 95–110. doi: 10.1177/1354067X15570488

Gazelle, H. (2006). Class climate moderates peer relations and emotional adjustment in children with an early history of anxious solitude: a child × environment model. *Dev. Psychol*, 42, 1179–1192. doi: 10.1037/0012-1649.42.6.1179

Gazelle, H. (2008). Behavioral profiles of anxious solitary children and heterogeneity in peer relations. *Dev. Psychol.* 44, 1604–1624. doi: 10.1037/a0013303

Gazelle, H., and Druhen, M. J. (2009). Anxious solitude and peer exclusion predict social helplessness, upset affect, and vagal regulation in response to behavioral rejection by a friend. *Dev. Psychol.* 45, 1077–1096. doi: 10.1037/a0016165

Gazelle, H., Putallaz, M., Li, Y., Grimes, C. L., Kupersmidt, J. B., and Coie, J. D. (2005). Anxious solitude across contexts: girls' interactions with familiar and unfamiliar peers. *Child Dev.* 76, 227–246. doi: 10.1111/j.1467-8624.2005.00841.x

Gest, S. D., and Rodkin, P. C. (2011). Teaching practices and elementary classroom peer ecologies. *J. Appl. Dev. Psychol.* 32, 288–296. doi: 10.1016/j.appdev.2011.02.004

Goodman, R. (1997). The strengths and difficulties questionnaire: a research note. *J. Child Psychol. Psychiatry* 38, 581–586.

Goodman, R. (1999). The extended Version of the Strengths and Difficulties Questionnaire as a guide to child psychiatric caseness and consequent burden. *J. Child Psychol. Psychiatry* 40, 791 –801.

Hamm, J. V., Farmer, T. W., Robertson, D., Dadisman, K. A., Murray, A., Meece, J. L., et al. (2010). Effects of a developmentally based intervention with teachers on Native American and White early adolescents' schooling adjustment in rural settings. *J. Exp. Educ.* 78, 343–377. doi: 10.1080/00220970903548038

Hamre, B. K., and Pianta, R. C. (2005). Can instructional and emotional support in the first-grade classroom make a difference for children at risk of school failure? *Child Dev.* 76, 949–967. doi: 10.1111/j.1467-8624.2005.00889.x

Hamre, B. K., Pianta, R. C., Downer, J. T., and Mashburn, A. J. (2008). Teachers' perceptions of conflict with young students: looking beyond problem behaviors. *Social Dev.* 17, 115–136. doi: 10.1111/j.1467-9507.2007.00418.x

Henricsson, L., and Rydell, A. (2004). Elementary school children with behavior problems: teacher-child relations and self-perceptions. *Merrill Palmer Q.* 50, 111–138. doi: 10.1353/mpq.2004.0012

Hughes, J. N. (2011). Longitudinal effects of teacher and student perceptions of teacher-student relationship, qualities on academic adjustment. *Elem. Sch. J.* 112, 38–60. doi: 10.1086/660686

Hughes, J., and Kwok, O. M. (2007). Influence of student-teacher and parent-teacher relationships on lower achieving readers' engagement and achievement in the primary grades. *J. Educ. Psychol.* 99, 39–51. doi: 10.1037/0022-0663.99.1.39

Hughes, J. N., Luo, W., Kwok, O. M., and Loyd, L. K. (2008). Teacher–student support, effortful engagement, and achievement: a 3-year longitudinal study. *J. Educ. Psychol.* 100, 1–14. doi: 10.1037/0022-0663.100.1.1

ISTAT (2011). *Rapporto Annuale* [Annual report]. Rome: Istituto Nazionale di Statistica.

Jindal-Snape, D. (2010). "Setting the scene: educational transitions and moving," in *Educational Transitions: Moving Stories from Around the World,* ed D. JindalSnape (New York, NY: Routledge), 1–10.

Koomen, H. M., and Jellesma, F. C. (2015). Can closeness, conflict, and dependency be used to characterize students' perceptions of the affective relationship with their teacher? Testing a new child measure in middle childhood. *Br. J. Educ. Psychol.* 85, 479–497. doi: 10.1111/bjep.12094

Labouvie, E. W., Pandina, R. J., and Johnson, V. (1991). Developmental trajectories of substance use in adolescence: differences and predictors. *Int. J. Behav. Dev.* 14, 305–328.

Li, Y., and Lerner, R. M. (2011). Trajectories of school engagement during adolescence: implications for grades, depression, delinquency, and substance use. *Dev. Psychol.* 47, 233–247. doi: 10.1037/a0021307

Libbey, H. P. (2004). Measuring student relationships to school: attachment, bonding, connectedness, and engagement. *J. Sch. Health* 74, 274–284. doi: 10.1111/j.1746-1561.2004.tb08284.x

Lynch, M., and Cicchetti, D. (1992). "Maltreated children's reports of relatedness to their teachers," in *Beyond the Parent: The Role of Other Adults in Children's Lives. New Directions for Child Development,* Vol. 57, ed R. C. Pianta (San Francisco, CA: Jossey-Bass), 81–107.

Mikami, A. Y., Gregory, A., Allen, J. P., Pianta, R. C., and Lun, J. (2011). Effects of a teacher professional development intervention on peer relationships in secondary classrooms. *School Psych. Rev.* 40, 367–385.

Murray, C., Murray, K. M., and Waas, G. A. (2008). Child and teacher reports of teacher-student relationships: concordance of perspectives and associations with school adjustment in urban kindergarten classrooms. *J. Appl. Dev. Psychol.* 29, 49–61. doi: 10.1016/j.appdev.2007.10.006

Myers, S. S., and Pianta, R. C. (2008). Developmental commentary: individual and contextual influences on student-teacher relationships and children's early problem behaviors. *J. Clin. Child Adoles. Psychol.* 37, 600–608. doi: 10.1080/15374410802148160

National Center for Education Statistics (2008). *Digest of Education Statistics 2008*. Available online at: https://nces.ed.gov/pubs2009/2009020.pdf

National Middle School Association (2010). *This We Believe: Successful Schools for Young Adolescents*. Westerville, OH: National Middle School Association.

Neild, R. C. (2009). Falling off track during the transition to High school: what we know and what can be done. *Future Children* 19, 53–76. doi: 10.1353/foc.0.0020

Neuenschwander, M. P., and Garrett, J. L. (2008). Causes and consequences of unexpected educational transitions in Switzerland. *J. Social Issues* 64, 41–58. doi: 10.1111/j.1540-4560.2008.00547.x

Ng-Knight, T., Shelton, K. H., Riglin, L., McManus, I. C., Frederickson, N., and Rice, F. (2016). A longitudinal study of self-control at the transition to secondary school: considering the role of pubertal status and parenting. *J. Adolesc.* 50, 44–55. doi: 10.1016/j.adolescence.2016.04.006

Nichols, S. L. (2008). An exploration of students' belongingess beliefs in one middle school. *J. Exp. Educ.* 76, 145–169. doi: 10.3200/JEXE.76.2.145-169

Noddings, N. (2005). *The Challenge to Care in Schools: An Alternative Approach to Education. Advances in Contemporary Educational Thought, 2nd Edn*. New York, NY: Teachers College Press.

NSW Department of Education and Training (2006). *Transition Project*. Sydney, NSW: NSW Department of Education and Training.

O'Connor, E. (2010). Teacher-child relationships as dynamic systems. *J. Sch. Psychol.* 48, 187–218. doi: 10.1016/j.jsp.2010.01.001

Oh, W., Rubin, K. H., Bowker, J. C., Booth-LaForce, C., Rose-Krasnor, L., and Laursen, B. (2008). Trajectories of social withdrawal from middle childhood to early adolescence. *J. Abnorm. Child Psychol.* 36, 553–566. doi: 10.1007/s10802-007-9199z

Pallant, J. (2001). *SPSS Survival Manual: A Step-by-Step Guide to Data Analysis Using SPSS for Windows (Version 10)*. Buckingham: Open University Press.

Pasta T., Mendola M., Longobardi C., Prino L. E., and Gastaldi F. G. M. (2013) Attribution style of children with and without specific learning disability. *Electron. J. Res. Educ. Psychol.* 11, 649–664. doi: 10.14204/ejrep.31.13064

Pianta, R. C., Belsky, J., Vandergrift, N., Houts, R., and Morrison, F. (2008a). Classroom effects on children's achievement trajectories in elementary school. *Am. Educ. Res. J.* 45 365–397. doi: 10.3102/0002831207308230

Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., and Justice, L. (2008b). Effects of web-mediated professional development resources on teacher-child interactions in pre-kindergarten classrooms. *Early Child. Res. Q.* 23, 431–451. doi: 10.1016/j.ecresq.2008.02.001

Pombeni, M. L., and D'Angelo, M. G. (1994). *L'orientamento di Gruppo*. Roma: Carocci.

Prino, L. E., Pasta, T., Gastaldi F. G. M., and Longobardi, C. (2016). The effect of autism spectrum disorders, down syndrome, specific learning disorders and hyperactivity and attention deficits on the student-teacher relationship. *Electron. J. Res. Educ. Psychol.* 89–106. doi: 10.14204/ejrep.38.15043

Rice, F., Frederickson, N., and Seymour, J. (2011). Assessing pupil concerns about transition to secondary school. *Br. J. Educ. Res.* 81, 244–263. doi: 10.1348/000709910X519333

Roeser, R. W., Eccles, J. S., and Sameroff, A. J. (1998). Academic and emotional functioning in early adolescence: longitudinal relations, patterns, and prediction by experience in middle school. *Dev. Psychopathol.* 10, 321–352.

Roybal, V., Thornton, B., and Usinger, J. (2014). Effective ninth-grade transition programs can promote student success. *Education* 134, 475–487.

Ryan, R. M., and Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* 55, 68–78. doi: 10.1037/0003-066X.55.1.68

Saft, E. W., and Pianta, R. C. (2001). Teacher's perceptions of their relationships with students: effects of child age, gender, and ethnicity of teachers and children. *School Psychol. Q.* 16, 125–141. doi: 10.1521/scpq.16.2.125.18698

Scalera, V., and Alivernini, F. (2010). La transizione alla scuola superiore: modello teorico, costruzione e validazione della Scala di Difficoltà di Transizione (SDIT). *J. Educ. Cult. Psychol. Stud.* 2, 55–94.

Schussler, D. L., and Collins, A. (2006). An empirical exploration of the who, what and how of school care. *Teach. Coll. Rec.* 108, 1460–1495. doi: 10.1111/j.1467-9620.2006.00700.x

Seidman, E., Aber, J. L., LaRue, A., and French, S. E. (1996). The impact of the transition to high school on the self-system and perceived social context of poor urban youth. *Am. J. Community Psychol.* 24, 489–515. doi: 10.1007/BF02506794

Settanni, M., Longobardi, C., Sclavo, E., and Prino, L. E. (2015). Development and psychometric analysis of the student-teacher relationship scale–short form. *Front. Psychol.* 6:898. doi: 10.3389/fpsyg.2015.00898

Shell, M. D., Gazelle, H., and Faldowski, R. A. (2014). Anxious solitude and the middle school transition: a Diathesis × stress model of peer exclusion and victimization trajectories. *Dev. Psychol.* 50, 1569–1583. doi: 10.1037/a0035528.supp

Suldo, S. M., Friedrich, A. A., White, T., Farmer, J., Minch, D., and Michalowski, J. (2009). Teacher support and adolescents' subjective well-being: a mixed-methods investigation. *School Psych. Rev.* 38, 67–85.

Southern Regional Education Board (2002). *Opening Doors to the Future: Preparing Low-Achieving Middle Grades Students to Succeed in High School*. Atlanta, GA: Southern Regional Education Board.

Tobia, V., Gabriele, M. A., and Marzocchi, G. M. (2011). Norme italiane dello Strengths and Difficulties Questionnaire (SDQ): Il comportamento dei bambini italiani valutato dai loro insegnanti. *Disturbi di Attenzione e Iperattività* 6, 167–174.

Tomada, G., Schneider, B. H., de Domini, P., Greenman, P. S., and Fonzi, A. (2005). Friendship as a predictor of adjustment following a transition to formal academic instruction and evaluation. *Int. J. Behav. Dev.* 29, 314–322. doi: 10.1177/01650250544000099

Turner, S. (2007). Preparing inner-city adolescents to transition into high school. *Prof. School Couns.* 10, 245–252. doi: 10.5330/prsc.10.3.aq10271p3q0467ml

Quaglia, R., Gastaldi, F. G. M., Prino, L. E., Pasta T., and Longobardi C. (2013). The pupil-teacher relationship and gender differences in primary school. *Open psychol. J.* 6, 69–75. doi: 10.2174/1874350101306010069

Van Ophuysen, S. (2009). Predictors and consequences of transition expectations in German pupils moving to secondary school. *Eur. Educ. Res. J.* 8, 434–446. doi: 10.2304/eerj.2009.8.3.434

Wang, M.-T., and Eccles, J. S. (2012). Adolescent behavioral, emotional, and cognitive engagement trajectories in school and their differential relations to educational success. *J. Res. Adoles.* 22, 31–39. doi: 10.1111/j.1532-7795.2011.00753.x

Waters, S. K., Lester, L., Wenden, E., and Cross, D. (2012). A theoretically grounded exploration of the social and emotional outcomes of transition to secondary school. *Aus. J. Guid. Couns.* 22, 190–205. doi: 10.1017/jgc.2012.26

Wentzel, K. R. (1994). Relations of social goal pursuit to social acceptance, classroom behavior, and perceived social support. *J. Educ. Psychol.* 86, 173–182. doi: 10.1037/0022-0663.86.2.173

Wentzel, K. R. (1998). Social relationships and motivation in middle school: the role of parents, teachers, and peers. *J. Educ. Psychol.* 90, 202–209. doi: 10.1037/0022-0663.90.2.202

Wentzel, K. R., Battle, A., Russell, S. L., and Looney, L. B. (2010). Social supports from teachers and peers as predictors of academic and social motivation. *Contemp. Educ. Psychol.* 35, 193–202. doi: 10.1016/j.cedpsych.2010.03.002

Wu, J., Hughes, J. N., and Kwok, O. (2010). Teacher student relationship quality type in elementary grades; effects on trajectories for achievement and engagement. *J. Sch. Psychol.* 48, 357–387. doi: 10.1016/j.jsp.2010.06.004

Zanobini, M., and Usai, M. C. (2002). Domain-specific self-concept and achievement motivation in the transition from primary to low middle school. *Educ. Psychol.* 22, 203–217. doi: 10.1080/01443410120115265

Zeedyk, M. S., Gallacher, J., Henderson, M., Hope, G., Husband, B., and Lindsay, K. (2003). Negotiating the transition from primary to secondary school: perceptions of pupils, parents and teachers. *Sch. Psychol. Int.* 24, 67–79. doi: 10.1177/0143034303024001010

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Longobardi, Prino, Marengo and Settanni. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 15 December 2016
doi: 10.3389/fpsyg.2016.01925

Problematic Social Situations for Peer-Rejected Students in the First Year of Elementary School

Luis J. Martín-Antón[1], María Inés Monjas[1], Francisco J. García Bacete[2] and Irene Jiménez-Lagares[3]*

[1] Department of Psychology, Excellence Research Group GR179 Educational Psychology, University of Valladolid, Valladolid, Spain, [2] Department of Developmental, Educational and Social Psychology and Methodology, Jaume I University, Castelló de la Plana, Spain, [3] Department of Developmental and Educational Psychology, University of Seville, Seville, Spain

This study examined the social situations that are problematic for peer-rejected students in the first year of elementary school. For this purpose, exploratory and confirmatory factor analyses were conducted on the Taxonomy of Problematic Social Situations for Children (TOPS, Dodge et al., 1985) in 169 rejected pupils, identified from a sample of 1457 first-grade students (ages 5–7) enrolled in 62 classrooms of elementary school. For each rejected student, another student of average sociometric status of the same gender was selected at random from the same classroom ($n_{average} = 169$). The model for the rejected students showed a good fit, and was also invariant in the group of average students. Four types of situations were identified in which rejected students have significantly more difficulties than average students. They are, in descending order: (a) respect for authority and rules, (b) being disadvantaged, (c) prosocial and empathic behavior, and (d) response to own success. Rejected boys have more problems in situations of prosociability and empathy than girls. The implications concerning the design of specific programs to prevent and reduce early childhood rejection in the classroom are discussed.

Keywords: peer rejection, peer relations, social status, gender, elementary school

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Claudio Longobardi, University of Turin, Italy
Paloma Braza, University of Cadiz, Spain

****Correspondence:***
Luis J. Martín-Antón
ljmanton@psi.uva.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *23 September 2016*
Accepted: *24 November 2016*
Published: *15 December 2016*

Citation:
Martín-Antón LJ, Monjas MI, García Bacete FJ and Jiménez-Lagares I (2016) Problematic Social Situations for Peer-Rejected Students in the First Year of Elementary School. Front. Psychol. 7:1925. doi: 10.3389/fpsyg.2016.01925

INTRODUCTION

Peer interactions in childhood are one of the pillars of child development, as they are the basis for building future relationships (Gifford-Smith and Brownell, 2003; Green et al., 2008). Among them, the relationship with classmates is of particular interest because children maintain constant contact at school and in extracurricular situations, and currently, also in virtual environments (Gallagher, 2005). Thus, the classroom becomes the context for academic learning, but also the basic framework of coexistence and relationship among students, enabling the implementation of important emotional and social skills (Mikame et al., 2010; Comellas, 2013). Peer exchanges contribute to the development of significant cognitive and socio-emotional achievements (Ladd, 2005; Rose-Krasnor and Denham, 2009) and hence, to school adaptation (Gifford-Smith and Brownell, 2003). Inadequate or deficient relationships during childhood can lead to diverse problems later on (Hartup, 1989; van Ijzendoorn, 2005; Hay et al., 2009; Pérez-Fuentes et al., 2016).

These issues are especially important for children between 5 and 6 years who begin compulsory schooling. The first year of elementary school is a stressful situation because students face the new academic and coping challenges of greater teacher and school demands

(Settanni et al., 2015). At the same time, it poses difficult interpersonal challenges arising from peer group entry, which will involve the implementation of new and more complex emotional skills (Ladd, 2005; Durlak et al., 2011). Being accepted and loved by their classmates, having friendly and satisfactory relationships with others, being integrated and participating actively in the group, and building dyadic relationships and friendships with peers are some of the aspects that children must achieve to attain optimal emotional, cognitive, and social development (Merrell and Gueldner, 2010).

It is also relevant for children to maintain warm relationship with the authority figure represented by the teaching staff (Birch and Ladd, 1997; Baker, 2006; Cadima et al., 2010; Koomen et al., 2012; Fraire et al., 2013; García Bacete et al., 2014; Lee and Bierman, 2016). Teachers are highly involved in the social dynamics of the classroom and in the specific aspects of vulnerable students' relationships (Kiuru et al., 2012). Rudasill and Rimm-Kaufman (2009) point out the importance of the frequency of teacher-student interactions. The quality of this interaction plays an important role in children's personal, social, and academic success, especially in children who are at risk of failure (Hamre and Pianta, 2005; García Bacete et al., 2014; Bush et al., 2015). The quality of these relationships is usually stable (Pianta and Stuhlman, 2004) and could depend on the teachers' gender and that of their students (Quaglia et al., 2013).

In fact, most children achieve positive relationships with their peers. Some children have a privileged social position: they are the preferred students, highly valued by their peers. Others simply get along well with others and have a few friends. However, there are some children who, for various reasons, do not fit in the group and are passively or actively rejected and excluded by their peers. These are the children with a rejected sociometric status. The identification of the sociometric type is usually done through sociometric strategies, based on collecting the relationship preferences of the classmates of each student (Cillessen, 2009; García Bacete and González Álvarez, 2010). According to the works of Coie et al. (1982), depending on the number of positive and negative nominations received by each student of the group, five sociometric types have been established: in addition to the popular and rejected status, there are the average, neglected, and controversial status.

In recent decades, developmental research has devoted considerable attention to the phenomenon of peer rejection, noting the harmful consequences for the socio-emotional, cognitive, and academic development of the rejected students (Gifford-Smith and Brownell, 2003; Bierman, 2004; Sandstrom and Zakriski, 2004; Asher and McDonald, 2009; Wentzel, 2009). Interest in rejection derives from its high incidence—between 10 and 15% of the students are rejected by their peers (García Bacete et al., 2008; McKown et al., 2011)—from its negative consequences—as well as involving important suffering by the rejected child, it predicts various psychological problems, academic failure, and dropout (Mayeux et al., 2007)—and from the stability and persistence of its effects (Coie and Dodge, 1983; Coie, 1990; Cillessen et al., 2000; Jiang and Cillessen, 2005).

Although the population of rejected students is very heterogeneous, numerous studies have tried to establish a profile associated with various behavioral, cognitive, and emotional correlates. Thus, Bierman (2004) points out that rejected students share some of the four following behavioral patterns; (a) low rates of sociability, orientation toward others, and prosocial behavior (low empathy, poor cooperative behaviors); (b) high aggression and disruptive behavior, which tends to predict situations of rejection in subsequent courses (Bierman et al., 2014); (c) high levels of immature behavior and lack of attention; and (d) social anxiety and avoidance behaviors. Along with these features, other characteristics emerge, such as low emotional self-regulation and difficulties to perceive, understand, and regulate emotions (Southam-Gerow and Kendall, 2002), difficulties to understand situational demands and interpret social signals, and in perspective-taking (White and Kistner, 2011). They also have social information processing biases, for example, when interpreting the reasons for others' behavior, rejected children frequently make hostile attributions to their classmates' behavior, especially in ambiguous situations that they interpret erroneously (Dodge et al., 2003; Dirks et al., 2007; Lansford et al., 2010). All this leads them to respond to the situation maladaptively.

Therefore, it could be argued that rejected children are socially less competent than their more valued peers. We should therefore clarify what is meant by being less competent. The approach of Asher and McDonald (2009) focuses on the behavior emitted by the child in response to specific social situations. They point out that problems in relationships do not necessarily appear in all social situations, but rather in some very specific situations that pose a problem for the child. Social competence is thus not considered so much as a general trait, but as the ability to respond adequately to different circumstances (Asher et al., 2012).

Asher and McDonald (2009) presented a list of 40 social situations, among which are peer group entry, ambiguous provocation, seeking, or offering help, or conflict management. Dodge et al. (1985) found that the greatest differences between rejected and unrejected children occurred in the Response to Provocation and in Teacher Expectations. Parker and Asher (1987) demonstrated that, for socially incompetent and aggressive children, peer group entry and knowing how to react to provocations were the most difficult social situations for them within the context of peer relationships. A similar response pattern is observed in all of these situations: compared to accepted children, children with low acceptance tend to emit more aggressive responses and fewer socially sophisticated responses (Asher et al., 2012).

Observational laboratory studies and vignettes have frequently been used to appraise social situations. The use of peers or teachers as informants is much less common (Asher and McDonald, 2009). However, teachers are quite familiar with their students' behavior and difficulties, and therefore, they have frequently been used to appraise various aspects of social competence and, in particular, rejected students' difficulties. It has been found that teachers are good informants (Pouwels et al., 2016), providing information that correlates highly with that provided by peers (McKown et al., 2011). These correlations are higher in studies of both sexes, and in studies carried out at school instead of in the laboratory (Renk and Phares, 2004).

TAXONOMY OF PROBLEMATIC SOCIAL SITUATIONS FOR CHILDREN

Dodge et al. (1985) proposed the Taxonomy of Problematic Social Situations for Children (TOPS) based on the identification of 64 situations by 50 teachers from first to fifth grade, grouped into eight categories. After a subsequent refinement, the list was reduced to 44 situations. To assess its psychometric properties, it was applied to a group of 45 rejected students and 39 average children from a general sample of 620 students of 23 classrooms from second to fourth grade (7–10 years old). The categories were thus reduced to six: Peer Group Entry, Response to Provocation, Response to Failure, Response to Success, Social Expectations, and Teacher Expectations.

The TOPS is a versatile instrument. Several studies have shown its effectiveness in different areas, for example, the identification of rejection and related situations at school (Nangle et al., 1994). Walker et al. (2002) found that three of the dimensions especially discriminate differences in social competence: Peer Group Entry, Peer Social Expectations, and Response to Provocation, and the last one differentiates intentional and ambiguous situations. The authors also found that girls are more competent in prosociality whereas boys have higher rates of aggressive responses. van Manen (2006) used the TOPS to assess the effectiveness of an intervention to reduce children's aggressive behavior. It has also been used in clinical settings, in studies of children with high levels of prenatal alcohol exposure (Timler, 2000). This author also compared the dimensions of the TOPS in children with and without language disorders, finding in the latter greater difficulties responding to provocation (Timler, 2008). Shah and Morgan (1996) related the TOPS to depressive symptoms in adolescents, reporting high discriminant power. Green et al. (2008) used this taxonomy, among others, to categorize the response to stories concerning the use of prosocial-assertive, passive, and coercive strategies in 6-year-old students.

Other studies have determined the structure factor of the TOPS, proposing short versions. Matthys et al. (2001) obtained a short version of the TOPS from exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) of the original scale in a sample of 652 students from first to sixth grade of elementary school, with appropriate psychometric properties. It consists of 18 items grouped into four oblique factors that explain 71.6% of the variance: Being Disadvantaged (consisting of 6 items from the factors Peer Group Entry and Response to Provocation from the original taxonomy), Coping with Competition (with 4 items from Response to Failure and Response to Success from the original taxonomy), Social Expectations of Peers (4 items), and Teacher Expectations (4 items), which correspond, respectively, to the fifth and sixth factor of the original taxonomy. Boys have more difficulties than girls in all the factors. With regard to the grade, only differences in Being Disadvantaged were found, with a decrease in difficulties as the grade advanced. However, they found no interaction between gender and grade. It must be borne in mind that out of the entire sample, 119 were first graders of elementary school and from all the sociometric status.

The Taxonomy of Problematic Social Situations-Adolescent Self-report Version (TOPS-A; van der Helm et al., 2013) was developed from the data of a sample of 128 young people in secure institutional and correctional youth care. It is made up of 22 items grouped into four factors: Disadvantage (8 items), Competition (5 items), Accepting/giving help (3 items), and Accepting Authority (6 items).

Other authors have developed versions for other age groups. For example, the Preschool Taxonomy of Problem Situations (PTOPS; Blankemeyer et al., 2002) was applied it to a sample of 42 abused preschoolers aged 3–5. It comprises 60 items grouped into eight factors: Peer Group Entry, Response to Provocation, Response to Failure, Response to Success, Social Expectations, Teacher Expectations, Reactive Aggression, and Proactive Aggression.

Summing up, a large part of the studies are promising, although they were conducted with small samples (Nangle et al., 1994; Barn, 2014), with clinical characteristics such as childhood abuse, juvenile delinquency, personality problems, etc. (Blankemeyer et al., 2002; van der Helm et al., 2013), considering the entire stage of elementary school and all the sociometric status (Matthys et al., 2001), or with adolescents suffering chronic rejection, the consequences of which have marked their socio-emotional development.

AIMS OF THE PRESENT STUDY

Considering the above-mentioned issues, the present study aims to identify, in a large sample, social situations that are specifically problematic for peer-rejected students at a crucial moment of their development such as the beginning of their compulsory schooling, as it will not consider situations that may not be very relevant at this age or for other sociometric status. In addition, it is expected that the degree to which these social situations are problematic will be related to inappropriate social behavior, and even antisocial behavior, which would provide an adequate indicator of convergent validity.

Finally, we intend to verify whether the identified model is also applicable to students with average sociometric status, comparing their results with those of the rejected students. Knowing the degree to which rejected students have more problems in social situations than average students, while taking gender into account, can provide valuable information to implement specific actions designed to prevent and reduce peer rejection at early ages.

METHODS

Participants

We started with an initial sample $N = 1457$ students (730 female) and their 62 teachers from 62 first-grade classrooms of urban public schools in four cities of Spain (37% from Castellón, 20% from Palma de Mallorca, 22% from Seville, and 21% from Valladolid). The number of students per classroom ranged between 18 and 27 ($M = 23.5$, $SD = 2.15$). They were between 5 and 7 years of age ($M = 6.41$, $SD = 0.37$), although 98% ($n =$

1430) were of the normative age corresponding to first grade. Of the rest, $n = 26$ children were 1 year older (because they were repeaters) and one child was 1 year younger (due to academic acceleration). The cultural and demographic characteristics of the schools are equivalent, with a similar number of students as in other countries and subcultures. The students from other countries represent 12.3% and mainly come from South America and Eastern Europe.

A sociometric procedure identified peer-rejected students, who represent 12.4% ($n = 181$), ranging from one to five rejected students per classroom ($M = 2.91$, $SD = 0.99$). We eliminated 12 subjects because they presented more than 50% school absenteeism, so their teachers did not have enough data to make an accurate assessment. As a result, the final sample of rejected students was $n_{\text{peerrejected}} = 169$ (109 males). As comparison sample, for each rejected student, we randomly selected a student with average sociometric status, from their same classroom and gender ($n_{\text{average}} = 169$, 109 males).

The present study was conducted in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards, with the approval of the management board of schools, the educational inspection services, the Department of Education of the Regional Government of Valencia (Spain), the Childhood Observatory of the Regional Government of Andalusia (Spain), the Socio-Educational Institute Foundation s'Estel of the Government of the Balearic Islands (Spain); and the Observatory School Coexistence of the Autonomous Government of Castilla y León (Spain). Participation in the study was voluntary. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

Measures

Taxonomy of Problematic Social Situations for Children (TOPS; Dodge et al., 1985)

This is a 44-item Likert scale on which the teachers rate the response that each student displays in different social situations, ranging from 1 (*never poses a problem*) to 5 (*almost always represents a problem*). Items are grouped into six factors with high internal consistency (total $\alpha = 0.98$): (a) Peer Group Entry (5 items, $\alpha = 0.95$), (b) Response to Provocation (10 items, $\alpha = 0.97$), (c) Response to Failure (9 items, $\alpha = 0.95$), (d) Response to Success (3 items, $\alpha = 0.89$), (e) Social Expectations (11 items, $\alpha = 0.94$), and (f) Teacher Expectations (6 items, $\alpha = 0.95$). Like Matthys et al. (2001), we eliminated Item 31 ("when this child is seated at lunch with a group of peers and a teacher is not nearby") because only 25% of the students habitually had lunch at school, and also the teachers were not usually present, so they did not have enough information to assess this item.

Peer Nominations Sociometric Questionnaire

This questionnaire can be applied individually or collectively, and each student chooses classmates, in a prioritized and reasoned fashion, based on two blocks of questions that can be applied together or separately. The first block contains two questions relating to the acceptance and rejection of his or her classmates ("who do you like to be with the most?" and "who do you like to be with the least?"). The second block also contains two questions about their perception of their acceptance and rejection by others ("The classmate/classmates that he/she believes like to be with him/her" and "the classmate/classmates that he/she believes do not like to be with him/her"). Normally, one, three, or unlimited nominations are allowed. The data were analyzed with the Sociomet software (González and García Bacete, 2010), according to an adaptation of the probabilistic procedure by Newcomb and Bukowski (1983). It classifies students into the different groups proposed by Coie et al. (1982): rejected, popular, controversial, neglected, and average.

School Social Behavior Scales (SSBS-2; Merrell, 2002, Translated into Spanish by Salazar and Caballo, 2006)

This scale measures the teaching staff's perception of the students' social behavior in the school environment. It has 64 items rated on a 5-point Likert scale ranging from 1 (*never*) to 5 (*often*), distributed in two scales of 32 items each, and six subscales, with good test-retest reliability, inter-evaluator agreement, high internal consistency, and fit indices in the confirmatory factor analysis (Crowley and Merrell, 2003). The A Scale, Social Competence assesses Peer relations (14 items, $\alpha = 0.97$), Self-management/compliance (10 items, $\alpha = 0.95$), and Academic behavior (8 items, $\alpha = 0.95$). The B Scale, Antisocial Behavior, measures Hostile/irritable behavior (14 items, $\alpha = 0.96$), Antisocial/aggressive (10 items, $\alpha = 0.93$), and Defiant/disruptive (8 items, $\alpha = 0.91$).

Procedure

After reaching agreements with the schools and obtaining the families' authorizations, the sociometric questionnaire was administered to the 1457 students, in the form of individual interviews, carried out by several trained assessors (hired or postgraduate psychology or educational psychology research collaborators). An unlimited number of nominations was allowed, by presenting the classmate's photo, where, in addition to the photo, his/her name or list number appeared. The administration was performed 2 months after start of the school year and it lasted 3 weeks, allowing all the students who regularly attended school to participate. From the acceptance and rejection nominations, analyzed with the Sociomet software, the following sociometric distribution was established: (a) 68.5% ($n = 997$) average students, (b) 13.2% ($n = 192$) popular students, (c) 12.4% ($n = 181$) rejected students, (d) 4.5% ($n = 66$) neglected students, and (e) 1.4% ($n = 21$) controversial students. As commented above, we eliminated 12 cases due to high absenteeism, leaving a total of 169 rejected students (109 males). This distribution is consistent with previous studies that estimate between 10 and 15% of rejected students, and of these, between 65 and 75% are males. Subsequently, an average-status, same-gender student was randomly assigned for each rejected student, with the condition that he/she must be from the same classroom, thereby forming, together with the rejected students, a total sample of 338 students. The teachers were asked to fill in the TOPS and the SSBS-2 with reference to these students, without knowing who were rejected or average students.

Data Analysis

Firstly, we performed EFA to detect the specific internal structure of the profile of rejected students at this age. Previously, we tested the assumption of multivariate normality through Mardia's coefficient, which should not exceed the value of 3 to assume multivariate normality (Mardia, 1970). We applied principal component analysis (unbiased for not fulfilling normality), selecting components with eigenvalues greater than 1, with two rotation methods to ensure a better fit: one based on an orthogonal Varimax model, and another oblique Promin model (Lorenzo-Seva, 1999), based on polychoric correlations, considering the items as ordinal. Calculations were done with the statistical software FACTOR (Lorenzo-Seva and Ferrando, 2013) version 10.1. In addition to calculating the solution from the polychoric correlation matrix, this program also provides data for multivariate goodness of fit.

We eliminated all items with factor loadings under 0.40, items that loaded significantly on more than one factor, and factors that did not have at least three indicators for each latent variable, because fewer indicators lead to identification and convergence difficulties (Lomax, 1982; Bentler and Chou, 1987; Anderson and Gerbing, 1988). We also calculated the internal consistency alpha coefficient, the factor simplicity indexes through Bentler's simplicity index (S, Bentler, 1977) and the loading simplicity index (LS; Lorenzo-Seva, 2003), as well as Cronbach's standardized alpha and the root mean square of residuals (RMSR), using the criterion proposed by Kelley (Kelley, 1935; Harman, 1962).

Next, we tested the structure factor found with CFA, comparing it to three alternative models. As the variables were ordinal and the multivariate normality assumption was not met, we used robust maximum-likelihood estimation (Satorra-Bentler scaled statistics or S-B χ^2, $p > 0.05$), although it is highly conditioned by sample size. Therefore, we complemented it with other indices that assess model fit (Bollen and Long, 1993). Among them, we used the relative chi square index (χ^2/df), whose values should be lower than 2 or 3 (Ullman, 2007; Kline, 2010), although a value lower than 5 can also be considered acceptable (Schumacker and Lomax, 2004); the comparative fit index (CFI > 0.95; Bentler, 1990); the normed fit index (NFI > 0.95; Bentler and Bonett, 1980; Hu and Bentler, 1999); the non-normed fit index (NNFI > 0.90; Hu and Bentler, 1999); the robust root mean-square error of approximation (RMSEA < 0.08; Hu and Bentler, 1999), and the Akaike information criterion (AIC; Akaike, 1974), which is useful to compare models, considering the criterion with the lowest value as the most adequate. We also checked the adequacy of the composite reliability (CR > 0.70), the convergent (average variance extracted, AVE > 0.50) and discriminant validity, using the variance extracted test, which postulates that the AVE of the related factors must be higher than its squared correlation (Fornell and Larcker, 1981; Netemeyer et al., 1990). To estimate convergent validity, we calculated Pearson correlations between the TOPS factors and the six SSBS-2 subscales.

To determine whether the model is also valid for a sample of different psychometric characteristics, we studied the configural, metric, scalar, and factor mean invariance through multigroup analysis (group of rejected and group of average students), with the Satorra-Bentler scaled chi square difference test (Satorra and Bentler, 2001), using the program developed by Crawford and Henry (2003). We adopted the criterion of Cheung and Rensvold (2002), calculated as the difference between the CFI values, and considering that invariance can be accepted if this difference is less than or equal to 0.01 in favor of less restrictive model ($\Delta CFI_{unconstrained} - \Delta CFI_{constrained} \leq 0.01$). These analyses were conducted with the computer program EQS 6.2 (Build 107).

Finally, two-way multivariate analysis of variance (MANOVA) was applied to determine possible differences in sociometric status and gender. Partial eta-squared effect sizes are presented: $0.01 < \eta_p^2 < 0.05$ is considered a small effect, $0.06 < \eta_p^2 < 0.13$ is considered a medium effect, and $\eta_p^2 > 0.14$ is considered a large effect (Cohen, 1988). Inter-subject effects were analyzed in order to determine which variables were significantly different. For paired comparisons, the *t*-test for two independent groups was used, including Cohen's *d* effect size (Cohen, 1988), considering: $d = 0.20$ small, $d = 0.50$ medium, and $d = 0.80$ large effect size. For this purpose, we used the statistical package IBM SPSS Statistics, version 22 (2013). All statistical analyses used a 95% confidence level.

RESULTS

Exploratory Factor Analysis (EFA)

Mardia's coefficient was 18.81, so the assumption of normal multivariate is violated, which is to be expected when working with categorical variables even if they are considered ordinal. However, the skewness or kurtosis values were within normal parameters, as none of the items presented values higher than 2 or 7, respectively (West et al., 1995), as shown in **Table 1**. The item to item correlations were low to high, ranging from 0.14 to 0.86. Were found only four correlations above a 0.70 level.

The data were suitable for using EFA, as indicated by the of Kaiser-Meyer-Olkin index (KMO = 0.89) and Bartlett's sphericity test, $\chi^2_{(136)} = 1880.80$, $p = < 0.001$. The best rotated solution was produced with the Promin method, with four related factors, explaining 73.71% of the variance, with high values in the item factor loadings (see **Table 2**). Specifically, we obtained (see Spanish items in Appendix): (a) Being Disadvantaged, consisting of 6 items that explain 43.18% of the variance, with internal consistency of $\alpha = 0.91$. This factor refers to situations in which the child gets damage from their peers (e.g., "when peers call this child a bad name"); (b) Respect for Authority and Rules, with 3 items, explaining 14.51% of the variance, and $\alpha = 0.87$ (e.g., "when this child is standing in line with peers and must wait a long time"); (c) Response to Own Success, also with 3 items, explaining 8.95%, and $\alpha = 0.88$ (e.g., "when this child has won a game against a peer"); and (d) Prosocial and Empathic Behavior with 5 items, explaining 7.07% of the variance, and $\alpha = 0.83$ (e.g., "when a peer is troubled, worried or upset and needs comfort from this child").

The factor simplicity indices, as well as the overall reliability and fit indices of the model are very high: $S = 0.9811$ (P_{100}) and

TABLE 1 | Polychoric Correlation Matrix and Descriptive Statistics of the Social Situations ($n = 169$).

Social Situations	3	6	12	14	16	17	19	24	27	28	30	33	36	37	38	39	43
CORRELATIONS																	
3. The student has won a game	—																
6. They insult the student	0.21	—															
12. The student plays a game better	0.68	0.17	—														
14. The student does a better task	0.68	0.17	0.82	—													
16. They do not return the student's belongings	0.20	0.61	0.19	0.16	—												
17. They exclude the student from a game	0.40	0.52	0.34	0.33	0.52	—											
19. They accidentally break the student's toy	0.28	0.67	0.21	0.28	0.69	0.59	—										
24. They provoke the student accidentally	0.29	0.72	0.22	0.22	0.64	0.60	0.67	—									
27. The teacher speaks to the whole class	0.40	0.46	0.34	0.32	0.47	0.34	0.45	0.49	—								
28. The student is in the row	0.34	0.54	0.33	0.32	0.50	0.44	0.49	0.61	0.67	—							
30. In class without the teacher	0.33	0.31	0.39	0.32	0.28	0.23	0.21	0.35	0.57	0.60	—						
33. Others are interested in the student	0.29	0.27	0.27	0.31	0.30	0.14	0.32	0.33	0.33	0.32	0.26	—					
36. They show their anger at the student	0.39	0.54	0.29	0.29	0.59	0.61	0.29	0.63	0.43	0.50	0.21	0.31	—				
37. They expect the student's praise	0.44	0.30	0.50	0.51	0.31	0.32	0.39	0.39	0.38	0.36	0.21	0.46	0.46	—			
38. They expect the student's comfort	0.38	0.23	0.48	0.42	0.32	0.24	0.37	0.32	0.36	0.31	0.18	0.46	0.44	0.86	—		
39. They expect the student's thanks	0.37	0.17	0.43	0.40	0.25	0.19	0.30	0.25	0.29	0.28	0.22	0.47	0.34	0.70	0.79	—	
43. The student must ask for help	0.30	0.26	0.40	0.34	0.31	0.20	0.25	0.26	0.41	0.31	0.25	0.56	0.32	0.58	0.57	0.57	—
DESCRIPTIVE STATISTICS																	
M	1.97	3.49	1.82	1.70	3.30	3.08	3.12	3.09	2.73	2.96	2.46	2.05	2.93	2.14	2.13	2.14	2.33
SD	0.94	1.13	0.91	0.86	1.13	1.05	1.17	1.16	1.28	1.23	1.29	0.91	1.13	0.99	1.00	1.05	1.02
Skewness	0.88	−0.24	1.13	1.31	−0.04	0.02	0.01	−0.06	0.30	0.13	0.60	0.86	0.13	0.60	0.88	0.87	0.55
Kurtosis	0.39	−0.77	1.09	1.72	−0.83	−0.72	−0.81	−0.78	−0.85	−0.90	−0.63	0.59	−0.77	−0.30	0.49	0.43	−0.30

$LS = 0.4853$ (P_{100}); standardized Cronbach's $\alpha = 0.92$; and RMSR $= 0.0459$ (Kelly's criterion < 0.0772).

Confirmatory Factor Analysis (CFA)

The indices showed an excellent fit, S-B $\chi^2_{(113)} = 132.41$, $p = 0.101$; S-B $\chi^2/df = 1.17$, CFI $= 0.99$, NFI $= 0.97$, NNFI $= 0.99$, RMSEA $= 0.032$, 90% CI [0.000, 0.052]. The *Lagrange multipliers contrast* and the Wald test did not indicate significant improvements, so it was not necessary to respecify. The composite reliability was high (0.92) and both composite reliability ($CR_{F1} = 0.91$, $CR_{F2} = 0.84$, $CR_{F3} = 0.89$, $CR_{F4} = 0.89$) and average variance extracted ($AVE_{F1} = 0.648$, $AVE_{F2} = 0.643$, $AVE_{F3} = 0.730$, $AVE_{F4} = 0.636$) exceeded the criterion values to be considered appropriate. Discriminant validity was good, as in all cases the extracted variance test was exceeded (**Table 3**).

Given that there was a significant reduction of items and sample specificity, we compared the fit of the previous model with other alternatives: (a) four orthogonal (independent) factors; (b) a hierarchical model in which the four factors are explained by a second-order factor; and (c) a univariate model in which all the items explain a single factor. The fit indices of the four models are shown in **Table 4**. It can be observed that the fit was not satisfactory in any of the three proposed alternative models, which also presented a higher AIC index.

Convergent Validity

To estimate convergent validity, we correlated the problematic situations factors with the social competence or antisocial behavior displayed in the school setting as measured by the SSBS-2 of Merrell (2002). These data are shown in **Table 5**. All the correlations were significant, although with a different sign and degree. Initially, the most notable correlations were the high positive correlation between Being Disadvantaged and Antisocial Behavior, and the negative correlation between Being Disadvantaged and Self-management/Compliance. Respect for Authority and Rules

TABLE 2 | Summary of Exploratory and Confirmatory Factor Analysis Results for Social Situations ($n = 169$).

Social Situations	Factor loadings for EFA					Factor loadings for CFA			
	F_1	F_2	F_3	F_4	h^2	F_1 St. Est. (R^2)	F_2 St. Est. (R^2)	F_3 St. Est. (R^2)	F_4 St. Est. (R^2)
F_1: BEING DISADVANTAGED									
6. They insult the student	**0.78**	0.18	−0.18	−0.03	0.70	0.80 (0.65)	–	–	–
16. They do not return the student's belongings	**0.77**	0.09	−0.22	0.11	0.69	0.82 (0.68)	–	–	–
17. They exclude the student from a game	**0.88**	−0.13	0.31	−0.27	0.71	0.71 (0.51)	–	–	–
19. They accidentally break the student's toy	**0.88**	0.07	−0.08	0.08	0.74	0.84 (0.71)	–	–	–
24. They provoke the student accidentally	**0.80**	0.16	−0.11	0.01	0.76	0.86 (0.75)	–	–	–
36. They show their anger at the student	**0.79**	−0.12	0.06	0.12	0.69	0.77 (0.60)	–	–	–
F_2: RESPECT FOR AUTHORITY AND THE RULES									
27. The teacher speaks to the whole class	0.11	**0.72**	0.02	0.12	0.71	–	0.80 (0.64)	–	–
28. The student is in the row	0.28	**0.68**	0.01	−0.01	0.75	–	0.90 (0.81)	–	–
30. In class without the teacher	−0.21	**0.96**	0.16	−0.08	0.79	–	0.69 (0.48)	–	–
F_3: RESPONSE TO OWN SUCCESS									
3. The student has won a game	0.13	0.12	**0.82**	−0.11	0.74	–	–	0.75 (0.56)	–
12. The student plays a game better	−0.04	0.15	**0.87**	0.01	0.84	–	–	0.93 (0.86)	–
14. The student does a better task	0.02	0.09	**0.88**	−0.02	0.82	–	–	0.88 (0.78)	–
F_4: PROSOCIAL AND EMPATHIC BEHAVIOR									
33. Others are interested in the student	−0.08	0.24	−0.16	**0.72**	0.54	–	–	–	0.57 (0.33)
37. They expect the student's praise	0.15	−0.14	0.18	**0.76**	0.80	–	–	–	0.87 (0.75)
38. They expect the student's comfort	0.08	−0.17	0.09	**0.88**	0.83	–	–	–	0.93 (0.86)
39. They expect the student's thanks	−0.06	−0.09	0.07	**0.88**	0.76	–	–	–	0.87 (0.75)
43. The student must ask for help	−0.12	0.17	−0.07	**0.81**	0.65	–	–	–	0.70 (0.49)

St. Est., Standardized Estimations. EFA factor loadings over 0.40 appear in bold.

TABLE 3 | Composite reliability indices, variance extracted indices, and correlations between the factors of the rejected students.

Factor	CR	AVE	r (r^2)		
			F_1	F_2	F_3
F_1: Being Disadvantaged	0.91	0.648			
F_2: Respect for Authority and the Rules	0.84	0.643	0.73 (0.53)		
F_3: Response to Own Success	0.89	0.730	0.31 (0.01)	0.42 (0.18)	
F_4: Prosocial and Empathic Behavior	0.89	0.636	0.46 (0.21)	0.43 (0.19)	0.57 (0.33)

CR, Composite Reliability; AVE, Average Variance Extracted.

had a high positive correlation with Antisocial Behavior and a high negative correlation with Self-management/Compliance. Response to Own Success had the lowest, albeit significant, negative correlation with Social Competence, and a positive correlation with Antisocial Behavior.

Invariance Analysis between Rejected and Average Students

Firstly, the fit indices of the model applied to the sample of students with average sociometric status were verified. These fit indices were adequate, similar to those obtained with the rejected students, S-B $\chi^2_{(113)} = 127.82$, $p = 0.161$; S-B $\chi^2/df = 1.13$, CFI = 0.99, NFI = 0.97, NNFI = 0.99, RMSEA = 0.028, 90% CI [0.000, 0.050]. The composite reliability and AVE presented adequate values (see **Table 6**), as did discriminant validity.

We subsequently analyzed the factorial invariance, conducting a multigroup analysis without any restrictions (see **Table 7**). The configural model will serve as a baseline for the comparison with the nested models on which successive restrictions will be imposed. The fit indices of this model were also acceptable. If we restrict the factor loadings of the items of this model (weak invariance), we obtain acceptable data. The difference between the CFI values of the models was acceptable (ΔCFI = 0.00) and the Satorra-Bentler scaled difference test was nonsignificant, $\chi^2_{(13)} = 16.11$, $p = 0.243$, showing that metric invariance was fulfilled. The following nested model adds to the former models the restriction of the intercepts, in order to determine possible scalar invariance. The result was not satisfactory. The *Lagrange multipliers contrast* suggested freeing the equality restrictions of the intercepts of Items 3, 14, and 38. In this corrected model, the difference between the models of the CFI value was acceptable (ΔCFI = −0.01) and the Satorra-Bentler scaled difference test was nonsignificant, $\chi^2_{(19)} = 26.66$, $p = 0.113$), showing that partial strong variance is met. We subsequently determined possible differences in the means of the latent factors. In this case, we expected that the invariance assumption would not be met, given that, theoretically, the two groups should obtain different outcomes, as, in fact, occurred. The fit indices of this model were not satisfactory. The difference in the CFI value far exceeded the

TABLE 4 | Goodness-of-fit indexes of the four possible models.

Model	S-B χ^2	*df*	S-B χ^2/df	CFI	NFI	NNFI	RMSEA, 90% [CI]	AIC
Four oblique factors	132.41	133	1.17	0.99	0.97	0.99	0.032, [0.000, 0.052]	−93.54
Four orthogonal factors	276.05***	119	2.32	0.96	0.93	0.96	0.089, [0.075, 0.102]	38.05
Hierarchical model	1197.09***	115	10.41	0.84	0.82	0.82	0.182, [0.169, 0.193]	967.08
Unifactorial model	1063.28***	119	8.93	0.77	0.75	0.74	0.217, [0.205, 0.229]	825.28

S-B χ^2, Satorra-Bentler Scaled Statistics; CFI, Comparative Fit Index; NFI, Normed Fit Index; NNFI, Non-Normed Fit Index; RMSEA, Root Mean-Square Error of Approximation; CI, Confidence Interval; AIC, Akaike Information Criterion.
$^{***}p < 0.001$.

TABLE 5 | Correlations between the problematic situations factors and the SSBS-2 ($n = 169$).

Measure	PR	S-M/C	AB	H/I	A/A	D/D
Being Disadvantaged	−0.33***	−0.59***	−0.35***	0.69***	0.66***	0.71***
Respect for Authority and Rules	−0.40***	−0.67***	−0.44***	0.58***	0.61***	0.74***
Response to Own Success	−0.26***	−0.36***	−0.23***	0.47***	0.46***	0.43***
Prosocial and Empathic Behavior	−0.40***	−0.43***	−0.34***	0.48***	0.48***	0.51***

PR, Peer Relations; S-M/C, Self-Management/Compliance; AB, Academic Behavior; H/I, Hostile/Irritable; A/A, Antisocial/Aggressive; D/D, Defiant/Disruptive.
$^{***}p < 0.001$.

TABLE 6 | Composite reliability indices, extracted variance indices, and correlations between the factors of average students.

Factor	CR	AVE	r (r^2)		
			F_1	F_2	F_3
F_1: Being Disadvantaged	0.90	0.608			
F_2: Respect for Authority and the Rules	0.79	0.560	0.37 (0.13)		
F_3: Response to Own Success	0.79	0.546	0.21 (0.05)	0.27 (0.07)	
F_4: Prosocial and Empathic Behavior	0.88	0.594	0.28 (0.08)	0.30 (0.09)	0.30 (0.09)

CR, Composite Reliability; AVE, Average Variance Extracted.

criterion value, $\Delta CFI = -0.25$, and the Satorra-Bentler scaled difference test was significant, $\chi^2_{(23)} = 85.56$, $p = < 0.001$. As a result, equality of means of the latent factors could not be assumed.

Differences between Rejected and Average Students

After confirming the problematic social situations for rejected students, and finding that the model was also explanatory for average students, we determined whether these rejected students' difficulties were greater than those of the control sample made up of students with average sociometric status, and also whether these results were modulated by gender.

Because equality of covariances was not met, Box's $M = 94.7$, $F_{(30,\ 178301)} = 3.08$, $p = < 0.001$, we used Pillai's trace, as it is the most robust statistic in small samples or when the assumption of covariance homogeneity is violated (Hair et al., 2009; Tabachnick and Fidell, 2013). The multivariate test only revealed differences in the main effects as a function of sociometric status, Pillai's Trace = 0.20, $F_{(4,\ 331)} = 20.69$, $p = < 0.001$, with a large effect size, $\eta_p^2 = 0.20$. However, there were no differences as a function of gender, Pillai's Trace = 0.02, $F_{(4,\ 331)} = 1.88$, $p = 0.488$, $\eta_p^2 = 0.02$; or in the interaction, Pillai's Trace = 0.01, $F_{(4,\ 331)} = 1.13$, $p = 0.260$, $\eta_p^2 = 0.01$.

The inter-subject effects analysis revealed that rejected students' scores were higher than those of average students in all the factors (see **Table 8**). In the factor Respect for Authority and Rules, the size effect was high. Moderate effects were found in the factors Being Disadvantaged and Prosocial and Empathic Behavior. Finally, the effect size of the factor Response to Own Success was small.

In the case of Prosocial and Empathic Behavior, the Sociometric status × Gender interaction was also significant. In the average group, no differences were found between males ($M = 8.26$, $SD = 3.05$) and females ($M = 8.61$, $SD = 2.86$); $t_{(167)} = -0.74$, $p = 0.462$. However, in the rejected group, males ($M = 11.26$, $SD = 4.19$) had more difficulties than females ($M = 9.97$, $SD = 3.68$); $t_{(167)} = 2.00$, $p = 0.047$, in Prosocial and Empathic Behavior but with a small effect size, $d = 0.32$.

DISCUSSION

This work aimed to identify the most relevant problematic social situations for rejected students who had just begun elementary school, through the use of the Taxonomy of Problematic Social Situations for Children (TOPS). We found that these situations are related to Being Disadvantaged, Respect for Authority and Rules, Response to their Own Success, and Prosocial and Empathic Behaviors. Rejected children present more difficulties in these situations than their peers—both boys and girls—of average sociometric status. However, within the group of rejected students, boys have more difficulties in Prosocial and Empathic Behavior.

The structural model found for rejected first-grade students presents appropriate fit indices. It is also invariant in the average sample. Our initial hypothesis of a specific structure than that of the original taxonomy was confirmed, like the findings of

TABLE 7 | Model summary for multi-group test of measurement invariance.

Model	S-B χ^2	*df*	S-B χ^2/df	CFI	NFI	NNFI	RMSEA, 90% [CI]
Configural	270.54*	226	1.20	0.99	0.97	0.99	0.034, [0.014, 0.049]
Full metric	286.94*	239	1.20	0.99	0.97	0.99	0.035, [0.015, 0.048]
Full scalar	386.50***	248	1.56	0.80	0.62	0.76	0.059, [0.048, 0.070]
Partial Scalar[a]	316.91***	245	1.29	0.98	0.92	0.98	0.045, [0.029, 0.058]
Means of the latent factors	520.78***	249	2.09	0.74	0.58	0.69	0.078, [0.068, 0.087]

S-B χ^2, Satorra-Bentler Scaled Statistics; CFI, Comparative Fit Index; NFI, Normed Fit Index; NNFI, Non-Normed Fit Index; RMSEA, Root Mean-Square Error of Approximation; CI, Confidence Interval.

[a]Item intercepts for items 3, 14, and 38 were not constrained.

**$p < 0.05$, ***$p < 0.001$.*

TABLE 8 | Group differences for factor scores between rejected or average sociometric status.

	Rejected[a]		Average[b]		$t_{(336)}$	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*			
Being disadvantaged	19.02	5.68	14.73	5.15	7.28	<0.001	0.79
Respect for authority and the rules	8.16	3.27	5.24	2.36	9.38	<0.001	1.02
Response to own success	5.49	2.44	4.46	1.87	4.34	<0.001	0.47
Prosocial and empathic behavior	10.80	4.05	8.38	2.98	7.28	<0.001	0.79

[a]n = 169. [b]n = 169.

Matthys et al. (2001) and van der Helm et al. (2013), with whom we coincide in the four-factor structure, but not in some of the typologies and specific behaviors, as we focused on the beginning of compulsory education. Likewise, they consider other situations that, due to the developmental stage, may not be relevant.

The factor that explained the most variance, Being Disadvantaged, corresponds to social situations included in the factors of Peer Group Entry and Response to Provocation from the original taxonomy. In our case, however, in Being Disadvantaged, only the situation in which the student is insulted emerged, but we considered all the intentional and ambiguous provocations, in contrast to Matthys et al. (2001) in Being Disadvantaged or van der Helm et al. (2013) in Disadvantage, where manifest disadvantages were observed, but fewer ambiguous provocations. It must be taken into account that these ages, direct physical aggression is not an isolated behavior although it is highly censored. It may therefore be considered nonproblematic or not exclusive to rejected students, because it is the result of immature behavior, when children are still learning control through self-regulation. This is especially true if the aggression is instrumental. However, this would not occur at later ages where children are expected to have adequate ability to assess the situation and exert the necessary self-control to deal with it in a socially adaptive way. Similarly, problems with provocation, especially ambiguous provocation, are a consequence of rejected students' difficulties to interpret the social signals and characteristics of the context (Dodge et al., 2003; Dirks et al., 2007; Lansford et al., 2010; Asher et al., 2012) and decide whether a provocation is accidental or deliberate.

A second factor we found is the Response to authority and rules, which includes situations relevant to the factor Teacher expectations of the original taxonomy, but only those that specifically involve following rules, both in the presence and absence of the teacher, which coincides with the factor that van der Helm et al. (2013) called Accepting authority. However, unlike the findings of Matthys et al. (2001), being alone on the playground does not discriminate, but being alone in the classroom does. We note that, at these ages, adult supervision and participation in recess is much more intense, and adults tend to be less strict about following rules, as the main goal is for the children to have fun and rest from academic duties. However, in later courses, students are allowed more autonomy to establish and maintain social relations, and they are required to follow the rules, many of which should be internalized. But when they are alone in class, even though this occurs only sporadically and for short periods, it is a prototypical and discriminant situation of rule-following, much clearer than on the playground.

The third factor found, Response to Own Success, coincides with the proposal of Dodge, Response to success. Rejected students have difficulties to identify and regulate emotions, displaying socially maladaptive emotional reactions. No item was considered for the factor of Response to failure. At this age, when competing, many children respond differently from older children. In this sense, other children's success may not necessarily be considered as one's failure, as competitive situations are more diluted than in higher grades, because teachers try to provide all the children with many successful experiences. Other authors grouped these aspects into a single general factor, albeit reduced, related to how children deal with competitive situations, like Coping with Competition (Matthys et al., 2001) or Competition (van der Helm et al., 2013).

The fourth and last factor, Prosocial and Empathic Behavior, slightly corresponds to Social expectations of the original taxonomy. It is similar to Peer expectations (Matthys et al., 2001) and coincides more with that of Accepting/giving help (van der Helm et al., 2013). These results confirm that rejected students have trouble understanding the feelings of others and performing helping behaviors (Bierman, 2004; Bierman et al., 2014), which is very important, as it is one of the characteristics most highly related to social preference (Torrente et al., 2014).

The intensity of rejected students' difficulties in social situations that imply Being Disadvantaged and Respect for Authority and Rules was positively correlated with Antisocial Behavior, especially Hostile, Aggressive, and Disruptive behavior (White and Kistner, 2011). In these social situations, the relation with desirable social competence, such as Self-management/Compliance, is negative. Rose and Asher (2004) noted the importance of paying attention to children's responses to tasks of offering and requesting help.

The lowest, albeit significant, global correlation was between problematic social situations and academic behavior. These results suggest a direct relation between behavioral difficulties and rejection (Bierman, 2004). However, the relation between such difficulties and academic effectiveness is lower at this age, because students are involved in basic learnings, which depend less on effort and dedication than in higher grades.

As mentioned, the structural model obtained in the sample of rejected and average students is invariant except for the means of the latent factors. Consequently, the two groups differ in the intensity of problematic social situations. In fact, all four types of social situations are significantly more problematic for rejected students. Respect for Authority and Rules, followed by Being Disadvantaged—a factor partly made up of items in Response to Provocation—are the most problematic. Like Parker and Asher (1987) and Dodge et al. (1985) agreed that these types of situations were the most difficult for children to master, in particular, for aggressive and rejected children. Next are Prosocial and Empathic Behavior, and lastly, responding to their own success. Rubin and Hubbard (2002) found that rejected children were more likely both to chat and to brag in a game situation.

In terms of gender, within the group of rejected children, rejected boys had more trouble with Prosocial and Empathic Behavior than girls, but not in the other situations. The differences between boys and girls are not caused by the rejection (van Lier et al., 2005) but by manifestation of aggressive and antisocial behavior, more frequent in boys than in girls (Dodge et al., 2003). However, there were no gender differences in the average group.

CONCLUSIONS, LIMITATIONS AND FUTURE DIRECTIONS

The study of students' problematic social situations at school opens up many possibilities. Firstly, it can help us to understand the variables involved in social situations at ages that have received little attention with regard to peer rejection. Secondly, because specifically knowing which situations are difficult for rejected students, and differentiating them from those of the average students provides specific intervention guidelines. Hence, interventions would not focus on situations with little discriminant power that could be considered normal for the developmental stage, but on those that differentiate rejected from average students.

In this sense, it is necessary to work on improving students' self-knowledge and self-control, which would give them the skills to follow rules and respect authority. This has a big impact on the formation of their social reputation. We should also enhance emotion identification and regulation to facilitate students' recognizing and emitting the appropriate response to different situations, especially situations involving their own success or intentional and ambiguous provocations. We should not neglect training in empathy, assertiveness, and prosociality, as they are key skills to know how to respond to situations involving disadvantage, how to ask for help but also to offer help adequately, and how to interpret social signals and the characteristics of the situation.

We would have liked to determine whether the model was invariant between boys and girls. However, although the phenomenon of peer rejection has a significant adverse effect on the social development, it must be taken into account that the percentage of identified rejected students per classroom is around 12%. Of them, only 25% are girls. The same thing occurs with the students from other countries or subcultures. This would imply the need to considerably increase the initial sample size and given that, at these ages, data collection is done through individual interviews, it would be very difficult to gather sufficient data.

Finally, it is essential to design and assess intervention proposals to prevent and reduce peer rejection at early ages, contextualized in concrete situations in which rejected students have difficulties. This is important because rejection is not yet chronic at these ages, as the social groups are constantly changing, and the students are learning many of the social skills that can make them resilient to frustration concerning their peers.

AUTHOR CONTRIBUTIONS

LM: Designed the study, performed the analysis and interpretation of the data, performed the measurement, and draft the manuscript. MM: Contributed to the study design, performed the measurement and participated in drafting the manuscript. FG: Led the study, coordinated data collection, performed the measurement and helped to draft the manuscript. IJ: Contributed to the study design, performed the measurement and helped to draft the manuscript. All authors approved the final manuscript as submitted.

ACKNOWLEDGMENTS

This work was supported by grant EDU2012-35930 from the Spanish Ministry of Economy and Competitiveness and grant P1-1A2012-04 from the Jaume I University. We thank all the students, teachers, and families for their participation.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg.2016.01925/full#supplementary-material

REFERENCES

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Trans. Automatic Control* 19, 716–723. doi: 10.1109/TAC.1974.1100705

Anderson, J. C., and Gerbing, D. W. (1988). Structural equation modelling in practice: a review and recommended two-step approach. *Psychol. Bull.* 103, 411–423. doi: 10.1037/0033-2909.103.3.411

Asher, S. R., MacEvoy, J. P., and McDonald, K. L. (2012). "Children's peer relations, social competence, and school adjustment: a social tasks and social goals perspective," in *Advances in Motivation and Achievement, Vol. 15: Social Psychological Perspectives,* eds M. L. Maehr, S. Karabenick, and T. Urdan (Bingley: Emerald), 357–390.

Asher, S. R., and McDonald, K. L. (2009). "The behavioral basis of acceptance, rejection, and perceived popularity," in *Handbook of Peer Interactions, Relationships, and Groups,* eds K. H. Rubin, W. M. Bukowski, and B. Laursen (New York, NY: Guilford), 232–248.

Baker, J. A. (2006). Contributions of teacher-child relationships to positive school adjustment during elementary school. *J. Sch. Psychol.* 44, 211–229. doi: 10.1016/j.jsp.2006.02.002

Barn, J. K. (2014). *Acculturation Preferences of Primary School Children of Muslim Faith from Different Arab Ethnicities: An Exploratory Study*. Doctoral thesis, School of Psychology, Cardiff University, Cardiff, Wales. Available online at: http://orca.cf.ac.uk/69290/1/Thesis%20DEdPsy%20-%20Final%20Version%20January%202015%20-%20Jagdish%20Barn%20.pdf

Bentler, P. M. (1977). Factor simplicity index and transformations. *Psychometrika* 42, 277–295. doi: 10.1007/BF02294054

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychol. Bull.* 107, 238–246. doi: 10.1037/0033-2909.107.2.238

Bentler, P. M., and Bonett, D. G. (1980). Significance test and goodness-of-fit in the analysis of covariance structures. *Psychol. Bull.* 88, 588–600. doi: 10.1037/0033-2909.88.3.588

Bentler, P. M., and Chou, C. (1987). Practical issues in structural modeling. *Sociol. Methods Res.* 16, 78–117. doi: 10.1177/0049124187016001004

Bierman, K. L. (2004). *Peer Rejection. Developmental, Processes and Intervention Strategies*. New York, NY: The Guilford Press.

Bierman, K. L., Kalvin, C. B., and Heinrichs, B. S. (2014). Early childhood precursors and adolescent sequelae of grade school peer rejection and victimization. *J. Clin. Child Adolesc. Psychol.* 44, 367–379. doi: 10.1080/15374416.2013.873983

Birch, S. H., and Ladd, G. W. (1997). The teacher-child relationship and children's early school adjustment. *J. Sch. Psychol.* 35, 61–79. doi: 10.1016/S0022-4405(96)00029-5

Blankemeyer, M., Culp, R. E., Hubbs-Tait, L., and McDonald Culp, A. (2002). A tool for identifying preschoolers' deficits in social competence: the preschool taxonomy of problem situations. *Educ. Treat. Child.* 25, 208–223. Available online at: http://www.jstor.org/stable/42900527

Bollen, K. A., and Long, J. S. (1993). *Testing Structural Equation Models*. Newbury Park, CA: Sage.

Bush, S., Rudasill, K. M., Kalutskaya, I. N., and Griese, E. R. (2015). Shyness and engagement: contributions of peer rejection and teacher sensitivity. *Early Child. Res. Q.* 30, 12–19. doi: 10.1016/j.ecresq.2014.07.010

Cadima, J., Leal, T., and Burchinal, M. (2010). The quality of teacher-student interactions: associations with first graders' academic and behavioral outcomes. *J. Sch. Psychol.* 48, 457–482. doi: 10.1016/j.jsp.2010.09.001

Cheung, G. W., and Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Struct. Equ. Model.* 9, 233–255. doi: 10.1207/S15328007SEM0902_5

Cillessen, A. H. N. (2009). "Sociometric methods," in *Handbook of Peer Interactions, Relationships, and Groups,* eds K. H. Rubin, W. M. Bukowski and B. Laursen (New York, NY: Guilford), 82–99.

Cillessen, A. H. N., Bukowski, W. M., and Haselager, G. J. T. (2000). "Stability of sociometric categories," in *Recent Advances in the Measurement of Acceptance and Rejection in the Peer System,* eds A. H. N. Cillessen and W. M. Bukowski (San Francisco, CA: Jossey-Bass Inc.), 75–93.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: LEA.

Coie, J. D. (1990). "Toward a theory of peer rejection," in *Peer Rejection in Childhood,* eds S. R. Asher and J. D. Coie (New York, NY: Cambridge University Press), 365–401.

Coie, J. D., and Dodge, K. A. (1983). Continuities and changes in children's social status: a five-year longitudinal study. *Merrill Palmer Q.* 29, 261–282.

Coie, J. D., Dodge, K. A., and Coppotelli, H. (1982). Dimensions and types of social status: a cross-age perspective. *Dev. Psychol.* 18, 557–570. doi: 10.1037/0012-1649.18.4.557

Comellas, M. J. (2013). El clima cotidiano en el aula. Contexto relacional de socialización [The daily climate in the classroom. Relational context of socialization]. *EJIHPE* 3, 289–300. doi: 10.1989/ejihpe.v3i3.51

Crawford, J. R., and Henry, J. D. (2003). The Depression Anxiety Stress Scales (DASS): normative data and latent structure in a large non-clinical sample. *Br. J. Clin. Psychol.* 42, 111–131. doi: 10.1348/014466503321903544

Crowley, S. L., and Merrell, K. W. (2003). The structure of the school social behavior scales: a confirmatory factor analysis. *Assess. Eff. Interv.* 28, 41–55. doi: 10.1177/073724770302800205

Dirks, M. A., Treat, T. A., and Weersing, V. R. (2007). The situation specificity of youth responses to peer provocation. *J. Clin. Child Adolesc. Psychol.* 36, 621–628. doi: 10.1080/15374410701662758

Dodge, K. A., Lansford, J. E., Burks, V. S., Bates, J. E., Pettit, G. S., Fontaine, R., et al. (2003). Peer rejection and social information processing factors in the development of aggressive behavior problems in children. *Child Dev.* 74, 374–393. doi: 10.1111/1467-8624.7402004

Dodge, K. A., McClaskey, C., and Feldman, E. (1985). Situational approach to the assessment of social competence in children. *J. Consult. Clin. Psychol.* 53, 344–353. doi: 10.1037/0022-006X.53.3.344

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., and Schellinger, K. (2011). The impact of enhancing students' social and emotional learning: a meta-analysis of school-based universal interventions. *Child Dev.* 82, 405–432. doi: 10.1111/j.1467-8624.2010.01564.x

Fornell, C., and Larcker, D. F. (1981). Evaluating structural equations models with unobservable variables and measurement error. *J. Mark. Res.* 18, 39–50. doi: 10.2307/3151312

Fraire, M., Longobardi, C., Prino, L. E., Sclavo, E., and Settanni, M. (2013). Examining the student-teacher relationship scale in the Italian context: a factorial validity study. *Electron. J. Res. Educ. Psychol.* 11, 649–664. doi: 10.14204/ejrep.31.13064

Gallagher, B. (2005). New technology: helping or harming children. *Child Abuse Rev.* 14, 367–373. doi: 10.1002/car.923

García Bacete, F. J., Ferrà, P., Monjas, M. I., and Marande, G. (2014). Teacher-students relationships in first and second grade classrooms. Adaptation of the questionnaire on teacher interaction-early primary (QTI-EP). *Rev. Psicodidac.* 19, 211–231. doi: 10.1387/RevPsicodidact.9081

García Bacete, F. J., and González Álvarez, J. (2010). *Evaluación de la Competencia Social Entre Iguales: La Sociometría y Otras Medidas [Assessment of the Peer Social Competence: the Sociometry and Other Measures]*. Madrid: TEA Ediciones.

García Bacete, F. J., Sureda, I., and Monjas, I. (2008). Sociometric distribution of boys and girls during all the schooling period. *Rev. Psicol. Soc.* 23, 63–74. doi: 10.1174/021347408783399480

Gifford-Smith, M. E., and Brownell, C. A. (2003). Childhood peer relationships: social acceptance, friendships, and peer networks. *J. Sch. Psychol.* 41, 235–284. doi: 10.1016/S0022-4405(03)00048-7

González, J., and García Bacete, F. J. (2010). *Sociomet. Programa para la Realización de Estudios Sociométricos [Sociomet, a Program for Conducting Sociometric Studies]*. Madrid: TEA Ediciones.

Green, V. A., Cillessen, A. H., Rechis, R., Patterson, M. M., and Hughes, J. M. (2008). Social problem solving and strategy use in young children. *J. Genet. Psychol.* 169, 92–112. doi: 10.3200/GNTP.169.1.92-112

Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2009). *Multivariate Data Analysis, 7th Edn.* Upper Saddle River, NJ: Prentice Hall.

Hamre, B. K., and Pianta, R. C. (2005). Can instructional and emotional support in the first-grade classroom make a difference for children at risk of school failure? *Child Dev.* 76, 949–967. doi: 10.1111/j.1467-8624.2005.00889.x

Harman, H. H. (1962). *Modern Factor Analysis, 2nd Edn*. Chicago, IL: University of Chicago Press.

Hartup, W. W. (1989). Social relationships and their developmental significance. *Am. Psychol.* 44, 120–126. doi: 10.1037/0003-066X.44.2.120

Hay, D. F., Caplan, M., and Nash, A. (2009). "The beginnings of peer relations," in *Handbook of Peer Interactions, Relationships and Groups,* eds K. H. Rubin, W. M. Bukowski, and B. Laursen (New York, NY: Guilford), 121–142.

Hu, L. T., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ. Model.* 6, 1–55. doi: 10.1080/10705519909540118

Jiang, X. L., and Cillessen, A. H. N. (2005). Stability of continous measures of sociometric status: a meta-analysis. *Dev. Rev.* 25, 1–25. doi: 10.1016/j.dr.2004.08.008

Kelley, T. L. (1935). *Essential Traits of Mental Life*. Cambridge, MA: Harvard University Press.

Kiuru, N., Poikkeus, A. M., Lerkkanen, M. K., Pakarinen, E., Siekkinen, M., Ahonen, T., et al. (2012). Teacher-perceived supportive classroom climate protects against detrimental impact of reading disability risk on peer rejection. *Learn. Instr.* 22, 331–339. doi: 10.1016/j.learninstruc.2011.12.003

Kline, R. B. (2010). *Principles and Practice of Structural Equation Modeling, 3rd Edn.* New York, NY: Guilford Press.

Koomen, H. M., Verschueren, K., van Schooten, E., Jak, S., and Pianta, R. C. (2012). Validating the student-teacher relationship scale: testing factor structure and measurement invariance across child gender and age in a dutch sample. *J. Sch. Psychol.* 50, 215–234. doi: 10.1016/j.jsp.2011.09.001

Ladd, G. W. (2005). "Making friends and becoming accepted in peer groups," in *Children's Peer Relationships and Social Competence: A Century of Progress,* ed G. W. Ladd (New Haven, CT: Yale University Press), 89–112.

Lansford, J. E., Malone, P. S., Dodge, K. A., Pettit, G. S., and Bates, J. (2010). Developmental cascades of peer rejection, social information processing biases, and aggression during middle childhood. *Dev. Psychopathol.* 22, 593–602. doi: 10.1017/S0954579410000301

Lee, P., and Bierman, K. (2016). Profiles of kindergarten classroom and elementary school context: associations with the first-grade outcomes of children transitioning from head start. *Elem. School J.* 117, 119–142. doi: 10.1086/687813

Lomax, R. G. (1982). A guide to LISREL-type structural equation modeling. *Behav. Res. Methods Instrum.* 14, 1–8. doi: 10.3758/BF03202105

Lorenzo-Seva, U. (1999). Promin: a method for oblique factor rotation. *Multivariate Behav. Res.* 34, 347–365. doi: 10.1207/S15327906MBR3403_3

Lorenzo-Seva, U. (2003). A factor simplicity index. *Psychometrika* 68, 49–60. doi: 10.1007/BF02296652

Lorenzo-Seva, U., and Ferrando, P. J. (2013). FACTOR 9.2 a comprehensive program for fitting exploratory and semiconfirmatory factor analysis and IRT models. *Appl. Psychol. Meas.* 37, 497–498. doi: 10.1177/0146621613487794

Mardia, K. V. (1970). Measures of multivariate skewnees and kurtosis with applications. *Biometrika* 57, 519–530. doi: 10.1093/biomet/57.3.51

Matthys, W., Maassen, G. H., Cuperus, J. M., and Van Engeland, H. (2001). The assessment of a situational specificity of children's problem behavior in peer-peer context. *J. Child Psychol. Psychiatry* 42, 413–420. doi: 10.1111/1469-7610.00734

Mayeux, L., Bellmore, A. D., and Cillessen, A. H. (2007). Predicting changes in adjustment using repeated measures of sociometric status. *J. Genet. Psychol.* 168, 401–424. doi: 10.3200/GNTP.168.4.401-424

McKown, C., Gumbiner, L. M., and Johnson, J. (2011). Diagnostic efficiency of several methods of identifying socially rejected children and effect of participation rate on classification accuracy. *J. Sch. Psychol.* 49, 573–595. doi: 10.1016/j.jsp.2011.06.002

Merrell, K., W (2002). *School Social Behavior Scales*, *2nd Edn*. Eugene, OR: Assessment-Intervention Resources.

Merrell, K. W., and Gueldner, B. A. (2010). *Social and Emotional Learning in the Classroom*. New York, NY: Guilford Press.

Mikame, A. Y., Lerner, M. D., and Lun, J. (2010). Social context influences on children's rejection by their peers. *Child Dev. Perspect.* 4, 123–130. doi: 10.1111/j.1750-8606.2010.00130.x

Nangle, D. W., Ellis, J. T., and Hansen, D. J. (1994). Clinical utility of the taxonomy of problematic social situations for children (TOPS): temporal stability and convergence with peer measures. *Educ. Treat. Child.* 17, 129–138.

Netemeyer, R. G., Johnston, M. W., and Burton, S. (1990). Analysis of role conflict and role ambiguity in a structural equations framework. *J. Appl. Psychol.* 75, 148–157. doi: 10.1037/0021-9010.75.2.148

Newcomb, A. F., and Bukowski, W. M. (1983). Social impact and social preference as determinants of children's peer group status. *Dev. Psychol.* 19, 856–867. doi: 10.1037/0012-1649.19.6.856

Parker, J. G., and Asher, S. R. (1987). Peer relations and later personal adjustment: are low-accepted children at risk? *Psychol. Bull.* 102, 357–389. doi: 10.1037/0033-2909.102.3.35

Pérez-Fuentes, M. C., Molero, M. N., Martos, A., Barragán, A. B., Gázquez, J. J., and Sánchez-Marchán, C. (2016). Análisis y validación española del *Peer Conflict Scale* [Spanish analysis and validation of Peer Conflict Scale]. *Eur. J. Educ. Psychol.* 9, 56–62. doi: 10.1016/j.ejeps.2016.03.001

Pianta, R. C., and Stuhlman, M. W. (2004). Teacher-child relationship and children's success in the first years of school. *Sch. Psychol. Rev.* 33, 444–458. Available online at: http://naspjournals.org/

Pouwels, J. L., Souren, P., Lansu, T. A. M., and Cillessen, A. H. N. (2016). Stability of peer victimization: a meta-analysis of longitudinal research. *Dev. Rev.* 40, 1–24. doi: 10.1016/j.dr.2016.01.001

Quaglia, R., Gastaldi, F. G. M., Prino, L. E., Pasta, T., and Longobardi, C. (2013). The pupil-teacher relationship and gender differences in primary school. *Open Psychol. J.* 6, 69–75. doi: 10.2174/1874350101306010069

Renk, K., and Phares, V. (2004). Cross-informant ratings of social competence in children and adolescents. *Clin. Psychol. Rev.* 24, 239–254. doi: 10.1016/j.cpr.2004.01.004

Rose, A. J., and Asher, S. R. (2004). Children's strategies and goals in response to help-giving and help-seeking tasks within a friendship. *Child Dev.* 75, 749–763. doi: 10.1037/a0023277

Rose-Krasnor, L. R., and Denham, S. (2009). "Social-emotional competence in early childhood," in *Handbook of Peer Interactions, Relationships, and Groups*, eds K. H. Rubin, W. M. Bukowski, and B. P. Laursen (New York, NY: The Guilford Press), 162–179.

Rubin, R. M., and Hubbard, J. A. (2002). Children's verbalizations and cheating behavior during game playing: the role of sociometric status aggression, and gender. *J. Abnorm. Child Psychol.* 31, 65–78. doi: 10.1023/A:1021773316251

Rudasill, K., and Rimm-Kaufman, S. E. (2009). Teacher-child relationship quality: the roles of child temperament and teacher-child interactions. *Early Child. Res. Q.* 24, 107–120. doi: 10.1016/j.ecresq.2008.12.003

Salazar, I., and Caballo, V. (2006). "Escalas de comportamiento social [Social Behavior Scales]," in *Manual Para la Evaluación Clínica de los Trastornos Psicológicos: Trastornos de la Edad Adulta e Informes Psicológicos [Handbook for the Clinical Assessment of Psychological Disorders: Adult Disorders and Psychological Reports],* ed E. V. Caballo (Madrid: Pirámide), 373–399.

Sandstrom, M. J., and Zakriski, A. L. (2004). "Understanding the experience of peer rejection," in *Children's Peer Relations: From Development to Intervention,* eds J. B. Kupersmidt and K. A. Dodge (Washington, DC: American Psychological Association), 101–118.

Satorra, A., and Bentler, P. M. (2001). A scaled difference chi-square test statistic for moment structure analysis. *Psychometrika* 66, 507–514. doi: 10.1007/BF02296192

Schumacker, R. E., and Lomax, R. G. (2004). *A Beginner's Guide to Structural Equation Modeling, 2nd Edn.* Mahwah, NJ: Lawrence Erlbaum Associates.

Settanni, M., Longobardi, C., Sclavo, E., Fraire, M., and Prino, L. E. (2015). Development and psychometric analysis of the student–teacher relationship scale – short form. *Front. Psychol.* 6:898. doi: 10.3389/fpsyg.2015.00898

Shah, F., and Morgan, S. B. (1996). Teachers' ratings of social competence of children with high versus low levels of depressive symptoms. *J. Sch. Psychol.* 34, 337–349. doi: 10.1016/S0022-4405(96)00019-2

Southam-Gerow, M. A., and Kendall, P. C. (2002). Emotion regulation and understanding: implications for child psychopathology and therapy. *Clin. Psychol. Rev.* 22, 189–222. doi: 10.1016/S0272-7358(01)00087-3

Tabachnick, B. G., and Fidell, L. S. (2013). *Using Multivariate Statistics, 6th Edn*. Boston, MA: Pearson.

Timler, G. R. (2000). *Investigation of Social Communication Skills during Peer Conflict Tasks in School-Age Children with Alcohol-Related Disabilities.* Unpublished doctoral dissertation, University of Washington, Seattle, WA.

Timler, G. R. (2008). Social knowledge in children with language impairments: examination of strategies, predicted consequences, and goals in peer conflict situations. *Clin. Linguist. Phonet.* 22, 741–763. doi: 10.1080/02699200822 12470

Torrente, C. E., Cappella, E., and Neal, J. W. (2014). Children's positive school behaviors and social preference in urban elementary classrooms. *J. Community Psychol.* 42, 143–161. doi: 10.1002/jcop.21599

Ullman, J. B. (2007). "Structural equation modeling," in *Using Multivariate Statistics, 5th Edn.*, eds B. G. Tabachnick and L. S. Fidell (Needham Height, MA: Allyn & Bacon), 676–780.

van der Helm, G. H., Matthys, W., Moonen, X., Giesen, N., van der Heide, E., and Stams, G. J. (2013). Measuring inappropriate responses of adolescents to problematic social situations in secure institutional and correctional youth care: a validation study of the TOPS-A. *J. Interpers. Violence* 28, 1579–1595. doi: 10.1177/0886260512468322

van Ijzendoorn, M. H. (2005). Attachment in social networks: toward an evolutionary social network model. *Hum. Dev.* 48, 85–88. doi: 10.1159/000083218

van Lier, P. A., Vitaro, F., Wanner, B., Vuijk, P., and Crijnen, A. A. M. (2005). Gender differences in developmental links among antisocial behavior, friends' antisocial behavior, and peer rejection in childhood: results from two cultures. *Child Dev.* 76, 841–855. doi: 10.1111/j.1467-8624.2005.00881.x

van Manen, T. G. (2006). *Assessment and Treatment of Aggressive Children, from a Social-Cognitive Perspective*. Unpublished doctoral dissertation, University of Amsterdam, Amsterdam.

Walker, S., Irving, K., and Berthelsen, D. (2002). Gender influences on preschool children's social problem-solving strategies. *J. Genet. Psychol.* 163, 197–209. doi: 10.1080/00221320209598677

Wentzel, K. R. (2009). "Peers and academic functioning at school," in *Handbook of Peer Interactions, Relationships, and Groups*, eds K. H. Rubin, W. M. Bukowski, and B. Laursen (New York, NY: Guilford Press), 531–547.

West, S. G., Finch, J. F., and Curran, P. J. (1995). "Structural equation models with nonnormal variables. Problems and remedies," in *Structural Equation Modeling: Concepts, Issues and Applications,* ed R. H. Hoyle (Newbury Park, CA: Sage), 56–75.

White, B. A., and Kistner, J. A. (2011). Biased self-perceptions, peer rejection, and aggression in children. *J. Abnorm. Child Psychol.* 39, 645–656. doi: 10.1007/s10802-011-9506-6z

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Martín-Antón, Monjas, García Bacete and Jiménez-Lagares. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 08 December 2016
doi: 10.3389/fpsyg.2016.01931

The Relationship between Impulsivity and Problem Gambling in Adolescence

Roberto Secades-Villa, Victor Martínez-Loredo, Aris Grande-Gosende and José R. Fernández-Hermida*

Department of Psychology, University of Oviedo, Oviedo, Spain

Gambling has become one of the most frequently reported addictive behaviors among young people. Understanding risk factors associated with the onset or maintenance of gambling problems in adolescence has implications for its prevention and treatment. The main aim of the present study was to examine the potential relationships between impulsivity and problem gambling in adolescence. Participants were 874 high school students (average age: 15 years old) who were surveyed to provide data on gambling and impulsivity. Self-reported gambling behavior was assessed using the South Oaks Gambling Screen – Revised for Adolescents (SOGS-RA) and impulsivity was measured using the Impulsive Sensation Seeking Questionnaire (ZKPQ), the Barratt Impulsiveness Scale (BIS-11-A), and a delay discounting task. The data were analyzed using both a prospective-longitudinal and a cross-sectional design. In the longitudinal analyses, results showed that the impulsivity subscale of the ZKPQ increased the risk of problem gambling ($p = 0.003$). In the cross-sectional analyses, all the impulsivity measures were higher in at-risk/problem gamblers than in non-problem gamblers ($p = 0.04$; 0.03; and 0.01, respectively). These findings further support the relationship between impulsivity and gambling in adolescence. Moreover, our findings suggest a bidirectional relationship between impulsivity and problem gambling in adolescence. These results have consequences for the development of prevention and treatment programs for adolescents with gambling problems.

Keywords: adolescence, gambling, impulsivity, delay discounting, risk factors

OPEN ACCESS

Edited by:
Alessandro Antonietti, Catholic University of the Sacred Heart, Italy

Reviewed by:
María Del Carmen Pérez Fuentes, University of Almería, Spain
María Del Mar Molero, University of Almeria, Spain

****Correspondence:***
Roberto Secades-Villa
secades@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *11 July 2016*
Accepted: *24 November 2016*
Published: *08 December 2016*

Citation:
Secades-Villa R, Martínez-Loredo V, Grande-Gosende A and Fernández-Hermida JR (2016) The Relationship between Impulsivity and Problem Gambling in Adolescence. Front. Psychol. 7:1931. doi: 10.3389/fpsyg.2016.01931

INTRODUCTION

There is growing evidence that opportunities to gamble and problematic gambling among adolescents are increasing in developed countries, mainly due to the growing availability of and access to online gambling (Huang and Boyer, 2007; Blinn-Pike et al., 2010; Secades-Villa et al., 2014). Problem gambling in young people has been associated with significant psychosocial and mental health problems, such as disruptive family relationships (Hardoon et al., 2004), school failure (Potenza et al., 2011), conduct and substance misuse problems (Hardoon et al., 2004; Estevez et al., 2015), depression (Hardoon et al., 2004; Lynch et al., 2004; Estevez et al., 2015), or ADHD (Derevensky et al., 2007).

In addition to the structural characteristics of the gambling activity itself (Parke and Griffiths, 2007), there are several potential individual and social factors contributing to the development and maintenance of problem gambling (Donati et al., 2013; Dixon et al., 2016). However, to date, very few studies have focused on risk factors that contribute to engagement in problem gambling in adolescent samples (Cosenza and Nigro, 2015).

As regards individual determinants, impulsivity seems to be one of the most critical factors associated with problem gambling and other disorders in adolescence such as substance use problems (Pérez-Fuentes et al., 2015) or eating disorder behavior (Wonderlich et al., 2004). Impulsivity is a multidimensional construct often defined as a human behavior characterized by the inclination of an individual to act on urge rather than thought, with diminished regard to consequences, and encompasses a range of maladaptive behaviors which are in turn affected by distinct neural systems (Meda et al., 2009). Impulsivity has been found to increase the likelihood of gambling onset in youths with low – but not high – socio-economic status (SES) (Auger et al., 2010; Dussault et al., 2011), and to predict gambling frequency (Benson et al., 2012) and problem gambling in low SES adolescent males. One study also found that positive urgency was associated with stronger scores of both gambling frequency and problem gambling (Canale et al., 2016).

Despite the significant contributions from previous studies, important questions remain regarding the influence of impulsivity on gambling severity and gambling onset among young people (Cosenza and Nigro, 2015). For example, almost all studies used cross-sectional designs (Barnes et al., 2005; Leeman et al., 2014; Canale et al., 2016) that cannot address directionality, and most of the few longitudinal studies only included male subjects (Vitaro et al., 1997, 1999; Dussault et al., 2011; Liu et al., 2013). Several previous studies did not find a relationship between impulsivity and gambling among young people (Barnes et al., 2005; Lee et al., 2011). Finally, most of the research has focused on only one of the domains of impulsivity (Mackillop et al., 2014; Cosenza and Nigro, 2015), evaluated in most cases with self-reports, and we do not know if the findings are generalizable to other impulsivity measures, including behavioral ones (Auger et al., 2010). To our knowledge, only three studies (all of them cross-sectional) in non-clinical samples have analyzed the relation between gambling and delay discounting among adolescents, and they have produced contradictory results (Holt et al., 2003; MacKillop et al., 2006; Cosenza and Nigro, 2015).

Thus, we sought to build on previous research to examine the relationship between different impulsivity domains (including both survey assessments and behavioral tasks) and gambling severity in a representative community sample of adolescents, using both a cross-sectional and a prospective longitudinal design. Given the findings summarized above, we hypothesized that the relationship between impulsivity and problem gambling in adolescence is bidirectional and that all impulsivity domains are related to gambling severity.

MATERIALS AND METHODS

Participants

The participants were 1,327 adolescents aged between 14 and 17 years, recruited from a total of 16 Spanish secondary schools in the region of Asturias. The schools were selected following a random stratified and incidental procedure. The inclusion criteria were: (1) having no sensory impairment, (2) not presenting difficulties understanding the Spanish language, and (3) not being diagnosed with an intellectual disability. Of the initial participants, 1,249 met the inclusion criteria for the cross-sectional analyses. The longitudinal analyses were performed 2 years later with a sub-sample of 874 respondents (56.1% males and 43.9% females). None of the participants refused to be assessed and participants were given guarantees of total confidentiality and anonymity. Participants' characteristics are shown in **Table 1**.

Procedure

After the acceptance of participation from schools, students were surveyed in their own classroom using digital devices (Samsung Galaxy Tab2 10.1 tablet). This method was used with the aim of reducing inconsistent answers. The software did not allow participants to skip any questions and was designed to avoid the asking of inappropriate questions in accordance with previous answers. Participants completed the battery of tests, which took a maximum of 75 min, sitting at individual desks, with supervisors checking that they were doing the task appropriately and making sure there was no interaction between them. The survey was designed in such a way that it allowed the individualization of the questions asked as a function of previous answers given by each participant. Before the start of the assessment, trained experimenters provided instructions on how to perform the tasks. Participants were also assured of complete anonymity and confidentiality.

Measures

Demographic Data

Data was collected regarding age, gender, number of siblings, amount of weekly allowance, family structure (i.e., living with no parents or with one or two parents), and the employment status of parents. Information on whether the participants had relatives with problematic gambling habits was also gathered.

Gambling Behavior

Participants completed a survey about their gambling activities, both in land-based and online-based modes. Gambling was defined as "any game that involves betting with money." The following gambling activities were measured: bingo, poker, other casino games (OCGs), sports betting, lottery, scratch-tickets, and electronic gambling machines (EGMs). Participants indicated how often they had engaged in each of these activities throughout their lifetimes, over the past year, and over the past month. Participants also indicated: age of gambling onset, time spent gambling, amount of money wagered on a regular day of gambling, and company (if they gambled alone or with other people).

Adolescent gambling behavior was also measured with the South Oaks Gambling Screen – Revised for Adolescents (SOGSRA) (Winters et al., 1993); Spanish version (Becona, 1997). It consists of 10 dichotomous items (no = 0, yes = 1) assessing gambling behavior and gambling-related problems during the past 12 months. The total score ranges from 0 to 12. Scores provide three categories: non-problem gambler (score of 0 or 1),

TABLE 1 | Sample characteristics.

	Total sample ($n = 874$)	Non-problem gamblers ($n = 832$)	At-risk and problem gamblers ($n = 42$)	p	Effect size
Age (years)[a]	14.93 ± 0.53	14.93 ± 0.52	14 ± 0.66	0.387[1]	–
Gender (% males)	56.1	55	76.2	0.011[2]	0.091*
Amount of weekly allowance (% participants between 20 and 40€)	8	7.9	9.5	0.04[3]	0.123**
Living with parents (% yes)	77.1	76.2	69	0.383[2]	–
Employment situation mother (%full time)	39.4	40	26.2	0.190[2]	–
Employment situation father (%full time)	53.8	53.7	54.8	0.153[3]	–
Relatives with problem gambling (% no)	98.4	98.2	97.6	1[2]	–

[a]*Mean ± Standard deviation;* [1]*Student t-test;* [2]*Yates correction for continuity;* [3]*Chi-square; *Phi; **Cramer's V.*

at-risk gambler (score of 2 or 3) and problem gambler (score of 4 or more). The Spanish version yielded a Cronbach's alpha of 0.80.

Three different measures of impulsivity were measured due that reveal independent domains of impulsivity that are related to gambling severity:

The Zuckerman-Kuhlman Personality Questionnaire (ZKPQ) (Zuckerman et al., 1993), which consists of true/false questions, eight of which pertain to impulsivity (primarily lack of premeditation) and eleven of which pertain to sensation seeking. For the purpose of this study, we used the impulsivity (Imp) subscale; Spanish version (Fernández-Artamendi et al., 2016). The Spanish version yielded a Cronbach's alpha of 0.83 (Imp: $\alpha = 0.75$; SS: $\alpha = 0.74$).

The Barratt Impulsiveness Scale (BIS-11-A; Patton et al., 1995); Spanish version (Martínez-Loredo et al., 2015). This measure of impulsivity captures the following three domains: (a) Attentional Impulsivity: difficulty dedicating adequate attention to a task; (b) Motor Impulsivity: propensity to act rashly without forethought; and (c) Non-planning Impulsivity: failure to adequately plan ahead. It contains 30 descriptive statements (maximum score of 120) to which participants respond with the extent to which each statement describes them on a 4-point Likert scale (1 = rarely/never; 2 = occasionally; 3 = often; 4 = almost always/always). The BIS-11-A consists of two subscales: general impulsivity (BIS-g) and non-planning impulsivity (BIS-np). Its validation with Spanish adolescents showed a good reliability with a Cronbach's alpha of 0.87 (Cronbach's alpha = 0.91 for BIS-g; and 0.85 for BIS-np).

Delay Discounting

Delay discounting describes how a reinforcer loses value as the delay to its receipt increases (Bickel and Marsch, 2001). Delay discounting is typically assessed using an adjusting-delay procedure in which an individual is presented with multiple choices (usually, hypothetical monetary rewards) between a smaller, more immediate reinforcer vs. a larger, more delayed one. The delay discounting task was presented to participants via a tablet running Android 4.0.3 operating system. Overall, the task took approximately 10 min to complete for each participant. Participants were instructed on how to interact with the delay discounting program and informed that they would not receive any of the monetary amounts presented, but that they were to respond as if the choices were real. Previous studies have demonstrated that participants respond similarly during delay discounting tasks for both real and hypothetical monetary values.

Participants were presented with a choice between €1,000 after a fixed delay, versus various amounts of money available immediately using an adjusting-amounts procedure (Holt et al., 2012). The delays values were 1 day, 1 week, 1 month, 6 months, 1 year, 5 years, and 25 years. The delays were presented in an ascending order for all the participants. The value of the immediate monetary option ranged from €5 to €1,000 in €5 increments and was adjusted via a titrating procedure that honed in on the indifference point based on the participants' responses. The titration procedure took the lower and upper limit of possible values (initial €0 and €1,000) and divided this total range randomly by 2, 3, or 4 to obtain an interval value. The value of the immediate option was one interval value above or below the upper and lower limits. If the immediate value was outside €0 and €1,000, another value was randomly chosen. New lower and upper limits were chosen based on the participant's response, adjusting the total range, and the titration process was repeated. Note that based on the possible values presented, the total range could occasionally increase if they chose an option outside of the total range. Once the total range was at or less than €40, the average of the upper and lower limits was taken as the indifference point, and the next delay was presented.

The dependent variable was the k-value, which describes the rate of discounting, with higher k-values showing greater discounting and more impulsive choices selected. In order to assess k-values for each participant, individual indifference points were fitted to the hyperbolic equation described by Mazur (1987):

$$V = A/(1 + kD)$$

The Eq. (1) shows how the value (V) of a reward of certain amount (A) is discounted as a function of delay (D) to its delivery (Mazur, 1987). As the distribution of k-values was skewed, analyses were performed on log-transformed k-values.

Control Variables

With the aim of detecting random answers, an infrequency scale was used (Oviedo Infrequency Scale, INF-OV) (Fonseca-Pedrero et al., 2009). This instrument is composed of 12 items randomly

interspersed and mixed throughout the assessment. Participants were required to respond to five-level Likert-type items (from totally disagree to totally agree) about obvious facts such as 'I know people who wear glasses' or 'I have sometimes watched films on TV.' The total score ranged from 0 to 60 points, with participants scoring more than three points on the scales being removed.

Data Analyses

Various descriptive and frequency analyses were carried out in relation to the participants' characteristics. Due to the low sample size in each SOGS-RA category and the substantial problems already associated with both at-risk and problem gambling among adolescents (Potenza et al., 2011), participants were classified in two groups on the basis of their score on the SOGS-RA: Non-problem gamblers (SOGS-RA $\leq$ 1; $n = 282$) versus at-risk and problem gamblers (SOGS-RA $\geq$ 2; $n = 42$). In order to analyze the association between impulsivity and problem gambling, Pearson's correlation between SOGS-RA and impulsivity scores were performed. On the other hand, to test previous impulsivity differences on adolescents with and without gambling problems, longitudinal analysis were performed using impulsivity scores obtained in the first wave and gambling score in the second wave. Also, a cross-sectional analysis was performed using impulsivity and gambling scores, both from the second wave. Several Student's *t*-tests were applied to test the relationship between the three different measures of impulsivity and problem gambling in both longitudinal and cross-sectional analyses. Effect sizes of principal comparisons were calculated using Cohen's d (*d*), due to the discrepancy between group sizes (Field, 2007). Values for small, medium and large effects for eta squared are 0.01, 0.06, and 0.14, respectively. Confidence level was 95%, and the statistical package used was the SPSS (V20; SPSS, Inc., Chicago, IL, USA).

RESULTS

Gambling Prevalences

Overall, 55.3% ($n = 483$) of participants reported gambling behavior during their lifetime, 37.1% ($n = 324$) of participants reported gambling in the past year, and 24% ($n = 210$) in the last month. On the basis of their scores on the SOGS-RA, 95.2% ($n = 282$) of the total sample were non-problem gamblers, 1.1% ($n = 10$) were problem gamblers and 3.7% ($n = 32$) were at-risk gamblers.

Gambling Characteristics

The most common gambling activities were the lottery (47.4%), sport betting (38.2%), scratch-cards (34.5%), poker (21.8%), bingo (28.6%) and EGMs (3.1%).

Regarding the mode of access (i.e., land-based, online-based and mixed-mode): 87.7% ($n = 285$) reported only land-based (non-internet) gambling, 0.9% reported only online-based gambling ($n = 3$), and 11.4% ($n = 37$) reported both non-internet and online-based gambling.

Gambling and Impulsivity

Relationships between all the impulsivity measures and gambling severity are presented in **Table 2**. All measures were significantly correlated with SOGS-RA scores excepting log*k* at the first wave. Mean differences in impulsivity according to problem gambling are shown in **Table 3**. In the longitudinal analyses, participants with high scores on the ZKPQ impulsivity subscale were more likely to be at-risk or problem gamblers in the second wave ($p = 0.003$). In the cross-sectional analyses, participants with high scores on all the impulsivity measures (ZKPQ imp subscale, BIS-11-A and log*k*) were more likely to be at-risk or problem gamblers.

DISCUSSION

The main purpose of this study was to test the relationship between impulsivity and gambling status during adolescence. Results showed that the prevalence of at-risk and problem gambling was 4.8%, that impulsivity precedes later gambling problems, and, significantly, that gambling problems increase impulsivity.

The percentage of at-risk and problem gambling among the total sample of adolescents was substantially lower than those found in previous studies (Olason et al., 2011; Jonkman et al., 2013; Dixon et al., 2016). Similarly, gambling prevalence among those who gambled in the last year was still below that found in previous studies (McCormack et al., 2013; Castren et al., 2015; Canale et al., 2016). Several factors might explain this divergent result. First, the legal restrictions enacted in Spain over the last few years may have contributed to reducing gambling prevalence among adolescents. Second, our study was conducted with a sample of adolescents aged under 18 while the vast majority of previous research included samples with a broad range of ages. Moreover, many studies only report gambling severity rates among bettors instead of the percentages of gambling severity among the total sample (Potenza et al., 2011; Gainsbury et al., 2015).

Different sources of impulsivity measure may contribute to the different findings in the two analyses (longitudinal and cross-sectional): High scores on the ZKPQ impulsivity subscale at the first wave increased the risk of problem gambling at the second

TABLE 2 | Correlation between impulsivity measures and gambling severity.

	South Oaks Gambling Screen
BIS-11-A_1	0.138*
BIS-11-A_2	0.138*
Impulsive $Subscale_1$	0.195**
Impulsive $Subscale_2$	0.216**
$Logk_1$	−0.039
$Logk_2$	0.182**

*BIS, Barratt Impulsiveness Scale; Logk, log-transformed k-value; subindices represent assessment waves. *$p < 0.05$; **$p < 0.001$.*

TABLE 3 | Impulsivity by gambling severity.

	Longitudinal analyses					Cross-sectional analyses				
	Non-problem gamblers	At-risk and problem gamblers				Non-problem gamblers	At-risk and problem gamblers			
	M ± *SD*	*M* ± *SD*	t_{df}	*p*	*d*	*M* ± *SD*	*M* ± *SD*	t_{df}	*p*	*d*
Imp	3 ± 2.30	4.17 ± 2.37	-3.037_{322}	0.003	0.34	3.23 ± 2.40	4.62 ± 2.22	-3.527_{322}	0.001	0.39
BIS-11-A	38.84 ± 15.42	43.52 ± 16.49	-1.818_{322}	0.070	–	47.03 ± 10.51	53.95 ± 14.72	$-2.935_{47.42}$	0.005	0.85
log*k*	−2.39 ± 1.47	−2.53 ± 1.53	0.587_{322}	0.558	–	−2.74 ± 1.17	−2.32 ± 1.54	-2.071_{322}	0.039	0.23

M ± SD, Mean ± Standard deviation; Imp, Impulsive Subscale (Zuckerman-Kuhlman Personality Questionnaire; ZKPQ); BIS-11-A, Barratt Impulsiveness Scale; logk, log-transformed k-value.

wave, and all the impulsivity measures (ZKPQ imp subscale, BIS-11-A and log*k*) were related to gambling problems in the cross-sectional analyses.

Consistent with previous studies (Vitaro et al., 1997, 1999; Dussault et al., 2011; Liu et al., 2013), youths who report a tendency toward impulsive behavior, specifically acting without thinking or planning, may be at risk for problem gambling in adolescence. Several factors may contribute to this result. It is possible that highly stimulating activities, such as gambling, are often pursued as a means to relieve stress among individuals with high impulsivity (Jacobs, 1986). Impulsive individuals tend to be more exposed to excessive chronic stress resulting from a hypo-aroused psychological state (Gupta and Derevensky, 1998). Impulsive youths may be at risk of developing gambling problems due to the fact that gambling often involves a high degree of sensory and mental stimulation (Nower et al., 2004). Finally, immaturity of frontal cortical and subcortical monaminergic systems during neurodevelopment in adolescence may predispose individuals to trait impulsivity, resulting in increased vulnerability to addictive behaviors such as problem gambling (Chambers and Potenza, 2003).

Our results also indicated that beyond the effect of impulsivity on gambling, all the impulsivity measures and tasks were significantly associated with gambling severity in the cross-sectional analyses. Previous studies using both measures of impulsivity, personality inventories (Vitaro et al., 1999; Liu et al., 2013), and delay discounting tasks (Alessi and Petry, 2003; Cosenza and Nigro, 2015) have found that gambling problems increase impulsivity. These results suggest that individuals who have the general tendency to make impulsive monetary decisions may also behave impulsively (Alessi and Petry, 2003). The fact that in these analyses the link between problem gambling and impulsivity is not dependent on a particular measure further supports the validity of this link.

Taken together, our results suggest that the link between impulsivity and problem gambling in adolescence is probably bidirectional, both influencing the other mutually in a negatively interactive spiral. These results are in agreement with research and clinical expertise that consider impulsivity to be integral to understanding pathological gambling behavior (Alessi and Petry, 2003).

This association suggests that these two problems are to be approached jointly when treating problem gambling in adolescents. The significant association of youth impulsivity with subsequent gambling problems highlights the importance of identifying and intervening with impulsive adolescents to prevent adolescent problem gambling. Moreover, the influence of gambling on impulsivity underscores the importance of developing innovative intervention strategies directed at decreasing impulsivity in this population.

This study has several limitations. First, the study sample consisted of urban participants, so the findings may not be generalizable to the general population and thus should be extrapolated with caution. Second, the observed significant association between impulsivity and gambling does not necessarily indicate a causal relationship. Third, self-reports of gambling problems may be subject to reporting bias.

Despite these limitations, the present study provides further evidence on the nature of the relationship between impulsivity and problem gambling. Our study indicates an inter-relationship between these constructs. Impulsivity, in terms of acting without thinking or planning, precedes later gambling problems, and gambling problems increase self-reported impulsivity and the preference for small immediate rewards over larger delayed rewards (delay discounting).

ETHICS STATEMENT

The study was approved by the Ethics Committee of the Spanish Education Ministry. Written consent was obtained from their parents.

AUTHOR CONTRIBUTIONS

RS-V designed the study, VM-L and AG-G managed the literature searches and wrote the first draft of the manuscript. JF-H conducted the statistical analyses. All authors contributed to and have approved the final manuscript.

FUNDING

Funding for this study was provided by the Council for Economy and Work (FC-15-GRUPIN14-047). This institution had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

REFERENCES

Alessi, S. M., and Petry, N. M. (2003). Pathological gambling severity is associated with impulsivity in a delay discounting procedure. *Behav. Processes* 64, 345–354. doi: 10.1016/S0376-6357(03)00150-5

Auger, N., Lo, E., Cantinotti, M., and O'Loughlin, J. (2010). Impulsivity and socio-economic status interact to increase the risk of gambling onset among youth. *Addiction* 105, 2176–2183. doi: 10.1111/j.1360-0443.2010.03100.x

Barnes, G. M., Welte, J. W., Hoffman, J. H., and Dintcheff, B. A. (2005). Shared predictors of youthful gambling, substance use, and delinquency. *Psychol. Addict. Behav.* 19, 165–174. doi: 10.1037/0893-164X.19.2.165

Becona, E. (1997). Pathological gambling in Spanish children and adolescents: an emerging problem. *Psychol. Rep.* 81, 275–287. doi: 10.2466/pr0.1997.81.1.275

Benson, L. A., Norman, C., and Griffiths, M. D. (2012). The role of impulsivity, sensation seeking, coping, and year of study in student gambling: a pilot study. *Int. J. Ment. Health Addict.* 10, 461–473. doi: 10.1007/s11469-011-9326-5

Bickel, W. K., and Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: delay discounting processes. *Addiction* 96, 73–86. doi: 10.1080/09652140020016978

Blinn-Pike, L., Worthy, S. L., and Jonkman, J. N. (2010). Adolescent gambling: a review of an emerging field of research. *J. Adolesc. Health* 47, 223–236. doi: 10.1016/j.jadohealth.2010.05.003

Canale, N., Scacchi, L., and Griffiths, M. D. (2016). Adolescent gambling and impulsivity: does employment during high school moderate the association? *Addict. Behav.* 60, 37–41. doi: 10.1016/j.addbeh.2016.04.001

Castren, S., Grainger, M., Lahti, T., Alho, H., and Salonen, A. H. (2015). At-risk and problem gambling among adolescents: a convenience sample of first-year junior high school students in Finland. *Subst. Abuse Treat. Prev. Policy* 10:9. doi: 10.1186/s13011-015-0003-8

Chambers, R. A., and Potenza, M. N. (2003). Neurodevelopment, impulsivity, and adolescent gambling. *J. Gambl. Stud.* 19, 53–84. doi: 10.1023/A:1021275130071

Cosenza, M., and Nigro, G. (2015). Wagering the future: cognitive distortions, impulsivity, delay discounting, and time perspective in adolescent gambling. *J. Adolesc.* 45, 56–66. doi: 10.1016/j.adolescence.2015.08.015

Derevensky, J. L., Pratt, L. M., Hardoon, K. K., and Gupta, R. (2007). Gambling problems and features of attention deficit hyperactivity disorder among children and adolescents. *J. Addict. Med.* 1, 165–172. doi: 10.1097/ADM.0b013e318142d081

Dixon, R. W., Youssef, G. J., Hasking, P., Yucel, M., Jackson, A. C., and Dowling, N. A. (2016). The relationship between gambling attitudes, involvement, and problems in adolescence: examining the moderating role of coping strategies and parenting styles. *Addict. Behav.* 58, 42–46. doi: 10.1016/j.addbeh.2016.02.011

Donati, M. A., Chiesi, F., and Primi, C. (2013). A model to explain at-risk/problem gambling among male and female adolescents: gender similarities and differences. *J. Adolesc.* 36, 129–137. doi: 10.1016/j.adolescence.2012.10.001

Dussault, F., Brendgen, M., Vitaro, F., Wanner, B., and Tremblay, R. E. (2011). Longitudinal links between impulsivity, gambling problems and depressive symptoms: a transactional model from adolescence to early adulthood. *J. Child Psychol. Psychiatry* 52, 130–138. doi: 10.1111/j.1469-7610.2010.02313.x

Estevez, A., Herrero-Fernandez, D., Sarabia, I., and Jauregui, P. (2015). The impulsivity and sensation-seeking mediators of the psychological consequences of pathological gambling in adolescence. *J. Gambl. Stud.* 31, 91–103. doi: 10.1007/s10899-013-9419-0

Fernández-Artamendi, S., Martínez-Loredo, V., Fernández-Hermida, J. R., and Carballo-Crespo, J. L. (2016). The Impulsive Sensation Seeking (ImpSS): psychometric properties and predictive validity regarding substance use with Spanish adolescents. *Pers. Individ. Dif.* 90, 163–168. doi: 10.1016/j.paid.2015.11.003

Field, A. (2007). *Discovering Statistics Using IBM SPSS Statistics*. London: SAGE.

Fonseca-Pedrero, E., Paino-Pineiro, M., Lemos-Giraldez, S., Villazon-Garcia, U., and Muniz, J. (2009). Validation of the schizotypal personality questionnaire-brief form in adolescents. *Schizophr. Res.* 111, 53–60. doi: 10.1016/j.schres.2009.03.006

Gainsbury, S. M., Russell, A., Blaszczynski, A., and Hing, N. (2015). The interaction between gambling activities and modes of access: a comparison of Internet-only, land-based only, and mixed-mode gamblers. *Addict. Behav.* 41, 34–40. doi: 10.1016/j.addbeh.2014.09.023

Gupta, R., and Derevensky, J. L. (1998). Adolescent gambling behavior: a prevalence study and examination of the correlates associated with problem gambling. *J. Gambl. Stud.* 14, 319–345. doi: 10.1023/A:1023046509031

Hardoon, K. K., Gupta, R., and Derevensky, J. L. (2004). Psychosocial variables associated with adolescent gambling. *Psychol. Addict. Behav.* 18, 170–179. doi: 10.1037/0893-164X.18.2.170

Holt, D. D., Green, L., and Myerson, J. (2003). Is discounting impulsive? Evidence from temporal and probability discounting in gambling and non-gambling college students. *Behav. Processes* 64, 355–367. doi: 10.1016/S0376-6357(03)00141-4

Holt, D. D., Green, L., and Myerson, J. (2012). Estimating the subjective value of future rewards: comparison of adjusting-amount and adjusting-delay procedures. *Behav. Processes* 90, 302–310. doi: 10.1016/j.beproc.2012.03.003

Huang, J. H., and Boyer, R. (2007). Epidemiology of youth gambling problems in Canada: a national prevalence study. *Can. J. Psychiatry* 52, 657–665.

Jacobs, D. F. (1986). A general theory of addictions: a new theoretical model. *J. Gambl. Behav.* 2, 15–31. doi: 10.1007/BF01019931

Jonkman, J., Blinn-Pike, L., and Worthy, S. L. (2013). How is gambling related to perceived parenting style and/or family environment for college students? *J. Behav. Addict.* 2, 42–49. doi: 10.1556/JBA.1.2012.014

Lee, G. P., Storr, C. L., Ialongo, N. S., and Martins, S. S. (2011). Compounded effect of early adolescence depressive symptoms and impulsivity on late adolescence gambling: a longitudinal study. *J. Adolesc. Health* 48, 164–169. doi: 10.1016/j.jadohealth.2010.06.002

Leeman, R. F., Hoff, R. A., Krishnan-Sarin, S., Patock-Peckham, J. A., and Potenza, M. N. (2014). Impulsivity, sensation-seeking, and part-time job status in relation to substance use and gambling in adolescents. *J. Adolesc. Health* 54, 460–466. doi: 10.1016/j.jadohealth.2013.09.014

Liu, W., Lee, G. P., Goldweber, A., Petras, H., Storr, C. L., Ialongo, N. S., et al. (2013). Impulsivity trajectories and gambling in adolescence among urban male youth. *Addiction* 108, 780–788. doi: 10.1111/add.12049

Lynch, W. J., Maciejewski, P. K., and Potenza, M. N. (2004). Psychiatric correlates of gambling in adolescents and young adults grouped by age at gambling onset. *Arch. Gen. Psychiatry* 61, 1116–1122. doi: 10.1001/archpsyc.61.11.1116

MacKillop, J., Anderson, E. J., Castelda, B. A., Mattson, R. E., and Donovick, P. J. (2006). Divergent validity of measures of cognitive distortions, impulsivity, and time perspective in pathological gambling. *J. Gambl. Stud.* 22, 339–354. doi: 10.1007/s10899-006-9021-9

Mackillop, J., Miller, J. D., Fortune, E., Maples, J., Lance, C. E., Campbell, W. K., et al. (2014). Multidimensional examination of impulsivity in relation to disordered gambling. *Exp. Clin. Psychopharmacol.* 22, 176–185. doi: 10.1037/a0035874

Martínez-Loredo, V., Fernández-Hermida, J. R., Fernández-Artamendi, S., Carballo, J. L., and García-Rodríguez, O. (2015). Spanish adaptation and validation of the Barratt Impulsiveness Scale for early adolescents (BIS-11-A). *Int. J. Clin. Health Psychol.* 15, 274–282. doi: 10.1016/j.ijchp.2015.07.002

Mazur, J. E. (1987). "An adjusting procedure for studying delayed reinforcement," in *Quantitative Analysis of Behavior: The Effects of Delay and Intervening Events on Reinforcement Value*, Vol. 55-73, eds M. L. Commons, J. E. Mazur, J. A. Nevin, and H. Rachlin (Hillsdale, NJ: Erlbaum), 88.

McCormack, A., Shorter, G. W., and Griffiths, M. D. (2013). An examination of participation in online gambling activities and the relationship with problem gambling. *J. Behav. Addict.* 2, 31–41. doi: 10.1556/JBA.2.2013.1.5

Meda, S. A., Stevens, M. C., Potenza, M. N., Pittman, B., Gueorguieva, R., Andrews, M. M., et al. (2009). Investigating the behavioral and self-report constructs of impulsivity domains using principal component analysis. *Behav. Pharmacol.* 20, 390–399. doi: 10.1097/FBP.0b013e32833113a3

Nower, L., Derevensky, J. L., and Gupta, R. (2004). The relationship of impulsivity, sensation seeking, coping, and substance use in youth gamblers. *Psychol. Addict. Behav.* 18, 49–55. doi: 10.1037/0893-164X.18.1.49

Olason, D. T., Kristjansdottir, E., Einarsdottir, H., Haraldsson, H., Bjarnason, G., and Derevensky, J. L. (2011). Internet gambling and problem gambling among 13 to 18 year old adolescents in Iceland. *Int. J. Ment. Health Addict.* 9, 257–263. doi: 10.1007/s11469-010-9280-7

Parke, J., and Griffiths, M. D. (2007). "The role of structural characteristics in gambling," in *Research and Measurement Issues in Gambling Studies*, eds G. Smith, D. Hodgins, and R. Williams (New York, NY: Elsevier), 211–243.

Patton, J. H., Stanford, M. S., and Barratt, E. S. (1995). Factor structure of the Barratt impulsiveness scale. *J. Clin. Psychol.* 51, 768–774. doi: 10.1002/1097-4679(199511)51:6$<$768::AID-JCLP2270510607$>$3.0.CO;2-1

Pérez-Fuentes, M., Gázquez, J., Molero, M., Cardila, F., Martos, A., Barragán, A., et al. (2015). Adolescent impulsiveness and use of alcohol and tobacco. *Eur. J. Invest.* 5, 371–382. doi: 10.1989/ejihpe.v5i3.139

Potenza, M. N., Wareham, J. D., Steinberg, M. A., Rugle, L., Cavallo, D. A., Krishnan-Sarin, S., et al. (2011). Correlates of at-risk/problem internet gambling in adolescents. *J. Am. Acad. Child Adolesc. Psychiatry* 50, 150–159. doi: 10.1016/j.jaac.2010.11.006

Secades-Villa, R., Calafat, A., Fernandez-Hermida, J. R., Juan, M., Duch, M., Skarstrand, E., et al. (2014). Duration of internet use and adverse psychosocial effects among European adolescents. *Adicciones* 26, 247–253. doi: 10.20882/adicciones.6

Vitaro, F., Arseneault, L., and Tremblay, R. E. (1997). Dispositional predictors of problem gambling in male adolescents. *Am. J. Psychiatry* 154, 1769–1770. doi: 10.1176/ajp.154.12.1769

Vitaro, F., Arseneault, L., and Tremblay, R. E. (1999). Impulsivity predicts problem gambling in low SES adolescent males. *Addiction* 94, 565–575. doi: 10.1046/j.1360-0443.1999.94456511.x

Winters, K. C., Stinchfield, R. D., and Fulkerson, J. (1993). Toward the development of an adolescent gambling problem severity scale. *J. Gambl. Stud.* 9, 63–84. doi: 10.1007/BF01019925

Wonderlich, S. A., Connolly, K. M., and Stice, E. (2004). Impulsivity as a risk factor for eating disorder behavior: assessment implications with adolescents. *Int. J. Eat. Disord.* 36, 172–182. doi: 10.1002/eat.20033

Zuckerman, M., Kuhlman, D. M., Joireman, J., Teta, P., and Kraft, M. (1993). A comparison of three structural models for personality: the Big Three, the Big Five, and the Alternative Five. *J. Pers. Soc. Psychol.* 65, 757–768. doi: 10.1037/0022-3514.65.4.757

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Secades-Villa, Martínez-Loredo, Grande-Gosende and Fernández-Hermida. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 29 November 2016
doi: 10.3389/fpsyg.2016.01838

Understanding Risk-taking Behavior in Bullies, Victims, and Bully Victims Using Cognitive- and Emotion-Focused Approaches

*Kean Poon**

Department of Special Education and Counselling, The Education University of Hong Kong, Hong Kong, Hong Kong

Bullying and risky behavior are two common problems among adolescents and can strongly affect a youth's overall functioning when both coexist. Some studies suggest that bullying in adolescence may promote risky behavior as a coping strategy to deal with victimization related stress. Other studies consider bullying as an outcome of high-risk behavior. Despite the association between the two is well-established, no study has examined the risk-taking patterns among bullying groups (i.e., bully, victim, and bully victim). This study attempted to elucidate the potential relationships between bullying and risk-taking by addressing the two models: a cognitive-focused model and an emotion-focused model of risk taking, and to clarify how adolescents' characteristics in risk taking associate with bullying outcomes.

Method: 136 Chinese adolescents (Mean Age = 14.5, $M = 65$, $F = 71$) were recruited and grouped according to bullying identity: Bully ($n = 27$), Victim ($n = 20$), Bully victim ($n = 37$) and Control ($n = 52$). Cognitive Appraisal of Risky Events (CARE) questionnaire was used to measure participants' expectancies about the risks, benefits and involvement associated with risky activities. Cambridge Gambling Task (CGT) was administered to capture the emotion-laden process in risk taking.

Results: Cognitively, Bully was associated with an overestimation of risk while Victim was associated with an underestimation of risk and overrated benefit. Bully victim exhibited a unique pattern with an overestimation of benefit and risk. All study groups projected higher involvement in risky behavior. Behaviorally, both Bully and Bully victim were associated with high risk modulation whereas Victim was associated with impulsive decision-making. Interestingly, compared with bully, bully victim had significantly higher bullying scores, suggesting a wider range and more frequent bullying activities. In conclusion, Bully maybe a group of adolescents that is vigilant in situational deliberation and risk modulation while Victims with high impulsivity, are more likely to place themselves in risky situations. Bully victims presented the combined pattern of the two pure groups and associated with the highest risk-taking propensity. Better picture of risk taking pattern associated with different groups was illustrated, allowing better matching for future prevention and intervention program for distinct bullying individuals.

Keywords: risk assessment, bullying, adolescents, peer victimization, risk taking

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Shaljan Areepattamannil, Emirates College for Advanced Education, UAE
Ken Cramer, University of Windsor, Canada

***Correspondence:**
Kean Poon
keanpoon@gmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *08 September 2016*
Accepted: *07 November 2016*
Published: *29 November 2016*

Citation:
Poon K (2016) Understanding Risk-taking Behavior in Bullies, Victims, and Bully Victims Using Cognitive- and Emotion-Focused Approaches. Front. Psychol. 7:1838. doi: 10.3389/fpsyg.2016.01838

INTRODUCTION

Bullying and victimization among youth is a serious and complex problem that is receiving increased attention. Bullying has been conceptualized as a distinct type of aggression characterized by a repeated and systematic abuse of power (Ttofi et al., 2012). It encompasses a spectrum of both physical and verbal aggressive actions. It can be direct (e.g., hitting, kicking, threatening, and extortion) or indirect (e.g., spreading rumors and social exclusion) (Karatzias et al., 2002). Because bullying involves a bully and a victim, early research tended to dichotomize children into one of these two mutually exclusive groups. However, there also appears to be a third group of bully victims who both bully and are bullied by others (Haynie, 2001; Veenstra et al., 2005).

Bullying and high-risk activities are two common problems among adolescents worldwide and can strongly affect a youth's physical, psychological, social, and educational functioning when both coexist (Currie et al., 2012). Recently, the link between bullying and risk-taking behavior is an emergent area of research. To date, studies have found associations between bullying and delinquency (Olweus, 1979), alcohol/substance use (Kaltiala-Heino et al., 2000; Nansel et al., 2001; Carlyle and Steinman, 2007), smoking (Ellickson et al., 1997; Forero et al., 1999), and unprotected sex (Liang et al., 2007). In particular, bullies and bully victims often exhibit the highest rate of wide ranged risk-taking behaviors (Haynie, 2001). On the other hand, there are major inconsistencies in the literature examining the association between victims and risk-taking behaviors. For example, some studies have suggested that adolescent victims are at a higher risk of heavy drinking and substance abuse than non-victim adolescents are (Wills and Filer, 1996; Khantzian, 1997; Maniglio, 2009). Other studies have revealed that victims of bullying had lower levels of smoking (Forero et al., 1999) and alcohol consumption (Nansel et al., 2001; Carlyle and Steinman, 2007) when compared to controls. Studies that explain the association between bullying and risk-taking behavior are bi-directional (e.g., Collier et al., 2013). Some studies suggest that bullying or other forms of peer victimization in adolescence may promote risky behavior such as substance abuse as a coping strategy or self-medication attempting to deal with or anesthetize victimization related stress or negative feelings (Danielson et al., 2010; Durand et al., 2013; Hong et al., 2014). However, other studies consider bullying as an outcome of, rather than a risk factor for, high-risk behavior. Despite the association between bullying and risk-taking behaviors, no study to date has examined risk-taking patterns among the three bully groups.

Risk Taking: The Decision-Making Model and the Social-Neuroscience Model

Both human and animal studies of risk-taking behavior have proposed models that predict risky choice. Recent studies have provided two new perspectives: the decision-making model (e.g., Millstein and Halpern-Felsher, 2001) and the social-neuroscience model (e.g., Steinberg, 2008). Decision-making theorists posit that individuals' beliefs about the consequences of their actions and perceptions of their vulnerability regarding those consequences play a key role in their behavior (Millstein and Halpern-Felsher, 2001). Researchers are interested in understanding why adolescents make the decisions they do and their competence in making these decisions. In conceptualizing and measuring perceptions of risk, decision-making theorists observe whether people recognize the benefits and risks inherent in a given situation in order to measure their sense of risk and vulnerability (Slovic, 1987; Siegrist et al., 2000). Recent studies have suggested that engagement in risky activities is determined by individual differences in cognitive appraisal (expected benefit minus expected risk) (Fromme et al., 1997, 1999). When a person overestimates the benefit of or underestimates the risk of certain events it increases the likelihood of their participation in a risky activity (Byrnes, 1998; Steinberg, 2004, 2005). In short, decision theorists generally believe that by adopting a risk-benefit analysis, one might obtain the net expectancy of the risky event, which might provide useful information in predicting an individual's involvement in risk-taking behavior (Steinberg, 2005). Under the decision-making model, risk perceptions play a fundamental role in behavioral intervention programs that try to encourage adolescents to recognize and acknowledge their own vulnerability to negative outcomes.

School bullying involves repeated aggression toward those who are perceived as weaker and less dominant and it has negative consequences for both bullies and victims (Ttofi et al., 2012). Many factors play an important role in school aggression: individual differences on how one encodes and emotionally processes evocative situations, interpretation and response to the behaviors of others, and motivation toward obtaining reward and avoiding punishment (e.g., Crick and Dodge, 1996). Another view of risk-taking behavior highlights the role of affective intensity and sensitivity to reward. According to this perspective, risky behavior cannot be fully explained by a deficiency in comprehending the potential consequences of these actions (Reyna and Farley, 2006). Moreover, leading environmental cues may "win" over cognitive control in emotionally charged circumstances. This model is supported by epidemiological reports of heightened affective responsiveness and incentive-based behavior changes when cognitive-based measures are hampered. Steinberg (2010) examined the social-neuroscience model of risk taking using behavioral measures. Steinberg used a gambling task to capture the reward-related decision-making process of participants and concluded that a heightened reward sensitivity and impulsivity were seen consistently and clearly in high-risk takers.

Study Objectives

In sum, while many studies on bullying and its associations with a variety of risk-taking behaviors have been performed, it is surprising that no study has examined and compared the risk-taking pattern among bullying groups (i.e., bully, victim, and bully victim). This study investigated the link between risk taking and bullying in adolescents in hopes to elucidate the potential relationship between bullying and risk-taking behavior by addressing the two models of risk taking. Within the framework of these two models, this study hopes to offer a holistic model for understanding and differentiating a risk-taking

pattern among the three bullying groups. Particularly, this study adopted a risk-appraisal questionnaire to address a cognitively focused process and a computerized gambling task to measure a motivational, emotion-focused process. It was hypothesized that bullies and victims would exhibit different patterns of risk appraisal and propensity. Moreover, bully victims were expected to present co-morbid patterns of both bullies and victims.

MATERIALS AND METHODS

Participants

The study sampled students from Hong Kong public secondary schools. A multi-stage sampling procedure was used to obtain the sample. Mass invitation has been sent to all public secondary schools in Hong Kong. Schools to be studied were then randomly selected such that the proportion of students in each selected district represented the number of students in that area. This selection procedure resulted in the selection of 4 schools respectively with one from Hong Kong Island, one from Kowloon Peninsula, and two from the New Territories. As schools were given the option to withdraw from participation, a further four schools were selected by the same procedure to act as a back-up. Schools that withdrew from participation were replaced by schools on the back-up list from within the same district. Of the originally selected schools, none withdrew from participation. From each school, six students were randomly selected from grade 7 to grade 12, such that a total of 36 students were selected per school for participation. With eight students dropped out in the middle of the study, 136 adolescents were recruited and tested. Participants ranged in age from 12 to 17 years ($M = 14.45$, $SD = 1.614$) and comprised of 65 males (M) (47.8%) and 71 females (F) (52.2%). Based on self-reported experience of school bullying and victimization in the last 4 months, the participants were categorized into four distinct groups: control group ($n = 52$, $M = 19$, $F = 33$), bully group ($n = 27$, $M = 10$, $F = 17$), victim group ($n = 20$, $M = 10$, $F = 10$), and bully victim group ($n = 37$, $M = 26$, $F = 11$). All participants had a clean medical history; spoke Cantonese as their first language; had normal intelligence; and had no suspected brain damage or neurological, sensory, or psychiatric problems.

Materials

This study consisted of a screening phase and an assessment phase. During the screening phase, participants were administered a standard Raven Progressive Matrices (RPM) as a proxy of intelligence in order to rule out low intellectual functioning. Only students with normal intelligence were invited to the assessment phase. During the assessment phase, the Computerized Cambridge Gambling Task (CGT) was administered individually to each participant. Participants then completed a demographic questionnaire including questions about age, educational level, family income, and the Cognitive Appraisal of Risky Events Questionnaire (CARE). The assessment phrase lasted approximately 1 h. All assessments were conducted by well-trained research assistants with undergraduate degrees in psychology who had been trained for approximately 2 h in test administration. All parents and adolescents provided informed consent to participate in this study. Ethical approval for the research was gained through the Human Research Ethics Committee at the Education University of Hong Kong.

Measures

Non-verbal Intelligence

A traditional RPM (Raven et al., 2000) was employed in this study for screening purposes. It is a non-verbal, intellect measure that captures both analytic reasoning and visual-spatial reasoning ability. It comprises 60 items. Participants first see one implicitly meaningful diagram with one missing piece and six choices. The goal is to complete the diagram by identifying the correct piece. As the test proceeds, participants will face tougher decisions with additional implicit rulings, diagrams, and similar answers introduced. Only participants who score in the 80th percentile or above re selected and proceed to the assessment phase. Since items serves as simple, perceptual-motor control it is capable to provide a pure measure of "g factor" (deductive and reproductive ability) regardless of cultural and knowledge influence (Prabhakaran et al., 1997).

School-Bullying

A school-bullying questionnaire (Ng and Tsang, 2008; Wong et al., 2008) was used in this study for grouping and measuring the frequency of being bullied or victimized. The questionnaire comprised three subscales: (a) the witness, (b) the bully, and (c) the victim, which include identical items with only a difference in perspective wordings (i.e., witnessed, bullied, or victimized). Only the bully and victim subscales were administrated in this study (see **Appendix A**). Each subscale measured the rate of bullying with five categories: physical, verbal, relational, extortion, and intimidation on a 4-point frequency scale consisting of 0 (*never*), 1 (*at least once per month*), 2 (*once per week*), and 3 (*everyday*). Participants were placed into corresponding groups according to features of bullying identity. The control group comprised participants who did not indicate any bullying-related experience, the bully group comprised participants who indicated experience in bullying only, the victim group comprised participants who indicated experience in being victimized only, and the bully victim group comprised participants who indicated experience with both bullying and victimization. The bully and victim subscales had an internal reliability of $\alpha = 0.72$ and 0.73, respectively.

Cognitive Appraisal in Risky Behavior

The CARE questionnaire was administered to measure adolescents' outcome expectancies about the risks and benefits associated with involvement in risky activities. These outcome expectancies were measured by three CARE subscales: expected benefits (CARE_EB, **Appendix B**), expected risks (CARE_ER, **Appendix C**), and expected involvements (CARE_EI, **Appendix D**) (Fromme et al., 1997). The CARE_EB and CARE_ER scales capture the extent that participants anticipate positive or negative outcomes from their participation in 30 risky activities on a 7-point Likert scale ranging from 1 *(not likely)* to 7 (*very likely*). The CARE_EI scale uses the same Likert

scale; however, it measures the likelihood of participation in these risky activities. The CARE questionnaire covers activities of illicit drug use (e.g., smoking marijuana), aggressive illegal behavior (e.g., slapping someone), risky sexual activities (e.g., sex with multiple partners), heavy drinking (e.g., drinking more than 5 alcoholic beverages), high-risk sports (e.g., mountain climbing), and negative academic work behavior (e.g., missing class). The goal of the CARE questionnaire is to predict behavioral problem tendencies associated with cognitive factors. Its reliability is excellent (Cronbach's α for CARE_EB, CARE_ER, and CARE_EI are 0.90, 0.90, and 0.89, respectively).

Behavioral Measure in Risky Behavior

The CGT was administered to capture risk-taking propensity and reward-related sensitivity under uncertainty (Edwards, 1957; Andrew and Cronin, 1997; Rogers et al., 1999; Greene et al., 2000; Ladouceur et al., 2000). It aims to minimize both the learning and executive/working memory demands on participants, which can confound the interpretation of test scores. In the CGT, participants see 10 boxes colored either red or blue on the top of the screen. Display of the boxes represents the probability of winning (e.g., 9B:1R, 5B:5R). The goal is to bet on the color with a higher probability in later trials staring with 100 points to earn more points. At the beginning of the first trial, all participants were informed that they were playing for a joint school competition and those who scored in the top ten would receive a souvenir as a reward. Four trials were administered and the first and third trial was for practice/instruction for the upcoming trial. An ascending rule was implemented on the first two trials as the amount-to-bet was determined progressively by the points the participant held: 5, 25, 50, 75, and 95%. A descending rule was also implemented as participants could decrease their bet progressively. Points available to bet would grow larger or shrink smaller, respectively. A high/low pitched sound was prompted informing participants if they won or lost at the end of every round. When the participant finished a trial, his/her final points were presented allowing him/her to compare their current score with their previous score and motivate him/herself to perform better in the next trial.

Verbal instruction

Participants were instructed that they could see a row of boxes across the top of the screen with "X" red boxes and "Y" blue boxes. The computer had hidden a yellow token under one of these boxes. Participants had to decide whether they thought it was hidden under a red box or a blue box.

Ascending stage

Participants were instructed that they were provided with 100 points to start. After they chose red or blue, they had to bet a certain amount of points that they could win. The first bet they were shown was small; however, as they waited, the bets grew larger, which allowed them to choose the size of your bet. The size of the bets also depended on how many points they had: the smallest bet as always 5% of the total and the largest bet was always 95% of the total. They were encouraged to try to make as much as they could. At the final score screen in between the blocks, several prompts were used depending on how well the participants' score was increasing. For example, "Well done! That was good. Now you are going to start off with 100 points again and you need to try to build up as many points as you can again." If the final score got too low participants received a prompt such as "hard luck!"

Descending training and test

This time, the way participants' selected their bets was slightly different as the first bet offered was large and then they gradually got smaller. Participants were instructed to practice and to make as much as they could.

Propensity outcome measures

The CGT consisted of six propensity outcome measures: (a) *Deliberation time* is the mean decision latency of participants choosing what color to bet on after presentation of the colored boxes. Higher scores represented longer deliberation time measured in milliseconds. (b) *Delay aversion* measures the difference in the bet's percentage in the ascending verses the descending condition. If participants were unwilling or unable to wait to make a decision then they would be more likely to bet larger amounts when the possible bets were displayed in descending rather than ascending order. Higher scores indicated greater impulsivity. (c) *Quality of decision-making* is the proportion of trials that the participant chose to gamble on the more likely outcome. Higher scores meant that more choices were made on the likely outcome. (d) *Risk taking* is the mean proportion of points that the participant makes on each trial when they had chosen the more likely outcome. Higher score indicated that more points were placed on the likely outcome. (e) *Risk adjustment* is the degree that a participant varies their risk taking in response to the ratio of red to blue boxes on each trial. Higher score represented more likelihood to modify his/her response when the outcome probability changed. (f) *Overall proportion bet* measured the mean proportion of points bet across all trials. Higher scores represented a larger overall bet amount.

Data were analyzed with the SPSS version 21 for Windows, and were inspected for normality to ensure that the assumptions of parametric statistics were met before analyses were performed. The significance level was set at $p < 0.05$.

RESULTS

Descriptive Statistics

Table 1 summarizes the descriptive statistics for each group. Close to a marginally significant level of group differences were found in general intellectual ability [$F(3,125) = 2.58$, $p = 0.06$, $\eta_p^2 = 0.06$]. *Post hoc* pairwise comparisons revealed that the control group had significantly outperformed the victim group ($p < 0.05$). No significant difference was found between the control and the bully victim group ($p = 0.68$). The four groups did not differ in age, education level (self, father, and mother), and average family income (all $ps > 0.10$). Total bully scores and victim scores captured from the school bullying questionnaire are also summarized in **Table 1** with higher scores representing more frequent bullying or victimization behavior.

TABLE 1 | Characteristics of controls, bullies, victims, and bully victims.

	Control (0) $n = 52$	Bully (1) $n = 27$	Victim (2) $n = 20$	Bully (3) $n = 37$	F	P	η_p^2	*Post hoc*
Age	14.56 (1.51)	14.41 (1.69)	14.35 (1.57)	14.38 (1.77)	0.13	0.94	0.00	
General intellectual ability[1,2]	108.35 (14.02)	102.60 (12.28)	100.25 (11.17)	107.18 (11.99)	2.58	0.06	0.06	0,3 > 1,2
Education level[3]	8.92 (1.37)	8.81 (1.47)	8.70 (1.81)	8.95 (1.49)	0.15	0.93	0.00	
Edu level father[3]	8.15 (2.94)	9.00 (2.39)	8.33 (3.09)	7.50 (3.29)	1.04	0.38	0.03	
Edu level mother[3]	8.53 (2.96)	8.89 (3.09)	9.47 (1.33)	8.68 (2.93)	0.47	0.71	0.02	
Average family income	6.20 (4.45)	5.92 (3.91)	5.79 (3.78)	4.65 (2.12)	1.20	0.31	0.03	
Total bully	0.00 (0.00)	1.67 (0.96)	0.00 (0.00)	2.54 (1.41)	79.39	0.00**	0.64	
Total victim	0.00 (0.00)	0.00 (0.00)	2.85 (2.87)	2.78 (2.45)	30.80	0.00**	0.41	

*[1]Standard Raven Progressive Matrices; [2]Scaled score; [3]American Grade System; Edu, education; *p < 0.05, **p < 0.01.*

The bully victim group showed significant higher bullying frequency than the bully group ($p < 0.001$); however, there was no difference in victim score between the victim and bully victim groups ($p > 0.10$). For sex, a chi-square analysis was applied and a statistical significance was found [see **Table 2**, $\chi^2(3, N = 136) = 9.72, p = 0.02$].

Cognitive Appraisal of Risky Events

To examine whether bullying identity (control, bully, victim, bully victim) was significantly associated with the three outcome expectancies measured by CARE, a series of 2 (bully vs. not bully) × 2 (victim vs. not victim) between subject ANCOVAs with general intellectual ability as covariate were computed and summarized in **Table 3**. A *post hoc* Fisher's Least Significant Difference (LSD) for group comparison within each sub-questionnaire was also conducted. Based on the framework of the decision-making model, a hierarchical regression analysis was conducted to examine the expected net (CARE_EN) (CARE_EN = CARE_EB – CARE_ER) in predicting CARE_EI (see **Table 4**). Results showed that the aggregate effect of expected benefit minus expected risk significantly predicted the expected involvement of risky events ($p < 0.001$).

Expected Benefits

The positive expectancy for risky activities was measured by the CARE_EB subscale. Higher scores represented a greater degree of positive outcome anticipation. There was significant main effect of victim [$F(1,120) = 24.49$, $p < 0.001$, $\eta_p^2 = 0.17$] meaning that victims anticipated risky events significantly more beneficial than the other groups did. Neither the main effect of being a bully [$F(1,120) = 2.98$, $p = 0.09$, $\eta_p^2 = 0.02$] nor the interaction between being a bully and victim [$F(1,120) = 0.04$, $p = 0.83$, $\eta_p^2 = 0.00$] was significant. Inspection of means showed bully victims and victims scored significantly higher than controls and bullies, who confirmed a main effect of victims overestimating the benefits of risky events (see **Table 3**).

Expected Risks

The negative expectancy of risk activities was captured through the CARE_ER subscale. Higher scores represented a greater degree of anticipating negative outcomes. There were significant main effects of bully [$F(1,120) = 4.41$, $p < 0.05$, $\eta_p^2 = 0.03$] and victim [$F(1,120) = 14.12$, $p < 0.001$, $\eta_p^2 = 0.10$] meaning that participants with a bully or a victim identity anticipated risky events as significantly more or less risky. There was no significant interaction effect ($p = 0.15$). Mean scores of victims were significantly lower than the other groups suggesting a main effect of victims underestimating risks and bullies overestimated risks (**Table 3**).

Expected Involvements

Anticipation of participation for risky events was measured using CARE Expected Involvement subscale. The higher score suggests the higher probability of participation in potentially harmful activities. There were significant main effects of Victim [$F(1,120) = 14.27$, $p < 0.001$, $\eta_p^2 = 0.10$] and Bully [$F(1,120) = 5.79$, $p < 0.05$, $\eta_p^2 = 0.05$]. There was no significant interaction effect ($p = 0.16$). Mean scores on Bully, Victim, and Bully Victim were significantly higher than Control group (see **Table 3**). The pattern suggested participants with Bully or Victim identity anticipate higher expected involvement in risky events.

Predicting Bully and Victim Scores

A hierarchical regression analysis was conducted to examine what CARE variables best predicted the severity of bullying and victimization. **Table 5** shows that CARE accounted for

TABLE 2 | Cross-tabulation of sex according to bully groups.

	Control (0) $n = 52$	Bully (1) $n = 27$	Victim (2) $n = 20$	Bully victim (3) $n = 37$	Total	χ^2	Φ
Male	19 (24.5)	10 (12.7)	10 (9.4)	25 (17.4)	64	9.72**	0.27
Female	33 (27.5)	17 (14.3)	10 (10.6)	12 (19.6)	72		
Total	52	27	20	37	136		

*Number in parentheses is total number of conferences in each category. Number in cells is expected counts. *p < 0.05, **p < 0.01.*

TABLE 3 | Cognitive appraisal of controls, bullies, victims, and bully victims: expected benefits, risks, and involvement.

	Control (0) (n = 51)	Bully (1) (n = 25)	Victim (2) (n = 20)	Bully victim (3) (n = 33)	Main effect				Interaction		ANCOVA	
	Total	Total	Total	Total	Bully		Victim		Bully*Victim			
Cognitive Appraisal	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*F*	η_p^2	*F*	η_p^2	*F*	η_p^2	*F*	*Post hoc*
Expected Benefits	52.65 (14.04)	59.04 (24.50)	73.20 (23.49)	82.09 (32.75)	2.98	0.02	24.49**	0.17	0.04	0.00	11.78**	3,2 > 1,0
Expected Risks	173.00 (36.53)	175.36 (34.29)	137.05 (46.72)	162.00 (18.78)	4.41*	0.03	14.12**	0.10	2.13	0.02	5.63**	0,1,3 > 2
Expected Involvement	45.94 (10.11)	55.72 (17.71)	58.90 (13.44)	62.48 (18.52)	5.79*	0.05	13.51**	0.10	1.98	0.02	10.11**	3,2,1 > 0

*$p < 0.05$, **$p < 0.01$.

TABLE 4 | Hierarchical regressions predicting expected involvement in the cognitive appraisal of risky events.

Step	IV	Total R^2	R^2 change	Standardized β	t
1	Expected Net (EB-ER)	0.08	0.08	0.29	3.49**

*EB, expected benefits; ER, expected risks, *$p < 0.05$, **$p < 0.01$.*

an additional 16.9% of the variance in Bullying severity, and CARE_EI was the only significant predictor of Bullying severity ($\beta = 0.40$, $t = 4.30$, $p < 0.001$). Regarding the severity of victimization, **Table 6** shows that CARE accounted for only an additional 2.5% of the variance in victimization severity, and none of the CARE variables significantly predicted the frequency of being bullied.

Behavioral Measure in Risky Behavior: The Cambridge Gambling Task

In order to capture behavior differences in adolescents' reward-related sensitivity and risk-taking propensity, the six CGT factors previously listed were analyzed with general intellectual ability as a covariate using a 2 (bully vs. not bully) × 2 (victim vs. not victim) between-subjects ANCOVA (see **Table 7**). A one-way ANCOVA followed by a *post hoc* LSD were conducted to examine significant differences between groups within each factor. Correlations between the CGT factors are shown in **Table 8**.

Deliberation Time

For mean decision latency, there was a significant main effect of victim [$F(1,120) = 5.56$, $p < 0.05$, $\eta_p^2 = 0.04$], and a marginal main effect of bully [$F(1,120) = 3.27$, $p = 0.07$, $\eta_p^2 = 0.03$]. An interaction effect was not found [$F(1,120) = 1.25$, $p = 0.27$, $\eta_p^2 = 0.01$]. Inspection of means revealed that victims might use shortened decision times than bullies (see **Table 7**).

Delay Aversion

Delay aversion captured differences between the scores in the descending and ascending conditions. There was a marginal main effect for bully [$F(1,120) = 3.30$, $p = 0.07$, $\eta_p^2 = 0.03$] and a significant main effect for victim [$F(1,120) = 7.41$, $p < 0.01$, $\eta_p^2 = 0.06$]. An interaction effect was not found [$F(1,120) = 0.85$, $p = 0.36$, $\eta_p^2 = 0.01$]. Inspection of mean scores on delay aversion revealed that victims had higher scores than controls, bullies, and bully victims, suggesting that victims might be more impulsive than the other groups.

Decision-Making Quality

Neither a main effect of bully [$F(1,120) = 1.75$, $p = 0.19$, $\eta_p^2 = 0.01$] nor a main effect of victim [$F(1,120) = 0.68$, $p = 0.41$, $\eta_p^2 = 0.01$] were significant. There was a significant interaction effect of bully and victim [$F(1,120) = 5.64$, $p < 0.05$, $\eta_p^2 = 0.04$]. The interaction effect revealed that with the absence of bullies, victims alone incurred significant impact to the proportion of trials participants gambled on the more favorite outcome, leaving the victim group as the only group that made more choices

TABLE 5 | Hierarchical regressions predicting cognitive appraisal in risky events variables among bully total.

Step	IV	Total R^2	R^2 change	Standardized β	*t*
1	Expected Involvements	0.169	0.169	0.365	4.296**
	Expected Benefits			0.111	1.25
	Expected Risks			0.042	0.499

*$p < 0.05$, **$p < 0.01$.

TABLE 6 | Hierarchical regressions predicting cognitive appraisal in risky events variables among victim total.

Step	IV	Total R^2	R^2 change	Standardized β	*t*
1	Expected Benefits	0.025	0.025	0.111	1.157
	Expected Involvements			0.086	0.930
	Expected Risks			0.033	0.366

*$p < 0.05$, **$p < 0.01$.

on the likely outcome. A subsequent means scores comparison revealed that victims scored higher than bully victims and controls (**Table 7**).

Risk Taking

Neither a main effect of bully ($p = 0.46$) or victim ($p = 0.85$) nor any interactions were significant ($p > 0.10$).

Risk Adjustment

There was a significant main effect of Bully [$F(1,120) = 9.66$, $p < 0.01$, $\eta_p^2 = 0.07$]. Neither main effects of Victim [$F(1,120) = 1.50$, $p = 0.22$, $\eta_p^2 = 0.01$] nor interaction effect [$F(1,120) = 0.45$, $p = 0.50$, $\eta_p^2 = 0.00$] were significant. Inspection of mean scores revealed that Bully had higher risk adjustment scores than Victim (**Table 7**) suggesting Bully identity exhibited higher risk modulation.

Overall Bet Proportion

There was no significant main effect of bully [$F(1,120) = 0.48$, $p = 0.49$, $\eta_p^2 = 0.00$], victim [$F(1,120) = 1.39$, $p = 0.24$, $\eta_p^2 = 0.001$], or interaction [$F(1,120) = 0.42$, $p = 0.52$, $\eta_p^2 = 0.00$].

Predicting Bullying and Victim Scores

A hierarchical regression analysis was conducted to examine what CGT variables best predicted the severity of bullying and victimization. **Table 9** shows that CGT accounted for an additional 10.2% of the variance in bullying severity and risk adjustment was the only significant predictor of bullying severity ($\beta = 0.25$, $t = 2.77$, $p < 0.01$). Regarding the severity of victimization, **Table 10** shows that CGT only accounted for an additional 3.5% of the variance in the frequency of victimization and none of the CGT variables significantly predicted the severity of victimization.

TABLE 7 | Cognitive appraisal of controls, bullies, victims, and bully victims using the Cambridge Gambling Task (CGT).

	Control (0) ($n = 51$)	Bully (1) ($n = 25$)	Victim (2) ($n = 20$)	Bully victim (3) ($n = 33$)	Main effect				Interaction		ANOVA	
					Bully		Victim		Bully*Victim			
Cambridge Gambling Task	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*F*	η_p^2	*F*	η_p^2	*F*	η_p^2	*F*	*Post hoc*
Deliberation time	2404.49 (970.58)	2618.58 (111.80)	1865.76 (409.84)	2317.85 (1274.03)	3.27	0.03	5.56*	0.04	1.25	0.01	2.60	0,1,3 > 2
Delay aversion	0.26 (0.32)	0.21 (0.29)	0.46 (0.25)	0.30 (0.22)	3.30	0.03	7.41**	0.06	0.85	0.01	3.04*	2 > 0,1,3
Quality of decision making	0.88 (0.14)	0.88 (0.10)	0.93 (0.11)	0.86 (0.16)	1.75	0.01	0.68	0.01	5.64*	0.04	2.30	2 > 0,1,3
Risk taking	0.53 (0.14)	0.49 (0.13)	0.52 (0.14)	0.54 (0.17)	0.13	0.00	0.92	0.01	1.20	0.01	0.73	
Risk adjustment	0.81 (0.97)	1.15 (0.91)	0.40 (0.91)	1.11 (0.79)	9.66**	0.07	1.50	0.01	0.45	0.00	3.28*	1,3 > 0,2
Overall bet proportion	0.49 (0.14)	0.45 (0.13)	0.49 (0.13)	0.50 (0.15)	0.48	0.00	1.39	0.01	0.42	0.00	0.68	

*$p < 0.05$, **$p < 0.01$.

TABLE 8 | Correlations among CGT variables.

	Delay aversion	Quality of decision making	Risk taking	Risk adjustment	Overall bet proportion
Deliberation time	−0.14	−0.49**	−0.24**	−0.05	−0.23**
Delay aversion		0.03	0.08	−0.08	0.13
Quality of decision making			0.27**	0.19*	0.32**
Risk taking				−0.09	0.97**
Risk adjustment					−0.15

*$p < 0.05$, **$p < 0.01$.

TABLE 9 | Hierarchical regressions predicting CGT variables among bully total.

Step	IV	R^2	R^2 change	Standardized β	*t*
1	Risk adjustment	0.102	0.102	0.252	2.770**
	Quality of decision making			−0.131	1.239
	Risk taking			0.343	0.923
	Delay aversion			−0.041	0.467
	Deliberation time			−0.043	0.431
	Overall proportion			−0.124	0.324

*$p < 0.05$, **$p < 0.01$.

TABLE 10 | Hierarchical regressions predicting CGT variables among victim total.

Step	IV	Total R^2	R^2 change	Standardized β	*t*
1	Quality of decision making	0.035	0.035	−0.086	0.782
	Risk adjustment			0.073	0.776
	Delay aversion			0.070	0.775
	Deliberation time			−0.050	0.488
	Risk taking			0.085	0.222
	Overall proportion			0.078	0.196

*$p < 0.05$, **$p < 0.01$.

DISCUSSION

Risk Taking in Bullies

Bullying and risk-taking behavior are two common problems among adolescents worldwide and can cause serious impact to adolescents' physical, psychological, social, and educational functioning when both coexist in the same youth (Currie et al., 2012). Despite the associations between bullying and risk-taking behaviors, no study thus far has examined and compared the risk-taking pattern among bullying groups (i.e., bully, victim and bully victim). This study elucidated the risk-taking pattern in these three bullying groups by addressing two risk-taking models (i.e., the decision-making model and the social-neuroscience model) and clarifying how adolescents' characteristics in risk taking may associate with outcomes in bullying or victimization.

These findings suggest that being a bully or victim is associated with distinct results on the two approaches, and these results contribute several novel findings to the current literature. Under the decision-making framework, bullying was associated with higher negative expectancy on risky activities and more expected involvement in them. In other words, being a bully meant more anticipated negative outcomes in risky activities. Interestingly, despite the higher anticipation of negative outcomes, bullies expected themselves to have higher involvement in these activities compared to the non-bully groups. In CGT, bullying was associated with positive risk-taking adjustment, an increased amount of gambling their points when the odds were in their favor, and vice versa. These results indicated that being a bully was vigilant in situational deliberation and risk modulation, and contradicted the general agreement that there was a positive link between bullying and impulsivity (Olweus, 1995; Schwartz et al., 2001; O'Brennan et al., 2009). Perhaps bullying is a unique, complex form of interpersonal aggression or group phenomenon (e.g., Olweus, 2001; Salmivalli, 2001; Rodkin and Hodges, 2003) and bullies tend to be hyper-vigilant to social cues and attribute negative intentions to others (Vaillancourt et al., 2003). The paradox of aggression is that it is both adaptive and maladaptive. Aggressive adolescents are at risk for a host of possible negative consequences (e.g., disciplinary punishment, school suspension, etc.) (Dodge et al., 2006). However, aggression is often a successful means in changing other's behavior and can be used to acquire resources and maintain group boundaries. Moreover, researchers generally agree that bullies tend to exhibit high levels of social intelligence and the ability to manipulate peers (e.g., Peeters et al., 2010). In other words, bullies may be a group of adolescents who are sensitive and respond quickly to external cues through peer manipulation, resulting in potential risk for themselves and victims.

Risk Taking in Victims

The results of the CARE questionnaire suggested that victims were associated with an overestimation of benefits, an underestimation of risks, and higher expected involvement in risky events. According to the decision-making model, these patterns suggested the lowest sense of risk and the highest vulnerability to it (Hunter and Boyle, 2004; Hunter et al., 2004; Wachs et al., 2012). Motivationally, victims were associated with less deliberation time and more delay aversion in CGT. In

CGT, even though delay response does not increase the available information for decision making, shorter deliberation time may indicate impulsive decision-making. This assumption was further supported by their poor performance in delay aversion and that victims were more likely to bet larger amounts when bets were displayed in a descending rather than an ascending way. It is well established that impulsivity is particularly relevant to peer victimization. For example, children with attention-deficit/hyperactivity disorder who share common features of impulsivity and high risk-taking propensity, show marked impairment in peer relationships and are significantly bullied by peers (e.g., Hoza, 2007). Researchers argued that individuals who are low on self-control or high on impulsivity are unable to see the consequences of their actions and more likely to place themselves in risky situations without regard for their long-term outcome (e.g., Higgins et al., 2009).

Risk Taking in Bully Victims

Consistent with our hypothesis, bully victims presented the combined pattern of the two pure groups. Cognitively, bully victims showed similar, but not identical patterns of the two pure groups. Bully victims overestimated the benefits of risk as well as benefit and projected the highest possibility of engaging in risky behavior. Motivationally, this unique group shared identical patterns with bullies in terms of positive risk adjustment. In other words, bully victims exhibited similar risk tendencies to victims in terms of cognitive-focused processes and to bullies on emotion-focused processes. Importantly, compared with bullies, bully victims had significantly higher bullying scores, showing that they engaged in a wider range of more frequent bullying activities. In fact, previous studies that focused on the frequency and forms of bullying also reported that bully victims used wider and more aggressive strategies than the pure groups did (Olweus, 1993; Schwartz, 1999; Olafsen and Viemerö, 2000). Additional evidence has suggested that bully victims may exhibit the highest aggression level of all three groups as well as the poorest emotion regulation (e.g., Nansel et al., 2004). Olweus (1978) suggested that bullies were generally more functional, more likely to use proactive aggression, and more likely to have an extensive social network than bully victims, who were more likely to react aggressively and show troubling risk patterns across virtually all adjustment indicators.

Implications

Concern about the frequency and effects of adolescent bullying was reflected in the increase in research aimed at understanding its causes and consequences in order to develop appropriate policy and intervention strategies. Nonetheless, the success of intervention programs to prevent or mitigate bullying in adolescence has been limited (e.g., Olweus, 1999; Merrell et al., 2008). Even when programs have an impact, the improvement appears to be in changing adolescents' knowledge and perceptions on bullying, but not the behavior. This study extended the existing literature on bullying and victimization by addressing the co-occurrence of bullying and victimization and identifying a range of risk-taking patterns associated with the three groups. This study suggested that there were significant group differences on how bullies, victims, and bully victims appraised risky events and emotionally processed evocative risky situations. Moreover, this study identified different predictors of bullying and victimization. In accordance with the decision-making model, this study provided further support that participants' perceived benefits and risk may play a key role in predicting their expected involvement in risky behaviors. Given that expected involvement in risky events is a significant predictor to the severity of bullying, future intervention programs should include cognitive training in risk evaluation (Steinberg, 2007). For instance, presenting strategies for effective risk and benefit evaluation will encourage less risky and healthier choices. Moreover, given the high vigilance of bullies to external cues, future interventions should target the enhancement of social skills and coping strategies on peer conflicts. Victims with marked impulsivity, on the other hand, may be targeted to deliver interventions on self-control that strengthen their ability to fit in with their peers and reduce the likelihood of rejection and victimization, or to provide supportive interpersonal relationships to reduce their isolation (Andreou et al., 2005). Effective and comprehensive evaluation of risk is another intervention focus for victims to help increase their awareness on the consequences of their risky choices.

Limitations and Future Directions

This study has several limitations that should be considered when interpreting our findings. First, the sample size was relatively small. Future studies should include a larger sample size and a power calculation to determine what sample size would be needed to detect differences between groups. Second, this study was cross-sectional in nature. Therefore, causation cannot be determined. A temporal relationship between bullying and a risk-taking pattern could not be inferred. Questions of causation can only be answered in a longitudinal research design, which should be implemented in the future. Third, this study was localized to Chinese adolescents. Even though assessment tools were standardized, a comprehensive assessment tool on risk appraisal may be needed to elicit cultural differences on risk perception. In China, school bullying is often regarded as a collective act (Cheng et al., 2011; Huang et al., 2013; Chui and Chan, 2015), and whether this is a form of "collective bullying" that may cause an impact to the risk-taking pattern is yet to be determined. Fourth, although this study examined emotional aroused stimulation (i.e., the gambling task), it might not present an authentic context where bullying is most likely to occur. Lastly, this study was limited by its use of self-report measures (e.g., the bully or the victim). Biases such as social desirability and retrospective recall issues may occur. Moreover, the likelihood of under-reporting adolescents' school bullying behavior was also possible. Future research should include other bullying behavioral assessments such as peer and teacher nominations and behavioral observations as supplementary measures to validate self-reported findings (e.g., Espelage and Holt, 2001; Espelage and Swearer, 2003).

With growing recognition that bullying is a complex phenomenon that is influenced by multiple factors, past research has been examined within a sociological framework. This study

enhanced the understanding of this social phenomenon from a psychological perspective by examining the risk-taking pattern associated with bullies, victims, and bully victims. This analysis will aid in not only comprehending the mechanism of how these groups respond to risk taking, but also lead to improved practice for prevention and intervention. Overall, bullying behavior is the result of the interaction of multiple causes and factors, and it is too early to believe that the identification of various risk-taking patterns or specific intervention that target their unique risk-taking processes would be a cure-all solution for the elimination of bullying or victimization in these groups. However, this study provides a basis for future studies to adopt a holistic approach in investigating the link between bullying and risk-taking behavior.

AUTHOR CONTRIBUTIONS

KP is the sole author of this research article and her task involves conception or design of the work, data analysis and interpretation, drafting the article and final approval of the version to be published.

ACKNOWLEDGMENT

The work described in this paper was partially supported by the Research Support Scheme 2016/2017 of the Department of Special Education and Counselling at the Education University of Hong Kong.

REFERENCES

Andreou, E., Vlachou, A., and Didaskalou, E. (2005). The roles of self-efficacy, peer interactions and attitudes in bully-victim incidents implications for intervention policy-practices. *Sch. Psychol. Int.* 26, 545–562.

Andrew, M., and Cronin, C. (1997). Two measures of sensation seeking as predictors of alcohol use among high school males. *Pers. Individ. Dif.* 22, 393–401. doi: 10.1016/S0191-8869(96)00214-0

Byrnes, J. P. (1998). *The Nature and Development of Decision-Making: A Self-Regulation Model*. Philadelphia, PA: Psychology Press.

Carlyle, K. E., and Steinman, K. J. (2007). Demographic differences in the prevalence, co-occurrence, and correlates of adolescent bullying at school. *J. Sch. Health* 77, 623–629. doi: 10.1111/j.1746-1561.2007.00242.x

Cheng, Y. Y., Chen, L. M., Liu, K. S., and Chen, Y. L. (2011). Development and psychometric evaluation of the school bullying scales: a Rasch measurement approach. *Educ. Psychol. Meas.* 71, 200–216. doi: 10.1177/0013164410387387

Chui, W. H., and Chan, H. C. O. (2015). Self-control, school bullying perpetration, and victimization among Macanese adolescents. *J. Child Fam. Stud.* 24, 1751–1761. doi: 10.1016/j.chiabu.2012.12.003

Collier, K. L., van Beusekom, G., Bos, H. M., and Sandfort, T. G. (2013). Sexual orientation and gender identity/expression related peer victimization in adolescence: a systematic review of associated psychosocial and health outcomes. *J. Sex Res.* 50, 299–317. doi: 10.1080/00224499.2012.750639

Crick, N. R., and Dodge, K. A. (1996). Social information-processing mechanisms in reactive and proactive aggression. *Child Dev.* 67, 993–1002. doi: 10.2307/1131875

Currie, C., Zanotti, C., Morgan, A., Currie, D., de Looze, M., Roberts, C., et al. (2012). *Social Determinants of Health and Well-Being among Young People*. Copenhagen: World Health Organization Regional Office for Europe.

Danielson, C. K., McCart, M., de Arellano, M. A., Macdonald, A., Doherty, L., and Resnick, H. (2010). Risk reduction for substance use and trauma-related psychopathology in adolescent sexual assault victims: findings from an open trial. *Child Maltreat.* 15, 261–268. doi: 10.1177/1077559510367939

Dodge, K. A., Coie, J. D., and Lynam, D. (2006). "Aggression and antisocial behavior in youth," in *Handbook of Child Psychology*, eds W. Damon and R. M. Lerner (Hoboken, NJ: John Wiley & Sons, Inc.).

Durand, G., Belacel, N., and LaPlante, F. (2013). Graph theory based model for learning path recommendation. *Inf. Sci.* 251, 10–21. doi: 10.1016/j.ins.2013.04.017

Edwards, A. L. (1957). *The Social Desirability Variable in Personality Assessment and Research*. New York, NY: Dryden Press.

Ellickson, P., Saner, H., and McGuigan, K. A. (1997). Profiles of violent youth: substance use and other concurrent problems. *Am. J. Public Health* 87, 985–991. doi: 10.2105/AJPH.87.6.985

Espelage, D. L., and Holt, M. K. (2001). Bullying and victimization during early adolescence: peer influences and psychosocial correlates. *J. Emot. Abuse* 2, 123–142. doi: 10.1300/J135v02n02_08

Espelage, D. L., and Swearer, S. M. (2003). Research on school bullying and victimization: What have we learned and where do we go from here? *Sch. Psychol. Rev.* 32, 365–384.

Forero, R., McLellan, L., Rissel, C., and Bauman, A. (1999). Bullying behaviour and psychosocial health among school students in New South Wales, Australia: cross sectional survey. *BMJ* 319, 344–348. doi: 10.1136/bmj.319.7206.344

Fromme, K., D'Amico, E. J., and Katz, E. C. (1999). Intoxicated sexual risk taking: an expectancy or cognitive impairment explanation? *J. Stud. Alcohol* 60, 54–63. doi: 10.15288/jsa.1999.60.54

Fromme, K., Katz, E. C., and Rivet, K. (1997). Outcome expectancies and risk-taking behavior. *Cogn. Ther. Res.* 21, 421–442. doi: 10.1023/A:1021932326716

Greene, K., Krcmar, M., Walters, L. H., Rubin, D. L., and Hale, L. (2000). Targeting adolescent risk-taking behaviors: the contributions of egocentrism and sensation-seeking. *J. Adolesc.* 23, 439–461. doi: 10.1006/jado.2000.0330

Haynie, D. L. (2001). Delinquent peers revisited: Does network structure matter? 1. *Am. J. Soc.* 106, 1013–1057. doi: 10.1086/320298

Hong, F. Y., Huang, D. H., Lin, H. Y., and Chiu, S. L. (2014). Analysis of the psychological traits, Facebook usage, and Facebook addiction model of Taiwanese university students. *Telemat. Informat.* 31, 597–606. doi: 10.1016/j.tele.2014.01.001

Hoza, B. (2007). Peer functioning in children with ADHD. *Ambul. Pediatr.* 7, 101–106. doi: 10.1016/j.ambp.2006.04.011

Higgins, G. E., Jennings, W. G., Tewksbury, R., and Gibson, C. L. (2009). Exploring the link between low self-control and violent victimization trajectories in adolescents. *Crim. Justice Behav.* 36, 1070–1084. doi: 10.1177/0093854809344046

Huang, H., Hong, J. S., and Espelage, D. L. (2013). Understanding factors associated with bullying and peer victimization in Chinese schools within ecological contexts. *J. Child Fam. Stud.* 22, 881–892. doi: 10.1007/s10826-012-9647-4

Hunter, S. C., and Boyle, J. M. (2004). Appraisal and coping strategy use in victims of school bullying. *Br. J. Educ. Psychol.* 74, 83–107. doi: 10.1348/000709904322848833

Hunter, S. C., Boyle, J. M., and Warden, D. (2004). Help seeking amongst child and adolescent victims of peer-aggression and bullying: the influence of school-stage, gender, victimisation, appraisal, and emotion. *Br. J. Educ. Psychol.* 74, 375–390. doi: 10.1348/0007099041552378

Kaltiala-Heino, R., Rimpelä, M., Rantanen, P., and Rimpelä, A. (2000). Bullying at school—an indicator of adolescents at risk for mental disorders. *J. Adolesc.* 23, 661–674. doi: 10.1006/jado.2000.0351

Karatzias, A., Power, K. G., and Swanson, V. (2002). Bullying and victimisation in Scottish secondary schools: Same or separate entities? *Aggress. Behav.* 28, 45–61. doi: 10.1002/ab.90005

Khantzian, E. J. (1997). The self-medication hypothesis of substance use disorders: a reconsideration and recent applications. *Harv. Rev. Psychiatry* 4, 231–244. doi: 10.3109/10673229709030550

Ladouceur, R., Dugas, M. J., Freeston, M. H., Léger, E., Gagnon, F., and Thibodeau, N. (2000). Efficacy of a cognitive–behavioral treatment for

generalized anxiety disorder: evaluation in a controlled clinical trial. *J. Consult. Clin. Psychol.* 68:957. doi: 10.1037/0022-006X.68.6.957

Liang, H., Flisher, A. J., and Lombard, C. J. (2007). Bullying, violence, and risk behavior in South African school students. *Child Abuse Neglect* 31, 161–171. doi: 10.1016/j.chiabu.2006.08.007

Maniglio, R. (2009). The impact of child sexual abuse on health: a systematic review of reviews. *Clin. Psychol. Rev.* 29, 647–657. doi: 10.1016/j.cpr.2009.08.003

Merrell, K. W., Gueldner, B. A., Ross, S. W., and Isava, D. M. (2008). How effective are school bullying intervention programs? A meta-analysis of intervention research. *Sch. Psychol. Q.* 23:26. doi: 10.1037/1045-3830.23.1.26

Millstein, S. G., and Halpern-Felsher, B. L. (2001). "Perceptions of risk and vulnerability," in *Adolescent Risk and Vulnerability: Concepts and Measurement*, Vol. 15, eds B. Fischhoff, E. O. Nightingale, and J. G. Iannotta (Washington, DC: National Academies Press).

Nansel, T. R., Craig, W., Overpeck, M. D., Saluja, G., and Ruan, W. J. (2004). Cross-national consistency in the relationship between bullying behaviors and psychosocial adjustment. *Arch. Pediatr. Adolesc. Med.* 158, 730–736. doi: 10.1001/archpedi.158.8.730

Nansel, T. R., Overpeck, M., Pilla, R. S., Ruan, W. J., Simons-Morton, B., and Scheidt, P. (2001). Bullying behaviors among US youth: prevalence and association with psychosocial adjustment. *JAMA* 285, 2094–2100. doi: 10.1001/jama.285.16.2094

Ng, J. W., and Tsang, S. K. (2008). School bullying and the mental health of junior secondary school students in Hong Kong. *J. Sch. Violence* 7, 3–20. doi: 10.1300/J202v07n02_02

O'Brennan, L. M., Bradshaw, C. P., and Sawyer, A. L. (2009). Examining developmental differences in the social-emotional problems among frequent bullies, victims, and bully/victims. *Psychol. Sch.* 46, 100–115. doi: 10.1002/pits.20357

Olafsen, R. N., and Viemerö, V. (2000). Bully/victim problems and coping with stress in school among 10-to 12-year-old pupils in Åland, Finland. *Aggress. Behav.* 26, 57–65. doi: 10.1002/(SICI)1098-2337(2000)26:1<57::AID-AB5>3.0.CO;2-I

Olweus, D. (1978). *Aggression in the Schools: Bullies and Whipping Boys*. Washington, DC: Hemisphere Publishing Corporation.

Olweus, D. (1979). Stability of aggressive reaction patterns in males: a review. *Psychol. Bull.* 86:852. doi: 10.1037/0033-2909.86.4.852

Olweus, D. (1993). "Victimization by peers: antecedents and long-term outcomes," in *Social Withdrawal, Inhibition, and Shyness in Childhood*, eds K. H. Rubin, and J. B. Asendorpf (Hillsdale, NJ: Erlbaum), 315–341.

Olweus, D. (1995). Bullying or peer abuse at school: facts and intervention. *Curr. Dir. Psychol. Sci.* 4, 196–200. doi: 10.1111/1467-8721.ep10772640

Olweus, D. (1999). "Sweden," in *The Nature of School Bullying: A Cross-National Perspective*, eds P. K. Smith, Y. Morita, J. Junger-Tas, D. Olweus, R. Catalano, and P. Slee (New York, NY: Routledge), 2–27.

Olweus, D. (2001). Bullying at school: tackling the problem. *OECD Observer* 3, 24–26.

Peeters, M., Price, T. J., Cervantes, A., Sobrero, A. F., Ducreux, M., Hotko, Y., et al. (2010). Randomized phase III study of panitumumab with fluorouracil, leucovorin, and irinotecan (FOLFIRI) compared with FOLFIRI alone as second-line treatment in patients with metastatic colorectal cancer. *J. Clin. Oncol.* 28, 4706–4713. doi: 10.1200/JCO.2009.27.6055

Prabhakaran, V., Smith, J. A., Desmond, J. E., Glover, G. H., and Gabrieli, J. D. (1997). Neural substrates of fluid reasoning: an fMRI study of neocortical activation during performance of the Raven's Progressive Matrices Test. *Cogn. Psychol.* 33, 43–63. doi: 10.1006/cogp.1997.0659

Raven, J., Raven, J. C., and Court, J. H. (2000). *Manual for Raven's Progressive Matrices and Vocabulary Scales*. San Antonio, TX: The Psychological Corporation.

Reyna, V. F., and Farley, F. (2006). Risk and rationality in adolescent decision making implications for theory, practice, and public policy. *Psychol. Sci. Public Interest* 7, 1–44. doi: 10.1111/j.1529-1006.2006.00026.x

Rodkin, P. C., and Hodges, E. V. (2003). Bullies and victims in the peer ecology: four questions for psychologists and school professionals. *Sch. Psychol. Rev.* 32, 384–400.

Rogers, R. D., Owen, A. M., Middleton, H. C., Williams, E. J., Pickard, J. D., Sahakian, B. J., et al. (1999). Choosing between small, likely rewards and large, unlikely rewards activates inferior and orbital prefrontal cortex. *J. Neurosci.* 19, 9029–9038.

Salmivalli, C. (2001). "Group view on victimization," in *Peer Harassment in School*, eds J. Juvonen and S. Graham (New York, NY: Guilford Press), 398–417.

Schwartz, D., Proctor, L. J., and Chien, D. H. (2001). "The aggressive victim of bullying," in *Peer Harassment in School: The Plight of the Vulnerable and Victimized*, eds J. Jovonen and S. Graham (New York, NY: Guilford Press), 147–174.

Schwartz, S. H. (1999). A theory of cultural values and some implications for work. *Appl. Psychol.* 48, 23–47. doi: 10.1111/j.1464-0597.1999.tb00047.x

Siegrist, M., Cvetkovich, G., and Roth, C. (2000). Salient value similarity, social trust, and risk/benefit perception. *Risk Anal.* 20, 353–362. doi: 10.1111/0272-4332.203034

Slovic, P. (1987). Perception of risk. *Science* 236, 280–285. doi: 10.1126/science.3563507

Steinberg, L. (2004). Risk taking in adolescence: What changes, and why? *Ann. N. Y. Acad. Sci.* 1021, 51–58. doi: 10.1196/annals.1308.005

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends Cogn. Sci.* 9, 69–74. doi: 10.1016/j.tics.2004.12.005

Steinberg, L. (2007). Risk taking in adolescence new perspectives from brain and behavioral science. *Curr. Dir. Psychol. Sci.* 16, 55–59. doi: 10.1111/j.1467-8721.2007.00475.x

Steinberg, L. (2008). A social neuroscience perspective on adolescent risk-taking. *Dev. Rev.* 28, 78–106. doi: 10.1016/j.dr.2007.08.002

Steinberg, L. (2010). A dual systems model of adolescent risk-taking. *Dev. Psychobiol.* 52, 216–224.

Ttofi, M. M., Farrington, D. P., and Lösel, F. (2012). School bullying as a predictor of violence later in life: a systematic review and meta-analysis of prospective longitudinal studies. *Aggress. Violent Behav.* 17, 405–418. doi: 10.1002/yd.20009

Vaillancourt, T., Hymel, S., and McDougall, P. (2003). Bullying is power: implications for school-based intervention strategies. *J. Appl. Sch. Psychol.* 19, 157–176. doi: 10.1300/J008v19n02_10

Veenstra, R., Lindenberg, S., Oldehinkel, A. J., De Winter, A. F., Verhulst, F. C., and Ormel, J. (2005). Bullying and victimization in elementary schools: a comparison of bullies, victims, bully/victims, and uninvolved preadolescents. *Dev. Psychol.* 41:672. doi: 10.1037/0012-1649.41.4.672

Wachs, S., Wolf, K. D., and Pan, C. C. (2012). Cybergrooming: risk factors, coping strategies and associations with cyberbullying. *Psicothema* 24, 628–633.

Wills, T. A., and Filer, M. (1996). "Stress—coping model of adolescent substance use," in *Advances in Clinical Child Psychology*, Vol. 18, eds T. H. Ollendick and R. J. Prinz (New York, NY: Springer), 91–132.

Wong, D. S., Lok, D. P., Lo, T. W., and Ma, S. K. (2008). School bullying among Hong Kong Chinese primary schoolchildren. *Youth Society* 40, 35–54. doi: 10.1177/0044118X07310134

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Poon. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

APPENDIX A

School Bullying Questionnaire

		Never	At least once a month	About once a week	Everyday
1	During the past 4 months, have you physically bullied others, such as kicking, punching, slapping, and pushing around?	0	1	2	3
2	During the past 4 months, have you verbal bullied others, such as cursing, ridiculing, insulting, and calling hurtful nicknames?	0	1	2	3
3	During the past 4 months, have you relational bullied others, such as ignoring, spreading rumors, and excluding from social circle?	0	1	2	3
4	During the past 4 months, have you extorted others, such as extorting, blackmailing, and exacting?	0	1	2	3
5	During the past 4 months, have you intimidated and forced others, such as intimidating, threatening, and scaring victims?	0	1	2	3
6	During the past 4 months, have you been physically bullied by your peers, such as being kicked, punched, slapped, and pushed around?	0	1	2	3
7	During the past 4 months, have you been verbal bullied by your peers, such as being cursed at, ridiculed, insulted, and called hurtful nicknames?	0	1	2	3
8	During the past 4 months, have you been isolated by your peers, such as being ignored, spread rumors, and excluded from social circle?	0	1	2	3
9	During the past 4 months, have you been extorted by your peers, such as being extorted, blackmailed, and exacted?	0	1	2	3
10	During the past 4 months, have you been intimidated by your peers, such as intimidated, threatened, and scared victims?	0	1	2	3

APPENDIX B

Cognitive Appraisal of Risky Event Questionnaire (CARE) – Expected Benefits

On a scale of 1 (not at all likely) to 7 (extremely likely), HOW LIKELY IS IT THAT YOU WOULD EXPERIENCE SOME POSITIVE CONSEQUENCE (e.g., pleasure, win money, feel good about yourself, etc.) if you were to engage in these activities?

		Positive Consequences						
		Not at all likely		**Moderately likely**			**Extremely likely**	
1	Trying/using drugs other than alcohol or marijuana	1	2	3	4	5	6	7
2	Missing class or work	1	2	3	4	5	6	7
3	Grabbing, pushing, or shoving someone	1	2	3	4	5	6	7
4	Leaving a social event with someone I have just met	1	2	3	4	5	6	7
5	Driving after drinking alcohol	1	2	3	4	5	6	7
6	Making a scene in public	1	2	3	4	5	6	7
7	Drinking more than 5 alcoholic beverages	1	2	3	4	5	6	7
8	Not studying for exam or quiz	1	2	3	4	5	6	7
9	Drinking alcohol too quickly	1	2	3	4	5	6	7
10	Disturbing the peace	1	2	3	4	5	6	7
11	Damaging/destroying public property	1	2	3	4	5	6	7
12	Sex without protection against pregnancy	1	2	3	4	5	6	7
13	Leaving tasks or assignments for the last minute	1	2	3	4	5	6	7
14	Hitting someone with a weapon or object	1	2	3	4	5	6	7
15	Rock or mountain climbing	1	2	3	4	5	6	7
16	Sex without protection against sexually transmitted diseases	1	2	3	4	5	6	7
17	Playing non-contact team sports	1	2	3	4	5	6	7
18	Failing to do assignments	1	2	3	4	5	6	7
19	Slapping someone	1	2	3	4	5	6	7
20	Not studying or working hard enough	1	2	3	4	5	6	7
21	Punching or hitting someone with fist	1	2	3	4	5	6	7
22	Smoking marijuana	1	2	3	4	5	6	7
23	Sex with a variety of partners	1	2	3	4	5	6	7
24	Snow or water skiing	1	2	3	4	5	6	7
25	Mixing drugs and alcohol	1	2	3	4	5	6	7
26	Getting into a fight or argument	1	2	3	4	5	6	7
27	Involvement in sexual activities without my consent	1	2	3	4	5	6	7
28	Playing drinking games	1	2	3	4	5	6	7
29	Sex with someone I have just met or don't know well	1	2	3	4	5	6	7
30	Playing individual sports	1	2	3	4	5	6	7

APPENDIX C

Cognitive Appraisal of Risky Event Questionnaire (CARE) – Expected Risks

On a scale of 1 (not at all likely) to 7 (extremely likely), HOW LIKELY IS IT THAT YOU WOULD EXPERIENCE SOME NEGATIVE CONSEQUENCE (e.g., become sick, be injured, embarrassed, lose money, suffer legal consequences, fail a class, or feel bad about yourself) if you engaged in these activities?

		Positive Consequences						
		Not at all likely			**Moderately likely**			**Extremely likely**
1	Trying/using drugs other than alcohol or marijuana	1	2	3	4	5	6	7
2	Missing class or work	1	2	3	4	5	6	7
3	Grabbing, pushing, or shoving someone	1	2	3	4	5	6	7
4	Leaving a social event with someone I have just met	1	2	3	4	5	6	7
5	Driving after drinking alcohol	1	2	3	4	5	6	7
6	Making a scene in public	1	2	3	4	5	6	7
7	Drinking more than 5 alcoholic beverages	1	2	3	4	5	6	7
8	Not studying for exam or quiz	1	2	3	4	5	6	7
9	Drinking alcohol too quickly	1	2	3	4	5	6	7
10	Disturbing the peace	1	2	3	4	5	6	7
11	Damaging/destroying public property	1	2	3	4	5	6	7
12	Sex without protection against pregnancy	1	2	3	4	5	6	7
13	Leaving tasks or assignments for the last minute	1	2	3	4	5	6	7
14	Hitting someone with a weapon or object	1	2	3	4	5	6	7
15	Rock or mountain climbing	1	2	3	4	5	6	7
16	Sex without protection against sexually transmitted diseases	1	2	3	4	5	6	7
17	Playing non-contact team sports	1	2	3	4	5	6	7
18	Failing to do assignments	1	2	3	4	5	6	7
19	Slapping someone	1	2	3	4	5	6	7
20	Not studying or working hard enough	1	2	3	4	5	6	7
21	Punching or hitting someone with fist	1	2	3	4	5	6	7
22	Smoking marijuana	1	2	3	4	5	6	7
23	Sex with a variety of partners	1	2	3	4	5	6	7
24	Snow or water skiing	1	2	3	4	5	6	7
25	Mixing drugs and alcohol	1	2	3	4	5	6	7
26	Getting into a fight or argument	1	2	3	4	5	6	7
27	Involvement in sexual activities without my consent	1	2	3	4	5	6	7
28	Playing drinking games	1	2	3	4	5	6	7
29	Sex with someone I have just met or don't know well	1	2	3	4	5	6	7
30	Playing individual sports	1	2	3	4	5	6	7

APPENDIX D

Cognitive Appraisal of Risky Event Questionnaire (CARE) – Expected Involvements

On a scale of 1 (not at all likely) to 7 (extremely likely), HOW LIKELY IS IT THAT YOU WILL ENGAGE IN EACH OF THESE ACTIVITIES in the next 6 months?

		Positive Consequences						
		Not at all likely			Moderately likely			Extremely likely
1	Trying/using drugs other than alcohol or marijuana	1	2	3	4	5	6	7
2	Missing class or work	1	2	3	4	5	6	7
3	Grabbing, pushing, or shoving someone	1	2	3	4	5	6	7
4	Leaving a social event with someone I have just met	1	2	3	4	5	6	7
5	Driving after drinking alcohol	1	2	3	4	5	6	7
6	Making a scene in public	1	2	3	4	5	6	7
7	Drinking more than 5 alcoholic beverages	1	2	3	4	5	6	7
8	Not studying for exam or quiz	1	2	3	4	5	6	7
9	Drinking alcohol too quickly	1	2	3	4	5	6	7
10	Disturbing the peace	1	2	3	4	5	6	7
11	Damaging/destroying public property	1	2	3	4	5	6	7
12	Sex without protection against pregnancy	1	2	3	4	5	6	7
13	Leaving tasks or assignments for the last minute	1	2	3	4	5	6	7
14	Hitting someone with a weapon or object	1	2	3	4	5	6	7
15	Rock or mountain climbing	1	2	3	4	5	6	7
16	Sex without protection against sexually transmitted diseases	1	2	3	4	5	6	7
17	Playing non-contact team sports	1	2	3	4	5	6	7
18	Failing to do assignments	1	2	3	4	5	6	7
19	Slapping someone	1	2	3	4	5	6	7
20	Not studying or working hard enough	1	2	3	4	5	6	7
21	Punching or hitting someone with fist	1	2	3	4	5	6	7
22	Smoking marijuana	1	2	3	4	5	6	7
23	Sex with a variety of partners	1	2	3	4	5	6	7
24	Snow or water skiing	1	2	3	4	5	6	7
25	Mixing drugs and alcohol	1	2	3	4	5	6	7
26	Getting into a fight or argument	1	2	3	4	5	6	7
27	Involvement in sexual activities without my consent	1	2	3	4	5	6	7
28	Playing drinking games	1	2	3	4	5	6	7
29	Sex with someone I have just met or don't know well	1	2	3	4	5	6	7
30	Playing individual sports	1	2	3	4	5	6	7

frontiers in Psychology

ORIGINAL RESEARCH
published: 23 November 2016
doi: 10.3389/fpsyg.2016.01791

System to Detect Racial-Based Bullying through Gamification

José A. Álvarez-Bermejo[1], Luis J. Belmonte-Ureña[2], Africa Martos-Martínez[3], Ana B. Barragán-Martín[3] and María del Mar Simón-Marquez[3]*

[1] Department of Informatics, Universidad de Almería, Almería, Spain, [2] Department of Economy and Business, Universidad de Almería, Almería, Spain, [3] Department of Psychology, Universidad de Almería, Almería, Spain

Prevention and detection of bullying due to racial stigma was studied in school contexts using a system designed following "gamification" principles and integrating less usual elements, such as social interaction, augmented reality and cell phones in educational scenarios. "Grounded Theory" and "User Centered Design" were employed to explore coexistence inside and outside the classroom in terms of preferences and distrust in several areas of action and social frameworks of activity, and to direct the development of a cell phone app for early detection of school bullying scenarios. One hundred and fifty-one interviews were given at five schools selected for their high multiracial percentage and conflict. The most outstanding results were structural, that is the distribution of the classroom group by type of activity and subject being dealt with. Furthermore, in groups over 12 years of age, the relational structures in the classroom in the digital settings in which they participated with their cell phones did not reoccur, because face-to-face and virtual interaction between students with the supervision and involvement of the teacher combined to detect bullying caused by racial discrimination.

Keywords: bullying, cell phone apps, discrimination, gamification, sociogram

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Francisco Manuel Morales, University of Malaga, Spain
Inmaculada Mendez, Universidad de Murcia, Spain

****Correspondence:***
José A. Álvarez-Bermejo
jaberme@ual.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *15 September 2016*
Accepted: *31 October 2016*
Published: *23 November 2016*

Citation:
Álvarez-Bermejo JA, Belmonte-Ureña LJ, Martos-Martínez A, Barragán-Martín AB and del Mar Simón-Marquez M (2016) System to Detect Racial-Based Bullying through Gamification. Front. Psychol. 7:1791. doi: 10.3389/fpsyg.2016.01791

INTRODUCTION

Bullying and cyberbullying, which are formally defined as is the act of harming or harassing, also via IT networks, in a repeated and deliberate manner against an individual who is unable to defend him, are a serious social problem among youth (Olweus, 1993). In addition, the individual and collective repercussions to adolescents known as victimization (Craig et al., 2009) lead to such injury to minors as psychological imbalance (Cook et al., 2010), suicide, health problems (Klomek et al., 2007) and high-risk social behavior (Carmona-Torres et al., 2015). Minors have to be protected from bullying/cyberbullying and the consequences of this type of aggression, as research in Europe, America, and Spain shows the prevalence of victimization of bullying and cyberbullying among students, suggesting that policies for improving the school environment are necessary (Caravaca et al., 2016). This idea is reinforced by the exhaustive work done in 33 countries from 2002 to 2010 with students aged 10–15, which concluded that countries which have made decisions concerning the social problem of bullying and have carried out specific actions in school contexts have reduced both occasional and chronic victimization (Chester et al., 2015). Another recent study included the family along with the school in the bullying/cyberbullying prevention measures (Ortega et al., 2016). Beyond that, even the need to talk about citizenship is suggested, as the relationship between bullying and cyberbullying with homophobia, sexism, racism and other discriminatory situations, which are reinforced and modeled by the adult society,

has been demonstrated, and structured action leading to the prevention of this phenomenon must start when schooling begins (Cabra and Marciales, 2015).

It has been attempted to analyze the causes generating bullying (Kim et al., 2006) and its consequences to its student victims (Bender and Lösel, 2011), and an important number of studies have analyzed its prevention (Ttofi and Farrington, 2010). The main purpose of these studies was to design preventive, analytical and intervention instruments for bullying/cyberbullying (Del Rey et al., 2012; Allison and Kirsten, 2015).

Recent research has concentrated more on a type of bullying called social stigma, that is, because of individual characteristics, such as race, weight, gender, social class or sexual orientation (Rosenthal et al., 2015). This type of bullying shares many characteristics with discrimination (Piña and Callejas, 2005), since the abuse originates from the victim pertaining to a deprecated social group. Research on bullying because of racial stigma has been mainly directed at adults, and the problem of bullying at school due to racial stigma has not been well enough studied in academic literature (Rosenthal et al., 2015). In this study, we concentrated on this type of bullying, because Spain is one of the main host countries for immigrants (Pajares, 2009). In this context, many immigrant students in Spain are bullied because of racial discrimination (Ávila, 2013) with disastrous consequences for their development, such as anxiety, or development of aggressive behavior (Smith et al., 2014).

In view of the above, that is the interest in preventing bullying/cyberbullying in schools, including social stigma, and minimizing later victimization in educational environments, the results of antibullying and bullying prevention programs have had only moderate success in changing intimidating behavior and conduct (Ansary et al., 2015). A review of prevention programs in Europe and the United States showed that interventions for bullying were only effective for a week (Pepler et al., 2004), while another concluded that about 20% of interventions did either not cause any change at all or caused changes that were negative (Craig et al., 2010). Recent reviews have suggested that anti-intimidation programs with the best results are the multidisciplinary or "whole-school" approach, which first, accentuates a good social and emotional climate in the school based on solid antibullying philosophy principles (Thornberg, 2011). Second, those maintaining a long-term program extend it to the community and it is externally supervised. And finally, they are constant and firm in applying the strategies when bullying appears (Ansary et al., 2015). Of the main antibullying programs considered effective, the one most used worldwide, is the "Olweus Bullying Prevention Program," which originated in Norway in 1983, and has been applied in other countries with some variations, such as the "Toronto Project" in Canada in 1991–1993 (Fekkes et al., 2006), and the "South Carolina Project" in 1995 (Limber, 2004) and the "Seattle Project" in 2003–2005 (Bauer et al., 2007) in the United States.

Another widely used program is the "Sheffield Project" which originated in England in 1991–1993 (Smith and Sharp, 1994). These two programs have been jointly implemented in Belgium since 1995–1997 (Smith et al., 2003), and in Spain, "SAVE (*Sevilla Anti Violencia Escolar*)" since 1996–96 (Ortega, 1997) and "ANDAVE (Andalucía Antiviolencia Escolar)" since 1999–2000 (Ortega and Mora-Merchán, 1998). Another two more recent programs, also from an integral perspective, are the "ViSC Program" started in Austria in 2008 (Trip et al., 2015), and also implemented in Turkey in 2012–2014 (Solomontos-Kauntouri et al., 2016) and the KiVA Project from Finlandia in 2006–2009 (Salmivalli and Poskiparta, 2012), which has been used in Estonia (Ginter and Tropp, 2012), Italy, the Netherlands and Whales (Clarkson et al., 2016). One characteristic which makes this project unique is the use of a virtual working environment with games simulating daily life, for constant team monitoring of the project (Kärnä et al., 2013).

But in the last few years, these "whole-school" programs are being enriched by research on preventing bullying which seeks the answers in students, teachers and families (Patton et al., 2015), (Cabra and Marciales, 2015), as bullying prevention programs should be adapted to the cultural context (Olweus, 2010), make use of ICTs related to social sciences and integrate prevention procedures close to adolescent experience (Huitsing and Veenstra, 2012), such as of cell phones (Ruiz and Belmonte, 2014) and gamification strategies (Bishop, 2014; Richter et al., 2015) in school environments (Hanewinkel, 2004; Middaugh and Kahne, 2013).

The term "gamified" refers to the use of videogame design elements in non-game contexts to improve user experience and the ability to hook and motivate (Schoech et al., 2013). A review of the scientific literature on the use of gamification in educational contexts, that is, the use of game design elements, such as including prizes, reward, score charts, credentials, levels, trophies, and so forth (Kapp, 2013), shows widely extended production spanning from studies on their effects on education (Hakulinen and Auvinen, 2014), improved educational quality (Kuo and Chuang, 2016), simulated activities (Rojas et al., 2014), student attention using mobile devices (Su and Cheng, 2015), motivation of different types of students (Hakulinen and Auvinen, 2014), academic scenarios for gamification (Laskowski, 2015), gamification in the search for educational innovation (González and Area, 2013), learning materials for gamification, and evaluation of gamification for motivating students to learn (Ibanez et al., 2014).

In the specific area of bullying, three applications should be highlighted, FearNot (Vannini et al., 2011), a videogame in third person which promotes learning antibullying strategies and which has had good results in detecting bullying by minors (Sapouna et al., 2010), Mii School (Carmona et al., 2011), a 3D videogame for youths in third person which helps detect bullying in schools based on five scenes in which the adolescent has to make choices from different roles (aggressor, victim), and ARBAX-School Bullying (Raminhos et al., 2015), which is a first-person 3D videogame for 16-year-old students, promoting awareness of racial intimidation, but no research at all has been done on this development.

Context

In recent years, as a result of a multitude of complex causes, the immigration role Spain has undergone a radical change since Spain has become one of the main recipients of immigrants,

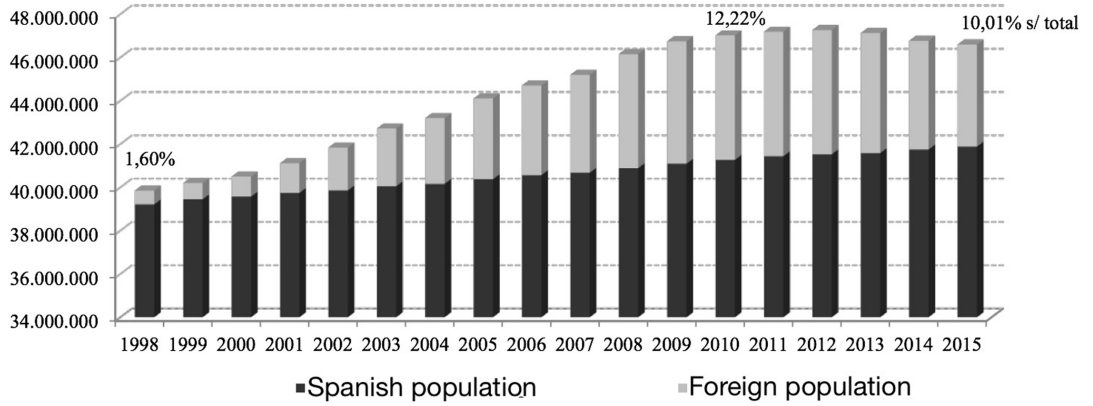


FIGURE 1 | Evolution of the population: Spaniards and foreigners (1998–2015). *Source*: INE.

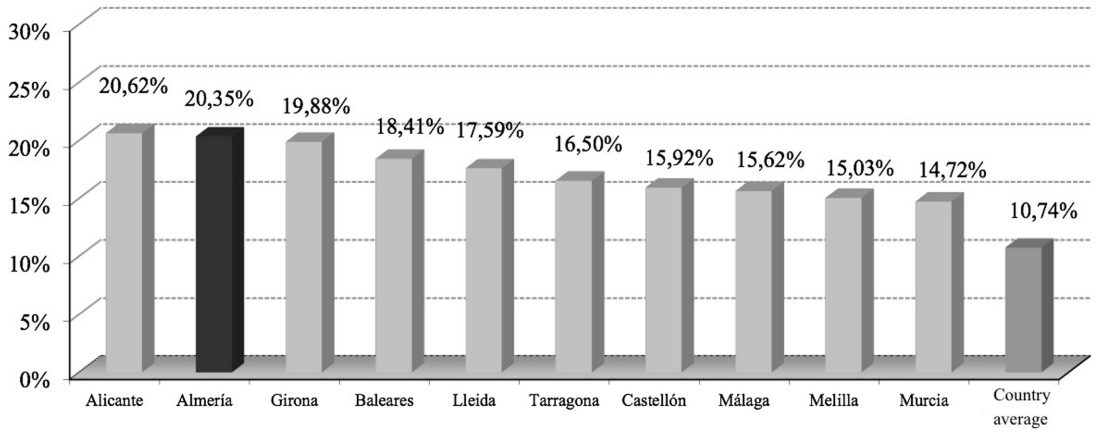


FIGURE 2 | Provinces with greater weight of foreigners on the total population (2014). *Source*: INE.

unlike what happened in the 50s and 60s (Pajares, 2009). In the last decade the growth rate of foreigners has been vertiginous, from 1,60% of the population in 1998 to the 12.22% of the population as of January 2012. While from 2012 to 2015 the foreign contingent has been reduced by more than one million people (see **Figure 1**). As a direct consequence of these important migratory movements, many immigrant adolescents under 16 are in the schools.

Over the past decade, Spain has experienced a remarkable influx of immigrants, especially sourcing from Africa and from Eastern Europe. In this scenario, Almeria is a priority destination for a bunch of nationalities that, in many cases, are emerging as outsiders with limited financial resources who come to this province in search of a job opportunity, in the sector of the intensive agriculture and sometimes they are discriminated against, relegating them to the last positions of the value chain. More specifically, it is noted that the province of Almeria has shown a tendency of growth of foreign population very pronounced since the mid-nineties, rising from 13,260 in 1998 to 142,810 in 2014 (see **Figure 2**). In this period the foreign population in the province has grown by 977% in simple variation rate, representing an average annual growth rate of 16%. Nationally, the growth of the foreign population between 1998 and 2014, amounted to 689%, in simple variation rate, and 13.8% in cumulative average rate variation. This significance of the contingent of foreigners in the province of Almeria is the highest across the country, behind only of Alicante, which has a percentage of 20.62% of foreigners. In turn, this percentage of significance is almost double the weight that has the group of foreigners in national average (10.74%).

If we consider the age group of less than 16 years, it is that the province of Almeria is in third place in the ranking of Spanish provinces with the highest number of adolescent foreigners, on the total population, with 19.69% (**Figure 3**).

In this regard, at the municipal level, the largest population, under 16, are concentrated around the capital of Almeria, Roquetas de Mar, El Ejido, Níjar and Vícar. These five municipalities account for 64% of young people fewer than 16, of the province (**Figure 4**). Also, in these five territories a large number of young foreigners that, in the case of Nijar, accounts for almost half of the population in this age group. Therefore, under the context depicted, it seems appropriated to analyze the causes

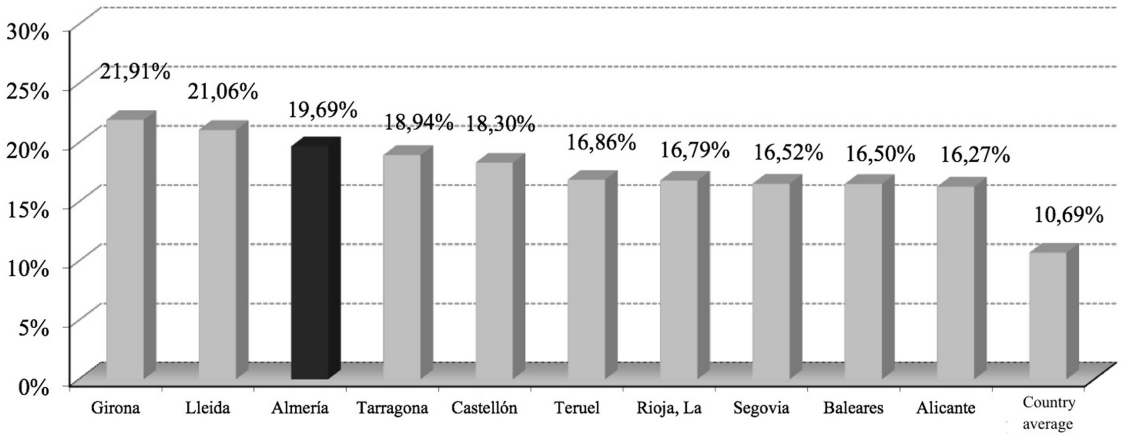


FIGURE 3 | Provinces with greater weight of under 16 foreigners on the total population of that age group (2014). *Source*: INE.

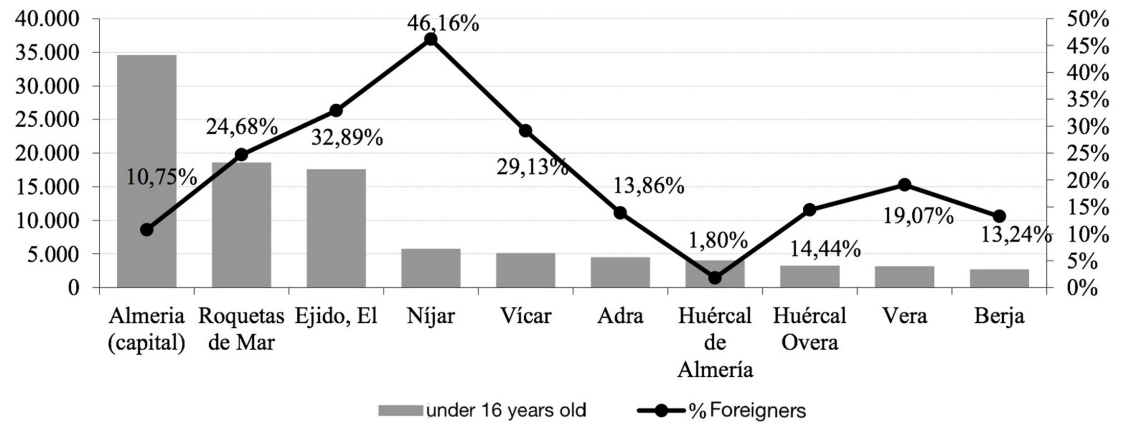


FIGURE 4 | Municipalities in Almeria with more young people under 16 years (main axis) weight of foreigners on total (secondary axis). Año 2014. *Source*: INE.

of racial harassment stigma among young people under 16 years. That severely affects school life.

METHODOLOGY AND PROCEDURE

The review of publications and analysis of antibullying videogames oriented the focus of our research and the methodological design which would best respond to the purpose of developing an application preventing bullying for social stigma. In brief, it showed the need to adapt antibullying action culturally and socially and develop new instruments for social mediation in realistic situations. That is, it should be based on the expressions and experiences of the social actors to find out what preventive/intervention actions, means and measures they prefer. It should also surpass the design of scenarios in which an attempt has been made to monitor the activity of students through the use of traditional videogames (Serrano et al., 2012), which does not

TABLE 1 | Group characteristics.

Group	School location	Grade	Age	N° of students[1]	% Foreign	Main nationality
A	Almería	1st year high school	12–13	40	8%	Morocco
B	Roquetas de Mar	4th year high school	15–16	27	22%	Rumania
C	El Ejido	5th grade primary	10–11	28	43%	Morocco
D	Níjar	3rd grade primary	8–9	31	39%	Morocco
E	Vícar	2nd grade primary	7–8	25	24%	Morocco

[1]*Number of students in the class at the time of the experiment.*

provide realistic results since the students are unaware of the real context of their class (i.e., although it is a videogame, it should not detach them completely from their setting). Furthermore, it is understood that it is not appropriate to measure violence using videogames which reinforce it and in which the players do not receive feedback on the consequences of the decisions they make during the game. Therefore, the use of cell phone games based on gamification principles and supported by augmented reality enabling classroom bullying to be detected was the option chosen for this study.

Its methodological design follows the principles of Grounded Theory (Strauss and Corbin, 1998; Charmaz, 2006), as its purpose is to identify basic social processes related to behavior in organizations, groups or social structures such as the school (Glaser, 1992). The grounded theory is very well-established in educational research. Let the work on inclusion in higher education (Givon and Court, 2010), on teaching staff in particular cultural settings (Cherubini et al., 2010), on new teachers during their first year (Smart and Brent, 2010) and in the field of bullying or cyberbullying (Mishna et al., 2009) suffice as examples.

In harmony with the above, User-Centered Design (Norman and Draper, 1986) principles, and specifically for education, Designed Based Research (Luckin et al., 2013), are also followed by incorporating the value of the user in the design of applications and/or tools. However, this subject value does not reside in the traditional view of the user as archetype, client or final user (Maguire, 2001), but in actors, who in this study are bully victims, bullies, witnesses, teachers, families, etc., are not investigated or directed (Sin, 2003; Penuel et al., 2007).

These references help understand the path taken in this study. To explain the methodology more clearly, it is described in two parts. The first part collected information from 151 students at five schools in Almeria province (Spain) with multiracial populations and coexistence problems. As this information is sensitive, it is not available nor has it been published by the schools. Thus their specific selection was based on information acquired from the school direction teams when discussing access with them. Also for reasons of confidentiality, the names of the five schools chosen from among 20 met with are not revealed either. However, **Table 1** shows details on the student population at each school and the characteristics of each group.

In addition to the meetings held with the direction teams, informal conversations were held with teachers, students and tutors, some at the school itself, in parents and teachers associations, immigrant associations, parks and plazas. When these were analyzed with the grounded theory (Strauss and Corbin, 1998), categories emerged and by theoretical triangulation (Denzin, 1989), specifically reviewing other questionnaires on school coexistence (Avilés, 2002, un published; Ortega and Del Rey, 2003), an ad hoc questionnaire was designed which was given to 151 students at five selected schools, with items for detecting the existence of discrimination by students, both in the classroom and outside of it (see **Table 2**). All of the items on the questionnaire were measured on a three-point Likert-type response scale where 1 was native student, 2 foreign student and 2 any student. The questionnaires were given a convenience sample of five Spanish students selected from each of the groups.

TABLE 2 | Questions asked to detect discrimination in the classroom by students of the mainstream ethnic group.

Multiracial student categories emerged	Information to be collected	Setting
Knowledge of the other:		
"They don't respect me" "They don't know me" "They think I'm stupid" "Sometimes I frighten them" "They think the class is theirs" "They think the playground is theirs "They stare at me"	Identifying the preference/distrust of the nationality of classmates can identify restrictions in developing daily coexistence in the classroom and among students	Coexistence in the classroom
Knowledge of what separates us:		
"They don't trust me" "Because we don't have any money" "They say we smell bad" "Like we're going to do something to them" "They think they're better than us" "They think we are all the same"	Identifying the causes of discrimination outside of the classroom can identify restriction of friendship among classmates outside the educational setting	Coexistence outside of the classroom

In the second part of the study, based on the process above, a free cell phone app was developed. This application, designed for smartphones, puts the gamification concept into practice for early detection of bullying among students. Obviously, this application is designed to involve students, but also teachers, since they play a fundamental role in these cases (Dedousis et al., 2014). The application pursues combination of face-to-face and virtual interaction among students, with the supervision and involvement of the teacher, to detect anomalous behavior among the students. It records the interaction among the students to be able to analyze it, classify it and arrive at conclusions. This study did not require ethical approval according to the local legislation. The study was submitted to the ethics committee of the Universidad de Almeria, Spain, who advised that full review and approval was not necessary.

The cell phone app proposal (PREVER, Prevention of Racial Stigma) was designed to evaluate discriminating bias in native youths under 16 against their foreign classmates. The gamified information system we propose is based on an interactive augmented reality game. The student plays, but at the same time he is also part of the game and its real setting (context) along with his classmates. All the students individually and the class as a group are aware that the rest of their classmates are real, as well as the setting, but not the interaction being generated by the game. This way they understand that their actions toward others, although not real, can trigger consequences in the real context. In the game, each participant is identified by a numeric code.

The game architecture is based on each student carrying a cell phone with the app installed. When the students play with the app they see the classroom setting on their cell phones with augmented information. This information comes from

identification of the opponents in the application. The whole class has this application and they interact freely with each other. The server collects the data in a csv file ("comma-separated values," a type of open format document with which it is easy to represent the data in tables) listing all the students so their interaction can be examined in a sociogram.

The interaction model proposed involves evidence of who the interaction takes place between. The participants have information when they interact so that the one who starts it cannot begin without an assumed probable consequence in the real setting. The game also encourages interaction because they are part of a game they are motivated to participate in. Students are identified by a numerical code.

To make it easier to understand, an example of interaction during the game could be that the student is asked to form a group of friends to perform a specific task, organizing a football game. During the interaction, the student is allowed to exclude classmates from the groups with a movement of the phone (the phones have a sensor called an accelerometer which detects how the phone moves and how hard). This way the rejection by one person of another who wants to be on the team is recorded, understanding that not only is it a violent reaction, but segregation. It is attempted to relate this segregating reaction with the difficulty of integrating immigrant students in the schools.

The interaction model not only selects classmates for activities, but can also be played for points two ways, by asking their opponents questions (if their opponent misses, the points are for the attacker) or by pushing (the student makes a pushing motion with the phone, which picks it up and subtracts points from the student attacked. But the one who attacks must answer a question first, and missing takes points away from the attacker).

System Architecture for the Detection of Racial Harassment Stigma through Gamification

This section describes the architecture of the system designed with the aim of assessing the discriminator bias local youth under 16 years with respect to foreign-born peers described. The gamified information system that we propose is based on an interactive game based on augmented reality. Through this system the student plays, but it is also part of the game and the real environment (context) of the game with his teammates. The game has connections with the real environment, which is an important aspect to consider. Everyone, from the student as the individual to the whole class as the collective, are aware that the other colleagues are real, as the environment. Thus they understand that their actions with others even if they are not real-, can trigger consequences in the real context.

The architecture of the game is based on each student carrying two elements (see **Figure 5B**) a Smartphone with the application and a QR code that identifies him/her in the game (each student is put a tag with two QR codes, one in the chest and another in the back). When a child plays with the application, she sees the classroom environment through their mobile device with augmented information (see **Figures 5C,D**). This augmented information comes from the query that the student's device performs to the terminal server (see **Figure 5A**) using the QR code of the person being pointed by. The server, then, sends interactive information on the student being pointed to the device which it interacts with. The system also recognizes the context in which students (e.g., class, patio) are and whether the interaction is performed through the front QR or through the rear QR code that the student is wearing. The whole class (**Figure 5C**) has these elements and interact freely among them. The server gathers the data in a csv file (comma-separated values; it is a document type in simple open format to represent data in tabular form) relating to all students to be examined by a sociogram (graphical representation of the different relationships between subjects that make up a group). So the interaction analysis can be performed.

The proposed model forces that both parties affected by an interaction are notified of the event. Participants have information notified to them when they are involved in an interaction, so that whoever starts it can not take any action without a supposed and probable consequence in the real environment. Likewise, interactions are catalyzed by the fact that it is a game in which they are motivated to participate.

Figure 6 refers to the starting screen of the game on the student's smartphone (see **Figure 6A**) and how it connects to the server (see **Figure 6B**) to register the student with his QR codes and data.

Following, an example of interaction in which a certain student is required to bringing together his friends in order to perform a task, namely the organization of a football. In interactions it is allowed to exclude fellow students from groups with a movement of the smartphone (smartphones incorporate sensors like accelerometers, which indicates how the phone is moved and how vehemently). Thus the rejection of one person to another who wants to join the team is registered. Understanding that, in this case, the reaction means not only segregation but a violent reaction. It is intended to relate this segregation reaction to the difficulty of integrating immigrant children in schools. **Figure 7** shows the smartphone screen of a student who is not being selected by any partner to perform a specific activity and that is not selecting any other student, he is simply using the game it to observe the classroom. In the top left of the screen you can see the score of the student (depending on the number of people in your group).

Figure 8 shows an example of interaction where you can add components to your group once launched a group activity.

The interaction model is not only limited to directly selecting partners for activities, and in addition it can be controlled in the sense that for every action you want to perform, a question must be correctly answered. In this case, if the question posed at the partner is not resolved, the opponent wins. On the contrary, if resolved who starts the interaction wins (and therefore the action is performed). **Figures 9** and **10** show this feature.

As noted above, the application server (see **Figure 5A**) records all interactions between students, so the teacher can access this

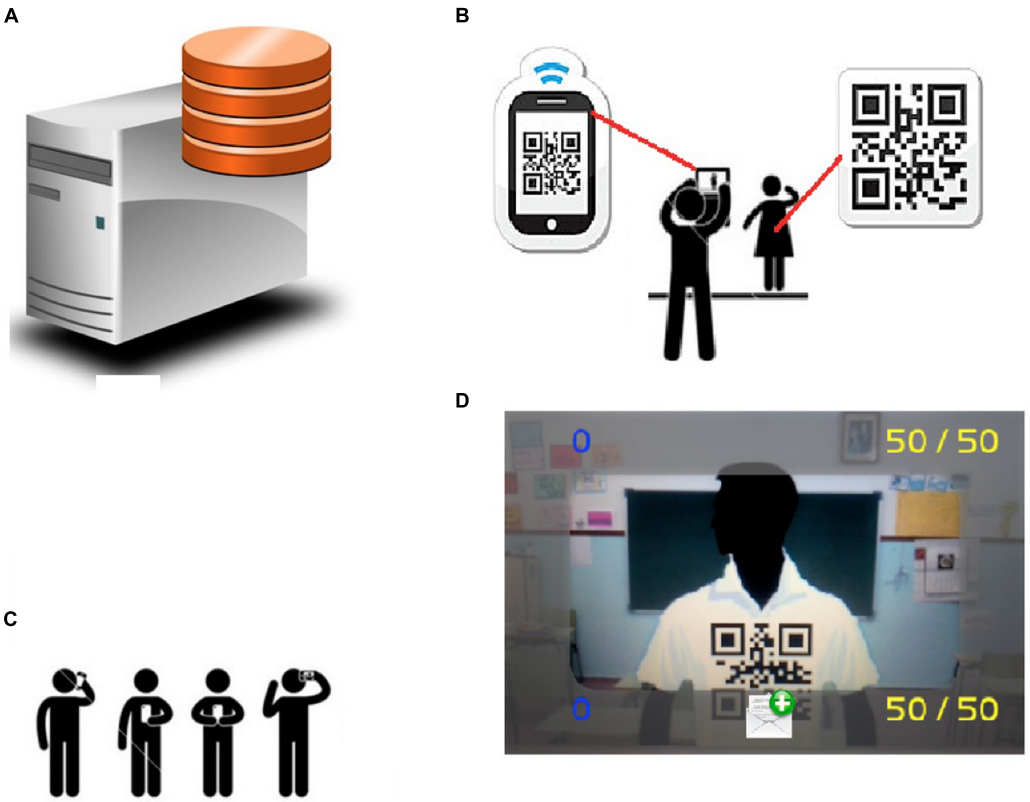


FIGURE 5 | Proposed architecture. (A) Database server. Stores the interactions. **(B)** How the interaction works: QR codes identify students. **(C)** All the students are equipped with QR and smartphones. **(D)** Screenshot of the game representing the interaction depicted in **(B)**.

server to download this information and to control what happens (i.e., what kind of interaction it is generated) among students in the class through a sociogram or x-ray interactions that occur in the group. See **Figure 11**, this is an example of the visual data that the application generates.

RESULTS

Concerning coexistence in the classroom, it should be mentioned that in four of the five classrooms analyzed, none of the foreign students sat at desks in the front row, that is, they were rather near the back of the class, except in the group of second-graders (Vicar), who were from seven to 8 years old. This agrees with studies done on discrimination in classrooms (i.e., they tend to "hide" in the last rows of the classroom) except in second-grade. Even though descriptive analyses of the data collected from the five schools shows that most of the students prefer to work or share a table with a native classmate (72% of the sample), distrust was not associated to any greater extent with foreign students (60% of the sample said they distrusted any classmate of whatever nationality). With respect to coexistence outside of the classroom, it should be mentioned that discrimination for racial stigma does not seem to be present in sports as clearly as in other cases mentioned above (only 20% of the sample said they would not invite an immigrant classmate). When organizing other non-sport activities (a birthday party), the percentage of rejection of foreign students rises slightly to 24% (64% of the sample said they might not invite "any classmate"). Finally, outside of the classroom in matters leading to closer involvement in their relations (go on vacation with a classmate), the results show that in this case in particular the majority of students prefer to go with foreign students (56% of the sample).

The PREVER app records all the interactions among students as described above, so the teacher can access the server and download this information to monitor what is happening (i.e., what type of interaction is being generated) among the students in the class on a sociogram of interactions going on in the group. **Figure 10** below shows an example of interaction in a class of students in the last year of primary school (to help understand the graphic, unimportant interactions have been omitted and only the more significant are kept in). It may be seen that three differentiated groups are joined by hubs common to them: (1) the group of Spaniards (numbered 0–8) has little interaction with the rest of the students who belong to other groups, (2) groups 9–15 are made up of Moroccans who have also established strong hubs basically among themselves (perhaps due to family interaction and the language, but they refuse to enlarge their groups), and (3) the Romanian

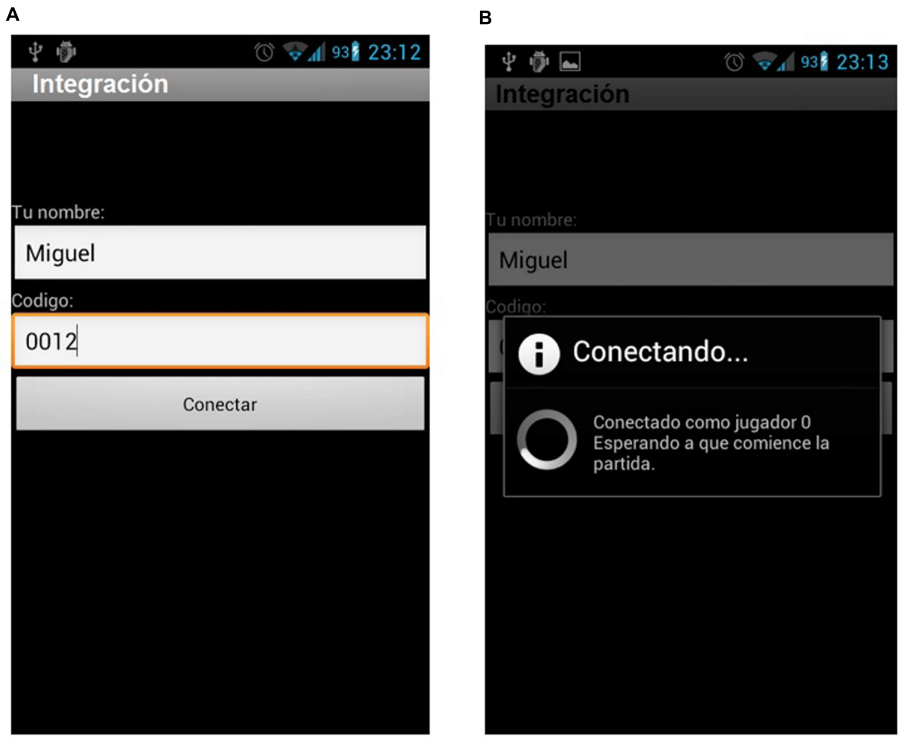


FIGURE 6 | Smartphone screenshots related to the game. (A) The student is assigned a numeric Id to avoid identity association. **(B)** The screen shows how, now, student 0012 is connecting. From now, the student will be tagged as 0012 instead of Miguel.



FIGURE 7 | Mobile screen without selecting a fellow student.

students (groups 17, 18, 19, and 20) and one Eastern European student (Russian). This sociogram shows how the students in a class relate to each other. Some strong cores of students and others not as strong are observed. The clusters detected are by origin. It is assumed that as they have the same origin and share the same language, relations among their

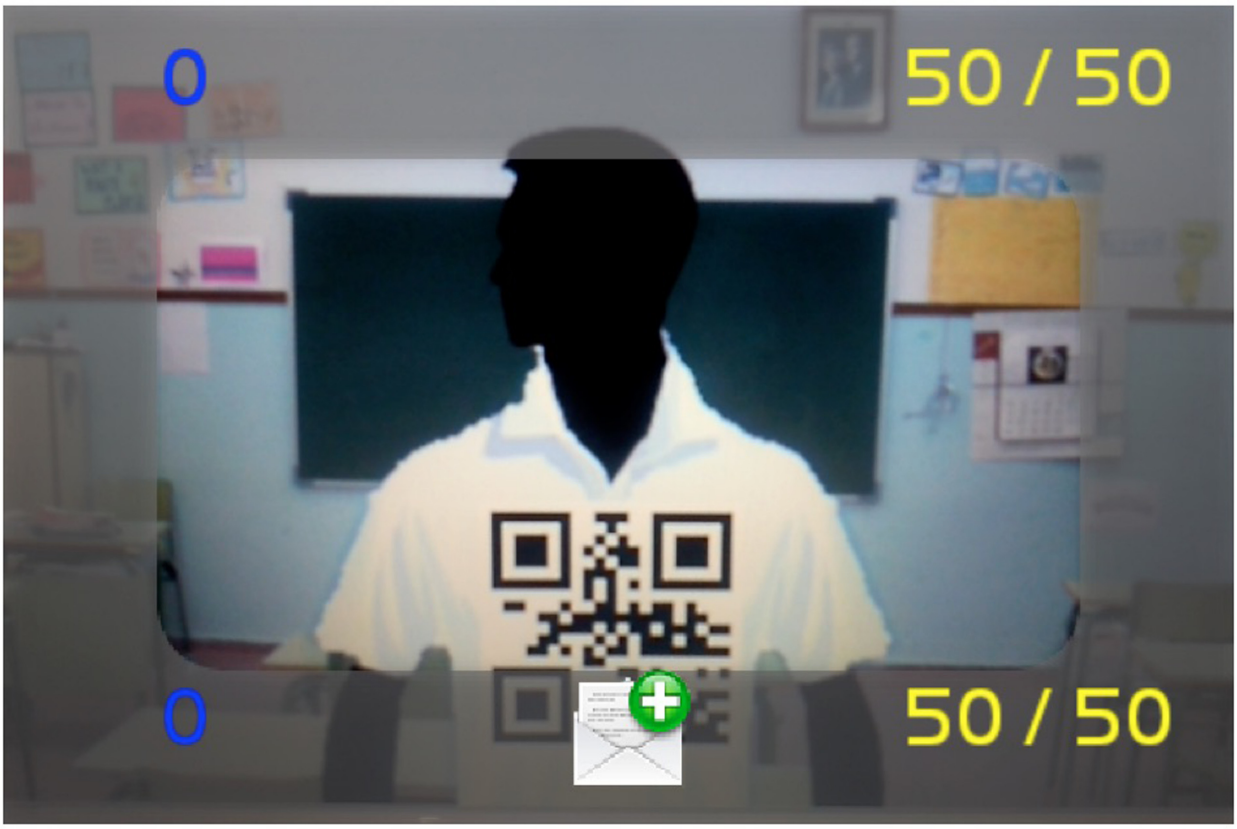


FIGURE 8 | Mobile screen selecting a fellow student.



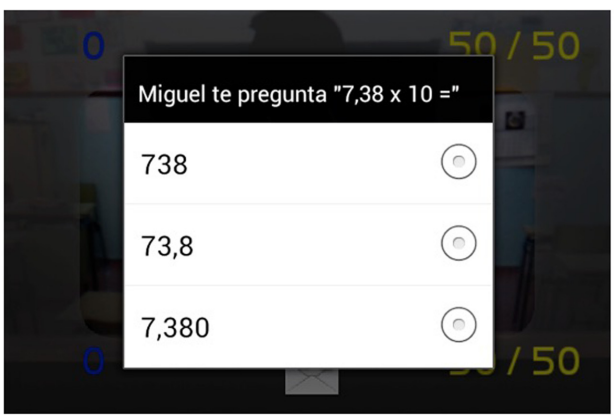


FIGURE 9 | Validation of an expulsion by the student #0012.

parents are quite probably closer and this generates stronger bonds.

DISCUSSION AND CONCLUSION

It is a fact that the discriminatory and excluding behavior in society should be detected early for better coexistence among the various nationalities that make up the population of a territory. However, acceptance of interculturality in the classroom is a problem that arises and affects immigrant students who are discriminated because of their origin and their appearance, which stigmatizes their future personal and professional development (Baysu et al., 2013). Gradual general awareness of the importance of human rights and repercussion in communications media of aggression in schools demand that the parties involved in

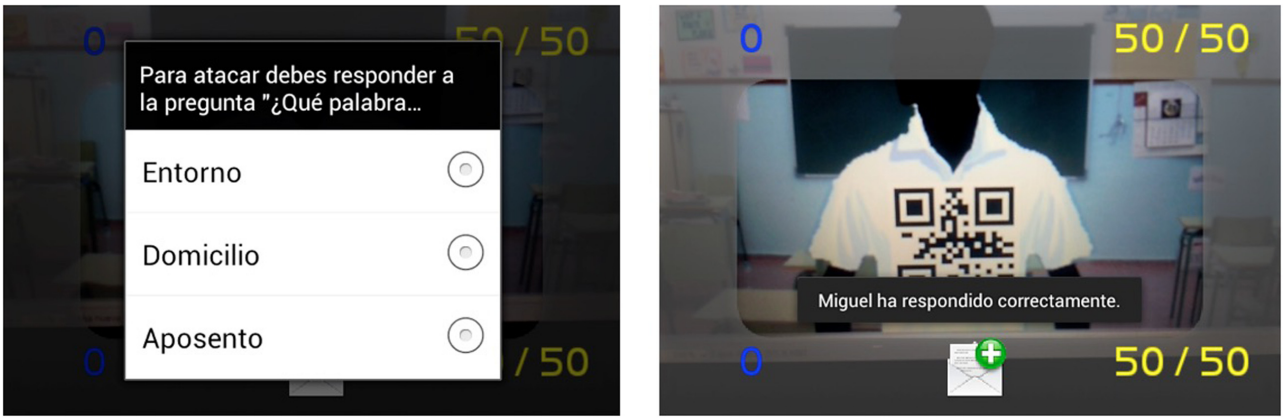


FIGURE 10 | Cancelation of an expulsion by the student #0012.

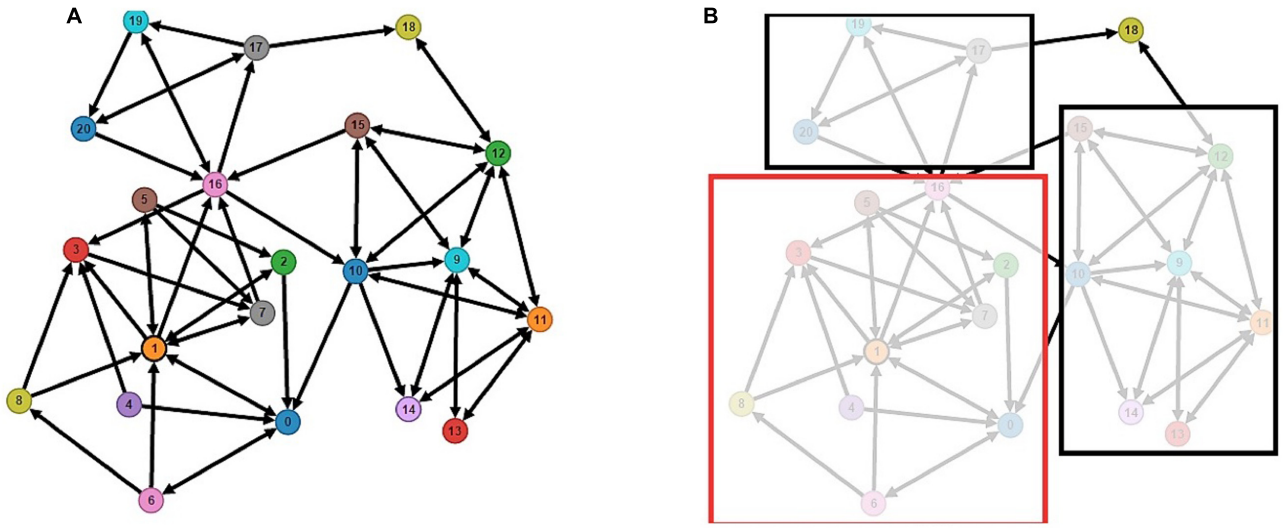


FIGURE 11 | Sociogram of the interaction. (A) The complete sociogram of the interaction. **(B)** The sociogram after the racial analysis. We can see how students group by nationality.

education intervene in both prevention and treatment of bullying when it occurs. In this sense, the subject of bullying has awakened growing interest in developing prevention and intervention programs for its reduction (Breakstone et al., 2009) which have had ambiguous results. This study has therefore attempted to advance in this matter by offering a gamified cell phone app which assists teachers in finding out the extent of interaction among students in a class and for early detection of possible bullying or discrimination based on the data stored in the proposed system's server.

The data analyzed demonstrate that the main problems of discrimination affecting the foreign population under 16 years of age in their compulsory education and which could potentially generate bullying are related more to their relations within the classroom itself. In spite of this, the app guides those students who install it on their devices through a series of stages dominated by situations in which they have to choose classmates which will lead them to select those with whom they prefer to interact and relate in each case. Thus it provides a useful dynamic tool for finding out the interactions taking place among students and for detecting cases of discrimination and even extreme cases of bullying.

The main implication of the study is possible decrease in cases of abuse derived from their early detection and consequent intervention/treatment by the teacher (and other parties involved), who can periodically consult data on student interaction stored on the system's server. It is an application mainly for implementation in classrooms to be used in student leisure periods (e.g., recess) and even outside of the classroom because of its gamified design. However, one of the main lines of future research is integration of the app in the learning setting itself, proposing this new context for interaction among students

which could provide more clues to their relationships in the classroom and outside it. Finally, the first thing that should be pointed out concerning the main limitations for using this type of technologies in the classroom is the need for the students to have access to a cell phone in which to install the app developed and interact with their classmates, as well as the different degrees of involvement developed by the students in their use of the applications. Other limitations related to the performance of the teacher's work should also be mentioned, since the introduction of this type of technology in the classroom means that more time would have to be devoted to periodic control of the interactions among students with the data stored on the server.

AUTHOR CONTRIBUTIONS

JA-B: He has developed and designed the software application for detecting the discrimination in the educational context. LB-U: He has been responsible for design the questionnaire that was passed to students in schools, as well as the study of the number of immigrants in Spain and Almeria. AM-M: She has participated in the field study, as pollster. Also, she has participated in the methodological support. AB-M: She has participated in the field study, as pollster. Also, she has participated in the methodological support. MdMS-M: She has participated in the field study, as pollster. Also, she has participated in the methodological support.

REFERENCES

Allison, A. P., and Kirsten, L. H. (2015). Old wine, new bottle? Comparing interpersonal bullying and cyberbullying victimization. *Youth Soc.* 47, 30. doi: 10.1177/0044118X15617401

Ansary, N. S., Elias, M. J., Greene, M. B., and Green, S. (2015). Best practices to address (or reduce) bullying in schools. *Phi Delta Kappan* 97, 30–35. doi: 10.1177/0031721715610088

Ávila, J. A. (2013). *El acoso escolar en Educación Primaria en la provincia de Huelva. [Bullying in Primary Education in the. province of Huelva*. Doctoral thesis, University of Huelva, Huelva.

Bauer, N. S., Lozano, P., and Rivara, F. P. (2007). The effectiveness of the olweus bullying prevention program in public middle schools: a controlled trial. *J. Adolesc. Health* 40, 266–274. doi: 10.1016/j.jadohealth.2006.10.005

Baysu, G., Phalet, K., and Brown, R. (2013). Relative group size and minority school success: the role of intergroup friendship and discrimination experiences. *Br. J. Soc. Psychol.* 53, 328–349. doi: 10.1111/bjso.12035

Bender, D., and Lösel, F. (2011). Bullying at school as a predictor of delinquency, violence and other anti-social behaviour in adulthood. *Crim. Behav. Ment. Health* 21, 99–106. doi: 10.1002/cbm.799

Bishop, J. (2014). *Gamification for Human Factors Integration: Social. Education, and Psychological Issues*. Hershey, PA: IGI Global.

Breakstone, S., Dreiblatt, M., and Dreiblatt, K. (2009). *How to Stop Bullying and Social Aggression?* Thousand Oak, CA: Corwin Press.

Cabra, F., and Marciales, G. (2015). "Cyberbullying and education: a review of emergent issues in Latin America research," in *Cyberbullying Across the Globe: Gender, Family, and Mental Health*, eds R. Navarro and S. Yubero (New York, NY: Springer), 131–147.

Caravaca, F., Falcón, M., Navarro-Zaragoza, J., Luna, A., Rodriges, O., and Luna, A. (2016). Prevalence and patterns of traditional bullying victimization and cyber-teasing among college population in Spain. *BMC Public Health* 16:176. doi: 10.1186/s12889-016-2857-8

Carmona, J. A., Espínola, M., Cangas, A. J., and Iribarne, L. (2011). MII-School: a 3d videogame for the early detection of abuse of substances, bullying, and mental disorders in adolescents. *Eur. J. Psychol.* 4, 75–84.

Carmona-Torres, J. A., Cangas, A. J., Langer, A. I., Aguilar-Parra, J. M., and Gallego, J. (2015). Acoso escolar y su relación con el consumo de drogas y trastornos alimentarios: comparación entre adolescentes de Chile y España [Bullying and its relation to drug abuse and eating disorders: a comparison between Chile and Spain teenagers]. *Psicol. Conduct* 23, 507–552.

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London: Sage.

Cherubini, L., Niemczyk, E., Hodson, J., and McGean, S. (2010). A grounded theory of new aboriginal teachers' perceptions: the cultural attributions of medicine wheel teachings. *Teach. Teach. Theory Pract.* 16, 545–557. doi: 10.1080/13540602.2010.507965

Chester, K., Callaghan, M., Cosma, A., Donnelly, P., Craig, W., Walsh, S., et al. (2015). Cross-national time trends in bullying victimization in 33 countries among children aged 11, 13 and 15 from 2002 to 2010. *Eur. J. Public Health* 25, 61–64. doi: 10.1093/eurpub/ckv029

Clarkson, S., Axford, N., Berry, V., Edwards, R. T., Bjornstad, G., Wrigley, Z., et al. (2016). Effectiveness and micro-costing of the KiVa school-based bullying prevention programme in wales: study protocol for a pragmatic definitive parallel group cluster randomised controlled trial. *BMC Public Health* 16:1. doi: 10.1186/s12889-016-2746-1

Cook, C. R., Williams, K. R., Guerra, N. G., Kim, T. E., and Sadek, S. (2010). Predictors of bullying and victimization in childhood and adolescence: a meta-analytic investigation (PDF). *Sch. Psychol. Q.* 25, 65–83. doi: 10.1037/a0020149

Craig, W., Harel-Fisch, Y., Fogel-Grinvald, H., Dostaler, S., Hetland, J., Simons-Morton, B., et al. (2009). A cross-national profile of bullying and victimization among adolescents in 40 countries. *Int. J. Public Health* 54, 216–224. doi: 10.1007/s00038-009-5413-9

Craig, W. M., Pepler, D. J., Murphy, A., and McCuaig-Edge, H. (2010). "What works in bullying prevention?," in *Preventing and Treating Bullying and Victimization*, eds E. M. Vernberg and B. K. Biggs (New York, NY: Oxford University Press), 215–242.

Dedousis, A., Shute, R., Varlow, M., Murrihy, R., and Kidman, T. (2014). Predictors of teacher intervention in indirect bullying at school and outcome of a professional development presentation for teachers. *Educ. Psychol.* 34, 862–875. doi: 10.1080/01443410.2013.785385

Del Rey, R., Casas, J. A., and Ortega, R. (2012). El programa ConRed, una práctica basada en la evidencia [The ConRed program, an evidence-based practice]. *Commun. Rev.* 39, 129–138.

Denzin, N. K. (1989). *The Research Act*. Englewood Cliffs, NJ: Prentice Hall.

Fekkes, M., Pijpers, F. I., and Verloove-Vanhorick, S. P. (2006). Effects of antibullying school program on bullying and health complaints. *Arch. Pediatr. Adolesc. Med.* 160, 638–644. doi: 10.1001/archpedi.160.6.638

Ginter, J., and Tropp, K. (2012). Questionnaire on violence in education: Estonia. *Int. J. Educ. L. Pol'y* 8:183. doi: 10.1186/s12884-015-0558-4

Givon, S., and Court, D. (2010). Coping strategies of high school students with learning disabilities: a longitudinal qualitative study and grounded theory. *Int. J. Qual. Stud. Educ.* 23, 283–303. doi: 10.1080/09518390903352343

Glaser, B. G. (1992). *Basics of Grounded Theory Analysis: Emerge vs. Forcing*. Mill Valley, CA: Sociology Press.

González, C., and Area, M. (2013). "Breaking the rules: gamification of learning and educational materials," in *Proceedings of the 2nd International Workshop on Interaction Design in Educational Environments*, Angers, 47–53.

Hakulinen, L., and Auvinen, T. (2014). "The effect of gamification on students with different achievement goal orientations," in *Proceedings of Conference on Learning and Teaching in Computing and Engineering (LaTiCE 2014)*, eds B. Aris and A. Selamat (Rome: IEEE), 47–54. doi: 10.1109/LaTiCE.2014.1

Hanewinkel, R. (2004). "Prevention of bullying in German schools: an evaluation of an anti-bullying approach," in *Bullying in schools: How Successful Can Interventions Be?*, eds P. K. Smith, D. Pepler, and K. Rigby (Cambridge: Cambridge University Press), 81–97.

Huitsing, G., and Veenstra, R. (2012). Bullying in classrooms: participant roles from a social network perspective. *Aggress. Behav.* 38, 494–509. doi: 10.1002/ab.21438

Ibanez, M., Di-Serio, A., and Delgado-Kloos, C. (2014). Gamification for engaging computer science students in learning activities: a case study. Learning Technologies. *IEEE Trans.* 7, 291–301. doi: 10.1109/TLT.2014.2329293

Kapp, K. M. (2013). *The Gamification of Learning and Instruction Fieldbook: Ideas into Practice*. Hoboken, NJ: John Wiley & Sons.

Kärnä, A., Voeten, M., Little, T., Alanen, E., Poskiparta, E., and Salmivalli, C. (2013). Effectiveness of the KiVa antibullying program: grades 1-3 and 7-9. *J. Educ. Psychol.* 105, 535–551. doi: 10.1037/a0031120

Kim, Y. S., Leventhal, B. L., Koh, Y. J., Hubbard, A., and Boyce, W. T. (2006). School bullying and youth violence: causes or consequences of psychopathologic behavior? *Arch. Gen. Psychiatr.* 63, 1035–1041. doi: 10.1001/archpsyc.63.9.1035

Klomek, A., Marrocco, F., Kleinman, M., Schonfeld, I. S., and Gould, M. S. (2007). Bullying, depression, and suicidality in adolescents. *J. Am. Acad. Child Adolesc. Psychiatry* 46, 40–49. doi: 10.1097/01.chi.0000242237.84925.18

Kuo, M. S., and Chuang, T. Y. (2016). How gamification motivates visits and engagement for online academic dissemination. An empirical study. *Comput. Hum. Behav.* 55, 16–27. doi: 10.1016/j.chb.2015.08.025

Laskowski, M. (2015). "Implementing gamification techniques into university study path. A case study," in *Proceedings of the IEEE Global Engineering Education Conference (EDUCON), 2015*, (Rome: IEEE), 582–586.

Limber, S. P. (2004). "Implemetation of the olweus bullying prevention program in American schools: lessons learned in the field," in *Bullying in American Schools: A Social-ecological Perspective on Prevention and Intervention*, eds D. L. Espelage and S. M. Swearer (Mahwah, NJ: Erlbaum), 351–363.

Luckin, R., Puntambekat, S., Goodyear, P., Grabowski, B. L., Underwood, J., and Winters, N. (2013). *Handbook of Design in Educational Technology*. London: Routledge.

Maguire, M. (2001). Methods to support human-centred design. *Int. J. Hum. Comput. Stud.* 55, 587–634. doi: 10.1006/ijhc.2001.0503

Middaugh, E., and Kahne, J. (2013). Nuevos medios como herramienta para el aprendizaje cívico. [New media as a tool for civic learning]. *Commun. Rev.* 40, 99–108. doi: 10.3916/C40-2013-02-10

Mishna, F., Saini, M., and Solomon, S. (2009). Ongoing and online: children and youth's perceptions of cyber bullying. *Child. Youth Serv. Rev.* 31, 1222–1228. doi: 10.1016/j.childyouth.2009.05.004

Norman, D. A., and Draper, S. W. (1986). *User Centered System Design*. London: Erlbaum.

Olweus, D. (1993). *Bullying at School: What We Know and What We Can Do*. Malden, MA: Willey-Black-Well.

Olweus, D. (2010). "Understanding and researching bullying: some critical issues," in *Handbook of Bullying in Schools: An International Perspective*, eds S. R. Jimerson, S. M. Swearer, and D. L. Espelage (New York, NY: Routledge), 9–33.

Ortega, J., Buelga, S., and Cava, M. J. (2016). Influencia del clima escolar y familiar en adolescentes, víctimas de ciberacoso [The influence of school climate and family climate among adolescents victims of cyberbullying]. *Commun. Rev.* 46, 57–65. doi: 10.3916/C46-2016-06

Ortega, R. (1997). El proyecto Sevilla anti-violencia escolar. Un modelo de intervención preventiva contra los malos tratos entre iguales [Sevilla school anti-violence project. A model of preventive intervention against abuse among equals]. *Rev. Educ.* 313, 143–158.

Ortega, R., and Del Rey, R. (2003). *Cuestionario Sobre Convivencia, Violencia y Experiencias de Riesgo-COVER. [Questionnaire on Coexistence, Violence and Risk Experiences-COVER]*. Córdoba: Universidad de Córdoba.

Ortega, R., and Mora-Merchán, J. (1998). *La convivencia Escolar: Qué es y Cómo Abordarla. Programa Educativo de Prevención de Maltrato Entre Compañeros y Compañeras [School life: What It is and How to Address It. Educational Abuse Prevention Program among Colleagues]*. Seville: Consejería de Educación y Ciencia. Junta de Andalucía.

Pajares, M. (2009). *Inmigración y mercado de trabajo. Informe 2009. [Immigration and labor market. report 2009]*. Madrid: Observatorio Permanente de la Inmigración, Secretaría de Estado de Inmigración y Emigración del Ministerio de Trabajo e Inmigración.

Patton, D. U., Hong, J. S., Patel, S., and Kral, M. J. (2015). A Systematic review of research strategies used in qualitative studies on school bullying and victimization. *Trauma Violence Abuse* doi: 10.1177/1524838015588502 [Epub ahead of print].

Penuel, W. R., Roschelle, J., and Shechtman, N. (2007). The WHIRL co-design process: participant experiences. *Res. Pract. Technol. Enhanc. Learn.* 2, 51–74. doi: 10.1142/S1793206807000300

Pepler, D., Smith, P. K., and Rigby, K. (2004). "Looking back and looking forward: implications for making interventions work effectively," in *Bullying in Schools: How Successful Can Interventions be?*, eds P. K. Smith, D. Pepler, and K. Rigby (New York, NY: Cambridge University Press), 307–324.

Piña Mendoza, C., and Callejas Fonseca, L. (2005). La estigmatización social como factor fundamental de la discriminación juvenil. [Social stigmatization as a fundamental factor in juvenile discrimination]. *El Cotidiano* 134, 64–70. Available at: http://www.redalyc.org/articulo.oa?id=32513409

Raminhos, C. S., Claudio, A. P., Carmo, M. B., Carvalhosa, S., de Jesus Candeias, M., and Gaspar, A. (2015). "A serious game to prevent bullying and promote empathy," in *Proceedings of the 10th Iberian Conference on Information Systems and Technologies (CISTI), 2015*, (Rome: IEEE), 1–6.

Richter, G., Raban, D. R., and Rafaeli, S. (2015). "Studying gamification: the effect of rewards and incentives on motivation," in *Gamification in Education and Business*, eds T. Reiners and L. C. Wood (London: Springer International Publishing), 21–46.

Rojas, D., Cowan, B., Kapralos, B., and Dubrowski, A. (2014). "Gamification and health professions education," in *Proceedings of the IEEE Games Media Entertainment (GEM)*, (Rome: IEEE), 1–2.

Rosenthal, L., Earnshaw, V., Carroll-Scott, A., Henderson, K., Peters, S., McCaslin, C., et al. (2015). Weight and race based bullying: health associations among urban adolescents. *J. Health Psychol.* 20, 401–412. doi: 10.1177/1359105313502567

Ruiz, F. J., and Belmonte, A. M. (2014). Los jóvenes como usuarios de aplicaciones de marca en dispositivos móviles. [Young people as users of branded applications on mobile devices]. *Commun. Rev.* 22, 73–81. doi: 10.3916/C43-2014-07

Salmivalli, C., and Poskiparta, E. (2012). Making bullying prevention a priority in finnish schools: the KiVa antibullying program. *New Dir. Youth Dev.* 2012, 41–53. doi: 10.1002/yd.20006

Sapouna, M., Wolke, D., Vannini, N., Watson, S., Woods, S., Schneider, W., et al. (2010). Virtual learning intervention to reduce bullying victimization in primary school: a controlled trial. *J. Child Psychol. Psychiatry* 51, 104–112. doi: 10.1111/j.1469-7610.2009.02137.x

Schoech, D., Boyas, J. F., Black, B. M., and Elias, N. (2013). Gamification for behavior change: lessons from developing a social, multiuser, web-tablet based prevention game for youths. *J. Technol. Hum. Serv.* 31, 197–217. doi: 10.1080/15228835.2013.812512

Serrano, A., Torrente, J., Moreno, P., and Fernández, B. (2012). Tracing a little for big improvements: application of learning analytics and videogames for student assessment. *Proc. Comput. Sci.* 15, 203–209. doi: 10.1016/j.procs.2012.10.072

Sin, K. W. M. (2003). Users' creative response and designers' roles. *Des. Issues* 19, 64–73. doi: 10.1136/bmjspcare-2015-000906.39

Smart, J. B., and Brent, I. L. (2010). A grounded theory of behavior management strategy selection, implementation, and perceived effectiveness reported by first-year elementary teachers. *Elem. Sch. J.* 110, 567–584.

Smith, M. A., Lambert, S. F., English, D., and Ialongo, N. S. (2014). Associations between trajectories of perceived racial discrimination and psychological symptoms among African American adolescents. *Dev. Psychopathol.* 26, 1049–1065. doi: 10.1017/S0954579414000571

Smith, P. K., Ananiadou, K., and Cowie, H. (2003). Interventions to reduce school bullying. *Can. J. Psychiatry* 48, 591–599.

Smith, P. K., and Sharp, S. (1994). "The problem of school bullying," in *School Bullying: Insights and Perspectives*, eds P. K. Smith and S. Sharp (London: Routledge), 1–19.

Solomontos-Kauntouri, O., Gradinger, P., Yanagigida, T., and Strohmeier, D. (2016). The implementation and evaluation of the ViSC program in cyprus: challenges of cross-national dissemination and evaluation results. *Eur. J. Dev. Psychol.* 13, 737–755. doi: 10.1080/17405629.2015.1136618

Strauss, A. L., and Corbin, J. (1998). *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, CA: Sage.

Su, C. H., and Cheng, C. H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. *J. Comp. Assist. Learn.* 31, 268–286. doi: 10.1111/jcal.12088

Thornberg, R. (2011). "She's Weird!" the social construction of bullying in school: a review of qualitative research. *Child Soc.* 25, 258–267. doi: 10.1111/j.1099-0860.2011.00374.x

Trip, S., Sipos-Gug, S., Tocai, I., Gradinger, P., Yanagida, T., and Strohmeier, D. (2015). Bullying prevention in schools by targeting cognitions, emotions and behavior: evaluating the Effectiveness of the REBE-ViSC Program. *J. Couns. Psychol.* 62, 732–740. doi: 10.1037/cou0000084

Ttofi, M. M., and Farrington, D. P. (2010). "School bullying: risk factors, theories and interventions," in *Handbook of Crime*, eds F. Brookman, M. Maguire, H. Pierpoint, and T. Bennett (Cullompton: Willan), 427–457.

Vannini, N., Enz, S., Sapouna, M., Wolke, D., Watson, S., Woods, S., et al. (2011). "FearNot!": a computer-based anti-bullying-programme designed to foster peer intervention. *Eur. J. Psychol. Educ.* 26, 21–44. doi: 10.1007/s10212-010-0035-4

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Álvarez-Bermejo, Belmonte-Ureña, Martos-Martínez, Barragán-Martín and del Mar Simón-Marquez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 15 November 2016
doi: 10.3389/fpsyg.2016.01774

Instructional Changes Adopted for an Engineering Course: Cluster Analysis on Academic Failure

José A. Álvarez-Bermejo[1], Luis J. Belmonte-Ureña[2], África Martos-Martínez[3], Ana B. Barragán-Martín[3] and María M. Simón-Márquez[3]*

[1] Department of Informatics, Universidad de Almería, Almería, Spain, [2] Department of Economics and Business, Universidad de Almería, Almería, Spain, [3] Department of Psychology, Universidad de Almería, Almería, Spain

As first year students come from diverse backgrounds, basic skills should be accessible to everyone as soon as possible. Transferring such skills to these students is challenging, especially in highly technical courses. Ensuring that essential knowledge is acquired quickly promotes the student's self-esteem and may positively influence failure rates. Metaphors can help do this. Metaphors are used to understand the unknown. This paper shows how we made a turn in student learning at the University of Almeria. Our hypothesis assumed that metaphors accelerate the acquisition of basic knowledge so that other skills built on that foundation are easily learned. With these goals in mind, we changed the way we teach by using metaphors and abstract concepts in a computer organization course, a technical course in the first year of an information technology engineering degree. Cluster analysis of the data on collective student performance after this methodological change clearly identified two distinct groups. These two groups perfectly matched the "before and after" scenarios of the use of metaphors. The study was conducted during 11 academic years (2002/2003 to 2012/2013). The 475 observations made during this period illustrate the usefulness of this change in teaching and learning, shifting from a propositional teaching/learning model to a more dynamic model based on metaphors and abstractions. Data covering the whole period showed favorable evolution of student achievement and reduced failure rates, not only in this course, but also in many of the following more advanced courses. The paper is structured in five sections. The first gives an introduction, the second describes the methodology. The third section describes the sample and the study carried out. The fourth section presents the results and, finally, the fifth section discusses the main conclusions.

Keywords: academic failure, metaphor, abstract concept, computer organization, concept metaphor

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Pedro Rosário, University of Minho, Portugal
Rebeca Cerezo-Menendez, University of Oviedo, Spain

****Correspondence:***
José A. Álvarez-Bermejo
jaberme@ual.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *04 July 2016*
Accepted: *28 October 2016*
Published: *15 November 2016*

Citation:
Álvarez-Bermejo JA, Belmonte-Ureña LJ, Martos-Martínez Á, Barragán -Martín AB and Simón-Márquez MM (2016) Instructional Changes Adopted for an Engineering Course: Cluster Analysis on Academic Failure. Front. Psychol. 7:1774. doi: 10.3389/fpsyg.2016.01774

INTRODUCTION

In Hager (2008), the author discusses whether or not the learning process takes place only *inside* the student. When one refers to old theories of learning, two metaphors come to mind: the acquisition and the transfer metaphors.

To present the framework in which the paper was developed, we must first acknowledge that we, as human beings, are not able to think without using metaphors based on our life experiences

or in what we have been taught. For example, when a toddler starts to explore and gain experience it learns via testing and then predicting the environment. After that, its first questions are asked of its relatives and those who must promote growth using simplistic metaphors. In other words, an adult may introduce a tiger as a wild cat, as the youngster probably only identifies with a household pet. Using this simplistic definition, the toddler can safely acquire new concepts, although this new knowledge will be refined later on. Using simplified contexts (Kövecses, 2015) always helps when facing more complex scenarios with no prior skills. In this first stage, metaphors are needed (Lakoff and Johnson, 1999; Hoover, 2016) to the case where the conceptual metaphors exposed by Lakoff and Johnson (1980) were not available. It is also considered that the process of making use of metaphors is involved in a creative process. Such a creative process is exploited, also, through metaphors to the tourism studies, as underlined in Adu-Ampong (2016) and discussed in Pereira de Barros et al. (2015).

Metaphors are useful but should not be used as a rule of thumb. In Scheffler (1960), a discussion on the fact that metaphors can also be counterproductive is presented. This led us to think that metaphors were used in the first stage of learning a complex concept or when knowledge must be acquired quickly and safely, meaning that the processing of the received information can be later used to synthesize the substratum upon which the coming knowledge will be built.

When we talk about learning, the mainstream thought is based, as Hager (2008) points out, on the fact that we learn because we first get the knowledge that we are going to need to solve problems and understand complex concepts. How to apply the knowledge is interesting in the field of engineering, but the most important part is the ability to acquire it and to extend it to connect with the knowledge that the student already had. Therefore, learning is built on how knowledge is acquired and the ability to apply it (Hager, 2005). The relevant part of cognition is embodied into the mind, and then we use our bodies to act accordingly. Following the line that Hager used to understand how we learn, Bereiter (2002) was the starting point considering that we may understand the mind as a recipient into which we could put content in during the process of acquisition.

Hager (2008) uses metaphors to explain the storyline, from Bereiter (2002) to Hager (2005), and these metaphors are the *acquisition metaphor* and the *transfer metaphor*. In Spain, the European Higher Education Space has considered moving from the traditional or formal educational model to a more dynamic one. The formal education model matches with the conception of the mind as a recipient and also defines the path to verifying if the student successfully acquired the knowledge via conventional tests or quizzes. We, at Universidad de Almería, understood this shift, imposed by EHES, in the educational paradigm as an opportunity to seize the metaphors used to understand learning. As Scheffler (1960) underlined, every metaphor has a limitation. Therefore, the way of teaching should also be shifted, accordingly. How sure are you that an exam, answered with no errors, means that all knowledge was properly acquired? From this first question, several others are also posed: Are we using models that tie content to a certain model of examination? Are we part of the academic failure of the students as we did not match the learning expectations? Is our teaching model providing concepts that easily adapt to a changing and rapidly evolving context?

Traditionally, the propositional learning, or static learning, was associated with higher education, whereas more practical learning and elemental versions of propositional learning were thought to be for low-profile students. In this model, if we analyze it, we are considering that the simplification of the context and the usage of the sensor-motor parts are catalysts to the acquisition of knowledge. But, is it correct that we prevent advanced students from using this schema of learning? We took this part to our analysis. We simplified the context and used more interaction to let freshmen acquire the key knowledge faster. Therefore, we tried to remove the first barrier of academic failure in engineering courses. We intended to homogenize skills at the first year. As in this learning schema, based in acquiring knowledge and applying it, there is an additional issue, which is the skill of acquiring the mentioned knowledge. This way we could consider that the mind is not the unique actor in learning as skills are not embodied into the mind. Skills are the tools that EHES-based educational models are using as their unit of learning (Hager and Holland, 2006). This is interesting from the perspective that skills are the result of learning as we have defined it. Let us consider that a certain student acquires some knowledge, and that he is able to transfer it by means of applying it to solve a set of problems. The student succeeded in that skill or competence. The EHES model is based in competences and, therefore, is not focused on the "things" the student knows, but rather on how they apply what they know. This is what is not considered in the conventional definition of learning, and it is a factor that affects learning (Hager and Smith, 2004).

If the conventional model fails in considering context (which is truly relevant, as exposed by Kövecses, 2015), then conventional teaching is not matching the needs and maybe it is not avoiding failure. Then what is learning? If we wish to reduce failure at universities, we should understand what learning is, and work to make the process of learning appropriate for this schema. Learning is defined by each one of us by tagging or constructing certain activities, like "learning" (Saljo, 2003). It is also affected by social-cultural issues, among others. This fact, of considering context as a key part of learning, is relevant using metaphors also (Kövecses, 2015).

How best to think of the process of learning and the ideal teaching techniques? (Hager, 2008) creates an interesting metaphor in which we have sustained an important part of our research. It was, in fact, in 2008 when we officially shifted our course methodology to the metaphor-based methodology, although the first course in which we started to apply metaphors was in 2005. The *becoming metaphor* considers that the learner is not disconnected from the context, and that has embodied knowledge, understanding, skills, and social

context. This metaphor considers that learning is a process where the person and the context both change and adapt to one another (Beckett and Hager, 2002; Hager and Halliday, 2006).

If learning is understood using this definition, then any person can learn by means of their context, skills and understanding (Comellas-Carbó, 2015; Kövecses, 2015). When the students are in their first year of an engineering degree, the context is not suitable for the learning process as the student faces a new educative model and new concepts never seen before that must be quickly metabolized to acquire new concepts. If we accept that skills are almost homogeneously distributed over the student population that enrolls in Computer Organization, then we must make the process of acquiring new quick. Metaphors are a very interesting tool for this purpose as we simplify the context. Once we have done this, the knowledge interconnecting network can be enhanced soon with the newly acquired concepts. Reducing the time to metabolize the knowledge means being able to show new skills fast. These skills are needed to set the basis for following courses where it is assumed that skills are well assimilated.

The relevance of the metaphors in university teaching is obviously not limited to engineering and experimental sciences, but also applicable to all other areas of knowledge and job pursuit (Fuentes-González and Belmonte-Ureña, 2015).

The main objective of this paper is to present the advantages which come from using metaphors and abstractions as a teaching methodology for the Computer Engineering degree at the University of Almería. Thus, after the application of the technique based in the cluster analysis, a representative sample of the evaluations obtained by the students during the entire period comprising 11 different academic courses spread along 11 years, and focused on the course: Computer Organization (475 observations), it is clearly observed that two distinct groups, named Cluster 1 and Cluster 2, were found to be perfectly characterized.

METHODOLOGY

Once we have set the framework where we intend to develop our methodology, we have to face an interesting and challenging task, which is teaching freshmen to get the needed skills. To do this, metaphors can help in the process of acquisition and contextualisation (Kövecses, 2015). Since the first stages of civilisation, the education process was based in the use of metaphors. They were useful to gain proximity with unrelated concepts. For example, in Margaret (2001) there is a clear example of how to use them to instruct library students. In that paper, authors use the trend outlined in Nibley (1991). There is a myriad of literature with respect to metaphors as a vehicle to knowledge (Sanders and Sanders, 1984), and as a means to reveal a path to the unknown. But, conveniently seized, metaphors can be quite useful (Rabinowitz, 1997).

There is an unavoidable cite when referring to metaphors; this is Lakoff and Johnson (1980), who presented the metaphor as an integral part of the way we see the world and of our "conceptual system." According to Lakoff and Johnson (1980) and Hager (2008), metaphors are a key component of the human thought process. Each metaphor represents an underlying metaphorical concept that dictates the way we assume the context, or environment. The metaphors work because people in the culture understand the underlying concepts, even if they cannot articulate them (Comellas-Carbó, 2015).

It is widely accepted that learning can be explained by means of the *becoming metaphor* as defined in Hager (2008) and its relationship to embodied cognition, and that to ensure that learning is properly directed and achieved quickly, we can make use of metaphors. Wilson and Golonka (2013) discuss an interesting issue regarding metaphors and embodied cognition. Wilson and Golonka (2013) researched metaphors as a means to approach cognition. The interesting point revealed in their research has to do with the fact that metaphors are of interest for an embodied cognition field as they can map contextual and bodily experiences onto abstract concepts (Lakoff and Johnson, 1980). There is much literature consistent with the notion that conceptual metaphors inform and shape thinking (Landau et al., 2010). Conceptual metaphors are able to combine two concepts that intuitively fit together (Schneider et al., 2011). Using conceptual metaphors for thought and judgment can be better organized as they represent general mappings. The aspect, as revealed by Schneider et al. (2011), with conceptual metaphors that we have exploited is that they meet inferences that can reinforce an individual's cognition. This is because one source concept activates another related concept.

Identifying target concepts and their relationships is the first step toward selecting the source concepts and the metaphors to establish the activation between source set and target set (Hellmann et al., 2013).

Using metaphors to activate target concepts from certain and previously selected source targets recalls the internal workings of a neural network, where connectivity is a key part of the embodied conceptual metaphor. When the usage of a conceptual metaphor is accepted and that it is part of the embodied cognition in the sense of the *becoming metaphor* (Hager, 2008), then experimenting results from the embodied cognition literature is easy. This can be done by adopting a computational model to create a controlled context where the source and target concepts are activated experimentally, in this way understanding how sensory motor mechanisms could emplace higher-level cognitive behavior over the process of learning. In Flusberg et al. (2010), authors create a controlled neural network to demonstrate the principle that gives birth to the *becoming metaphor*.

During the course of time, researchers have devoted their work to proving that the mind is situated and embodied. But how does cognition appear? It does appear through the physical interactions with the context, which is exactly what is stated by the *becoming metaphor*, the guiding principle that we are following to adopt the turn in our teaching. This is supported by researchers such as Clark (1998), Barsalou (1999, 2008), Lakoff

and Johnson (1999), and Chemero (2009). Embodied cognition states that cognitive processes are tuned and structured by the interaction and reciprocal evolution of an agent and its context. In Rizzolatti and Craighero (2004), for example, emotion and action perception are evident in the cognition process (recently demonstrated by the work presented by Aziz-Zadeh and Gamez-Djokic, 2016). If we refer to Margaret (2001), the engagement through emotion was part of the success of the learning process, which is more proof that the *becoming metaphor* is useful to model learning. If it is useful to model learning, then the action of teaching can be directed to that model of learning and focusing in the pedagogy, as in Harr et al. (2014). If we aim to use metaphors to activate target concepts using source concepts, given that the mind and cognition are dependent and related to the context, then we can get to the point where we wonder if this mechanism is artificial. But, again, this is a debate that is continuously held between researchers (Lakoff and Johnson, 1980, 1999; Gibbs, 2006; Feldman, 2006; Pinker, 2007). It was Lakoff and Johnson (1980) who first proposed a widely accepted argument in favor of talking about complex or abstract concepts, the inevitable need for metaphors and borrowing elements from concrete and well-known domains. Therefore, metaphors are elements that we use not only when we talk about abstract things, but how we think of them as well.

The justification of the turn in our teaching methodology is experimentally demonstrated in the form of experiments showing that activating a concrete source domain influences inferences in the abstract target domain (Jostmann et al., 2009; Ackerman et al., 2010).

In Flusberg et al. (2010), the authors propose a controlled and simplistic model where these theories can be validated. This controlled model is a computational model based in neural networks. These simplified models let researchers deeply understand complex cognitive processes, to a point where embodied cognition was lacking (Spivey, 2007; McClelland, 2009).

CONTEXT

The context where the methodology based in understanding the learning process described in Hager (2008), by the *becoming metaphor*, where the cognition can be approached by means of interconnected concept metaphors, was applied in a Computer Organization course, which is scheduled during the first semester of the first year. In this course, the knowledge of the students is void as it is mostly technical. The context is therefore not helping the learning process, if we understand it using the *becoming metaphor*. In addition to this, students—freshmen—have enrolled in a degree where a high percent of the curricula was not studied in previous stages. In this context, it is vital that the knowledge that the student acquires is properly achieved and metabolized as it is the foundational framework for all the concepts required in upcoming courses. Also, it guarantees that skills and competences are properly acquired.

During the Computer Organization course the student faces a very low level of details in terms of how the computer is designed. This requires the student to be engaged in the understanding of all details. Many of the concepts are directly used by other courses, even during the same semester. These include the concepts of cache memory and the concept of system clock. Others are used in more advanced courses, like the concept of micro-architecture and instruction-set architecture. So, if we fail to properly introduce this knowledge at this stage, then the failure (and sentiment of low engagement) will be a constant during the students' career. Recall that, according to Rizzolatti and Craighero (2004), emotions are an important part of the learning process and of cognition. Here is where we adopted the methodological change to reduce failure, at least by means of metaphors to let students land smoothly in this course, feel confident with the contents, and therefore promote their skills.

The course contents were completely redesigned to accommodate the changes referring to the mentioned concepts: cache, system clock, and micro-architecture and instruction-set architecture. We moved from the mere transmission of technical details to a more PPK (Pedagogical Psychological Knowledge) centered method where the metaphors were the core part:

(i) *Understanding cache*: The cache memory of the system, in Computer Organization, was previously defined as an internal memory built with fast semiconductors that can be found both inside and outside of the core in the chip-set IO processor. If a student in his first semester is given this, then the negative emotional impact may affect the rest of the learning process. But, if the concept is rewritten as: You may understand the cache as an internal memory that resides inside the processor core and in the auxiliary communications processor. Its purpose is making data processing quicker, so to understand the cache means thinking of your kitchen pantry or fridge. If you do not have cache, or a pantry, then you will not eat until you go to the grocery store, get home, cook, sit down, and then finally eat your first course. To eat your second dish, you need to stand up, return to the supermarket (your main memory area), and do everything all over again. What about dessert? Again, you leave your home (processor), go to the supermarket (main memory), get your ice cream (data), return home, and eat it (process it). How may this affect your cache (first dish, second dish, dessert)? If you use your cache (pantry) when you visit the supermarket you get all the data that you may need for your next few operations, and keep that in the pantry. So when you pretend to have lunch, your first dish is already there. You cook it so you can proceed directly to the second dish without having to leave your home (processor). This accelerates your process of eating. The pantry is small in size (you do not really need a big one) but many foods have expiration dates. Size and expiration dates are two concepts that are related to: temporal locality and spacial locality that affects program performance. If your pantry

is big you may store data (food) that you will never eat and then dispose of due to your expiration date. So, you and the processor, when using the cache, are filled up with little data. These data are the information that the processor will cook in the next operations (days)—temporal locality—and these pieces of data are related and tied to a date, like food.

(ii) *Understanding the system clock*: It is in this course (Computer Organization) where the importance of the quartz oscillator is revealed. The oscillator is the system clock. It commands the speed at which every part of a processor can work. The problem here is that the number of students that really got the meaning and the importance of the oscillator was very small when the definition given was this: *The oscillator is a train of squared digital pulses*. Students tend to study its definition and repeat exercises until, mechanically, they were able to "solve them." If the exercise was changed, the student did not know how to do it. In this case we used the metaphor of the galley. In it there is a person that sets the working rhythm by hitting a drum. Each time the person hit the drum, all the rowers had to row at the same time. Otherwise, the galley would not advance in a straight line. If the person that hits the drum increases the frequency of the hits, then rowers work faster, the galley travels faster. Also, related to the frequency concept, we can introduce concepts such as the heat generation and loss of performance (as the drummer increases his frequency, rowers will operate faster, and therefore be affected by the heat they generate; if the galley is not able to reduce the heat, then rowers will throttle down to avoid collapse). The drummer is the system clock and with this concept we can reveal related and abstract concepts as frequency and its relationship to performance, the heat problem and the importance of using the correct heat sink (TDP factor) to avoid collapse or a loss of performance due to a frequency deceleration. These concepts can be perfectly revealed and prepared if the metaphor is explained instead of immediately using the technical definition, which will be perfectly understood once the metaphor is transferred to the class.

(iii) *Entering into a real person-sized processor*: It is also in this course where the students are told about a program and the fact that it is composed by instructions. The instructions are pieces of 1s and 0s that tell the processor which circuit should be used (adders, multipliers, etc.) and with which data to do all the tasks that are implemented into a program. Concepts such as the ISA (Instruction Set Architecture) are also presented in this course. As you may see, there are many new and technical concepts that harness skill acquisition. For these concepts we prepared the metaphor of the car-wash tunnel, where the inner workings of a processor are revealed comparing the architecture of a processor to that of a car wash tunnel. In a first instance, the students are presented *the instruction* that is explained using the plastic token (**Figure 1**) that car-wash tunnels use to operate. This plastic token has little holes which let the car-wash tunnel read the type of washing operation you bought. This works exactly the same as with computer instructions where 1s and 0s configure the type of operation to be done with the data. In this case, the data is our car. In computer instruction it is, for example, a number. The plastic token is inserted in a small device (**Figure 2**) that reads the token and prepares the whole architecture of the tunnel for you. The same occurs in a processor. The instruction is decoded in the *control unit*. This device that understands the plastic tokens is key for the processor. This device sets the number of different instructions according to the different operations that it is able to do. This set of instructions (plastic tokens) is what we call the Instruction Set Architecture. Two processors that have the same *small device,* without caring about the rest of the architecture, are compatible (Intel and AMD). The rest of the car-wash tunnel is what (in processor) is called data path (**Figure 3**). This is where data (cars) pass and is operated according to the instruction (plastic token) that we have inserted into the car-wash tunnel (control unit). **Figure 4** shows the technical sketch to explain all these concepts. Students are now presented this metaphor and then they are given the technical sketch. **Figure 5** shows the target skill that the student must acquire. We see that if the students are offered the technical concepts with no metaphors, they take much more time to get the target skills. If they are exposed to the metaphors, they quickly understand the concepts and are able to advance faster.



FIGURE 1 | Plastic token as a metaphor for the instruction.

As a direct consequence of the methodological change in this context (it was started in 2005), we experienced an improvement in results. We decided to switch textbooks from the conventional one to one more focused on the concept of metaphors. Since then, the recommended textbook for this

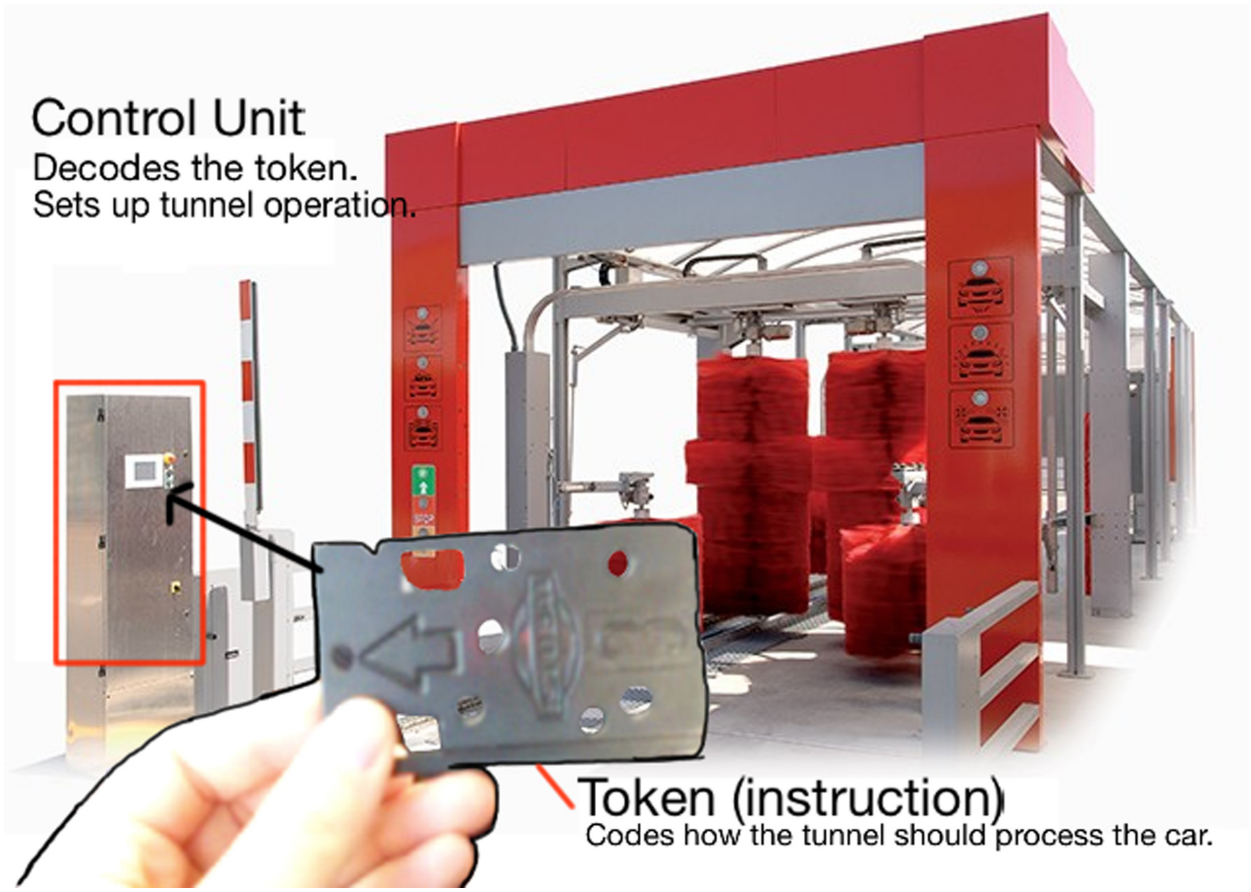


FIGURE 2 | Small device that reads the token and configures the tunnel. Metaphor for control unit and instruction decoding.

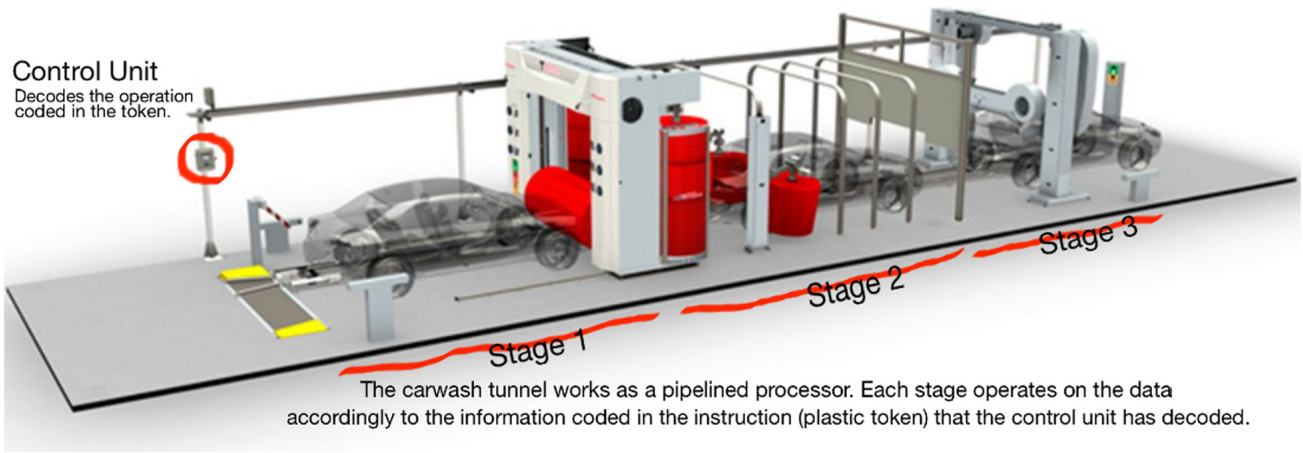


FIGURE 3 | Car-wash tunnel metaphor for the data-path unit of a processor.

course is Alvarez-Bermejo (2008). This book has redesigned the course without compromising the curriculum and has also helped first year students to adapt to the material more quickly.

METHOD

To have a real contrast of the effectiveness of the instructional changes adopted, instead of simply evaluating the performance

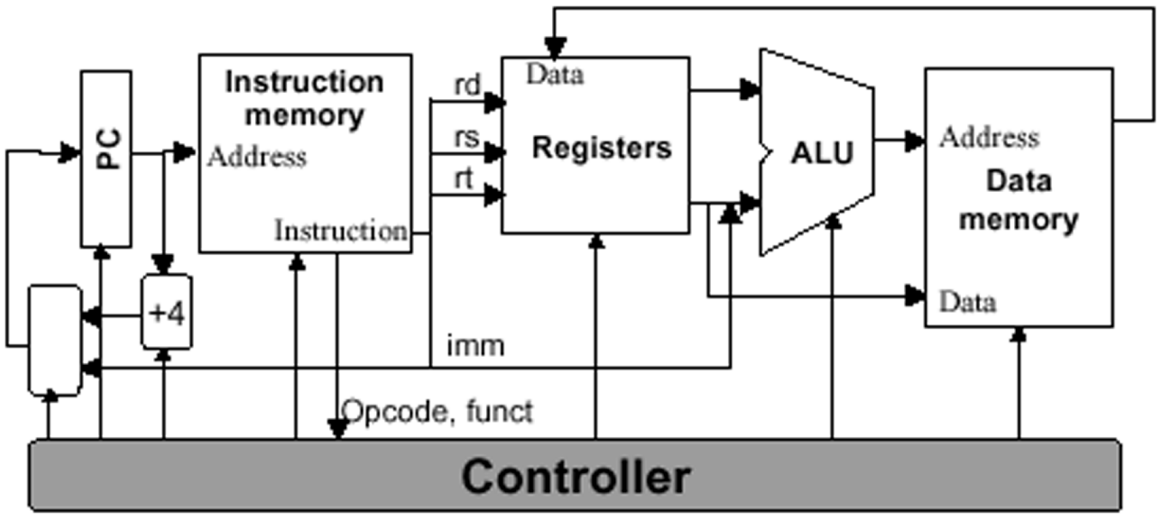


FIGURE 4 | Simplistic model of the processor architecture.

of each student, we have considered that to add their opinion as well as input from students themselves is of relevance. For this purpose, a table has been built for each student, including data that identify the course (year, group, etc.), date on which the student took the exam, final grades, and the percentage of homework/labs fulfilled by the student during the course and the attendance rate. Additionally, we also took as a reference the feeling of the students (their opinion); in our university we, the faculty, have access to the evaluation that the student completes when the course is over. This evaluation, controlled by our university, is completed by the student (as a means to measure teaching quality). The data related to these surveys, which are passed out to the students each semester, are provided to us. These surveys are collected while gathering student evaluations, for each teacher and course, during that semester and at the end of the period. However, as each survey completed by any student is anonymous it is not possible to obtain a certain student's answer. Therefore, the data are aggregated to build a performance profile for each faculty. To incorporate the results of such surveys, we are using the average opinion for each course. Thus, the sample consists of 475 records, which reflect the performance and behavior that every student has had regarding the Computer Organization course for the last 11 academic years, i.e., from 2002/2003 to 2012/2013.

For each student six variables are defined:

- **V1**: Identification number (ID) for each student. This is unique and personal.
- **V2**: Academic course in which the record of the student was obtained.
- **V3**: Examination date in which the student opted to take the examination; this date can take four possible values: February, June, September, or December.
- **V4:** Qualification obtained for the course. This variable shows the numeric value representing the success value to pass the course.
- **V5:** Percentage of lab assignments that the student was able to complete. This percentage is accounted as additional to the written exercise (exam) and therefore adds to the final score of the student. This additional evaluation is considered, somehow, a continuous evaluation to evaluate how the student progresses.
- **V6:** Number of absences, or rate of absenteeism, in the lecture sessions, which includes how often the student missed lectures during the semester. This entry gives an idea of the degree of involvement, engagement, and student interest in the course.

It is also known that during the 11 academic courses analyzed and sampled, the teacher of the course was the same. The unique, significant turn in the methodology used ordinarily for the course was the adoption, from the academic year 2005/2006, of a new method of lecturing that was supplemented with notes of support in the form of metaphors and abstractions following, first, the embodied cognition metaphors and from 2008 the *becoming metaphor* to understand learning. The resulting course material was subsequently published as a book (Alvarez-Bermejo, 2008) that is still in use (and whose edition was extended to Latin America).

Table 1 gathers a summary of the sample under study, examination dates, and average scores.

The mining of information gathered from the sample was started with an analysis of the characteristics of the group of students surveyed through the use of statistical classification techniques and cluster analysis, which allowed us obtain a characterisation of the students evaluated into two clearly separated groups.

The cluster analysis used for the processing of information consisted of the application of the K-means algorithm. However, in a previous stage, the DBSCAN—Density-Based Spatial Clustering of Applications with Noise—proposed by Ester et al.

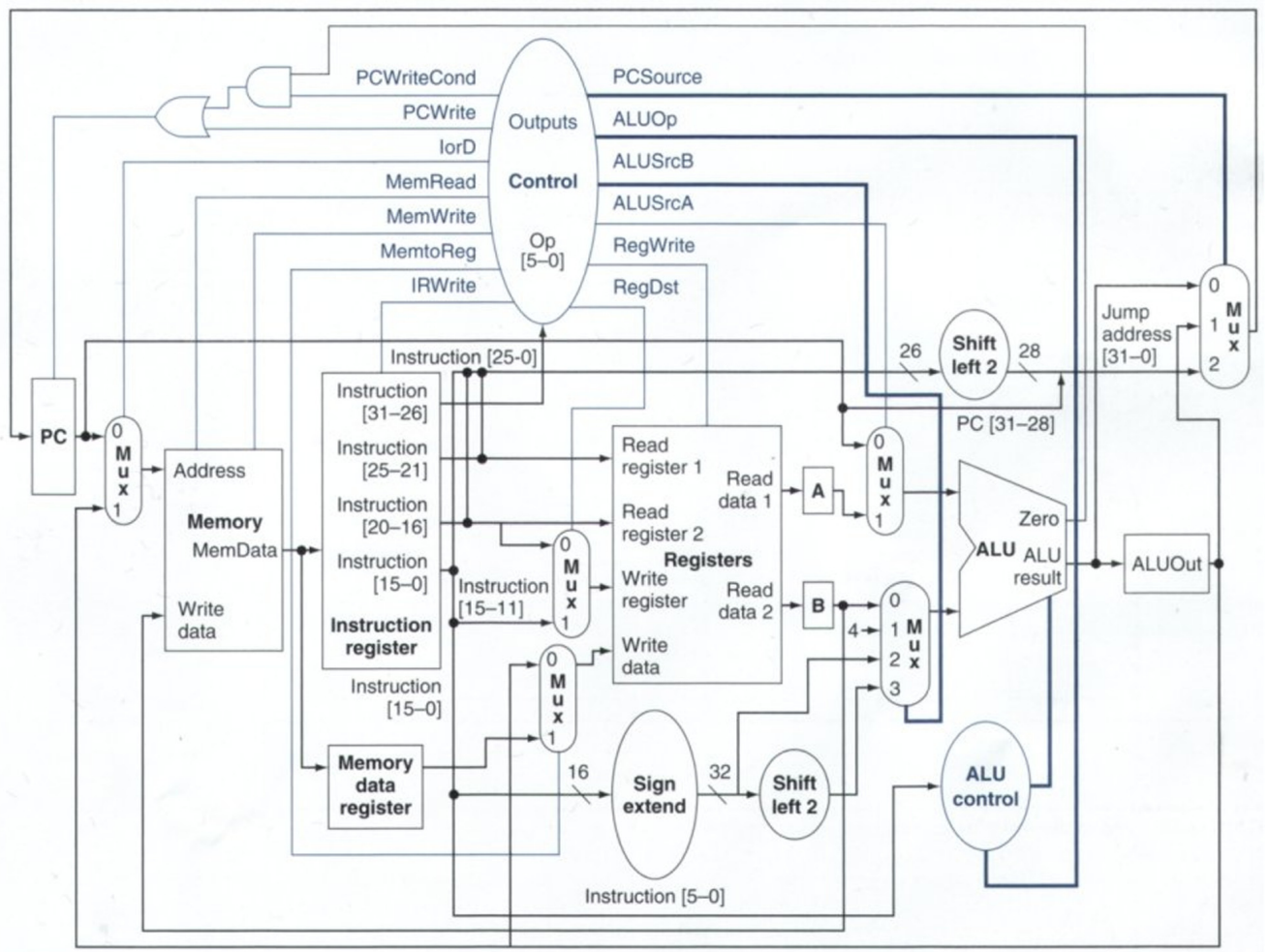


FIGURE 5 | Final model of the processor architecture.

(1996) was applied. Both methods (K-means and DBSCAN) have been used in numerous research papers as a path to obtain the optimal number of groups that can be created from the original sample. So, the latter algorithmic procedure provides a significant advantage over the classical cluster analysis based on the K-means algorithm, because with DBSCAN it is not required to specify the number of final clusters desired.

RESULTS

The realization of the cluster analysis has allowed us to obtain deeper knowledge of the characteristics of the two groups of students that make up each cluster. We have considered three typifying variables from each cluster, as presented in **Table 2**.

In view of the statistics, the analysis regarding the coefficient of variation (CV) is remarkable. This statistical concept is used to instrument the dispersion of data regardless of the units in which the variable is expressed. Thus, the higher the CV, the greater the dispersion, that is, less data homogeneity. In this regard, it is noteworthy that the high dispersion was presented by V5 (percentage of lab assignments completed by the student), with a CV value of 62.3% and the rate of absenteeism registered during the lecture sessions (V6).

Thus, the total sample consisting of 475 students that took the examination and were qualified for the period comprising the eleven academic courses have been classified into two homogeneous groups: one with 257 records (Cluster 1) and the other with 218 (Cluster 2). Only three from the total of six variables considered for the study were instrumental in breaking this classification into two clusters, as presented in **Table 3**.

According to the average of the records registered for the six variables, the characteristics of each cluster are described as:

TABLE 1 | Distribution of the simple: course, examination date and average scores.

Course	Exam date	Students	Average score	% Labs assigments completed	Average absenteeism
2002–2003	december	15	3,60	26%	2,10
	june	51	3,29	23%	2,31
	september	24	2,89	19%	2,50
2003–2004	december	18	5,61	46%	1,00
	june	46	4,25	33%	1,95
	september	12	5,04	40%	1,42
2004–2005	december	8	5,75	48%	0,88
	june	33	3,82	28%	2,36
	september	18	3,83	28%	2,33
2005–2006	december	6	4,67	37%	1,67
	june	20	5,94	53%	0,97
	september	10	4,20	67%	2,45
2006–2007	december	3	7,50	100%	0,25
	june	39	5,05	76%	1,94
	september	13	5,77	83%	1,40
2007–2008	december	3	5,00	75%	1,92
	june	35	5,98	85%	1,33
	september	10	6,17	87%	1,14
2008–2009	diciembre	3	6,00	85%	1,25
	junio	34	4,88	74%	2,04
	septiembre	9	6,00	85%	1,25
2009–2010	june	30	5,33	78%	1,70
	september	4	6,00	85%	1,25
2010–2011	june	12	3,00	55%	3,25
	september	8	6,00	85%	1,25
2011–2012	february	1	6,00	85%	1,25
	june	8	5,00	75%	1,92
	september	1	6,00	85%	1,25
2012–2013	february	1	6,00	85%	1,25
	june	1	7,50	100%	0,25

TABLE 2 | Typifying variables from each cluster and descriptive statistics.

Variable	Description	Mín.	Max.	Average	Typical deviation	Variation coefficient
V_4	Final grade score for the student	2,00	10,00	4,51	1,99	44,0%
V_5	Percentage of lab assignments completed	10%	100%	48%	0,30	62,3%
V_6	Absenteeism rate for lecture sessions	0,00	3,25	1,89	1,12	59,3%

TABLE 3 | ANOVA analysis of the typifying variables.

Variable	Descripción	aggregated cuadratic mean	gl	Error cuadratic mean	gl	*F*	Sig. (*)
V_4	Final grade for the student	1593,422	1	0,585	473	2723,210	0,0000000
V_5	Percentage of lab assignment completed by the student	25,307	1	0,038	473	657,883	0,0000000
V_6	Rate of absenteeism in lecture sessions	545,007	1	0,110	473	4944,834	0,0000000

(*) At the 95% of confidence, all the typifying variables are significant.

Cluster 1. "Unmotivated students with the course." There were 257 students, since the academic year 2002/2003 until mid-2004/2005, who enrolled in the course Computer Organization when the teaching of the lectures was without any methodological change adopted other than the conventional teaching/learning scheme. This group is characterized in that it has an average of qualification (V4) below the overall average, that is, 3.88 compared to 4.51. In both cases, the score is a signal of academic failure. This group is also characterized as the least participative, with a very low level of engagement in class with a very low number of lab assignments completed, which is a factor

TABLE 4 | Cluster characterization.

	Num observations	Final grade V_4	% completed labs V_5	Num. absenteeism V_6
Cluster 1	257	3,87	28,75%	2,05
Cluster 2	218	5,26	70,91%	1,69
Sample	475	4,51	48,16%	1,89

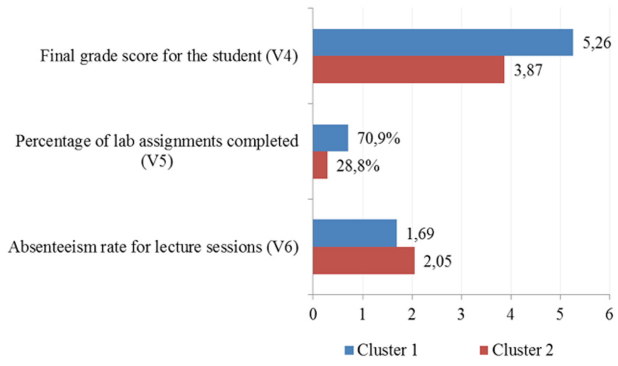


FIGURE 6 | Characterisation of the cluster variables.

that affects negatively on continuous evaluation delivered as only 28.75% of the total of labs assignments scheduled by the faculty. Finally, this group of students is the group with the highest average number of absenteeism during lecture hours, with two absences per student on average.

Cluster 2. "Motivated students with the course." This cluster brings together 218 students who were learners by applying the methodology of using metaphors and abstractions to design new study material and additional study material to the conventional contents of the course. Specifically, they were given the concepts in the way described in section context previously defined. This group is characterized in that it has an average of qualifications (V4) higher than the overall average, that is, 5.26 compared to 4.51, reflecting a considerable increase in the evaluation of the group. This positive result in final grades is reinforced by the high participation of students in class as students grouped in this cluster finished the final exam with a high percentage of their lab assignments completed (70.91%). Finally, it is worth noting that the percentage of absenteeism during lecture hours has been successfully reduced, as the engagement of the students was much greater than Cluster 1.

Table 4 and **Figure 6** show the behavior of each variable, its mean value, according to the cluster considered.

DISCUSSION

There is a myriad of methods developed in infinite literature on teaching students critical thinking skills and also on how to involve them in the learning process. The methods applied, combined with the advanced concepts, made for a more interesting instruction session for all involved. The success of the method in this subject has encouraged us to experiment with courses for sophomores. The result was students who were able to more quickly absorb the base concepts in which they needed to build superior knowledge. We achieved a twofold objective: On one hand, we could reduce the percentage of failure without losing quality and depth in the course. On the other hand, we were able to discover that students felt self-confident as they could successfully deal with the subject.

The results of this work show that the application of metaphors and abstractions as additional support to the conventional methodology followed during conventional lectures is useful to enhance the academic performance, engagement, and motivation of many students. This was proven by the increased participation in class and the reduction in the ratio of absences per student. The cluster analysis technique has allowed the objective detection of two groups of students: unmotivated and motivated, raised from performance that they have shown after analyzing their final grades, the percentage of completed lab assignments, and the number of absences from lecture hours.

When evaluating possible teaching strategies and methodologies, especially for the first courses in technical careers that intend to improve the student motivation and engagement and reduce academic failure at university, it is interesting to consider the advantages offered by metaphors to enhance student learning abilities and the acquisition of skills and competences that are planned in their respective curricula.

AUTHOR CONTRIBUTIONS

JÁ-B, LB-U, ÁM-M, AB-M, and MS-M designed the study. Dr. JÁ-B was in charge of collecting all the data from each course and student during the whole period. And describing the teaching strategies for each one of the years of the study. The description of each metaphor and concept that changed during the course instruction was also carefully documented. Dr. LB-U designed all the data analysis related to the collected data. His knowledge of the cluster analysis techniques (usually applied to the labor market) was of real help for getting numerical patterns and figures. The data, in fact, were treated following the same guidelines as in labor markets, in fact. ÁM-M interpreted the data together with Dr. LB-U, from the methodological perspective. Her support was relevant as data should be interpreted in the field of metaphor thinking and learning. AB-M and MS-M, both provided all the methodological support to the study to understand how the instructional changes affected in improving the success rate of the students. And who framed the changes into the concept of metaphors. All the authors were active during the edition of the paper.

REFERENCES

Ackerman, J., Nocera, C., and Bargh, J. (2010). Incidental haptic sensations influence social judgments and decisions. *Science* 328:1712. doi: 10.1126/science.1189993

Adu-Ampong, E. A. (2016). A metaphor analysis research agenda for tourism studies. *Ann. tour. res.* 57, 234–278.

Alvarez-Bermejo, J. A. (2008). *Estructura de Computadores. Procesadores MIPS y su Ensamblador*. Madrid: RA-MA.

Aziz-Zadeh, L., and Gamez-Djokic, V. (2016). Comment: the interaction between metaphor and emotion processing in the brain. *Emot. Rev.* 8, 275–276. doi: 10.1177/1754073915595098

Barsalou, L. (1999). Perceptual symbol systems. *Behav. Brain Sci.* 22, 577–660. doi: 10.1017/S0140525X99532147

Barsalou, L. (2008). Grounded cognition. *Annu. Rev. Psychol.* 59, 617–645. doi: 10.1146/annurev.psych.59.103006.093639

Beckett, D., and Hager, P. (2002). *Life, Work and Learning: Practice in Postmodernity*. London: Routledge.

Bereiter, C. (2002). *Education and Mind in the Knowledge Age*. London: Lawrence Erlbaum Associates.

Chemero, A. (2009). *Radical Embodied Cognitive Science*. Cambridge, MA: MIT Press.

Clark, A. (1998). *Being There: Putting Brain, Body, and World Together Again*. Cambridge, MA: MIT Press.

Comellas-Carbó, M. J. (2015). El clima cotidiano en el aula. Contexto relacional de socialización. *Eur. J. Invest.* 3, 289–300.

Ester, M., Kriegel, H. P., Sander, J., and Xu, X. (1996). "A density-based algorithm for discovering clusters in large spatial databases with noise," in *Proceedings of the Second International Conference on Knowledge Discovery and Data Mining*, (Menlo Park, CA: AAAI Press), 226–231.

Feldman, J. (2006). *From Molecule to Metaphor: A Neural Theory of Language*. Cambridge, MA: MIT Press.

Flusberg, S. J., Thibodeau, P. H., Sternberg, D. A., and Glick, J. J. (2010). A connectionist approach to embodied conceptual metaphor. *Front. Psychol.* 1:197. doi: 10.3389/fpsyg.2010.00197

Fuentes-González, D., and Belmonte-Ureña, L. J. (2015). La metáfora en el lenguaje económico. Una aproximación sociometafórica al concepto de burbuja inmobiliaria. *Hispania* 98, 762–778. doi: 10.1353/hpn.2015.0144

Gibbs, R. (2006). *Embodiment and Cognitive Science*. Cambridge: Cambridge University Press.

Hager, P. (2005). Philosophical accounts of learning. *Educ. Philos. Theor.* 37, 649–666. doi: 10.1111/j.1469-5812.2005.00149.x

Hager, P. (2008). Learning and metaphors. *Med. Teach.* 30, 679–686. doi: 10.1080/01421590802148899

Hager, P., and Halliday, J. (2006). *Recovering Informal Learning: Wisdom, Judgement and Community*. Dordrecht: Springer.

Hager, P., and Holland, S. (2006). *Graduate Attributes, Learning and Employability*. Dordrecht: Springer.

Hager, P., and Smith, E. (2004). The inescapability of significant contextual learning in work performance. *Rev. Educ.* 2, 33–46.

Harr, N., Eichler, A., and Renkl, A. (2014). Integrating pedagogical content knowledge and pedagogical/psychological knowledge in mathematics. *Front. Psychol.* 5:924. doi: 10.3389/fpsyg.2014.00924

Hellmann, J. H., Echterhoff, G., and Thoben, D. F. (2013). Metaphor in embodied cognition is more than just combining two related concepts: a comment on Wilson and Golonka (2013). *Front. Psychol.* 4:201. doi: 10.3389/fpsyg.2013.00201

Hoover, D. L. (2016). Metaphors we may not live by. *Lit. Linguist.* 5, 1–16.

Jostmann, N. B., Lakens, D., and Schubert, T. W. (2009). Weight as an embodiment of importance. *Psychol. Sci.* 20, 1169–1174. doi: 10.1111/j.1467-9280.2009.02426.x

Kövecses, Z. (2015). *Where Metaphors Come From: Reconsidering Context in Metaphor*. Oxford: Oxford University Press.

Lakoff, G., and Johnson, M. (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.

Lakoff, G., and Johnson, M. (1999). *Philosophy in the Flesh: The Embodied Mind and Its Challenge to Western Thought*. New York, NY: Basic Books.

Landau, M. J., Meier, B. P., and Keefer, L. A. (2010). A metaphor-enriched social cognition. *Psychol. Bull.* 136, 1045–1067. doi: 10.1037/a0020970

Margaret, A. F. (2001). Metaphors for learning: a cognitive exercise for students. *Res. Strategies* 18, 39–48. doi: 10.1016/S0734-3310(02)00066-6

McClelland, J. L. (2009). The place of modeling in cognitive science. *Top. Cogn. Sci.* 1, 11–38. doi: 10.1111/j.1756-8765.2008.01003.x

Nibley, E. (1991). The use of metaphor in bibliographic instruction. *RQ* 30, 343–347.

Pereira de Barros, D., Primi, R., Koich, M. F., Almeida, L., and Oliveira, E. (2015). Metaphor creation: a measure of creativity or intelligence? *Eur. J. Educ. Psychol.* 3, 103–115.

Pinker, S. (2007). *The Stuff of Thought: Language as a Window into Human Nature*. New York, NY: Viking Press.

Rabinowitz, C. (1997). Gathering information: how to get there from here. *Coll. Res. Libr. News* 58, 19–20.

Rizzolatti, G., and Craighero, L. (2004). The mirror-neuron system. *Annu. Rev. Neurosci.* 27, 169–192. doi: 10.1146/annurev.neuro.27.070203.144230

Saljo, R., and T, Tuomi-Gröm (2003). "From transfer to boundarey-crossing," in *Between School and Work: New Perspectives on Transfer and Boundary-Crossing*, ed. Y. Engeström (Amsterdam: Elsevier Science), 311–321.

Sanders, D., and Sanders, J. (1984). *Teaching Creativity through Metaphor: An Integrated Brain Approach*. New York, NY: Longman.

Scheffler, I. (1960). *The Language of Education*. Springfield, IL: Charles C. Thomas.

Schneider, I. K., Rutjens, B., Jostmann, N. B., and Lakens, D. (2011). Weighty matters: importance literally feels heavy. *Soc. Psychol. Pers. Sci.* 2, 474–478. doi: 10.1177/1948550610397895

Spivey, J. (2007). *The Continuity of Mind*. Oxford: Oxford University Press.

Wilson, A. D., and Golonka, S. (2013). Embodied cognition is not what you think it is. *Front. Psychol.* 4:58. doi: 10.3389/fpsyg.2013.00058

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer RC-M and the handling Editor declared their shared affiliation, and the handling Editor states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2016 Álvarez-Bermejo, Belmonte-Ureña, Martos-Martínez, Barragán-Martín and Simón-Márquez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 11 November 2016
doi: 10.3389/fpsyg.2016.01765

"My Child has Cerebral Palsy": Parental Involvement and Children's School Engagement

*Armanda Pereira[1], Tânia Moreira[1], Sílvia Lopes[1], Ana R. Nunes[1], Paula Magalhães[1], Sonia Fuentes[2], Natalia Reoyo[3], José C. Núñez[4] and Pedro Rosário[1]**

[1] Department of Applied Psychology, School of Psychology, University of Minho, Braga, Portugal, [2] Facultad de Educación, Universidad Central de Chile, Santiago, Chile, [3] Departamento de Psicología, Universidad de Valladolid, Valladolid, Spain, [4] Department of Psychology, Universidad de Oviedo, Oviedo, Spain

Engaged students tend to show school-committed behaviors (e.g., attend classes, get involved with the learning process), high achievement, and sense of belonging. However, students with disabilities are prone to show a lack of engagement with school due to the specific difficulties they have to handle. In fact, children with disabilities are likely to show poor participation in school when compared with children without disabilities. This poor involvement is related to their low autonomy to participate in the school activities, which, in turn, results in low school engagement. Parents play a crucial role in their children's education. Parental involvement in school activities promotes autonomous behaviors and, consequently, school engagement. In fact, extant literature has shown close relationships between parental involvement, school engagement, and academic performance. Yet, parental involvement in school activities of children with Cerebral Palsy (CP) has received little direct attention from researchers. These children tend to display lower participation due to the motor, or cognitive, impairments that compromise their autonomy, and have a high likelihood to develop learning disabilities, with special incidences in reading and arithmetic. Therefore, our aim is twofold, to understand the parental styles; and how the perceived parental involvement in school activities is related to their children school engagement. Hence, 19 interviews were conducted with one of the parents of 19 children with CP. These interviews explored the school routines of children and the perceived involvement of parents in those routines. Additionally, children filled out a questionnaire on school engagement. Results show that the majority of the parents were clustered in the Autonomy Allowance and Acceptance and Support parental style, and the majority of their children were perceived as autonomous. Moreover, about a half of the children reported a high level of school engagement. Finally, neither children's autonomous behaviors reported by parents, nor parental style, seem to be related with the children's level of school engagement. Rehabilitation centers and schools could consider training parents/caregivers focusing on their educational needs, promotion of reflections on the usefulness of applying autonomy promotion strategies with their child, and foster their involvement.

Keywords: school engagement, cerebral palsy, semi-structured interview, parental style, autonomy, thematic analysis

OPEN ACCESS

Edited by:
Jesus De La Fuente, University of Almería, Spain

Reviewed by:
Eva M. Romera, University of Córdoba, Spain
Emily Louise Castell, Curtin University, Australia

****Correspondence:***
Pedro Rosário
prosario@psi.uminho.pt

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *18 July 2016*
Accepted: *26 October 2016*
Published: *11 November 2016*

Citation:
Pereira A, Moreira T, Lopes S, Nunes AR, Magalhães P, Fuentes S, Reoyo N, Núñez JC and Rosário P (2016) "My Child has Cerebral Palsy": Parental Involvement and Children's School Engagement. Front. Psychol. 7:1765. doi: 10.3389/fpsyg.2016.01765

INTRODUCTION

School Engagement

The concept of school engagement (SE) emerges as closely related to educators' increasing concern about the high rates of school dropout and low academic achievement (Finn, 1993; Finn and Rock, 1997; European Commission, 2014). SE is a multidimensional and multifaceted construct involving three interrelated dimensions: students' behaviors, emotions, and cognition (Fredricks et al., 2004; Wang and Holcombe, 2010). Specifically, behavioral engagement can be conceptualized in three levels: (i) school attendance and fulfillment of schoolwork, (ii) participation in class, and (iii) active participation, such as doing extra work for school courses (Finn and Rock, 1997). Emotional engagement is related to feelings about school. Identification with school is crucial for the involvement in activities and is closely related to students' feelings of belongingness (Connell et al., 1994). Lastly, cognitive engagement comprises efforts, will and deliberation, to master complex skills, and is closely related to self-regulated strategies (Fredricks et al., 2004; Rodríguez et al., 2014; Rosário et al., 2015). Together, these three components of engagement can enhance educational performance (Finn and Zimmer, 2012).

School Engagement in Children with Disabilities

Children with disabilities struggle with difficulties in school, being, as a consequence, prone to develop a poor SE (Blackorby and Cameto, 2004). This educational scenario may be related to their high levels of school absenteeism. In fact, children with disabilities miss, on average, 3 weeks of school in a school year (Blackorby and Cameto, 2004). Contrary to students without disabilities, in which absenteeism may be associated with "skipping school," students with disabilities frequently involuntarily miss classes due to health issues. School absenteeism constitutes, therefore, a real barrier to the progression in the learning processes and in school participation. Regarding school participation, Finn (1993) considered that the way students identify and involve themselves with the school environment reflects how they are engaged with school. Specifically, the time children spend interacting in social and physical environments (e.g., with peers, materials) are associated with SE (Maher Ridley et al., 2000). Hence, the level and quality of participation in school activities play an important role in developing SE in students with disabilities (Almqvist et al., 2006). In fact, children without disabilities show a higher rate of participation in autonomous activities than children with disabilities (Eriksson and Granlund, 2004).

Participation, as defined by the International Classification of Functioning, Health, and Disability, is the active involvement of individuals in their life situations considering their social, functional, and health dimensions (World Health Organisation [WHO], 2001). In addition, according to Eriksson and Granlund (2004), participation demands that students experience feelings of belonging, as well as their perceived control and involvement with the school context, which will prevent feelings of school alienation. This school alienation is characterized by feelings of estrangement and social isolation, which may trigger dropout or school failure (Finn, 1993; Fredricks et al., 2004). Children's active participation requires, therefore, not only their personal will, but also their capacity to autonomously assume the control of their participation in the school activities (Almqvist et al., 2006). Yet, students with disabilities face difficulties in controlling activities on their own due to their lower level of autonomy in comparison with students without disabilities (Blackorby and Cameto, 2004). Autonomous behavior requires self-initiation and self-regulation competences (Wang and Holcombe, 2010), and children with physical or cognitive disabilities are likely to show limitations in their autonomy. Additionally, regarding the physical disabilities, the degree of body limitation has more influence in the children's participation than the type of body disability [i.e., the area of the body limitation have more influence in the children's autonomy if the limitation is classified as severe (e.g., IV or V in GMFCS levels)] (Simeonsson et al., 2001). Lastly, the school environment plays an important role on the limited autonomy of children with disability. The spatial organization of the school environment, for example, informs children about their possibilities to move and participate in the classroom routines (e.g., if do not have space to drive my wheelchair in class, I'll not go to the blackboard check my homework). Those perceptions, consequently, influence children expectations to participate in the activities developed in that context (Eriksson and Granlund, 2004).

However, the difficulties inherent to the disabilities, and the physical constraints of the environment, are not the only explanations to the limited autonomy of children with disabilities. In fact, parents of these children, and society, are likely to create low expectations about the autonomy of children with disabilities and act accordingly, for example by controlling their behavior. These low expectations may contribute to strengthen these children's sense of low autonomy or lack of participation in school activities (Blackorby and Cameto, 2004; Elad et al., 2013).

A Specific Disability: Cerebral Palsy

Among the childhood physical disorders, Cerebral Palsy (CP) is considered the most common, with a lifelong impact (Rosenbaum, 2003; Aisen et al., 2011; Novak et al., 2013). In fact, it is estimated that the prevalence of this clinical condition is about 3 to 4 children per 1000 live births (Yeargin-Allsopp et al., 2008) and is present in the lives of about 17 million people (Cerebral Palsy Alliance [CPA], 2013). CP subsumes a group of neurological, non-progressive, and permanent (but changeable) disorders that mainly affect movement and posture. This disorder can result from lesions or disturbances in early brain development during the prenatal, perinatal, or postnatal periods (Rosenbaum, 2003; Bax et al., 2005; Rosenbaum et al., 2007).

The classification of CP depends on a neurological examination to evaluate the nature of the motor impairment and the topographic type, i.e., parts of the body affected (Bax et al., 2005; Aisen et al., 2011). The nature of motor impairment includes the following classifications: dyskinetic, ataxic, spastic, and mixed. Dyskinetic is characterized by uncontrolled, writhing, and slowed movements, and, sometimes, drool and grimace.

Ataxic is the rarest form of CP and is characterized by difficulties in coordination and balance, expressed in gait and fine motor problems. Spastic is the most common and is characterized by the presence of deep tendon reflexes and muscle tone, tremors, muscle weakness, and gait problems. Frequently, spastic is related to dysarthria, oromotor problems with drooling and swallowing difficulties. Lastly, a mixed clinical picture can also be observed and represents 30% of the cases of children with CP (Sankar and Mundkur, 2005; Straub and Obrzut, 2009; Aisen et al., 2011; Richardson et al., 2014). In addition, the topographic classification adds information about the part of the body impaired. It includes diplegia (lower limbs more affected than upper limbs), hemiplegia (upper and lower unilateral extremity impairment), and quadriplegia (severe four-extremity impairment). The severity of these clinical pictures can be very diverse, with distinct repercussions in the autonomy of the individual. According to the Gross Motor Function Classification System (GMFCS; Palisano et al., 1997; Andrada et al., 2007), the movement ability (e.g., self-initiated movement) can be evaluated in a range of five levels of functionality (I, minor difficulties to V, major difficulties). Therefore, all these classifications are important to understand the kind of functional difficulties that children will face, being the determinant for rehabilitation interventions.

Aside from this major evaluation, it is also important to evaluate the associated impairments that accompany the diagnosis of CP, such as sensation and perception deficits, and impairments in terms of cognitive, emotional, behavioral, communication, and social competences (Bax et al., 2005; Odding et al., 2006; Parkes et al., 2009). The consequences of these impairments extend to the Activities of Daily Life, with repercussions in the learning process (Mutsaarts et al., 2006; Van Rooijen et al., 2015). In fact, children with CP have a high risk of showing learning disabilities, which may arise before the schooling years (Jenks et al., 2009; Michel et al., 2011; Scope, 2013). The risk of learning disabilities is not determined exclusively by the cognitive impairment. In fact, children with CP with a normative cognitive level can still present specific learning difficulties (e.g., mathematics and reading; Frampton et al., 1998; Bottcher et al., 2009).

The specificities that characterize this population contribute to lower autonomy and participation in activities in their daily life. As previously mentioned, the indicators of CP picture contribute to the rising issue of a student's feeling of alienation from school, which is at the root of low levels of SE.

The Role of Parents in the Promotion of Autonomy and Participation

Parents can play a key role in the promotion of autonomy and participation of their children in daily life activities. Literature has shown that parental involvement in child development is a strong predictor of a positive educational trajectory (Barlow and Humphrey, 2012; Al-Alwan, 2014). The style of parental involvement can be a promoter of more, or less, autonomy and participation of children in their activities (Raftery et al., 2012). In fact, parenting behaviors have been classified in two dimensions: (i) parental Control and Restriction (CR), and Autonomy Allowance (AA); and (ii) parental Rejection and Hostility (RH), and Acceptance and Support (AS; Schaefer, 1965; Chorpita and Barlow, 1998; Aran et al., 2007). Regarding the first dimension, parental CR refers to overprotective behavior, excessive supervision, and imposition regarding the way children have to feel or think, or in the decisions they have to make; whereas, AA refers to the provision of opportunities to children to make their own decisions and be independent. The second dimension of parental behaviors integrates aspects of RH, which can be characterized by feelings of coldness and low desire to be, and interact, with the child. Finally, AS is characterized by positive emotional involvement with the child, implying active listening, care, and affection (Schaefer, 1965; Chorpita and Barlow, 1998; Aran et al., 2007).

Each style comprises elements of both dimensions; that is, the Autonomy Allowance and Acceptance and Support (AA/AS) parenting style, besides being a promoter of autonomy (Aran et al., 2007), is also a predictor of increased motivational strategies, with impacts on children's achievement (Grolnick et al., 1997; Raftery et al., 2012). In fact, literature highlights that parental autonomy support promotes children's self-regulation, motivation, and achievement and, consequently, their SE (Raftery et al., 2012). Conversely, the parental style of Control and Restriction and Rejection and Hostility (CR/RH) restrains the development of autonomous behaviors through restriction of opportunities and impediment on children to act freely (Aran et al., 2007). In fact, CR/RH emerges as the predominant parental style in parents/caregivers with children with disabilities, namely CP (Elad et al., 2013; Racine et al., 2013). For example, Elad et al. (2013) found that the mothers of children with hemiplegic CP scored their children performance lower than the therapists using clinical assessment protocols. This finding may be explained by the fact that mothers of children with disabilities are likely to perceive their children as vulnerable and low autonomous. This perceived lower autonomy often results in an overprotective set of behaviors, which could help explain why the CR/RH parental style is the most predominant among parents of children with CP. In sum, the parenting style can provide more, or less, orientation toward the learning process and may differently impact children SE.

The Aim of This Study

Barlow and Humphrey (2012) stressed the need to analyze whether, and how, the parental styles described in literature are adopted by parents of children with Special Educational Needs and Disabilities (SEND). Findings are expected to help in the design of interventions well-fitted to educational practice and guidelines for educational policies. A recent meta-analysis (Castro et al., 2015) with typically developing students reports that parents who participate in, and closely follow, their children's academic goals are likely to promote their SE. Additionally, findings from the same meta-analysis report that children less able to comply with the academic demands need more involved parents (Castro et al., 2015). Consistent with this proposition, authors (Castro et al., 2015) found that parental involvement in school activities and dynamics of children with SEND has

positive outcomes in the promotion of SE. Still, despite the voluminous literature reporting positive relationships between parental involvement and SE, to our knowledge no study has yet examined how parents of children with CP perceive their involvement with their children's school related activities and how this perceived parental involvement relates to the SE reported by their children.

Importantly, as Novak et al. (2013) highlighted, CP is considered the most common childhood physical disorder and researchers highlight the lack of investigation in the participation domain and the need of informing the literature by using qualitative and quantitative designs (Coster and Khetani, 2008; Kemps et al., 2011). Thus, we aim to understand the parental styles adopted by parents of children with CP in relation to their children's level of autonomy and SE. To accomplish this aim, we explored the role of parental involvement in the promotion of autonomous behaviors in children with CP in relation to the SE reported by those children. Data collected from parents and students are expected to help researchers and educators in their work with children with CP.

MATERIALS AND METHODS

Study Design

Two research questions guided our study: (1) How does the parental style promotes autonomous behaviors in children with CP?; (2) How does the parental style adopted by parents of children with CP relates to the level of SE reported by children?

To answer these questions, qualitative (i.e., interviews) and quantitative (i.e., questionnaire) approaches were followed. The parents of children with CP were interviewed about the daily and school routines of their children. The analysis targeted how parents perceived the autonomy of their children and how they promoted this autonomy, and provided indicators to define each parent/caregiver parental style. The children of the parents/caregivers interviewed were asked to fill in questionnaires assessing their SE.

The participation of parents and children was voluntary and unrewarded. Finally, informed consent were obtained from all the participants, being guaranteed data confidentiality. Additionally, all the participating parents/caregivers authorized the consultation of their children's medical diagnoses to help researchers learn the children's CP type and topographic classification of motor impairment. This study was carried out in accordance with the recommendations of the ethics committee of the University of Minho. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

Participants

This paper reports findings drawn from 19 parents/caregivers of children diagnosed with CP and from the 19 children of those parents. All participants attended CP rehabilitation centers in Portugal. In the first part of this study, the parents/caregivers were interviewed by two of the authors, trained to conduct semi-structured interviews. The second part involved the collection of SE questionnaires from the children with CP under the care of these parents/caregivers.

TABLE 1 | Demographic characteristics of participants: parents/caregivers (*N* = 19).

Participants characteristics – parents/caregivers of children with CP	
Age (years) mean ± SD	42.22 ± 8.83
Gender *n* (%)	
Male	2 (10.5%)
Female	17 (89.5%)
Degree of relatedness *n*(%)	
Mother	16 (84.2%)
Father	2 (10.5%)
Other Situation	1 (5.3%)
Education level *n* (%)	
Elementary School	4 (21.1%)
Middle School	8 (42.1%)
High School	4 (21.1%)
Higher Education	3 (15.8%)

TABLE 2 | Demographic characteristics of participants: children (*N* = 19).

Participants characteristics - children with CP	
Age (years) mean ± SD	9.89 ± 2
Gender *n* (%)	
Male	9 (47.4%)
Female	10 (52.6 %)
Type of CP *n* (%)	
Diplegia	7 (36.8%)
Right hemiplegia	7 (36.8%)
Left hemiplegia	2 (10.5%)
Without classification	3 (15.8%)
Quality of tonus *n* (%)	
Spastic	14 (73.7%)
Diskenetic athetoid	2 (10.5%)
Ataxic	2 (10.5%)
Mixed	1 (5.3%)
GMFCS *n* (%)	
Level I	11 (57.9%)
Level II	6 (31.6%)
Level III	2 (10.6%)

Regarding parents/caregivers, 17 are female and two are male, aged between 26 and 65 years ($M = 42.22$; $SD = 8.83$). Fifty percent of parents/caregivers completed the 9 years of the compulsory education, and the remaining graduated from high school, and from University (**Table 1**). Of the 19 children, 10 are female and nine are male, aged between 6 and 12 years ($M = 9.89$; $SD = 2$), and were in the elementary ($N = 15$, second to fifth grade) and in the middle school ($N = 4$, seventh grade). Participants attended three CP rehabilitation centers (approximate distribution among the three centers: 47, 42, and 11%). The majority of the children have the CP classification of hemiplegic and spastic (**Table 2**). All children, except one, attended mainstream schools. The other child attended special education classes in a mainstream school. Still, these classes are

designed for children with SEND and the curriculum is adapted to each child's needs.

Procedure

The Ethics Commission of University of Minho approved the study and all the interviewees authorized the recording of the interview using a digital recorder. A verbatim transcription was carried out to capture all the information. The interviews were conducted in person with a guarantee of privacy and confidentiality and lasted about 40 min each. Different researchers, all authors of this paper, were involved in the transcription and reviewing process. All data was stored in secured drives.

All the 18 Rehabilitation Centers in Portugal were contacted to participate in this study, five answered positively (a response rate of 28%). From these centers, three were randomly selected.

A total of 19 interviews of parents of children with CP and 19 questionnaires by their children were collected. The questions used in the interviews were selected from a semi-structured interview, Routine Based Interview (McWilliam et al., 2009), and focused on three dimensions: daily routines, school routines, and executive functioning. Parents were asked about their children's daily and school routines, and to describe their involvement in those tasks (e.g., how you describe one normal day of your child?). Additionally, parents/caregivers describe their involvement in the promotion of their children's autonomy and empowerment. Finally, parents/caregivers were inquired about the executive functioning of their children (e.g., Did he/she loose control frequently?). This last topic was not addressed in the present study.

The school engagement questionnaire used in the current study was adapted for the population of children with CP from the questionnaire by Wang and Holcombe (2010) validated to the adolescent normative population. In the current study, we used 13 items focusing on students' perceptions of school engagement (e.g., For me is difficult to finish my homework; School is very important to me). One question from the original questionnaire was deleted because it did not match with this population (item 5: Getting a good education is the best way for me to get ahead in life in my neighborhood). Items were presented in a Likert-like format of five points (1 (never to 5 (always) and some of these items were in the positive format and others in the negative format. ($\chi^2(366, N = 1046) = 1{,}105.36$, $p < 0.001$; CFI = 0.92, TLI = 0.91, RMSEA = 0.05.

To complement these data, the medical and therapists records of the 19 children with CP were consulted regarding information about the type and topographic classification of the motor impairment, as well as on the GMFCS (Palisano et al., 1997; Andrada et al., 2012). This classification determines the level of motor function in different levels (I, minor difficulties to V, major difficulties). These indicators were collected to help frame each children autonomy pattern.

Data Analysis

Interviews were analyzed using thematic analysis – by identifying and interpreting pattern themes (Braun and Clarke, 2006). To guide this process, outlined phases of thematic analysis described by Braun and Clarke (2006) were taken into account. Although a theory-based meaning was prioritized, codes emerged both in a "top down" and "bottom up" way. The codes allowed to find patterns, and connections between codes and to generate themes (Braun and Clarke, 2006). Before starting an in-depth analysis of the data, a coding frame (codebook) was developed based on the theoretical background. Subsequently, data were coded using a deductive approach in order to fit into these theoretical-driven

TABLE 3 | Codebook of qualitative analysis.

Autonomy (Proot et al., 2000; Ryan and Deci, 2000; Cardol et al., 2002; Clapton and Kendall, 2002)	+ Autonomy − Autonomy	(i) Initiative; (ii) Make decisions; (iii) Capacity to perform (even when adapted to the limitations – physical or cognitive); (iv) Self-governance; (v) Self-awareness
Parental Style (Schaefer, 1965; Chorpita and Barlow, 1998; Aran et al., 2007)	Parental autonomy allowance/acceptance and support	(i) Provide opportunities; (ii) Promotion of independence; (iii) Positive emotional involvement; (iv) Provide care.
	Parental control and restriction/ rejection and hostility	(i) Overprotective behavior; (ii) Excessive supervision; (iii) Control of feelings or thought? or decision-making.
School routines (Núñez et al., 2014, 2015a,b; Regueiro et al., 2015)	School activities	(i) Participation (how); (ii) School identification; (iii) Difficulties in school dynamics (e.g., physical barriers).
	Exam Preparation	(i) Initiative; (ii) Help requests; (iii) Schedule/Planning/Monitoring; (iv) Solving difficulties
	Homework task	(i) Initiative; (ii) Help requests; (iii) Schedule/Planning/Monitoring (iv) Solving difficulties.

codes. Yet, during coding, new codes emerged from the data (**Table 3**).

To assist this qualitative data analysis, a set of tools from NVivo software was used. Created mainly as software to manage data, NVivo aims to facilitate the way to accede data efficiently (Bazeley and Jackson, 2013). Besides, NVivo queries (namely, coding queries and matrix coding queries) helped to check for patterns and to map interconnections between codes, allowing to gather them into emerging themes and to map connections between themes.

To ensure the precision of the coding scheme, inter-observer agreement was calculated. Two independent researchers with training on the coding scheme codified all the data. Raters discussed discrepancies in the coding scheme to reach a consensual coding. The second rater codified over 30% of the data and an almost perfect agreement was achieved (kappa coefficient = 0.89), according to Landis and Koch (1977). Main themes, subthemes, and interconnections between themes and subthemes were identified.

Regarding the questionnaire, for each child, scores of the individual items were summed and a total SE score was obtained. Thereafter, all total SE scores were ordered by quartiles. Finally, children in the first and second quartile were grouped in the Higher SE level, whereas children in the third and fourth quartile were grouped in the Lower SE level.

FINDINGS

The data from the interviews were coded and themes were clustered into three main categories – autonomy level, parental style, and school routine (**Table 3**). To enhance comprehension, the analysis is presented in two different ways: (1) general analysis of the autonomy (regarding children daily routines) and parental style categories considering the GMFCS level of each child (**Figure 1**); and (2) case by node analysis regarding school routines, grouping results in three main categories (school activities, exam preparation, and homework tasks), considering the SE and GMFCS levels of each child (**Figure 2**).

Results are presented in **Figures 1** and **2**. In **Figure 1**, each circle represents a child and the size of the circle refers to the level of GMFCS (large size – level I and small size – level III). The color of the circles (one for each child) refers to children autonomy reported by parents (i.e., Percent of quotes from parents interviews stressing children autonomy) crossed with parental style (e.g., darker circles mean more perceived autonomy and more percent of quotes coded in the AA/AS parental style). In **Figure 2**, similarly to **Figure 1**, each circle represents a child, the size of the circle represents the level of GMFCS, and the color represents the level of SE (e.g., gray represents higher SE and white represents lower SE).

General Analysis of the Perceived Children Autonomy and Parental Style

Parents were interviewed about the daily and school routines of their children and also about their involvement in those routines; data was used to draw the pattern of parental style. Besides, self-involvement reported by parents in those routines was taken into consideration to help classify children as more or less autonomous.

In general, respondents reported using strategies related to the parental style of AA/AS. Behaviors and strategies associated with this parental style are characterized by guiding children's behavior to foster their self-involvement in daily routines.

Parent/caregiver 9 illustrates how parents promote autonomous behaviors through the strategy *training* during homework tasks:

> Parent/caregiver 9: *When he returns home from school, he promptly does his homework. Now, we are training with him, and he does the homework alone. . . only asking for help to check whether the answers are right or wrong. If we don't do that, he has the habit of asking for help all the time and needs to have one of us around him.*

Similarly, parent/caregiver 2 describes a situation at home in which the child helps in taking care of a little baby who stays during the workday with her parents, being the responsibility of this parent/caregiver:

> Parent/caregiver 2: *I think the fact that she has a little [baby] at home, who we take care of, with us also helped her feel like her big sister. For a long time she asked us to give her the baby bottle and to change the diaper. . .. But. . . the diaper she's not allowed, yet. Now, I think that the fact that the [baby] is with us at home is influencing her thoughts about the future. She asked me if she will be able to have a baby and to take care of her children. I answered: Yes, of course! You have to work hard. And I showed her success stories on the Internet. . .*

In this utterance, the parent/caregiver evaluates the level of autonomy and confidence of the child to help taking care of the baby. This allows the child feel a sense of autonomy and responsibility for her actions when taking care of someone else.

Regarding **Figure 1**, despite the GMFCS levels of the participating children ranging between levels I and III, participant parents/caregivers reported that their children display more autonomous behaviors than less autonomous. Nonetheless, the set of children for which parents/caregivers reported less autonomy behaviors mainly includes children with a clinical picture (e.g., mixed type, dyskinetic atethoid type) characterized by severe difficulties in performing some of the daily tasks mentioned in the interview (e.g., brush teeth, button up a coat).

The following situations illustrated by parent/caregivers 13 and 2 exemplifies the motor difficulties of their children and how they minimize their intervention while children execute the specific tasks (morning hygiene and dress by herself):

> Parent/caregiver 13: *Her grandmother has to dress her. . . she goes to the bathroom, brushes her teeth, and brushes her hair, but all the things with her grandma's help.*

> Parent/caregiver 2: *She started to use a bra. . . and in this phase. . . she cannot dress by herself. She tries, but it gets stuck. She isn't flexible enough and I end up doing it for her.*

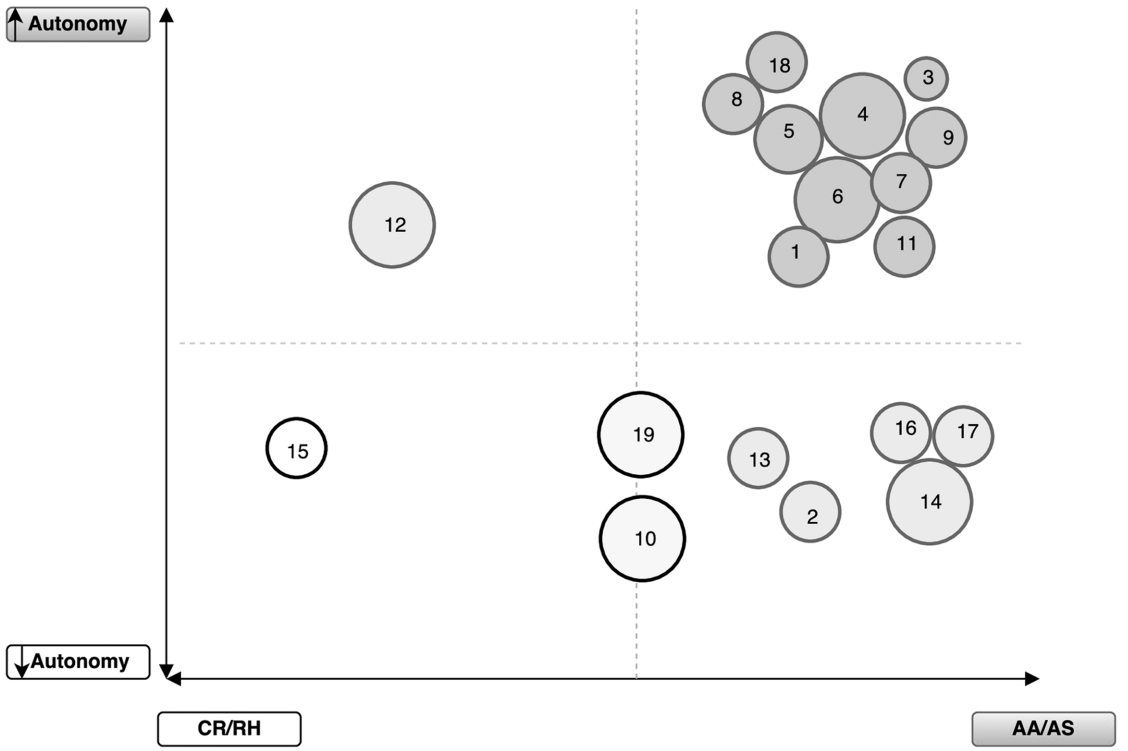


FIGURE 1 | Parental style and children autonomy reported by parents, contrasting with the level of motor functional impairment Gross Motor Function Classification System (GMFCS). Each circle represents one child; the size represents the GMFCS level (large to level I – minor impairment; smaller to level III); the color of the circles represents the cross between the references of autonomy perceived and parental style. CR/RH, Control and Restriction/Rejection and Hostility; AA/AS, Autonomy Allowance/Acceptance and Support.

Parental Autonomy Allowance/Acceptance and Support and Autonomous Behaviors

According to the literature, parents reporting AA/AS behaviors/strategies play an important role in the promotion of their children's autonomy (Aran et al., 2007). Our data is consistent with the above; in fact parents/caregivers declare using more supportive behaviors with their children and, also, identify more autonomous behaviors in their children.

However, data also shows that the GMFCS levels were not related to the AA/AS behaviors/strategies parenting style and autonomy behaviors. In other words, higher motor functional impairment of the children did not show an impact in the autonomy perceived by their parents/caregivers.

> Parents/caregiver 6: For example. . . when I go shopping in the supermarket, he sometimes goes with me and I ask: Please, go buy ham while I go get the fish. These little things I try to do. . .

> Parent/caregiver 7: Now she knows that I only help her in the end to see if it is right or wrong [homework]. At the beginning I needed to be around her all the time.

Parents/caregivers reported to displaying AA/AS behaviors/strategies even when they perceive their children as less participatory in daily life activities. As mentioned above, less autonomous behaviors can be related to the constraints imposed by the clinical picture of the participants included in this cluster (**Figure 1**). Nonetheless, parents/caregivers utterances include references to strategies in the promotion of autonomy despite the specificities of the motor impairment. Parents/caregivers and children find strategies together to overcome the motor difficulties and be autonomous in daily activities (e.g., bath).

> Parent/caregiver 2: *She sits and I put the clothes on her side and usually she dresses herself in the bathroom because its warm. Sometimes things may get complicated and she calls me: "Mother come here!" then I help her. . . only a little bit. . . I insist she do it by herself.*

> Parent/caregiver 16: *She tends to call me because sometimes she did not understand the text and, ah, asks me if I can explain to her, if I can read. . . And I insist that she must try and complete the work by herself.*

Parental Control and Restriction/Rejection and Hostility and Autonomous Behaviors

Although less representative (only two cases), data shows that some parents/caregivers declared using the parental style of CR/RH to respond to more and less autonomous behaviors displayed by their children.

One of the children (child 12) is included in the cluster that refers to reported parental CR/RH behaviors and autonomous behaviors. This parent/caregiver mentioned using a parenting

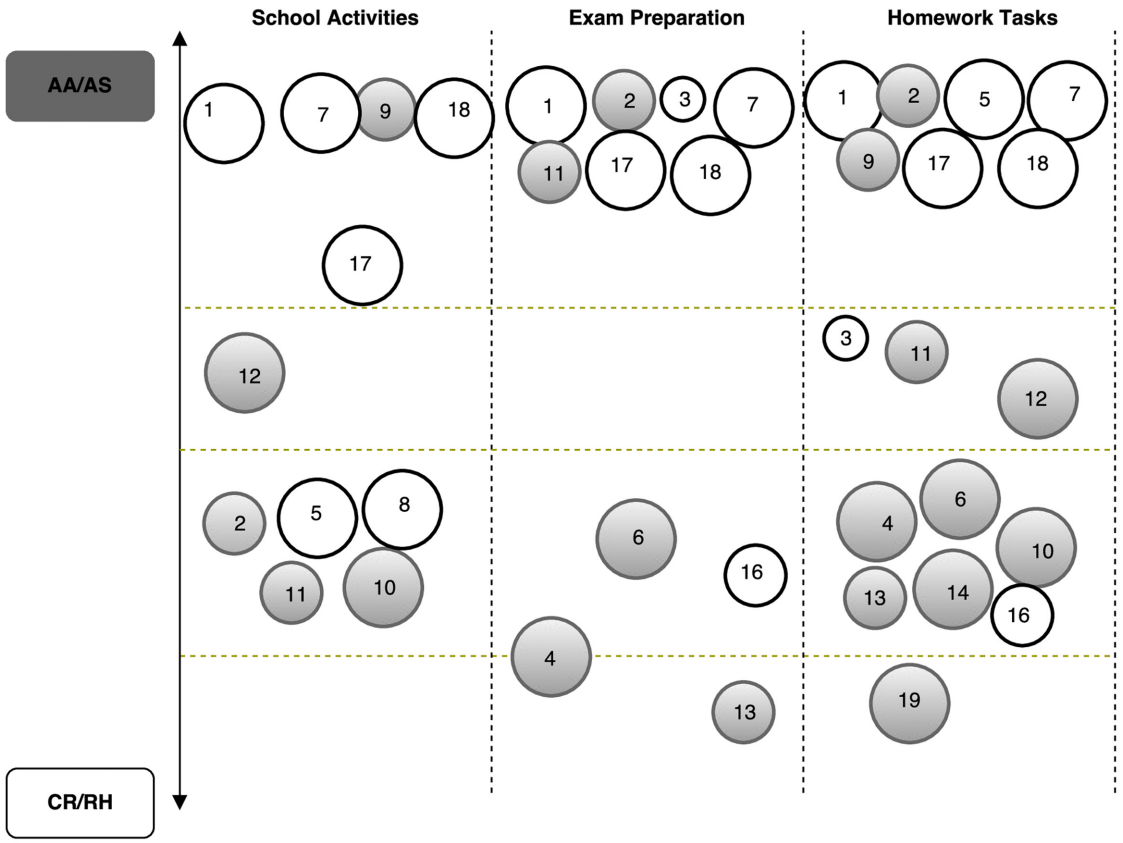


FIGURE 2 | Children's school engagement (SE) and GMFCS level; and its relation with parental style. Each circle represents one child; the size represents the GMFCS level (large to level I – minor impairment; smaller to level III); the gray circles represent higher SE level and white circles represents lower SE level. CR/RH, Control and Restriction/Rejection and Hostility; AA/AS, Autonomy Allowance/Acceptance and Support.

style with a control profile, despite the autonomous behavior exhibited by his child in most daily life activities.

It is important to stress that the AA/AS parental style is characterized by strategies such as active listening, care, and affection with the purpose of providing opportunities to the child be autonomous and feel a positive emotional involvement (Schaefer, 1965; Chorpita and Barlow, 1998; Aran et al., 2007). This parent/caregiver was able to recognize the motor competence of his child, but was not displaying the adequate strategies, as aforementioned, to help the child maintain these autonomous behaviors, as the following quotations illustrate:

> Parent/caregiver 12: *Yes, she does everything... her part. She dresses herself. Once in a while I have to help to button up her coat... in the winter... She asks for help.*

> Parent/caregiver 12: *For them [their children] to go, they need to go with me! Don't get out alone. Is what I say if they want to go by themselves... if I don't go, no one goes!*

Finally, the other parent/caregiver reported to displaying CR/RH behaviors and less autonomous behaviors when interacting with his child (15). Despite the low autonomy behaviors reported, child 15 is, still, close to the cutoff point for autonomous behavior (**Figure 1**).

> Participant 15: *I always accustomed... I always accustomed [her] to do homework with the television on. If not, she doesn't do anything.*

Linking School Routines, SE, and GMFCS

As aforementioned, the results regarding the school routines, SE, and GMFCS will be interpreted as a function of the coded parental style (**Figure 2**).

Findings show that participants' utterances were mainly related to an AA/AS parental style, regardless of the GMFCS and SE of their children. Within the autonomy AA/AS parental style, when compared to the other parental style, the majority of children reported a high level of SE. Even so, data displays a balance between the children who reported higher and lower SE levels.

Within the CR/RH parental style, the majority of children reported a high level of SE. Also, parents/caregivers who reported CR/RH parental style behaviors in the General Analysis of the Perceived Children Autonomy and Parental Style, maintained that style in relation to School Routines.

Findings also show that some parents/caregivers can range from an AA/AS parental style to a CR/RH parental style depending on the type of school activity under analysis (e.g.,

school routines, exam preparation, homework tasks; **Figure 2**). Moreover, irrespective of the SE level reported by children, some parents/caregivers reported CR/RH practices mostly related to Homework and Exam preparation tasks (e.g., 10, 13, 12, and 19).

Illustrative of low autonomy in the homework task, parent/caregiver 19 remarks that her presence is required for the child do homework. The parent is highlighting the need for a behavior change, such that the child becomes more autonomous and capable of performing the homework without her presence. However, there is no reference of strategies to change this behavior.

> Parent/caregiver 19: *Sometimes. . . well, he only does the homework with me. . . Sometimes the dad is at home, but he doesn't say that he has homework to do. . . Only when I arrive home, he says what he has to do.*

Regarding Exam Preparation, parents/caregivers 10 and 13 display, in their speeches, some signs of CR/RH behaviors with aspects related to the rejection/hostility dimension:

> Parent/caregiver 10: *He doesn't prepare for the exams. He only says to me 'Tomorrow I will have an exam.' And that's it! He only brings the textbooks if he has homework to do. He never brings the books to study for an exam at home. Never...*

> Parent/caregiver 13: *So, usually, as in this week, on Wednesday. . . I don't know. . . I think it was on Friday; well never mind, she brought the books home and said for the first time that she had exams on Monday, Tuesday, and Wednesday. . .*

School Routines, Parental Style, and SE Level

The school routines category was subdivided into three subcategories: (i) School Activities; (ii) Exam Preparation; and (iii) Homework Tasks. The subcategory School Activities includes how children participate in school, the difficulties children face to cope with the school dynamics (e.g., the physical barriers to movement in the school building), and their sense of belonging. The Exam Preparation subcategory includes topics such as: the child's initiative to self-set goals to the exam, study for exams, the monitoring strategies used while studying, the frequency of help requests (e.g., constantly or only when in doubt), and the child's autonomy and strategies used to solve difficulties and problems. The Homework subcategory included the same topics with a focus on this specific task (e.g., initiative to self-set goals to do the homework).

The majority of the parents/caregivers are clustered in the AA/AS parental style, reporting displaying supportive practices to promote autonomous behaviors in relation to their children's School routines; in particular, concerning homework and exam preparation assignments. Moreover, findings show a balance between children who reported high and low levels of SE.

Independent of the level of SE reported by children, parents/caregivers adopting an AA/AS parental style tend to promote their children's autonomous behaviors, helping them deal with school responsibilities (e.g., be punctual to class, complete homework, bring the textbooks to class every day).

To clarify this finding, the following quotes represent two cases: AA/AS and higher SE (parent/caregiver 9), and AA/AS and lower SE (parent/caregiver 7):

> Parent/caregiver 9: *Now we [parents] opt for asking to him to do the homework in the kitchen, because when we are cooking, he does his tasks. This way he can see us, feel safe, and do the work alone. He works independently, and only call us to see if the work is OK.*

> Parent/caregiver 7: *Yes, yes. Now she no longer asks for my help all the time. She doesn't call until the work is finished. In that moment I see if it is right or wrong...*

Findings also show that CR/RH practices, with greater focus on the rejection/hostility dimension, while less effective in the development of children's autonomy, do not seem to be linked with lower levels of engagement behaviors in school tasks, as the following quotation suggests.

> Parent/caregiver 5: *When he has exams. . . so we know about when he will have exams. . . and then we tell him 'Hey [kiddo], don't you have to study?' 'Ahhh, I studied, I know, it is not necessary, I have already studied. . .'*

DISCUSSION

The major goal of the present study was to understand the parental styles adopted by parents of children with CP in relation to their children's levels of autonomy and SE. The majority of the parents/caregivers were clustered in an AA/AS parental style and the majority of their children were perceived as autonomous. Furthermore, neither children's autonomous behaviors reported by parents, nor the parental style, seem to be related to the children's SE or the GMFCS.

Moreover, findings showed that the AA/AS style encompasses both high and low levels of SE, and also that the CR/RH parental style is associated with higher levels of SE.

Furthermore, a main finding of the present study was that the majority of parents were identified as holding an AA/AS parenting style. This result is not consistent with the literature (Elad et al., 2013; Racine et al., 2013) and may be related to the fact that all the participating children attend rehabilitation centers in which a family centered approach is adopted. In the family centered approach the families are expected to be involved in the therapy of their children (e.g., physiotherapy). While participating in the sessions, parents/caregivers learn the appropriate strategies to adopt with their child to accomplish particular goals, being expected to reproduce them at home. Parents/caregivers attending rehabilitation centers with this framework are likely to be prone to understanding, in depth, the process followed by their children and to be prompt to develop strategies to support the autonomy of their child, because that is what they learn at the center. They are also prone to search for information and seek to understand the clinical needs of their children. The educational experience of these parents at the center is consistent with the AA/AS parental style and may help to explain findings. Moreover, these parents are likely to take a holistic approach to the health care, development, and learning of their child (Woodgate et al., 2015).

Despite the literature suggesting that children with disabilities, especially with physical disabilities, tend to show low autonomy in their daily life contexts (Simeonsson et al., 2001), still, in

the current study, the majority of parents/caregivers did not describe their children's behaviors as showing low autonomy (i.e., assessed by the level of GMFCS and by data extracted from the parents interviews). A possible explanation for this finding may be that parents of children with disabilities are more likely to value the little progresses accomplished by their children in terms of autonomy when compared with parents of children without disabilities (Blackorby and Cameto, 2004). Additionally, compared to professional evaluations, parents/caregivers tend to overvalue the level of functioning of their child (Keith and Markie, 1961).

Literature reports that the AA/AS parental style is related to the promotion of children's autonomous behaviors (Aran et al., 2007). Still, interestingly, we found that a parent/caregiver identified as CR/RH (participant 12) perceived low autonomous behaviors in his child, but his child's SE was high. Duncan and Caughy (2009) suggest a possible explanation for this mismatch. These authors mention that parents/caregivers of children with disabilities tend to perceive their children as vulnerable and in need of overprotection. Yet, children may not perceive their parents behavior as overprotective and, therefore, the parents' behavior may not negatively influence the children's SE level, as would be expected (Harper, 1977). Children with disabilities could perceive their parents/caregivers controlling behaviors as a pattern of security and comfort, with no influence on school perceptions and involvement (Eggland, 1973; Cohen et al., 2008).

Our findings suggest that parental style is an important variable with impact on children's SE, but also stress the need to consider other variables that may influence the level of SE, such as the way children perceive school or their future academic expectations (Cohen et al., 2008). Researchers might consider examining parents parenting style perceived by children with CP and the motives for displaying particular educational strategies (e.g., instigate autonomy by pushing children to dress themselves). Findings are expected to help researchers understand the complex relationships between parenting styles, the promotion of autonomy, and SE. For example, to understand why almost half of the children in our study reported higher SE, and the other lower, despite the parents/caregivers displaying an AA/AS parental style. Additionally, researchers could also consider analyzing data beyond the parent-child dyad. For example, understand how the systems and structures that surround the child may promote or restrict the child's autonomous behavior.

This finding may be explained because children, despite their parents' efforts and involvement in school activities, anticipate their future after school as difficult and without opportunities for people with their clinical condition (Connell, 1990; Skinner and Belmont, 1993). Another hypothesis to clarify this finding may be that parents/caregivers perceiving their child as not being able to be successful in school or in a professional course are likely to devalue schoolwork and show low involvement in school activities (e.g., helping with homework). Rather, parents/caregivers focus their children educational goals on areas of functioning (e.g., physical recuperation) other than school. Children with parents holding these beliefs may face difficulties in their commitment to school and show a high SE, but still they can achieve school success.

Our results reveal other aspects of the complex nature of the parenting styles construct. Parents/caregivers with a particular parenting style were not consistent with that style with all the different activities analyzed. For example, some parents/caregivers were identified as using the AA/AS parenting style in some school routines (e.g., homework tasks) and the CR/RH parenting style in others (e.g., school activities and exam preparation). This finding stresses the need to analyze the parenting style in relation to particular tasks. Homework, for example, being an universal instructional strategy (Núñez et al., 2015b; Valle et al., 2016), is likely to be conceptualized by parents as a promoter of academic learning, which could lead parents to be prone to encourage their children's autonomy in this activity (Cunha et al., 2015).

Parents/caregivers lacking consistency in their parenting styles may have difficulty in promoting their children's autonomy in all contexts of daily life. Still, in the current research, some children with parents holding inconsistent parenting styles reported high SE.

Limitations and Future Studies

Findings on children's autonomous behaviors reported by parents and the parental style provide a corpus of knowledge that is expected to help in the design of interventions fitted to particular family needs. Still, despite being promising, our results are preliminary, present limitations, and should be further investigated. First, the study is focused on children's autonomous behaviors reported by parents, as well as on parental involvement in their children's daily life routines. So, data cannot be generalized, but only understood in light of the study's participants. Qualitative research does not intend to generalize findings to a larger population, but to facilitate the transferability of the results, for example informing and facilitating insights into contexts other than that in which the survey was conducted (Carpenter and Suto, 2008). Second, participants (i.e., parents/caregivers and their children) attend rehabilitation centers following an approach focused on family collaboration, which could limit the phenomenon comprehension. Further studies with children from rehabilitation centers following different types of theoretical frameworks, or with children who do not attend any rehabilitation center, are needed to compare findings. Third, SE was assessed with a self-report measure. Future research might consider including other ways to assess this construct, such as class observation or self-reports using other sources of information. Lastly, we did not include parents' parental style perceived by children. This measure could have increased the trustworthiness of the findings. To address these limitations, researchers might consider, for example, crossing the perceived autonomy of children with CP and SE with the children's autonomy and SE perceived by parents.

This information would help to disclose the complex relationships between parental involvement and children outputs, and to design tailored interventions fitted to the educational needs of children with CP. Moreover, Aran et al. (2007) found that the parental style has more impact in the

quality of life of children with CP than in their siblings' quality of life (typically developed). Therefore, it would be interesting to analyze if the impact of the parental style in the specific case of children with CP is different in the case of typically developing children.

Rehabilitation centers, and also schools, could consider organizing training addressing parents/caregivers' educational needs. A close relationship between the strategies used by therapists while working with children with CP (e.g., physiotherapists) and those used by parents/caregivers at home is expected to help children become more autonomous (Pereira et al., in press). Additionally, this training could promote parents/caregivers reflections on parental styles and SE, stress the practical applicability of promoting these strategies with their child, and foster their involvement.

AUTHOR CONTRIBUTIONS

AP, TM, SL, and AN were responsible for the literature search, data collection, data analysis, and data interpretation. PM, SF, and NR were in charge of technical guidance. PR and JN made important intellectual contribution in research design and manuscript revision. All authors were involved in the writing process of this manuscript.

FUNDING

This study was conducted at Psychology Research Centre (UID/PSI/01662/2013), University of Minho, and supported by the Portuguese Foundation for Science and Technology and the Portuguese Ministry of Science, Technology and Higher Education through national funds and co-financed by FEDER through COMPETE2020 under the PT2020 Partnership Agreement (POCI-01-0145-FEDER-007653). AP was supported by a PhD fellowship from the Portuguese Foundation for Science and Technology (FCT – SFRH/BD/95104/2013). PM was supported by a Post-Doctoral fellowship from the Research Center on Psychology (CIPsi), School of Psychology, University of Minho.

ACKNOWLEDGMENT

Authors would like to thank Priya Kabaria for the English editing of the manuscript.

REFERENCES

Aisen, M. L., Kerkovich, D., Mast, J., Mulroy, S., Wren, T. A., Kay, R. M., et al. (2011). Cerebral palsy: clinical care and neurological rehabilitation. *Lancet Neurol.* 10, 844–852. doi: 10.1016/S1474-4422(11)70176-4

Al-Alwan, A. F. (2014). Modeling the relations among parental involvement, school engagement and academic performance of high school students. *Int. Educ. Stud.* 7, 47–56. doi: 10.5539/ies.v7n4p47

Almqvist, L., Hällnäs, P., Stefansson, M., and Granlund, M. (2006). I can play! Young children's perception of health. *Pediatr. Rehabil.* 9, 275–284. doi: 10.1080/13638490500521303

Andrada, G., Virella, D., Folha, T., Gouveia, R., Cadete, A., Alvarelhão, J., et al. (2012). *Vigilância Nacional da Paralisia Cerebral aos 5 anos: crianças nascidas entre 2001e 2003*. Coimbra: Federação das Associações Portuguesas de Paralisia Cerebral.

Andrada, M. G., Virella, D., Calado, E., Gouveia, R., Alvarelhão, J. J. M., and Folha, T. (2007). *Versão Portuguesa – Sistema de Classificação da Função Motora Global*. Hampton, VA: Canchild.

Aran, A., Shalev, R. S., Biran, G., and Gross-Tsur, V. (2007). Parenting style impacts on quality of life in children with cerebral palsy. *J. Pediatr.* 151, 56–60. doi: 10.1016/j.jpeds.2007.02.011

Barlow, A., and Humphrey, N. (2012). A natural variation study of engagement and confidence among parents of learners with special educational needs and disabilities (SEND). *Eur. J. Special Needs Educ.* 27, 447–467. doi: 10.1080/08856257.2012.711959

Bax, M., Goldstein, M., Rosenbaum, P., Leviton, A., Paneth, N., Dan, B., et al. (2005). Proposed definition and classification of cerebral palsy. *Dev. Med. Child Neurol.* 47, 571–576. doi: 10.1017/S001216220500112X

Bazeley, P., and Jackson, K. (eds). (2013). *Qualitative Data Analysis with NVivo*. London: Sage Publications Limited.

Blackorby, J., and Cameto, R. (2004). "Changes in school engagement and academic performance of students with disabilities," in *Wave 1 Wave 2 Overview, SEELS* (Menlo Park, CA: SRI International), 1–24.

Bottcher, L., Flachs, E. M., and Uldall, P. (2009). Attentional and executive impairments in children with spastic cerebral palsy. *Dev. Med. Child Neurol.* 52, e42–e47. doi: 10.1111/j.1469-8749.2009.03533.x

Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.* 3, 77–101. doi: 10.1191/1478088706qp063oa

Cardol, M., De Jong, B. A., and Ward, C. D. (2002). On autonomy and participation in rehabilitation. *Disabil. Rehabil.* 24, 970–974. doi: 10.1080/09638280210151996

Carpenter, C., and Suto, M. (2008). *Qualitative Research for Occupational and Physical Therapists: A Practical Guide*. Oxford: Blackwell.

Castro, M., Expósito-Casas, E., López-Martín, E., Lizasoain, L., Navarro-Asencio, E., and Gaviria, J. L. (2015). Parental involvement on student academic achievement: a meta-analysis. *Educ. Res. Rev.* 14, 33–46. doi: 10.1016/j.edurev.2015.01.002

Cerebral Palsy Alliance [CPA] (2013). *ParentWise Podcast Series, Making the Most of Your Child's Mealtimes*. Available at: www.cpresearch.org.au/pdfs/pw_tr_Making_the_Most_of_Your_Child's_Mealtimes_2.pdf [accessed May 11, 2016].

Chorpita, B. F., and Barlow, D. H. (1998). The development of anxiety: the role of control in the early environment. *Psychol. Bull.* 124, 3–21. doi: 10.1037/0033-2909.124.1.3

Clapton, J., and Kendall, E. (2002). Autonomy and participation in rehabilitation: time for a new paradigm? *Disabil. Rehabil.* 24, 987–991. doi: 10.1080/09638280210152058

Cohen, E., Biran, G., Aran, A., and Gross-Tsur, V. (2008). Locus of control, perceived parenting style, and anxiety in children with cerebral palsy. *J. Dev. Phys. Disabil.* 20, 415–423. doi: 10.1007/s10882-008-9106-8

Connell, J. P. (1990). "Context, self, and action: a motivational analysis of self-system processes across the life-span", in *The Self in Transition: Infancy to Childhood*, ed. D. Cicchetti, (Chicago: University of Chicago Press), 61–97.

Connell, J. P., Beale-Spencer, M., and Aber, J. L. (1994). Educational risk and resilience in African-American youth: context, self, action, and outcomes in school. *Child Dev.* 65, 493–506. doi: 10.1111/j.1467-8624.1994.tb00765.x

Coster, W., and Khetani, M. A. (2008). Measuring participation of children with disabilities: issues and challenges. *Disabil. Rehabil.* 30, 639–648. doi: 10.1080/09638280701400375

Cunha, J., Rosário, P., Macedo, L., Nunes, A. R., Fuentes, S., Pinto, R., et al. (2015). Parents' conceptions of their homework involvement in elementary school. *Psicothema* 27, 159–165. doi: 10.7334/psicothema2014.210

Duncan, A. F., and Caughy, M. O. B. (2009). Parenting style and the vulnerable child syndrome. *J. Child Adolesc. Psychiatr. Nurs.* 22, 228–234. doi: 10.1111/j.1744-6171.2009.00203.x

Eggland, E. T. (1973). Locus of control and children with cerebral palsy. *Nurs. Res.* 22, 329–333. doi: 10.1097/00006199-197307000-00007

Elad, D., Barak, S., Eisenstein, E., Bar, O., Givon, U., and Brezner, A. (2013). Discrepancies between mothers and clinicians in assessing functional capabilities and performance of children with cerebral palsy. *Res. Dev. Disabil.* 34, 3746–3753. doi: 10.1016/j.ridd.2013.07.036

Eriksson, L., and Granlund, M. (2004). Perceived participation. A comparison of students with disabilities and students without disabilities. *Scand. J. Disabil. Res.* 6, 206–224. doi: 10.1080/15017410409512653

European Commission (2014). *Report on the Implementation of the EU Framework for National Roma Integration Strategies (COM(2014) 209)*. Brussels: European Union.

Finn, J. D. (1993). *School Engagement & Students at Risk*. Washington, DC: National Center for Education Statistics.

Finn, J. D., and Rock, D. A. (1997). Academic success among students at risk for school failure. *J. Appl. Psychol.* 82, 221–234. doi: 10.1037/0021-9010.82.2.221

Finn, J. D., and Zimmer, K. S. (2012). "Student engagement: what is it? Why does it matter?," in *Handbook of Research on Student Engagement*, eds S. L. Christenson, A. L. Reschly, and C. Wylie (New York, NY: Springer), 97–131. doi: 10.1007/978-1-4614-2018-7_5

Frampton, I., Yude, C., and Goodman, R. (1998). The prevalence and correlates of specific learning difficulties in a representative sample of children with hemiplegia. *Br. J. Educ. Psychol.* 68, 39–51. doi: 10.1111/j.2044-8279.1998.tb01273.x

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. H. (2004). School engagement: potential of the concept, state of the evidence. *Rev. Educ. Res.* 74, 59–109. doi: 10.3102/00346543074001059

Grolnick, W. S., Deci, E. L., and Ryan, R. M. (1997). "Internalization within the family: the self-determination theory perspective", in *Parenting and Children's Internalization of Values: A Handbook of Contemporary Theory*, eds J. Grusec and L. Kuczynski (New York, NY: Wiley), 135–161.

Harper, D. C. (1977). Perceived maternal child-rearing behavior among disabled and non-disabled adolescents. *Percept. Mot. Skills* 44, 1095–1105. doi: 10.2466/pms.1977.44.3c.1095

Jenks, K. M., van Lieshout, E. C., and de Moor, J. (2009). The relationship between medical impairments and arithmetic development in children with cerebral palsy. *J. Child Neurol.* 24, 528–535. doi: 10.1177/0883073809335009

Keith, R. A., and Markie, G. S. (1961). Parental and professional assessment of functioning in cerebral palsy. *Dev. Med. Child Neurol.* 11, 735–742. doi: 10.1111/j.1469-8749.1969.tb01517.x

Kemps, R. J. J. K., Siebes, R. C., Gorter, J. W., Ketelaar, M., and Jongmans, M. J. (2011). Parental perceptions of participation of preschool children with and without mobility limitations: validity and reliability of the PART. *Disabil. Rehabil.* 33(15–16), 1421–1432. doi: 10.3109/09638288.2010.533242

Landis, J. R., and Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics* 33, 159–174. doi: 10.2307/2529310

Maher Ridley, S., McWilliam, R. A., and Oates, C. S. (2000). Observed engagement as an indicator of child care program quality. *Early Educ. Dev.* 11, 133–146. doi: 10.1207/s15566935eed1102_1

McWilliam, R. A., Casey, A. M., and Sims, J. (2009). The routines-based interview: a method for gathering information and assessing needs. *Infants Young Child.* 22, 224–233. doi: 10.1097/IYC.0b013e3181abe1dd

Michel, E., Roethlisberger, M., Neuenschwander, R., and Roebers, C. M. (2011). Development of cognitive skills in children with motor coordination impairments at 12-month follow-up. *Child Neuropsychol.* 17, 151–172. doi: 10.1080/09297049.2010.525501

Mutsaarts, M., Steenbergen, B., and Bekkering, H. (2006). Anticipatory planning deficits and task context in hemiparetic cerebral palsy. *Exp. Brain Res.* 172, 151–162. doi: 10.1007/s00221-005-0327-0.

Novak, I., Mcintyre, S., Morgan, C., Campbell, L., Dark, L., Morton, N., et al. (2013). A systematic review of interventions for children with cerebral palsy: state of the evidence. *Dev. Med. Child Neurol.* 55, 885–910. doi: 10.1111/dmcn.12246

Núñez, J. C., Suárez, N., Cerezo, R., González-Pienda, J., Rosário, P., Mourão, R., et al. (2015a). Homework and academic achievement across Spanish Compulsory Education. *Educ. Psychol.* 35, 726–746. doi: 10.1080/01443410.2013.817537

Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Cerezo, R., and Valle, A. (2014). Teachers' feedback on homework, homework-related behaviors and academic achievement. *J. Educ. Res.* 1, 1–13. doi: 10.1080/00220671.2013.878298

Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Valle, A., and Epstein, J. L. (2015b). Relationships between parental involvement in homework, student homework behaviors, and academic achievement: differences among elementary, junior high, and high school students. *Metacogn. Learn.* 10, 375–406. doi: 10.1007/s11409-015-9135-5

Odding, E., Roebroeck, M. E., and Stam, H. (2006). The epidemiology of cerebral palsy: incidence, impairments and risk factors. *Disabil. Rehabil.* 28, 183–191. doi: 10.1080/09638280500158422

Palisano, R., Rosenbaum, P., Walter, S., Russell, D., Wood, E., and Galuppi, B. (1997). Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Dev. Med. Child Neurol.* 39, 214–223. doi: 10.1111/j.1469-8749.1997.tb07414.x

Parkes, J., White-Koning, M., McCullough, N., and Colver, A. (2009). Psychological problems in children with hemiplegia: a European multicentre survey. *Arch. Dis. Child.* 94, 429–433. doi: 10.1136/adc.2008.151688

Pereira, A., Magalhães, C., Magalhães, P., Lopes, S., Sampaio, A., Magalhães, C., et al. (in press). Why is he special? The importance of educational diet in children with hemiplegic cerebral palsy: a case study. *Eur. J. Educ. Psychol.*

Proot, I. M., Crebolder, H. F., Abu-Saad, H. H., Macor, T. H., and ter Meulen, R. H. (2000). Facilitating and constraining factors on autonomy the views of stroke patients on admission into nursing homes. *Clin. Nurs. Res.* 9, 460–478. doi: 10.1177/10547730022158690

Racine, E., Larivière-Bastien, D., Bell, E., Majnemer, A., and Shevell, M. (2013). Respect for autonomy in the healthcare context: observations from a qualitative study of young adults with cerebral palsy. *Child Care Health Dev.* 39, 873–879. doi: 10.1111/cch.12018

Raftery, J. N., Grolnick, W. S., and Flamm, E. S. (2012). "Families as facilitators of student engagement: toward a home-school partnership model", *Handbook of Research on Student Engagement*, eds S. L. Christenson, A. L. Reschly, and C. Wylie (New York, NY: Springer), 343–364. doi: 10.1007/978-1-4614-2018-7_16

Regueiro, R., Suárez, N., Valle, A., Núñez, J. C., and Rosário, P. (2015). Homework motivation and engagement throughout compulsory education. *Revista de Psicodidáctica,* 20, 47–73. doi: 10.1387/RevPsicodidact.12641

Richardson, M., Roberts, B., and Lyons, A. (2014). "A life with cerebral palsy: Neil's story and Jose's case studies", in *Intellectual Disability in Health and Social Care*, eds S. Atkinson, J. Lay, S. McAnelly, and M. Richardson (New York, NY: Routledge), 247–270.

Rodríguez, S., Regueiro, B., Blas, R., Valle, A., Piñeiro, I., and Cerezo, R. (2014). Teacher self-efficacy and its relationship with students' affective and motivational variables in higher education. *Eur. J. Educ. Psychol.* 7, 107–120. doi: 10.1989/ejep.v7i2.183

Rosário, P., Núñez, J. C., Vallejo, G., Cunha, J., Azevedo, R., Pereira, R., et al. (2015). Promoting Gypsy children school engagement: a story-tool project to Enhance self-regulated learning. *Contemp. Educ. Psychol.* 1–11. doi: 10.1016/j.cedpsych.2015.11.005

Rosenbaum, P. (2003). Cerebral palsy: what parents and doctors want to know. *Br. Med. J.* 326, 970–974. doi: 10.1136/bmj.326.7396.970

Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., Bax, M., Damiano, D., et al. (2007). A report: the definition and classification of cerebral palsy April 2006. *Dev. Med. Child Neurol.* 109(suppl. 109), 8–14. doi: 10.1111/j.1469-8749.2007.tb12610.x

Ryan, R. M., and Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* 55, 68–78. doi: 10.1037/0003-066X.55.1.68

Sankar, C., and Mundkur, N. (2005). Cerebral palsy-definition, classification, etiology and early diagnosis. *Indian J. Pediatr.* 72, 865–868. doi: 10.1007/BF02731117

Schaefer, E. S. (1965). Children's reports of parental behavior: an inventory. *Child Dev.* 36, 413–424. doi: 10.2307/1126465

Scope (2013). *Scope to Help and Information: Introduction to Cerebral Palsy*. Available at: http://www.scope.org.uk/support/families/diagnosis/cerebral-palsy [accessed May 10, 2016].

Simeonsson, R. J., Carlson, D., Huntington, G. S., Sturtz McMillen, J., and Brendt, J. L. (2001). Students with disabilities: a national survey of participation in school activities. *Disabil. Rehabil.* 23, 49–63. doi: 10.1080/096382801750058134.

Skinner, E. A., and Belmont, M. J. (1993). Motivation in the classroom: reciprocal effect of teacher behavior and student engagement across the school year. *J. Educ. Psychol.* 85, 571–581. doi: 10.1037/0022-0663.85.4.571

Straub, K., and Obrzut, J. E. (2009). Effects of cerebral palsy on neuropsychological function. *J. Dev. Phys. Disabil.* 21, 153–167. doi: 10.1007/s10882-009-9130-3

Valle, A., Regueiro, B., Núñez, J. C., Rodríguez, S., Piñeiro, I., and Rosário, P. (2016). Academic goals, student homework engagement, and academic achievement in elementary school. *Front. Psychol.* 7:463. doi: 10.3389/fpsyg.2016.00463

Van Rooijen, M., Verhoeven, L., and Steenbergen, B. (2015). From numeracy to arithmetic: precursors of arithmetic performance in children with cerebral palsy from 6 till 8 years of age. *Res. Dev. Disabil.* 45, 49–57. doi: 10.1016/j.ridd.2015.07.001

Wang, M. T., and Holcombe, R. (2010). Adolescents' perceptions of school environment, engagement, and academic achievement in middle school. *Am. Educ. Res. J.* 47, 633–662. doi: 10.3102/0002831209361209

Woodgate, R. L., Edwards, M., Ripat, J. D., Borton, B., and Rempel, G. (2015). Intense parenting: a qualitative study detailing the experiences of parenting children with complex care needs. *BMC Pediatr.* 15:197. doi: 10.1186/s12887-015-0514-5

World Health Organisation [WHO] (2001). *International Classification of Functioning, Disability and Health (ICF)*. Geneva: WHO.

Yeargin-Allsopp, M., Braun, K. V. N., Doernberg, N. S., Benedict, R. E., Kirby, R. S., and Durkin, M. S. (2008). Prevalence of cerebral palsy in 8-year-old children in three areas of the United States in 2002: a multisite collaboration. *Pediatrics* 121, 547–554. doi: 10.1542/peds.2007-1270

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Pereira, Moreira, Lopes, Nunes, Magalhães, Fuentes, Reoyo, Núñez and Rosário. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 25 October 2016
doi: 10.3389/fpsyg.2016.01611

Estimating the Epidemiology and Quantifying the Damages of Parental Separation in Children and Adolescents

*Dolores Seijo[1], Francisca Fariña[2], Tania Corras[3], Mercedes Novo[1] and Ramon Arce[1]**

[1] Political Science and Sociology, University of Santiago de Compostela, Santiago de Compostela, Spain, [2] Departamento de Análise e Intervención PsicoSocioEducativa, University of Vigo, Pontevedra, Spain, [3] Psychology Forensic Service, University of Santiago de Compostela, Santiago de Compostela, Spain

Parental separation is linked to multiple negative outcomes for children in all spheres of life. A field study was designed to estimate the epidemiology and to quantify the outcomes on the wellbeing of children from separated parents. Thus, data on socio-economic status, psychological adjustment, behavioral disorders, social relations, self-concept, and academic achievement were gathered from 346 children and adolescents, 173 separated parents, and 173 parents from intact families in the paediatric catchment area of Galicia (Spain). The results showed that parental separation had a significant negative impact on the children's and adolescents' family income (increasing the probability of falling below the poverty line); psychological adjustment (i.e., higher scores in anxiety, depression, hostility, paranoid ideation, and interpersonal alienation); social relations (i.e., less self-control in social relations; higher social withdrawal); self-concept (lower levels of academic, emotional, physical, and family self-concept), and academic achievement (lower academic achievement with higher school dropout rates). Moreover, children from separated families had a higher probability of being exposed to gender violence. Epidemiologically, parental separation is associated to the probability of falling below the poverty line 33.9%; being exposed to gender violence 43.2%; and symptoms such as depression, anxiety, hostility, paranoid ideation interpersonal alienation, and social withdrawal, i.e., 20, 17, 27, 20, 19, and 35.5%, respectively. Inversely, self-control in social relations, and academic, emotional, physical, and family self-concept fell to 16, 32, 27, 22, and 37%, respectively. The interrelationship among these variables and the implications of these results for interventions are discussed.

Keywords: parental separation, children of divorce, psychological adjustment, behavioral problems, social relations, self-concept, academic performance

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Eva M. Romera, University of Cordoba, Spain
Alfonso Palmer Pol, Balearic Island University, Spain
Raúl Quevedo-Blasco, Universidad de Granada, Spain

****Correspondence:***
Ramon Arce
ramon.arce@usc.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *23 June 2016*
Accepted: *03 October 2016*
Published: *25 October 2016*

Citation:
Seijo D, Fariña F, Corras T, Novo M and Arce R (2016) Estimating the Epidemiology and Quantifying the Damages of Parental Separation in Children and Adolescents. Front. Psychol. 7:1611. doi: 10.3389/fpsyg.2016.01611

INTRODUCTION

The 4.2 decline in the crude marriage rate in the EU-28 (marriages per 1,000 inhabitants), has been accompanied by a simultaneous 2.0 increase in the crude divorce rate (EUROSTAT, 2015a), resulting in a 0.48 risk of separation. Thus, the crude divorce rate rose 150% between 1965 and 2011. In absolute terms, the number of marriages in 2011 was around 2,100,000 with about 986,000 divorces, with just over half (∼500,000) being divorces involving children (EUROSTAT, 2015b).

Parental separation is linked to multiple negative outcomes for children in all spheres of life, primarily in psychological adjustment, academic performance, behavioral disorders, self-concept, and social adjustment (Amato and Keith, 1991; Amato, 2001). Two hypothesis may explain these outcomes. The first contends that it is a selection process, i.e., negative outcomes are not due to parental separation, but to other factors such as parental incompetence, parental characteristics (e.g., antisocial personality), or genetic predispositions with the effects of separation being spurious. Alternatively, the other hypothesis suggests a causal relationship, i.e., negative effects are the consequence of parental separation. Although a few studies have lent some support to the selection hypothesis, longitudinal studies, and studies with a design controlling factors not germane to separation have also underscored a causal relationship between parental separation and negative outcomes for children (Capaldi and Patterson, 1991; Averdijk et al., 2012; Lacey et al., 2014). Notwithstanding, a high degree of intersubject variability has been observed, i.e., either negative or positive results were found in a minority, but for the majority they remained unchanged, with a greater prevalence in follow-up studies (pre-separation vs. post-separation) of negative versus positive outcomes (Amato and Anthony, 2014). One explanation for the lack of effects is that many of the problems detected in children following parental separation already existed prior to breakup (Sun, 2001), whereas those who highlight the positive results focus on the degree of conflict, and suggest children living with both parents in situations of intense and chronic parental conflict improve after separation (Hanson, 1999). These results cohabit in studies that view separation as a discrete event (comparing pre- vs. post-separation, with legal separation being the classification criterion), and not as a process whose ultimate aim is legal separation. This would explain much of the injury to children registered "prior to separation" (Arce et al., 2005). Moreover, the size of the negative effects in children from separated and intact families appears to vary through time, i.e., high from the 1950s–1979, falling in the 1980s before rising again in the 1990s (Amato, 2001). Thus, the socio-legal context also influences the results of separation in children. As for the long-term effects of sequelae, two empirically supported alternatives have been proposed in the literature (Hetherington, 2006; Lacey et al., 2014), one proposes the negative outcomes of parental separation on children fade over time (the crisis model); whereas the other suggests that, owing to the persistence of stressors (e.g., reduced quality of parent–child relationships; economic disadvantage, academic performance, and occupational status), negative outcomes pervade over time, becoming chronic or consolidated (chronic stress model), throughout a person's entire life, and leads to the higher probability of marital breakdown in adult partnerships (Dronkers and Härkönen, 2008). However, these outcomes neither remain static, nor have immediate effects, i.e., delayed expression. Thus, unforeseen circumstances such as remarriage can change the sign of the effects (e.g., increased earnings, rising above the poverty threshold, appearance of new stressors), whereas the appearance of negative outcomes may not be immediate, i.e., deferred expressions (American Psychiatric Association, 2013). In short, though the relation reported in the literature between parental separation and the development of disorders in children was influenced by study design, there is no doubt it entails real and significant negative effects, though these are restricted to only part of the population of children from separated families, whose prevalence and size of injury has as yet to be estimated.

Several theories and models have attempted to explain the results, e.g., the family stress model, family systems theory, life course theory, or social capital theory, which rest on the constructs of stress, coping, risk, and resiliency. Though they all enjoy a degree of plausibility and empirical support, they are nonetheless tenuous. Drawing from these sources, Amato (2000) designed the Divorce-stress-adjustment perspective that views separation as a process that begins before it actually occurs (legal separation), and may continue long after. In order to further explain individual differences in the impact of separation, stressors, and mediators have been introduced (e.g., changing school, a fall in income, continuous exposure to parental conflict, exposure to long-drawn-out parental litigation), which serve to further aggravate injury associated to separation (Ross and Mirowsky, 1999; Lacey et al., 2014); and the moderators (e.g., individual, interpersonal and structural resources, reason of separation, demographic characteristics) used to identify which subjects and under what conditions relationships will occur. Thus, depending on the configuration of the moderating factors for each individual, these may act as protectors (resilience), or as risks (vulnerable), explaining the intersubjects variability in the outcomes of parental separation.

Although, parental separation should take place without any consequences for children (true null hypothesis), that is, no adverse outcomes, the results showed separation had significant negative outcomes for children, with an effect size that is traditionally interpreted as small (Cohen, 1988). Cohen himself has pointed out qualitative interpretations must be contextualized so that a small effect size, in a context where confirmation of the null hypothesis is desirable, is really crucial. Thus, these results must be interpreted taking into account the qualitative categories of serious adverse effects, that is, the undesirable adverse reactions of medication (drugs). Even more so, when the results are mean effects where the negative effects have been weighted either positively or negatively in a minority, but remain unchanged for the majority.

Bearing in mind the literature, a field study was designed to contrast the outcomes, i.e., socio-economic, psychological adjustment, behavioral disorders, social relations, self-concept, and academic achievement domains in a sample of Spanish children from separated families as compared to children from intact families. Succinctly, the consolidated/chronic effects were assessed (>1 year after parental separation), epidemiological increases were estimated, the adverse effects associated to parental separation were quantified, and the minimum and maximum epidemiological ranges of the effects were analyzed to determine variability (moderating factors). Finally, the results were generalized to other samples.

MATERIALS AND METHODS

Participants

The sample consisted of 346 children, 183 girls (52.9%), and 163 boys (47.1%); 173 from separated families and 173 from intact families; age range 6–17 years ($M = 11.69$, $SD = 3.39$). For the group of children from separated families the mean time-lapse since parental separation was 6.72 years ($SD = 3.90$), with a 1-year minimum time-lapse since the legal separation.

Measures

Parents' self-reports of annual income were corroborated with their annual tax declarations (joint income or the sum of both independent incomes), to determine the total income of the family unit. Pre- and post-separation data was obtained. The raw data was transformed into categorical variable (income below the poverty threshold or above poverty threshold). The criteria for defining the relative poverty threshold were taken from the Spanish Bureau of Census [Instituto Nacional de Estadística][1], and from the Dossiers on poverty in Spain by EAPN [European Anti-Poverty Network, Spain][2].

As for psychological adjustment, the Spanish adaptation (Derogatis, 1977) of the Symptom Check List 90-R (SCL-90-R) was administered to adolescents older than 13 years of age. The checklist consisted of 90 items assessing nine primary symptom dimensions (somatization, $\alpha = 0.86$, obsessive-compulsive, $\alpha = 0.86$, interpersonal sensitivity, $\alpha = 0.83$, depression, $\alpha = 0.90$, anxiety, $\alpha = 0.85$, hostility, $\alpha = 0.84$, phobic anxiety, $\alpha = 0.82$, paranoid ideation, $\alpha = 0.80$, psychoticism, $\alpha = 0.77$), and three global distress indexes (global severity index, positive symptom distress index, and positive symptom total). Participants were required to rate their psychopathological disorders and symptoms on a 5-point Likert-type scale ranging from "not at all" (0), "a little bit" (1), "moderately" (2), "quite a bit" (3) to "extremely" (4).

Socialization was evaluated using the BAS-3 Socialization Battery (Silva and Martorell, 1989), applied to adolescents (minimum 12 years) self-report consisting of 75 items on a yes/no response format. It is structured around five dimensions: consideration for others ($\alpha = 0.82$, social sensitivity or concern for others); self-control in social relations ($\alpha = 0.78$, measuring a bipolar dimension representing at one end the positive dimension, i.e., compliance with social rules and norms fostering peaceful coexistence; and at the other the negative dimension, i.e., aggressive, dominant, stubborn, and disobedient); social withdrawal ($\alpha = 0.81$, active and passive alienation); social/shyness anxiety ($\alpha = 0.78$, detecting different manifestations of anxiety, fear, and nervousness together with shyness in social relations); and leadership ($\alpha = 0.73$, ascendency, popularity, initiative, and self-confidence).

Self-concept was evaluated using the Forma 5 [AF-5] Self-concept questionnaire (García and Musitu, 2014), a self-report questionnaire for 12-year-olds and older, consisting of 30 items scored on a 3-point Likert-type scale ranging from "always" (1), "a little bit" (2), to "never" (3). A total of five factors were measured: academic ($\alpha = 0.88$; self-perception of the quality of their work as a student); social ($\alpha = 0.71$; social relations); emotional ($\alpha = 0.73$; emotional states and responses to specific situations, commitment and involvement to some degree in everyday life); physical ($\alpha = 0.76$; self-perception of their physical aspect and condition); and family ($\alpha = 0.80$, implication, participation, and integration within the family).

Academic performance was self-reported by children as either good or bad, given that the evaluation scales and levels varied from grade to another. Moreover, self-reports of dropping out of school, in response to the question on whether they had repeated a grade, was crosschecked with the parents, and full consistency was observed. This was only applicable to 8-year-olds and older (under the Spanish education system children under the age of 8 years cannot fail a grade, and from 10 to 12 years, they may repeat a grade only once every 2 years, and from 12 years onward students may repeat a grade on a yearly basis).

Behavioral disorders were measured in two context, i.e., school and social relations, using the disobedience subscales (disruptive behavior in class, $\alpha = 0.82$), and social aggressiveness (confrontation, arguments, and verbal and physical assaults, $\alpha = 0.77$) of the TAMAI (Hernández-Guanir, 2015). The norms of the test classify the behavioral disorders as not confirmed (percentile 60 or lower) and confirmed (percentile 61 or higher).

Procedure and Design

This study was approved by the Clinical Research Ethics Committee of the Autonomous Community of Galicia (Spain). The families and participants were selected from hospital and Primary Healthcare pediatric services in Galicia. During their appointments, parents were explained by the pediatrician the objectives of the study and were asked to collaborate. A member of the research team contacted parents who had freely volunteered to participate in the study, and had signed informed consent. For each separated family with children (remarriage was excluded) a control with similar socio-demographic characteristics [e.g., children's gender and age prior to separation, economic status, family size, location (urban, suburban, rural), school type (state, private), and parent's education]. Thereafter, the measurement instruments were administered by rotating the order of administration. No case exceeded 50 min of continuous evaluation. Data were processed in compliance with the Spanish Data Protection Law to guarantee the privacy and non-identification of people or families.

A quasi-experimental research methodology to contrast the consequences of parental separation in children and adolescents was performed. As for design sensitivity analysis, the probability of detecting (1-β) significant differences ($\alpha < 0.05$) for a small effect size (Amato and Keith, 1991; Amato, 2001) of an association between two variables ($df = 1$, $N > 180$) was >98%; and for F test between two groups (numerator $df = 9$; denominator $d = 145$) was >98%.

[1] http://www.ine.es/

[2] www.eapn.es/

Data Analysis

Associations between variables were estimated by the chi-squared for independent or related samples accordingly, and effect size was estimated by the Odds Ratio (OR).

Increases in adverse effects were estimated using to the Binomial Effect Size Display (Rosnow and Rosenthal, 1996), transforming the effect sizes of Cohen's *d* or OR to *r*, or by obtaining the effect sizes directly from *r*, and the confidence intervals transformed into *r* to *z* (Fisher's transformation). The increase in adverse effects in samples related to categorical variables was calculated in terms of proportions and their confidence intervals. The size of injury was interpreted in terms of categories of adverse reactions or undesired effects: very frequent/very important (≥1/10), frequent/important (≥1/100 to <1/10), not frequent/not important (≥1/1000 to <1/100), rare/scarce (≥1/10,000 to 1/1000), very rare/very scarce (<1/10,000; World Health Organization, n.d.).

As for mean comparisons, MANOVAs were performed with Pillai-Bartlett trace as the multivariate test statistic given that it is more robust to the heterogeneity effects of the variance matrices (Olson, 1976). Though variance homogeneity is not an important requisite when dealing with similar sized groups (big/small <1.5), it was analyzed to determine if it supported or rejected the hypothesis by comparing the theoretical *F* (of the homogeneity test) with the empirical one: if the theoretical *F* is smaller than the empirical one, the alternative hypothesis is substantiated, and vice versa (Palmer, 1996). The effect sizes were estimated as "partial eta-squared" for multivariate contrasts and Cohen's *d* (Glass delta when heterogeneity of variance was observed: Glass et al., 1981, p. 29), with the confidence intervals, CIs (when 95% CIs do not include zero, the results may be generalized to other samples with a 97.5% probability), derived from the formula of Hedges and Olkin (1985).

RESULTS

Socio-Economic Consequences of Parental Separation

The probability of falling below the poverty line is significantly increased by parental separation, $\chi^2(1, N = 186) = 22.42$, $p < 0.001$. The probability of separated families (0.645) of falling below the poverty threshold is twice (OR = 2.11) in contrast to pre-parental separation (0.306). These results are generalizable to other post-separation samples with a probability of 97.5%, 95% CI [0.574, 0.710]. Epidemiologically, this entails an increase in the poverty incidence rate of 33.9% (0.339), 95% CI [0.275, 0.409], ranging with a 95% probability from 27.5 to 40.9%.

Psychological Adjustment Consequences of Parental Separation

The results showed an effect of parental separation on the psychological adjustment of children (clinical dimensions), Pillai's Trace = 0.13, $F(9,143) = 2.31$, $p < 0.05$, 1-β = 0.896, explaining 12.7% of the variance of mental health, $\eta^2_p = 0.127$. Moreover, parental separation also had effects on global distress, Pillai's Trace = 0.05, $F(3,148) = 2.75$, $p < 0.05$, 1-β = 0.656, explaining 5.3% of the variance, $\eta^2_p = 0.053$.

The univariate effects (**Table 1**) showed that, in comparison to children from intact families, children from separated families exhibited higher levels of depression, anxiety (generalized), hostility (i.e., aggression, anger, fury, irritability, rage, resentment), paranoid ideation (i.e., suspicious, fear of losing autonomy, need of control, difficulties in expressing their hostility), and psychoticism (in non-psychiatric populations it is associated to interpersonal alienation, i.e., feeling different to others, feeling mistreated, misunderstood, unwanted, finding it difficult to express their hostility or in extreme cases the belief that someone is trying physically harm them). Epidemiologically, parental separation was responsible for 20, 17, 27, 20, and 19% increases in symptomatology in depressive, anxiety, hostility, persecutory ideas and interpersonal alienation, respectively. Moreover, parental separation entailed greater global severity distress (GSI), which increased by 17%. Furthermore, the 95% CIs for *r* showed, with a 95% probability, that injury ranged from 4.3 to 38.4% for depression; from 1.2 to 32% for anxiety; from 11.6 to 41.1% for hostility; from 4.3 to 34.8% for paranoid ideation; from 3.2 to 33.8% for psychoticism; and from 1.2 to 32% for global distress. As the mean effect sizes (*d*) for depression, anxiety, hostility, paranoid ideation, psychoticism, and global distress were significantly positive (more symptomatology and clinical severity), and the confidence intervals did not include zero, the results, i.e., significant positive effects of parental separation on children were generalizable to other samples with a probability of 97.5%.

Impact of Parental Separation on Social Relations

The results of a MANOVA showed a significant multivariate effect of the sample factor (separated family vs. intact family) on the socialization of children, Pillai's Trace = 0.08, $F(5,146) = 2.36$, $p < 0.05$, 1-β = 0.741, with the sample explaining 7.5% of socialization, $\eta^2_p = 0.075$.

The univariate effects on the dimensions of socialization showed children from separated families exhibited less self-control in social relation, i.e., less compliant with social rules and norms fostering peaceful coexistence, with an estimated loss of 16%, ranging with a 95% probability from 1 to 31% (**Table 2**). Moreover, the results revealed more social withdrawal in children from separated families as compared to intact families, i.e., they were actively or passively alienated from others with a higher mean than in intact families 21%, ranging with a 95% probability from a minimum of 4.9 to a maximum of 35.5%. As the mean effect sizes (*d*) in self-control and social withdrawal were significantly negative, and the confidence intervals did not include zero, the results, i.e., significant negative effects of parental separation on children in self-control, and social withdrawal were generalizable to other samples with a probability of 97.5%.

TABLE 1 | Univariate effects on the clinical dimensions and distress global indices for the sample factor (separated vs. intact family).

Variable	*F*	M_{sf}	M_{if}	*d* (95% CI_d)	*r* (95% CI_r)
Clinical dimensions					
Somatisation	2.24	0.74	0.59	0.24 (−0.079, 0.559)	0.12 (−0.039, 0.274)
Obsessive-compulsive	0.05	1.12	1.09	0.04 (−0.277, 0.357)	0.02 (−0.139, 0.178)
Interpersonal sensitivity	0.52	1.02	0.94	0.11 (−0.208, 0.428)	0.05 (−0.110, 0.207)
Depression	5.98*	1.07	0.77	0.40 (0.079, 0.721)	0.20 (0.043, 0.348)
Anxiety	4.60*	0.87	0.63	0.35 (0.030, 0.670)	0.17 (0.012, 0.320)
Hostility	12.09***	1.09	0.62	0.56 (0.236, 0.884)	0.27 (0.116, 0.411)
Phobic anxiety	2.23	0.55	0.41	0.23 (−0.089, 0.549)	0.11 (−0.050, 0.264)
Paranoid ideation	6.32*	1.01	0.73	0.40 (0.079, 0.721)	0.20 (0.043, 0.348)
Psychoticism	5.89*	0.57	0.35	0.39 (0.070, 0.710)	0.19 (0.032, 0.338)
Distress global indices					
Global severity index (GSI)	4.42*	0.89	0.69	0.35 (0.030, 0.670)	0.17 (0.012, 0.320)
Positive symptom total (PST)	1.23	38.97	35.37	0.18 (−0.141, 0.501)	0.09 (−0.071, 0.246)
Positive symptom distress index (PSDI)	1.62	2.83	1.66	0.20 (−0.118, 0.518)	0.10 (−0.060, 0.254)

*df(1, 151); *p < 0.05; ***p < 0.001; M_{sf}, mean of the separated family group; M_{if}, mean of the intact family group.*

TABLE 2 | Univariate effects on the socialization for the sample factor (separated vs. intact family).

Variable	*F*	M_{sf}	M_{mf}	*d* (95% CI_d)	*r* (95% CI_r)
Consideration	0.14	12.48	12.60	−0.05 (−0.369, 0.269)	−0.03 (−0.189, 0.130)
Self-control	4.04*	9.14	10.15	−0.33 (−0.646, −0.014)	−0.16 (−0.310, −0.001)
Social withdrawal	6.83**	3.17	2.10	0.42 (0.735, 0.105)	0.21 (0.355, 0.049)
Anxiety-shyness	0.79	3.87	3.51	0.14 (−0.179, 0.459)	0.07 (−0.091, 0.227)
Leadership	1.44	5.09	4.64	0.19 (−0.129, 0.509)	0.09 (−0.071, 0.228)

*df(1, 150); *p < 0.05; **p < 0.01; M_{sf}, mean of the separated family group; M_{if}, mean of the intact family group.*

No effects were observed for the sample factor in consideration, anxiety-shyness and leadership.

Self-Concept and Impact of Parental Separation

A MANOVA was performed on self-concept with the sample factor (separated family vs. intact family), the results show the sample factor had a significant effect on self-concept, Pillai's Trace = 0.23, $F(5,146) = 8.85$, $p < 0.001$, 1-β = 1.00, explaining 23.2%, $\eta_p^2 = 0.232$, of self-concept.

The univariate effects on the dimensions of socialization revealed (**Table 3**) children from separated homes had a low academic self-concept (i.e., poor perception of academic performance); emotional (i.e., low self-perception of emotional adjustment and emotional regulation); physical (i.e., low capacity and poor physical appearance), and family (i.e., less of a feeling of adjustment and importance as a member of the family). Epidemiologically, the mean loss linked to parental separation was in academic self-concept 32%; emotional 27%; physical 22%; and family 37%. Furthermore, the 95% CIs for *r* show, with a 95% probability that the loss ranged from 16.9 to 47.5% for academic self-concept; from 11.5 to 41.2% for emotional self-concept; from 6.3 to 36.7% for physical self-concept; and from 19.4 to 47.7% for family self-concept. As the mean effect sizes of (*d*) were significantly negative in academic, emotional, physical, and family self-concept, and the confidence intervals did not include zero, the results, i.e., significant negative effects of parental separation on children, were generalizable to other samples with a probability of 97.5%.

No effects were observed for the sample factor in social self-concept.

Behavioural Disorders

Parental separation was associated to more disruptive behavior in class (disobedience), $\chi^2(1, N = 314) = 5.49$, $p < 0.05$, $\varphi = 0.132$. Briefly, children from separated families more than doubling the probability of disruptive behavior in the class, OR = 2.18, than children from intact families. Moreover, these results were generalizable to other samples with a probability of 97.5%, 95% CI [1.12, 4.24]. Epidemiologically, parental separation increased the mean disruptive behavior in class of 13.2%, 95% IC [0.022, 0.239], with a 95% probability, ranging from 2.2 to 23.9%.

Parental separation was coupled to a significant increase in aggressive behavior in social contexts (social aggressiveness), $\chi^2(1, N = 320) = 4.47$, $p < 0.05$, $\varphi = 0.118$. Succinctly, 1.65 more cases of aggressive behavior (OR = 1.65) were reported in children from separated families than intact families. These results were generalizable to other samples with a probability of 97.5%, 95% CI [1.04, 2.64]. Epidemiologically, parental separation was linked to an increase in mean aggressive behavior in social relations of 11.8%, 95% IC [0.009, 0.225], ranging with a 95% probability from 0.9 to 22.5%.

TABLE 3 | Univariate effects on the self-concept for the sample factor (separated vs. intact family).

Variable	*F*	M_{sf}	M_{if}	*d* (95% CI_d)	*r* (95% CI_r)
Academic	17.40***	5.25	6.58	−0.67 (−0.979, −0.361)	−0.32 (−0.457, −0.169)
Social	0.32	7.05	7.21	−0.09 (−0.408, 0.228)	−0.05 (−0.208, 0.111)
Emotional	11.91***	4.96	6.02	−0.56 (−0.872, −0.248)	−0.27 (−0.412, −0.115)
Physical	8.22**	5.46	6.35	−0.46 (−0.774, −0.146)	−0.22 (−0.367, −0.063)
Family	24.27***	7.33	8.70	−0.80 (−1.11, −0.495)	−0.37 (−0.477, −0.194)

*df(1, 150); **$p < 0.01$; ***$p < 0.001$; M_{sf}, mean of the separated family group; M_{if}, mean of the intact family group.*

Impact of Parental Separation on Academic Performance

Self-reported academic performance, measured as either good or bad, was significantly associated to parental separation, $\chi^2(1, N = 346) = 9.87$, $p < 0.001$, $\varphi = 0.169$. Thus, children from separated families doubled the probability of negative academic performance, OR = 2.16, than children from intact families. Moreover, these results were generalizable to other samples with a probability of 97.5%, 95% CI [1.33, 3.52]. Epidemiologically, parental separation entailed an increase in the mean incidence rate of academic performance of 16.9%, 95% CI [0.065, 0.270], ranging with a 95% probability from 6.5 to 27%.

School failure, as measured by repeated grades, was associated to parental separation, $\chi^2(1, N = 181) = 3.85$, $p < 0.05$, $\varphi = 0.146$, with children from separated families doubling the probabilities of school failure, OR = 2.27, as compared to intact families. Moreover, these results were generalizable to other samples with a probability of 97.5%, 95% CI [0.99, 5.21]. Epidemiologically, parental separation implied an increase in the mean school dropout rate of 14.6%, 95% CI [0.025, 0.263], ranging with a 95% probability from 2.5 to 26.3%.

DISCUSSION

One of the main distinguishing features of separated families was the significant increase in relative poverty, i.e., insufficient income to cover part or all of the basic needs in Spanish society, which was linked to problems in psychological adjustment (e.g., depression, anxiety), behavioral disorders (e.g., disruptive behavior, deviant behavior, behavioral disorders, aggressive behavior), physical health problems (e.g., obesity), low academic achievers, and a lack of socio-emotional skills (Wadsworth and Achenbach, 2005; Yoshikawa et al., 2012; McLoyd et al., 2014). Parental separation doubled the probability of families falling below the relative poverty line, and the tendency is for this to be prolonged through their entire lives (Lacey et al., 2013), which in turn raises the probability of developing other problems associated to poverty. The size of the increase in mean poverty, and the upper and lower limits were very important (≥1/10).

The negative outcomes of parental separation on the psychological adjustment of children were related to low self-concept (Verrocchio et al., 2015); juvenile and adult behavioral problems (Arce et al., 2010; Novo et al., 2012; Ibabe et al., 2014); lower levels of academic performance (Lacey et al., 2013); material disadvantage (Lacey et al., 2014); more physical health problems (Martinón et al., in press), and the lack of social skills (Arce et al., 2011). Additionally, no differences in social self-concept means that the children assessed their social fit as normal instead of the negative effects of parental separation, linked to deviation risk (Contreras and Cano, 2016). The results showed parental separation led to a mean increase of approximately 20% in depressive symptoms, anxiety (generalized), hostility, paranoid ideation, and interpersonal alienation, as well as a "global severity distress" (GSI), with a very important size of injury (≥1/10), which becomes chronic and is linked to continued exposure to stressors derived from parental separation (Hetherington, 2006). The variability in increased symptomatology was considerable, at the lower limit ranging from 1.2 (anxiety) to 4.3% (depression, paranoid ideation), and an important size of adverse injury (≥1/100 to <1/10), to the upper limit, 38.4% (depression), and an important size of injury, save for hostility that was related to behavioral disorders (Arce et al., 2010), with a lower limit exceeding the important threshold of adverse injury, 11.6%, and the upper limit exceeding it fourfold, 41.1%. In short, parental separation led to a very important injury in psychological adjustment in children in general, being intervention possible and effective (Vázquez et al., 2015).

In terms of the impact on the children's social skills, parental separation increased social withdrawal, aggressive behavior, dominance, stubbornness, and disobedience (less self-control). This combination undermined facilitating factors (self-control), and intensified inhibitors (social withdrawal) of social competence which in turn lead to deficiencies in problem-solving and conflict management skills, and this to social incompetence (Sestir and Bartholow, 2007; Arce et al., 2010). Mean injury in these social competence factors derived from parental separation was 16% in self-control, and 21% in "social withdrawal," a very important size of adverse injury, ranging between (lower limit) important adverse effects to (upper limit) effects that tripled the threshold of very important effects (31 and 35.5% for self-control and social withdrawal, respectively). Succinctly, parental separation was linked in general, to los children very important adverse injury in the acquisition of social competency skills.

According to the sign, self-concept acts as either a protective factor or as a risk factor of maladjustment, i.e, in academic performance (Marsh et al., 2014); in emotions, e.g., coping skills (Davis and Humphrey, 2014); in physical capabilities and the assessment of perceived competence (Babic et al., 2014); and the risk of social maladjustment in the family (Arce et al., 2010). The results revealed a very important mean adverse effects for children from separated families in academic

(32%), emotional (27%), physical (22%), and family (37%) self-concept. Moreover, the lower limits of adverse effects were very important size in (physical self-concept), and very important in (academic, emotional, and family self-concept); meanwhile the upper limits tripled (physical self-concept), and quadrupled (academic, emotional, and family self-concept) the threshold for very important effects. Briefly, injury in the self-concept of children was very important, i.e., in the region of vulnerability and maladjustment, and affected four dimensions, with no compensatory effect among them (Postigo et al., 2013).

Behavioral disorders correlated with a wide range of risk factors (Guillén et al., 2015; Riglin et al., 2016), that is, they were the consequence of being vulnerable to risk. The results of this study found adverse effects of disruptive and aggressive behavior of a very important mean size in children from separated families. The size of injury ranged from (lower limit) frequent ($\geq$1/100 to $<$1/10) disruptive behavior at school to not frequent ($\geq$1/1000 to $<$1/100) aggressive behavior in social contexts, and the (upper limit) twice the very important threshold for effects. Disruptive behavior at school and social aggressiveness were linked to an increasing tendency of social maladjustment (Arce et al., 2010).

Parental separation undermined academic performance and increased school dropout rates, with the mean size of the adverse effects being very frequent ($\geq$1/10), and ranging from important (lower limit) to very important (upper limit). Poor academic performance leads to economic and behavioral problems, relational life course deficits (Arce et al., 2011; Lacey et al., 2014), and subsequently to significant clinical distress or impairment in social, occupational, and other important areas of life (American Psychiatric Association, 2013). Thus, negative outcomes in academic performance are the vehicle to life course negative consequences in other areas.

The results of this study have implications for interventions at three levels: socio-family, school, and personal life. At the socio-family level, parental separation should be planned with the family since parental separation is strongly linked to family poverty (and associated child poverty). At the personal level, children and adolescents from separated families need interventions aimed at preventing and/or repairing injury in social competence resulting from parental separation which puts them at risk of social exclusion, and psychological maladjustment. At school, children from separated families should undergo interventions designed to prevent the negative effects on academic performance and dropout rates. A meta-analytical review (Durlak et al., 2011) of the universal school-based intervention programs to promote students' social and emotional learning has highlighted that interventions were effective in socio-emotional skills (Hedge's $g = 0.57$), behavioral disorders ($g = -0.22$), emotional distress ($g = -0.24$), positive social behavior ($g = 0.24$), and improvement in academic performance ($g = 0.27$). In terms of the efficacy of an intervention, this implied an associated improvement of 10.9, 11.9, 13.4, and 27.4% in socio-emotional skills, behavioral disorders; emotional distress, positive social behavior, and improvement in academic performance, respectively. As problems and deficits occurred both at the personal level (negatives outcomes for parents and children), and the socio-family level (e.g., deficient financial resources, parent-child interaction, and in academic and occupational settings), a multilevel perspective should be adopted to enhance the efficacy of the intervention (individuals – parents, children, new members of the family such as new partners – new families, new social life), and a multimodal cognitive and behavioral approach (Arce and Fariña, 1996).

As for explanatory models that integrate the results, the divorce-stress-adjustment perspective can be complemented by two contrasted models explaining social maladjustment: the additive/accumulative deficits model (Farrington, 1992; Lösel and Bender, 2003), and the "natural developmental trajectory model" (Arce et al., 2010). The accumulative deficits model underscores the adverse outcomes were not restricted to one sole domain, but were combined in an interrelated set. Moreover, the natural developmental trajectory model offers an explanation on the natural course of adverse effects on children due to parental conflict, followed by the initial effects in personal areas (e.g., psychological adjustment, relationships with parents), followed by academic areas that facilitate long-term chronification of adverse effects.

Though the adverse effects found in this study were generalizable to other samples with a high probability ($>$0.975), and the power of the design was high ($>$0.98), these may reflect potential cultural differences, particularly in the size and ranges of the adverse effects observed (American Psychiatric Association, 2013), and the size of the adverse effects may vary through time (Amato, 2001). Nevertheless, regardless of the effect sizes, the adverse effects of parental separation on children are significant and extemporal in western cultures (Amato and Keith, 1991; Amato, 2001). The results of this study on poverty were limited to assessing parental income, but the effects derived from additional expenditure were not included (e.g., running two households, legal fees), and often lead to further financial hardship.

Research is required to examine and define the mediating effects of variables such as gender in children and the development of associated consequences (Hetherington et al., 1985); the age of children at the time of separation; the degree of conflict in the separation; and to contrast the pre and post effects following parental separation (Evans et al., 2008; McCloskey and Eisler, 2008).

AUTHOR CONTRIBUTIONS

All authors listed, have made substantial, direct and intellectual contribution to the work, and approved it for publication.

FUNDING

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article. This research was funded by the project with reference PI12/00604 (Instituto de Salud Carlos III, Spanish Ministry of Economy and Competitiveness).

REFERENCES

Amato, P. R. (2000). The consequences of divorce for adults and children. *J. Marriage Fam.* 62, 1269–1287. doi: 10.1111/j.1741-3737.2000.01269.x

Amato, P. R. (2001). Children of divorce in the 1990s: an update of the Amato and Keith (1991) meta-analysis. *J. Fam. Psychol.* 15, 355–370. doi: 10.1037/0893-3200.15.3.355

Amato, P. R., and Anthony, C. J. (2014). Estimating the effects of parental divorce and death with fixed effects models. *J. Marriage Fam.* 76, 370–386. doi: 10.1111/jomf.12100

Amato, P. R., and Keith, B. (1991). Parental divorce and the well-being of children: a meta-analysis. *Psychol. Bull.* 110, 26–46. doi: 10.1037/0033-2909.110.1.26

American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edn. Washington, DC: Author.

Arce, R., and Fariña, F. (1996). "From jurors to jury decision making. A non-model approach," in *Psychology, Law and Criminal Justice. International Developments in Research and Practice*, eds G. Davis, M. McMurran, C. Wilson, and S. Lloyd-Bostock (Berlin: Walter de Gruyter), 337–343.

Arce, R., Fariña, F., and Seijo, D. (2005). Razonamientos judiciales en procesos de separación: análisis cognitivo y de contenido de las motivaciones [Judicial reasoning in parental separation and divorce proceedings: content and cognitive analysis of judicial reasoning]. *Psicothema* 17, 57–63.

Arce, R., Fariña, F., and Vázquez, M. J. (2011). Grado de competencia social y comportamientos antisociales delictivos y no delictivos en menores [Social competence and delinquent, antisocial, and non-deviant behavior in adolescents]. *Rev. Latinoam. Psicol.* 43, 473–486.

Arce, R., Seijo, D., Fariña, F., and Mohamed-Mohand, L. (2010). Comportamiento antisocial en menores: riesgo social y trayectoria natural de desarrollo [Antisocial behavior in adolescents: social risk and natural developmental trajectory]. *Rev. Mex. Psicol.* 27, 127–142.

Averdijk, M., Malti, T., Eisner, M., and Ribeaud, D. (2012). Parental separation and child aggressive and internalizing behavior: an event history calendar analysis. *Child Psychiatry Hum. Dev.* 43, 184–200. doi: 10.1007/s10578-011-0259-9

Babic, M. J., Morgan, P. J., Plotnikoff, R. C., Lonsdale, C., White, R. L., and Lubans, D. R. (2014). Physical activity and physical self-concept in youth: systematic review and meta-analysis. *Sports Med.* 44, 1589–1601. doi: 10.1007/s40279-014-0229-z

Capaldi, D. M., and Patterson, G. R. (1991). Relation of parental transitions to boys' adjustment problems: I. A linear hypothesis: II. Mothers at risk for transitions and unskilled parenting. *Dev. Psychol.* 27, 489–504. doi: 10.1037/0012-1649.27.3.489

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*, 2nd Edn. Hillsdale, NJ: LEA.

Contreras, L., and Cano, M. C. (2016). Child-to-parent violence: the role of exposure to violence and its relationship to social-cognitive processing. *Eur. J. Psychol. Appl. Legal Context* 8, 43–50. doi: 10.1016/j.ejpal.2016.03.003

Davis, S. K., and Humphrey, N. (2014). Ability versus trait emotional intelligence: dual influences on adolescent psychological adaptation. *J. Ind. Differ.* 35, 54–62. doi: 10.1027/1614-0001/a000127

Derogatis, L. R. (1977). *Manual I: Scoring, Administration and Procedures for the SCL-90*. Baltimore, MD: Clinical Psychometric Research.

Dronkers, J., and Härkönen, J. (2008). The intergenerational transmission of divorce in cross-national perspective: results from the Fertility and Family Surveys. *Popul. Stud.* 62, 273–288. doi: 10.1080/00324720802320475

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., and Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: a meta-analysis of school-based universal interventions. *Child Dev.* 82, 405–432. doi: 10.1111/j.1467-8624.2010.01564.x

EUROSTAT (2015a). *Marriage and Divorce Statistics*. Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Marriage_and_divorce_statistics

EUROSTAT (2015b). *Analytical Web Note 3/2015 - Demography Report (2015)*. Available at: http://ec.europa.eu/social/keyDocuments.jsp?advSearchKey=AnalyticalWebNotes-Occasionalwebnotes&mode=advancedSubmit&langId=en&policyArea=&type=0&country=0&year=0

Evans, S. E., Davies, C., and DiLillo, D. (2008). Exposure to domestic violence: a meta-analysis of child and adolescent outcomes. *Aggress. Violent Behav.* 13, 131–140. doi: 10.1016/j.avb.2008.02.005

Farrington, D. P. (1992). "Explaining the beginning, progress and ending of antisocial behavoir from birth to adulthood," in *Facts, Frameworks and Forecasts. Advances in Criminological Theory*, Vol. 3, ed. J. McCord (New Brunswick, NJ: Transaction Publishers), 253–286.

García, F., and Musitu, G. (2014). *AF-5: Autoconcepto Forma 5*, 4th Edn. Madrid: TEA Ediciones.

Glass, G. V., McGaw, B., and Smith, M. L. (1981). *Meta-Analysis in Social Research*. Beverly Hills, CA: Sage.

Guillén, N., Roth, E., Alfaro, A., and Fernández, E. (2015). Youth alcohol drinking behavior: associated risk and protective factors. *Rev. Iberoam. Psicol. Salud* 6, 53–63. doi: 10.1016/j.rips.2015.03.001

Hanson, T. L. (1999). Does parental conflict explain why divorce is negatively associated with child welfare? *Soc. Forces* 77, 1283–1316. doi: 10.1093/sf/77.4.1283

Hedges, L. V., and Olkin, I. (1985). *Statistical Methods for Meta-Analysis*. Orlando, FL: Academic Press.

Hernández-Guanir, P. (2015). *TAMAI: Test Autoevaluativo Multifactorial de Adaptación Infantil. [TAMAI: Mutifactorial Self-Administered Test of Child Adjustment. Manual]*, 7th Edn. Madrid: TEA Ediciones.

Hetherington, E. M. (2006). "The influence of conflict, marital problem solving and parenting on children's adjustment in nondivorced, divorced, and remarried families," in *Families Count: Effect on Child and Adolescent Development*, eds A. Clarke-Stewart and J. Dunn (New York, NY: Cambridge University Press), 203–237.

Hetherington, E. M., Cox, M., and Cox, R. (1985). Long-term effects of divorce and remarriage on the adjustment of children. *J. Am. Acad. Child Psychiatry* 24, 518–530. doi: 10.1016/S0002-7138(09)60052-2

Ibabe, I., Arnoso, A., and Elgorriaga, E. (2014). Behavioral problems and depressive symptomatology as predictors of child-to-parent violence. *Eur. J. Psychol. Appl. Legal Context* 6, 53–61. doi: 10.1016/j.ejpal.2014.06.004

Lacey, R. E., Bartley, M., Pikhart, H., Stafford, M., and Cable, N. (2014). Parental separation and adult psychological distress: an investigation of material and relational mechanisms. *BMC Public Health* 14:272. doi: 10.1186/1471-2458-14-272

Lacey, R. E., Kumari, M., and McMunn, A. (2013). Parental separation in childhood and adult inflammation: the importance of material and psychosocial pathways. *Psychoneuroendocrinology* 38, 2476–2484. doi: 10.1016/j.psyneuen.2013.05.007

Lösel, F., and Bender, D. (2003). "Protective factors and resilience," in *Early Prevention of Antisocial Behaviour*, eds D. P. Farrington and J. W. Coid (Cambridge, MA: Cambridge University Press), 130–204.

Marsh, H. W., Kuyper, H., Seaton, M., Parker, P. D., Morin, A. J., Möller, J., et al. (2014). Dimensional comparison theory: an extension of the internal/external frame of reference effect on academic self-concept formation. *Contemp. Educ. Psychol.* 39, 326–341. doi: 10.1016/j.cedpsych.2014.08.003

Martinón, J. M., Fariña, F., Corras, T., Seijo, D., Souto, A., and Novo, M. (in press). Impacto de la ruptura de los progenitores en el estado de salud física de los hijos. *Eur. J. Educ. Psychol.* 7.

McCloskey, L. A., and Eisler, R. (2008). "Family structure and family violence," in *Encyclopedia of Violence, Peace, and Conflict*, ed. L. Kurtz (San Diego, CA: Academic Press), 813–820.

McLoyd, V., Mistry, R. S., and Hardaway, C. R. (2014). "Poverty and children's development," in *Societal Contexts of Child Development: Pathways of Influence and Implications for Practice and Policy*, eds E. T. Gershoff, R. S. Mistry, and D. A. Crosby (New York, NY: Oxford University Press), 109–124.

Novo, M., Fariña, F., Seijo, D., and Arce, R. (2012). Assessment of a community rehabilitation programme in convicted male intimate-partner violent offenders. *Int. J. Clin. Health Psychol.* 12, 219–234.

Olson, C. L. (1976). On choosing a test statistic in manova. *Psychol. Bull.* 83, 579–586. doi: 10.1037/0033-2909.83.4.579

Palmer, A. L. (1996). *Análisis Unifactorial de Variancia*. Palma de Mallorca: Servei de Publicacions de la UIB.

Postigo, S., González, R., Montoya, I., and Ordoñez, A. (2013). Theoretical proposals in bullying research: a review. *Anales Psicol.* 29, 413–425. doi: 10.6018/analesps.29.2.148251

Riglin, L., Thapar, A., Shelton, K. H., Langley, K., Frederickson, N., and Rice, F. (2016). Profiling depression in childhood and adolescence: the role of

conduct problems. *J. Child Psychol. Psychiatry* 57, 481–490. doi: 10.1111/jcpp.12465

Rosnow, R. L., and Rosenthal, R. (1996). Computing contrasts, effect sizes, and counternulls on other people's published data: general procedures for research consumers. *Psychol. Methods* 1, 331–340. doi: 10.1037/1082-989X.1.4.331

Ross, C. E., and Mirowsky, J. (1999). Parental divorce, life-course disruption, and adult depression. *J. Marriage Fam.* 61, 1034–1045. doi: 10.2307/354022

Sestir, M. A., and Bartholow, B. D. (2007). "Theoretical explanations of aggression and violence," in *Aggressive Offenders' Cognition. Theory, Research, and Practice*, eds T. A. Gannon, T. Ward, A. R. Beech, and D. Fisher (Chichester, MA: Wiley), 157–178.

Silva, F., and Martorell, M. C. (1989). *BAS-3. Batería de Socialización (Autoevaluación)*, 2nd Edn. Madrid: TEA Ediciones.

Sun, Y. (2001). Family environment and adolescents' well-being before and after parents' marital disruption: a longitudinal analysis. *J. Marriage Fam.* 63, 697–713. doi: 10.1111/j.1741-3737.2001.00697.x

Vázquez, F. L., Torres, Á., Blanco, V., Otero, P., and Hermida, E. (2015). Intervenciones psicológicas administradas por teléfono para la depresión: una revisión sistemática y meta-análisis [Telephone-administered psychological interventions for depression: a systematic review and meta-analysis]. *Rev. Iberoam. Psicol. Salud* 6, 39-52.

Verrocchio, M. C., Marchetti, D., and Fulcheri, M. (2015). Perceived parental functioning, self-esteem, and psychological distress in adults whose parents are separated/divorced. *Front. Psychol.* 6:1760. doi: 10.3389/fpsyg.2015.01760

Wadsworth, M. E., and Achenbach, T. M. (2005). Explaining the link between low socioeconomic status and psychopathology: testing two mechanisms of the social causation hypothesis. *J. Consult. Clin. Psychol.* 73, 1146–1153. doi: 10.1037/0022-006X.73.6.1146

World Health Organization (n.d.). *Definitions*. Available at: http://www.who.int/medicines/areas/quality_safety/safety_efficacy/trainingcourses/definitions.pdf

Yoshikawa, H., Aber, J. L., and Beardslee, W. R. (2012). The effects of poverty on the mental, emotional, and behavioral health of children and youth: implications for prevention. *Am. Psychol.* 67, 272–284. doi: 10.1037/a0028015

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Seijo, Fariña, Corras, Novo and Arce. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 18 October 2016
doi: 10.3389/fpsyg.2016.01612

Age-Related Differences of Individuals' Arithmetic Strategy Utilization with Different Level of Math Anxiety

Jiwei Si, Hongxia Li, Yan Sun, Yanli Xu and Yu Sun*

School of Psychology, Shandong Normal University, Jinan, China

The present study used the choice/no-choice method to investigate the effect of math anxiety on the strategy used in computational estimation and mental arithmetic tasks and to examine age-related differences in this regard. Fifty-seven fourth graders, 56 sixth graders, and 60 adults were randomly selected to participate in the experiment. Results showed the following: (1) High-anxious individuals were more likely to use a rounding-down strategy in the computational estimation task under the best-choice condition. Additionally, sixth-grade students and adults performed faster than fourth-grade students on the strategy execution parameter. Math anxiety affected response times (RTs) and the accuracy with which strategies were executed. (2) The execution of the partial-decomposition strategy was superior to that of the full-decomposition strategy on the mental arithmetic task. Low-math-anxious persons provided more accurate answers than did high-math-anxious participants under the no-choice condition. This difference was significant for sixth graders. With regard to the strategy selection parameter, the RTs for strategy selection varied with age.

Keywords: math anxiety, strategy utilization, computational estimation, mental arithmetic, age-related differences

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Thomas James Lundy, virtuallaboratory.net, inc, USA
Ronny Scherer, Centre for Educational Measurement at the University of Oslo, Norway

****Correspondence:***
Jiwei Si
sijiwei1974@126.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *08 April 2016*
Accepted: *03 October 2016*
Published: *18 October 2016*

Citation:
Si J, Li H, Sun Y, Xu Y and Sun Y (2016) Age-Related Differences of Individuals' Arithmetic Strategy Utilization with Different Level of Math Anxiety. Front. Psychol. 7:1612. doi: 10.3389/fpsyg.2016.01612

INTRODUCTION

Strategy Utilization and Arithmetic Performance

A strategy is "a procedure or a set of procedures for achieving a higher level goal or task" (Lemaire and Reder, 1999). The ability of individuals to effectively solve a problem depends primarily on the combination of information available for choosing and implementing the appropriate strategy. Siegler and Lemaire (1997) proposed a four-dimensional theoretical framework to explain how individuals utilize strategies, including strategy repertoire, strategy distribution, strategy execution, and strategy selection. Specifically, an examination of strategy execution focuses on efficiency (Imbo and LeFevre, 2009), and an investigation of strategy selection focuses on utilization. From a cognitive perspective, individual differences in arithmetic performance can be explained in terms of strategy utilization (Lemaire, 2010a). Lemaire (2010a) found that participants who were unable to use strategy efficiently were more likely to select a disadvantageous approach, which resulted in

poor performance on an arithmetic task. Consistent with this result, Seaman et al. (2014) found that participants who select a simple, disadvantageous strategy during the first session performed poorer than others. Additionally, the ways in which arithmetic strategies are restricted by individual factors has become a focus of current research, particularly with regard to math anxiety (Imbo and Vandierendonck, 2007).

Math Anxiety and Arithmetic Performance

Math anxiety, which is undue or excessive anxiety related to math, leads to physical, behavioral, and psychological changes that affect functioning in these domains. Such effects may appear in mathematics learning (Ashcraft and Krause, 2007), consumption decisions (Jones et al., 2012; Suri et al., 2013), and other areas. Young et al. (2012) found that math anxiety induced negative emotions. Evidence shows that math anxiety affects the ability to perform mental arithmetic (Ashcraft and Faust, 1994; Hopko et al., 2003) and computational estimation (Si et al., 2011). Si et al. (2011) found that math anxiety had a significant impact on computational estimation in two distinct contexts. The average reaction time (RT) of the low-math-anxiety group was significantly shorter than that of the middle- and high-math-anxiety groups. Additionally, the average accuracy of the high-math-anxiety group was the lowest among the three groups in both a pure digital and a word problem context. Wahid et al. (2014) revealed that math anxiety affected students' performance, specifically, higher scores for math anxiety led to poorer performance in math course. Similarly, Andrews and Brown (2014) found that mathematics anxiety was negatively related to scores on standardized aptitude and achievement tests.

Math Anxiety and Individual Arithmetic Strategies

From a cognitive perspective (Lemaire, 2010b), individual differences in math performance can be interpreted in terms of strategy utilization, and investigation of the characteristics of such utilization is among the advanced topics in this area (e.g., Chen et al., 2011). Studies have demonstrated that the utilization of arithmetic strategies depends on circumstances, individual characteristics, the questions involved, and so on, and math anxiety was one of the most important contributors to this phenomenon (Imbo and Vandierendonck, 2007).

Evidence has demonstrated that math anxiety affects the processes involved in mental estimation encoding, retrieval, and strategy selection (Cui et al., 2011). Mental estimation, one of the most widely discussed subjects, refers to the performance of arithmetic activities without the help of external instruments, and it includes the cognitive processes involved in encoding and other operations (Liu and Wang, 2008). Many studies have investigated this phenomenon from the perspective of the selection of mental estimation strategies (Núñez-Peña et al., 2006; Chen et al., 2011), and Imbo and Vandierendonck (2007) found that highly anxious individuals were less likely to choose strategies involving shortcuts to solve problems. Additionally, the effect of math anxiety depended on the difficulty of mental estimation problems (Seyler et al., 2003). Specifically, math anxiety had a minor effect on simple problems, but its effect increased as a function of the difficulty of problem (Wang and Liu, 2007). Moreover, the effects of math anxiety on strategy selection increased with age (Geng and Chen, 2005). Recent research has focused on the effects of problem characteristics, strategy characteristics, task circumstances, and participant characteristics on the selection of a computational estimation strategy (Hodzik and Lemaire, 2011; Si et al., 2012) as well as on identifying an efficient instrument with which to investigate the frequency of, diversity in, and variations in strategy utilization. Computational estimation, which involves the interaction of mental estimation, number conceptions, and arithmetic skills, refers to the process by which an individual uses her or his original knowledge to provide an imprecise answer to a problem (Si, 2002). Computational estimation is closely connected with mental estimation, as they involve common mental processes, although they are separate mental phenomena.

Choice/No-Choice Method

The choice/no-choice method could obtain unbiased estimates of performance characteristics of strategies. As suggested by the name, the choice/no-choice method requires testing each participants under two types of conditions: conditions in which participants can freely choose which strategy to use (the choice condition) and conditions in which they must use a given strategy on all problems (the no-choice condition) (Siegler and Lemaire, 1997).

Questions and Hypothesis

Several theories attempts to explain the effects of anxiety on arithmetic performance. According to attentional control theory, anxiety impairs the efficiency of two executive functions, including the inhibition and shifting functions. Additionally, high-anxious individuals often use compensatory strategies such as enhanced effort and use of processing resources to achieve a reasonable level of performance effectiveness (Eysenck and Derakshan, 2011). And the effects of math anxiety on age-related differences in the utilization of arithmetic strategies are worth discussing, and several preliminary explorations of the links between math anxiety and math strategies have already been conducted. Ashcraft and Faust (1994) found that high-anxiety individuals did not use self-terminating economic and time-saving strategies to finish verification tasks, reflecting their lack of flexibility and failure to adapt their strategy for use with complex mental arithmetic. Imbo and Vandierendonck (2007) found that fewer high-anxious children in the fourth, fifth, and sixth grades chose retrieval strategies compared with low-anxious children. Wu (2010) found that math anxiety affected the selection and execution of mental arithmetic strategies by third-grade children: low-anxiety children were more likely to select efficient retrieval strategies and worked rapidly and high accurately, whereas high-anxiety children were more likely to implement their strategy slowly and to have lower accuracy. Geng and Chen (2005) argued that the effects of math anxiety on arithmetic strategy selection vary among children and are more obvious among those in higher grades. Thus, the current study assumed that the effects of math

anxiety on strategy utilization differed by age and that children would be more affected by this phenomenon than adults would.

Current research tends to use a mental arithmetic rather than a computational estimation task to explore the effects of math anxiety on strategy utilization (Wu, 2010; Chen et al., 2011). Computational estimation is considered one of the most effective tools for examining the flexibility and diversity that characterize individuals' use of strategies (Si, 2002). Although computational estimation and metal arithmetic share several psychological processes, computational estimation is different from mental arithmetic. Specifically, mental arithmetic activates the left prefrontal cortex, whereas computational estimation primarily activates the bilateral parietal lobe (Dehaene et al., 1999; Lemer et al., 2003). Are there differences between effects of math anxiety on computational estimation and mental arithmetic? We currently lack adequate information to answer this question. Furthermore, the effects of math anxiety on the development of arithmetic strategies remain to be fully developed. Yet, it is important to examine the influence of math anxiety on individual development from childhood to adulthood. To this end, we must rely on both computational estimation and mental arithmetic, examining the execution and outcomes of different arithmetic calculation strategies according to the level of math anxiety of individuals to reveal changes in flexibility and in domain-specific and age-related strategy utilization. Thus, the present study assumed that both computational estimation and mental estimation were affected by math anxiety and that the strategy utilization of low-anxious individuals would be significantly superior to that of high-anxious individuals.

Evidence suggests that the way in which children utilize estimation strategies changes between fourth and sixth grades (Dowker, 1997; Lemaire et al., 2000). Ramirez et al. (2013) found a negative correlation between math anxiety and math scores in first and second graders, which showed that math anxiety had begun developing in children who had just entered school. Given that children in fourth grade have been learning two-digit addition, we included students in the fourth and sixth grades as well as adults as participants in our study to provide credible evidence of age-related differences in the effects of mathematics anxiety on certain problem-solving strategies. It is worth noting that math skills also affect mental arithmetic strategies (Imbo and Vandierendonck, 2007) and that the level of one's computational estimation strategy increases as one's numeracy skills develop (Dowker, 1997). To exclude the potential effects of differences in numeracy skills, this study used covariates to explore the specific factors influencing age-related differences in the effects of math anxiety on the utilization of arithmetic strategies.

MATERIALS AND METHODS

Participants

A total of 203 undergraduates, 215 sixth-grade students, and 221 fourth-grade students from a city of Jinan in China completed group tests measuring math anxiety and math skills. All participants provided written informed consent. We divided these participants into high- and low-anxiety participants. Divide top and bottom 15% math scores into high and low anxiety participants, select 60 participants from each group students. After we eliminated invalid data, the final sample consisted of the following groups: adult high-anxiety group ($n = 30$: 14 male/16 female, $M = 20.58$ years), adult low-anxiety group ($n = 30$: 12 male/18 female, $M = 20.57$ years); sixth-grade high-anxiety group ($n = 26$: 11 male/15 female, $M = 11.67$ years), sixth-grade low-anxiety group ($n = 30$: 15 male/15 female, $M = 11.64$ years); fourth-grade group high-anxiety group ($n = 27$: 17 male/10 female, $M = 9.63$ years), fourth-grade low-anxiety group ($n = 30$: 14 male/16 female, $M = 9.76$ years). The average age of the adult group was 20.58 years, that of the sixth-grade group was 11.65 years, and that of the fourth-grade group was 9.65 years.

Experimental Design

We used a 3 (age: fourth-grade students, sixth-grade students, adults) × 2 (math anxiety: high, low) × 2 (task type: computational estimation, mental arithmetic) × 3 (strategy utilization condition: choice, no-choice/1, no-choice/2) design. No-choice/1 and no-choice/2 indicated the no-choice/rounding-up and no-choice/rounding-down conditions, respectively, in the computational task, and they indicated the no-choice/partial-decomposition and no-choice/full-decomposition conditions, respectively, in the mental arithmetic task. Age and math anxiety were treated as between-subjects variables, and task type was treated as a within-subject variable. Data regarding RTs, accuracy, and strategy were recorded under each condition.

Materials

Revised Mathematics Anxiety Rating Scale (R-MARS)

Participants completed the Revised Mathematics Anxiety Rating Scale (Liu, 2009, unpublished), a 21-item version of a widely used measure of math anxiety that asks respondents to indicate the degree to which different situations would make them anxious using a 5-point scale ranging from "not at all anxious" to "very anxious." Higher scores reflected higher levels of math anxiety. The α coefficient of the original R-MARS was 0.932, and the α coefficient in this study was 0.94.

Math Anxiety Scale for Children

We used the 22-item amended version of the Math Anxiety Scale for Children (MASC) developed by Geng and Chen (2005). Our sample of children rated their level of anxiety in response to various activities on a 4-point scale on which 4 indicated "extremely nervous," 3 indicated "very nervous," 2 indicated "a little nervous," and 1 indicated "not nervous." The total score on the 22 items reflect a child's level of mathematics anxiety, and higher scores reflect higher levels of math anxiety. The α coefficient of the scale ranged from 0.87 to 0.92. The α coefficient in this study was 0.903.

Arithmetic Skills Test

We used the French Kit (French et al., 1963) version of this standardized paper-and-pencil test, which includes one page of complex addition problems and one page of complex subtraction and multiplication problems. Each page contains six rows of 10 vertically oriented problems, and each participant was given

2 min per page to solve the problems as quickly and accurately as possible. Total arithmetic scores are calculated based on the number of correct answers, and higher scores reflect higher levels of arithmetic skills.

Arithmetic Calculations

The computational estimation and mental arithmetic tasks were the equivalent of 84 two-digit addition problems. The unit digit of one operand was larger than 5, that of the other operand was smaller than 5, and the sum consisted of three digits. Half of the problems did not involve carrying a number from the units to the 10s (e.g., 34 + 21), and the other half did involve such a carry (e.g., 16 + 38). A total of 84 problems were divided into three blocks, and each strategy-utilization condition included 28 problems. Problems were selected to control for variables that crucially influence arithmetic performance (Geary, 1996 for reviews). We ensured that (a) no operand included the digit 0 or 5 (e.g., 20 or 35), (b) no problems included the same tens digit (e.g., 73 + 76), (c) no operands included a repeated digit (e.g., 44 + 79), (d) no problems included reversed operands (e.g., if 73 + 58 were used, 58 + 73 was not), (e) half of the larger operands were presented on the right and the other half were presented on the left, and (f) half of the larger units of operands were presented on the right side and the other half were presented on the left.

Experimental Procedures

The experiment was conducted in a quiet room. The computational estimation test was administered first, followed by the mental arithmetic test. Each test lasted approximately 45–60 min; the two tests were conducted in the morning and the afternoon of the same day or during 2 days. Two computational estimation strategies were presented to the participants before the computational estimation test: rounding up and rounding down. The rounding-down strategy was described as rounding both operands down to the nearest smaller decade (e.g., 30 + 50 to estimate 32 + 56). The rounding-up strategy was described as rounding both operands up to the nearest larger decade (e.g., 40 + 60 to estimate 32 + 56). The participants were then informed that three strategy conditions would be used in this test: the choice condition (C1), in which one strategy must be chosen for each question to estimate the correct answer as closely as possible; the no-choice/rounding-up condition (C2), in which all questions must be answered using the rounding-up strategy; and the no-choice/rounding-down condition (C3), in which all questions must be answered by using the rounding-down strategy. Stimuli were presented in 42-point Times New Roman font at the center of a 13-inch computer screen controlled by a Lenovo B450 laptop. The experiment was controlled by E-Prime software. The program generated the displays and recorded latencies to the nearest millisecond. The experimental procedures were the same under each experimental condition: (a) the number of the participants was entered into the computer; (b) instructions were presented at the middle of the screen; (c) participants began after they understood the instructions; (d) each trial started with a fixation point "+," which was displayed for 750 ms; (e) after the fixation point disappeared, the question appeared, the time to answer each question was recorded, and participants pressed the "Enter" key to stop the timing; and (f) the next trial began. After a practice exercise, participants began the formal experiment, which followed the same procedures. The test order was C1→C2→C3, and participants rested for 5 m at the end of each experimental condition (**Figure 1**).

Before the beginning of the mental arithmetic test, two strategies were presented: the full-decomposition strategy, which involved splitting off the 10s and the units in both integers and adding (e.g., 73 + 58 = _; 70 + 50 = 120, 3 + 8 = 11, 120 + 11 = 131), and the partial-decomposition strategy, which involved adding first the 10s and then the units of the second integer to the first un-split integer (e.g., 73 + 58 = _; 73 + 50 = 123, 123 + 8 = 131). The participants were informed that three conditions would be used in this test: the choice condition (C1), in which respondents chose which of the two strategies was the quickest way to solve the problem; the no-choice/partial-decomposition strategy (C2), in which all the questions had to be solved used the partial-decomposition strategy; and the no-choice/full-decomposition strategy (C3), in which all the questions had to be solved using the full-decomposition strategy. The test procedures were almost the same as those used in the computational estimation test; only C1 differed slightly: after participants input their answers and pressed Enter, one question appeared: "Which strategy did you use to solve the problem? (1) The partial-decomposition strategy or (2) The full-decomposition strategy." Participants were asked to respond truthfully and continue to the next question. The order and rest time were identical those used during the computational estimation test.

Data Processing

The experimental data were analyzed with repeated-measures ANOVAs with SPSS 17.0. There were no missing data in this study. The reasons are as follows: first of all, in order to

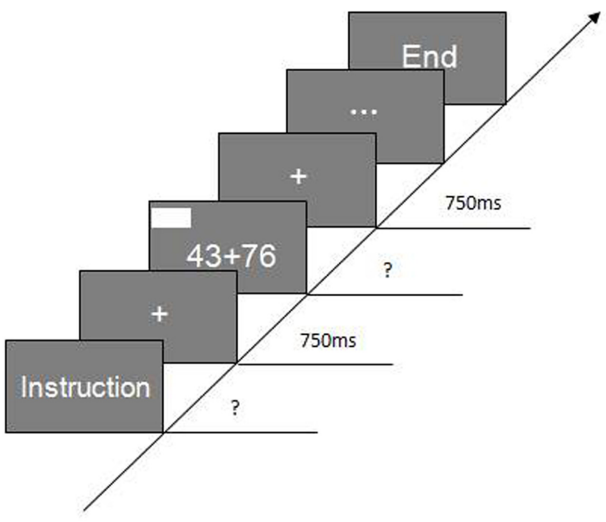


FIGURE 1 | Experimental procedures.

ensure participants can complete all trials, stimulates would not disappear until participants press the key. Secondly, we arranged experiments base on participants' available time, so all participants selected took part in this study and never gave up during the process of study.

RESULTS

Strategy Execution

Strategy execution refers to the speed and accuracy with which individuals solve problems when they must use specific strategies to do so. The results of our experiment are presented in **Tables 1** and **2**.

We analyzed the response times (RTs) and accuracy of two computational estimation no-choice conditions with repeated-measures ANOVAs using a 3 (age group: fourth and sixth graders, adults) × 2 (math anxiety: high and low anxiety) × 2 (no-choice conditions) design with arithmetic skill as the covariate (**Table 3**). The results were as follows: (a) RTs: The main effect under the no-choice condition was significant [$F_{(1,166)} = 58.81$, $\eta^2 = 0.262$, $p < 0.001$], and the rounding-up strategy required more time than the rounding-down strategy (6324 and 3883 ms, respectively). The main effect of age group was significant, $F_{(2,166)} = 12.78$, $\eta^2 = 0.133$, $p < 0.001$. Fisher's Least Significant Difference (LSD) test was applied in *post hoc* analyses due to its higher sensitive and convenience. *Post hoc* analyses revealed no significant difference between adults and sixth-grade students, whereas significant differences between the other pairs of groups were observed [$p_{(\text{adults, sixth graders})} = 0.720$, $p_{(\text{adults, fourth graders})} = 0.007$, $p_{(\text{sixth graders, fourth graders})} < 0.001$]. We also used Bonferroni method to check our findings. Bonferroni method found the same results. There is no significant difference between adults and sixth-graders [$p_{(\text{adult, sixth graders})} = 1 > 0.05$], whereas significant difference between the other pairs of groups were found [$p_{(\text{adult, fourth graders})} = 0.02 < 0.05$, $p_{(\text{sixth graders, fourth graders})} < 0.001$]. The main effect of math anxiety was significant, $F_{(1,166)} = 6.11$, $\eta^2 = 0.036$, $p = 0.014$, as the high-anxiety group was slower than the low-anxiety group (C2: 6727 and 5952 ms, respectively; C3: 4178 and 3610 ms, respectively). No interaction was found for the following. (b) Accuracy: the main effect of math anxiety was significant, $F_{(1,166)} = 8.45$, $\eta^2 = 0.048$, $p = 0.004$; the low-anxiety group was more accurate that the high-anxiety group (C2: 94.31 and 96.08%, respectively; C3: 97.35 and 98.52%, respectively). The interaction between the non-choice condition and age group was significant, $F_{(2,166)} = 3.42$, $\eta^2 = 0.040$, $p = 0.035$. Simple-effect analysis revealed no significant difference between adults and sixth graders, whereas significant differences between the other pairs of groups were observed [$p_{(\text{adults, sixth graders})} = 0.468$, $p_{(\text{adults, fourth graders})} = 0.001$, $p_{(\text{sixth graders, fourth graders})} = 0.010$]. The effect of age group was not significant under C3, $F_{(2,166)} = 0.56$, $p = 0.572$.

The RTs and accuracy of the two mental arithmetic no-choice conditions were analyzed separately with repeated-measures ANOVAs with a 3 (age group: fourth and sixth graders, adults) × 2 (math anxiety: high and low anxiety) × 2 (no-choice condition) design treating arithmetic skill as the covariate (**Table 4**). This analyses revealed the following: (a) RTs: the main effect of the no-choice condition was significant, $F_{(1,166)} = 27.45$, $\eta^2 = 0.142$, $p < 0.001$, and the partial-decomposition strategy required more time than the full-decomposition strategy (8155 and 6785 ms, respectively). The main effect of age group was significant, $F_{(2,166)} = 13.22$, $\eta^2 = 0.137$, $p < 0.001$, as adults were faster than the sixth graders, and sixth graders were faster than fourth graders (C2: 5230, 8169, and 11221 ms, respectively; C3: 4342, 6812, and 9329 ms, respectively). Fisher's LSD test analyses revealed no significant difference between adults and sixth graders, whereas significant differences between other pairs of groups were observed [$p_{(\text{adults, sixth graders})} = 0.247$, $p_{(\text{adults, fourth graders})} = 0.041$, $p_{(\text{sixth graders, fourth graders})} < 0.001$]. Bonferroni test revealed no significant difference between adults and sixth graders [$p_{(\text{adults, sixth graders})} = 0.74 > 0.05$], whereas significant differences between fourth graders and sixth graders [$p_{(\text{fourth graders, sixth graders})} < 0.001$], These results are consistent with LSD test findings. Additionally, Bonferroni test found no significant difference between adults and fourth graders [$p_{(\text{adults, fourth graders})} = 0.12 > 0.05$], this is not consistent with LSD test. The main effect of math anxiety was not significant, $F_{(1,166)} = 1.23$, $\eta^2 = 0.007$, $p = 0.270$. No interaction was found. (b) Accuracy: only the interaction between math anxiety and age group was significant, $F_{(2,166)} = 2.93$, $\eta^2 = 0.034$, $p = 0.056$. According to **Figure 2**, the simple-effect analysis revealed no significant difference between the high- and low-anxiety groups among adults, $F < 1$ (C2: 94.74 and 94.56%, respectively; C3: 96.22 and 97.26%, respectively); the accuracy of the high-anxiety group was lower than that of the low-anxiety group among sixth graders, $F_{(1,54)} = 6.87$, $p = 0.011$ (C2: 88.90 and 93.48%, respectively; C3: 89.01 and 94.62%, respectively); no significant difference was found between the high- and low-anxiety groups among fourth graders, $F = 0.26$ (C2: 91.74 and 91.46%, respectively; C3: 93.09 and 91.25%, respectively).

Strategy Selection

The results of the computational estimation test under the choice condition reflected the choice of a strategy. If the result of the chosen strategy was close to the correct result, we regarded the strategy as correct; the accuracy of a strategy choice was the rate at which a correct strategy was selected. The RTs and accuracy rates of the three groups of participants are presented in **Table 1**. We analyzed RTs and accuracy separately using repeated-measures ANOVAs with a 3 (age group: fourth and sixth graders, adults) × 2 (math anxiety: high and low anxiety) design, treating arithmetic skill as the covariate. This analysis revealed the following: (a) RTs: the main effect of age group was marginally significant, $F_{(2,166)} = 2.57$, $\eta^2 = 0.030$, $p = 0.79$. An LSD test analyses showed that adults (6086 ms) were much faster than sixth graders (9250 ms), and sixth graders were much faster than fourth-grade students (11215 ms). These results are consistent with Bonferroni test findings. The main effect of math anxiety was not significant, $F_{(1,166)} = 0.36$, $\eta^2 = 0.002$, $p = 0.55$, and the interaction between age group and math anxiety was not significant, $F_{(2,166)} = 0.99$, $\eta^2 = 0.012$, $p = 0.374$. (b) Accuracy:

TABLE 1 | Response time (RT) and accuracy of participants in computational estimation strategy use *M*(*SD*).

Grade group	Math anxiety level	Mean RT (ms)			Accuracy (%)		
		C1	C2	C3	C1	C2	C3
Grade four group	High anxiety	10789 (3441)	9608 (2745)	5650 (2069)	61.41 (12.63)	92.10 (6.69)	96.85 (3.33)
	Low anxiety	11599 (3978)	8107 (2400)	5060 (1753)	61.97 (16.23)	94.39 (5.44)	98.45 (2.60)
Grade six group	High anxiety	9688 (4594)	7096 (2411)	4489 (1709)	61.24 (16.45)	94.17 (6.61)	96.88 (3.82)
	Low anxiety	8870 (3637)	5816 (2222)	3437 (1313)	75.75 (15.36)	97.25 (3.60)	98.81 (2.17)
Adult group	High anxiety	6071 (1131)	3813 (768)	2583 (557)	83.93 (10.84)	96.43 (4.19)	98.22 (1.9)
	Low anxiety	6100 (1586)	3935 (754)	2334 (335)	85.03 (12.21)	96.60 (3.03)	98.30 (2.91)

TABLE 2 | Response time (RT) and accuracy of participants in mental arithmetic strategy use *M*(*SD*).

Grade group	Math anxiety level	Mean RT (ms)			Accuracy (%)		
		C1	C2	C3	C1	C2	C3
Grade four group	High anxiety	12458 (4300)	11546 (3409)	9343 (2029)	92.49 (7.09)	91.74 (5.56)	93.09 (7.34)
	Low anxiety	11009 (3295)	10928 (3733)	9316 (2875)	92.10 (7.96)	91.46 (9.40)	91.25 (10.34)
Grade six group	High anxiety	9878 (3470)	9183 (2883)	7645 (1974)	88.89 (9.51)	88.90 (10.75)	89.01 (9.45)
	Low anxiety	7228 (2643)	7290 (3410)	6091 (2149)	91.17 (7.49)	93.48 (4.72)	94.62 (5.53)
Adult group	High anxiety	5324 (1080)	5289 (1240)	4334 (855)	94.80 (4.03)	94.74 (4.29)	96.22 (3.21)
	Low anxiety	5395 (820)	5171 (1207)	4351 (710)	95.74 (4.46)	94.56 (4.65)	97.26 (2.96)

the main effect of age group was significant, $F_{(2,166)} = 14.67$, $\eta^2 = 0.150$, $p < 0.001$, as the accuracy rate of adults (84.48%) was much higher than that of sixth-grade students (69.02%), and that of the latter group was much higher than that of fourth-grade students (61.70%). The main effect of math anxiety was significant, $F_{(1,166)} = 6.59$, $\eta^2 = 0.038$, $p = 0.011$, as the accuracy rate of the low-anxiety group was lower than that of the high-anxiety group (69.50 and 74.25%, respectively). The interaction between age group and math anxiety was significant, $F_{(2,166)} = 4.60$, $\eta^2 = 0.053$, $p = 0.011$. **Table 2** presents the simple-effect analysis, which suggests the following: (a) Among adults, no significant difference was observed in the accuracy of the strategy choices of the low- and high-anxiety groups, with both groups being highly accurate (high anxiety: 83.93%, low anxiety: 85.03%); (b) Among sixth-grade students, the accuracy of the high-anxiety group's strategy choice was much lower than that of the low-anxiety group (61.24 and 75.75%, respectively); (c) Among fourth graders, the accuracy rate of the strategy choice was low for both groups (61.41 and 61.97% for high- and low-anxiety groups, respectively), and the groups did not differ significantly ($t_{\text{adults}} = -0.37$, $p = 0.713$; $t_{\text{sixth graders}} = -3.41$, $p = 0.001$; $t_{\text{fourth graders}} = -0.14$, $p = 0.886$) (**Figure 3**).

The accuracy score on the mental arithmetic task was calculated as the percentage of correct answers produced by the use of one of the mental arithmetic strategies. The RTs and accuracy rates are shown in **Table 2**. We analyzed the RTs and accuracy rates for each choice condition separately using repeated-measures ANOVAs with a 3 (age group: fourth and sixth graders, adults) × 2 (math anxiety: high and low anxiety) design, treating arithmetic skill as the covariate. The results were as follows: (a) RTs: the main effect of age group was significant $F_{(2,166)} = 10.4$, $\eta^2 = 0.111$, $p < 0.001$. An LSD test analyses showed no significant difference between adults and sixth graders [$p_{(\text{adults, sixth graders})} = 0.84$], whereas significant difference between adults and fourth graders [$p_{(\text{adults, fourth graders})} < 0.05$], sixth graders and fourth graders [$p_{(\text{sixth graders, fourth graders})} < 0.001$]. Specifically, sixth graders (7663 ms) were much faster than adults (7810 ms), who were much faster than fourth graders (9977 ms). Bonferroni test revealed the same findings [$p_{(\text{adults, sixth graders})} = 1 > 0.05$, $p_{(\text{adults, fourth graders})} = 0.034 < 0.05$, $p_{(\text{sixth graders, fourth graders})} < 0.001$, respectively]. The main effect of math anxiety was significant, $F_{(1,166)} = 5.84$, $\eta^2 = 0.034$, $p = 0.017$, as the high-anxiety group spent more time choosing a strategy (high-anxiety group: 9071 ms, low-anxiety group:

TABLE 3 | Repeated-measures ANOVAs of computational estimation strategy execution.

	Mean RT (ms)		Accuracy (%)	
	F	*p*	*F*	*p*
The no-choice condition	58.81	0.000***	1.56	0.214
Grade group	12.78	0.000***	1.88	0.156
Math anxiety	6.11	0.014*	8.45	0.004**
Grade group × the no-choice condition	2.80	0.084	3.42	0.035*
Math anxiety × the no-choice condition	0.30	0.586	0.83	0.363
Math anxiety × Grade group	0.18	0.833	1.66	0.194
Math anxiety × Grade group × the no-choice condition	1.55	0.216	0.22	0.802

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

TABLE 4 | Repeated-measures ANOVAs of mental arithmetic strategy execution.

	Mean RT (ms)		Accuracy(%)	
	F	*p*	*F*	*p*
The no-choice condition	27.45	0.000***	0.03	0.869
Grade group	13.22	0.000***	0.60	0.553
Math anxiety	1.23	0.270	1.38	0.242
Grade group × the no-choice condition	1.28	0.281	0.18	0.836
Math anxiety × the no-choice condition	0.48	0.489	0.04	0.842
Math anxiety × Grade group	1.02	0.364	2.93	0.056*
Math anxiety × Grade group × the no-choice condition	0.23	0.799	1.04	0.355

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

7877 ms). The interaction between age group and math anxiety was not significant, $F_{(2,166)} = 0.73$, $\eta^2 = 0.009$, $p = 0.483$. (b) Accuracy: only the main effect of age group was marginally significant, $F_{(2,166)} = 2.97$, $\eta^2 = 0.035$, $p = 0.054$. Fisher's LSD test analyses revealed no significant difference between adults and fourth graders, adults and sixth graders, whereas significant differences were found between fourth graders and sixth graders [$p_{(\text{adults, fourth graders})} > 0.05$, $p_{(\text{adults, sixth graders})} > 0.05$, $p_{(\text{sixth graders, fourth graders})} < 0.05$; 92.8, 90.9, and 94.1% for adults, sixth graders, and fourth graders, respectively]. Bonferroni test found no significant among ages [$p_{(\text{adults, fourth graders})} = 1 > 0.05$, $p_{(\text{adults, sixth graders})} = 1 > 0.05$, $p_{(\text{sixth graders, fourth graders})} = 0.06 > 0.05$]. The main effect of math anxiety was not significant, $F_{(1,166)} = 0.28$, $\eta^2 = 0.002$, $p = 0.596$, and the interaction between math anxiety and age group was also not significant, $F_{(2,166)} = 0.53$, $\eta^2 = 0.006$, $p = 0.590$.

Adaptiveness of Strategy Choice

Following prior research (Imbo and LeFevre, 2011), we defined the adaptiveness of a computational estimation strategy choice as follows: if the estimate produced by the chosen strategy was close to the correct answer, the choice of participants was adaptive. According to this definition, under C1, the accuracy rate of strategy use was the index of the adaptiveness of the strategy choice. In the context of the foregoing analysis, we can conclude the following: (1) adults' strategy choices were more adaptive than were those of children, and adults' choices were not influenced by math anxiety; (2) fourth-grade students' strategy choices were less adaptive than adults, but these choices were not influenced by math anxiety; and (3) the adaptiveness of sixth graders' strategy choices was influenced by math anxiety, with the low-anxiety group making more adaptive choices.

Following previous research (e.g., Imbo and LeFevre, 2009), we determined the best mental arithmetic strategy based on the performance of participants under the no-choice condition. In this context, the strategy that can be implemented most quickly is the best strategy. The percentage of participants utilizing

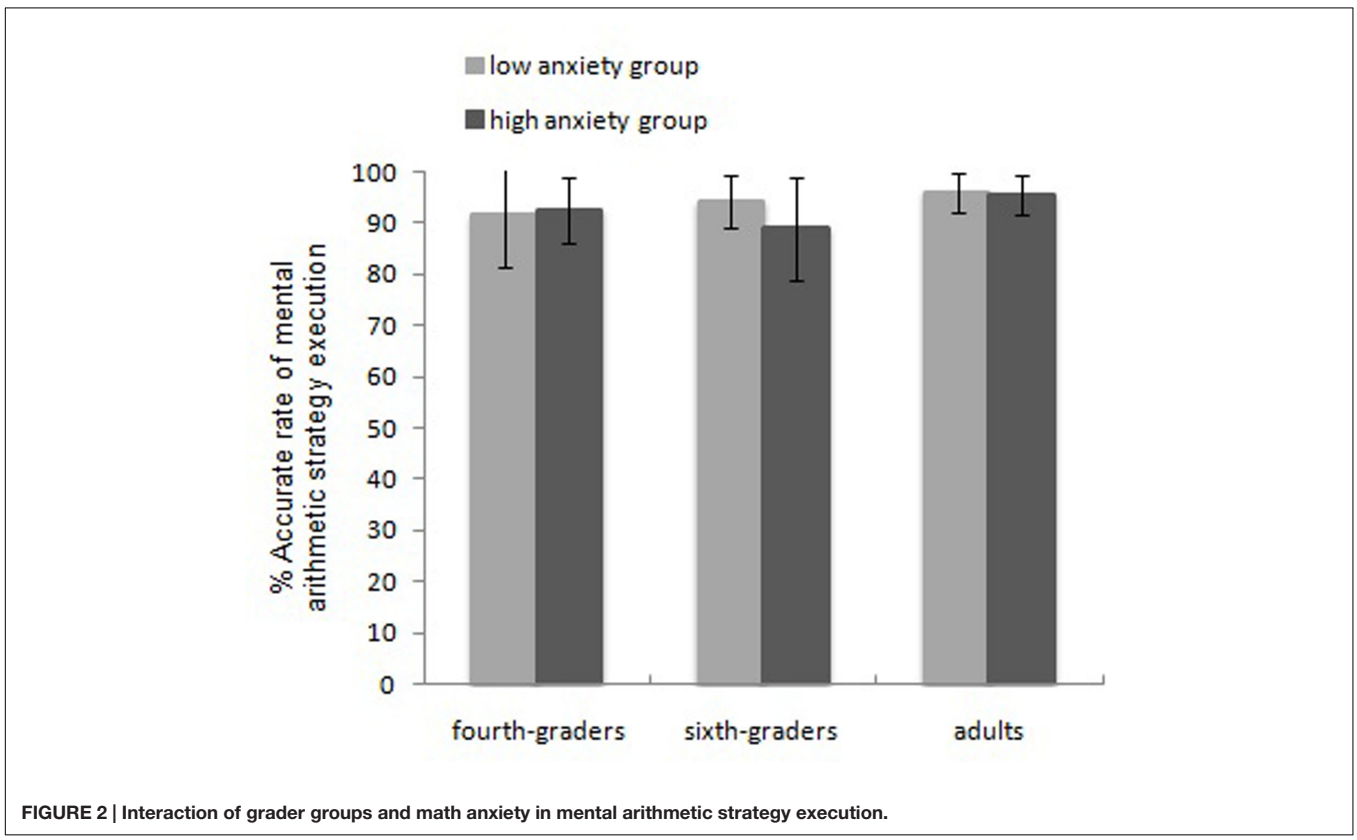


FIGURE 2 | Interaction of grader groups and math anxiety in mental arithmetic strategy execution.

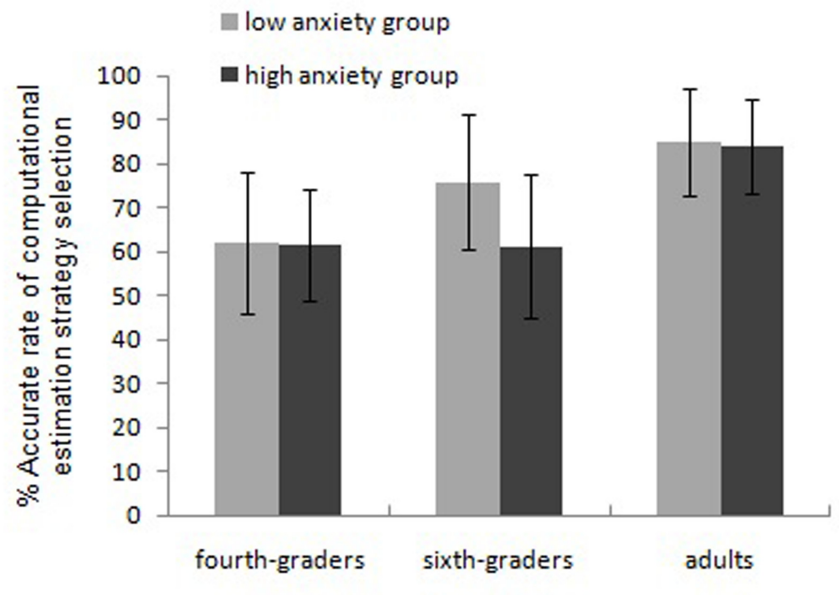


FIGURE 3 | Interaction between grade groups and math anxiety in computational estimation strategy selection.

the best strategy was the index of the adaptiveness of the mental arithmetic strategy under the choice condition. Analysis of variance using a 3 (age group) × 2 (math anxiety) design to examine the percentage of those using the optimal strategy revealed that neither the main effect nor the interaction was significant.

DISCUSSION AND CONCLUSION

Why Math Anxiety Affects the Use of Arithmetic Strategies

The present study found that math anxiety affected the choice of the strategy used for computational estimation and mental arithmetic processing. These results can be explained from a variety of perspectives. (1) According to cognitive interference theory (Northern, 2010), people with high levels of anxiety are concerned about others' evaluation of them while they are performing tasks. This generates evaluation anxiety, which leads to negative self-statements, which diverts working memory resources from the central executive system and the phonological loop, resulting in poor performance. (2) According to processing efficiency theory (Eysenck et al., 2007), working memory resources are limited. When people are anxious, their anxiety occupies part of their working memory resources, thereby reducing the resources available to process the current tasks, leading to a reduction in the efficiency of cognitive processing. According to this view, math anxiety occupies working memory resources and thereby affects individuals' cognitive performance (Cui et al., 2011). Si et al. (2014) provided evidence that highly anxious individuals had a higher working memory load than did individuals with low levels of anxiety. In terms of strategy-switch costs, participants must inhibit the strategy they just executed and activate a new strategy when selecting a strategy for a new problem (Lemaire, 2010b), and this process occupies additional working memory resources. Anxiety, strategy-switching, and cognitive tasks compete for limited cognitive resources, resulting in poor performance in people with high levels of anxiety. (3) According to attentional control theory (Eysenck and Derakshan, 2011), people with high levels of math anxiety transfer their focus from the arithmetic tasks (i.e., the goal-directed attentional system) to mathematics anxiety (i.e., the stimulus-directed attentional system), resulting in their poor performance on arithmetic tasks. According to many studies (e.g., Derakshan and Eysenck, 2009), this imbalance leads directly to negative effects on inhibition and the shifting function. According to this theory, the suppression and conversion functions of the central executive are more susceptible to math anxiety compared with updating and dual-task coordination functions. Issues regarding strategy, especially strategy selection, are closely related to suppression and conversion functions; therefore, the strategy utilization of people with high levels of anxiety is inferior. (4) According to inhibition theory (Hopko et al., 1998), people with high levels of anxiety have difficulty inhibiting intrusive anxious thoughts when performing arithmetic tasks, which hinders their performance on those tasks. Si et al. (2014) also found that participants who were highly anxious about math selected their strategy more slowly because of the effects of anxiety. Based on the foregoing, we can conclude that different components of the working memory system are affected differently by anxiety and that the phonological loop and central executive components (the suppression and conversion functions) are especially susceptible to anxiety. We speculate that mathematical problem-solving situations generate math anxiety, which interferes with the

working memory system required to solve such problems. Math anxiety affects the working memory system (especially the phonological loop and the central executive component), thereby influencing the process by which a strategy is implemented, which ultimately impacts performance.

The Specific Impact of Math Anxiety on the Use of Computational Estimation and Mental Arithmetic Strategies

This study found that math anxiety affects the use of computational estimation and mental arithmetic strategies in different ways. Specifically, math anxiety affects the execution of strategies for computational estimation but not those for mental arithmetic. In terms of strategy choice, math anxiety affects the adaptiveness of the choice of computational estimation strategies and the speed with which a mental arithmetic strategy is chosen. This shows that the speed–accuracy trade-off related to strategy selection differs for the two tasks: individuals finish computational estimation tasks quickly at the expense of accuracy, whereas they perform mental calculation accurately at the expense of speed, indicating that the effect on strategy choice is domain specific. There are several reasons for these differences. First, computational estimation and mental arithmetic constitute two different forms of arithmetic based on significantly different physiological substrates. Second, individuals are usually not familiar with computational estimation, as they tend to focus on written and oral calculation in daily life. Third, the difficulty of the task may also be relevant. The performance of computational estimation tasks requires participants to use only rounding-down and rounding-up strategies, but the problems are mixed (i.e., the unit of one operand is larger than 5, and the unit of the other is smaller than 5); thus, the results produced by a mixed strategy were closer to the correct answers. Participants (especially those who do not know the rules) find it difficult to make choices while solving a variety of different problems, as these choices require more cognitive resources. From this perspective, the computational estimation tasks used in this study were more difficult the than mental calculation ones.

Age Differences in the Effects of Math Anxiety on the Use of Arithmetic Strategies

The results show that the impact of math anxiety on math strategies significantly differs by age. This difference is reflected in the strategy selection for computational estimation tasks and in the accuracy of mental arithmetic tasks. It is more difficult to choose strategies for computational estimation than for mental arithmetic tasks; in terms of strategy execution, mental arithmetic tasks are more difficult than computational estimation tasks because mental arithmetic tasks involve two-digit addition, whereas computational estimation involves only one-digit addition. This phenomenon can be interpreted in terms of processing efficiency theory. Attentional resources are limited, and task performance is worse when arithmetic tasks are difficult (Eysenck et al., 2007). Depending on the results, in the strategy selection for computational estimation tasks and in the accuracy of mental arithmetic tasks, only sixth-grade children were constrained by math anxiety, and students with higher levels of anxiety devoted more attention to speed and sacrificed accuracy. It is possible that fourth-grade students were at the primary stage of math anxiety (Ashcraft and Moore, 2009) and were therefore less affected by such anxiety. As individuals age, they accumulate knowledge, and the difficulty of the material they learn increases; thus, their experience with and the effect of math anxiety increases, leading to poor performance by those with high levels of anxiety. These results are consistent with previous findings: high- and low-anxiety adults differed in their performance of complex but not of simple arithmetic tasks (Imbo and Vandierendonck, 2007). The adults in the present study were less affected by math anxiety, which can be interpreted in terms of processing efficiency theory. Due to the maturity of their cognitive development, adults found the arithmetic tasks in the study easier and had to use fewer cognitive resources than was the case with the children. Thus, even adults with high levels of anxiety had sufficient resources to solve the problems. This observation is consistent with previous findings showing that people with high math anxiety perform worse on complex arithmetic tasks, but that they perform at the same level as people with lower levels of math anxiety on simple tasks (Imbo and Vandierendonck, 2007). Siegler and Lortie-Forgues (2014) suggested that individual skills at magnitude representation gradually improve with age and that experiences that foster magnitude representation also improve other numerical skills, such as arithmetic learning. However, Imbo and Vandierendonck (2007) found that math anxiety had significant effects on the selection and utilization of simple arithmetic strategies. These discrepant results may be attributable to cultural differences between the East and West, as evidence shows that Chinese participants had better computational skills than did Belgian and Canadian participants (Imbo and LeFevre, 2009, 2011). Cultural differences in the behaviors involved in computational estimation strategies were also investigated except mental arithmetic strategy behaviors (Imbo and LeFevre, 2011). Consistent with this view, Xu et al. (2014) found that Chinese participants were more efficient than Belgian and Canadian participants, but their choices were less adaptive. One possible explanation for these cultural differences is that Chinese, Belgian, and Canadian students have different educational experiences. Indeed, Chinese individuals may be less tolerant than those from other cultures of approximate solutions. Hence, when asked to perform rounding strategies, Chinese participants may have to inhibit their tendency to perform exact calculations, a process that consumes working memory resources. In contrast, educational reform movements in European countries over the last 20 years have emphasized flexibility, adaptive expertise, and the use of metastrategies as part of children's learning about arithmetic (Verschaffel et al., 2009). Thus, Belgian and Canadian students are likely to be quite familiar with using a variety of strategies and capitalizing on the most appropriate one.

Limitations and Future Research

The present research has several limitations. First, the range of participants is not widely enough. Fourth and sixth graders

are relatively close in age and perhaps in learning progression. Wigfield and Meece (1988) found ninth-grade students reported experiencing the most worry about math and sixth graders the least. So future researches should pay attention to younger math learners or middle school or high school participants. That might speak more to the developmental progression. Second, we didn't use oral report. So although we asked participants to use rounding strategy we can't ensure the process of participants computational estimation or mental arithmetic. Third, it may be a problem to analyze the adult data with the Grade 4 and 6 data given that the adult had close to ceiling performance. Moreover, Krinzinger et al. (2009) revealed a close relationship between math anxiety and math ability on evaluation of mathematics in primary school children and math anxiety did not exert direct effects on math ability. So further researches should pay more attention to mediators between math anxiety and math performance.

Despite these limitations, this study addresses some key issues in the current literature on math anxiety. First of all, the present study revealed that the effect of math anxiety on computational estimation was more pronounced than that on mental arithmetic. This may be due to the fact that students received more formal training in mental arithmetic at school. Imbo and Vandierendonck (2008) found practice effects on strategy selection and strategy efficiency for simple mental arithmetic problems. Thus appropriate practice and educational intervention may promote the development of children's computational estimation strategy choice. Secondly, sixth-grade students with lower arithmetic skills are more strongly affected by math anxiety than adults with higher arithmetic skills. In other words, improving arithmetic skills can reduce math anxiety. This also suggests that education, learning, and practice play key roles in strategy development. Finally, this study found that the effect of math anxiety on arithmetic strategy utilization may change with age. It is consistent with findings in Lemaire's study (Lemaire, 2010a). Specifically, students in lower grade were less affected by math anxiety, but this impact gradually increased as students progressed through school. Subsequently, the impact of math anxiety would decrease slightly with the development of cognitive function and more skilled at arithmetic (Lemaire, 2010a). So we can suppose that the effect of math anxiety on the utilization of relevant strategies may follow an unstable inverted U-shaped trend over the course of individual development due to external factors (e.g., the math curriculum), internal factors (e.g., cognitive development) (Ramirez et al., 2016) and their interactions. But there is a need for systematic studies to investigate the trend due to the limitation of our samples.

Issues related to students' mathematics performance are widely discussed. Because mathematics is a compulsory subject in higher-level institutions, especially in courses of study in science and technology, failure in that subject may result in delayed graduation or dismissal from a university. Hence, future researches should focus on the development of students' strategies to improve their flexibility via practice.

ETHICAL STANDARDS

All procedures performed in studies involving human participants were in accordance with the ethical standards of the ethics committee on human experimentation of Shandong Normal University and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

AUTHOR CONTRIBUTIONS

JS and HL made substantial contributions to the conception, design of the work, the acquisition, analysis, interpretation of data for the work; and drafting the work, revising it critically for important intellectual content; and final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. YaS made substantial contributions to the conception or design of the work, or the acquisition, analysis, or interpretation of data for the work; and revising it critically for important intellectual content; and Final approval of the version to be published; and Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. YX and YuS made substantial contributions to the acquisition, analysis, or interpretation of data for the work; and revising it critically for important intellectual content; and final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ACKNOWLEDGMENTS

This study was funded by National Natural Science Foundation of China (grant number 31371048), Shandong Province Natural Science Foundation (grant number ZR2010CM059), and the Key Subject Funds of Shandong Province, P. R. China (2011–2015).

REFERENCES

Andrews, A., and Brown, J. L. (2014). "The effects of math anxiety on mathematical academic success during the freshman year," in *Poster Session Presented at the Eastern Educational Research Association Conference*, Jacksonville, FL.

Ashcraft, M. H., and Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: an exploratory investigation. *Cogn. Emot.* 8, 97–125. doi: 10.1080/02699939408408931

Ashcraft, M. H., and Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychon. Bull. Rev.* 14, 243–248. doi: 10.3758/BF03194059

Ashcraft, M. H., and Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *J. Psychoeduc. Assess.* 27, 197–205. doi: 10.1177/0734282908330580

Chen, Y., Liu, C., Zhang, X., Xu, X., and Shen, W. (2011). An ERP study of mix strategy selection in mental arithmetic. *Acta Psychol. Sin.* 43, 384–395. doi: 10.3724/SP.J.1041.2011.00384

Cui, J. F., Li, N. X., and Chen, Y. H. (2011). The mechanism of the effect of mathematics anxiety on children's math performance. *Psychol. Dev. Educ.* 27, 118–125.

Dehaene, S., Spelke, E., Pinel, P., Stanescu, R., and Tsivkin, S. (1999). Sources of mathematical thinking: behavioral and brain-imaging evidence. *Science* 284, 970–976. doi: 10.1126/science.284.5416.970

Derakshan, N., and Eysenck, M. W. (2009). Anxiety, processing efficiency, and cognitive performance: new developments from attentional control theory. *Eur. Psychol.* 14, 168–176. doi: 10.1027/1016-9040.14.2.168

Dowker, A. (1997). Young children's addition estimates. *Math. Cogn.* 3, 140–153. doi: 10.1080/135467997387452

Eysenck, M. W., and Derakshan, N. (2011). New perspectives in attentional control theory. *Pers. Individ. Dif.* 50, 955–960. doi: 10.1016/j.paid.2010.08.019

Eysenck, M. W., Derakshan, N., Santos, R., and Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion* 7, 336–353. doi: 10.1037/1528-3542.7.2.336

French, J. W., Ekstrom, R. B., and Price, L. A. (1963). *Manual for Kit of Reference Tests for Cognitive Factors*. Princeton, NJ: Educational Testing Service.

Geary, D. C. (1996). The problem-size effect in mental addition: developmental and cross-national trends. *Math. Cogn.* 2, 63–93. doi: 10.1080/1354679963 87543

Geng, L. N., and Chen, Y. H. (2005). The relationship between children's mathematics anxiety and add-and-subtract cognitive strategy selection and implement. *Psychol. Dev Educ.* 21, 24–27.

Hodzik, S., and Lemaire, P. (2011). Inhibition and shifting capacities mediate adults' age-related differences in strategy selection and repertoire. *Acta Psychol.* 137, 335–344. doi: 10.1016/j.actpsy.2011.04.002

Hopko, D. R., Ashvraft, M. H., Gute, J., Ruggiero, K. J., and Lewis, C. (1998). Mathematics anxiety and working memory: support for the existence of a deficient inhibition mechanism. *J. Anxiety Disord.* 12, 343–355. doi: 10.1016/S0887-6185(98)00019-X

Hopko, D. R., McNeil, D. W., Lejuez, C. W., Ashcraft, M. H., Eifert, G. H., and Riel, J. (2003). The effects of anxious responding on mental arithmetic and lexical decision task performance. *J. Anxiety Disord.* 17, 647–665. doi: 10.1016/S0887-6185(02)00240-2

Imbo, I., and LeFevre, J. A. (2009). Cultural differences in complex addition: efficient Chinese versus adaptive Belgians and Canadians. *J. Exp. Psychol. Learn. Mem. Cogn.* 35, 1465–1476.

Imbo, I., and LeFevre, J. A. (2011). Cultural differences in strategic behavior: a study in computational estimation. *J. Exp. Psychol. Learn. Mem. Cogn.* 37, 1294–1301.

Imbo, I., and Vandierendonck, A. (2007). The development of strategy use in elementary school children: working memory and individual differences. *J. Exp. Child Psychol.* 96, 284–309. doi: 10.1016/j.jecp.2006.09.001

Imbo, I., and Vandierendonck, A. (2008). Practice effects on strategy selection and strategy efficiency in simple mental arithmetic. *Psychol. Res.* 72, 528–541. doi: 10.1007/s00426-007-0128-0

Jones, W. J., Childers, T. L., and Jiang, Y. (2012). The shopping brain: math anxiety modulates brain responses to buying decisions. *Biol. Psychol.* 89, 201–213. doi: 10.1016/j.biopsycho.2011.10.011

Krinzinger, H., Kaufmann, L., and Willmes, K. (2009). Math anxiety and math ability in early primary school years. *J. Psychoeduc. Assess.* 27, 206–225. doi: 10.1177/0734282908330583

Lemaire, P. (2010a). Cognitive strategy variations during aging. *Curr. Dir. Psychol. Sci.* 19, 363–369. doi: 10.1177/0963721410390354

Lemaire, P. (2010b). Executive functions and strategic aspects of arithetic performance: the case of adults' and children's arithmetic. *Psychol. Belg.* 50, 335–352. doi: 10.5334/pb-50-3-4-335

Lemaire, P., Lecacheur, M., and Farioli, F. (2000). Children's strategy use in computational estimation. *Can. J. Exp. Psychol.* 54, 141–148. doi: 10.1037/h0087336

Lemaire, P., and Reder, L. (1999). What effects strategy selection in arithmetic? An example of parity and five effects on product verification. *Mem. Cognit.* 27, 364–382. doi: 10.3758/BF03211420

Lemer, C., Dehaene, S., Spelke, E., and Cohen, L. (2003). Approximate quantities and exact number words: dissociable systems. *Neuropsychologia* 41, 1942–1958. doi: 10.1016/S0028-3932(03)00123-4

Liu, C., and Wang, C. (2008). Mental calculation: studies from cognitive neuroscience. *Adv. Psychol. Sci.* 116, 446–452.

Northern, J. J. (2010). *Anxiety and Cognitive Performance: A Test of Predictions made by Cognitive Interference Theory and Attentional Control Theory*. Ph.D. Dissertation, Bowling Green State University, Bowling Green, OH.

Núñez-Peña, M. I., Cortiñas, M., and Escera, C. (2006). Problem size effect and processing strategies in mental arithmetic. *Neuroreport* 17, 357–360. doi: 10.1097/01.wnr.0000203622.24953.c2

Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., and Beilock, S. L. (2016). On the relationship between math anxiety and math achievement in early elementary school: the role of problem solving strategies. *J. Exp. Child Psychol.* 141, 83–100. doi: 10.1016/j.jecp.2015.07.014

Ramirez, G., Gunderson, E. A., Levine, S. C., and Beilock, S. L. (2013). Math anxiety, working memory and math achievement in early elementary school. *J. Cogn. Dev.* 14, 187–202. doi: 10.1080/15248372.2012.664593

Seaman, K. L., Howard, D. V., and Howard, J. H. J. (2014). Adult age differences in subjective and objective measures of strategy use on a sequentially cued prediction task. *Aging Neuropsychol. Cogn.* 22, 170–182. doi: 10.1080/13825585.2014.898736

Seyler, D. J., Kirk, E. P., and Ashcraft, M. H. (2003). Elementary subtraction. *J. Exp. Psychol. Learn. Mem. Cogn.* 29, 1339–1352.

Si, J., Yang, J., Jia, G., and Zhou, C. (2012). The effect of central executive load on adult's strategy using in computational estimation. *Acta Psychol. Sin.* 44, 1490–1500. doi: 10.3724/SP.J.1041.2012.01490

Si, J. W. (2002). *Computational Estimation Competence of Primary School Children*. Ph.D. Dissertation, Southwest University, Chongqing, China.

Si, J. W., Xu, Y., Feng, H., Xu, X., and Zhou, C. (2014). Differences of arithmetic strategy use in adults with different level mathematic anxiety: an ERP study. *Acta Psychol. Sin.* 46, 1835–1849.

Si, J. W., Xu, Y. L., and Liu, X. H. (2011). The impact of math anxiety and problem type on multiplication computational estimation. *J. Psychol. Sci.* 34, 407–413.

Siegler, R. S., and Lemaire, P. (1997). Older and young adults' strategy choices in multiplication: testing predictions of ASCM using the choice/no choice method. *J. Exp. Psychol. Gen.* 126, 71–92. doi: 10.1037/0096-3445.126.1.71

Siegler, R. S., and Lortie-Forgues, H. (2014). An integrative theory of numerical development. *Child Dev. Perspect.* 8, 144–150. doi: 10.1111/cdep.12077

Suri, R., Monroe, K. B., and Koc, U. (2013). Math anxiety and its effects on consumers' preference for price promotion formats. *J. Acad. Mark. Sci.* 41, 271–282. doi: 10.1007/s11747-012-0313-6

Verschaffel, L., Luwel, K., Torbeyns, J., and Van Dooren, W. (2009). Conceptualizing, investigating, and enhancing adaptive expertise in elementary mathematics education. *Eur. J. Psychol. Educ.* 24, 335–359. doi: 10.1007/BF03174765

Wahid, S. N. S., Yusof, Y., and Razak, M. R. (2014). Math anxiety among students in higher education level. *Procedia* 123, 232–237.

Wang, C. Y., and Liu, C. (2007). Mathematics anxiety and its effect on mental arithmetic. *Adv. Psychol. Sci.* 15, 795–801.

Wigfield, A., and Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *J. Educ. Psychol.* 80, 210–216. doi: 10.1037/0022-0663.80.2.210

Wu, C. (2010). *The Effects of Working Memory and Math Anxiety on Children's Mental Arithmetic Cognition Strategy*. Master's thesis, Henan University, China.

Xu, C., Wells, E., LeFevre, J. A., and Imbo, I. (2014). Strategic flexibility in computational estimation for Chinese- and Canadian-educated adults. *J. Exp. Psychol. Learn. Mem. Cogn.* 40, 1481–1497.

Young, C. B., Wu, S. S., and Menon, V. (2012). The neurodevelopmental basis of math anxiety. *Psychol. Sci.* 23, 492–501. doi: 10.1177/0956797611429134

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Si, Li, Sun, Xu and Sun. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 18 October 2016
doi: 10.3389/fpsyg.2016.01507

Bullying and Cyberbullying in Minorities: Are They More Vulnerable than the Majority Group?

Vicente J. Llorent[1]*, *Rosario Ortega-Ruiz*[2] and *Izabela Zych*[2]

[1] Department of Education, University of Córdoba, Córdoba, Spain, [2] Department of Psychology, University of Córdoba, Córdoba, Spain

Inclusion in education of all the children is necessary for the success, equality and peace among individuals and societies. In this context, special attention needs to be paid to the minorities. These groups might encounter additional difficulties which make them more vulnerable to be involved in bullying and cyberbullying. The current study was conducted with the objective of describing the involvement in bullying and cyberbullying of students from the majority group and also from sexual and ethnic-cultural minorities. The second objective was to explore if the implication is predicted by the interaction with gender, grade and the size of the population where the schools are located. It is an *ex post facto* transversal descriptive study with a survey on a representative sample of adolescents enrolled in the Compulsory Secondary Education in the south of Spain (Andalusia). The survey was answered by 2139 adolescents (50.9% girls) in 22 schools. These participants were selected through the random multistage cluster sampling with the confidence level of 95% and a sampling error of 2.1%. The results show that the minority groups, especially sexual minorities, are more involved in bullying and cyberbullying. Regression analyses show that being in the majority or a minority group predicts a small but significant percentage of variance of being involved in bullying and cyberbullying. Results are discussed taking into account the social vulnerability of being a part of a minority group and the need of designing educational programs which would prevent this vulnerability thorough the inclusion in education. There is a need for an educational policy that focuses on *convivencia* and *ciberconvivencia* which would promote the social and educational development of all the students.

Keywords: ethnic-cultural minorities, sexual minorities, bullying, cyberbullying, vulnerable groups, secondary education

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
David Álvarez-García, University of Oviedo, Spain
Alejandra Dobarro, University of Oviedo, Spain
Lidón Villanueva, University Jaume I, Spain

***Correspondence:**
Vicente J. Llorent
vjllorent@uco.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *14 July 2016*
Accepted: *20 September 2016*
Published: *18 October 2016*

Citation:
Llorent VJ, Ortega-Ruiz R and Zych I (2016) Bullying and Cyberbullying in Minorities: Are They More Vulnerable than the Majority Group? Front. Psychol. 7:1507. doi: 10.3389/fpsyg.2016.01507

INTRODUCTION

The economic growth and richness in the developed world are apparently increasing in the last years. At the same time, the gap between the rich and the poor seems to increase and many groups are becoming even more vulnerable to violence and social exclusion (UNESCO, 2015a). Thus, the World Education Forum (UNESCO, 2015b) highlights the importance of the inclusive education which would lead to academic success, equity and peace for individuals and societies. Many research studies and contributions in educational settings try to optimize the educational system and achieve school success for all the students including the most vulnerable groups (Ainscow, 2012). Researchers point out that minorities might have some difficulties in accessing and following

formal education and that these difficulties should be solved making it possible that all the students have equal opportunities to be included in the system (Booth and Ainscow, 2002). This led to the development of the inclusive education perspective (Ainscow et al., 2006) according to which schools should guarantee that no student is left behind because of marginalization, exclusion or failure.

Different minorities are present in the modern societies and therefore also in schools. Among them, new research lines focus on diverse ethnic-cultural groups and sexual minorities. For example, in some European countries, there are permanent ethnic-cultural minorities such as Gypsies and new minorities of first and second generations of immigrants (Llorent-Bedmar, 2013). This diversity is increased by the migrations of the refugees proceeding from the zones in ongoing armed conflicts (Sanahuja, 2014). Although sexual minorities have always been present in the school settings, the first studies on the topic were conducted at the end of the XX century (Kosciw et al., 2014). It has been pointed out that the inclusion of these groups is still insufficient and that there are still cases of discrimination in schools (Graybill and Proctor, 2016).

Besides acquiring academic knowledge, modern schools are places in which students are intended to be educated to gain skills for life. In this context, interpersonal relationships among the members of the school communities are a key factor for the education of future citizens of the world. A Spanish word *convivencia*[1] is a term that describes relationships that are positive and based on moral principles of solidarity and respect, where rules are established and followed and conflicts are solved through democratic dialogue (Ortega-Ruiz and Zych, 2016). Given the fact that interpersonal relationships among young people are also initiated and maintained through the new technologies, a new line of studies on *convivencia* in the cyberspace (*ciberconvivencia*) has been recently started (Ortega-Ruiz et al., 2014). There are many authors who suggest that positive school-climate and good interpersonal relationships are also possible in multicultural and diverse school settings (Byrd, 2015). Thus, successful education should include *convivencia* and *ciberconvivencia* among different minority and majority groups.

Convivencia and *ciberconvivencia* are not always present in the schools. In some cases, negative relationships among different members of the school community can evolve in aggressive behaviors and violence (Ortega-Ruiz, 2015). School bullying is an extremely damaging type of violence present in schools. It is a long-term intentional aggressive behavior perpetrated by some students on their peers who cannot defend themselves (Smith and Brain, 2000). It is perpetrated under a dominance-submission scheme and imbalance of power (Ortega, 2010). Cyberbullying has been defined as bullying perpetrated through the electronic devices (Tokunaga, 2010), it is also intentional, frequent and long term and the victim has difficulties in defending him or herself from this kind of violence (Smith et al., 2008). Both phenomena were found to be correlated and there is overlap between the two (Del Rey et al., 2012; Baldry et al., 2016).

Cross-cultural research shows that bullying and cyberbullying are present in different countries (Smith et al., 2002; Craig et al., 2009; Ortega et al., 2012; Baldry et al., 2015). Many studies were conducted to compare their prevalence among genders, age groups and some focused also on the school location such as rural or urban settings or population size. Given the fact that research on bullying is conducted in schools, age and grade are often used interchangeably. A systematic review of theoretical studies on bullying and cyberbullying (Zych et al., 2015a) shows that the results are inconclusive and that there is no specific profile of involvement in this kind of violence. Meta-analytic results including 153 empirical studies on bullying (Cook et al., 2010) showed that boys were more involved in all the bullying roles (perpetration, victimization and bully/victim), although with small gender difference. This study also found weak positive relationship of age with perpetration and no relationship with victimization. A meta-analysis conducted by Barlett and Coyne (2014) that included 109 studies on cyberbullying showed that perpetration was slightly more common in boys than in girls but this difference was very small. They also found that girls were more involved in younger age groups and boys were more involved in older age groups. In a meta-analysis on cyberbullying with 131 empirical studies, Kowalski et al. (2014) found that there was a weak positive correlation of perpetration with age and no relationship in case of victimization. A systematic narrative review conducted by Tokunaga (2010) shows that most of the studies did not find gender differences in cyber-victimization rates and concludes that its prevalence with age could be curvilinear. According to the narrative review conducted by Farrington and Baldry (2010), direct perpetration is more common in boys and indirect perpetration seems to be more common among girls. The relationship of perpetration with age is not clear whereas victimization rates seem to drop in older children.

Findings on prevalence in relation to school location in rural or urban areas and different population sizes are also contradictory. O'Moore et al. (1997) found that in primary schools, there was more bullying in urban locations and in secondary education, prevalence was higher in rural zones. Wolke et al. (2001) found that there was more bullying in rural English schools. In a broad sample of more than 15.000 US students, Nansel et al. (2001) found that there was no difference in victimization in urban, sub-urban, town or rural locations and that there were slightly more students (3–5%) who reported perpetration in rural locations. Smokowski et al. (2013) found that the prevalence of victimization in rural areas was higher than the US national rate. Other studies report no differences between rural and urban locations (Olweus, 1993; Seals and Young, 2003). In Turkey, Akbulut et al. (2010) revealed that there was no significant difference among big cities, small cities, towns and villages in cyber-victimization rates.

Some studies focused also on bullying and cyberbullying in minority and majority groups, although research on the latter is still very scarce (Zych et al., 2015b). There are several

[1]Convivencia, in Spanish (valid for the Kingdom of Spain and all the Spanish-speaking countries) is a term referring to the positive school climate including interpersonal relationships of the students and teachers with each other, their peers, family and community; based on the principles of equality and respect. Ciberconvivencia is based on the same educational principles but in the computer-mediated communication.

meta-analyses on the topic that, again, report contradictory findings. Vitoroulis and Vaillancourt (2015) conducted a meta-analysis with 105 empirical studies and found no overall difference between ethnic majority and minorities. Nevertheless, when analyzed by country, minorities were more victimized in the UK whereas the majority groups were found to suffer more victimization in the US. A narrative systematic review of seven studies on minorities and cyberbullying (Hamm et al., 2015) found that the results are inconclusive, with some studies finding more involvement in minorities, others in majorities and others no differences between the groups.

Different empirical studies also found contradictory results. In adolescents from Spain and England, Monks et al. (2008) reported no difference in personal victimization and more cultural verbal victimization in the minorities. A study with Asian American adolescents shows that they are less bullied than other groups although the victimization rate is also higher for racist victimization (Cooc and Gee, 2014). There are also other studied that found no difference in victimization between majorities and minorities in general victimization but more discriminatory racist victimization in minorities (Durkin et al., 2012). On the other hand, a study with children including first and second generation immigrants in Finland (Strohmeier et al., 2011) shows that these groups suffered more victimization than the majority. In Spanish adolescents, Rodríguez-Hidalgo et al. (2014) found that the majority group suffered less peer victimization than the ethnic—cultural minority groups and that victimization of the minorities was even greater in case of racist victimization (e.g., racist insults). Wolke et al. (2001) found that, in English and German primary school pupils, there was no difference between the majority and ethnic minorities in perpetration but minorities were more victimized. In Flemish adolescents, Agirdag et al. (2011) found that for the native students, ethnic concentration in school did not predict victimization whereas for non-native adolescents, higher concentration of minorities predicted less peer-victimization. Thus, some studies show that ethnic-cultural minorities are more vulnerable to be involved in bullying and others show that there is no difference with the majority.

Results regarding sexual minorities are also inconclusive. Fedewa and Ahn (2011) meta-analyzed 18 studies on victimization in sexual minorities and found that sexually charged victimization was higher in this group when compared to the majority. Similarly, a meta-analysis conducted by Toomey and Russell (2016), also with 18 empirical studies, revealed that sexual minorities are more victimized than the heterosexual classmates. In a study conducted by Espelage et al. (2008) students who had doubts about their sexual orientation were more victimized then their heterosexual or LGB (lesbians, gays and bisexuals) peers. LGB youth reported more homophobic teasing than the sexual majority but there was no difference between the two in general victimization. In another study, when divided in subgroups and compared to the sexual majority, homosexual students of any gender reported more victimization, bisexual females reported more victimization and also more perpetration and gay males reported lower levels of perpetration (Berlan et al., 2010).

As described above, bullying and cyberbullying are serious problems present in schools all over the world. There are no specific profiles of children involved in the phenomena and findings regarding gender, age/grade or school location have been contradictory. Findings regarding the involvement of different minority and majority groups have also been contradictory and the number of studies on the topic is still scarce. Details related to the involvement of the minorities regarding gender, grade or school location are still needed. Thus, the current study has been conducted with the objective of describing the implication in bullying and cyberbullying victimization and perpetration of ethnic-cultural and sexual majority and minority students in Spain. The second objective was to find out whether this implication was different depending on gender, grade and school location (interaction). It is hypothesized that the minorities are more vulnerable than the majority group to be involved in bullying and cyberbullying. This was done with a representative sample of secondary education students in Andalusia.

METHODS

Participants

The participants of this study were randomly selected from the population of 372,031 (2014/2015) secondary compulsory education students in Andalusia, Spain. Multi-stage stratified random sampling was used taking into account the proportion of student in each province (Almería, Cádiz, Córdoba, Granada, Huelva, Jaén, Málaga, and Sevilla), public and private schools and location in small (<10,000 inhabitants), medium (10,000–100,000 inhabitants) and big cities/towns (>100,000 inhabitants). Schools were considered as clusters and it was estimated that selecting one line from each grade (1–4) in each school would give at least 80 students in each school (20 per classroom).

With these considerations, 22 schools were randomly selected to be included in this study. The total number of students was of 2139 which accounts for 95% of reliability and a sampling error of 2.1%. Among these students, 1088 were girls (50.9%), 1026 were boys (48.0%), their mean age was of 13.79 years ($SD = 1.40$) ranging from 11 to 19 (grade 1 $M = 12.21$, $SD = 0.64$; grade 2 $M = 13.36$, $SD = 0.81$; grade 3 $M = 14.36$, $SD = 0.85$; grade 4 $M = 15.35$, $SD = 0.80$). Students were equally distributed among the grades: 542 in the first grade (25.3%), 555 in the second grade (25.9%), 529 in the third grade (24.7%) and 508 in the fourth grade (23.7%).

Participants were classified into minority and majority groups. Taking into account their ethnic-cultural group, there were 1636 (76.5%) of students with Spanish nationality who did not identify themselves as Gypsies, first or second generation immigrants. Students who identified themselves as first generation immigrants were 136 (6.4%) and 178 (8.3%) indicated that one or both of their parents were immigrants and were classified as second generation immigrants. Among the minorities, 101 (4.7%) identified themselves as Gypsies and there were also 88 (4.2%) students who did not identify their ethnic-cultural group. Students were also asked to indicate their sexual orientation with 2021 (94.5%) students who identified themselves as heterosexual, 26 (1.2%) as homosexual, 22 (1.0%) as bisexual, 2

(0.1%) transsexual, 35 with doubts. These groups were classified as heterosexual majority 2021 (94.5%) and sexual minorities (all the others) 85 (4.8%).Thirty three students (1.5%) did not report their sexual orientation. A double minority group (24 students) included participants who identified themselves in an ethnic-cultural minority and also sexual minority (e.g., immigrant and homosexual).

Design and Procedure

This is an *ex post facto* transversal descriptive study conducted with a survey answered by a randomly selected representative sample of Andalusian adolescents. To increase representativeness regarding the time point in the academic year (the beginning, the end, the first or the second semester), data were collected in the second semester of the 2014/2015 and the first semester of the 2015/2016 academic years. After selecting the 22 schools, researchers contacted the head teachers providing information about the study and asking for their collaboration. After obtaining the permissions, researchers went to each school and explained the objectives of the study together with the instructions on the completion of the survey. Then, they asked students to fill in the questionnaires in about 30 min during their regular classroom hours. Participation was voluntary and totally anonymous and students were allowed to refuse to participate or withdraw in any moment (only 15 participants decided to do this). Teachers had no access to the questionnaires which were directly collected by the senior researchers responsible for the project. Procedure was approved by the ethic committee of the University of Cordoba.

Instruments

First, students answered a series of questions on the sociodemographic variables such as gender, age, grade, ethnic-cultural group (an open question on the nationality of the student, country of origin of their mothers and fathers) and sexual orientation (checking a box next to heterosexual, homosexual, bisexual, transsexual or I have doubts). The meaning of each term was explained by the researchers before these questions were answered. Then, students were asked to fill in the following questionnaires:

- European Bullying Intervention Project Questionnaire (Brighi et al., 2012; Del Rey et al., 2012; Ortega-Ruiz et al., 2016) is a scale with 14 items divided into two factors: seven items for victimization and seven items for perpetration. These items are answered on a five point Likert scale ranging from 0 (never) to 4 (more than once a week) and in this study they referred to "the past few months." This questionnaire shows very good Cronbach alphas in its validation study (Del Rey et al., 2012; victimization 0.84 and perpetration 0.73) and for the current sample (victimization $\alpha = 0.90$, $\Omega = 0.90$ and perpetration $\alpha = 0.90$, $\Omega = 0.90$). Also in this study, Confirmatory Factor Analysis shows very good adjustment of the data to this two factor structure (SB $\chi^2 = 962.01$; $df = 76$; NFI = 0.95; NNFI 0.94; CFI = 0.95; RMSEA = 0.076, 90% CI = 0.072–0.081).
- European Cyberbullying Intervention Project Questionnaire (Brighi et al., 2012; Del Rey et al., 2015; Ortega-Ruiz et al., 2016) is a questionnaire with 22 items also divided into two factors—11 for cyber-victimization and 11 for cyber-perpetration. These items are answered on a five point Likert scale ranging from 0 (never) to 4 (more than once a week) and in this study they referred to "the past few months." This questionnaire shows excellent Cronbach alphas in its validation study (Ortega-Ruiz et al., 2016); victimization 0.80 and perpetration 0.88) and for the current sample (victimization $\alpha = 0.94$, $\Omega = 0.94$ and perpetration $\alpha = 0.96$, $\Omega = 0.96$). Also in the current study, Confirmatory Factor Analysis shows very good adjustment of the data to this two factor structure (SB $\chi^2 = 1426.06$; $df = 208$; NFI = 0.97; NNFI 0.97; CFI = 0.98; RMSEA = 0.054, 90% CI = 0.052–0.057).

Data Analysis

Reliability statistics (Cronbach's alphas and McDonald's omegas) for the questionnaires were calculated by means of the FACTOR software and Confirmatory Factor Analyses were performed with EQS 6.2 software to find out whether the factor structure is adequate for the data.

Students were classified to majority vs. minority groups. First, ethnic-cultural majority (Spanish nationality with no report of first or second generation immigrant or a Gypsy minority) was compared to the ethnic-cultural minority as a whole (first and second generation immigrants and Gypsy). Then, sexual majority (heterosexual) was compared to the sexual minority (LGBT and doubts). These groups were compared by means of the Student-*t*-test with SPSS 23 and effect sizes were calculated with Cohen's d on the Campbell Collaboration effect size calculator.

Later, specific groups such as majority (ethnic-cultural and sexual), sexual minority (LGBT and doubts), first generation immigrants, second generation immigrants, Gypsy and double minority (students who reported ethnic-cultural and sexual minority at the same time) were compared by means of ANOVA (Welch if variance was found to be heterogeneous). Pairwise Games-Howell comparisons were performed and effect sizes were calculated with Cohen's d. The latter is considered significant if the confidence intervals do not include 0. Although the *p* value is related to the effect size, it is affected by the number of participants in a group (Frías et al., 2000). Thus, in the current study, possible difference between the two (e.g., non-significant *p* and significant effect size) could be explained by the small or unequal number of participants in some groups. Specific subgroups (e.g., bisexual, homosexual, transsexual or immigrants from Latin America, Europe, Asia, etc.), were not compared because the number of participants in each group was considered too low to be statistically analyzed.

Hierarchical lineal regression analyses with main effects and interactions were performed. Interaction analyses were performed to find out whether minorities involvement in bullying or cyberbullying differ by gender, grade or location size (e.g., if minority boys are more or less victimized than minority girls or if minorities are more or less victimized in small or big cities). All these variables were dummy coded (0,1) where 0 was assigned as "no" and 1 as "yes" (e.g., majority − 0 = no, 1 = yes, boys − 0 = no, 1 = yes, etc.). To avoid the dummy variable trap, redundant variables such as girls, big location size and grade 1

were not included. Involvement in bullying and cyberbullying was treated as continuous variables and therefore, it refers to the total score on victimization and perpetration but without classifying participants as victims or bullies.

RESULTS

First all the ethnic-cultural minorities grouped in one ($n = 413$) were compared to the ethnic-cultural majority group ($n = 1630$) in their involvement in bullying and cyberbullying perpetration and victimization. The results show no difference in bullying victimization [minority $M = 4.74$; $SD = 5.75$ and majority $M = 4.19$; $SD = 5.08$; $t_{(586.09)} = 1.79$, $p = 0.07$] or cyber-victimization [minority $M = 3.37$; $SD = 5.24$ and majority $M = 2.84$; $SD = 4.67$; $t_{(572.34)} = 1.87$, $p = 0.06$]. Minorities were found to be more involved in bullying perpetration [minority $M = 2.83$; $SD = 4$ and majority $M = 2.26$; $SD = 3.54$; $t_{(585.12)} = 2.64$, $p < 0.01$; $d = 0.16$, 95% CI = 0.05–0.26] but there was no significant difference in cyber-perpetration [minority $M = 1.91$; $SD = 3.79$ and majority $M = 1.65$; $SD = 3.81$; $t_{(2014)} = 1.24$, $p = 0.22$].

Second, all sexual minorities grouped in one ($n = 83$) were compared to the sexual majority ($n = 2015$) in relation to bullying and cyberbullying perpetration and victimization. It was found that bullying victimization [minority $M = 6.90$; $SD = 6.46$ and majority $M = 4.23$; $SD = 5.23$; $t_{(86.48)} = 3.72$, $p < 0.01$; $d = 0.51$, 95% CI = 0.29–0.73] and cyber-victimization [minority $M = 5.29$; $SD = 7.53$ and majority $M = 2.91$; $SD = 4.80$; $t_{(84.81)} = 2.86$, $p < 0.01$; $d = 0.48$, 95% CI = 0.26–0.70] were both higher in sexual minorities. In bullying perpetration, there was no difference between sexual minorities and majority [minority $M = 3.12$; $SD = 4.78$ and majority $M = 2.37$; $SD = 3.67$; $t_{(86.02)} = 1.41$, $p = 0.16$] and sexual minorities scored higher in cyber-perpetration [minority $M = 3.30$; $SD = 6.55$ and majority $M = 1.65$; $SD = 3.76$; $t_{(84.27)} = 2.29$, $p < 0.05$; $d = 0.42$, 95% CI = 0.20–0.64].

After comparing the minorities grouped altogether in big groups, we conducted also analysis to find out which particular minorities differed in their implication in bullying and cyberbullying. Students were classified as majority when they were not from ethnically-cultural minority group (not first or second immigrants or Gypsies) and were not from the sexual minority group. Double minority students were those who were from one of the ethnic-cultural group and also sexual minority group. The results are presented in **Table 1**.

As shown in **Table 1**, there are no significant differences among the groups in bullying or cyberbullying perpetration. On the other hand, there are significant differences in both, bullying and cyberbullying victimization. Taking into account that the Levene test show unequal variances in both variables ($p < 0.01$), Games-Howell pairwise *post-hoc* comparisons were performed to find out which groups differed in victimization. Through Games-Howell comparisons, significant differences were found only between majority and sexual minority in bullying victimization ($M = 4.11$, $SD = 5.04$ vs. 6.51; $SD = 6.21$; $p = 0.05$).

Taking into account unequal and sometimes small number of participants in the groups, also Cohen's d with confidence intervals were calculated to find other possible differences among the groups. For bullying victimization, significant differences were found between majority and sexual minority ($d = 0.47$; 95% CI = 0.21–0.73), majority and double minority ($d = 0.74$; 95% CI = 0.34–1.15). For bullying perpetration, differences were found between majority and Gypsies ($d = 0.32$; 95% CI = 0.11–0.53) and also majority and double minority ($d = 0.53$; 95% CI = 0.12–0.93). For cyberbullying victimization, significant differences were found between majority and Gypsies ($d = 0.27$; 95% CI = 0.06–0.47), majority and sexual minorities ($d = 0.48$; 95% CI = 0.22–0.74) and majority with double minority ($d = 0.67$; 95% CI = 0.26–1.07). For cyberbullying perpetration, significant differences were found between the majority and sexual minorities ($d = 0.40$; 95% CI = 0.14–0.66) and the majority with double minority ($d = 0.58$; 95% CI = 0.17–0.98).

To find out if minority or majority groups and their interaction with gender, setting (small, medium or big towns/cities) and grade predicted involvement in bullying and cyberbullying victimization and perpetration, hierarchical linear regression analyses were performed. Variables were dummy coded (0, 1) and then, location size, grade and gender were entered in Block 1, minority groups in Block 2 and interactions in Block 3 (see **Table 2**).

The regression analysis shows that the amount of variance in bullying and cyberbullying perpetration and victimization predicted by the location size, grade and gender is low (1%, 5%, 1% and 2%, respectively) but significant. Lower level of bullying and cyberbullying victimization and perpetration is predicted by middle size location ($\beta = -0.06$, $p < 0.01$, $\beta = -0.06$, $p < 0.05$, $\beta = -0.10$, $p < 0.01$ and $\beta = -0.06$, $p < 0.01$; respectively). Being in grade 4 predicts lower bullying victimization ($\beta = -0.08$, $p < 0.01$) but higher bullying perpetration ($\beta = 0.08$, $p < 0.01$) and higher cyberbullying perpetration ($\beta = 0.10$, $p < 0.01$). Being a boy predicts higher level of perpetration in bullying ($\beta = 0.19$, $p < 0.01$) and cyberbullying ($\beta = 0.09$, $p < 0.01$).

Being in a minority group predicts bullying and cyberbullying victimization and perpetration above and beyond the demographic variables included in the Block 1. Nevertheless, the increase in the amount of variance, although significant, is low (1% in each dependent variable). Being in the Gypsy group predicts higher level of bullying perpetration ($\beta = 0.05$, $p < 0.05$) and cyberbullying victimization ($\beta = 0.05$, $p < 0.05$). Being in a sexual minority predicts higher level of bullying victimization ($\beta = 0.08$, $p < 0.01$), cyberbullying victimization ($\beta = 0.07$, $p < 0.01$), and cyberbullying perpetration ($\beta = 0.07$, $p < 0.01$). Being in a double minority (ethnic-cultural and sexual at the same time) predicts higher level of bullying and cyberbullying victimization and perpetration ($\beta = 0.08$, $p < 0.01$, $\beta = 0.05$, $p < 0.05$, $\beta = 0.07$, $p < 0.01$ and $\beta = 0.06$, $p < 0.01$; respectively).

Adding interactions in the Block 3 predicts bullying and cyberbullying perpetration (but not victimization) above and beyond the demographic variables and being in a minority group. Again, the increase in the amount of variance is significant but low (3% in both cases). Being a second generation immigrant and boy predicts lower level of bullying perpetration ($\beta = -0.12$,

TABLE 1 | Implication in bullying and cyberbullying roles of the majority group, first and second generation immigrants, Gypsies and sexual minorities.

	Majority $n = 1555$ M (SD)	1st generation immigrants $n = 126$ M (SD)	2nd generation immigrants $n = 167$ M (SD)	Gypsies $n = 96$ M (SD)	Sexual minority $n = 59$ M (SD)	Double minority $n = 24$ M (SD)	Total $n = 2027$ M (SD)	$F_{(5, 143)}$
Bullying victimization	4.11 (5.04)	4.93 (6.29)	4.55 (5.50)	4.04 (4.77)	6.51 (6.21)	7.88 (7.09)	4.31 (5.25)	3.43**
Bullying perpetration	2.25 (3.52)	2.37 (3.52)	2.65 (3.64)	3.40 (4.44)	2.71 (4.07)	4.13 (6.19)	2.38 (3.64)	2.02
Cyberbullying victimization	2.78 (4.59)	3.05 (4.49)	2.87 (4.91)	4.03 (5.96)	5.05 (7.73)	5.88 (7.15)	2.96 (4.87)	2.62*
Cyberbullying perpetration	1.60 (3.68)	2.02 (3.99)	1.55 (2.96)	1.94 (3.91)	3.12 (6.74)	3.75 (6.17)	1.71 (3.83)	2.48

*$p < 0.05$, **$p < 0.01$.

$p < 0.01$). Being a boy in a double minority predicts higher level of perpetration in bullying ($\beta = 0.09$, $p < 0.05$) and cyberbullying ($\beta = 0.15$, $p < 0.01$). Being in the majority group or second generation immigrant in a middle size location predicts lower levels of cyberbullying victimization ($\beta = -0.30$, $p < 0.01$, $\beta = -0.09$, $p < 0.01$; respectively) and perpetration ($\beta = -0.24$, $p < 0.05$, $\beta = -0.09$, $p < 0.01$; respectively). Being a first generation immigrant in middle size location predicts lower levels of bullying perpetration ($\beta = -0.09$, $p < 0.05$) and cyberbullying victimization ($\beta = -0.12$, $p < 0.01$) and perpetration ($\beta = -0.11$, $p < 0.01$). Being in the Gypsy group in a small location predicts lower level of bullying victimization ($\beta = -0.08$, $p < 0.01$). Being in a double minority in a small location predicts lower bullying victimization ($\beta = -0.07$, $p < 0.05$) and perpetration ($\beta = -0.07$, $p < 0.05$). Sexual minority in grade 2 and 4 predicts more cyberbullying perpetration ($\beta = 0.09$, $p < 0.05$, $\beta = 0.10$, $p < 0.05$; respectively), in grade 3 predicts more cyberbullying victimization ($\beta = 0.09$, $p < 0.05$). Double minority in grade 2 and 3 predicts higher levels of bullying victimization ($\beta = 0.12$, $p < 0.01$, $\beta = 0.08$, $p < 0.05$; respectively) and perpetration ($\beta = 0.13$, $p < 0.01$, $\beta = 0.09$, $p < 0.01$; respectively) and cyberbullying victimization ($\beta = 0.08$, $p < 0.01$, $\beta = 0.08$, $p < 0.01$; respectively). Grade 4 and double minority predicts higher bullying victimization ($\beta = 0.08$, $p < 0.05$) and perpetration ($\beta = 0.14$, $p < 0.01$) and cyberbullying perpetration ($\beta = 0.11$, $p < 0.01$).

DISCUSSION

Bullying and cyberbullying are extremely damaging types of interpersonal violence present in schools throughout different countries and regions (Zych et al., 2015a). Implication in these phenomena leads to very serious consequences such as violence (Ttofi et al., 2012), offending (Ttofi et al., 2011a) or drug use (Ttofi et al., 2016) later in life (Ttofi et al., 2011b). Given the fact that these problems are still present and prevalent (Zych et al., 2016), it is important to advance knowledge on the topic to eradicate bullying and cyberbullying.

Cultural, ethnic or sexual diversity is present in schools (Llorent-Bedmar, 2013) and the societies are concerned with inclusive education and not leaving any child behind due to the inadequate response to their needs (Ainscow et al., 2006). Thus, it is crucial to conduct research specifically focused on these possibly vulnerable minority groups. Studies on bullying and cyberbullying in this context are still very scarce (see the review conducted by Zych et al., 2015b). Thus, the objectives of this study were to describe the involvement in bullying and cyberbullying victimization and perpetration of students from the minority and majority groups and find out whether the involvement can be predicted by the group in relation to gender, grade and school location. This study was done with a representative sample of adolescents from southern Spain (Andalusia).

When all the ethnic-cultural minorities were treated as one group, it was found that there was no difference in bullying and cyberbullying victimization in comparison to the majority group. These findings are similar to those reported in other studies (Monks et al., 2008; Durkin et al., 2012; Vitoroulis and Vaillancourt, 2015). There was also no difference in cyberbullying perpetration but the minority was found to be more involved in bullying perpetration. For sexual minorities, results show the opposite pattern. In comparison to the majority, they were found to be more victimized (bullying and cyberbullying) and there was no difference in bullying perpetration. On the other hand, sexual minorities were found to be more involved in cyberbullying perpetration. Very few studies were conducted on this topic but previous research found that sexually charged victimization was more frequent in this group (Fedewa and Ahn, 2011), findings that are in line with the current results.

When groups were separated in different minorities, sexual minority was found to be the most vulnerable to be victimized through bullying. When differences were calculated through Cohen's d, it was found that sexual and double minorities were more victimized through bullying and cyberbullying than the majority. In case of cyberbullying, Gypsies were also found to be more victimized. Double minority and Gypsies were also found to be more involved in bullying perpetration and both, sexual and double minorities were more involved in cyberbullying perpetration. Thus, the current study shows that some minorities (especially sexual minorities) are indeed more vulnerable to be involved in bullying and cyberbullying. These results are similar to some previously reported findings (Wolke et al., 2001; Strohmeier et al., 2011; Rodríguez-Hidalgo et al., 2014).

Prediction analyses show that being in the majority or minority group predicts a small (but significant) amount of variance of the involved in bullying or cyberbullying victimization and perpetration. Being in the Gypsy group predicts more bullying perpetration and cyberbullying

TABLE 2 | Hierarchical lineal regression analysis predicting bullying and cyberbullying victimization and perpetration taking into account majority and minority groups, gender, location size and grade.

	Bullying				Cyberbullying			
	Victimization		Perpetration		Victimization		Perpetration	
	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
MODEL 1	0.01**		0.05**		0.01**		0.02**	
Middle size		−0.06**		−0.06*		−0.10**		−0.06**
Small size		0.02		−0.04		−0.01		−0.02
Grade 2		0.00		0.03		0.03		0.03
Grade 3		−0.05		0.03		0.02		0.05
Grade 4		−0.08**		0.08**		0.04		0.10**
Boys		0.01		0.19**		0.02		0.09**
MODEL 2	0.01**		0.01*		0.01**		0.01**	
Immi1st		0.04		−0.01		0.01		0.02
Immi2nd		0.02		0.02		0.01		−0.01
Gypsy		−0.01		0.05*		0.05*		0.02
Sexual minority		0.08**		0.02		0.07**		0.07**
Double minority		0.08**		0.05*		0.07**		0.06**
MODEL 3	0.02		0.03**		0.02		0.03**	
Middle size		0.03		0.11		0.21*		0.18
Small size		0.20		−0.07		0.04		0.03
Grade 2		0.06		−0.13		−0.07		−0.05
Grade 3		−0.02		−0.06		−0.01		0.11
Grade 4		−0.04		−0.06		0.06		−0.03
Boys		0.03		0.33**		−0.05		−0.01
Immi1st		0.14*		−0.00		−0.01		0.00
Immi2nd		0.04		0.07		0.05		0.04
Gypsy		−0.01		−0.01		0.08		0.00
Sexual minority		0.13*		−0.00		−0.10		−0.16**
Double minority		−0.08		−0.21**		−0.08		−0.15**
Majority*boys		−0.02		−0.13		0.08		0.10
Immi1st*boys		0.01		−0.06		0.01		0.04
Immi2nd*boys		−0.01		−0.12**		−0.02		−0.03
Gypsy*boys		0.01		−0.02		−0.00		0.04
Sexual min*boys		−0.03		−0.05		0.04		0.07
Double*boys		0.02		0.09*		0.07		0.15**
Majority*middle		−0.09		−0.18		−0.30**		−0.24*
Majority*small		−0.16		0.03		−0.04		−0.05
Immi1st*middle		−0.07		−0.09*		−0.12**		−0.11**
Immi1st*small		−0.03		0.03		−0.01		−0.02
Immi2nd*middle		−0.01		−0.04		−0.09*		−0.09*
Immi2nd*small		−0.04		0.03		−0.03		−0.00
Gypsy*middle		0.02		0.01		−0.06		−0.04
Gypsy*small		−0.08*		−0.01		−0.01		−0.02
Sex min*middle		−0.05		0.01		−0.00		−0.06
Sex min*small		−0.02		0.04		0.02		0.03
Double*middle		0.01		0.07		−0.01		0.03
Double*small		−0.07*		−0.07*		−0.05		−0.06
Majority*Grade2		−0.05		0.16		0.10		0.07
Majority*Grade3		−0.02		0.09		0.02		−0.07
Majority*Grade4		−0.03		0.12		−0.04		0.09
Immi1st*Grade2		−0.08		0.05		0.04		0.03
Immi1st*Grade3		−0.03		0.04		0.06		−0.01
Immi1st*Grade4		−0.08		0.07		0.03		0.08
Immi2nd*Grade2		−0.01		0.07		0.02		0.04
Immi2nd*Grade3		−0.03		−0.01		0.00		−0.02
Immi2nd*Grade4		−0.05		0.01		−0.04		0.03
Gypsy*Grade2		−0.02		0.05		0.01		0.01
Gypsy*Grade3		−0.02		0.04		−0.03		−0.04
Gypsy*Grade4		−0.05		0.05		0.01		0.07
Sex min*Grade2		−0.04		0.00		0.07		0.09*
Sex min*Grade3		−0.01		0.03		0.09*		0.06
Sex min*Grade4		−0.02		0.03		0.09		0.10*
Double*Grade2		0.12*		0.13**		0.08*		0.07
Double*Grade3		0.08*		0.09**		0.08*		0.05
Double*Grade4		0.08*		0.14**		0.06		0.11**
TOTAL	0.05**		0.08**		0.04**		0.06**	

*$p < 0.05$, **$p < 0.01$; adjusted R^2 for bullying victimization = 0.02; bullying perpetration = 0.06; cyberbullying victimization = 0.02, and cyberbullying perpetration = 0.04. Small size, locations with less than 10,000 inhabitants; Middle size, locations with 10,000–100,000 inhabitants; Immi1st, first generation immigrants; Immi 2nd, second generation immigrants; Sexual min, sexual minorities; Double, sexual and ethnic-cultural minority.*

victimization; sexual minority predicts more bullying and cyberbullying victimization and cyberbullying perpetration and double minority predicts more bullying and cyberbullying victimization and perpetration. Being a boy in the double minority predicts more perpetration, findings in line with other research that points out that the frequency of perpetration is higher in boys (Cook et al., 2010; Barlett and Coyne, 2014). Location in the middle size towns predicts less implication in cyberbullying of the majority group and first and second generation immigrants. It also predicts less bullying perpetration in first generation immigrants. Location in small towns predicts less bullying victimization in Gypsies and less bullying victimization and perpetration in double minorities. Results show also interaction with being enrolled in different grades (1–4). In grades 2 and 4, sexual minorities are involved in more cyberbullying perpetration, and in grade 3 in more cyber-victimization. Double minorities more involved in bullying victimization and perpetration in grades 2, 3, and 4 whereas in cyberbullying, they are more involved in victimization in grades 2 and 3 and in perpetration in grade 4.

All the patterns and interactions found in this study should be taken into account when identifying the most vulnerable minority groups. At the same time, they should be interpreted with caution given the small amount of explained variance. Other limitations are related to the fact that the socio-economic status of the families, parental styles, social and emotional competencies or access to the information and communication technologies were not controlled for. These variables were found to be important in different studies on bullying and cyberbullying (Gómez-Ortiz et al., 2014, 2016; Herrera López et al., 2016; Romera et al., 2016). Specific minority sub-groups could not be compared (e.g., immigrants from different countries or different sexual minorities) due to the low number of

participants in each group. All these questions could be answered in future studies. Future research should also focus on whole-school policy, inclusive education and school management strategies that could eradicate bullying in all the ethnic-cultural groups. It could be interesting to discover, for example, which strategies and policies are the most effective in culturally diverse settings.

The findings of this study show that minorities are more vulnerable than the majority to be involved in bullying and cyberbullying. These findings should have implications for educational policy and practice. It is important to promote inclusion, *convivencia* and *cyberconvivencia* among all the minority and majority groups so that no child is left behind. Previous studies found that increase in ethnic concentration did not affect the majority but was related to less victimization in the minorities (Agirdag et al., 2011). Thus, it is possible that more diverse and inclusive school settings, in which all the groups are respected and cared for, in which educators and policy makers are able to respond to the needs of each and every student would make it possible to eradicate bullying and cyberbullying.

AUTHOR CONTRIBUTIONS

All authors made substantial contribution to the theoretical framework, design, data collection or interpretation of this study. All contributed to this article and approved its publication.

ACKNOWLEDGMENTS

The current work was supported by a research grant for the project "Addiction to the new technologies: The role of cyber emotional competencies and emotional intelligence" BIL/14/S2/163 granted to the third author by the Fundación MAPFRE and by the project "E-Intelligence: risks and opportunities of the emotional competencies expressed online" (PSI2015-64114-R) granted to the third author and the research team by the Spanish Ministry of Economy and Competitiveness within the I+D+I 2015 National Program for Research Aimed at the Challenges of the Society (RETOS). The authors would like to express their special gratitude to the Editor and also to the Reviewers. Their comments and support helped us to improve the consecutive versions of this manuscript.

REFERENCES

Agirdag, O., Demanet, J., Van Houtte, M., and Van Avermaet, P. (2011). Ethnic school composition and peer victimization: a focus on the interethnic school climate. *Int. J. Intercult. Relat.* 35, 465–473. doi: 10.1016/j.ijintrel.2010.09.009

Ainscow, M. (2012). Haciendo que las escuelas sean más inclusivas: lecciones a partir del análisis de la investigación internacional. *Rev. Educ. Inclusiva* 5, 39–49. Available online at: http://www.ujaen.es/revista/rei/linked/documentos/documentos/15-4.pdf

Ainscow, M., Booth, T., and Dyson, A. (2006). *Improving Schools, Developing Inclusion*. Nueva York, NY: Taylor & Francis.

Akbulut, Y., Sahin, Y. L., and Eristi, B. (2010). Cyberbullying victimization among turkish online social utility members. *Educ. Technol. Soc.* 13, 192–201. Available online at: http://www.ifets.info/journals/13_4/17.pdf

Baldry, A. C., Farrington, D. P., and Sorrentino, A. (2015). Am I at risk of cyberbullying? A narrative review and conceptual framework for research on risk of cyberbullying and cybervictimization: the risk and needs assessment approach. *Aggress. Violent Behavior.* 23, 36–51. doi: 10.1016/j.avb.2015.05.014

Baldry, A. C., Farrington, D. P., and Sorrentino, A. (2016). Bullying and cyberbullying among youngsters. A pattern of disruptive behavior. *Psicol. Educativa* 22, 19–26. doi: 10.1016/j.pse.2016.02.001

Barlett, C., and Coyne, S. M. (2014). A meta-analysis of sex differences in cyber-bullying behavior: the moderating role of age. *Aggress. Behav.* 40, 474–488. doi: 10.1002/ab.21555

Berlan, E. D., Corliss, H. L., Field, A. E., Goodman, E., and Austin, S. B. (2010). Sexual orientation and bullying among adolescents in the growing up today study. *J. Adoles. Health* 46, 366–371. doi: 10.1016/j.jadohealth.2009.10.015

Booth, T., and Ainscow, M. (2002). *Index for Inclusion*. Bristol: Centre for Studies on Inclusive Education.

Brighi, A., Ortega, R., Pyzalski, J., Scheithauer, H., Smith, P. K., Tsormpatzoudis, C., et al. (2012). *European Bullying Intervention Project Questionnaire (EBIPQ) (Unpublished manuscript)*. Bologna: University of Bologna.

Byrd, C. M. (2015). The associations of intergroup interactions and school racial socialization with academic motivation. *J. Educ. Res.* 108, 10–21. doi: 10.1080/00220671.2013.831803

Cooc, N., and Gee, K. A. (2014). National trends in school victimization among Asian American adolescents. *J. Adolesc.* 37, 839–849. doi: 10.1016/j.adolescence.2014.05.002

Cook, C. R., Williams, K. R., Guerra, N. G., Kim, T. E., and Sadek, S. (2010). Predictors of bullying and victimization in childhood and adolescence: a meta-analytic investigation. *School Psychol. Q.* 25, 65–83. doi: 10.1037/a0020149

Craig, W., Harel-Fisch, Y., Fogel-Grinvald, H., Dostaler, S., Hetland, J., Simons-Morton, B., et al. (2009). A cross-national profile of bullying and victimization among adolescents in 40 countries. *Int. J. Public Health* 54, 216–224. doi: 10.1007/s00038-009-5413-9

Del Rey, R., Casas, J. A., Ortega-Ruiz, R., Schultze-Krumbholz, A., Scheithauer, H., Smith, P., et al. (2015). Structural validation and cross-cultural robustness of the European Cyberbullying Intervention Project Questionnaire. *Comput. Human Behav.* 50, 141–147. doi: 10.1016/j.chb.2015.03.065

Del Rey, R., Elipe, P., and Ortega-Ruiz, R. (2012). Bullying and cyberbullying: overlapping and predictive value of the co-occurrence. *Psicothema* 24, 608–613. Available online at: http://www.psicothema.com/pdf/4061.pdf

Durkin, K., Hunter, S., Levin, K. A., Bergin, D., Heim, D., and Howe, C. (2012). Discriminatory peer aggression among children as a function of minority status and group proportion in school context. *Eur. J. Soc. Psychol.* 42, 243–251. doi: 10.1002/ejsp.870

Espelage, D. L., Aragon, S. R., Birkett, M., and Koenig, B. W. (2008). Homophobic teasing, psychological outcomes, and sexual orientation among high school students: what influence do parents and schools have? *School Psych. Rev.* 37, 202–216. Available online at: http://apps.nasponline.org/resources-and-publications/download.aspx?file=spr/spr372espelage.pdf

Farrington, D., and Baldry, A. (2010). Individual risk factors for school bullying. *J. Aggress. Confl. Peace Res.* 2, 4–16. doi: 10.5042/jacpr.2010.0001

Fedewa, A. L., and Ahn, S. (2011). The effects of bullying and peer victimization on sexual minority and heterosexual youths: a quantitative meta-analysis of the literature. *J. GLBT Fam. Stud.* 7, 398–418. doi: 10.1080/1550428X.2011.592968

Frías, M. D., Pascual, J., and García, J. F. (2000). Tamaño del efecto y significación estadística. *Psicothema* 12, 236–240.

Gómez-Ortiz, O., Del Rey, R., Casas, J. A., and Ortega-Ruiz, R. (2014). Parenting styles and bullying involvement. *Cult. Educ.* 26, 132–158. doi: 10.1080/11356405.2014.908665

Gómez-Ortiz, O., Romera, E. M., and Ortega-Ruiz, R. (2016). Parenting styles and bullying. The mediating role of parental psychological aggression and physical punishment. *Child Abuse Negl.* 51, 132–143. doi: 10.1016/j.chiabu.2015.10.025

Graybill, E. C., and Proctor, S. L. (2016). Lesbian, gay, bisexual, and transgender youth: limited representation in school support personnel journals. *J. Sch. Psychol.* 54, 9–16. doi: 10.1016/j.jsp.2015.11.001

Hamm, M. P., Newton, A. S., Chisholm, A., Shulhan, J., Milne, A., Sundar, P., et al. (2015). Prevalence and effect of cyberbullying on children and young people a scoping reviewof social media studies. *JAMA Pediatr.* 169, 770–777. doi: 10.1001/jamapediatrics.2015.0944

Herrera López, M., Romera Félix, E. M., Ortega Ruiz, R., and Gómez Ortiz, O. (2016). Influence of social motivation, self-perception of social efficacy and normative adjustment in the peer setting. *Psicothema* 28, 32–39. doi: 10.7334/psicothema2015.135

Kosciw, J. G., Greytak, E. A., Palmer, N. A., and Boesen, M. J. (2014). *The 2013 National School Climate Survey: The Experiences of Lesbian, Gay, Bisexual and Transgender Youth in our Nation's Schools*. New York, NY: GLSEN.

Kowalski, R. M., Giumetti, G. W., Schroeder, A. N., and Lattaner, M. R. (2014). Bullying in the digital age: a critical review and meta-analysis of cyberbullying research among youth. *Psychol. Bull.* 140, 1073–1137. doi: 10.1037/a0035618

Llorent-Bedmar, V. (2013). Inmigración y educación para la diversidad en la Unión Europea. *En-clave Pedagógica Rev. Int. Invest. Innov. Educ.* 13, 31–44. Available online at: http://rabida.uhu.es/dspace/bitstream/handle/10272/8170/Inmigracion_y_educacion.pdf?sequence=2

Monks, C. P., Ortega-Ruiz, R., and Rodríguez-Hidalgo, A. J. (2008). Peer victimization in multicultural schools in Spain and England. *Eur. J. Dev. Psychol.* 5, 507–535. doi: 10.1080/17405620701307316

Nansel, T., Overpeck, M., Pilla, R. S., Ruan,W. J., Simmons-Morton, B., and Schmidt, P. (2001). Bullying behaviors among US youth. *J. Am. Med. Assoc.* 285, 2094–2100. doi: 10.1001/jama.285.16.2094

O'Moore, A. M., Kirkham, C., and Smith, M. (1997). Bullying behaviour in Irish schools: a nationwide study. *Irish J. Psychol.* 18, 141–169.

Olweus, D. (1993). *Bullying At School: What We Know and What We Can Do*. New York, NY: Blackwell.

Ortega, R. (2010). *Agresividad Injustificada, Bullying y Violencia Escolar*. Madrid: Alianza Editorial.

Ortega, R., Elipe, P., Mora−Merchán, J. A., Genta, M. L., Brighi, A., Guarini, A., et al. (2012). The emotional impact of bullying and cyberbullying on victims: a European cross−national study. *Aggress. Behav.* 38, 342–356. doi: 10.1002/ab.21440

Ortega-Ruiz, R. (2015). *Convivencia y Ciberconvivencia. Un Modelo Educativo para la Prevención del Acoso y el Ciberacoso Escolar*. Madrid: Machado Libros.

Ortega-Ruiz, R., Casas, J. A., and Del Rey, R. (2014). Towards the construct of cyberconvivencia/Hacia el constructo ciberconvivencia. *Infancia y Aprendizaje* 37, 602–628. doi: 10.1080/02103702.2014.957537

Ortega-Ruiz, R., Del Rey, R., and Casas, J. A. (2016). Evaluar el bullying y el cyberbullying validación española del EBIP-Q y del ECIP-Q. *Psicología Educ.* 22, 71–79. doi: 10.1016/j.pse.2016.01.004

Ortega-Ruiz, R., and Zych, I. (2016). *Convivencia Escolar: Manual Para Docentes*. Madrid: Editorial.

Rodríguez-Hidalgo, A. J., Ortega-Ruiz, R., and Zych, I. (2014). Peer victimization and ethnic-cultural peer victimization: self-esteem and school relations between different cultural groups of students in Andalusia, Spain. *Rev. Psicodidáctica* 19, 191–210. doi: 10.1387/RevPsicodidact.7909

Romera, E. M., Cano, J. J., García-Fernández, C. M., and Ortega-Ruiz, R. (2016). Cyberbullying: social competence, motivation and peer relationships. *Comunicar* 24, 71–79. doi: 10.3916/C48-2016-07

Sanahuja, J. A. (2014). "La Unión Europea y la crisis de los refugiados: fallas degobernanza, securitización y diplomacia de chequera," in *Retos Inaplazables en el Sistema Internacional. Anuario 2015-16*, ed M. Mesa (Madrid. Centro de Educación e Investigación para la Paz, CEIPAZ), 71–105.

Seals, D., and Young, J. (2003). Bullying and victimization: prevalence and relationship to gender, grade level, ethnicity, self-esteem, and depression. *Adolescence* 38, 735–747.

Smith, P. K., and Brain, P. (2000). Bullying in schools: lessons from two decades of research. *Aggress. Behav.* 26, 1–9. doi: 10.1002/(SICI)1098-2337(2000)26:1<1::AID-AB1>3.0.CO;2-7

Smith, P. K., Cowie, H., Olafsson, R. F., and Liefooghe, A. P. D. (2002). Definitions of bullying: a comparison of terms used, and age and gender differences, in a fourteen-country international comparison. *Child Dev.* 73, 1119–1133. doi: 10.1111/1467-8624.00461

Smith, P. K., Mahdavi, J., Carvalho, M., Fisher, S., Russell, S., and Tippett, N. (2008). Cyberbullying: its nature and impact in secondary school pupils. *J. Child Psychol. Psychiatry* 49, 376–385. doi: 10.1111/j.1469-7610.2007.01846.x

Smokowski, P. R., Cotter, K. L., Robertson, C. I. B., and Guo, S. (2013). Anxiety and aggression in rural youth: baseline results from the rural adaptation project. *Child Psychiatry Hum. Dev.* 44, 479–492. doi: 10.1007/s10578-012-0342-x

Strohmeier, D., Kärnä, A., and Salmivalli, C. (2011). Intrapersonal and interpersonal risk factors for peer victimization in immigrant youth in Finland. *Dev. Psychol.* 47, 248–258. doi: 10.1037/a0020785

Tokunaga, R. S. (2010). Following you home from school: a criticalreview and synthesis of research on cyberbullying victimization. *Comput. Human Behav.* 26, 277–287. doi: 10.1016/j.chb.2009.11.014

Toomey, R. B., and Russell, S. T. (2016). The role of sexual orientation in school-based victimization: a meta-analysis. *Youth Soc.* 48, 176–201. doi: 10.1177/0044118X13483778

UNESCO (2015a). *Rethinking Education. Towards a Global Common Good*. Available online at: http://unesdoc.unesco.org/images/0023/002325/232555e.pdf

UNESCO (2015b). *Education 2030: Towards Inclusive and Equitable Quality Education and Lifelong Learning for All*. World Education Forum 2015. Available online at: http://unesdoc.unesco.org/images/0023/002331/233137E.pdf

Ttofi, M. M., Farrington, D. P., and Lösel, F. (2012). School bullying as a predictor of violence later in life: a systematic review and meta-analysis of prospective longitudinal studies. *Aggress. Violent Behav.* 17, 405–418. doi: 10.1016/j.avb.2012.05.002

Ttofi, M. M., Farrington, D. P., Lösel, F., Crago, R. V., and Theodorakis, N. (2016). School bullying and drug use later in life: a meta-analytic investigation. *School Psychol. Q.* 31, 8–27. doi: 10.1037/spq0000120

Ttofi, M. M., Farrington, D. P., Lösel, F., and Loeber, R. (2011a). The predictive efficiency of school bullying versus later offending: a systematic/meta-analytic review of longitudinal studies. *Crim. Behav. Mental Health* 21, 80–89. doi: 10.1002/cbm.808

Ttofi, M. M., Farrington, D. P., Lösel, F., and Loeber, R. (2011b). Do the victims of school bullies tend to become depressed later in life? A systematic review and metaanalysis of longitudinal studies. *J. Aggress. Conflict Peace Res.* 3, 63–73. doi: 10.1108/17596591111132873

Vitoroulis, I., and Vaillancourt, T. (2015). Meta-analytic results of ethnic group differences in peer victimization. *Aggress. Behav.* 41, 149–170. doi: 10.1002/AB.21564

Wolke, D., Woods, S., Stanford, K., and Schulz, H. (2001). Bullying and victimization of primary school children in England and Germany: prevalence and school factors. *Br. J. Psychol.* 92, 673–696. doi: 10.1348/000712601162419

Zych, I., Ortega-Ruiz, R., and Del Rey, R. (2015a). Systematic review of theoretical studies on bullying and cyberbullying: facts, knowledge, prevention and intervention. *Aggress. Violent Behav.* 23, 1–21. doi: 10.1016/j.avb.2015.10.001

Zych, I., Ortega-Ruiz, R., and Del Rey, R. (2015b). Scientific research on bullying and cyberbullying: where have we been and where are we going. *Aggress. Violent Behav.* 24, 188–198. doi: 10.1016/j.avb.2015.05.015

Zych, I., Ortega-Ruiz, R., and Marín-López, I. (2016). Cyberbullying: a systematic review of research, its prevalence and assessment issues in Spanish studies. *Psicología Educ.* 22, 5–18. doi: 10.1016/j.pse.2016.03.002

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewers AD and DA and handling Editor declared their shared affiliation, and the handling Editor states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2016 Llorent, Ortega-Ruiz and Zych. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 18 October 2016
doi: 10.3389/fpsyg.2016.01610

Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence

Ana Bernardo[1], María Esteban[1]*, Estrella Fernández[1], Antonio Cervero[2], Ellián Tuero[1] and Paula Solano[1]*

[1] Psychology Department, University of Oviedo, Oviedo, Spain, [2] Department of Education, University of Oviedo, Oviedo, Spain

Dropping out of university has serious consequences not only for the student who drops out but also for the institution and society as a whole. Although this phenomenon has been widely studied, there is a need for broader knowledge of the context in which it occurs. Yet research on the subject often focuses on variables that, although they affect drop-out rates, lie beyond a university's control. This makes it hard to come up with effective preventive measures. That is why a northern Spanish university has undertaken a ex post facto holistic research study on 1,311 freshmen (2008/9, 2009/10, and 2010/11 cohorts). The study falls within the framework of the ALFA-GUIA European Project and focuses on those drop-out factors where there is scope for taking remedial measures. This research explored the possible relationship of degree drop-out and different categories of variables: variables related to the educational stage prior to university entry (path to entry university and main reason for degree choice), variables related to integration and coexistence at university (social integration, academic integration, relationships with teachers/peers and value of the living environment) financial status and performance during university studies (in terms of compliance with the program, time devoted to study, use of study techniques and class attendance). Descriptive, correlational and variance analyses were conducted to discover which of these variables really distinguish those students who drop-out from their peers who complete their studies. Results highlight the influence of vocation as main reason for degree choice, path to university entry, financial independency, social and academic adaptation, time devoted to study, use of study techniques and program compliance in the studied phenomenon.

Keywords: higher education, university drop-out, academic performance, academic adaptation, social adaptation

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Rickard Enström, MacEwan University, Canada
Leandro S. Almeida, University of Minho, Portugal

****Correspondence:***
Ana Bernardo
bernardoana@uniovi.es
María Esteban
maria_esteban_garcia@hotmail.com

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *20 July 2016*
Accepted: *03 October 2016*
Published: *18 October 2016*

Citation:
Bernardo A, Esteban M, Fernández E, Cervero A, Tuero E and Solano P (2016) Comparison of Personal, Social and Academic Variables Related to University Drop-out and Persistence. Front. Psychol. 7:1610. doi: 10.3389/fpsyg.2016.01610

INTRODUCTION

Dropping out of higher education is a global phenomenon and it affects virtually all universities (UNESCO, 2004). That is why higher education institutions have researched the kinds of drop-outs, their causes and consequences ever since the early 20th century, and in particular since the 1970s. Durán-Aponte and Pujol (2012) argue that university drop-outs can be classified under one of three heads: voluntary (voluntary or forced drop-out); temporary (whether initial, early or late); scope (internal, institutional or from the education system). However, research currently under

way on the phenomenon tends to focus on initial or early voluntary drop-out (that is to say, during the first year of university). That is because this is when most drop-outs tend to occur (Castaño et al., 2004; Willcoxson, 2010; Belloc et al., 2011). Also, for practical reasons most studies focus on internal drop-outs (or change of degree) and institutional drop-outs (where students leave the university concerned but do not necessarily stop studying, whether at a university or other institution). Practical reasons lie behind this focus, especially with regard to sample identification. Such studies cover a wide range of variables (a holistic approach) in order to avoid the biases that were once common.

Detailed study of the factors involved in university drop-out has both given rise to different explanatory models of the phenomenon and revealed its complexity. Some models focus solely on the possible influence of economic variables (Jensen, 1981; Donoso and Schiefelbein, 2007). Other models focus on the various psychological characteristics of students who drop-out (Fishbein and Ajzen, 1977; Belloc et al., 2011). Yet others stress the influence of sociological factors that go beyond the individual (Pincus, 1980), or that affect the education institution itself (Kamers, 1971) or on the interaction between these two (Tinto, 1975). All models look at variables that may explain drop-out and shed light on the phenomenon. That said, at present one of the most commonly applied ones is a reformulation of Tinto's (1993) adaptive explicative model. This model highlights the importance of characteristics pre-dating university entry and variables such as background, and student adaptation to the institution's social and academic atmosphere as factors determining student drop-out. This model has been criticized for failing to take into account the cultural diversity of students (Guiffrida, 2006) or variables outside the academic context such as family involvement (Bean, 1983). Notwithstanding these criticisms, the variables included by Tinto in his model seem to carry weight in studies regardless of the context in which they were carried out. This is especially true in those covering the first year of university (Tinto, 2001; Upcraft et al., 2004). On the other hand, learning theorists believe that a student's commitment to his studies and ability to tackle tasks in a strategic fashion are important variables in academic performance (Azevedo et al., 2010; Broadbent and Poon, 2015). They argue that these variables bear heavily on students deciding whether to stay on at university or to drop-out (Arco-Tirado et al., 2011). Students' academic adaptation to the university setting thus assumes great importance in the decision to either continue one's studies or to drop-out. It seems reasonable to think (and has been shown to be true) that it is the students who fail at university that drop-out, not those that succeed (Araque et al., 2009).

Of the drop-out related variables falling under the head of *background*, it seems that the student's academic track record (e.g., matriculation grade; Smith and Naylor, 2001; Belloc et al., 2011; Burillo et al., 2011) and the student's financial possibilities are constantly found to be relevant factors. Some research shows that pre-university training can play a role in fostering continuation and completion of the student's academic studies. Thus some university entrance options (Corominas, 2001; Rodrigo et al., 2012) are associated with higher drop-out rates than others. Reserved place schemes (e.g., vocational training or for those over the age of 25/45) stand out in this respect. This seems to be because students entering through reserved place schemes have different *backgrounds* from those entering straight from school. Here, students joining from school are more likely to complete their studies than those that do not (Lassibille and Navarro, 2009). Similarly, student performance at this stage lays the foundations for future academic attainment. This is because academic grades prior to entry are a good predictor of university performance — something corroborated by Casaravilla et al. (2012) — and thus of the likelihood of a student dropping out. However, one must also take into account the link between choice of degree and reasons for dropping out. As Duncan (2006) noted, this is because informed choice of degree is a predictor of both switching studies and of drop-out from higher education (a variable that combines both matriculation grade and motivational aspects). Here, we should bear in mind that although students may know and wish to entry in a particular degree, a limited availability of places and the requirements of the institution (ej. outstanding academic performance during high school) often prevent them from getting enrolled in their first choice. Not surprisingly, students who have to make do with another choice of degree are more likely to drop-out. In fact, 80% of students who drop-out of certain degree programs had not taken them as their first choice. This was so because either the student's matriculation grade was too low to get their first choice or factors other than student motivation played a role (Cabrera et al., 2006b; Elias, 2008; Burillo et al., 2011).

In addition to the student's academic background, financial support is also a constant factor. Students' financial circumstances and the opportunity cost of undertaking university studies (Chen, 2008) play a role. Students who depend on their own slender resources at university and especially those doing a full-time job during their studies are the ones who are likeliest to drop-out (Elias, 2008; Goldenhersh et al., 2011; Esteban et al., 2016).

While these variables have been shown to be highly relevant, they only partly predict university drop-outs. That is because (as with academic achievement), dropping out is a complex phenomenon. Accordingly, other variables need to be taken into account to explain why students facing similar risks and challenges (financial ones, for instance) and taking the same degrees still manage to graduate (Landry, 2003). Given this, the student's social adaptation to university, his motivation, commitment and ability to meet academic demands, could be the answer. There are many variables that influence a student's decision on whether to drop-out or to continue studying — a point noted by Tinto (2006). Some of these variables lie beyond the university's control. An example here might be the cultural level of the student's family. So while we concede the theoretical interest of analyzing all aspects bearing on dropping out of university, in this paper we shall focus on those where universities have a chance of making a difference.

University study habits and techniques are linked to both academic performance and student drop-out (Antoni, 2003; Cabrera et al., 2006a). Given the results obtained by Vermetten et al. (1999) and Schmeck (2013), we acknowledge that the

most suitable study techniques may vary with the kind of academic training imparted and the student's preferred learning styles. Depending on the degree chosen, the student's study techniques may or may not be those required for successful completion of the course. Hence the need to detect mismatches between student's study techniques and academic requirements, and to take remedial action are necessary (Hernández et al., 2015). In this regard, regular class attendance makes it easier to freshmen to adapt and develop their skills, in order to match the requirements of their particularstudy program, promoting a good academic progress at university (Rodríguez and Herrera, 2009). Regular class attendance also facilitates social contacts, helping to forge links among students, parents, faculty, and other university staff. Such relationships not only foster students' social and academic adaptation but also help keep students in the degree program (Tinto, 1997). Student support services play a particularly important role in this regard. However, the results may be mediated by the teaching methodology and teaching method, as Braxton et al. (2000) have highlighted. These variables are highly relevant. It therefore behooves universities to delve into them so that they can improve their teaching and organizational methods. Here, universities cannot shirk their responsibilities by laying all the blame for drop-outs on student fecklessness — a point made by Tinto (2006). Instead, universities should strive harder to meet students' needs. One should not blithely assume that a student who drops out does so because he is poorly motivated, does not work hard enough or lacks ability. Nor should such arguments be taken as an excuse for the university to wash its hands of the situation. Instead, the university must grasp the risk factors so that the right remedial measures can be taken. The university should work with both the student and others, providing as many tools as possible to ensure students graduate.

One should also bear in mind the longitudinal dimension of dropping out — a point stressed by Tinto (1988). In order to explain different kinds of drop-outs, regarding on the moment when the student makes this decision. Tinto (1988) draws on anthropological studies on trive rites of passage, arguing that access to higher education is comparable to these ancient rites, symbolizing the transition of individuals from one social group to another (a process described by Van Gennep, 1960). Here, it is necessary to to recognize feelings of isolation and weakness, similar to those described by Durkheim (1954) under the term "anomie."

Given the plethora of research studies undertaken to date and for diverse purposes (descriptive, explanatory, predictive, for improvement), one wonders whether further contributions to knowledge are needed in this field. Nevertheless, studying which factors affect dropping out in every cultural context is vital if one is to come up with effective, well-targeted counter-measures. That is because students' circumstances and educational levels vary among countries and the regions within them (Willcoxson et al., 2011). As Lamb et al. (2010) state, some educational systems are more effective than others at hanging on to students and making sure they graduate.

In northern Spain, although students show many similarities with those in other countries, they also exhibit major differences: Spanish students tend not to live on a university campus — unlike the case elsewhere. This means that most interaction takes place in classrooms (Ariño and Llopis, 2011); classes tend to be large, sometimes over a hundred students, making it hard if not impossible to cater to individual needs (Montmarquette et al., 2001); there is little cultural or ethnic diversity and *non-traditional students* [who are more likely to drop-out — as found in other studies, such as those by Stoessel et al. (2015)] are very thin on the ground in Spanish universities. That is because such students tend to drop-out of school and do not make it to Higher Education or opt for Vocational Training instead (University of Sussex, 2015); the link between getting a university degree and a job post-graduation is weaker than in other countries (Prokou, 2008; Schomburg, 2011); few students resort to bank loans to fund their studies and hence the financial disincentives for dropping are not as stark (Hillman, 2014). As Di Pietro (2006) highlighted, dropping out is a phenomenon that is linked to time and setting (even though there may be common features and factors among Higher Education institutions). It therefore behooves universities to constantly update their analyses of the problem.

Accordingly, our study analyses the differences between those students who drop-out and those who stay on. The variables examined for this purpose cover personal, social and academic characteristics that may affect adaptation between student and institution. Regarding the literature review, we assume the following hypothesis:

(a) Students that decided to drop-out have worse integration (social and academic) than those who persist.
(b) Students than quit their university degree migth have worse relationships with teachers and peers than those who do not quit.
(c) Participants behavior (in terms of class attendance, time devoted to study, use of study techniques and performance) would be better in the persistence groups, in comparison to the drop-out group.

MATERIALS AND METHODS

Participants

The research sample was 1,301 students from a university in northern Spain (University of Oviedo). This sample is part of a larger one used in a European project, *The Alfa-Guide Project* (DCI-ALA/2010/94), one of whose lines of action focused on comprehensive diagnosis of the problem of drop-outs in Higher Education. This initiative involved 16 institutions of Higher Education in Europe and America. Parallel research was conducted, the work being coordinated by the Technical University of Madrid. The pooled sample amounted to 9,982 university freshmen in the 2008/9, 2009/10, and 2010/11 academic years. The University of Oviedo took part in the project, contributing 715 participants to the joint sample (of whom 541 were on the drop-out track, while the rest made up the control group). To balance the samples and to perform meaningful analysis of both drop-outs and

students who stayed the course, it was decided to broaden the sample to yield a confidence level of 95% and a sampling error not exceeding 3.3%. Specifically, of the 1,301 students in the study, 698 were continuing their studies (36.68% men and 63.32% women) and 603 were dropping out (50.58% men and 49.42% women). The students were drawn from five branches of knowledge (Arts and Humanities, Sciences, Health Sciences, Engineering and Architecture, Social and Legal Sciences).

Procedure and Instruments

This paper has followed an ex post facto design. The information was gathered in three stages and from two sources. Initially, the university filtered personal information (e.g., age, gender, first year of matriculation, place of residence, etc.) of students who were dropping out. It then chose a control group (students who were staying on) with similar characteristics to the drop-outs. Informed consent was then obtained from each of the students who were to take part in the study. Once consent was given, the third step was for students to answer the *ad hoc,* questionnaire, which was administered remotely (by phone or by e-mail, depending on each student's preference). The questionnaire applied within the Alfa-Guide project framework consisted of over 100 items, to be completed by the institution and students. It gathered information on the students that was of a demographic, personal, social, institutional, and academic nature. This questionnaire solely covered information on those personal variables bearing on the study objectives. That is to say, it bore on variables linked to university entry, reasons for taking a degree, adaptation to the institution, student behavior in performing academic tasks but discounted performance. Accordingly, the study excluded variables whose natures were demographic, family, institutional and non-academic (for instance, health).

Specifically, the questionnaire used comprised *background* variables, four of them dichotomous (1 = yes, 0 = no) bearing on the reason for the student's choice of degree (e.g., *The choice of the degree was mainly due to vocational reasons*); a nominal variable on matriculation route (e.g., *I entered university from school etc.*); two nominal variables on the student's financial means (e.g., *I am financially independent*); and a 5-point Likert scale (1 = very bad/none; 5 = very good/always) covering social-academic data (e.g., *Relationships with peers have been...*); two personal variables on the student's perception of his academic and social adaptation to the institution; and four academic and personal variables on general performance (e.g., *Rate your level of class attendance*; **Table 1**).

Data Analysis

Differences between those students who stayed on and those who dropped out were considered in relation to reason for degree choice, the entry path to college and financial dependence. The results were analyzed using the Chi-square test given the dichotomous/nominal nature of the variables used.

The Student's *t*-test for independent samples was used to see whether there were statistically significant differences between 'stayers' and 'drop-outs,' depending on the impact of personal, social and academic variables in each case. All the variables met the assumption of normality, following the criterion proposed by Finney and DiStefano (2006) but not all of them met the assumption of homogeneity of variance (Levene test). Accordingly, equal variances in the variables was not assumed. The Effect Size of statistically significant differences was estimated by the *d* Cohen statistic, applying the criteria set out in Cohen's (1988) seminal work : $d = 0.20$ indicates a small effect size, $d = 0.50$ indicates a medium effect size, $d = 0.80$ indicates a large effect size.

RESULTS

Regarding students' first choice of degree, a statistically significant relationship was observed for matriculation being made mainly on vocational grounds ($\chi^2 = 45.03$; $p < 0.001$), with students who continued their university studies showing a higher percentage for this reason than was the case for drop-outs. As for the other reasons for choice, no statistical differences were observed in any of the cases: *interest in the Labor market* ($\chi^2 = 0.75$; $p = 0.386$); *family tradition* ($\chi^2 = 2.57$; $p = 0.109$); and, *professional orientation* ($\chi^2 = 1.67$; $p = 0.197$).

As for the remaining background variables there are statistically significant differences in both cases — that is to say in both the path to college ($\chi^2 = 28.61$; $p < 0.001$), being more common for students who stay on to have joined university straight from school, and in relation to financial aspects ($\chi^2 = 22.96$; $p < 0.001$), being more common for students who are financially independent to show higher drop-out rates.

Table 2 shows the descriptive results for the group of students that persist and the drop-out group, depending on the personal variables bearing on students' coexistence in the institution, social and academic adaptation, and general performance. The posible values of these variables rank from 1 to 5. As can be observed, theses means go from 3.5 to 4.41, being "relationship with peers" the one with the highest mean for both groups (persistence and drop-out), also obtaining remarkable puntuations the rest of variables from this group.

Adaptation (either social or academic) and performance also obtained high puntuations regarding their means. As for the variance within each group, class attendance present the highest standard deviation, showing a relevant variablity in class attendance habtis in both groups.

Results of mean comparison showed that, both,those who presist and those who quit atribute a good value in regard to its social relationships (no diferences statistically significant). No difference was found between the two groups regarding university atmosphere and coexistence or peer relationships. However, this rating is significantly higher in the case of the persistence group. when it comes to the student-teacher relationship, although the effect size is small. In spite of the general perception by students that the relational environment is good, data also reveal how the level of social adaptation to the institution is higher in students who didn't give up, resulting in statistically significant differences with a small effect size. In other words, whether students continue studying or drop-out, a

TABLE 1 | Summary of variables in this study.

Kind of variable	Item	Possible values
Background	Reason for taking the the degree: *The choice of degree was mainly due to··(reasons).*	(i) Vocational (yes/no). (ii) Labor market (yes/no). (iii) Family tradition (yes/no). (iv) Professional orientation (yes/no).
	Path to the degree: *I entered university from:*	University access test or other paths (e.g., Vocational Training, Adult Admission >25 years old).
	Finances: *Financially dependent on:*	Myself or on others (e.g., parents).
Coexistence	Relationship with teachers Relationship with peers Living environment	1 = very bad /none to 5 = very good/always.
Adaptation	Social adaptation Academic adaptation	1 = very bad /none to 5 = very good/always.
Performance	Compliance with program Time devoted to study Use of study techniques Class attendance	1 = very bad /none to 5 = very good/always.

TABLE 2 | Descriptive statistics of the variables for coexistence, adaptation and performance according to the belonging group (persistent or drop-out).

	Persist ($N = 698$)		Drop-out ($N = 603$)		DM_{S-DO}	$t_{(gl)}$	p	d
	M	SD	M	SD				
Coexistence								
Relationship with teachers	4.01	0.58	3.92	0.61	0.087	$2.63_{(1251)}$	0.009	0.15
Relationship with peers	4.41	0.59	4.37	0.59	0.042	$1.28_{(1299)}$	0.200	–
Living environment	4.01	0.59	4.03	0.56	−0.017	$-0.52_{(1299)}$	0.604	–
Adaptation								
Social adaptation	4.25	0.57	4.09	0.65	0.166	$4.87_{(1212)}$	0.000	0.26
Academic adaptation	4.03	0.59	3.66	0.77	0.368	$9.56_{(1121)}$	0.000	0.55
Performance								
Compliance with program	3.82	0.60	3.74	0.67	0.076	$2.14_{(1223)}$	0.032	0.13
Studying time	3.87	0.73	3.50	0.82	0.373	$8.61_{(1213)}$	0.000	0.48
Use of study techniques	3.81	0.69	3.56	0.76	0.255	$6.31_{(1224)}$	0.000	0.35
Class attendance	4.32	1.03	4.03	1.23	0.280	$4.42_{(1224)}$	0.000	0.26

M = mean; SD, standard deviation. The minimum value of all the variables on the scale is 1 and the maximum value is 5.

positive interaction between students and between students and teachers can be observed. That said, the students who drop-out adapt whose than those who stay on. On the other hand, there are statistically significant differences regarding the level of academic adaptation. Again, students who persist show greater adaptation than the drop-outs, with statistically significant differences with a medium size effect.

As for students' academic performance, there are statistically significant differences between both groups in terms of the time they devoted to studying, the use of study techniques and class attendance. In regard of the size effect, a greater effect was found for study time (medium) and the use of study techniques (low) than for class attendance (low), showing how stayers spend more time working on their own and taking a more strategic approach to academic tasks (that is to say, they adapt better to academic demands). In addition, statistically significant differences between the two groups were observed with regard to program compliance, although the effect size is small.

DISCUSSION

The beginning of university studies is the turning point in a transition that spans from the start of the course pre-dating college entry to the end of the first year of university (Aguilar, 2007). Both students and institutions need to make social and academic adjustments in the light of the degree program. However, as Tinto (1988) noted, freshers may encounter problems from the outset. If they are not given sufficient support, they may end up adapting poorly to their new university setting. Here, one needs to be aware that many of the variables that affect the drop-out rate lie beyond universities' control. Two such factors are the student's socio-economic status and his entry path. That is why it is advisable to focus analysis on those problems where the institution has some leeway (Tinto and Pusser, 2006). That is why, under the European ALFIA-GUIDE project for Drop-Out Management, the University of Oviedo considered studying those variables that might hinder

such adaptation between the student and the institution and which the university was in a position to do something about (Marín et al., 2000; Cabrera et al., 2006b; Bethencourt et al., 2008; Elias, 2008; Lehman, 2014). It was also planned for the study to take into account the reasons given by students for their choice of degree, vocation, and the financial and other support provided by the university.

Thus, both so-called *background* variables (such as those bearing on students' social and academic integration, and general performance) were examined.

As for variables bearing on social integration and adaptation to academic life, three of them (relationship with faculty; level of social adaptation; level of academic adaptation) did not influence either relations with peers or rating of coexistence. This finding may have been colored by the tendency of stayers and drop-outs alike to positively rate both aspects. The results confirm that the relationships forged between teachers and students (when positively rated by the student body) contribute to academic results and the completion of degree studies. These findings are consistent with those obtained by other authors (McPartland and Jordan, 2001; Willcoxson, 2010; Gilardi and Guglielmetti, 2011) and confirm our first and hypothesis. A university is a very different beast from a secondary school not only in terms of academic and administrative size but also with regard to its social scope. Hence the need to ensure student adaptation to this new context. Here, our study has shown that a student is more likely to persevere with his studies if he is well adapted. Similar results were obtained by Tinto (2005), Duncan (2006) and Elias (2008). In this regard, one should note that the World Health Organization (WHO) recommends that education institutions should foster good relations as part of their duty to care for their students' health and welfare (Prior et al., 2011). This makes it vital to improve university teachers' initial and continuing training so that faculty members have the knowledge and skills they need to effectively play their tutorial role in the way described by Troyano and García (2011). In this respect, it is also essential that this tutoring role be institutionally acknowledged — something also suggested by Albione et al. (2005).

In connection with the foregoing, it has been found that some paths to university (particularly the one from school) facilitate this adaptation better than others (for instance, professional training, and an entrance exam for those over the age of 25/45). Here, our findings are similar to those obtained by Lassibille and Navarro (2009) and Rodrigo et al. (2012). That is why we recommend special remedial measures be taken for students entering university by paths other than straight from school.

Leaving freshers' educational backgrounds aside, adaptation to the university setting is a long and often arduous process for many students. This fact makes it advisable to take measures aimed at the student body as a whole. Here, one should note the impact of the passing and application of the University Student Statute (MEC, 2010) in recent years at Spanish universities. The Statute followed on from implementation of the European Higher Education Area (EHEA, 2015), which recognizes students' rights to tutoring and guidance as part of their education. The Statute has encouraged Spanish universities to set up specific plans of action for tutoring in the various programs offered (in most cases, the faculty draw up these plans). The aim of these plans is to provide career and lifelong guidance, and to monitor student learning (in terms of academic, personal and professional skills). Putting such plans into action is fraught with difficulties given universities' lack of sufficient resources (Álvarez, 2013; Domínguez et al., 2013). In any event, it is worth faculties drawing up a comprehensive plan of action for student tutorials and monitoring on the lines suggested by Álvarez and González (2009).

As for the variables reflecting the student's performance (class attendance, time spent studying, use of study skills) and its relation with the studied phenomenon, our findings reveal that only these three variables are linked to dropping out from university: Poor class attendance has been proven to be strongly linked to dropping out from university. This is in line with the results obtained by Iñigo et al. (2011), and Bernardo et al. (2015). Nevertheless, the variable has a low size effect because merely attending classes is no guarantee that the student will benefit from them), as Pintor et al. (2012) highlight. On the other hand, time spent studying/working on one's own in an assiduous fashion outside exam periods helps shape a student's study habits and has proven to boost degree completion rates. There is a medium size effect in this case. Similar results were obtained by Elias (2008) and Trevizán et al. (2009) and are supported by the findings of Broadbent and Poon (2015), who (following a systematic review of the relationship between self-regulated learning and academic success) concluded that almost all research studies found a link between time management and academic success.

Likewise, intensive use of study techniques has also been shown to correlate strongly with degree completion. In view of the advanced, specialized content found in modern curriculums, it comes as little surprise that university students can now bring a wider range of learning strategies and study techniques to bear in their academic work. These findings are consistent with those of Bethencourt et al. (2008), who affirm that this of variables play a remarkable role in dropping out of university.

Thus, students who persist spend more time working on their own and do a better use of study techniques (in line with our hypothesis). Such students are more authonomous in the teaching-learning process, which confirms that training measures focusing on these skills will yield better academic results (Tan et al., 2008; Balkıs, 2011). For example, Azevedo et al. (2010) proposed the use of MetaTutor software, which purpose is to provide diagnosis and training for self-learning in virtual settings. The software also allows one to broaden scientific knowledge of these highly popular environments and provides a useful tool for greatly boosting students' academic performance.

One of the questions that now arises is how to put theory into practice, i.e., get the student's retention in university classrooms. Given the results of our research, it seems that the institution as a whole, and its role in the EHEA's work, are both on the right track. However, one must also give students tools to help them adapt academically and its diverse demands. The introduction of hosting programs (to facilitate students' initial adaptation; commitment to their degrees; practice in training strategies; time management) all help boost academic performance and completion of studies. However, at this point one should recall

the recommendation made by Tinto and Pusser (2006) on the need to systematically tackle the issue of university drop-outs. All remedial measures need to form part of an Institutional Action Plan that involves the various groups and ensures proper resource management. The aim should be to exploit synergies to render plan implementation more effective. Nevertheless, the greatest limitations here stem from the savage cuts that have been made in Spanish universities since the beginning of the present economic crisis makes it hard to implement such plans and research into the problem of university drop-out.

Future research might employ a representative sample of students from other universities operating in similar cultural settings and analyze whether the results here are consistent with those found in other branches of knowledge.

LIMITATIONS AND FUTURE RESEACH

This paper show results obtained in an ex post facto research. Althougth this research method have important limitations, such as the inability to manipulate the independent variables, our research team considered that was the most suitable design; it is not practical to apply experimental design to study university drop-out, as this kind of design would oblige us to wait at least 1 year between the aplication of the pre-test and the post-test, in order to wait for the phenomenon to occur. However, the cost and time savings, result of this kind of research, are remarkables advantages that we took into account.

It is also neccessary highlight that in this research we have not explored in depth the psychological characteristics of our participants and are often related to drop-out (eg., self-efficacy, resilience, mental health) due to budget and time limitations. Therefore, it would be advisable to develop further research to analyze the influence of these variables in the phenomenon.

AUTHOR CONTRIBUTIONS

AB directed the research developed in the frame of the Alfaguia Project (funded by the European Union) and was one of the authors of this paper. The other authors are: ME, who was the student that assisted the director along every research phase and still contributing in this research topic. AC, who is a PhD student that is developing his thesis about university drop-out, using the data collected in Alfaguia Project and, therefor, is a contributor of this paper. EF, ET, and PS are team members that joint this research topic once that Alfaguia Project was finished, but contribute to study university abandonment helping AB reviewing the literature, carrying out analysis and writing papers.

FUNDING

Alfaguia Project was developed thanks to the European Union funding (DCI-ALA/2010/94).

REFERENCES

Aguilar, M. (2007). "La transición a la vida universitaria. Éxito, Fracaso, Cambio y Abandono," in *Proceedings of the fourth Encuentro Nacional de Docentes Universitarios Católicos (ENDUC IV) Universidad y Nación*, (Santa Fe: Camino al bicentenario, Universidad Católica de Santa Fe), 18–20.

Albione, M., Gregoret, A., Núñez, A., and Vitale, B. (2005). "Fortalecimiento del acompañamiento, seguimiento y control de los estudiantes en sus procesos académicos," in *Proceedings of the fifth Coloquio internacional sobre Gestión Universitaria en América del Sur*, Mar del Plata, 8–10. Available at: http://164.73.2.147/alfaguia/files/1320776608_5196.pdf

Álvarez, P. R. (2013). La función tutorial del profesorado universitario: una nueva competencia de la labor docente en el contexto del EEES. *Rev. Portuguesa Pedagog.* 47, 85–106.

Álvarez, P. R., and González, M. C. (2009). Modelo comprensivo para la institucionalización de la orientación y la tutoría en la enseñanza universitaria. *Qurriculum Rev. Teoria Investig. Prác. Educativa* 22, 73–95.

Antoni, E. J. (2003). *Alumnos Universitarios: el Porqué de Sus Éxitos y Fracasos*. Buenos Aires: Miño y Dávila Editores.

Araque, F., Roldán, C., and Salguero, A. (2009). Factors influencing university drop out rates. *Comput. Educ.* 53, 563–574. doi: 10.1016/j.compedu.2009.03.013

Arco-Tirado, J. L., Fernández-Martín, F. D., and Fernández-Balboa, J. M. (2011). The impact of a peer-tutoring program on quality standards in higher education. *High. Educ.* 62, 773–788. doi: 10.1007/s10734-011-9419-x

Ariño, A., and Llopis, R. (2011). *¿Universidad sin Clases? Condiciones de Vida de los Estudiantes Universitarios en España (Eurostudent IV)*. Madrid: Ministerio de Educación.

Azevedo, R., Johnson, A., Chauncey, A., and Burkett, C. (2010). "Self-regulated learning with MetaTutor: advancing the science of learning with MetaCognitive tools," in *New Science of Learning: Computers, Cognition, and Collaboration in Education*, eds M. S. Khine and I. M. Saleh (New York, NY: Springer), 225–247.

Balkıs, M. (2011). Academic efficacy as a mediator and moderator variable in the relationship between academic procrastination and academic achievement. *Eurasian J. Educ. Res.* 45, 1–16.

Bean, J. (1983). The application of a model of turnover in work organizations to the student attrition process. *Rev. High. Educ.* 17, 129–148.

Belloc, F., Maruotti, A., and Petrella, L. (2011). How individual characteristics affect university students drop-out: a semiparametric mixed-effects model for an Italian case study. *J. Appl. Stat.* 38, 2225–2239. doi: 10.1080/02664763.2010.545373

Bernardo, A., Cerezo, R., Rodríguez-Muñiz, L. J., Núñez, J. C., Tuero, E., and Esteban, M. (2015). Predicción del abandono universitario: variables explicativas y medidas de prevención. *Rev. Fuentes* 16, 63–84.

Bethencourt, J. T., Cabrera, L., Hernández, J. A., Álvarez, P., and González, M. (2008). Variables psicológicas y educativas en el abandono universitario. *Electron. J. Res. Educ. Psychol.* 6, 603–622.

Braxton, J. M., Milem, J. M., and Sullivan, A. S. (2000). The influence of active learning on the college student departure process: toward a revision of Tinto's theory. *J. High. Educ.* 71, 569–590. doi: 10.2307/2649260

Broadbent, J., and Poon, W. L. (2015). Self-regulated learning strategies & academic achievement in online higher education learning environments: a systematic review. *Internet High. Educ.* 27, 1–13. doi: 10.1016/j.iheduc.2015.04.007

Burillo, V., Arriaga, J., Carpeño, A., and Casaravilla, A. (2011). "El estudio de la influencia de factores personales y de ingreso en la universidad en el abandono. Valorando el riesgo o probabilidad de abandono en la Universidad Politécnica de Madrid," in *Proceedings of the first Conferencia Latinoamericana sobre el Abandono en la Enseñanza Superior*, Managua, 18–19.

Cabrera, L., Bethencourt, J. T., Álvarez, P., and González, M. (2006a). El problema del abandono de los estudios universitarios. *Rev. Electrón. Investig. Evaluación Educativa.* 12, 171–203.

Cabrera, L., Bethencourt, J. T., González, M., and Álvarez, P. (2006b). Un estudio transversal retrospectivo sobre la prolongación y abandono de estudios universitarios. *Rev. Electrón. Investig. Evaluación Educativa* 12, 105–127.

Casaravilla, A., Del Campo, J. M., García, A., and Torralba, M. R. (2012). "Análisis del abandono en estudios de ingeniería y arquitectura en la Universidad Politécnica de Madrid," in *Proceedings of the second Conferencia Latinoamericana sobre el Abandono en Educación Superior*, Rio Grande Do Sul.

Castaño, E., Gallón, S., Gómez, K., and Vásquez, J. (2004). Deserción estudiantil universitaria: una aplicación de modelos de duración. *Lecturas Econ.* 60, 39–66.

Chen, R. (2008). Financial aid and student dropout in higher education: a heterogeneous research approach. *High. Educ.* 23, 209–239. doi: 10.1007/978-1-4020-6959-8_7

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences,* 2nd Edn. Hillsdale, NJ: Erlbaum.

Corominas, E. (2001). La transición a los estudios universitarios. Abandono o cambio en el primer año de universidad. *Rev. Investig. Educativa* 19, 127–151.

Di Pietro, G. (2006). Regional labour market conditions and university dropout rates: evidence from Italy. *Reg. Stud.* 40, 617–630. doi: 10.1080/00343400600868770

Domínguez, G., Álvarez, F. J., and López, A. (2013). Acción tutorial y orientación en el periodo de transición de la educación secundaria a la universidad. la orientación al alumnado de nuevo ingreso. REDU. *Rev. Docencia Univ.* 11, 221–241.

Donoso, S., and Schiefelbein, E. (2007). Análisis de los modelos explicativos de retención de estudiantes en la universidad: una visión desde la desigualdad social. *Estud. Pedagóg.* 33, 7–27.

Duncan, N. (2006). *Predicting Perceived Likelihood of Course Change, Return to University Following Withdrawal, and Degree Completion in Glasgow University Students*. Available at: www.psy.gla.ac.uk/~steve/localed/nduncan.pdf

Durán-Aponte, E. D., and Pujol, L. (2012). Diferencias de género y área de estudio en las atribuciones causales de estudiantes universitarios. *An. Universidad Metropolitana* 12, 39–51.

Durkheim, E. (1954). *Suicide*. Glencoe: The Free Press.

EHEA (2015). *European Higher Education Area And Bologna Process*. Available at: http://www.ehea.info/

Elias, M. (2008). Los abandonos universitarios: retos ante el Espacio Europeo de Educación Superior. *Estud. Sobre Educ.* 15, 101–121.

Esteban, M., Bernardo, A., and Rodríguez-Muñiz, L. J. (2016). Permanencia en la universidad: la importancia de un buen comienzo. *Aula Abierta* 44, 1–6. doi: 10.1016/j.aula.2015.04.001

Finney, S. J., and DiStefano, C. (2006). "Non-normal and categorical data in structural equation modeling," in *A Second Course in Structural Equation Modeling*, eds G. R. Hancock and R. O. Mueller (Greenwich: Information Age Publishing), 269–314.

Fishbein, M., and Ajzen, I. (1977). Belief, attitude, intention, and behavior: an introduction to theory and research reading. *Philos. Rhetor.* 10, 130–132.

Gilardi, S., and Guglielmetti, C. (2011). University life of non-traditional students: engagement styles and impact on attrition. *J. High. Educ.* 82, 33–53. doi: 10.1353/jhe.2011.0005

Goldenhersh, H., Coria, A., and Saino, M. (2011). Deserción estudiantil: Desafíos de la Universidad pública en un horizonte de inclusión. *Rev. Argentina Educ. Super.* 3, 96–120.

Guiffrida, D. A. (2006). Toward a cultural advancement of Tinto's theory. *Rev. High. Educ.* 29, 451–472. doi: 10.1353/rhe.2006.0031

Hernández, C. M., López, M. D., and Olmedo, E. M. (2015). Evaluación de la satisfacción de estudiantes universitarios de nuevo ingreso con el programa ESCLOSA: experiencia de un programa de orientación/Satisfaction assessment of freshmen university by" ESCLOSA" programme: a guidance programme experience. *Rev. Esp. Orientac. Psicopedagog.* 26, 123–135.

Hillman, N. W. (2014). College on credit: a multilevel analysis of student loan default. *Rev. High. Educ.* 37, 169–195. doi: 10.1353/rhe.2014.0011

Iñigo, X., Ochoa de Eribe, I., and Otxoa-Berrio, L. M. (2011). "Análisis y estudio del abandono de los estudiantes universitarios," in *Proceedings of the Eighth Jornadas Internacionales de Innovación Universitaria*, Madrid, 11–12.

Jensen, E. (1981). Student financial aid and persistence in college. *Stud. High. Educ.* 15, 89–99.

Kamers, D. (1971). The college "charter" & college size: effects on occupational choice and college attrition. *Sociol. Educ.* 44, 270–296. doi: 10.2307/2111994

Lamb, S., Markussen, E., Teese, R., Sandberg, N., and Polesel, J. (Eds) (2010). *School Dropout and Completion: International Comparative Studies in Theory and Policy*. Dordrecht: Springer Science & Business Media.

Landry, C. C. (2003). *Self-Efficacy, Motivation and Outcome Expectation Correlates of College Students' Intention Certainty*. Ph.D. Dissertation, Louisiana State University, Baton Rouge, LA.

Lassibille, G., and Navarro, M. L. (2009). Tracking students' progress though the Spanish University School Sector. *High. Educ.* 58, 821–839. doi: 10.1007/s10734-009-9227-8

Lehman, Y. P. (2014). University students in crisis: university dropout and professional re-selection. *Estud. Psicol. (Campinas)* 31, 45–54. doi: 10.1590/0103-166X2014000100005

Marín, M., Infante, E., and Troyano, Y. (2000). El fracaso académico en la universidad: aspectos motivacionales e intereses profesionales. *Rev. Latinoam. Psicol.* 32, 505–517.

McPartland, J., and Jordan, W. (2001). *Essential Components of High School Dropout Prevention Reforms*. Available at: http://bit.ly/29YNX3c

MEC (2010). *La Estrategia Universidad 2015: Contribución de las Universidades al Progreso Socioeconómico Español 2010-2015*. Madrid: MECD.

Montmarquette, C., Mahseredjian, S., and Houle, R. (2001). The determinants of university dropouts: a bivariate probability model with sample selection. *Econo. Educ. Rev.* 20, 475–484. doi: 10.1016/S0272-7757(00)00029-7

Pincus, F. (1980). The false promise of community college: class conflict and vocational education. *Harv. Educ. Rev.* 50, 332–361. doi: 10.17763/haer.50.3.y733663386302231

Pintor, E., Gargantilla, P., Rubio, M., and Herreros, B. (2012). Aparatos electrónicos utilizados por los alumnos de medicina en las clases teóricas: ¿herramientas docentes o fuentes de distracción? *Rev. Clín. Esp.* 212, 469–470. doi: 10.1016/j.rce.2012.04.009

Prior, M., Manzano, E., Villar, E., Caparrós, B., Juan, J., and Luz, E. (2011). Estilos comunicativos, vinculación universitaria y adaptación psicosocial. *Rev. Investig. Educativa* 29, 387–405.

Prokou, E. (2008). The emphasis on employability and the changing role of the university in Europe. *High. Educ. Eur.* 33, 387–394. doi: 10.1080/03797720802522593

Rodrigo, M. F., Molina, J. G., García-Ros, R., and Pérez-González, F. (2012). Efectos de interacción en la predicción del abandono en los estudios de Psicología. *An. Psicol.* 28, 113–119.

Rodríguez, C., and Herrera, L. (2009). Análisis correlacional-predictivo de la influencia de la asistencia a clase en el rendimiento académico universitario. Estudio de caso en una asignatura. *Profesorado Rev. Curriculum Formación Profesorado* 13:16.

Schmeck, R. R. (Ed.) (2013). *Learning Strategies and Learning Styles*. New York, NY: Springer Science & Business Media.

Schomburg, H. (2011). "Employability and mobility of bachelor graduates: the findings of graduate surveys in ten European countries on the assessment of the impact of the Bologna Reform," in *Employability and Mobility of Bachelor Graduates in Europe*, eds H. Schomburg and U. Teichler (Rotterdam: SensePublishers), 253–273.

Smith, J. P., and Naylor, R. A. (2001). Dropping out of university: a statistical analysis of the probability of withdrawal for U.K. university students. *J. R. Stat. Soc.* 164, 389–405. doi: 10.1111/1467-985X.00209

Stoessel, K., Ihme, T. A., Barbarino, M. L., Fisseler, B., and Stürmer, S. (2015). Sociodemographic diversity and distance education: who drops out from academic programs and why? *Res. High. Educ.* 56, 228–246. doi: 10.1007/s11162-014-9343-x

Tan, C. X., Ang, R. P., Klassen, R. M., Yeo, L. S., Wong, I. Y., Huan, V. S., et al. (2008). Correlates of academic procrastination and students' grade goals. *Curr. Psychol.* 27, 135–144. doi: 10.1007/s12144-008-9028-8

Tinto, V. (1975). Dropout from higher education: a theoretical synthesis of recent research. *Rev. Educ. Res.* 45, 89–125. doi: 10.3102/00346543045001089

Tinto, V. (1988). Stages of student departure: reflections on the longitudinal character of student leaving. *J. High. Educ.* 59, 438–455. doi: 10.2307/1981920

Tinto, V. (1993). Building Community. *Lib. Educ.* 79, 16–21.

Tinto, V. (1997). Classrooms as communities: exploring the educational character of student persistence. *J. High. Educ.* 68, 599–623. doi: 10.2307/2959965

Tinto, V. (2001). *Rethinking the First Year of College*. Syracuse, NY: Syracuse University.

Tinto, V. (2005). "Student retention: what next?," in *Proceedings of the National Conference on Student Recruitment, Marketing and Retention*, Washington, DC.

Tinto, V. (2006). Research and practice of student retention: what next? *J. Coll. Stud. Ret.* 8, 1–19. doi: 10.2190/4YNU-4TMB-22 DJ-AN4W

Tinto, V., and Pusser, B. (2006). *Moving from Theory to Action: Building a Model of Institutional Action for Student Success*. Washington, DC: National Postsecondary Education Cooperative, 1–51.

Trevizán, A. L., Beltrán, C., and Cosolito, P. (2009). Variables que condicionan la deserción y retención durante el trayecto universitario de alumnos de carrera de Ingeniería Agronómica de la Universidad Nacional de Rosario. *Rev. Epistemol. Cienc. Hum.* 1, 85–95.

Troyano, Y., and García, A. J. (2011). Expectativas del alumnado sobre el profesorado tutor en el contexto del Espacio Europeo de Educación Superior. *REDU Rev. Docencia Univ.* 7, 1–8.

UNESCO (2004). *World Higher Education Database*. Available at: http://www.unesco.org/iau/directories/index.html

University of Sussex (2015). *Marginalized Minorities in Higher Education in Spain: Policies and Practice*. Available at: http://bit.ly/29MCaBq

Upcraft, M., Gardner, J., and Barefoot, B. (Eds) (2004). *Challenge and Support: Creating Climates for First-Year Student Success*. San Francisco, CA: Jossey-Bass.

Van Gennep, A. (1960). *The Rites of Passage*. Chicago, IL: The University of Chicago Press.

Vermetten, Y. J., Lodewijks, H. G., and Vermunt, J. D. (1999). Consistency and variability of learning strategies in different university courses. *High. Educ.* 37, 1–21. doi: 10.1023/A:1003573727713

Willcoxson, L. (2010). Factors affecting intention to leave in the first, second and third year of university studies: a semester-by-semester investigation. *High. Educ. Res. Dev.* 29, 623–639. doi: 10.1080/07294360.2010.501071

Willcoxson, L., Cotter, J., and Joy, S. (2011). Beyond the first-year experience: the impact on attrition of student experiences throughout undergraduate degree studies in six diverse universities. *Stud. High. Educ.* 36, 331–352. doi: 10.1080/03075070903581533

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Bernardo, Esteban, Fernández, Cervero, Tuero and Solano. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 17 October 2016
doi: 10.3389/fpsyg.2016.01480

Interpersonal Values and Academic Performance Related to Delinquent Behaviors

María Del Mar Molero Jurado, María Del Carmen Pérez Fuentes, Antonio Luque De La Rosa, África Martos Martínez, Ana Belén Barragán Martín and María del Mar Simón Márquez*

Department of Psychology, University of Almería, Almeria, Spain

The present study analyzes the relation between delinquent behaviors, interpersonal values, and academic performance. It also analyzes the possible protective function of interpersonal values against delinquent behaviors. The Interpersonal Values Questionnaire (IVQ) was used to assess interpersonal values, and the Antisocial-Delinquent Behaviors Questionnaire (A-D) was employed to assess antisocial behaviors. The sample was made up of 885 students of Compulsory Secondary Education, aged from 14 to 17 years. The results show that individuals who fail a subject as well as those who repeat a course present higher means in delinquent behaviors. Repeaters present higher means in the values of recognition and leadership, and non-repeaters in the value stimulation, whereas students who do not fail obtain higher scores in the value benevolence. Students with high levels of recognition, independence, and leadership, as well as students with low levels of conformity and benevolence display significantly higher levels of delinquent behaviors. Lastly, the probability of presenting a high level of delinquent behaviors is greater in individuals with: high independence, high leadership, high recognition, low benevolence, and low conformity.

Keywords: interpersonal values, academic performance, delinquent behaviors, secondary education, adolescence

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Juan Luis Castejon, University of Alicante, Spain
David Álvarez-García, University of Oviedo, Spain

****Correspondence:***
María Del Carmen Pérez Fuentes
mpf421@ual.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *19 August 2016*
Accepted: *14 September 2016*
Published: *17 October 2016*

Citation:
Molero Jurado MDM, Pérez Fuentes MDC, Luque De La Rosa A, Martos Martínez Á, Barragán Martín AB and Simón Márquez MdM (2016) Interpersonal Values and Academic Performance Related to Delinquent Behaviors. Front. Psychol. 7:1480. doi: 10.3389/fpsyg.2016.01480

INTRODUCTION

The presence of behavior problems during childhood and adolescence is currently a phenomenon causing great concern (Thomas, 2010). These problematic behaviors frequently lead to antisocial and/or delinquent behaviors with negative consequences for the development and psychosocial adjustment of the adolescent (Fuentes et al., 2011; de la Torre et al., 2013; Gázquez et al., 2015a). In spite of the fact that delinquent behavior includes a large variability of manifestations (Martínez and Gras, 2007), course, and prognosis (White and Frick, 2010), there is a consensus among authors about a series of common traits: these behaviors are a threat to the integrity of others, they infringe social and juridical norms, they are notably frequent and intense, and they are a risk for development and they interfere especially in the individual's processes of adaptation (Garaigordobil, 2005; Peña and Graña, 2006; Burt and Donnellan, 2009; Pahlavan and Andreu, 2009). Thus, taking into account the complexity of the construct, we could refer to a continuum that begins with problem behaviors, passing through antisocial behavior, and ending with delinquent behaviors, of greater severity and social scope.

One of the topics that has received the most attention in the study of delinquent behavior is the analysis of the factors that intervene in the origin and maintenance of this type of

attitudinal/behavioral repertories. The more traditional hypotheses point toward certain personal variables as the main triggers of delinquent behavior. In the same vein are the notable contributions like that of Patrick et al. (2009), which refer to two personality dimensions (Impulsivity/Emotional insensitivity) that could be directly related to the presence of severe behavior problems and participation in delinquent actions (Lynam et al., 2009). The presence of psychopathic personality traits has also been indicated as one of the triggering factors of severe patterns of antisocial/delinquent behavior in children and adolescents (López-Romero et al., 2011). In other cases, sensation seeking is proposed as one of the characteristic traits of adolescent personality that, along with the lack of control of impulses, favors the subject's involvement in risk behaviors (Peach and Gaultney, 2013; Pérez-Fuentes et al., 2015). According to Harden et al. (2012), this adolescent tendency to seek sensations is mainly due to changes in personality, explained by genetic factors. Thus, changes in sensation seeking would partially explain a greater proclivity to delinquency during adolescence.

In spite of studies that separately analyze the factors involved in the origin of delinquent behavior, the current tendency is based on a multidimensional and dynamic approach, in which the proposed variables must be considered as part of a compendium and in continuous interaction (Muñoz and Navas, 2004). Thus, we found works analyzing the relation between emotional intelligence and aggressiveness (Inglés et al., 2014), behavior problems (Siu, 2009), and antisocial and delinquent behaviors (Garaigordobil and Oñederra, 2010).

On the other hand, authors like Van der Graaff et al. (2012) point to the moderating role of empathy in the perception of parents' support and their children's performing delinquent actions. These authors found that adolescents with lower empathy had a more negative perception of the support received from their parents and they presented a greater number of delinquent behaviors.

Parenting styles and the characteristics of family relations may be the elements that have received the most attention in the analysis of problem behaviors, either as risk or protection factors (Martínez et al., 2013). In any case, the efficacy of the interventions reveals the importance of family factors as a cause of and/or solution to this problem (Tolan et al., 2013). Concerning the family context, report that children's exposure to episodes of domestic violence and frequent conflicts between the parents is related to the onset of aggressive and delinquent behavior in adolescence. Likewise, other noteworthy works on attachment and delinquent behavior (Sousa et al., 2011) indicate that the establishment of stronger ties with the parents predicts a lower risk of delinquent behavior in adolescence, regardless of the degree of exposure to violent episodes during childhood. In other cases, interest is drawn to the study of the effects of parental control (Harris-McKoy and Cui, 2013) and the use of discipline (Lansford et al., 2011), as key aspects in the origin and maintenance of delinquent behaviors in adolescents.

In the school setting, in addition to the presence of delinquent behaviors, the increasing frequency of academic failure is another concern (Pérez-Fuentes et al., 2011). Many authors (Briggs-Gowan and Carter, 2008; Gázquez and Pérez-Fuentes, 2010; Preddy and Fite, 2012), coincide in relating involvement in delinquent actions to low academic performance, leading to failure, and school dropout (Henry et al., 2012). In this regard, the self-concept as a correlation of social adaptation in adolescence (Fuentes et al., 2011; Álvarez et al., 2015) plays an essential role. Jiménez et al. (2007) found that a positive academic self-concept fulfills a protector function against the development of delinquent behaviors. Likewise, authors like Nakamoto and Schwartz (2010) state that involvement in violent episodes will have a negative effect on academic performance. Ma et al. (2009) note that aggressors perceive their competences as being more impaired and, therefore, they obtain worse academic results. On the other hand, the expectations of self-efficacy and the academic goals give rise motivational profiles (Valle et al., 2015) and may be detrimental to academic performance, in the cases involving aggressors.

Problems relating to the peer group can derive in academic difficulties, the development of violent interactions in childhood, or the amplification of behavior problems in adolescence (Dishion and Tipsord, 2011). At this point, especially during adolescence, the processes of peer influence determine psychosocial adjustment and the acquisition of certain interpersonal values that will guide relations with the peer group (Paciello et al., 2013; Gázquez et al., 2015b). According to Knecht et al. (2010), adolescents select other group members as friends as a function of the level of similarity in interpersonal values. Therefore, processes of influence and adaptation of antisocial/delinquent behavior among its members will take place in the peer group.

In addition, both in the family context and in the peer group, the acquisition of certain interpersonal values—positively or negatively related to delinquent behavior—is implied, an aspect that the present study attempts to examine. Recently, others proposals show the predictive value of social support in the emotional intelligence of adolescents (Azpiazu et al., 2015).

On the other hand, the time dedicated by adolescents to the use of internet and inappropriate videogames has been related to the acquisition and change in the values of youth, and may be associated with a higher probability of delinquent activities (Holtz and Appel, 2011). This is why more attention has been paid in recent years to the variables that make the onset of antisocial behaviors less likely (Inglés et al., 2015) or that attenuate their manifestations after they have emerged (Loeber and Farrington, 2012). Thus, attitudes and values, such as social sensitivity, prosocial leadership, or safety in interpersonal relations, have been related to competence and adequate social adaptation in adolescents (Jiménez and López-Zafra, 2011).

Lastly, in order to provide greater clarity in this regard, we present this work, which will attempt, on the one hand, to analyze the influence of academic performance (measured as failing a subject or repeating a course) on delinquent behaviors and interpersonal values ($Hypothesis_1$ = Poor academic performance is associated with a greater presence of delinquent behavior). On the other hand, it also analyzes the relation between high or low scores in interpersonal values and the presence of delinquent behaviors in secondary education

students (Hypothesis$_2$ = Subjects with high levels of recognition, independence and leadership, and low levels of conformity and benevolence, have higher levels of delinquent behavior). Lastly, we wish to analyze the degree to which interpersonal values fulfill a protective function against delinquent behaviors in secondary education, as well as the interaction of academic performance with interpersonal values and its impact on the presence of delinquent behaviors (Hypothesis$_3$ = The presence of high levels in some interpersonal values such as benevolence, exert a protective function against delinquent behavior, with a mediator effect of academic performance).

MATERIALS AND METHODS

Participants

The initial sample was made up of 1055 students from the 3rd and 4th grade of Compulsory Secondary Education (CSE) of Almeria province (Spain), of whom 120 (11.37%) were eliminated because they were aliens and had not completed the questionnaires in time due to their lack of mastery of the Spanish language; additionally, due to errors or omissions, or to not having attended one of the two administration sessions, another 50 (4.74%) subjects were excluded. The final sample was made up of 885 students of CSE, of whom 49.8% ($n = 441$) were male and 50.2% ($n = 444$) were female, with age ranging from 14 to 18 years, mean age of 15.2 years ($SD = 0.90$) for the total sample, and 15.22 years ($SD = 0.92$) and 15.19 years ($SD = 0.89$) for males and females, respectively.

The distribution of the sample as a function of having failed a subject was as follows: those who failed a subject ($n = 729$; 377 males and 352 females) and those who did not fail ($n = 156$; 64 males and 92 females). The chi-square test of homogeneity of the frequency distribution, $c^2_{(1885)} = 5.87$, $p = 0.02$, revealed statistical differences between the four groups made up of the variables Gender and Failing. However, regarding the variable repeating a course: Repeaters ($n = 273$; 139 males and 134 females) and Non-repeaters ($n = 612$; 302 males and 310 females). In this case, no statistical differences were observed among the four groups made up of the variables Gender and Repeating, $c^2_{(1885)} = 0.19$, $p = 0.67$.

To obtain the sample, we used random cluster sampling, attending to the different geographical areas of the province of Almeria (center, east, and west). Each area had at least one public school, with the sample of each area always exceeding 200 students [center 212 subjects (24%), east 333 subjects (37.6%), and west 340 subjects (38.4%)], four classes in each school (two classes of 3rd grade and two of 4th grade).

Instruments

Academic Performance

This was measured with the items: *Did you ever fail a subject? Have you ever repeated a course?* In both cases, the response options were YES/NO.

Interpersonal Values Questionnaire (Gordon, 1977)

This 90-item instrument has two response options (YES-NO) and analyzes six aspects of the individual's relationship with others: Stimulation, Conformity, Recognition, Independence, Benevolence, and Leadership.

Antisocial-Delinquent Behaviors-Questionnaire (Seisdedos, 1995)

This includes a total of 40 items that assess antisocial (entering a forbidden place, throwing rubbish on the floor) and delinquent behaviors (using drugs, stealing, etc.).

Internal consistency was analyzed by the coefficient Kuder-Richardson (KR-20) for each of the scales of Interpersonal Values Questionnaire (K-R20$_S$ = 0.74; K-R20$_C$ = 0.81; K-R20$_R$ = 0.77; K-R20$_I$ = 0.81; K-R20$_B$ = 0.85; K-R20$_L$ = 0.78), and scale of criminal behavior of Antisocial-Delinquent Behaviors Questionnaire (K-R20$_{ADd}$ = 0.87). In general, the internal consistency coefficients obtained for scales in the study sample were high (>0.70), indicating adequate homogeneity among the items of the questionnaires.

Procedure

We contacted the headmasters and guidance counselors of the selected schools to present the goals of the study and the instruments to be used therein. If they expressed interest in participating, we requested their permission and the necessary collaboration to carry out the study. This study was exempt from ethical approval, because the study did not involve any potential risk for the participants. All participants provided written consent. We held a meeting with the parents and the principal researchers and, after informing the parents, we obtained their consent for their children to participate in the study. We then scheduled the application of the questionnaires. The questionnaires were administered in two 50-min sessions, with a variable resting time between them, separated either by a class and a recess, or simply a recess, with more than 20 min between sessions. The questionnaires were administered collectively in the classroom or in one of the spaces of the school if various classes were grouped together. The questionnaires were voluntary and anonymous.

Data Analysis

For the present study, we used a cross-sectional, descriptive, and correlational design in order to determine the relations between interpersonal values (stimulation, conformity, recognition, independence, benevolence, and leadership) and delinquent behaviors, as well as the relationship between these two aspects with the subjects' academic performance, measured as a function of having failed a subject and having repeated a course (failing and repeating).

After the normal distribution of all the SIV scales (Gordon, 1977) had been determined, we identified the criterion to define the thresholds (high and low) of the sample on these scales. Thus, the total sample of subjects ($N = 885$) was divided into two groups for each one of the scales: (a) students with low scores on Stimulation, Conformity, Recognition, Independence, Benevolence, and Leadership, that is, who obtained scores equal to or lower than percentile 25 (scores equal to or higher than 14, 11, 8, 13, 14, and 7, respectively; $n_{2S} = 233$; 26.3%; $n_{2C} = 235$; 26.6%; $n_{2A} = 218$; 24.6%; $n_{2I} = 237$; 26.8%; n_{2B}

= 262; 29.6%; n_{2L} = 240; 27.1%); (b) students with high scores on Stimulation, Conformity, Recognition, Independence, Benevolence, and Leadership, that is, who obtained scores equal to or higher than percentile 75 (scores equal to or higher than 20, 19, 15, 21, 22, and 14, respectively) ($n_{1S} = 291$; 32.9%; $n_{1C} = 227$; 25.6%; $n_{1A} = 238$; 26.9%; $n_{1I} = 268$; 30.3%; $n_{1B} = 248$; 28%; $n_{1L} = 246$; 27.8%).

We used Student's *t*-test to analyze the differences between individuals with high and low scores on the SIV Questionnaire scales, between students who had/had not failed, as well as between students who had/had not repeated a course, regarding delinquent behavior. To determine the magnitude of the effect size of the significant differences yielded by the *t*-test, we used Cohen's *d* index, the interpretation of which is: $d \leq 0.50$ indicates a small effect size; $d \leq 0.79$ indicates a medium effect size; and $d \geq 0.80$ indicates a large effect size.

In order to analyze the predictive capacity of interpersonal values and academic performance on delinquent behaviors, we performed binary logistic regression analysis, using the forward stepwise regression procedure based on Wald's statistic. Thus, the six predictor variables (stimulation, conformity, recognition, independence, benevolence, and leadership) and the criterion variable (delinquent behavior) were divided as a function of high and low thresholds, maintaining for the predictor variables the one used in the previous test. Regarding the predictor variables failing and repeating, it was not necessary to establish any threshold because the students were grouped as a function of whether or not they had that characteristic. To classify the sample according to delinquent behavior, we followed the same criterion as with the SIV Questionnaire, dividing the sample into subjects with high and low scores as follows: (a) subjects scoring high in delinquent behavior were those who scored equal to or higher than percentile 75 (scores equal to or higher than 3; $N_1 = 247$; 27.9%); (b) subjects with low scores in delinquent behavior were those who scored equal to or lower than percentile 25 (scores equal to 0; $N_2 = 373$; 42.1%).

This model allows determining the probability of occurrence of a certain fact or event (e.g., aggressive behavior) in the presence one or various predictors (e.g., high scores in stimulation, conformity, recognition, independence, benevolence, and leadership, failing, or repeating) using the Odds Ratio (OR) statistic to estimate this probability both in the total sample and in the sample as a function of the variables gender, failing, and repeating.

TABLE 1 | Difference of means in delinquent behaviors and interpersonal values in students who had not and who had failed.

	Did not fail			Failed			Statistical significance		
Total	***N***	***M***	***SD***	***N***	***M***	***SD***	t_{860}	***p***	***d***
SIV-S	155	17.81	4.34	715	17.30	4.42	1.31	0.19	0.12
SIV-C	153	15.27	5.45	709	14.76	5.27	1.09	0.27	0.1
SIV-R	155	10.17	4.10	712	12.08	4.66	−4.71	0.00	0.42
SIV-I	153	17.95	5.68	711	17.21	5.79	1.45	0.14	0.13
SIV-B	154	19.16	5.90	712	17.43	5.83	3.32	0.01	0.3
SIV-L	151	9.39	5.12	708	11.08	4.90	−3.82	0.00	0.34
Delinquent behavior	156	1.01	2.28	729	2.46	3.46	−6.53	0.00	0.58
Male	***N***	***M***	***SD***	***N***	***M***	***SD***	t_{424}	***p***	***d***
SIV-S	64	17.92	4.40	369	17.13	4.45	1.31	0.19	0.18
SIV-C	63	15.10	5.61	363	14.35	5.14	1.05	0.29	0.14
SIV-R	63	11.05	4.39	368	13.04	4.58	−3.20	0.01	0.44
SIV-I	64	17.09	5.98	366	17.31	5.73	−0.27	0.78	0.04
SIV-B	64	18.67	6.13	365	15.99	5.85	3.35	0.01	0.46
SIV-L	63	9.84	5.41	367	12.04	5.03	−3.17	0.01	0.43
Delinquent behavior	64	1.50	3.11	377	3.34	4.10	−4.16	0.00	0.56
Female	***N***	***M***	***SD***	***N***	***M***	***SD***	t_{434}	***p***	***d***
SIV-S	91	17.74	4.32	346	17.48	4.39	0.49	0.62	0.06
SIV-C	90	15.40	5.36	346	15.19	5.39	0.33	0.74	0.04
SIV-R	92	9.58	3.80	344	11.06	4.53	−3.19	0.01	0.37
SIV-I	89	18.57	5.41	345	17.10	5.85	2.14	0.03	0.26
SIV-B	90	19.50	5.73	347	18.95	5.41	0.85	0.39	0.1
SIV-L	88	9.07	4.91	341	10.05	4.55	−1.77	0.07	0.21
Delinquent behavior	92	0.66	1.36	352	1.52	2.26	−4.60	0.00	0.54

SIV-S, Stimulus; SIV-C, Conformity; SIV-R, Acknowledgement; SIV-I, Independence; SIV-B, Benevolence; SIV-L, Leadership.

TABLE 2 | Difference of means in delinquent behaviors values and interpersonal values in repeater and non-repeater students.

	Non-repeaters			Repeaters			Statistical significance		
Total	***N***	***M***	***SD***	***N***	***M***	***SD***	t_{860}	***p***	***d***
SIV-S	600	17.79	4.42	270	16.51	4.27	3.99	0.00	0.29
SIV-C	594	14.85	5.39	268	14.86	5.12	−0.03	0.98	0
SIV-R	599	11.66	4.60	268	11.91	4.66	−0.75	0.45	0.05
SIV-I	596	17.29	5.79	268	17.45	5.75	−0.37	0.71	0.03
SIV-B	600	17.85	5.94	266	17.48	5.74	0.86	0.39	0.06
SIV-L	592	10.35	5.10	267	11.75	4.56	−3.84	0.00	0.28
Delinquent behavior	612	1.82	2.96	273	3.06	3.91	−4.65	0.00	0.38
Male	***N***	***M***	***SD***	***N***	***M***	***SD***	t_{424}	***p***	***d***
SIV-S	296	17.68	4.44	137	16.32	4.33	2.98	0.01	0.31
SIV-C	291	14.32	5.39	135	14.76	4.80	−0.82	0.41	0.08
SIV-R	295	12.66	4.72	136	12.93	4.33	−0.56	0.57	0.06
SIV-I	296	17.31	5.89	134	17.19	5.50	0.21	0.83	0.02
SIV-B	295	16.40	6.14	134	16.38	5.60	0.03	0.97	0
SIV-L	294	11.42	5.33	136	12.36	4.64	−1.77	0.07	0.18
Delinquent behavior	302	2.56	3.69	139	4.18	4.47	−3.73	0.00	0.41
Female	***N***	***M***	***SD***	***N***	***M***	***SD***	t_{434}	***p***	***d***
SIV-S	304	17.90	4.40	133	16.71	4.22	2.64	0.01	0.27
SIV-C	303	15.36	5.35	133	14.95	5.45	0.72	0.47	0.08
SIV-R	304	10.69	4.26	132	10.87	4.78	−0.39	0.69	0.04
SIV-I	300	17.27	5.69	134	17.71	6.00	−0.73	0.46	0.08
SIV-B	305	19.26	5.38	132	18.60	5.69	1.16	0.24	0.12
SIV-L	298	9.29	4.64	131	11.11	4.41	−3.81	0.00	0.4
Delinquent behavior	310	1.11	1.73	134	1.89	2.80	−2.99	0.01	0.37

SIV-S, Stimulus; SIV-C, Conformity; SIV-R, Acknowledgement; SIV-I, Independence; SIV-B, Benevolence; SIV-L, Leadership.

Lastly, to analyze conjointly the scores of the subgroups derived from the interaction of the predictor variables (failing, repeating, and interpersonal values), we carried out a two-factor ANOVA with interaction.

RESULTS

Delinquent Behaviors and Interpersonal Values As a Function of Failing and Repeating

Observing the mean scores for delinquent behavior and the different interpersonal values as a function of the variable failing, students who had failed a subject presented significantly higher mean scores in delinquent behaviors, recognition, and leadership, with small effect sizes ($d \leq 0.50$), except for delinquent behaviors, where the effect was medium ($d = 0.58$). On the other hand, significantly higher scores were only found in the value benevolence for students who had never failed and, again in this case, the effect of the variable failing was small ($d = 0.30$).

When addressing gender, we observed that the same results were repeated in the groups of males and females, except that for the females, no differences were found in the mean score of the value leadership (see **Table 1**).

The analysis of the mean scores of interpersonal values and delinquent behaviors as a function of repeating/not repeating a course (see **Table 2**) revealed significantly higher scores in leadership and delinquent behaviors for repeaters, with a small effect for the variable repeating in both cases ($d \leq 0.50$), whereas non-repeaters presented significantly higher scores in stimulation, also with a small effect for the variable repeating ($d = 0.29$). The same thing occurred in the analysis as a function of gender in the group of males and females, except that in the males, no differences in the mean scores of leadership were obtained.

Delinquent Behaviors in Students with High and Low Scores in Interpersonal Values

Table 3 presents the differences in the presence of delinquent behaviors between students with high and low scores in the diverse SIV scales, in the total sample, as well as according to gender, failing, and repeating a course. For the total sample, all the scales presented significant differences except for the value stimulation. Thus, students with high levels of recognition, independence, and leadership showed significantly higher levels of delinquent behaviors, with a small effect size of the values recognition and leadership ($d = 0.28$ and $d = 0.49$, respectively), whereas the effect size of the value independence was medium (d

TABLE 3 | Difference of means in delinquent behaviors in students low and high levels in interpersonal values.

SIV		Low Level			High Level			Statistical significance		
Total		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{522}	***p***	***d***
Delinquent behavior	SIV-S	233	2.18	3.55	291	1.91	2.58	0.97	0.33	0.09
	SIV-C	235	3.32	3.76	227	1.37	2.57	6.55	0.00	0.61
	SIV-R	218	1.82	2.90	238	2.78	3.81	−3.02	0.01	0.28
	SIV-I	237	1.33	2.52	268	3.11	3.94	−6.11	0.00	0.53
	SIV-B	262	3.14	3.89	248	1.16	1.98	7.30	0.00	0.64
	SIV-L	240	1.53	2.58	246	3.15	3.87	−5.41	0.00	0.49
Male		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{251}	***p***	***d***
Delinquent behavior	SIV-S	115	3.23	4.31	138	2.29	3.03	1.96	0.05	0.26
	SIV-C	127	4.32	4.32	105	2.18	3.32	4.16	0.00	0.55
	SIV-R	82	2.51	3.33	151	3.42	4.31	−1.79	0.07	0.23
	SIV-I	111	2.07	3.32	133	4.02	4.62	−3.82	0.00	0.48
	SIV-B	167	3.61	4.25	91	1.70	2.61	4.45	0.00	0.51
	SIV-L	94	2.37	3.43	161	3.84	4.31	−2.98	0.01	0.37
Female		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{269}	***p***	***d***
Delinquent behavior	SIV-S	118	1.15	2.19	153	1.56	2.05	−1.58	0.11	0.19
	SIV-C	108	2.15	2.53	122	0.66	1.35	5.47	0.00	0.75
	SIV-R	136	1.40	2.53	87	1.66	2.38	−0.74	0.46	0.11
	SIV-I	126	0.68	1.17	135	2.22	2.89	−5.71	0.00	0.69
	SIV-B	95	2.31	2.98	157	0.84	1.41	4.49	0.00	0.69
	SIV-L	146	0.99	1.63	85	1.84	2.38	−2.89	0.01	0.44
Did not fail		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{96}	***p***	***d***
Delinquent behavior	SIV-S	38	1.29	3.82	60	0.84	1.21	0.86	0.39	0.18
	SIV-C	40	1.50	1.98	44	0.55	0.99	2.75	0.01	0.61
	SIV-R	57	0.88	1.46	22	0.78	1.02	0.29	0.77	0.07
	SIV-I	35	0.52	0.85	52	1.67	3.21	−2.47	0.02	0.55
	SIV-B	36	0.89	1.72	64	0.64	1.20	0.85	0.39	0.18
	SIV-L	58	0.64	1.22	24	1.25	2.05	−1.36	0.18	0.41
Failed		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{424}	***p***	***d***
Delinquent behavior	SIV-S	195	2.35	3.48	231	2.19	2.77	0.54	0.59	0.05
	SIV-C	195	3.69	3.93	183	1.56	2.79	6.12	0.00	0.63
	SIV-R	161	2.16	3.20	216	2.98	3.93	−2.23	0.03	0.23
	SIV-I	202	1.48	2.68	216	3.46	4.03	−5.96	0.00	0.58
	SIV-B	226	3.49	4.02	184	1.34	2.16	6.94	0.00	0.69
	SIV-L	182	1.82	2.82	222	3.35	3.97	−4.52	0.00	0.45
Non-repeater		***N***	***M***	***SD***	***N***	***M***	***SD***	t_{361}	***p***	***d***
Delinquent behavior	SIV-S	142	1.64	2.99	221	1.78	2.50	−0.49	0.62	0.05
	SIV-C	165	3.25	3.74	161	.96	1.69	7.15	0.00	0.79
	SIV-R	156	1.38	2.42	156	2.61	3.68	−3.50	0.01	0.4
	SIV-I	170	1.17	2.18	183	2.61	3.43	−4.75	0.00	0.5
	SIV-B	172	2.73	3.55	178	0.98	1.76	5.80	0.00	0.63
	SIV-L	191	1.23	2.07	145	2.83	3.78	−4.60	0.00	0.55

(Continued)

TABLE 3 | Continued

SIV		Low Level			High Level			Statistical significance		
Repeater		*N*	*M*	*SD*	*N*	*M*	*SD*	t_{159}	*p*	*d*
Delinquent behavior	SIV-S	91	3.01	4.16	70	2.30	2.82	1.29	0.19	0.2
	SIV-C	70	3.50	3.82	66	2.36	3.81	1.74	0.08	0.3
	SIV-R	62	2.94	3.65	82	3.09	4.06	−0.23	0.81	0.04
	SIV-I	67	1.75	3.20	85	4.19	4.71	−3.80	0.00	0.6
	SIV-B	90	3.91	4.37	70	1.60	2.41	4.25	0.00	0.64
	SIV-L	49	2.72	3.79	101	3.60	3.98	−1.30	0.19	0.23

SIV-S, Stimulus; SIV-C, Conformity; SIV-R, Acknowledgement; SIV-I, Independence; SIV-B, Benevolence; SIV-L, Leadership.

= 0.53). Students with low levels of conformity and benevolence displayed significantly higher levels of delinquent behaviors, in both cases with a medium effect size of both values ($d \geq 0.50$).

In the analysis as a function of gender, we observed that males and females with high levels of independence and leadership both presented significantly higher mean levels of delinquent behaviors, with a small effect size in all cases ($d \leq 0.50$), except for the females in the value independence, where the effect of delinquent behaviors was medium ($d = 0.69$).

Regarding the variable failing, as in the total sample, the students who had failed and who presented high levels in recognition, independence, and leadership also displayed significantly levels higher in antisocial behaviors with a small effect size ($d \leq 0.50$), except for the value independence, where the effect was medium ($d = 0.58$). In the group of students who did not fail, only the value independence had an effect on delinquent behaviors, with a medium effect ($d = 0.58$); the mean level of delinquent behaviors was statistically higher among students with high levels of independence. In the group of students who had failed, those with low levels of conformity and benevolence obtained significantly higher mean scores in antisocial behaviors, with a medium effect size for both values ($d \geq 0.50$). This same result was observed in the group of students who did not fail, but only for the value conformity, with a medium effect of this value on delinquent behavior.

Lastly, with regard to repeating a course, non-repeaters who scored high on the scales of recognition, independence, and leadership also obtained significantly higher mean levels of delinquent behaviors, with effect sizes of $d = 0.40$, $d = 0.50$, and $d = 0.55$, respectively. This effect was also observed for the value independence among repeaters. Likewise, non-repeaters with low levels of conformity and benevolence presented higher mean levels of delinquent behaviors, with a medium effect size for both values ($d \geq 0.50$). This same relation was observed among repeaters between the value benevolence and delinquent behaviors, with the same effect size as in the non-repeaters.

Do Interpersonal Values Predict Delinquent Behaviors?

Table 4 presents the probability of presenting high levels of delinquent behavior derived from the binary logistic regression in the total sample, considering the variables gender, failing, and repeating. The correct percentages of classification ranged between 57.4 and 69.8% for recognition and conformity, respectively. Regarding gender, for males, the correct classification ranged from 57.7% for the factor leadership to 67.4% for the factor conformity. With regard to the females, the correct classification ranged between 71.6% for independence and 74.4% for conformity. Concerning failing, the percentages for those who had failed a subject ranged from 62.2% for leadership to 70.6% for conformity, but recognition did not enter the model. In the group of students who had never failed, the correct percentages ranged from 80.3% for independence to 81.4% for conformity. In the analysis of the groups of repeaters and non-repeaters, the levels of correct classification ranged between 64% for recognition and 72.1% for conformity. In the group of repeaters, the correct classification ranged from 72.6% for the factor independence to 69.6% for the factor benevolence. Nagelkerke's R^2 ranged between 0.02 for the females in the factor leadership and 0.28 for the non-repeaters in the factor conformity.

The analysis and interpretation of the OR data obtained in total sample indicate that the probability of presenting high levels of delinquent behavior is: (a) 4.58 times higher in students with high independence, (b) 3.34 times higher in students with high leadership, (c) 1.77 times higher in students with high recognition, (d) 0.21 times lower in students with high benevolence, and (e) 0.18 times lower in students with high conformity.

In the analysis as a function of gender and the variables failing and repeating, the probability of presenting high levels of delinquent behavior is: (a) 0.24 (males), 0.11 (females), 0.21 (NOT failing), 0.17 (Failing), and 0.11 (Non-repeater) times lower in students with high conformity; (b) 0.07 (Non-repeater) times higher in students with high recognition; (c) 3.14 (males), 7.45 (females), 0.24 (NOT failing), 5.33 (Failing), 4.08 (Non-repeater), and 7 (Repeater) times higher in students with high independence; (d) 0.36 (males), 0.16 (females), 0.28 (Failing), 0.20 (Non-repeater), and 0.20 (Repeater) times lower in students with high benevolence; and (e) 1.09 (males), 0.03 (females), 2.82 (Failing), and 3.25 (Non-repeater) times higher in students with high leadership.

TABLE 4 | Logistic regression of the probability of high delinquent behaviors.

Total	***B***	***SE***	**Wald**	***p***	**OR**	**95% CI**	**Nagelkerke R^2**	**Correctly classified %**
SIV-C (low level)	−1.73	.25	49.393	0.00	0.18	0.11–0.29	0.21	69.8
SIV-R (high level)	0.57	0.22	6.497	0.01	1.77	1.14–2.76	0.03	57.4
SIV-I (high level)	1.52	0.24	40.718	0.00	4.58	2.87–7.30	0.16	66.7
SIV-B (low level)	−1.58	0.24	43.749	0.00	0.21	0.13–0.33	0.17	67.1
SIV-L (high level)	1.21	0.23	27.461	0.00	3.34	2.13–5.24	0.11	64
Male	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**Nagelkerke R^2**	**Correctly classified %**
SIV-C (low level)	−1.41	0.33	18.34	0.00	0.24	0.13–0.47	0.14	67.4
SIV-I (high level)	1.14	0.32	12.92	0.00	3.14	0.00–3.14	0.10	64
SIV-B (low level)	−1.02	0.32	9.96	0.01	0.36	0.19–0.68	0.07	61.9
SIV-L (high level)	0.08	0.02	13.39	0.00	1.09	1.04–1.14	0.06	57.7
Female	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**Nagelkerke R^2**	**Correctly classified %**
SIV-C (low level)	−2.22	0.44	25.12	0.00	0.11	0.04–0.26	0.27	74.4
SIV-I (high level)	2.01	0.40	25.23	0.00	7.45	3.40–16.32	0.23	71.6
SIV-B (low level)	−1.85	0.38	23.14	0.00	0.16	0.07–0.33	0.20	73.7
SIV-L (high level)	0.06	0.03	4.20	0.06	0.03	1.00–1.12	0.02	74
Did not fail	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**Nagelkerke R^2**	**Correctly classified %**
SIV-C (low level)	−1.58	0.74	4.55	0.03	0.21	0.05–0.88	0.13	81.4
SIV-I (constant)	−1.41	0.32	19.08	0.00	0.24	–	–	80.3
Failed	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**Nagelkerke R^2**	**Correctly classified %**
SIV-C (low level)	−1.77	0.27	43.33	0.00	0.17	0.10–0.29	0.22	70.6
SIV-I (high level)	1.67	0.26	41.74	0.00	5.33	3.21–8.85	0.19	69.3
SIV-B (low level)	−1.63	0.26	37.57	0.00	0.20	0.12–0.33	0.18	68.3
SIV-L (high level)	1.04	0.25	17.30	0.00	2.82	1.73–4.59	0.08	62.2
Non-repeater	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**Nagelkerke R^2**	**Correctly classified %**
SIV-C (low level)	−2.16	0.33	43.43	0.00	0.11	0.06–0.22	0.28	72.1
SIV-R (high level)	1.01	0.29	12.01	0.01	2.76	1.55–4.89	0.07	64
SIV-I (high level)	1.41	0.29	22.68	0.00	4.08	2.29–7.27	0.13	65.3
SIV-B (low level)	−1.58	0.30	27.22	0.00	0.20	0.11–0.37	0.16	66.4
SIV-L (high level)	1.18	0.29	16.64	0.00	3.25	1.84–5.73	0.10	66.5
Repeater	***B***	***SE***	**Wald**	***p***	**OR**	**IC 95%**	**Nagelkerke R^2**	**Correctly classified %**
SIV-I (high level)	1.95	0.44	19.88	0.00	7.00	2.98–16.47	0.25	72.6
SIV-B (low level)	−1.63	0.41	15.56	0.00	0.20	0.09–0.44	0.19	69.6

SIV-S, Stimulus; SIV-C, Conformity; SIV-R, Acknowledgement; SIV-I, Independence; SIV-B, Benevolence; SIV-L, Leadership; B, coefficient; CI, 95% confidence interval.

Interpersonal Values Predicting Delinquent Behaviors: with and without Interaction with the Variables Failing and Repeating

We analyzed the scores obtained in the five factors as a function of both variables (failing and repeating), by means of a two-factor ANOVA with interaction, obtaining a significant interaction only between the factor benevolence and the variable failing, $F_{(1,\ 509)} = 7.4$, $p = 0.01$, $R^2 = 0.13$, as shown in **Figure 1**.

DISCUSSION

With regard to the first goal of this study, we note that the students who failed and the repeaters present higher means of delinquent behaviors, both in males and in females, with a medium effect of the variable failing ($d \leq 0.79$), and a small effect for the variable repeating ($d \leq 0.50$), respectively. These results are in line with those found by other studies relating low academic performance with delinquent actions (Briggs-Gowan

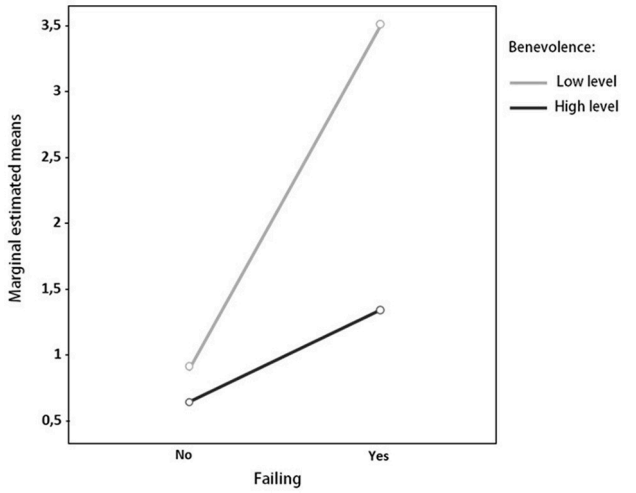


FIGURE 1 | Two-factor ANOVA with interaction: Failing and interpersonal value benevolence.

and Carter, 2008; Gázquez and Pérez-Fuentes, 2010; Preddy and Fite, 2012).

Not only students who fail, but also the repeaters present higher means in the values of recognition, as well as in the value of leadership. These differences are maintained in the groups of males and females who fail a subject, but only for the value recognition, with a small effect size ($d \leq 0.50$). On the other hand, students who had not failed obtained higher scores in the value benevolence, and non-repeaters in the value stimulation, with small effects ($d \leq 0.50$) of both variables, failing and repeating, respectively. Whereas in other studies, the value leadership is understood as prosocial leadership and is related to competence and social adaptation in adolescents (Jiménez and López-Zafra, 2011), in our study, leadership has a negative interpretation in the questionnaire that assesses it, because it refers to exerting authority over other people, that is, a position of control or power. Therefore, it may be appropriate to use another type of instrument that would allow us to measure this value positively in order to analyze the influence of prosocial leadership on adolescents' delinquent behavior.

The results achieved for our second goal reveal that students with high levels of recognition, independence, and leadership show significantly higher levels of delinquent behaviors, regardless of the variables failing and repeating and of gender concerning independence and leadership. Moreover, students with low levels of conformity and benevolence obtained significantly higher levels of delinquent behaviors, regardless of the variables failing and repeating. That is, individuals who like to be acknowledged, admired and approved of by others; who use their own criteria to decide what they have a right to do; who exert authority and power over others; who do not follow socially correct or appropriate norms or rules; and who are not very generous and do not help others-all these individuals present higher levels of delinquent behaviors.

Lastly, with regard to the third goal, the probability of presenting a high level of delinquent behavior is greater among students with: high independence, high leadership, high recognition, low benevolence, and low conformity. These five negative predictors should be the target of intervention in order to eliminate delinquent behavior.

Ultimately, we note the great importance of the interaction of benevolence and failing, which, when levels of benevolence are low and the student has failed some subject, leads to a considerable increase in delinquent behavior.

A limitation of this study is the sample, which, although representative, only included students from secondary education. A possible goal of future research is to carry out this same study with higher educational levels or in non-regulated studies, to determine whether the influence of interpersonal values on delinquent behaviors changes or remains the same.

Therefore, although the present study presents some limitations to be taken into account in future studies, it can be considered a precursor in a new line of research to clarify the relation between delinquent behavior and violence, adding to the diverse studies that have not clarified the relation between them. It may also be of great interest to the educational community because it contributes relevant data for the design of interventions promoting protector factors and reducing risk factors, for example, in the peer group (Knecht et al., 2010; Paciello et al., 2013). It is also of interest to parents and in order to elaborate programs targeting the parents, because, as indicated, family factors are highly involved in the origin of adolescents' delinquent behaviors (Martínez et al., 2013; Tolan et al., 2013).

AUTHOR CONTRIBUTIONS

The authors incorporated worked with AMM and ABBM in the literature search. The distribution of tasks would be as follows: MMJ and MCPF (Drafting and analysis of data). AMM, ABBM, and MMSM (bibliographic search). ALR Helped in the realization of the changes requested by the reviewer).

FUNDING

This work is the result of Research Project P08-SEJ-04305, co-financed by the Consejería de Innovación, Ciencia y Empresa (Council of Innovation, Science and Enterprise) of the Junta of Andalucía and FEDER.

REFERENCES

Álvarez, A., Suárez, N., Tuero, E., Núñez, J. C., Valle, A., and Regueiro, B. (2015). Implicación familiar, autoconcepto del adolescente y rendimiento académico [Family involvement, adolescent self-concept and academic achievement]. *Eur. J. Invest.* 5, 293–311. doi: 10.1989/ejihpe.v5i3.133

Azpiazu, L., Esnaola, I., and Sarasa, M. (2015). Capacidad predictiva del apoyo social en la inteligencia emocional en adolescentes [Predictive capacity of social

support on emotional intelligence in adolescence]. *Eur. J. Educ. Psychol.* 8, 23–29. doi: 10.1016/j.ejeps.2015.10.003

Briggs-Gowan, M. J., and Carter, A. S. (2008). Social-emotional screening status in early childhood predicts elementary school outcomes. *Pediatrics* 121, 957–962. doi: 10.1542/peds.2007-1948

Burt, S., and Donnellan, M. (2009). Development and validation of the subtypes of antisocial behavior questionnaire. *Aggress. Behav.* 35, 376–398. doi: 10.1002/ab.20314

de la Torre, M. J., Casanova, P. F., Villa Carpio, M., and Cerezo, M. (2013). Consistencia e inconsistencia parental: relaciones con la conducta agresiva and satisfacción vital de los adolescentes [Perceived interparental-consistency: relationships between aggressive behavior and life satisfaction in adolescents]. *Eur. J. Educ. Psychol.* 6, 135–149. doi: 10.1989/ejep.v6i2.112

Dishion, T. J., and Tipsord, J. M. (2011). Peer contagion in child and adolescent social and emotional development. *Ann. Rev. Psychol.* 62, 189–214. doi: 10.1146/annurev.psych.093008.100412

Fuentes, M. C., García, J. F., Gracia, E., and Lila, M. (2011). Autoconcepto y ajuste psicosocial en la adolescencia [Self-concept and psychosocial adjustment in adolescence]. *Psicothema* 23, 7–12.

Garaigordobil, M. (2005). Conducta antisocial durante la adolescencia: correlatos socioemocionales, predictores y diferencias de género [Antisocial behavior in adolescence: socioemotional correlates, predictors, and gender differences]. *Psicol. Conduct.* 13, 197–215.

Garaigordobil, M., and Oñederra, J. A. (2010). Inteligencia emocional en las víctimas de acoso escolar y en los agresores [Emotional intelligence in the victims of bullying and in the aggressors]. *Eur. J. Educ. Psychol.* 3, 243–256. doi: 10.1989/ejep.v3i2.63

Gázquez, J. J., and Pérez-Fuentes, M. C. (2010). "School violence and academic performance: instrument to diagnose performance profiles associated with violence in schools," in *School Coexistence. Psychological and Educational Aspects*, eds J. J. Gázquez and M. C. Pérez-Fuentes (Granada: GEU), 333–338.

Gázquez, J. J., Pérez-Fuentes, M. C., Carrión, J. J., Luque, A., and Molero, M. M. (2015a). Perfiles de valores interpersonales y análisis de conductas y actitudes sociales de adolescentes [Interpersonal value profiles and analysis to adolescent behavior and social attitudes]. *Rev. Psicodidáctica* 20, 321–337. doi: 10.1387/RevPsicodidact.12978

Gázquez, J. J., Sainz, J., Pérez-Fuentes, M. C., Molero, M. M., and Soler, F. J. (2015b). Interpersonal value profiles and analysis of adolescent academic performance and social thinking. *Front. Psychol.* 6:575. doi: 10.3389/fpsyg.2015.00575

Gordon, L. V. (1977). *Interpersonal Values Questionnaire (SIV)*. Madrid: TEA.

Harden, K. P., Quinn, P. D., and Tucker-Drob, E. M. (2012). Genetically influenced change in sensation seeking drives the rise of delinquent behavior during adolescence. *Dev. Sci.* 15, 150–163. doi: 10.1111/j.1467-7687.2011.01115.x

Harris-McKoy, D., and Cui, M. (2013). Parental control, adolescent delinquency, and young adult criminal behavior. *J. Child Fam. Stud.* 22, 836–843. doi: 10.1007/s10826-012-9641-x

Henry, K. L., Knight, K. E., and Thornberry, T. P. (2012). School disengagement as a predictor of dropout, delinquency, and problem substance use during adolescence and early adulthood. *J. Youth Adolesc.* 41, 156–166. doi: 10.1007/s10964-011-9665-3

Holtz, P., and Appel, M. (2011). Internet use and video gaming predict problem behavior in early adolescence. *J. Adolesc.* 34, 49–58. doi: 10.1016/j.adolescence.2010.02.004

Inglés, C. J., Gonzálvez-Maciá, C., García-Fernández, J. M., Vicent, M. V., and Martínez-Monteagudo, M. C. (2015). Current status of research on school refusal. *Eur. J. Educ. Psychol.* 8, 37–52. doi: 10.1016/j.ejeps.2015.10.005

Inglés, C. J., Torregrosa, M. S., García-Fernández, J. M., Martínez-Monteagudo, M. C., Estévez, E., and Delgado, B. (2014). Conducta agresiva e inteligencia emocional en la adolescencia [Aggressive behavior and emotional intelligence in adolescence]. *Eur. J. Educ. Psychol.* 7, 29–41.

Jiménez, M. I., and López-Zafra, E. (2011). Actitudes sociales y adaptación social en adolescentes españoles: el papel de la inteligencia emocional percibida [Social attitudes and social adjustment in Spanish adolescents: the role of perceived emotional intelligence]. *Rev. Psicol. Soc.* 26, 105–117. doi: 10.1174/021347411794078417

Jiménez, T. I., Murgui, S., Estévez, E., and Musitu, G. (2007). Family communication and delinquent behavior among Spanish adolescents: the mediating role of self-esteem. *Rev. Latinoam. Psicol.* 39, 473–485.

Knecht, A., Snijders, T. A., Baerveldt, C., Steglich, C. E., and Raub, W. (2010). Friendship and delinquency: selection and influence processes in early adolescence. *Soc. Dev.* 19, 494–514. doi: 10.1111/j.1467-9507.2009.00564.x

Lansford, J. E., Criss, M. M., Laird, R. D., Shaw, D. S., Pettit, G. S., Bates, J. E., et al. (2011). Reciprocal relations between parents' physical discipline and children's externalizing behavior during middle childhood and adolescence. *Dev. Psychopathol.* 23, 225–238. doi: 10.1017/S0954579410000751

Loeber, R., and Farrington, D. P. (2012). Advancing knowledge about direct protective factors that may reduce youth violence. *Am. J. Prev. Med.* 43, 24–25. doi: 10.1016/j.amepre.2012.04.031

López-Romero, L., Romero, E., and Luengo, M. A. (2011). La personalidad psicopática como indicador distintivo de severidad y persistencia en los problemas de conducta infanto-juveniles [The psychopathic personality as a distinctive indicator of the severity and persistence of child-youth behavior problems]. *Psicothema* 23, 660–665.

Lynam, D. R., Miller, D. J., Vachon, D., Loeber, R., and Stouthamer-Loeber, M. (2009). Psychopathy in adolescence predicts official reports of offending in adulthood. *Youth Violence Juv. J.* 7, 189–207. doi: 10.1177/1541204009333797

Ma, L., Phelps, E., Lerner, J. V., and Lerner, R. M. (2009). Academic competence for adolescents who bully and who are bullied. *J. Early Adolesc.* 29, 862–897. doi: 10.1177/0272431609332667

Martínez, G., and Gras, M. (2007). *La Conducta Antisocial Percibida por Adolescentes de Enseñanza Secundaria Obligatoria: Frecuencia, Contexto y Atribución Causal [Antisocial Behavior Perceived by Adolescents in Secondary Education: Frequency, Context, and Causal Attribution]*. Barcelona: Universidad de Barcelona.

Martínez, I., Fuentes, M., García, F., and Madrid, I. (2013). El estilo de socialización familiar como factor de prevención o riesgo para el consumo de sustancias y otros problemas de conducta en los adolescentes españoles [Family socialization style as a prevention or risk factor for substance consumption and other behavior problems in Spanish adolescents]. *Adicciones. Rev. Socidrogalcohol.* 25, 235–242. doi: 10.20882/adicciones.51

Muñoz, J., and Navas, E. (2004). Conducta antisocial en adolescentes: teorías explicativas psicosociales [Antisocial behavior in adolescents: psychosocial explanatory theories]. *Psiquis* 25, 79–86.

Nakamoto, J., and Schwartz, D. (2010). Is peer victimization associated with academic achievement? A meta-analytic review. *Soc. Dev.* 19, 221–242. doi: 10.1111/j.1467-9507.2009.00539.x

Paciello, M., Fida, R., Tramontano, C., Cole, E., and Cerniglia, L. (2013). Moral dilemma in adolescence: the role of values, prosocial moral reasoning and moral disengagement in helping decision making. *Eur. J. Dev. Psychol.* 10, 190–205. doi: 10.1080/17405629.2012.759099

Pahlavan, F., and Andreu, J. M. (2009). Sex-specific effects of sociocultural changing on aggression: fact or artefact? *J. Organ. Trans. Soc. Change* 2, 106–131. doi: 10.1386/jots.6.2.103_1

Patrick, C. J., Fowles, D. C., and Krueger, R. F. (2009). Triarchic conceptualization of psychopathy: developmental origins of disinhibition, boldness and meanness. *Dev. Psychopathol.* 21, 913–938. doi: 10.1017/S0954579409000492

Peach, H. D., and Gaultney, J. F. (2013). Sleep, impulse control, and sensation-seeking predict delinquent behavior in adolescents, emerging adults, and adults. *J. Adolesc. Health* 53, 293–299. doi: 10.1016/j.jadohealth.2013.03.012

Peña, M. E., and Graña, J. L. (2006). Agresión y conducta antisocial en la adolescencia: una integración conceptual [Aggression and antisocial behavior in adolescence: a conceptual integration]. *Psicopatol. Clín. Leg. Forense.* 1, 9–23.

Pérez-Fuentes, M. C., Gázquez, J. J., Mercader, I., Molero, M. M., and García, M. M. (2011). Rendimiento académico y conductas antisociales y delictivas en alumnos de educación secundaria obligatoria [Academic achievement and antisocial behavior in public secondary education students]. *Intern. J. Psychol. Psychol. Ther.* 11, 401–412.

Pérez-Fuentes, M. C., Gázquez, J. J., Molero, M. M., Cardila, F., Martos, A., Barragán, A. B., et al. (2015). Impulsividad y consumo de alcohol y tabaco en adolescentes [Adolescent impulsiveness and use of alcohol and tobacco]. *Eur. J. Invest.* 5, 371–382. doi: 10.1989/ejihpe.v5i3.139

Preddy, T. M., and Fite, P. J. (2012). Differential associations between relational and overt aggression and children's psychosocial adjustment. *J. Psychopathol. Behav. Assess.* 34, 182–190. doi: 10.1007/s10862-011-9 274-1

Seisdedos, N. (1995). *Cuestionario, A.-D., Conductas Antisociales-Delictivas [Antisocial-Delinquent Behaviors-Questionnaire]*. Madrid: TEA.

Siu, A. F. Y. (2009). Trait emotional intelligence and its relationships with problem behavior in Hong Kong adolescents. *Pers. Individ. Dif.* 47, 553–557. doi: 10.1016/j.paid.2009.05.004

Sousa, C., Herrenkohl, T. I., Moylan, C. A., Tajima, E. A., Klika, J. B., Herrenkohl, R. C., et al. (2011). Longitudinal study on the effects of child abuse and children's exposure to domestic violence, parent-child attachments, and antisocial behavior in adolescence. *J. Interpers. Violence* 26, 111–136. doi: 10.1177/0886260510362883

Thomas, C. R. (2010). "Oppositional defiant and conduct disorder," in *Dulcan's Textbook of Child and Adolescent Psychiatry*, ed M. K. Dulcan (Arlington, AL: American Psychiatric Publishing), 223–239.

Tolan, P. H., Dodge, K., and Rutter, M. (2013). "Tracking the multiple pathways of parent and family influence on disruptive behavior disorders," in *Disruptive Behavior Disorders*, eds P. H. Tolan and B. Leventhal (New York, NY: Springer), 161–191.

Valle, A., Regueiro, B., Rodríguez, S., Piñeiro, I., Freire, C., Ferradás, M., et al. (2015). Perfiles motivacionales como combinación de expectativas de autoeficacia y metas académicas en estudiantes universitarios [Motivational profiles as a combination of self-efficacy expectations and academic goals in university students]. *Eur. J. Educ. Psychol.* 8, 1–8.

Van der Graaff, J., Branje, S., De Wied, M., and Meeus, W. (2012). The moderating role of empathy in the association between parental support and adolescent aggressive and delinquent behavior. *Aggress. Behav.* 38, 368–377. doi: 10.1002/ab.21435

White, S. T., and Frick, P. J. (2010). "Callous-unemotional traits and their importance to causal models of severe antisocial behavior in youth," in *Handbook of Child & Adolescent Psychopathy*, eds R. T. Salekin and D. R. Lynam (New York, NY: Guilford Press), 135–155.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer DÁ and the handling Editor declared their shared affiliation, and the handling Editor states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2016 Molero Jurado, Pérez Fuentes, Luque De La Rosa, Martos Martínez, Barragán Martín and Simón Márquez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 October 2016
doi: 10.3389/fpsyg.2016.01554

Profiles of Psychological Well-being and Coping Strategies among University Students

Carlos Freire[1], María Del Mar Ferradás[1], Antonio Valle[1], José C. Núñez[2] and Guillermo Vallejo[2]*

[1] Research Group in Educational Psychology, Department of Evolutionary and Educational Psychology, University of A Coruña, A Coruña, Spain, [2] Department of Psychology, University of Oviedo, Oviedo, Spain

In the transactional model of stress, coping responses are the key to preventing the stress response. In this study, the possible role of psychological well-being as a personal determinant of coping strategies in the academic context was analyzed. Specifically, the study has two objectives: (a) to identify different profiles of students according to their level of psychological well-being; and (b) to analyze the differences between these profiles in the use of three coping strategies (positive reappraisal, support-seeking, and planning). Age, gender, and degree were estimated as covariables. A total of 1,072 university students participated in the study. Latent profile analysis was applied to four indices of psychological well-being: self-acceptance, environmental mastery, purpose in life, and personal growth. An optimal four-profile solution, reflecting significant incremental shifts from low to very high psychological well-being, was obtained. As predicted, the profile membership distinguished between participants in positive reappraisal, support-seeking, and planning. Importantly, the higher the profile of psychological well-being was, the higher the use of the three coping strategies. Gender differences in coping strategies were observed, but no interaction effects with psychological well-being were found. Age and degree were not relevant in explaining the use of coping strategies. These results suggest that psychological well-being stands as an important personal resource to favor adaptive coping strategies for academic stress.

Keywords: psychological well-being, academic stress, coping strategies, university students, latent profile analysis

OPEN ACCESS

Edited by:
Jesus De La Fuente, University of Almería, Spain

Reviewed by:
Christian Wandeler, California State University, Fresno, USA
James Rumbold, Sheffield Hallam University, UK

****Correspondence:***
Carlos Freire
carlos.freire.rodriguez@udc.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *24 June 2016*
Accepted: *23 September 2016*
Published: *13 October 2016*

Citation:
Freire C, Ferradás MM, Valle A, Núñez JC and Vallejo G (2016) Profiles of Psychological Well-being and Coping Strategies among University Students. Front. Psychol. 7:1554. doi: 10.3389/fpsyg.2016.01554

INTRODUCTION

In psychological research, stress is one of the variables of greatest impact due to its effect on people's health and well-being. This evidence contrasts with the minimal attention reserved for academic stress, particularly for student stress (Michie et al., 2001), despite the fact that research has shown its high prevalence among university students (Zajacova et al., 2005; Dyson and Renk, 2006). In fact, this prevalence is comparable to that of some clinical samples (e.g., González and Landero, 2007). In this sense, high levels of stress appear to negatively affect the quality of student learning (Lumley and Provenzano, 2003) and, even more importantly, students' physical (Loureiro et al., 2008) and psychological well-being (Garlow et al., 2008).

In this study, the role of psychological well-being as a coping resource in the academic context is analyzed. First of all, stress is defined with an emphasis on the importance of coping, taken as

a modulating variable of stress responses. Subsequently, we approach the concept of psychological well-being from a eudaimonic perspective and we analyze its possible role as a personal resource to favor adaptive coping for academic demands.

According to the widely accepted transactional model of stress (see Lazarus and Folkman, 1984), stress is a dynamic interaction process between the individual and his or her environment. Therefore, the stress response does not depend solely on the existence of an environmental stressor, but also on how this stressor is perceived by the person (cognitive appraisal) and what resources and strategies he or she uses to cope (coping process).

Cognitive appraisal comprises two interdependent processes: primary appraisal and secondary appraisal. Through primary appraisal, we judge whether the situation is irrelevant, positive, or stressful. That is, that the event is irrelevant because it does not bear any implications for our well-being; positive, in that the situation is favorable for the purpose of satisfying our personal goals; or stressful in that it requires the use of resources to cope because our well-being could otherwise be at risk (stress does not have to be negative but implies the need for an adaptive effort). In turn, the stressful situation may pose a threat where, we anticipate possible damage or loss before it occurs. It may also lead to loss or damage if damage has already occurred, with consequent damage to our esteem, health, family, and social relationships, among others, and we understand that the situation will remain unchangeable. The stressful situation may also be seen as a challenge when, we consider that despite difficulties, there is a chance of profit or benefits if, we mobilize adequate resources. Thus, threat and challenge appraisals lead to different coping expectancies, since the former are associated with a lower confidence on one's ability to cope with demands of stressful situations whereas challenge appraisals predict higher expectancies for successful coping (Skinner and Brewer, 2002). In secondary appraisal, we judge the resources at our disposal to successfully address the situation. In this process, we are aware of the discrepancy between our resources and coping strategies and the repertoire of resources and strategies required to address the stressful situation. The greater the discrepancy is, the more likely, we are to experience stress (Carver and Scheier, 1999).

Coping refers to cognitive, emotional, and/or behavioral efforts to address (master, reduce, or tolerate) a troubled person-environment relationship (Folkman and Lazarus, 1985). Accordingly, coping strategies play a crucial role in people's health (Kraag et al., 2006), with relevant implications for subjective well-being (e.g., Parsons et al., 1996; Sheldon and Lyubomirsky, 2006; Viñas et al., 2015) and psychological well-being (e.g., Loukzadeh and Bafrooi, 2013; Portocarrero and Bernardes, 2013; Bryden et al., 2015; Mayordomo et al., 2015).

Assuming that coping strategies are important for people's well-being, prolific research has focused on studying whether some coping mechanisms are more adaptive than others. Although the contextual nature of coping suggests that one strategy can be adaptive in one context but not in others (Endler et al., 1994), approach coping is generally considered more adaptive than avoidant coping (e.g., Gustems-Carnicer and Calderón, 2013; Syed and Seiffge-Krenke, 2015). Approach copping involves the cognitive, emotional, or behavioral strategies aimed at either resolving the stressful situation or modifying the underlying negative emotions. Conversely, avoidant coping involves the adoption of cognitive, emotional, or behavioral strategies aimed at avoiding having to deal with the problem or negative emotions that would result from the stressful situation (Endler and Parker, 1990). Based on this approach, Skinner et al. (2013), using a variety of studies as the background, comprehensively reviewed the coping procedures that proved to be effective and those that proved to be dysfunctional in the academic domain. According to their findings, the most adaptive strategies for addressing academic demands are planning, seeking instrumental support, seeking comfort (e.g., emotional support), self-support (encouraging oneself), and commitment to the tasks. However, according to the researchers, experiencing cognitive confusion, being mentally estranged from the problems, hiding the problems from people who are close, systematically blaming oneself for all evils, ruminating on the problems, and projecting the responsibility for all negative matters onto others constitute dysfunctional strategies for students, given that they hinder the completion of the task and even increase emotional distress.

The complex structure of the coping process spans the existence of a set of hierarchical categories on which coping can be conceptualized (see Skinner et al., 2003 for a review). Indeed, coping strategies constitute an intermediate category, since they represent recognizable action schemas in dealing with stressful transactions that can be expressed at the lowest level by different responses (i.e., coping behaviors) according to a specific stressful event. At the same time, coping strategies can be classified into higher order categories, called coping resources, which involve a set of bio-psycho-social resources that take part in the coping efforts by either hindering or favoring them (Cohen and Edwards, 1989) and, consequently, increasing the vulnerability or resistance to stress. Thus, these personal resources are important determinants of coping strategies (Taylor, 1991; Skinner et al., 2003). Within this set of coping resources, psychological variables are receiving increasing attention. In this sense, increasing interests exist in the study of individual strengths and potentials as optimal resources to facilitate adaptive responses to daily academic challenges and adversities, and which encompass a majority of students (e.g., Martin and Marsh, 2009; Putwain et al., 2012). This research approach is well represented by the eudaimonic well-being perspective, which posits that the maximum development of individual potential (i.e., psychological well-being) is determined by six indicators of positive psychological functioning: self-acceptance (SA), environmental mastery (EM), positive relations with others, autonomy, purpose in life (PL), and personal growth (PG; Ryff, 1989).

An extensive body of research suggests that several variables that are closely linked to these six dimensions of psychological well-being favor the adoption of adaptive coping strategies in the academic context. Some of these variables are self-esteem (Cabanach et al., 2014), perceived control (Doron et al., 2009), quality of social support (Fernández-González et al., 2015), self-determination (Ryan and Deci, 2000), PL (Freire et al., 2015), and pursuit of self-realization (Miquelon and Vallerand, 2008).

However, to date, very few studies have examined the possible role of psychological well-being, considered a global construct, as a personal resource that could favor adaptive coping to academic demands. Based on this consideration, significant differences in coping strategies have been observed in adolescent students according to their level (high vs. low) of psychological well-being (González et al., 2002; Figueroa et al., 2005). Higher levels of psychological well-being led to the adoption of adaptive strategies such as commitment, positive reappraisal, or seeking for instrumental and emotional support. Conversely, students with lower levels of psychological well-being used dysfunctional coping strategies such as ignoring the problem, blaming themselves about the situation, or taking refuge in fantastic thoughts.

González et al. (2002) and Figueroa et al. (2005) used a median split technique to determine the level of psychological well-being in their samples. This technique has the disadvantage that it dichotomizes continuous variables, which underestimates the strength of relationships and reduces statistical power for detecting true effects (Maxwell and Delaney, 1993). Such statistical limitation can be overcome by adopting a person-centered approach that groups students who have a similar functioning on psychological well-being indicators (Bhullar et al., 2014).

Therefore, the primary objective of this study is to identify profiles of psychological well-being according to their functioning in the different dimensions that comprise psychological well-being. Based on the results obtained by González et al. (2002) and Figueroa et al. (2005), we hypothesize the identification of at least two quantitative profiles consisting of students who are either low or high in indices of psychological well-being. Our second objective is to determine whether the identified profiles of psychological well-being differ in terms of coping strategies that the students adopt to deal with academic demands. It is expected that students with high functioning on psychological well-being indices use adaptive coping strategies to a greater extent than students with a profile of low psychological well-being.

Our study focused on university students, a group that has not been examined by previous research. Although from a developmental perspective the university stage typically corresponds with adolescence, some authors postulated that within the heterogeneity in this age, university students constitute a particular group. As Rodríguez and Agulló (1999) stated, the formative capital of these students partially determines a lifestyle characterized by certain values, attitudes, and life experiences that distinguish them from other young people. This set of idiosyncratic characteristics and their interaction with the learning environment may influence the students' well-being (see Lazarus, 1999). Additionally, factors such as the transition and adaptation to the university context (Fisher, 1984), the evaluation stage (Cabanach et al., 2014), the work overload (Salanova et al., 2005), or the need for academic success that enables access to the labor market (Zeidner, 1995) contribute to stress reaching its highest point at the university stage (e.g., Dyson and Renk, 2006). All of this makes the study of the role played by psychological well-being on coping especially important among university students.

To achieve these objectives, we attempted to control for the effect of variables such as age and major, because previous studies have suggested that these variables are related to a differential use of academic stress coping strategies (e.g., Martín et al., 1997; Cassaretto et al., 2003). Controlling for the effect of gender is also important because a significant number of studies have shown that males and females use different academic coping mechanisms. While the latter would mainly choose searching for support, the former would be more likely to use some type of more direct action (Feldman et al., 2008; Matheny et al., 2008; Cabanach et al., 2013). Therefore, these three variables (age, major, and gender) could significantly affect the research results.

MATERIALS AND METHODS

Participants

The study was conducted with students from the University of A Coruña, a small university in northern Spain with 21,362 students. Considering that, with a confidence level of 95% and a maximum margin of error of 5%, the minimum sample size required for this study was 400 subjects. Because the selection of the sample was not random, we wanted to work with a sufficiently large number of subjects so that the results would be as generalizable as possible.

Thus, a total of 1,072 students between 18 and 48 years of age ($M = 21.09$; $SD = 3.16$) participated in the study. With regard to gender, 68% ($n = 729$) were women and 32% ($n = 343$) were men. Of the total sample, 35.7% ($n = 383$) were pursuing degrees in Education Sciences (Early Childhood Education, Primary Education, Physical Education, Hearing and Language, Social Education and Speech Therapy, and Educational Psychology); 19% ($n = 203$) were pursuing degrees in the Health Sciences (Physiotherapy, Nursing, and Sciences of Physical Activity and Sport); 26% ($n = 279$) of the participants were studying technical majors (Architecture, Engineering, and Technical Architecture and Engineering of Roads, Channels, and Ports); and 19.3% ($n = 207$) were pursuing degrees in the legal and social fields (Law and Sociology). Regarding the grade variable, 28.4% of the subjects ($n = 304$) were in their first year of study; 28.6% ($n = 307$) in their second; 28.2% ($n = 302$) in their third; and 8.5% ($n = 91$) and 6.3% ($n = 68$) in their fourth and fifth years, respectively.

Instruments

Psychological Well-being

The Spanish adaptation of the Ryff Scales of Psychological Well-being (Díaz et al., 2006) was used to measure psychological well-being. This instrument contains 29 items that assess the six dimensions of eudaimonic well-being proposed by Ryff (1989): SA, positive relationships with others, autonomy, EM, PL, and PG. However, previous studies with both elderly people (Tomás et al., 2012) and university students (Freire et al., 2016) have shown through confirmatory factor analysis

(CFA) that the structure with the best fit included only the four dimensions constituting the core of psychological well-being (Springer and Hauser, 2006): SA (three items; e.g., "In general, I feel confident and positive about myself"); PG (four items; e.g., "I have the sense that I have developed a lot as a person over time"); EM (five items; e.g., "In general, I feel I am in charge of the situation in which I live"); and PL (six items; e.g., "I clearly understand the direction and purpose of my life"). In our study, this structure has shown a good fit to the empirical data: χ^2/degrees of freedom (χ^2/DF = 2.95); $p < 0.001$; goodness-of-fit index (GFI = 0.97); adjusted goodness-of-fit index (AGFI = 0.95); comparative fit index (CFI = 0.96); parsimony comparative fit index (PCFI = 0.75); Tucker Lewis index (TLI = 0.95); and root mean square error of approximation (RMSEA = 0.04). The factors for internal consistency were as follows: SA ($\alpha = 0.78$), PG ($\alpha = 0.63$), EM ($\alpha = 0.63$), and PL ($\alpha = 0.75$). The students responded to the items through a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Higher scores reflect higher levels in each dimension of psychological well-being.

Coping Strategies

The instrument used to measure coping strategies was the Coping Scale of Academic Stress Questionnaire (Escala de Afrontamiento del Cuestionario de Estrés Académico, A-CEA) by Cabanach et al. (2010). The scale contains 23 items that assess three academic coping mechanisms: *positive reappraisal*, understood as a coping strategy aimed at changing the meaning of a problematic situation, highlighting its positive aspects and activating positive expectations (10 items; e.g., "When I am faced with a problematic situation, I forget unpleasant aspects and highlight the positive ones"); *support-seeking*, which involves both seeking advice and information on how to resolve a problem, and seeking understanding and support for the emotional state caused by the problem (seven items; e.g., "When I am faced with a problematic situation, I ask for advice from a family member or a close friend"); and *planning*, aimed at analyzing and designing an action plan intended to solve a problematic situation (six items; e.g., "When I am faced with a difficult situation, I list the tasks that I have to fulfill, I complete them one at a time, and I do not go to the next step until I have completed the previous one"). To contextualize the use of coping strategies in the academic context, the participants received the following written clarification at the beginning of the test: "read each item carefully and indicate to what extent you behaved accordingly when faced with an academic problematic situation." This three-component structure has shown good psychometric properties (α between 0.81 and 0.91) in previous studies with university populations (e.g., Cabanach et al., 2009, 2013) and showed a good fit to the empirical data in the present study (χ^2/DF = 3.74; $p < 0.001$; GFI = 0.95; AGFI = 0.94; IFC = 0.95; PCFI = 0.79; TLI = 0.95; RMSEA = 0.05) as well as adequate reliability: positive reappraisal ($\alpha = 0.86$), support-seeking ($\alpha = 0.90$), and planning ($\alpha = 0.81$). The participant responses were collected using a five-point Likert scale ranging from 1 (*never*) to 5 (*always*).

Procedure

The study was carried out in accordance with the recommendations of the Ethics Committee of the University of A Coruña and the American Psychological Association with written consent from all subjects in accordance with the Declaration of Helsinki. Thus, prior to participation, students were informed about the goals of the research, duration, procedure, and anonymity of their data. Participation in the study was voluntary, and students were assured that all of their responses would remain confidential and used for research purposes only. Data were collected in each of the centers attended by the students who participated in the investigation, in the classroom and during school hours. The questionnaires were administered in a single session by trained personnel.

Data Analysis

A latent profile analysis (LPA) (Lanza et al., 2003) was performed to obtain the categorical latent variables that can group people into classes based on their characteristics. The objective of this analysis was to classify individuals from a heterogeneous population into smaller homogeneous subgroups based on individual values from numerical variables. This approach uses all of the information available in the numeric dependent variables to classify subjects into various classes using the maximum likelihood estimation method (Little and Rubin, 1987). Through this approach, the probability that an individual is correctly categorized, which enables each person to be placed in the class with best fit, is estimated simultaneously with the global model. In this study, the Mplus program version 6.11 (Muthén and Muthén, 1998–2012) was used to determine which model among a finite set of models best fit the data, adding successive latent classes to the target model. As a rule, the optimum number of classes in the data sample is selected using the adjusted Lo-Mendell-Rubin maximum likelihood ratio test (LMRT) (Lo et al., 2001), the Akaike information criterion (AIC), Schwarz's Bayesian information criterion (BIC), and the sample-size adjusted BIC (SSA-BIC), in addition to the entropy value. In this work, we also used the sample sizes for all of the subgroups as criteria.

The p value associated with the LMRT indicates whether the solution with more ($p < 0.05$) or fewer classes ($p > 0.05$) is the solution that best fits the data. The AIC, BIC, and SSA-BIC criteria are descriptive fit indices where lower values indicate a better fit of the model. It is desirable for these criteria to complement the information provided by the formal test of conditional fit, but the former should never replace the latter because formal testing ultimately determines the decision. Similarly, it should be noted that small classes (those containing less than 5% of the sample) are typically considered spurious classes, a condition that is often associated with the removal of an excessive number of profiles (Hipp and Bauer, 2006). Therefore, in addition to the substantive meaning of each solution, parsimony, and/or theory (i.e., structure of psychological well-being, according to Ryff, 1989) and the quality of the obtained solution, the size of the classes must also be considered to select the optimal number of classes.

To avoid biases in the standard errors as much as possible, the fact that the students were pursuing over 15 different degrees was taken into account in the data analysis. Indeed, it was expected that students completing the same degree were more homogeneous regarding their psychological well-being than those pursuing different degrees. In other words, homogeneity would be lower if the subjects were considered as independently sampled units without any relationship between them. Because the bootstrapped likelihood ratio (BLRT) is not available when using the clustering option in Mplus, the only formal test reported here is the LMRT referred to above.

Another approach considered in the assessment of the selected model concerns the analysis of the differences between classes in relation to the variables comprised in them. It was expected that the differences between classes in the criterion variables would be significant. Cohen's *d* was used to assess the effect size.

Finally, the relationship between the profiles of psychological well-being (latent classes) and the use of academic stress coping strategies was studied through multivariate analysis of covariance (MANCOVA). As a strategy for statistical control of unwanted effects in the estimation of the type of profile of psychological well-being and the use of coping strategies, three covariates were included in the model (age, major, and gender). The three covariates were not significantly related to the explanatory variables (the type of profile of psychological well-being): age [$F(3,1068) = 2.25$, $p > 0.05$], major [$F(3,1068) = 2.48$, $p > 0.05$], and gender (Wald $\chi^2 = 1.11$, $p > 0.05$). The eta squared was used to calibrate the size of this relationship, by taking the dependent variables (the three coping strategies) together and individually. Cohen's (1988) criteria were used to interpret the effect size, indicating that the effect was small when $\eta^2 = 0.01$ ($d = 0.20$), medium when $\eta^2 = 0.059$ ($d = 0.50$), and large when $\eta^2 = 0.138$ ($d = 0.80$). These analyses were carried out in the SPSS 21 statistical software (IBM Corp, 2012).

RESULTS

Descriptive Statistics

The descriptive statistics of the variables and Pearson correlation coefficients were performed using SPSS 21 (IBM Corp, 2012). As shown in **Table 1**, the variables were significantly inter-correlated, without presenting extreme values (the highest correlation was $r = 0.67$) and with a moderate average correlation ($r = 0.40$). The skewness and kurtosis values of the variables were within the intervals that denote a normal distribution (all were between −1 and 1).

Profiles of Psychological Well-being

Several models of latent profiles, including one, two, three, four, and five classes (groups), were fit to the data. Model fitting stopped when non-significant LMRT results occurred or when a group of subjects with less than 1% of the total sample was obtained. The goodness-of-fit indices of the model for each LPA are shown in **Table 2**. The shown LMRT indicated that the three-class solution provided a better fit to the data than the two-class solution (or the single-class solution). Initially, the three-class solution was deemed superior to the four-class solution, because the LMRT indicated that there were no significant differences between the two solutions (LMRT = 201.46; $p = 0.18$). However, the four-class solution was also an interesting alternative because none of the classes had a number of subjects below 5% of the total sample (size = 0). Although the AIC, BIC, and SSA-BIC criteria showed a slight decrease when comparing four classes against three (the lower they are, the better the model fit), they were not taken into account because these are nested models. However, entropy was taken into account (quality of the proposed grouping), noting that that the four-class model (entropy = 0.78) was better than the three-class model (entropy = 0.77). Therefore, after analyzing the two alternative LPA configurations (three vs. four classes), the four-class model was thought to provide the best empirical (and theoretical) fit, correctly classifying over 78% of the subjects.

Table 3 shows the number of students in absolute (*n*) and relative (%) terms in each of the four classes of the model chosen, in addition to the classification accuracy in each class. Three classes composed most of the sample (92.5%): Class 4 with 41.9%, Class 3 with 35.4%, and Class 1 with 15.2%. However, Class 2 was somewhat particular and comprised only 7.5% of the cases. In relation to the accuracy with which subjects were classified, **Table 3** shows that Class 2 had greater classification precision (88.2%). The diagonal in **Table 3** shows the accuracy of the four classes. In line with the above, the values outside the diagonal show that individuals classified as Class 2 were the least likely to be allocated to other classes (only a 3.2% chance of being assigned to Class 3). In general, the classification accuracy of the four classes was similar and adequate.

After establishing the four-class model as the best solution, the next step was to interpret these classes. The average scores of the subjects in the latent classes, which could vary between classes and were used in this study to substantively interpret each profile, are shown in **Table 4**.

In general terms, the four classes showed similar trends in the profiles, although they had different levels in the four variables. As shown in **Figure 1**, the four profiles presented some parallelism, with greater differences between classes in the SA, EM, and PL variables and smaller differences in the PG variable. However, as shown in **Table 5**, the inter-class differences in the four variables were always significant with medium and large effect sizes (even very large in some pairs).

Consequently, the four latent classes can be interpreted as *general profiles of psychological well-being* that vary in magnitude, since the four profiles displayed a similar pattern at different levels.

To qualify the four groups of students, the variable means in each class were taken as reference (see **Table 4**), in addition to the average values of the classes (Class 1 = 4.60, Class 2 = 2.80, Class 3 = 3.60, and Class 4 = 4.12) and the values of the measurement scale (1 = strongly disagree, 2 = mostly disagree, 3 = agree more than disagree, 4 = mostly agree, and 5 = strongly agree). Accordingly, Class 1 represented a *profile with very high psychological well-being*; Class 2 a *profile with low psychological well-being*; Class 3 a *profile with medium psychological well-being*; and Class 4 a *profile with high psychological well-being*.

TABLE 1 | Means, standard deviations, and correlations between the four dimensions of psychological well-being and the three academic stress coping strategies ($N = 1072$).

	1	2	3	4	5	6	7
(1) Self-acceptance	–						
(2) Environmental mastery	0.65	–					
(3) Purpose in life	0.67	0.65	–				
(4) Personal growth	0.41	0.40	0.48	–			
(5) Positive reappraisal	0.51	0.38	0.41	0.24	–		
(6) Support-seeking	0.29	0.26	0.35	0.28	0.23	–	
(7) Planning	0.34	0.32	0.45	0.27	0.55	0.30	–
M	3.87	3.75	3.82	4.17	3.01	3.44	3.05
SD	0.71	0.63	0.67	0.58	0.71	0.87	0.74
Skewness	−0.74	−0.58	−0.64	−0.71	0.05	−0.15	0.07
Kurtosis	0.71	0.37	0.35	0.86	−0.46	−0.79	−0.44

All Pearson r correlation coefficients are significant at $p < 0.001$. Psychological well-being scales (1 = strongly disagree,. . .5 = strongly agree). Coping strategies scale (1 = never,. . .5 = always; higher scores reflect higher levels of psychological well-being and a higher use of coping strategies).

TABLE 2 | Results obtained when comparing the latent class models.

	Latent class models				
Criteria	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
AIC	8411.09	7158.93	6727.65	6540.98	6506.54
BIC	8450.90	7243.55	6857.06	6715.19	6725.54
SSA-BIC	8425.49	7189.55	6774.48	6604.02	6585.79
Entropy	–	0.77	0.77	0.78	0.75
LMRT	–	1250.24	442.24	201.46	51.63
(*p*)		(0.0001)	(0.017)	(0.176)	(0.596)
Size	0	0	0	0	1

AIC, Akaike information criterion; BIC, Bayesian information criterion; SSA-BIC, Sample-size-adjusted BIC; LMRT, Lo-Mendell-Rubin adjusted likelihood ratio test.

TABLE 3 | Latent class characterization and precision in the classification of individuals in each class.

		Latent class			
		Class 1	**Class 2**	**Class 3**	**Class 4**
Number of cases		163	80	379	450
Percentage of cases (%)		15.2	7.5	35.4	41.9
Probability of success in the classification	Class 1	**0.87**	0.00	0.00	0.13
	Class 2	0.00	**0.88**	0.12	0.00
	Class 3	0.00	0.03	**0.88**	0.09
	Class 4	0.05	0.00	0.10	**0.86**

Class 1, very high psychological well-being; Class 2, low psychological well-being; Class 3, medium psychological well-being; Class 4, high psychological well-being. Higher scores (close to 1.00) reflect greater precision classification.

Differences between Profiles of Psychological Well-being in Academic Coping Strategies

The differences between profiles of psychological well-being (low, medium, high, and very high) in the use of academic coping strategies (positive reappraisal, support-seeking, and planning) was examined through various variance and covariance analyses, taking the profiles of psychological well-being (four levels) as the independent variable and the three strategies for coping with stress as dependent variables. The students' major (the sample had 15 different majors), age (the sample was selected from the population of all of the grades in the major), and gender were incorporated as covariates. **Table 6** provides the corresponding descriptive statistics.

Globally considered, the data suggest a statistically significant relationship between the type of profile of psychological well-being and the three coping strategies used by the students [$\lambda_{\text{Wilks}} = 0.724$, $F(9,2587) = 40.825$, $p < 0.001$, $\eta^2 = 0.102$], with a medium effect size. The results showed significant differences between the four profiles of students with respect to the three coping strategies taken individually: positive reappraisal [$F(3,1065) = 93.41$, $p < 0.001$, $\eta^2 = 0.21$], support-seeking [$F(3,1065) = 44.24$, $p < 0.001$, $\eta^2 = 0.11$], and planning [$F(3,1065) = 70.91$, $p < 0.001$, $\eta^2 = 0.17$]. In terms of effect size, the differences were large for positive reappraisal and planning and medium for support-seeking. Regarding the group means, the same trend was observed in the three dependent variables: the higher the profile of psychological well-being was, the greater the use of stress coping strategies.

With regard to the covariates included in the model, the gender variable showed significant differences in the three dependent variables: positive reappraisal [$F(1,1065) = 56.56$,

TABLE 4 | Description of latent classes.

	Profiles of psychological well-being			
	Self-acceptance	Environmental mastery	Purpose in life	Personal growth
	M (*SE*)	*M* (*SE*)	*M* (*SE*)	*M* (*SE*)
Latent Class 1	4.65 (0.09)	4.39 (0.04)	4.63 (0.11)	4.73 (0.03)
Latent Class 2	2.50 (0.20)	2.67 (0.15)	2.54 (0.18)	3.50 (0.13)
Latent Class 3	3.54 (0.06)	3.39 (0.07)	3.46 (0.08)	3.10 (0.03)
Latent Class 4	4.12 (0.06)	4.03 (0.05)	4.07 (0.06)	4.25 (0.09)

SE, Standard error; Latent Class 1, very high psychological well-being; Latent Class 2, low psychological well-being; Latent Class 3, medium psychological well-being; Latent Class 4, high psychological well-being. Psychological well-being scales (1 = strongly disagree,. . .5 = strongly agree; higher scores reflect higher levels in each dimension of psychological well-being).

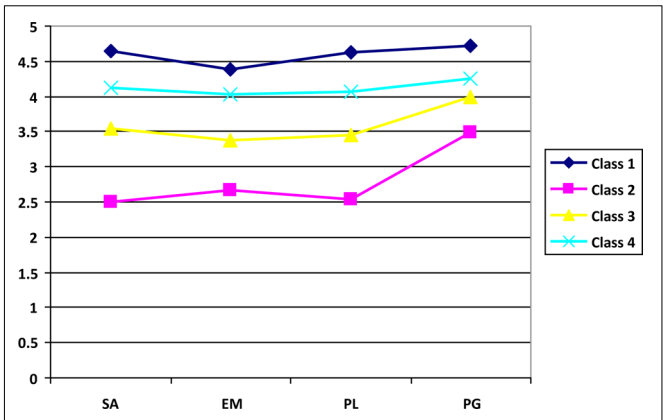


FIGURE 1 | Graphical representation of the psychological well-being profiles. Class 1, very high psychological well-being; Class 2, low psychological well-being; Class 3, medium psychological well-being; Class 4, high psychological well-being; SA, Self-acceptance; EM, Environmental mastery; PL, Purpose in life; PG, Personal growth.

$p < 0.001$, $\eta^2 = 0.05$] and support-seeking [$F(1,1065) = 43.76$, $p < 0.001$, $\eta^2 = 0.04$] with a medium effect size, and planning [$F(1,1065) = 4,35$, $p < 0.05$, $\eta^2 = 0.004$], with a small effect size. The students' major and age were not relevant in explaining the use of academic stress coping strategies.

Because gender differences were significant in the use of strategies for coping with stress, it was important to examine the possible interactions between this variable and the type of profile of psychological well-being. For this reason, a series of factorial analyses of variance were conducted, including the type of profile and gender as factors and the three stress coping strategies as dependent variables.

The analysis results showed only the main effects on the three dependent variables. No interaction effects were found. In particular, we found that men had higher levels of positive reappraisal (see **Figure 2**) and planning (**Figure 4**) than women in the four types of profiles of psychological well-being. Such differences were similar in magnitude and yielded parallel profiles for men and women, leading to a non-interaction between the two variables ($p > 0.05$). In the case of support-seeking, women presented higher levels (see **Figure 3**). Although the gender profiles were not fully parallel, the interaction was not significant.

TABLE 5 | Differences of class means across indicators of well-being.

	Indicators of psychological well-being			
	Self-acceptance	Environmental mastery	Purpose in life	Personal growth
Class 1 – Class 2	1.56	1.97	1.46	1.62
Class 1 – Class 3	0.99	0.81	0.81	1.23
Class 1 – Class 4	0.42	0.40	0.46	0.30
Class 2 – Class 3	0.84	0.50	0.62	0.64
Class 2 – Class 4	1.20	1.30	1.24	0.44
Class 3 – Class 4	0.49	0.53	0.46	0.18

Class 1, very high psychological well-being; Class 2, low psychological well-being; Class 3, medium psychological well-being; Class 4, high psychological well-being. Relative size of Cohen's d: negligible effect (≥ −0.15 and <0.15), small effect (≥0.15 and <0.40), medium effect (≥0.40 and <0.75), large effect (≥0.75 and <1.10), very large effect (≥1.10 and <1.45), and huge effect (>1.45).

DISCUSSION

This study provides some interesting results with regard to the relationship between coping strategies and psychological well-being in a population that is especially vulnerable to stress, as is the case with university students (Zajacova et al., 2005). Previous studies on adolescents (e.g., González et al., 2002; Figueroa et al., 2005) concluded that there was a differential use of coping mechanisms depending on the individuals' level of psychological well-being. However, in these studies, the variable-centered approach adopted to determine the level of psychological well-being failed to characterize the common profile-based patterns. To answer this question, our work adopted a person-centered approach to determine whether there were different university student profiles based on different functioning levels on several psychological well-being indicators. Additionally, we analyzed whether these profiles were significantly different in relation to the use of mechanisms including positive reappraisal, support-seeking, and planning to cope with the potentially stressful demands of the academic context.

Our initial hypothesis was based on the existence of two profiles of psychological well-being. However, this hypothesis was partially rejected, since our results identified the existence of four different profiles of university students according to their level of psychological well-being: a first group with very high psychological well-being, a second group with a high level of well-being, and two other groups with medium and low psychological well-being. Each of these profiles showed significant differences in the effect sizes of SA, EM, PL, and PG. These dimensions have been considered the core of psychological well-being (e.g., Tomás et al., 2012).

Regarding our second objective, our data suggested the existence of considerable differences between the four profiles in

TABLE 6 | Means and standard deviations of the profiles of psychological well-being for each of the coping strategies and their univariate tests.

Profiles of psychological well-being	Coping strategies of academic stress					
	Positive reappraisal		Support-seeking		Planning	
	M	*SD*	*M*	*SD*	*M*	*SD*
Low	2.42	0.66	2.90	0.89	2.43	0.71
Medium	2.74	0.61	3.21	0.83	2.82	0.65
High	3.16	0.65	3.58	0.80	3.16	0.68
Very high	3.54	0.64	3.85	0.83	3.56	0.70
Univariate tests	**Positive reappraisal**		**Support-seeking**		**Planning**	
Profiles [$F_{(3,1065)}$]	93.41** $\eta^2 = 0.21$		44.24** $\eta^2 = 0.11$		70.91** $\eta^2 = 0.17$	
Gender [$F_{(1,1065)}$]	56.56** $\eta^2 = 0.05$		43.76** $\eta^2 = 0.04$		4.35* $\eta^2 = 0.004$	

*Coping strategies scale (1 = never,...5 = always; higher scores reflect a higher use of coping strategies). Relative size of eta squared: negligible effect (<0.01), small effect (>0.01 and <0.059), medium effect (>0.059 and <0.138), and large effect (>0.138). *p < 0.05; **p < 0.001.*

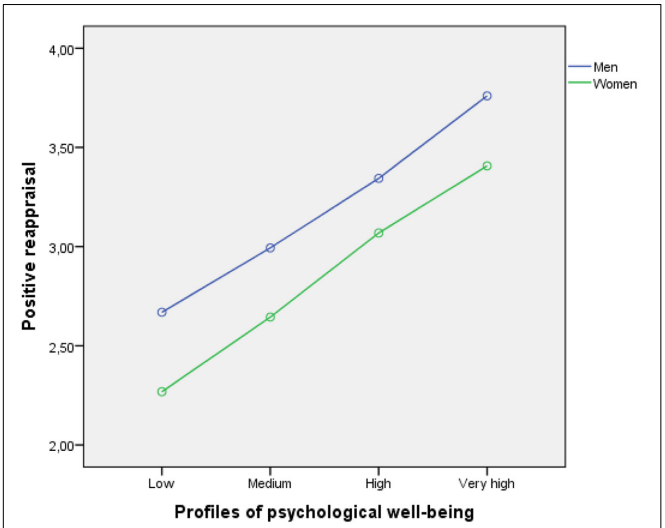


FIGURE 2 | Relationship between psychological well-being profiles (low, medium, high, and very high), use of positive reappraisal as a coping strategy, and student gender.

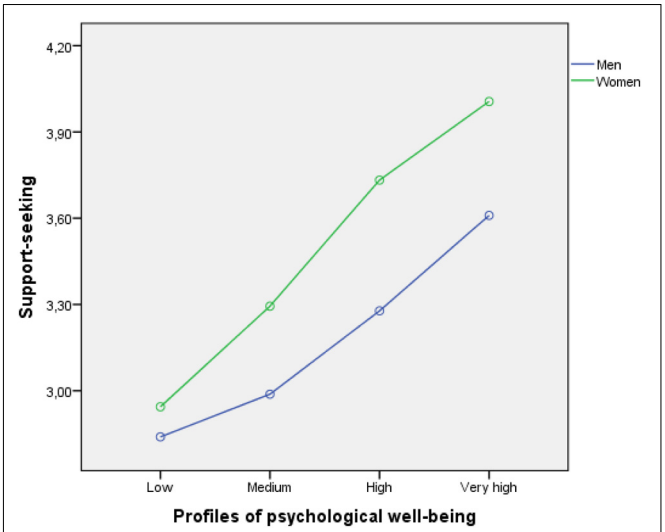


FIGURE 3 | Relationship between psychological well-being profiles (low, medium, high, and very high), use of support-seeking as a coping strategy, and student gender.

the use of positive reappraisal, support-seeking, and planning, evidencing that the higher the degree of SA, EM, PL, and PG reported by the students, the greater the use of these three coping strategies. These results are consistent with studies that positively relate psychological well-being and the use of adaptive coping strategies (e.g., Loukzadeh and Bafrooi, 2013; Portocarrero and Bernardes, 2013; Mayordomo et al., 2015).

The students' major, age, and gender were considered covariates in the study. In contrast with the results obtained in other studies (e.g., Martín et al., 1997; Cassaretto et al., 2003), our findings failed to show significant differences neither for major nor age in the use of the three analyzed coping strategies. Given the breadth and diversity of majors and school years involved in our work, this finding led us to conclude that the use of adaptive coping strategies, as is the case with positive reappraisal, support-seeking, and planning, does not depend on the type of academic demands or on the students' level of experience; instead, it depend on their own psychological functioning.

However, gender differences were significant in the use of the three coping strategies. In line with a large body of research referring to the differences between males and females in the management of academic stress (e.g., Feldman et al., 2008; Matheny et al., 2008; Cabanach et al., 2013), our results suggest that male students used positive reappraisal and planning as academic stress coping mechanisms to a greater extent than females, whereas females mainly made recourse to support-seeking.

Despite this differential use of academic coping strategies associated with gender, the findings of this study show that

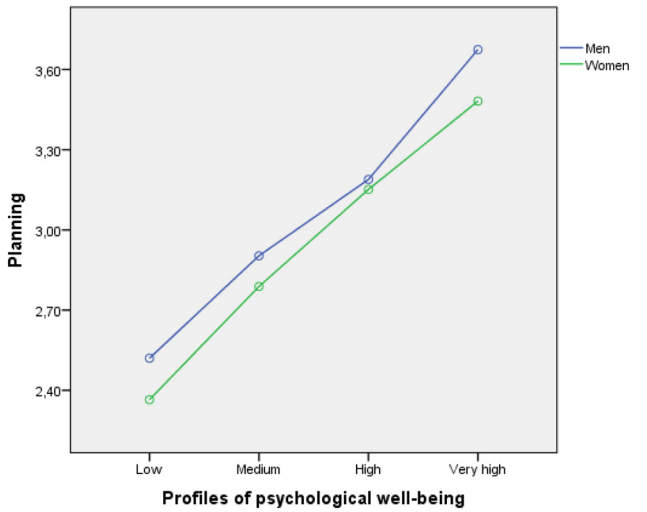


FIGURE 4 | Relationship between type of psychological well-being profile (low, medium, high, and very high), use of planning as a coping strategy, and student gender.

this variable did not significantly interact with psychological well-being in explaining the use of positive reappraisal, support-seeking, and planning. Accordingly, the positive linear trend observed in the differences between the profiles of psychological well-being in the use of the three coping strategies was almost parallel in males and females, such that in both genders, the higher the level of psychological well-being was, the greater the use of such coping mechanisms.

Overall, our data suggest that psychological well-being and, more specifically, its constitutive dimensions (SA, EM, PL, and PG) represent a personal resource of unquestionable worth to favor adaptive coping within the demands of the university context. Therefore, these findings add to the growing line of work that positively relates adaptive coping with stress and certain psychosocial variables that are closely linked to psychological well-being, such as self-esteem (Cabanach et al., 2014), hardiness (Otero-López et al., 2014), resilience (González-Torres and Artuch, 2014), PL (Freire et al., 2015), quality of social support (Fernández-González et al., 2015), and pursuit of self-realization (Park and Adler, 2003; Miquelon and Vallerand, 2008).

In summary, these results contribute to expanding the spectrum of interventions aimed at reducing student stress, addressing this issue from an eminently proactive perspective focused on the development of individual strengths and abilities. Thus, an important implication derived from these results is the need to design and implement initiatives and programs to promote students' psychological well-being. In this regard, numerous universities from different geographical and cultural contexts have successfully developed initiatives aimed at fostering students' personal potentials and virtues in recent years (Moshki et al., 2012; Carter et al., 2013; Romero et al., 2013).

However, it is necessary to consider some limitations in this work. First, the cross-sectional nature of the research design does not allow to properly evaluate the dynamical nature of the stress process and, consequently, to establish causal relations between the analyzed variables. Future longitudinal research or studies using structural equation models could analyze the extent to which students' psychological well-being promotes more functional coping with academic stress and even contemplate the existence of a bidirectional relationship between these variables. Second, this study did not analyze the role played by some important components of the transactional model of stress such as academic stressors or students' cognitive appraisal of stressful achievement events (see Skinner and Brewer, 2002). Thus, future works should analyze the interaction between academic demands, psychological well-being, cognitive appraisal, and coping strategies.

Third, although our sample comprised a large number of students (1,072), all of them were from the University of A Coruña, thus limiting the possible generalization of the results to the overall university population. Therefore, future research should corroborate our results with university students from other geographical and cultural contexts.

Fourth, most of the subjects in our sample (almost 70%) were female. Given that the study included majors in all fields of knowledge, we cannot consider this a limitation but rather an indicator of the university landscape today. Overall, we believe that a male sample that was quantitatively more representative could have enabled a deeper analysis regarding the causes and consequences that underlie the gender differences in coping with stress. Thus, we understand that this issue could be a potential line of future research.

A fifth limitation is the use of self-report measures as exclusive data collection method because it can lead to response bias. In future research, combining methodologies to include classroom observations, surveys, and student interviews, would greatly increase our understanding of students' PL and personal strengths and their ways to manage academic stress. Finally, the limitations of the instrument used to measure coping should be noted. Although the three above-mentioned strategies (positive reappraisal, support-seeking, and planning) constitute good exponents of adaptive coping in classrooms (Skinner et al., 2013), we understand that a more extensive classification of strategies, including both adaptive and dysfunctional strategies, would provide a broader and more comprehensive perspective on their relationship with psychological well-being. In this regard, future work should analyze the possible protective role of psychological well-being compared to markedly undesirable strategies, for example, avoidance or rumination.

AUTHOR CONTRIBUTIONS

CF and MF collect data, data analysis, writing the paper. AV writing the paper. JN and GV data analysis, writing the paper.

REFERENCES

Bhullar, N., Hine, D. W., and Phillips, W. J. (2014). Profiles of psychological well-being in a sample of Australian university students. *Int. J. Psychol.* 49, 288–294. doi: 10.1002/ijop.12022

Bryden, C. I., Field, A. M., and Francis, A. J. P. (2015). Coping as a mediator between negative life events and eudaimonic well-being in female adolescents. *J. Child Fam. Stud.* 24, 3723–3733. doi: 10.1007/s10826-015-0180-0

Cabanach, R. G., Fariña, F., Freire, C., González, P., and Ferradás, M. M. (2013). Diferencias en el afrontamiento del estrés en estudiantes universitarios hombres y mujeres [Differences in coping between men and women in university studies]. *Eur. J. Educ. Psychol.* 6, 19–32.

Cabanach, R. G., Millán, P., and Freire, C. (2009). El afrontamiento del estrés en estudiantes de ciencias de la salud. Diferencias entre hombres y mujeres [Coping strategies in university students of Health Sciences. Differences according to sex]. *Aula Abierta* 37, 3–10.

Cabanach, R. G., Souto, A., Freire, C., and Ferradás, M. M. (2014). Relaciones entre autoestima y estresores percibidos en estudiantes universitarios [Links between self-esteem and perceived stressors in university students]. *Eur. J. Educ. Psychol.* 7, 43–57. doi: 10.1989/ejep.v7i1.151

Cabanach, R. G., Valle, A., Rodríguez, S., Piñeiro, I., and Freire, C. (2010). Escala de afrontamiento del estrés académico (A-CEA) [The coping scale of academic stress questionnaire (A-CEA)]. *Rev. Iber. Psicol. Salud* 1, 51–64.

Carter, M. R., Kelly, R. K., Montgomery, M., and Cheshire, M. (2013). An innovate approach to health promotion experiences in community health nursing: a university collaborative partnership. *J. Nurs. Educ.* 52, 108–111. doi: 10.3928/01484834-20130121-04

Carver, C. S., and Scheier, M. F. (1999). "Stress, coping, and self-regulatory processes," in *Handbook of Personality: Theory and Research*, 2nd Edn, eds L. A. Pervin and O. P. John (New York, NY: Guilford Press), 553–575.

Cassaretto, M., Chau, C., Oblitas, H., and Valdez, N. (2003). Estrés y afrontamiento en estudiantes de psicología [Stress and coping in students of psychology]. *Rev. Psicol.* 21, 363–392.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Erlbaum.

Cohen, S., and Edwards, J. R. (1989). "Personality characteristics as moderators of the relationship between stress and disorder," in *Advances in the Investigation of Psychological Stress. Wiley Series on Health Psychology/Behavioral Medicine*, ed. R. W. J. Neufeld (Oxford: John Wiley & Sons), 235–283.

Corp, I. B. M. (2012). *SPSS STATISTICS for Windows, Version 21.0*. Armonk, NY: IBM Corp.

Díaz, D., Rodríguez-Carvajal, R., Blanco, A., Moreno-Jiménez, B., Gallardo, I., Valle, C., et al. (2006). Adaptación española de las escalas de bienestar psicológico de Ryff [Spanish adaptation of the psychological well-being scales (PWBS). *Psicothema* 18, 572–577.

Doron, J., Stephan, Y., Boiché, J., and Le Scanff, C. (2009). Coping with examinations: exploring relationships between students' coping strategies, implicit theories of ability, and perceived control. *Br. J. Educ. Psychol.* 79, 515–528. doi: 10.1348/978185409X402580

Dyson, R., and Renk, K. (2006). Freshmen adaptation to university life: depressive symptoms, stress, and coping. *J. Clin. Psychol.* 62, 1231–1244. doi: 10.1002/jclp.20295

Endler, N. S., Kantor, L., and Parker, J. D. A. (1994). State-trait coping, state-trait anxiety and academic performance. *Pers. Indiv. Dif.* 16, 663–670. doi: 10.1016/0191-8869(94)90208-9

Endler, N. S., and Parker, J. D. (1990). Multidimensional assessment of coping: a critical evaluation. *J. Pers. Soc. Psychol.* 58, 844–854. doi: 10.1037//0022-3514.58.5.844

Feldman, L., Gonçalves, L., Chacón-Puignau, G., Zaragoza, J., Bagés, N., and de Pablo, J. (2008). Relaciones entre estrés académico, apoyo social, salud mental y rendimiento académico en estudiantes universitarios venezolanos [Relationships between academic stress, social support,mental health and academic performance in Venezuelan university students]. *Univ. Psychol.* 7, 739–751.

Fernández-González, L., González-Hernández, A., and Trianes, M. V. (2015). Relationships between academic stress, social support, optimism-pesimism and self-esteem in college students. *Electron. J. Res. Educ. Psychol.* 13, 111–130. doi: 10.14204/ejrep.35.14053

Figueroa, M. I., Contini, M., Lacunza, A. B., Levín, M., and Estévez, A. (2005). Las estrategias de afrontamiento y su relación con el nivel de bienestar psicológico: un estudio con adolescentes de nivel socioeconómico bajo de Tucumán (Argentina) [The coping strategies and its relation with the level of psychological well-being. A research with adolescents of low socioeconomic level of Tucuman (Argentina)]. *An. Psicol.* 21, 66–72.

Fisher, S. (1984). *Stress and Perception of Control*. London: Lawrence Erlbaum.

Folkman, S., and Lazarus, R. S. (1985). If it changes it must be a process: study of emotion and coping during three stages of a college examination. *J. Pers. Soc. Psychol.* 48, 150–170. doi: 10.1037/0022-3514.48.1.150

Freire, C., Ferradás, M. M., Núñez, J. C., and Valle, A. (2016). Estructura factorial de las escalas de bienestar psicológico de Ryff en estudiantes universitarios [The factorial structure of Ryff's psychological well-being scales in university students]. *Eur. J. Educ. Psychol.* 9.

Freire, C., Ferradás, M. M., Regueiro, B., Piñeiro, I., Rodríguez, S., and Valle, A. (2015). Propósitos vitales y afrontamiento del estrés en estudiantes universitarios [Purposes in life and coping in university students]. *Rev. Psicol. Educ. Cult.* 19, 42–54.

Garlow, S. J., Rosenberg, J., Moore, J. D., Haas, A. P., Koestner, B., Hendin, H., et al. (2008). Depression, desperation, and suicidal ideation in college students: results from the American foundation for suicide prevention college screening project at emory university. *Depress. Anxiety* 25, 482–488. doi: 10.1002/da.20321

González, M. T., and Landero, R. (2007). Factor structure of the perceived stress scale (PSS) in a sample from Mexico. *Span. J. Psychol.* 10, 199–206. doi: 10.1017/S1138741600006466

González, R., Montoya, I., Casullo, M. M., and Bernabéu, J. (2002). Relación entre estilos y estrategias de afrontamiento y bienestar psicológico en adolescentes [Relationship between coping strategies and psychological well-being in adolescents]. *Psicothema* 14, 363–368.

González-Torres, M. C., and Artuch, R. (2014). Profiles of resilience and coping strategies at university: contextual and demographic variables. *Electron. J. Res. Educ. Psychol.* 12, 621–648. doi: 10.14204/ejrep.34.14032

Gustems-Carnicer, J., and Calderón, C. (2013). Coping strategies and psychological well-being among teacher education students. *Eur. J. Psychol. Educ.* 28, 1127–1140. doi: 10.1007/s10212-012-0158-x

Hipp, J. R., and Bauer, D. J. (2006). Local solutions in the estimation of growth mixture models. *Psychol. Methods* 11, 36–53. doi: 10.1037/1082-989X.11.1.36

Kraag, G., Zeegers, M. P., Kok, G., Hosman, C., and Abu-Saad, H. H. (2006). School programs targeting stress management in children and adolescents: a meta-analysis. *J. Sch. Psychol.* 44, 449–472. doi: 10.1016/j.jsp.2006.07.001

Lanza, S. T., Flaherty, B. P., and Collins, L. M. (2003). "Latent class and latent transition analysis," in *Handbook of Psychology: Research Methods in Psychology*, eds J. A. Schinka and W. F. Velicer (Hoboken, NJ: Wiley), 663–685.

Lazarus, R. S. (1999). *Stress and Emotion*. New York, NY: Springer.

Lazarus, R. S., and Folkman, S. (1984). *Stress, Appraisal, and Coping*. New York, NY: Springer.

Little, R. J., and Rubin, D. B. (1987). *Statistical Analysis with Missing Data*. New York, NY: Wiley.

Lo, Y., Mendell, N. R., and Rubin, D. B. (2001). Testing the number of components in a normal mixture. *Biometrika* 88, 767–778.

Loukzadeh, Z., and Bafrooi, N. M. (2013). Association of coping style and psychological well-being in hospital nurses. *J. Caring Sci.* 2, 313–319. doi: 10.5681/jcs.2013.037

Loureiro, E., McIntyre, T., Mota-Cardoso, R., and Ferreira, M. A. (2008). A relação entre o stress e os estilos de vida nos estudantes de medicina da faculdade de medicina do Porto [The relationship between stress and life-style of students at the faculty of medicine of porto]. *Acta Med. Port.* 21, 209–214.

Lumley, M. A., and Provenzano, K. M. (2003). Stress management through written emotional disclosure improves academic performance among college students with physical symptoms. *J. Educ. Psychol.* 95, 641–649. doi: 10.1037/0022-0663.95.3.641

Martin, A. J., and Marsh, H. (2009). Academic resilience and academic buoyancy: multidimensional and hierarchical conceptual framing of causes, correlates and cognate constructs. *Oxford Rev. Educ.* 35, 353–370. doi: 10.1080/03054980902934639

Martín, M. D., Jiménez, M. P., and Fernández-Abascal, E. G. (1997). Estudio sobre la escala de estilos y estrategias de afrontamiento (E3A) [A study base on the

coping styles and strategies scale (E3A)]. *Rev. Electr. Motiv. Emocion* Retrieved from http://reme.uji.es/articulos/agarce4960806100/texto.html

Matheny, K. B., Roque-Tovar, B. E., and Curlette, W. L. (2008). Perceived stress, coping resources, and life satisfaction among U.S. and Mexican college students: a cross-cultural study. *Ann. Psicol.* 24, 49–57.

Maxwell, S. E., and Delaney, H. D. (1993). Bivariate and median splits and spurious statistical significance. *Psychol. Bull.* 113, 181–190. doi: 10.1037/0033-2909.113.1.181

Mayordomo, T., Meléndez, J. C., Viguer, P., and Sales, A. (2015). Coping strategies as predictors of well-being in youth adult. *Soc. Indic. Res.* 122, 479–489. doi: 10.1007/s11205-014-0689-4

Michie, F., Glachan, M., and Bray, D. (2001). An evaluation of factors influencing the academic self-concept, self-esteem and academic stress for direct and re-entry students in Higher Education. *Educ. Psychol.* 21, 455–472. doi: 10.1080/01443410120090830

Miquelon, P., and Vallerand, R. J. (2008). Goal motives, well-being, and physical health: an integrative model. *Can. Psychol.* 49, 241–249. doi: 10.1037/a0012759

Moshki, M., Amiri, M., and Khosravan, S. (2012). Mental health promotion of Iranian university students: the effect of self-esteem and health locus of control. *J. Psychiatr. Ment. Health Nurs.* 19, 715–721. doi: 10.1111/j.1365-2850.2011.01806.x

Muthén, L. K., and Muthén, B. O. (1998–2012). *Mplus User's Guide*, 6th Edn. Los Angeles, CA: Muthén and Muthén.

Otero-López, J. M., Villardefrancos, E., Castro, C., and Santiago, M. J. (2014). Stress, positive personal variables and burnout: a path analytic approach. *Eur. J. Educ. Psychol.* 7, 95–106. doi: 10.1989/ejep.v7i2.182

Park, C. L., and Adler, N. E. (2003). Coping style as a predictor of health and well-being across the first year of medical school. *Health Psychol.* 22, 627–631. doi: 10.1037/0278-6133.22.6.627

Parsons, A., Frydenberg, E., and Poole, C. (1996). Overachievement and coping strategies in adolescent males. *Br. J. Educ. Psychol.* 66, 109–114. doi: 10.1111/j.2044-8279.1996.tb01180.x

Portocarrero, M., and Bernardes, M. L. (2013). Roads to positive self-development: styles of coping that predict well-being. *Int. J. Dev. Educ. Psychol.* 1, 383–392.

Putwain, D. W., Connors, L., Symes, W., and Douglas-Osborn, E. (2012). Is academic buoyancy anything more than adaptive coping? *Anxiety Stress Coping* 25, 349–358. doi: 10.1080/10615806.2011.582459

Rodríguez, J., and Agulló, E. (1999). Estilos de vida, cultura, ocio y tiempo libre de los estudiantes universitarios [Lifestyles, culture, leisure and free time of university students]. *Psicothema* 11, 247–259.

Romero, A., Cruz, S., Gallardo, C., and Peñacoba, C. (2013). Cómo promocionar la salud la salud y el bienestar en la comunidad universitaria. Universidad Rey Juan Carlos, universidad saludable [How to promote health and well-being for the entire university community. Rey Juan Carlos University, healthy university]. *Rev. Iber. Psicol. Salud* 4, 49–64.

Ryan, R. M., and Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. *Am. Psychol.* 55, 68–78. doi: 10.1037/0003-066X.55.1.68

Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *J. Pers. Soc. Psychol.* 57, 1069–1081. doi: 10.1037/0022-3514.57.6.1069

Salanova, M., Martínez, I. M., Bresó, E., Llorens, S., and Grau, R. (2005). Bienestar psicológico en estudiantes universitarios: facilitadores y obstaculizadores del desempeño académico [Psychological well-being among university students: facilitators and obstacles of academic performance]. *Ann. Psicol.* 21, 170–180.

Sheldon, K. M., and Lyubomirsky, S. (2006). How to increase and sustain positive emotion: the effects of expressing gratitude and visualizing best possible selves. *J. Posit. Psychol.* 1, 73–82. doi: 10.1080/17439760500510676

Skinner, E. A., Edge, K., Altman, J., and Sherwood, H. (2003). Searching for the structure of coping: a review and critique of category systems for classifying ways of coping. *Psychol. Bull.* 129, 216–269. doi: 10.1037/0033-2909.129.2.216

Skinner, E. A., Pitzer, J., and Steele, J. (2013). Coping as part of motivational resilience in school. A multidimensional measure of families, allocations, and profiles of academic coping. *Educ. Psychol. Meas.* 73, 803–835. doi: 10.1177/0013164413485241

Skinner, N., and Brewer, N. (2002). The dynamics of threat and challenge appraisals prior to stressful achievement events. *J. Pers. Soc. Psychol.* 83, 678–692. doi: 10.1037/0022-3514.83.3.678

Springer, K. W., and Hauser, R. M. (2006). An assessment of the construct validity of Ryff's Scales of Psychological Well-being: method, mode and measurement effects. *Soc. Sci. Res.* 35, 1080–1102. doi: 10.1016/j.ssresearch.2005.07.004

Syed, M., and Seiffge-Krenke, I. (2015). Change in ego development, coping, and symptomatology from adolescence to emerging adulthood. *J. Appl. Dev. Psychol.* 41, 110–119. doi: 10.1016/j.appdev.2015.09.003

Taylor, S. E. (1991). *Seamos Optimistas. Ilusiones Positivas [Let's be Optimistic. Positive Illusions]*. Barcelona: Martínez-Roca.

Tomás, J. M., Sancho, P., Meléndez, J. C., and Mayordomo, T. (2012). Resilience and coping as predictors of general well-being in the elderly: a structural equation modeling approach. *Aging Ment. Health* 16, 317–326. doi: 10.1080/13607863.2011.615737

Viñas, F., González, M., García, Y., Malo, S., and Casas, F. (2015). Los estilos y estrategias de afrontamiento y su relación con el bienestar personal en una muestra de adolescentes [Coping strategies and styles and their relationship to personal well-being in a sample of adolescents]. *Ann. Psicol.* 31, 226–233. doi: 10.6018/analesps.31.1.163681

Zajacova, A., Lynch, S. M., and Espenshade, T. J. (2005). Self-efficacy, stress, and academic success in college. *Res. High. Educ.* 46, 677–706. doi: 10.1007/s11162-004-4139-z

Zeidner, M. (1995). Adaptive coping with test situations: a review of the literature. *Educ. Psychol.* 30, 123–133. doi: 10.1207/s15326985ep3003_3

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Freire, Ferradás, Valle, Núñez and Vallejo. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 October 2016
doi: 10.3389/fpsyg.2016.01550

"To be or not to be Retained . . . That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals, and Grades

Francisco Peixoto[1], Vera Monteiro[1], Lourdes Mata[1], Cristina Sanches[1], Joana Pipa[1] and Leandro S. Almeida[2]*

[1] Centro de Investigação em Educação, ISPA – Instituto Universitário, Lisbon, Portugal, [2] Instituto de Educação, Universidade do Minho, Braga, Portugal

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Anastasia Efklides, Aristotle University of Thessaloniki, Greece
Ronny Scherer, University of Oslo, Norway

****Correspondence:***
Francisco Peixoto
fpeixoto@ispa.pt

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *08 July 2016*
Accepted: *22 September 2016*
Published: *13 October 2016*

Citation:
Peixoto F, Monteiro V, Mata L, Sanches C, Pipa J and Almeida LS (2016) "To be or not to be Retained . . . That's the Question!" Retention, Self-esteem, Self-concept, Achievement Goals, and Grades. Front. Psychol. 7:1550. doi: 10.3389/fpsyg.2016.01550

Keeping students back in the same grade – retention – has always been a controversial issue in Education, with some defending it as a beneficial remedial practice and others arguing against its detrimental effects. This paper undertakes an analysis of this issue, focusing on the differences in student motivation and self-related variables according to their retention related status, and the interrelationship between retention and these variables. The participants were 695 students selected from two cohorts (5th and 7th graders) of a larger group of students followed over a 3-year project. The students were assigned to four groups according to their retention-related status over time: (1) students with past and recent retention; (2) students with past but no recent retention; (3) students with no past but recent retention; (4) students with no past or recent retention. Measures of achievement goal orientations, self-concept, self-esteem, importance given to school subjects and Grade Point Average (GPA) were collected for all students. Repeated measures MANCOVA analyses were carried out showing group differences in self-esteem, academic self-concept, importance attributed to academic competencies, task and avoidance orientation and academic achievement. To attain a deeper understanding of these results and to identify profiles across variables, a cluster analysis based on achievement goals was conducted and four clusters were identified. Students who were retained at the end of the school year are mainly represented in clusters with less adaptive motivational profiles and almost absent from clusters exhibiting more adaptive ones. Findings highlight that retention leaves a significant mark that remains even when students recover academic achievement and retention is in the distant past. This is reflected in the low academic self-concept as well as in the devaluation of academic competencies and in the avoidance orientation which, taken together, can undermine students' academic adjustment and turn retention into a risk factor.

Keywords: retention, self-esteem, self-concept, achievement goals, academic achievement

INTRODUCTION

The organization of the school curriculum in an increasing level of complexity in terms of knowledge learned by students requires that teachers assess whether students are able or not to move to the next grade on an annual basis. Grade retention could be defined as a practice of requiring a student to repeat a particular grade when he or she doesn't meet the academic standards of his/her current grade level. The argument underlying this remedial practice is to provide low-achieving students with an additional opportunity to improve their achievement and meet those standards (Owings and Magliaro, 1998; Lorence, 2006, 2014; Chen et al., 2010).

However, the efficacy of this practice is controversial due to contradictory research findings on the benefits vs. the harmful effects of grade retention. Some research points to the benefits of grade retention for student achievement (e.g., Allen et al., 2009; Lorence, 2014) while other research states that holding students back a year does not improve or can even be detrimental to their academic outcomes (e.g., Jimerson et al., 1997; Jimerson, 2001; Wu et al., 2008b; Chen et al., 2010; Moser et al., 2012).

This lack of consistency is mainly a result of the different justifications and forms of implementation of the practice and is also due to methodological and measurement problems and sample characteristics of the studies (Jimerson et al., 1997; Jimerson, 1999, 2001; Lorence, 2006, 2014; Allen et al., 2009). To illustrate these inconsistencies, Lorence (2014), using a sample of 38.000 students from third to tenth grades, found that students retained in third grade outperformed their classmates who had been socially promoted (i.e., those students who had failed to meet the academic standards of their grade level but still advanced to the next grade level) in later grades. Also, Allen et al. (2009) in their meta-analysis of 22 studies concluded that the effects of retention are less negative than often claimed or have a neutral impact on student achievement.

On the opposite direction, Jimerson's (2001) meta-analysis of 20 studies using samples of students attending kindergarten to 12th grade revealed that 80% of the studies found an unfavorable effect of retention on academic and socioemotional outcomes. While in the short term retained students can show a boost in their academic achievement, in the long term this improvement tends to decrease, disappear, or even reverse when comparing these students with their socially promoted peers (Jimerson, 1999; Wu et al., 2008a; Chen et al., 2010; Moser et al., 2012).

Besides the effects of grade retention on academic achievement, grade retention has been associated with several detrimental outcomes, such as: a lowering of self-esteem (Setencich, 1994; Jimerson et al., 1997; Martin, 2011), higher rates of school dropout (Jimerson, 1999; Jimerson et al., 2002; Jimerson and Ferguson, 2007) and school absenteeism (Jimerson, 2001), increases in aggression and disruptive behaviors (Pagani et al., 2001; Jimerson and Ferguson, 2007; Inglés et al., 2015), lower cognitive growth (Hong and Raudenbush, 2005; Roderick and Nagaoka, 2005), and a lower likelihood of completing high-school and pursuing post-secondary education (Fine and Davis, 2003).

Although retention is usually seen as a consequence of low academic achievement, this is not necessarily the case (Shepard and Smith, 1986; Huang, 2014). For example it does not explain why some low-achieving students get retained while similarly low-achieving classmates get promoted (Huang, 2014). Despite the wide range of empirical research demonstrating that grade retention can be harmful for students in several outcomes it is still a current practice. In the Portuguese context, for example, official data indicates that 13,7% of students from the 1st to the 12th grades were retained in the 2012–2013 school year (CNE, 2015). Moreover, retention rates are higher between the 5th and the 12th grades (ranging from 12,5% to 19%) than during the elementary-school years (1st to 4th grades in the Portuguese school-system, which shows a retention rate of 4%).

Given these rates it is crucial to identify which children are at most risk for grade retention and to determine which factors contribute to grade retention (Davoudzadeh et al., 2015). The most frequently cited factors in the literature associated with retention can be divided into three major groups: demographic variables (e.g., gender, socioeconomic status, ethnicity, and chronological age), parental characteristics (e.g., mothers' educational level, parental IQ, parental involvement in school) and children's characteristics (e.g., cognitive abilities, early school readiness skills, social and emotional skills, having special needs and academic performance).

Studies have generally shown that grade retention is more likely to occur in male (e.g., Jimerson et al., 1997; Chen et al., 2010; Huang, 2014; Klapproth and Schaltz, 2015; Davoudzadeh et al., 2015), young-for-grade children (see Huang, 2014), from low socioeconomic status (e.g., Davoudzadeh et al., 2015; Klapproth and Schaltz, 2015), and being from an ethnic minority (e.g., Klapproth and Schaltz, 2015). Retention is also more likely when the students' parental education level is low, mothers have a lower IQ (e.g., Jimerson et al., 1997; Jimerson et al., 2006) and parents are less involved in school life (e.g., Jimerson et al., 1997).

Moreover, children are more likely to repeat a grade level when they have low cognitive abilities (e.g., McCoy and Reynolds, 1999), low school readiness skills (e.g., Duncan et al., 2007; Huang, 2014; Davoudzadeh et al., 2015), poor academic performance (e.g., McCoy and Reynolds, 1999; Huang, 2014; Davoudzadeh et al., 2015), low social and emotional skills (e.g., Willson and Hughes, 2009; Winsler et al., 2012), maladaptive behavior (Sandoval, 1984), or even when they have physical characteristics (e.g., height) associated with immaturity (e.g., Huang, 2014).

Being held back a grade may constitute a rather negative psychological experience for students (Robles-Piña, 2011), affecting their self-image and their self-perception of competence and confidence, their achievement and performance, and strongly increasing the probability of school dropout (Jimerson et al., 2002). Given this, it is important to understand the relationship between grade retention and the students' affective components of learning, such as self-efficacy beliefs, self-esteem, self-concept, values, or motivation.

Research on the relationship between grade retention and these affective components of learning is scarce and mainly

examines the effects of grade retention on these variables. Overall, findings are contradictory and follow the same tendency of those obtained on the effects of retention on subsequent achievement.

On one hand, some studies report the beneficial or neutral effects of retention. For example, Ehmke et al. (2010) have found a short-time increase in student self-concept in mathematics in the year after retention. Also Bonvin et al. (2008) found that, compared to the control group, second-grade retainers showed short-term improvements in academic self-concept, and a more positive attitude toward school, although this positive effect diminished in the course of the school year. Hong and Yu (2008) in turn have not found any detectable effects of kindergarten retention on children's self-perceived competence 2 and 4 years after being held back, while Wu et al. (2010) in a 4-year longitudinal study, found that retention in the first grade had a positive short-term effect on children's perceived school belonging and a positive long-term effect on perceived academic self-efficacy.

On the other hand a large number of studies report the negative effects of being retained on the affective components of learning (Martin, 2011; Robles-Piña, 2011; Goos et al., 2013; Lamote et al., 2014). Goos et al. (2013) have found that first-grade repeaters seem to be behind in several psychosocial skills, for at least a part of their primary education when compared to their similarly at-risk grade-mates who got promoted. Martin (2011) has also found that grade retention is a significant negative predictor of academic self-concept and of self-esteem and these negative effects persist in follow-up analyses using a sub-sample of retained and promoted students matched by ability and gender. Additionally, Robles-Piña (2011) has found that although those adolescents who had been retained presented higher GPA, they also reported a lower self-concept and higher rates of depression. Indeed, in this study self-concept was a stronger predictor of student retention status than GPA. Although Lamote et al. (2014) found that students retained in the 8th grade had a significantly higher academic self-concept in the year of retention, this advantage disappeared over time and by Grade 12, there was no longer any significant difference between the retained and the promoted low-achieving students.

Overall, these findings highlight the stressful nature of retention and suggest that the positive short-term effects of being retained observed in some cases, tend to decrease or even disappear in the long-term. Given these results, Robles-Piña (2011) argued that retention should be revisited from the perspective of mental health outcomes and well-being perspectives, rather than solely focusing on student academic outcomes.

Throughout the research on the impact of school achievement on the affective components of learning (e.g., self-concept, motivation), the reciprocal influence of these relationships has been also highlighted (e.g., Huang, 2011). Nevertheless, empirical evidence on the interrelationship between these variables and grade retention is much more limited, almost exclusively addressing the effects of retention on students' subsequent self-concept, self-esteem, or motivation and not its opposite. Illustrating this idea, Marsh and Craven (2006) proposed the reciprocal-effects model (REM), arguing that prior self-concept affects subsequent achievement, and prior achievement affects subsequent self-concept. Corroborating this hypothesis, Huang (2011) in a meta-analysis of 39 longitudinal studies found significant relationships between previous self-concept and subsequent academic achievement, as well as between previous academic achievement and subsequent self-concept. However, the magnitude of the correlations between self-concept and achievement varied depending on whether these studies used a global measure of self-concept or an academic/subject-specific self-concept measure (Huang, 2011). These results are in line with research in the educational field demonstrating that academic achievement is more strongly correlated to academic self-concept than with global self-concept, and that achievement in specific domains is more strongly correlated to the corresponding specific domains of self-concept.

A recent longitudinal study by Seaton et al. (2014) also confirmed the reciprocal relations between mathematics self-concept and mathematics achievement which were highly consistent over time, even when the effects of the previous time wave were controlled for. In line with the REM (e.g., Marsh and Craven, 2006), these findings lead Seaton et al. (2014) to conclude that interventions focusing on skills improvement in mathematics are necessary but, to improve mathematics performance it is also important to promote the students positive perceptions of their abilities.

Although some studies have shown the predictive effect of students' early approaches to learning and their social and emotional skills on early grade retention (e.g., Davoudzadeh et al., 2015), the role played by student self-esteem, their academic self-concept, or even their motivational orientations in the explanation of grade retention has rarely been considered. Studies relating retention and motivation from the point of view of achievement goal theory are uncommon, despite the goals by which students guide their action when performing learning tasks are a very important indicator of their academic performance (Boekaerts, 2002).

From the point of view of achievement goal theory, when facing an academic task, students can focus either on the acquisition of knowledge and on increasing competence (mastery/learning/task orientation) or focus on the self, ability or performance relative to others (performance/ego) (Nicholls, 1984; Ames and Archer, 1988; Elliott and Dweck, 1988; Skaalvik, 1997; Pintrich, 2000). Students endorsing ego goals can focus on outperforming others (performance approach/self-enhancing ego orientation) or on avoiding negative judgments from others (performance avoidance/self-defeating ego orientation). A fourth type of goal is avoidance orientation where the focus is on doing the least possible, escaping from school work (Nicholls, 1984; Middleton and Midgley, 1997; Skaalvik, 1997; Seifert and O'Keefe, 2001).

The type of goals that the student aspires to will lead him to focus on different elements of the learning process (Darnon et al., 2006) and consequently originating different outcomes. A meta-analysis by Linnenbrink-Garcia et al. (2008) on the relationship between goal orientation and achievement indicates

that approximately 50% of the studies found a significant positive correlation between mastery goals or performance-approach goals and achievement, suggesting that both type of goals can be beneficial for achievement. In the opposite direction, performance–avoidance goals have been consistently found to be negatively related with achievement and academic performance (e.g., Elliot, 1999; Korn and Elliot, 2016).

Martin (2009) has examined the influence of grade retention on high school students' academic motivation, engagement, and performance. He found that retained students had significantly lower scores in self-efficacy, task orientation, valuing of school, persistence, enjoyment of school, class participation, school attendance and performance, and higher scores in failure avoidance and disengagement.

If student motivational orientations and self-concept influence their achievement and academic performance, it seems likely that these variables can be good predictors of grade retention as well, although research in this area is very limited. One of the few studies addressing this issue was conducted by Nascimento and Peixoto (2012). Their longitudinal study over a school year with 9th graders showed that students that were at risk of being retained presented lower levels of global self-esteem when compared with both underachievers (students with previous retention) and good achievers. Moreover, students at risk of being retained presented lower levels of academic self-concept, similar to the underachievers and significantly lower than their successful classmates. Results also revealed that students at risk of being retained showed lower levels of non-academic self-concept than their underachieving colleagues. In motivation related variables, such as the importance attributed to academic competencies, task orientation and avoidance orientation, students at risk of retention presented low scores, closer to those exhibited by underachievers.

The Present Study

The main goal of this study is to analyze the differences in students achievement, motivation, and self-related variables according to their retention status (students with past retention and that are going to be retained again, students with past retention but that aren't going to be retained, students that are going to be retained for the first time and successful students – without past retention and that aren't going to be retained). Taking into consideration that retention has an impact on academic achievement, self-representations, and motivation we expected that students differentiated in terms of retention status would present differences in those variables. Following research in this area we hypothesized that these differences would appear in academic achievement, academic self-concept, task orientation, and avoidance orientation (Jimerson, 2001; Allen et al., 2009; Martin, 2009, 2011; Chen et al., 2010; Robles-Piña, 2011; Nascimento and Peixoto, 2012; Lorence, 2014).

Adopting a person-centered approach (Magnusson, 1988; von Eye and Bogat, 2006; Tuominen-Soini et al., 2012; Pulkka and Niemivirta, 2013), we anticipated that students with recent retention could present less adaptive motivational profiles.

MATERIALS AND METHODS

Participants

Participants were 695 Portuguese students attending 12 schools in the Lisbon region. Participants were selected from two cohorts (5th and 7th graders) of a larger group of students followed over a 3-year longitudinal research project. Student ages ranged from 10 to 17 years old ($M = 12.11$, $SD = 1.59$), 48% were in 5th grade in the beginning of the project, and 50.8% were male. In terms of educational background[1] 16.5% of students came from families in which mothers had a university education, 30.1% attended secondary education (10th to 12th grade), 25.9% attended the 3rd cycle (7th to 9th grade) and 27.5% attended the 1st or 2nd cycle of basic education (1st to 6th grade)

The students were selected if they had already experienced retention before the beginning of the research project (past retention) or if they experienced retention in 1 of the 3 years of the project (recent retention). An additional group of students was randomly selected among those who had never been retained (either in the past or recently). Therefore, participants were assigned to four groups according to their retention-related status over time: (1) students with past retention and recent retention (PR – RR, $N = 171$); (2) students with past retention but no recent retention (PR – NRR, $N = 104$); (3) students with no past retention but with recent retention (NPR – RR, $N = 231$); (4) students with no past retention and no recent retention (NPR – NRR, $N = 189$)[2]. The distribution of the participants by gender and mother's education level for the four groups is presented in **Table 1**.

Measures

Self-concept and Self-esteem

Self-concept and self-esteem measures were collected through the Self-concept and Self-esteem scale for Adolescents (Peixoto

[1]We used the mother's education level as indicator of educational background because this variable is identified as highly related with student school performance (Gutman et al., 2003; Alves et al., 2016).

[2]Students with recent retention are those who were retained at the end of the school year, although that information was unknown at the time the measures were completed.

TABLE 1 | Student distribution by retention status, mother's education level and gender.

	PR – NRR	PR – RR	NPR – RR	NPR – NRR
Mother's Education level				
6th Grade or low	50	57	48	29
7th to 9th grade	40	49	69	26
10th to 12th grade	47	42	61	64
University	15	13	33	52
Gender				
Males	83	94	102	75
Females	66	70	109	96

PR – NRR, group with past but no recent retention; PR – RR, group with past and recent retention; NPR – RR, group with no past but recent retention; NPR – NRR, group with no past or recent retention.

and Almeida, 1999, 2010, 2011) and for Pre-Adolescents (Peixoto et al., 2016). The scale for adolescents has 51 items grouped in 10 different subscales, 9 related to specific domains of self-concept and one directed toward the evaluation of global self-esteem. Each specific domain of self-concept is assessed through 5 items and global self-esteem is a 6-item measure (e.g., "Some young people do like the way they are leading their lives") assessing the global feeling of self-worth. The items assessing the specific domains of self-concept address school competence (e.g., "Some young people understand everything that teachers teach in class"), social acceptance (e.g., "Some young people are really well accepted by their colleagues"), athletic competence (e.g., "Some young people are very good at playing any kind of sport"), physical appearance (e.g., "Some young people don't feel very satisfied with their appearance"), romantic appeal (e.g., "Some young people easily manage to date the people they fall in love with"), behavior (e.g., "Some young people easily get into trouble with the things they do"), close relationships (e.g., "Some young people have a special friend they can share their secrets with"), verbal competence (e.g., "Some young people manage to express themselves very well"), and competence in mathematics (e.g., "Some young people manage to solve math problems very quickly"). The Self-concept and Self-esteem scale for pre-adolescents was constructed from the version for adolescents with the same item wording but excluding two dimensions (close relationships and romantic appeal). It is possible to have global measures (e.g., academic self-concept) for both scales. Subscales used in the study consisted of academic self-concept (including school competence, verbal competence and mathematics competence), non-academic self-concept (social acceptance, athletic competence, and physical appearance), and self-esteem. Cronbach's alphas in the three moments of data collection ranged from 0.84 to 0.85 for academic self-concept, from 0.84 to 0.87 for non-academic self-concept and from 0.75 to 0.80 for self-esteem. Items were answered in a 4-point scale ranging from "*Exactly like me*" to "*Completely different from me.*" The self-concept measures were obtained by averaging the items of each dimension.

Importance Attributed to Academic Competencies

The importance *attributed* to academic competencies is a six-item measure taping the same dimensions of academic self-concept on the self-concept and self-esteem scale (e.g., school competence, verbal competence, and math competence). The items are similar to those of the self-concept scale but rephrased in order for the respondent to answer in terms of the importance that he/she attributes to the self-concept dimension (e.g., "Some young people think that it is important to be a good student at school" for Importance given to School Competence; "Some young people think that it is important to be a good student in Portuguese subjects" for Importance given to Verbal Competence; "Some young people don't think it is important to achieve good grades in Mathematics" for Importance given to Competence in Mathematics). Reliability was acceptable with Cronbach's alpha ranging from 0.78 to 0.81. Responses ranged on a 4-point Likert scale from "*Exactly like me*" to "*Completely different from me.*" The importance attributed to academic competencies was obtained by averaging the items of this scale.

Goal Orientations Scale

The Goal Orientations Scale (GOS; Skaalvik, 1997; Pipa et al., 2016) is a 14-item scale measuring four types of goal orientations in academic contexts: task orientation (e.g., "Some students are interested in improving their skills in school"), self-enhancing ego orientation (e.g., "Some students always try to do better than their classmates"), self-defeating ego orientation (e.g., "When a student gives a wrong answer in class is most concerned about what their classmates think about them"), and avoidance orientation (e.g., "At school some students like to do as little as possible"). Cronbach's alpha ranging from 0.75 to 0.76 for task orientation, from 0.80 to 0.84 for self-enhancing ego orientation, from 0.83 to 0.87 for self-defeating ego orientation and from 0.72 to 0.73 to avoidance orientation. Items were answered on a 4-point scale ranging from "*Exactly like me*" to "*Completely different from me.*" To compute the different goal orientations the items of each dimension were averaged.

Academic Achievement

Academic achievement was collected from students' records at the end of the 3rd term of the school year in four core subjects: Portuguese, English, Mathematics, and Natural Sciences. A single GPA value was obtained by averaging the grades in these subjects, ranging from 1 to 5.

Procedure

The Goal Orientation Scale, Self-concept and Self-esteem Scale and student demographical information were undertaken together with the order of presentation counterbalanced. These measures were undertaken by trained research assistants during regular classes. Parental consent was obtained and students participated on a voluntary basis. Students were informed about the study objectives and confidentiality.

Data Analysis

For those students who had been retained over the 3 years of the project variables were calculated using data of the retention year (Time 2) and of the previous year (Time 1). Among those that had not been retained during this period, for half of them variables were computed using data of the first (Time 1) and 2nd year (Time 2) and for the other half, variables were computed using data of the second (Time 1) and 3rd year (Time 2).

Repeated measures MANCOVA/ANCOVA analyses were conducted in order to analyze the differences in self-concept, self-esteem, goal orientations, and academic achievement between the four groups of students with cohort also as a factor and age and mother's education level as co-variates.

A cluster analysis was carried out to identify profiles based on goal orientations. Clusters analyses were conducted following the methodology proposed by Hair et al. (2010) using a hierarchical followed by a non-hierarchical classification method to decide the number of clusters. Thus the analysis using Ward's Method and the squared Euclidean distance as a measure of similarity was carried out first, followed by the analysis using *K*-means. In

order to validate the clusters obtained a discriminant analysis was conducted as well as ANOVA analysis on self-related variables and achievement. Student distribution in the different profiles according to their retention status was analyzed through the Chi square test.

In MANCOVA/ANCOVA/ANOVA analyses the effect sizes were found using partial eta squared.

RESULTS

Table 2 shows the means and standard deviations for achievement and self-related variables for the four groups taken into consideration: students with past but no recent retention (PR – NRR), students with past and recent retention (PR – RR), students with no past but recent retention (NPR – RR) and students with no past or recent retention (NPR – NRR). The means revealed that the groups with retention experience (PR – NRR, NPR – RR) showed lower achievement and lower self-esteem and academic self-concept, both in the year before and in the year of retention, in comparison to their peers with no retention. In relation to non-academic self-concept, those students with past retention and those with recent retention presented higher levels than the successful group (NPR – NRR). Detailed analysis on the mean values demonstrated that the group with past and recent retention presented the lowest values in self-esteem and self-concept, and this group along with the group with no past but with recent retention presented the greatest decrease and the lower values in achievement. Moreover, the results also demonstrated that the students with recent retention (PR – RR and NRB – R) presented the lowest academic self-concept.

Repeated measures ANCOVA on academic achievement showed a main effect of retention status, $F(3,525) = 174.4$, $p < 0.001$, $\eta_p^2 = 0.50$, and an interaction effect between time and retention status, $F(3,525) = 26.03$, $p < 0.001$, $\eta_p^2 = 0.13$. Pairwise comparison using Bonferroni correction showed significant differences between the successful group and the other three ($p < 0.001$) as well as differences between the group of students with past but no recent retention (PR – NRR) and the two groups of students with recent retention (PR – RR and NPR – RR). Successful students showed the highest scores in academic achievement, students with recent retention (PR – RR and NPR – RR) had the lowest grades and students with past but no recent retention (PR – NRR) were in between (**Table 2**). The interaction effect between time and group was expected in the sense that the groups with recent retention (PR – RR and NPR – RR) presented a noticeable decrease in grades whereas the two groups which were not retained (PR – NRR and NPR – NRR) showed relative stability (**Figure 1**).

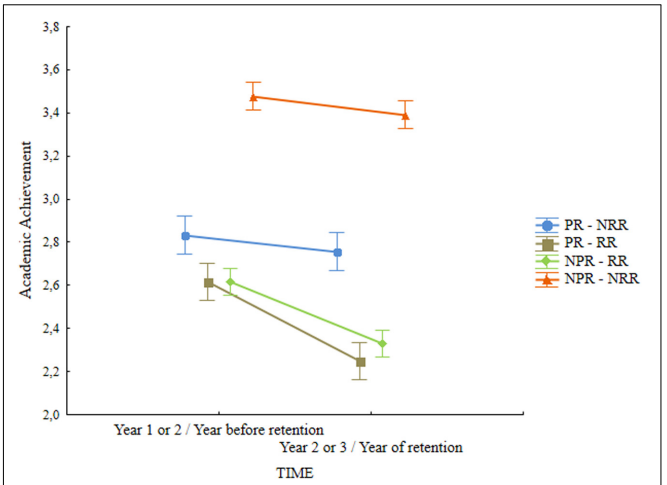


FIGURE 1 | Retention status × time interaction for academic achievement. Vertical bars denote 0,95 confidence intervals. PR – NRR, group with past but no recent retention; PR – RR, group with past and recent retention; NPR – RR, group with no past but recent retention; NPR – NRR, group with no past or recent retention.

Repeated measures ANCOVA on self-esteem showed a small effect from retention status, $F(3,513) = 1.54$, $p = 0.042$, $\eta_p^2 = 0.016$. Pairwise comparisons with Bonferroni adjustment showed a marginal difference, $p = 0.065$, between the group of successful students (NPR – NRR) and the group of students with no past retention but with recent retention (NPR – RR). No interaction effects between time, retention status and cohort were found for self-esteem.

TABLE 2 | Mean and standard deviation for the four groups for achievement and self-related variables.

	Ach-T1[1]		Ach-T2[2]		SE-T1		SE-T2		ASC-T1		ASC-T2		NASC-T1		NASC-T2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
PR – NRR	2.92	0.33	2.89	0.31	2.82	0.57	2.87	0.54	2.46	0.46	2.49	0.39	2.87	0.49	2.86	0.46
PR – RR	2.74	0.20	2.28	0.27	2.78	0.57	2.78	0.55	2.34	0.40	2.32	0.34	2.86	0.51	2.87	0.45
NPR – RR	2.73	0.32	2.36	0.24	2.82	0.63	2.83	0.57	2.42	0.42	2.33	0.37	2.88	0.51	2.86	0.50
NPR – NRR	3.58	0.67	3.51	0.70	2.95	0.62	2.98	0.61	2.78	0.49	2.76	0.48	2.83	0.51	2.84	0.50

Ach, Achievement; SE, Self-esteem; ASC, Academic Self-concept; NASC, Non-academic self-concept; PR – NRR, group with past but no recent retention; PR – RR, group with past and recent retention; NPR – RR, group with no past but recent retention; NPR – NRR, group with no past or recent retention.

[1] *"Time 1" applies for the year before retention in PR – RR and NPR – RR students and for the first or the 2nd year of data collection for the students in the groups PR – NRR and NPR – NR.*

[2] *"Time 2" applies for the year of retention in PR – RR and NPR – RR students; and for the 2nd or the 3rd year of data collection for the students in the groups PR – NRR and NPR – NR.*

TABLE 3 | Mean and standard deviation for the four groups for importance given to academic competencies and goal orientations.

	IGAC-T1[1]		IGAC-T2[2]		Task-T1		Task-T2		SEnh-T1		SEnh-T2		SDef-T1		SDef-T2		Av-T1		Av-T2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
PR – NRR	3.17	0.55	3.13	0.53	2.85	0.51	2.77	0.51	2.62	0.73	2.51	0.65	2.24	0.74	2.25	0.69	2.22	0.63	2.27	0.61
PR – RR	3.19	0.53	2.97	0.51	2.78	0.55	2.64	0.48	2.54	0.66	2.33	0.56	2.43	0.82	2.30	0.76	2.27	0.56	2.48	0.57
NPR – RR	3.31	0.58	3.08	0.54	2.83	0.55	2.61	0.48	2.61	0.71	2.42	0.66	2.47	0.86	2.26	0.83	2.23	0.69	2.41	0.60
NPR – NRR	3.51	0.49	3.41	0.52	3.0	0.55	2.91	0.53	2.56	0.78	2.51	0.75	2.29	0.88	2.14	0.77	2.02	0.62	2.12	0.55

IGAC, Importance given to Academic Competencies; Task, Task orientation; SEnh, Self-enhancing ego orientation; SDef, Self-defeating ego orientation; Av, Avoidance orientation; PR – NRR, group with past but no recent retention; PR – RR, group with past and recent retention; NPR – RR, group with no past but recent retention; NPR – NRR, group with no past or recent retention.

[1] "Time 1" applies for the year before retention in PR – RR and NPR – RR students and for the first or the 2nd year of data collection for the students in the groups PR – NRR and NPR – NRR.

[2] "Time 2" applies for the year of retention in PR – RR and NPR – RR students; and for the 2nd or the 3rd year of data collection for the students in the groups PR – NRR and NPR – NRR.

Repeated measures MANCOVA analysis on self-concept (academic and non-academic self-concept) showed a main effect of retention status, Pillai's Trace = 0.219, $F(6,1026) = 21.07$, $p < 0.001$, $\eta_p^2 = 0.110$. This main effect was on academic self-concept, $F(3,513) = 38.24$, $p < 0.001$, $\eta_p^2 = 0.183$, with the successful group (NPR – NRR) presenting significantly higher academic self-concept (**Table 2**) than the other three groups (all comparisons significant at $p < 0.001$).

Regarding the importance attributed to academic competencies (**Table 3**) ANCOVA analysis showed a main effect of retention status, $F(3,513) = 11.88$, $p < 0.001$, $\eta_p^2 = 0.065$, and a marginal interaction effect between time and retention status $F(3,513) = 2.39$, $p = 0.068$, $\eta_p^2 = 0.014$. Pairwise comparison between the groups showed that the successful group attributed stronger importance to academic competencies (**Table 3**) than the other three groups ($p = 0.001$ for the comparison with the PR – NRR group and $p < 0.001$ for the comparisons with the other two groups). The interaction effect between time and retention status (**Figure 2**) showed that despite the fact that in all groups the importance given to academic competencies decreased, the highest decrease was in those students with recent retention (PR – RR and NPR – RR).

Concerning goal orientations only retention status had a small significant effect, Pillai's Trace = 0.069, $F(12,1536) = 3.02$, $p < 0.001$, $\eta_p^2 = 0.023$. Univariate analyses showed that those effects were on task orientation, $F(3,513) = 7.33$, $p < 0.001$, $\eta_p^2 = 0.041$, and on avoidance orientation, $F(3,513) = 7.97$, $p < 0.001$, $\eta_p^2 = 0.045$. Pairwise comparison using Bonferroni correction showed significant differences between the successful group and the two groups of students with recent retention (PR – RR and NPR – RR, $p = 0.017$ and $p < 0.001$, respectively) for task orientation and between the successful group and the other three for avoidance orientation ($p = 0.063$ for the

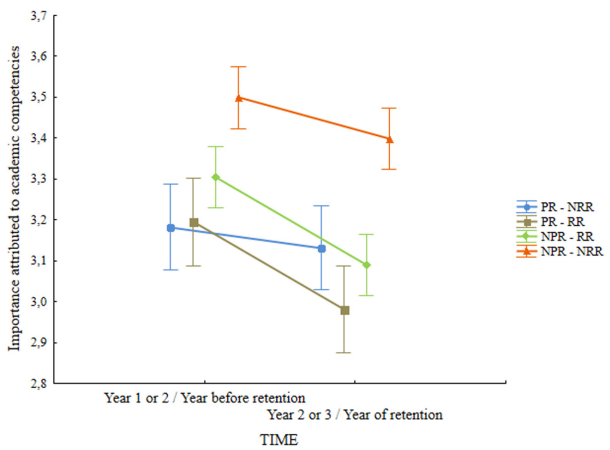


FIGURE 2 | Retention status × time interaction for the Importance given to academic competence. Vertical bars denote 0,95 confidence intervals. PR – NRR, group with past but no recent retention; PR – RR, group with past and recent retention; NPR – RR, group with no past but recent retention; NPR – NRR, group with no past or recent retention.

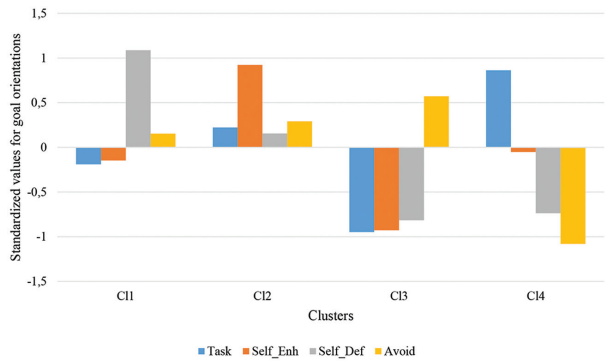


FIGURE 3 | Students' standardized mean scores on achievement goals across the four clusters. Task, Task orientation; Self_Enh, Self-enhancing ego orientation; Sef_Def, Self-defeating ego orientation; Avoid, Avoidance orientation.

comparison with the PR – NRR group and $p < 0.001$ for the comparison with the other two groups, PR – RR and NPR – RR).

Cluster analyses enabled to differentiate four different groups (**Figure 3**) based on students' goal orientations in the retention year (for those who were retained) or year 2 or 3 for the others. Since the clusters obtained were very similar to those obtained in previous research (Tuominen-Soini et al., 2008, 2011, 2012; Pulkka and Niemivirta, 2013) they were given identical labels. The first cluster, labeled "self-defeating oriented," comprised 195 students whose main characteristic was the high scores in self-defeating ego orientation. The second cluster, labeled "self-enhancing oriented," was composed by 193 students showing high values in self-enhancing ego orientation. The third cluster was labeled "disengaged" and includes 152 students whose distinctive feature was the high scores in avoidance orientation. The fourth cluster, labeled "task oriented," was composed by 160 students showing high scores in task orientation.

A discriminant analysis on the cluster solution revealed a 95.6% classification adequacy. ANOVA analyses on self-related variables and on academic achievement showed significant effects of the clusters, $F(3,696) = 45.28$, $p < 0.001$, $\eta_p^2 = 0.16$ for academic self-concept, $F(3,696) = 15.05$, $p < 0.001$, $\eta_p^2 = 0.06$ for non-academic self-concept, $F(3,693) = 44.09$, $p < 0.001$, $\eta_p^2 = 0.16$ for the importance accorded to academic competencies, $F(3,694) = 21.25$, $p < 0.001$, $\eta_p^2 = 0.09$, for self-esteem, and $F(3,671) = 12.50$, $p < 0.001$, $\eta_p^2 = 0.05$ for academic achievement. These results strengthened the classification reached through clusters analysis because differences found in goal orientations were also found in related variables thus supporting the validation of cluster analysis.

Table 4 shows the composition of the clusters by the four groups of students according to their academic status (PR – NRR, PR – RR, NPR – RR, and NPR – NRR). The differences in the distribution of students according to their academic status by clusters was statistically significant, $\chi^2(9) = 47.1$, $p < 0.001$. Analyses through the adjusted residuals showed

TABLE 4 | Students distribution by retention status and clusters.

	PR – NRR	PR – RR	NPR – RR	NPR – NRR
Self-defeating oriented	24	55	76	40
Self-enhancing oriented	32	50	62	49
Disengaged	20	47	56	29
Task oriented	28	20	40	72

PR – NRR, group with past but no recent retention; PR – RR, group with past and recent retention; NPR – RR, group with no past but recent retention; NPR – NRR, group with no past or recent retention.

that successful students were underrepresented in the self-defeating and disengaged oriented cluster and prevailed in the task orientation group. Students with recent retention (NPR – RR and PR – RR) were underrepresented in the task oriented cluster and those who had been retained previously and again at the end of the year (PR – RR) were overrepresented in the disengaged group. The students with past but no recent retention were evenly distributed over the four clusters.

DISCUSSION

This study focused on analyzing the differences in academic achievement, self-related variables and motivation in students with different retention status. Results showed that a retention history and/or the perspective of being retained differentiate students both in terms of academic achievement and of the affective components of learning.

Academic Achievement

In relation to academic achievement results showed that retention status differentiates students, with successful students (never been retained) showing the highest grades followed by students with past but no recent retentions (PR – NRR) which remain in the middle range between successful students and those who were retained at the end of the year (PR – RR and NPR – RR). Moreover, the two groups of students that were retained at the end of the school year (PR – RR and NPR – RR) showed a significant decrease in grades from the year before to the year of the retention. This interaction effect between retention status and time presented one of the strongest effects sizes, corroborating research showing previous academic achievement as one of the important predictors of retention (e.g., McCoy and Reynolds, 1999; Huang, 2014; Davoudzadeh et al., 2015). Also in line with the results from several longitudinal studies (e.g., Moser et al., 2012), even when a short term boost is observed in the grades of retained students, in the long run their grades tend to decrease and this boost tend to even dissipate over time (Jimerson, 1999; Wu et al., 2008a; Chen et al., 2010; Moser et al., 2012).

When observing and matching the trajectories of grades of these two groups of students who were retained at the end of the school year we can focus on two lines of analysis. One showing that students who are going to be retained present significantly lower grades in the year before retention. This is in line with previous findings (Huang, 2014; Davoudzadeh et al., 2015) highlighting the predictive value of school achievement in

grade retention. The other, stressing that retention has no positive effect on grades, as the group with past retention also showed a decrease in grades.

These findings corroborate research showing the negative effects of grade retention in terms of academic outcomes for students who have cumulatively past and recent retentions (Martin, 2009, 2011) as well as more long term consequences that persist in young adulthood and in most cases thwart further educational achievement (Fine and Davis, 2003). However, our results can also contribute to explain differences and inconsistencies in research on the effects of retention on academic achievement. The fact of having different retention status groups and having longitudinal data allowed us to show that not all previously retained students continue to be retained. This apparently positive or neutral effect of retention for some students (Allen et al., 2009; Lorence, 2014) can be due to the different ways teachers, students and families cope with this situation, in order to promote student success (Jimerson, 2001; Brophy, 2006; Moser et al., 2012). Nevertheless, among the participants of our research only one third of retained students (37,8%) succeeded in not repeating again, showing that for the most part retention was not a positive decision. Besides academic achievement, data concerning competence beliefs and motivation also help in understanding the positive and/or harmful effects of retention for students.

Self-representations

The effects of retention status on self-representations must be distinguished between those on global self-representations (self-esteem) and on more specific facets of self-representations (academic and non-academic self-concepts). Effects on self-esteem are minor but even then showing lower levels of self-esteem for those students who are in the path of being held back. These findings are in line with previous research showing that low achievers can exhibit low self-esteem when they forecast retention as a close possibility for their academic near future (Jimerson et al., 1997; Peixoto, 2010; Martin, 2011; Nascimento and Peixoto, 2012), as well as with research showing the absence of differences between successful students and their grade-mates with past retentions (Peixoto and Almeida, 2010). The results in the group with past retention can be explained in light of past research (Alves-Martins et al., 2002; Peixoto and Almeida, 2010), where students with past retention showed similar levels of self-esteem to their peers with no grade retention experience. These results were explained through the use of self-esteem protection mechanisms such as devaluating academic-related activities, showing negative attitudes toward school and/or presenting higher self-concepts in non-academic dimensions (Alves-Martins et al., 2002; Peixoto and Almeida, 2010).

Academic self-concept is also affected by retention status with successful students showing higher academic self-concepts than the students from the other three groups, corroborating previous research showing the effects of retention on academic self-representations (Veiga, 1995, 1996; Peixoto, 2010; Peixoto and Almeida, 2010; Martin, 2011; Robles-Piña, 2011; Nascimento and Peixoto, 2012; Rosário et al., 2013). The effect size of retention status on academic self-concept is also one of the strongest effects sizes obtained, drawing attention to the impact that retention (or the possibility of it) has on self-representation of academic competence. Moreover this result stresses that students with past but no recent retention still maintain low levels of academic self-concept even though at least 1 year mediates between the last retention and the evaluation of academic self-concept. Studies also revealed that the self-concept of students who experienced grade retention tended to decrease overtime, supporting the predictive effect of retention in self-concept (Martin, 2011; Robles-Piña, 2011; Lamote et al., 2014). However, when observing the low self-concept scores among the students of the group with no past but with recent retention, we observed that those scores were already low in the year before retention, highlighting the idea that self-concept can also predict academic achievement and retention. Overall, these data seem to be in accordance to the reciprocal effects model which maintains that self-concept is affected and also affects academic achievement (Marsh and Craven, 2006; Huang, 2011).

Motivation

In relation to motivation both the importance attributed to academic competencies by students and their goal orientations were taken into consideration. For the importance attributed to academic competencies, results showed that successful students valued academic competencies more than the students with past and/or future retention and that the undervaluing of academic competencies is higher for those students that are going to be held back at the end of the year and for older students. Research has shown that the perception of academic competence and valuing of academic achievement have a determinant role in student behaviors such as effort and persistence (Deci and Ryan, 2000; Wigfield et al., 2012). The underlying argument is that when students believe that they are competent and value academic tasks they invest more energy and they are more persistent. Thus, affecting the value attached to academic achievement, retention affects motivation which will reflect in the attitudes of these students toward learning.

When we analyze the quality of motivation in terms of goal orientations, differences appear in task and avoidance orientations introduced by retention status. In both orientations students that are going to be retained clearly differentiate from successful students, presenting lower task orientation and higher avoidance orientation. Students with past but no recent retention did not differentiate significantly from their successful classmates in task orientation but presented higher levels of avoidance orientation. These results highlight the adaptive role of task goals and the detrimental role of avoidance goals in line with previous research (Meece et al., 2006; Nascimento and Peixoto, 2012; Federici et al., 2015). The profiles obtained through cluster analysis reinforced this finding with successful students overrepresented in the task oriented group and students with recent retention being the majority in the disengaged clusters. Students with recent retention are also predominant in self-defeating and in self-enhancing oriented clusters. If it would be expected their predominance in the disengaged and self-defeating clusters, it is a little bit surprising that they are also the majority in the self-enhancing cluster. However, observing the profile of these

students shows that they also present high scores in self-defeating and avoidance orientations which is the second cluster with the highest scores in these two orientations. This result is similar to a group that Covington (2009) called "overstrivers" (with high levels in both ego/performance and avoidance orientations). According to Covington (2009) these students are simultaneously engaged in demonstrating success and, at the same time, trying to avoid failure. The result suggests that these particular students who will be retained, according to the self-worth approach, have adopted a defensive position for avoiding prospective failure by engaging in self-enhancement goals (Covington, 2009), and this may serve as a protection mechanism for further experiences of failure.

CONCLUSION

The results of the present study provided additional information on the relationship between grade retention and academic achievement and its affective aspects and in the longitudinal trajectories characterizing different groups of students with different retention profiles. Four groups of students were identified according to their retention history and given the extent of the measures used in the present research our results allowed us to clarify the detrimental effect of retention both on academic and non-academic outcomes (self-concept, importance given to academic competences, motivation). Our findings also pave the way for research on a possible reciprocal effect between the retention and these affective aspects (Marsh and Craven, 2006; Huang, 2011) suggesting that retention affects and is, at the same time, affected by self-representations and the goal orientations that students pursue.

Observing the similarities between the groups with recent retention and the group with past but no recent retention and taking into consideration the longitudinal studies on the effects of retention, it is suggested that the experience of repeating a grade, whether in the past or recently and, most importantly, whether this occurred only once, leaves a profound mark on those students, undermining their achievement and socioemotional wellbeing (Jimerson, 2001). Therefore, future research should address the long-term effects of retention on socioemotional variables, by following students throughout their school career, to see whether this mark perpetuates or attenuates over time.

Despite these predominantly negative findings, the practice of grade retention continues to be a response to under-achievement in many countries. Portugal has a high rate of grade retention [more than 35% of 15 year olds had repeated one or more years, compared to an OECD average of 13,0% (OECD, 2013)]. Brophy (2006, p. 7) maintains that "low achievement patterns of grade repeaters tend to be associated with poverty indicators at both the school and the family levels."Students in developing countries tend to repeat a grade not only because they have low achievement but also because they stop attending school the previous year. In 2015, 13,5% of Portuguese students drop out early (Ffms, 2016). Based on the assumptions of Martin (2011) other explanations can be put forward for the fact that in our country grade retention continues to be a systematic strategy used to help under-achieving students. One reason for this is because it is a direct and swift strategy to implement and doesn't require changes in the school and school innovation. According to Brophy (2006) teachers and parents believe that repeating a year yields positive outcomes leading to such practices becoming part of the school culture.

Justino et al. (2014, pp. 90–91) argues that this culture of retention and dropout in Portugal as a solution to low achievement does not "necessarily pass for outlawing retention or to eluding the pursuit of success at any cost. The solution is before – by preventing it." This position is shared by several researchers in different countries who affirm the need to rethink retention and its benefits as a remedial practice (Owings and Magliaro, 1998; Lorence, 2006, 2014; Chen et al., 2010). Therefore early intervention, working what students do not know, diversifying teaching methods, and engaging parents, are some preventive strategies that could be implemented to improve academic achievement (Brophy, 2006; Rebelo, 2009; Rodrigues, 2010, 2014).

AUTHOR CONTRIBUTIONS

FP conceived the study with input from LM and VM. CS carried out the data collection. FP conducted data analysis. FP, LM, VM, CS, and JP wrote and critically revised the manuscript. LA gave substantial contributions to the conception of the work, analysis and interpretation of the data and revised the work critically. All authors read and approved the final manuscript.

FUNDING

This study was supported by the FCT - Fundação para a Ciência e a Tecnologia through the research project PTDC/CPE-CED/121358/2010.

ACKNOWLEDGMENT

The authors are grateful for the support from the schools and for the participation of the students involved in this study.

REFERENCES

Allen, C. S., Chen, Q., Willson, V. L., and Hughes, J. N. (2009). Quality of research design moderates effects of grade retention on achievement: a meta-analytic, multi-level analysis. *Educ. Eval. Policy Anal.* 31, 480–499. doi: 10.3102/0162373709352239

Alves, A. F., Gomes, C. M. A., Martins, A., and Almeida, L. S. (2016). Social and cultural contexts change but intelligence persists as incisive to explain children's academic achievement. *Ponte Int. Sci. Res. J.* 72, 70–89. doi: 10.21506/j.ponte.2016.9.6

Alves-Martins, M., Peixoto, F., Gouveia-Pereira, M., Amaral, V., and Pedro, I. (2002). Self-esteem and academic achievement among adolescents. *Educ. Psychol.* 22, 51–62. doi: 10.1080/01443410120101242

Ames, C., and Archer, J. (1988). Achievement goals in the classroom: students' learning strategies and motivation processes. *J. Educ. Psychol.* 80, 260–267. doi: 10.1111/j.1467-6494.2011.00750.x

Boekaerts, M. (2002). Bringing about change in the classroom: strengths and weaknesses of the self-regulated learning approach—EARLI presidential address, 2001. *Learn. Ins.* 12, 589–604. doi: 10.1016/S0959-4752(02)00010-5

Bonvin, P., Bless, G., and Schuepbach, M. (2008). Grade retention: decision-making and effects on learning as well as social and emotional development. *Sch. Eff. Sch. Improv.* 19, 1–19. doi: 10.1080/09243450701856499

Brophy, J. (2006). *Grade Repetition*. Brussels: The International Institute for Educational Planning (IIEP) and The International Academy of Education (IAE).

Chen, X., Liu, C., Zhang, L., Shi, Y., and Rozelle, S. (2010). Does taking one step back get you two steps forward? Grade retention and school performance in poor areas in rural China. *Int. J. Edu. Dev.* 30, 544–559. doi: 10.1016/j.ijedudev.2009.12.002

CNE (2015). *Relatório técnico: Retenção Escolar nos Ensinos Básicos e Secundário [Technical report: Grade Retention in Middle and High School]*. Lisboa: CNE.

Covington, M. (2009). "Self-worth theory," in *Handbook of Motivation at School*, eds K. Wentzel and A. Wigfield (New York, NY: Routledge), 141–169.

Darnon, C., Muller, D., Schrager, S. M., Pannuzzo, N., and Butera, F. (2006). Mastery and performance goals predict epistemic and relational conflict regulation. *J. Educ. Psychol.* 98, 766–776. doi: 10.1037/0022-0663.98.4.766

Davoudzadeh, P., McTernan, M. L., and Grimm, K. J. (2015). Early school readiness predictors of grade retention from kindergarten through eighth grade: a multilevel discrete-time survival analysis approach. *Early Child. Res. Q.* 32, 183–192. doi: 10.1016/j.ecresq.2015.04.005

Deci, E. L., and Ryan, R. M. (2000). The "what" and "why" of goal pursuits: human needs and the self-determination of behavior. *Psychol. Inq.* 11, 227–268. doi: 10.1207/S15327965PLI1104_01

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., et al. (2007). School readiness and later achievement. *Dev. Psychol.* 43, 1428–1446. doi: 10.1037/0012-1649.43.6.1428

Ehmke, T., Drechsel, B., and Carstensen, C. H. (2010). Effects of grade retention on achievement and self-concept in science and mathematics. *Stud. Educ. Eval.* 36, 27–35. doi: 10.1016/j.stueduc.2010.10.003

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educ. Psychol.* 34, 169–189. doi: 10.1207/s15326985ep3403_3

Elliott, E. S., and Dweck, C. S. (1988). Goals: an approach to motivation and achievement. *J. Pers. Soc. Psychol.* 54, 5–12. doi: 10.1037/0022-3514.54.1.5

Federici, R. A., Skaalvik, E. M., and Tangen, T. N. (2015). Students' perceptions of the goal structure in mathematics classrooms: relations with goal orientations, mathematics anxiety, and help-seeking behavior. *Int. Educ. Stud.* 8, 146–158. doi: 10.5539/ies.v8n3p146

Ffms. (2016). *Taxa de Abandono Precoce de Educação e Formação: Total e por sexo [Early dropout rate in Eduation and Training: Total and by Sex]*. Available at: http://www.pordata.pt/DB/Portugal/Ambiente+de+Consulta/Tabela

Fine, J. G., and Davis, J. M. (2003). Grade retention and enrollment in post-secondary education. *J. Sch. Psychol.* 41, 401–411. doi: 10.1016/j.jsp.2003.07.001

Goos, M., Van Damme, J., Onghena, P., Petry, K., and de Bilde, J. (2013). First-grade retention in the flemish educational context: effects on children's academic growth, psychosocial growth, and school career throughout primary education. *J. Sch. Psychol.* 51, 323–347. doi: 10.1016/j.jsp.2013.03.002

Gutman, L. M., Sameroff, A. J., and Cole, R. (2003). Academic growth curve trajectories from the 1st grade to 12st grade: effects of multiple social risk factors and preschool child factors. *Dev. Psychol.* 39, 777–790. doi: 10.1037/0012-1649.39.4.777

Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. (2010). *Multivariate Data Analysis*, 7th Edn. New Jersey: Pearson Education.

Hong, G., and Yu, B. (2008). Effects of kindergarten retention on children's social-emotional development: an application of propensity score method to multivariate, multilevel data. *Dev. Psychol.* 44, 407–421. doi: 10.1037/0012-1649.44.2.407

Hong, G. L., and Raudenbush, S. W. (2005). Effects of kindergarten retention policy on children's cognitive growth in reading and mathematics. *Educ. Eval. Policy An.* 27, 205–224. doi: 10.3102/01623737027003205

Huang, C. (2011). Self-concept and academic achievement: a meta-analysis of longitudinal relations. *J. Sch. Psychol.* 49, 505–528. doi: 10.1016/j.jsp.2011.07.001

Huang, F. L. (2014). Further understanding factors associated with grade retention: birthday effects and socioemotional skills. *J. App. Dev. Psychol.* 35, 79–93. doi: 10.1016/j.appdev.2013.12.004

Inglés, C. J., González-Maciá, C., Garcia-Fernández, J. M., Vicent, M., and Martínez-Monteagudo, M. C. (2015). Current status of research on school refusal. *Eur. J. Educ. Psychol.* 8, 37–52. doi: 10.1016/j.ejeps.2015.10.005

Jimerson, S., Carlson, E., Rotert, M., Egeland, B., and Sroufe, E. (1997). A prospective longitudinal study of the correlates and consequences of early grade retention. *J. Sch. Psychol.* 35, 3–25. doi: 10.1016/S0022-4405(96)00033-7

Jimerson, S. R. (1999). On the failure of failure: examining the association between early grade retention and education and employment outcomes during late adolescence. *J. Sch. Psychol.* 37, 243–272. doi: 10.1016/S0022-4405(99)00005-9

Jimerson, S. R. (2001). Meta-analysis of grade retention research: implications for practice in the 21st century. *Sch. Psychol. Rev.* 30, 420–437.

Jimerson, S. R., Anderson, G. E., and Whipple, A. D. (2002). Winning the battle and losing the war: examining the relation between grade retention and dropping out of high school. *Psychol. Sch.* 39, 441–457. doi: 10.1002/pits.10046

Jimerson, S. R., and Ferguson, P. (2007). A longitudinal study of grade retention: academic and behavioral outcomes of retained students through adolescence. *Sch. Psychol. Q.* 22, 314–339. doi: 10.1037/1045-3830.22.3.314

Jimerson, S. R., Pletcher, S. M., Graydon, K., Schnurr, B. L., Nickerson, A. B., and Kundert, D. K. (2006). Beyond grade retention and social promotion: promoting the social and academic competence of students. *Psychol. Sch.* 43, 85–97. doi: 10.1002/pits.20132

Justino, D., Pascueiro, L., Franco, L., Santos, R., Almeida, S., and Batista, S. (2014). *Atlas da Educação. Portugal* 1991-2001-2011 [Atlas of Education. Portugal 2001-2011]. Lisboa: CESNOVA/EPIS/FCSH-UNL.

Klapproth, F., and Schaltz, P. (2015). Who is retained in school, and when? Survival analysis of predictors of grade retention in Luxembourgish secondary school. *Eur. J. Psychol. Educ.* 30, 119–136. doi: 10.1007/s10212-014-0232-7

Korn, R. M., and Elliot, A. J. (2016). The 2 x 2 standpoints model of achievement goals. *Front. Psychol.* 7:742. doi: 10.3389/fpsyg.2016.00742

Lamote, C., Pinxten, M., Van Den Noortgate, W., and Van Damme, J. (2014). Is the cure worse than the disease? A longitudinal study on the effect of grade retention in secondary education on achievement and academic self-concept. *Educ. Stud.* 40, 496–514. doi: 10.1080/03055698.2014.936828

Linnenbrink-Garcia, L., Tyson, D. F., and Patall, E. A. (2008). When are achievement goal orientations beneficial for academic achievement? A closer look at main effects and moderating factors. *Rev. Int. Psychol. Soc.* 21, 19–70.

Lorence, J. (2006). Retention and academic research revisited from a united states perspective. *Int. Educ. J.* 7, 731–777.

Lorence, J. (2014). Third-grade retention and reading achievement in Texas: a nine year panel study. *Soc. Sci. Res.* 48, 1–19. doi: 10.1016/j.ssresearch.2014.05.001

Magnusson, D. (1988). *Individual Development From an Interactionist Perspective*. Hillsdale, NJ: Erlbaum.

Marsh, H. W., and Craven, R. G. (2006). Reciprocal effects of self-concept and performance from a multidimensional perspective: beyond seductive pleasure and unidimensional perspectives. *Perspect. Psychol. Sci.* 1, 133–163. doi: 10.1111/j.1745-6916.2006.00010.x

Martin, A. J. (2009). Age appropriateness and motivation, engagement, and performance in high school: effects of age within cohort, grade retention, and delayed school entry. *J. Educ. Psychol* 101, 101–114. doi: 10.1037/a0013100

Martin, A. J. (2011). Holding back and holding behind: grade retention and students' non-academic and academic outcomes. *Brit. Educ. Res. J.* 37, 739–763. doi: 10.1080/01411926.2010.490874

McCoy, A. R., and Reynolds, A. J. (1999). Grade retention and school performance: an extended investigation. *J. Sch. Psychol.* 37, 273–298. doi: 10.1016/S0022-4405(99)00012-6

Meece, J. L., Anderman, E. M., and Anderman, L. H. (2006). Classroom goal structure, student motivation, and academic achievement. *An. Rev. Psychol.* 57, 487–503. doi: 10.1146/annurev.psych.56.091103.070258

Middleton, M. J., and Midgley, C. (1997). Avoiding the demonstration of lack of ability: an under-explored aspect of goal theory. *J. Educ. Psychol.* 89, 710–718. doi: 10.1037/0022-0663.89.4.710

Moser, S. E., West, S. G., and Hughes, J. N. (2012). Trajectories of math and reading achievement in low achieving children in elementary school: effects of early and later retention in grade. *J. Educ. Psychol.* 104, 603–621. doi: 10.1037/a0027571

Nascimento, S., and Peixoto, F. (2012). Relações entre o estatuto escolar e o autoconceito, auto-estima e orientações motivacionais em alunos do 9° ano de escolaridade. *[Relationships between school status and self-concept, self-esteem and motivational orientations in* 9th grade students]. *Anal. Psicol.* 30, 421–434.

Nicholls, J. (1984). Achievement motivation: conceptions of ability, subjective experience, task choice, and performance. *Psychol. Rev.* 91, 328–346. doi: 10.1037/0033-295X.91.3.328

OECD (2013). *Synergies for Better Learning: An International Perspective on Evaluation and Assessment*. Paris: Organization for Economic Cooperation and Development.

Owings, W. A., and Magliaro, S. (1998). Grade retention: a history of failure. *Educ. Leadersh.* 56, 86–88.

Pagani, L., Tremblay, R. E., Vitaro, F., Boulerice, B., and McDuff, P. (2001). Effects of grade retention on academic performance and behavioral development. *Dev. Psychopathol.* 13, 297–315. doi: 10.1017/S0954579401002061

Peixoto, F. (2010). "Relationships between self-esteem, self-concept and academic achievement in adolescents," in *Proceedings of the 12th Biennial Conference of the European Association for Research on Adolescence*, ed. R. Zukauskiene (Bologna: Medimond Editore), 249–253.

Peixoto, F., and Almeida, L. S. (1999). "Escala de auto-conceito e auto-estima," in *Avaliação psicológica: Formas e contextos*, Vol. 6, eds A. P. Soares, S. Araújo, and S. Caires (Braga: APPORT), 632–640.

Peixoto, F., and Almeida, L. S. (2010). Self-concept, self-esteem and academic achievement: Strategies for maintaining self-esteem in students experiencing academic failure. *Eur. J. Psychol. Educ.* 25, 157–175. doi: 10.1007/s10212-010-0011-z

Peixoto, F., and Almeida, L. S. (2011). A organização do autoconceito: análise da estrutura hierárquica em adolescentes. *Psicol-Reflex. Crit.* 24, 533–541. doi: 10.1590/S0102-79722011000300014

Peixoto, F., Mata, L., Monteiro, V., Sanches, C., Bártolo-Ribeiro, R., and Pipa, J. (2016). Validação da escala de autoconceito e autoestima (EAAPA) e análise da estrutura organizativa do autoconceito em pré-adolescentes [Validation of the self-concept and self-esteem scale (EAAPA) and organization of self-concept in pre-adolescents]. *Rev. Iberoam. Diagn. Ev.* 2016:1

Pintrich, P. R. (2000). An achievement goal theory perspective on issues in motivation terminology, theory, and research. *Contemp. Educ. Psychol.* 25, 92–104. doi: 10.1006/ceps.1999.1017

Pipa, J., Peixoto, F., Mata, L., Monteiro, V., and Sanches, C. (2016). The goal orientations scale (GOS): validation for portuguese students. *Eur. J. Dev. Psychol.* 1–12. doi: 10.1080/17405629.2016.1216835

Pulkka, A., and Niemivirta, M. (2013). Adult students' achievement goal orientations and evaluations of the learning environment: a person-centred longitudinal analysis. *Educ. Res. Eval.* 19, 297–322. doi: 10.1080/13803611.2013.767741

Rebelo, J. A. (2009). Efeitos da retenção escolar, segundo os estudos científicos, e orientações para uma intervenção eficaz: uma revisão. *Rev. Port. Pedagog.* 43, 27–52. doi: 10.14195/1647-8614_43-1_2

Robles-Piña, R. A. (2011). Depression and self-concept: personality traits or coping styles in reaction to school retention of hispanic adolescents. *Depress Res. Treat.* 2011:151469. doi: 10.1155/2011/151469

Roderick, M., and Nagaoka, J. (2005). Retention under Chicago's high-stakes testing program: helpful, harmful, or harmless? *Educ. Eval. Policy Anal.* 27, 309–340. doi: 10.3102/01623737027004309

Rodrigues, M. L. (2010). *A Escola Pública Pode Fazer a Diferença [Public School Can Make the Difference]*. Coimbra: Almedina.

Rodrigues, M. L. (2014). *40 Anos de Políticas de Educação em Portugal - Construção do Sistema Democrático de Ensino [40 years of Educational Politics in Portugal]*, Vol. 1. Coimbra: Almedina.

Rosário, P., Núñez, J. C., Valle, A., González-Pienda, J., and Lourenço, A. (2013). Grade level, study time, and grade retention and their effects on motivation, self-regulated learning strategies, and mathematics achievement: a structural equation model. *Eur. J. Psychol. Educ.* 28, 1311–1331. doi: 10.1007/s10212-012-0167-9

Sandoval, J. (1984). Repeating the first grade: how the decision is made. *Psychol. Sch.* 21, 457–462. doi: 10.1002/1520-6807(198410)21:4<457::AID-PITS2310210410>3.0.CO;2-A

Seaton, M., Parker, P., Marsh, H. W., Craven, R. G., and Yeung, A. S. (2014). The reciprocal relations between self-concept, motivation and achievement: juxtaposing academic self-concept and achievement goal orientations for mathematics success. *Educ. Psychol.* 34, 49–72. doi: 10.1080/01443410.2013.825232

Seifert, T., and O'Keefe, B. (2001). The relationship of work avoidance and learning goals to perceived competence, externality and meaning. *Brit. J. Educ. Psychol.* 71, 81–92. doi: 10.1348/000709901158406

Setencich, J. (1994). The impact of early grade retention on the academic achievement and self-esteem of seventh and eighth grade students. *Paper presented at the Annual Convention of the National Association of School Psychologists*, Seattle: WA.

Shepard, L. A., and Smith, M. L. (1986). Synthesis of research on readiness and kindergarten retention. *Educ. Leadersh.* 44, 78–86.

Skaalvik, E. M. (1997). Self-enhancing and self-defeating ego orientation: relations with task and avoidance orientation, achievement, self-perceptions, and anxiety. *J. Educ. Psychol.* 89, 71–81. doi: 10.1037/0022-0663.89.1.71

Tuominen-Soini, H., Salmela-Aro, K., and Niemivirta, M. (2008). Achievement goal orientations and subjective well-being: a person-centred analysis. *Learn. Instr.* 18, 251–266. doi: 10.1016/j.learninstruc.2007.05.003

Tuominen-Soini, H., Salmela-Aro, K., and Niemivirta, M. (2011). Stability and change in achievement goal orientations: a person-centered approach. *Contemp. Educ. Psychol.* 36, 82–100. doi: 10.1016/j.cedpsych.2010.08.002

Tuominen-Soini, H., Salmela-Aro, K., and Niemivirta, M. (2012). Achievement goal orientations and academic well-being across the transition to upper secondary education. *Learn. Individ. Diff.* 22, 290–305. doi: 10.1016/j.lindif.2012.01.002

Veiga, F. H. (1995). *Transgressão e Autoconceito dos Jovens na Escola [Transgression and Self-Concept in Youth at School]*. Lisboa: Fim de Século Edições.

Veiga, F. H. (1996). Autoconceito e rendimento dos jovens em matemática e ciências: análise por grupos com diferente valorização do sucesso [Youth self-concept and achievement in math and science: analysis on groups with diffent valorization of success]. *Rev. Educ.* 5, 41–53.

von Eye, A., and Bogat, G. A. (2006). Person-oriented and variable-oriented research: concepts, results, and development. *Merrill-Palmer Q.* 52, 390–420. doi: 10.1353/mpq.2006.0032

Wigfield, A., Cambria, J., and Eccles, J. S. (2012). "Motivation in education," in *The Oxford Handbook of Human Motivation*, ed. R. Ryan (New York, NY: Oxford University Press), 463–478.

Willson, V., and Hughes, J. (2009). Who gets retained in first grade? A psychosocial perspective. *Elem. Sch. J.* 109, 251–266. doi: 10.1086/592306

Winsler, A., Hutchison, L., De Feyter, J., Manfra, L., Bleiker, C., Hartman, S., et al. (2012). Child, family, and childcare predictors of delayed school entry and kindergarten retention among linguistically and ethnically diverse children. *Dev. Psychol* 48, 1299–1314. doi: 10.1037/a0026985

Wu, W., West, S. G., and Hughes, J. N. (2008a). Effect of retention in first grade on children's achievement trajectories over 4 years: a piecewise growth analysis using propensity score matching. *J. Educ. Psychol.* 100, 727–740. doi: 10.1037/a0013098

Wu, W., West, S. G., and Hughes, J. N. (2008b). Short-term effects of grade retention on the growth rate of Woodcock–Johnson III broad math and reading scores. *J. Sch. Psychol.* 46, 85–105. doi: 10.1016/j.jsp.2007.01.003

Wu, W., West, S. G., and Hughes, J. N. (2010). Effect of grade retention in first grade on psychosocial outcomes. *J. Educ. Psychol.* 102, 135–152. doi: 10.1037/a0016664

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Peixoto, Monteiro, Mata, Sanches, Pipa and Almeida. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 October 2016
doi: 10.3389/fpsyg.2016.01560

Academic Performance of Native and Immigrant Students: A Study Focused on the Perception of Family Support and Control, School Satisfaction, and Learning Environment

Miguel A. Santos[1]*, *Agustín Godás*[2], *María J. Ferraces*[2] and *Mar Lorenzo*[1]

[1] Faculty of Education, University of Santiago de Compostela, A Coruña, Spain, [2] Faculty of Psychology, University of Santiago de Compostela, A Coruña, Spain

The international assessment studies of key competences, such as the PISA report of the OECD, have revealed that the academic performance of Spanish students is significantly below the OECD average. In addition, it has also been confirmed that the results of immigrant students are consistently lower than those of their native counterparts. Given the context, the first objective of this work is to observe the variables (support, control, school satisfaction, and learning environment) which distinguish between retained and non-retained native and immigrant students. The second objective is to check, by comparing the retained and non-retained native and immigrant students and separating the two levels, in order to find out which of the selected variables clearly differentiate the two groups. A sample of 1359 students was used (79.8% native students and 20.2% immigrant students of Latin American origin), who were enrolled in the 5th and 6th year of Primary Education (aged 10–11 years) and in the 1st and 2nd year of Secondary Education (aged 12–13 years). The measurement scales, which undergo a psychometric analysis in the current work, have been developed in a previous research study (Lorenzo et al., 2009). The construct validity and reliability are reported (obtaining alpha indices between 0.705 and 0.787). Subsequently, and depending on the results of this analysis, inferential analyses are performed, using as independent variables the ethno-cultural origin and being retained or not, whereas, as dependent variables, the indices referring to students' perception of family support and control, as well as the assessment of the school and learning environment. Among other results, the Group × Being retained/Not being retained [$F_{(1,\ 1315)} = 4.67$, $p < 0.01$] interaction should be pointed out, indicating that native non-retained subjects perceive more control than immigrants, as well as the Group × Being retained/Not being retained [$F_{(1,\ 1200)} = 5.49$, $p < 0.01$] interaction, showing that native non-retained students perceive more family support. Given the results obtained, our intention is to provide solid evidence that would facilitate the design of family involvement programs, helping to improve students' educational performance.

Keywords: academic performance, family support and control, school satisfaction, learning environment, immigrant students

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
María Del Carmen Pérez Fuentes, University of Almería, Spain
Mercedes Inda-Caro, University of Oviedo, Spain

***Correspondence:**
Miguel A. Santos
miguelangel.santos@usc.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *23 June 2016*
Accepted: *26 September 2016*
Published: *13 October 2016*

Citation:
Santos MA, Godás A, Ferraces MJ and Lorenzo M (2016) Academic Performance of Native and Immigrant Students: A Study Focused on the Perception of Family Support and Control, School Satisfaction, and Learning Environment. Front. Psychol. 7:1560. doi: 10.3389/fpsyg.2016.01560

INTRODUCTION

Although, as a result of the economic crisis, the number of immigrants arriving in Spain has diminished in recent years, and in spite of the warnings that immigration flows are increasing in most countries (OECD, 2015), we should not lose sight of two important elements that characterize Spanish migratory flows: first, the quantitative data that, at the end of 2015, there were a total of 4,905,495 foreigners residing in Spain; and secondly, with a constant influx of immigrants in the twenty-first century, there is an increased presence of family immigration which results in a significant number of children from these families being attendant within the Spanish educational system.

More specifically, in Spain the figure for the academic year 2014–2015 showed 712,098 foreign children (8.8% of the total), mainly from African countries (30.47%) and the EU-28 (27.49%), who were primarily enrolled in Secondary Compulsory Education (Ministry of Education Culture, and Sports, 2015). These students' school success is obviously essential for their social inclusion.

Data from the latest PISA Report (2012) of the OECD, show that the academic performance of Spanish students remains basically stable in relation to previous editions, that is, it is still significantly below the OECD average (Ministry of Education Culture, and Sports, 2013). In this context, it is not surprising that the early dropout rate in Spain is twice the average, and is on an upward trend, in contrast to other European countries (Casquero et al., 2012).

But the Report also reflects an even less flattering reality for the students of immigrant origin living in Spain. The assessment of competences shows that the results of these students are consistently lower than those obtained by native students. More specifically, in Mathematics, students of immigrant origin obtained a mean of 439.1 points compared to 491.7 points obtained by their Spanish counterparts. In any case, the mean improves (457) with second-generation students (students born in Spain with both parents of foreign origin; Calero and Escardibúl, 2013).

Similar conclusions were drawn by Vaquera and Kao (2012) in their study conducted with a sample of 2710 Compulsory Secondary Education students. These authors confirm the constant disadvantage regarding the performance of first-generation immigrant students in Spain, with Latin American students showing the lowest performance overall.

This trend can be extrapolated to other countries, as reflected in the scientific literature. In particular, Schnell and Azzolini (2015) focus their research, based on PISA 2009 and 2012, on countries from southern Europe (Greece, Spain, Portugal, and Italy), which share the status of being recent immigration destinations.

These authors state that there are big gaps in terms of educational achievement between immigrant and native children in these four countries. Their results also suggest the existence of a negative association, although weak, between the age of arrival in the host country and their school performance. If immigrant children arrive after 6 years of age (when Compulsory Education begins), they face the greatest disadvantages in terms of educational performance, whereas the second-generation students and those who arrive at an early age perform, on average, better than the former, even if they do not reach the native students' level.

López et al. (2001) stated that migrants were academically the most vulnerable group in the United States, showing lower academic performance and higher dropout rates. In this regard, Levels et al. (2008) explained how the results of these students should be interpreted according to their country of origin and destination, showing that these students have a better educational performance in countries traditionally known as immigrant destinations. This is corroborated, contrary to what most studies argue, by Areepattamannil et al. (2015) who found differences in favor of first- and second-generation immigrant adolescents, compared with their counterparts in Qatar, in terms of performance and disposition toward Mathematics.

Considering the data above, it is not surprising that school failure, one of whose determining factors is precisely retention, is one of the major problems of the Spanish education system, given its magnitude, evolution, and social consequences (OECD, 2012).

Social research has attempted to identify the variables that explain students' performance, and even the differences that occur between native and immigrant students. Thus, it is argued that performance is influenced by both a number of factors and the interaction between these factors (Barbero et al., 2007; Creemers and Kyriakides, 2008; Winne and Nesbit, 2010). Notably, the circumstances in which learning is developed, the starting conditions, as well as the social, economic and cultural backgrounds of students and schools should be taken into account (Suárez-Orozco and Suárez-Orozco, 2008; Lorenzo et al., 2009, 2012; Suárez et al., 2011).

The research provides a greater explanatory weight to students' individual variables, with the socioeconomic and cultural background of the family being of particular importance (Eccles, 2005; Grayson, 2011); by contrast, it also provides a reduced weight to center variables, such as school characteristics, its resources, educational processes, or composition of its student body (Santos Rego et al., 2012, 2013; Calero and Escardibúl, 2013). From a comparative perspective, the weight of the students' variables is more pronounced in the Spanish context (Cordero et al., 2013).

On the same line of research, the results of the study conducted by Núñez et al. (2014) with upper-secondary education students from Spain and Portugal, showed that most (85.6%) of the observed performance variability in the subject of Biology, is due to students' variables, whereas only the remaining 14.4% corresponds to classroom-related variables.

Specifically, at student level, performance was found to be associated with the learning approach, prior knowledge, school absenteeism, and parents' educational level. At classroom level, performance is only associated with the teachers' teaching approach, although not associated directly, but through students' own study approach. It should be recalled, in this sense, that the Coleman Report in 1966 had already attributed 10% of the students' performance variance to the school, whereas the

remaining 90% had been attributed to students' socioeconomic status (Coleman et al., 1966).

Han (2006) argued that the characteristics of the child and their family accounted for many of the differences in academic achievement of immigrant children, whereas their home, school, and neighborhood, although important, are not as pronounced. In any case, the home and school influence on performance is higher for Latin American children than for those of Asian origin.

At present, the research on the determining factors of academic performance continues to seek evidence in connection with the student's personal motives (Carbonero et al., 2015), in the weight of the socioeconomic status of the families that support them, and a number of contextual determinants, many of which still need to be determined.

The study presented herein is based on the structure of the dynamic model developed by Creemers and Kyriakides (2008), which establishes a set of related factors, grouped on four levels to explain educational effectiveness: the contextual level, which includes national or regional education policies and an evaluation thereof; the school level, which covers the analysis and evaluation of both the educational project of each center and its planning with respect to the learning environment; the classroom level, which is based on an analysis of the faculty's guidance when pointing out targets for the specific content to be explained, of the materials, the techniques used to encourage discussion, strategies to solve the designed activities and the opportunities to implement or apply the explained content; and finally, regarding the students' level, other factors are proposed.

On the one hand, the so-called stable factors (family's socioeconomic status, ethnicity, personality traits, and gender), and, on the other, factors which can change over time, including expectations, motivation, and thinking styles. Other, more psychological factors should not be omitted either: skills, perseverance, and variables related to specific learning tasks, that is, time devoted to homework and learning opportunities.

AIMS OF THIS STUDY

The research line followed in this work has been previously considered with other populations and other variables, both individual and contextual (Covington, 2000; González-Pienda et al., 2003; Valle et al., 2009; Barca et al., 2012; Santos Rego et al., 2012, 2013; Dufur et al., 2013; Núñez et al., 2014). These works found that the highest average academic performance (in terms of specific grades) is based on student's personal characteristics, motivational variables, support and family control and friendly relationships. All of them, with uneven influential weight, determine satisfactory or unsatisfactory response in terms of the school context and set of variables: that is, they determine the best or worse academic performance.

Given the context, our first objective is to observe what the variables are regarding family support and control, school satisfaction, and assessment of the learning environment that distinguish between retained and non-retained native and immigrant students; the second objective is to check, by comparing the retained and non-retained native and immigrant students, and separating the two levels, in order to find out which of the selected variables clearly differentiate the two groups.

MATERIALS AND METHODS

Participants

The study involved a total of 1359 individuals enrolled in the last 2 years (5th and 6th) of Primary Education (42.3%) and the first two (1st and 2nd) of Secondary Education (57.7%), from 33 schools selected according to the official statistics of educational administration, based on two criteria: the first one was that they taught the two levels of education; and the second was that a large number of immigrant students be enrolled in the respective school and academic years. Thus, 79.8% of the selected individuals are Spanish (native students) and 20.2% have a Latin American origin (immigrant students). **Table 1** shows the main sociodemographic characteristics.

Measures

A single instrument (questionnaire) was used, consisting of closed and categorical questions regarding students' socio-demographic profile (see **Table 1**) and three *Likert* scales, on

TABLE 1 | Characteristics of the individuals participating in the research study (%).

Variables	Native students	Immigrant students
GENDER		
Males	80.1	79.5
Females	19.9	20.5
AGE		
9–10 years old	17.4	10.4
11–12 years old	51.9	44.9
13–14 years old	26.7	35.6
15–16 years old	3.9	9.6
GRADE		
5th Primary Education	12.3	8.0
6th Primary Education	42.5	41.6
1st Secondary Education	28.2	33.6
2nd Secondary Education	17.0	16.8
FAMILY COMPOSITION		
Father and mother	71.7	55.5
Father	1.3	0.4
Mother	6.5	11.3
Father and relatives	3.0	6.6
Mother and relatives	7.8	16.4
Father and other people	0.3	0
Mother and other people	0	0.4
Other relatives	8.0	8.3
Other people	1.4	1.1
NUMBER OF SIBLINGS		
None	16.6	9.1
One	59.7	30.3
Two	15.8	27.3
Three	4.8	17.2
More than three	3.1	16.1

the perception of family support and control and on the overall assessment of the school and learning environment, comprising a total of 43 items. The three scales were developed and used at a descriptive and inferential level in a research project aimed at evaluating an educational intervention program by Lorenzo et al. (2009).

Family Support Scale

This consists of 14 items (with 7 each referring to the father and mother) relating to support in terms of mood, help when facing problems, assistance with school work, perception of trust, respect, concern, and clear communication of expectations. Five-response choices were used—1: never, 2: rarely; 3: sometimes; 4: almost always, 5: always. Its factorial structure and reliability indices can be considered coherent and acceptable, as shown in **Table 2**, with the following values: the general α index was 0.854, the paternal support α index was 0.842, and the maternal support α index was 0.705.

Family Control Scale

This consists of 12 items (with 6 each referring to the father and mother) on the control over the time their children spend away from home, their friends, their activities outside the home, how they spend their money, school attendance and time spent each day to study. Five-response choices were used—1: none, 2: a little, 3: somewhat; 4: quite a lot; 5: very much—and its factorial structure, as well as its reliability indices are satisfactory and consistent with the objective of the instrument (see **Table 2**). In this case, the general α index was 0.855, the paternal control α index was 0.793, and the maternal control α index was 0.725, respectively.

School Environment Rating Scale

The third scale consists of 17 items, 9 of them on school satisfaction and 8 on assessment of the learning environment:

1. The subscale of satisfaction collects information on personal relationships with teachers, subjects, forms of evaluation, relationships with peers, the image that teachers have about students, parents' reaction to the grades obtained, the school they are enrolled in, how to meet the school's standards, and the sanctions imposed when failing to comply with them. Responses include five options—1, very satisfied; 2, fairly satisfied; 3, indifferent; 4, quite dissatisfied; 5, very dissatisfied.
2. The assessment subscale of the learning environment provides information about teachers' teaching styles, ways of reinforcing students, the public recognition of a job well done, the perception of fairness in assessments, the use of group work, sufficient time available for homework, promotion of autonomy in students, and the general evaluation of the courses received. The response format is similar to the satisfaction scale with five response options—1, strongly agree; 2, somewhat agree; 3, indifferent; 4, somewhat disagree; 5, strongly disagree.

TABLE 2 | Factorial structure of the control scales (FC-fathers and MC-mothers), family support (FS-fathers and MS-mothers), and assessment of the school environment, saturation values and reliability index (Alpha index).

Control. general	Support. general	Assessment of the school. general
KMO = 0.771 Chi-square = 7559.498; $p \leq 0.000$.	KMO = 0.768 Chi-square = 9410.088; $p \leq 0.000$.	KMO = 0.925 Chi-square = 6434.421; $p \leq 0.000$.
Explained variance (69.244%).	Explained variance (73.758%).	Explained variance (58.823%).
Factor I (38.679%). Items: FC (0.741) and MC (0.694) about friends. FC (0.686) and MC (0.667) about their behavior on the street. FC (0.643) and MC (0.614) about their timetable.	Factor I (35.408%). Items: FS (0.767) encouraged to do the best they can. FS (0.743) help when facing problems. FS (0.733) help with school work.	Factor I (34.399%) Items: My parents' reaction to my grades (0.790). The image that my teachers have of me (0.734). Evaluations (0.575). Relationships with teachers (0.549).
Factor II (11.964%). Items: MC (0.909) and FC (0.818) about money.	Factor II (11.056%). Items: FS (0.839) and MS (0.478) respect me. MS (0.686) and FS (0.656) I trust them.	Factor II (7.131%). Items: How rules are enforced (0.789). Penalties for breaking rules (0.735).
Factor III (9.922%). Items: MC (0.867) and FC (0.863) over their attendance at school.	Factor III (9.496%). Items: MS (0.818) encouraged to do the best they can. MS (0.762) help when facing problems. MS (0.415) help with school work.	Factor III (6.059%). Items: We work hard as a group (0.728). They let us make decisions about the tasks (0.695). Public recognition from the teacher (0.505). Classes are interesting and varied (0.430).
Factor IV (8.678%). Items: FC (0.834) and MC (0.783) over the hours devoted to daily study.	Factor IV (9.057%). Items: MS (0.937) and FS (0.856) clear communication of expectations.	Factor IV (5.721%). Items: Teachers want us to understand (0.811). Teachers want us to enjoy learning (0.659). We have enough time for homework (.470).
	Factor V (8.741%). Items: MS (0.904) and FS (0.695) care about my academic success.	Factor V (5.513%). Items: With the peers (0.932) With the school in general (0.405).
Reliability indices: General alpha index = 0.855 Paternal control alpha index = 0.793 Maternal control alpha index = 0.725.	Reliability indices: General alpha index = 0.854 Paternal support alpha index = 0.842 Maternal support alpha index = 0.705.	Reliability indices: General alpha index = 0.871 Satisfaction alpha index = 0.827 Learning environment alpha index = 0.782.

TABLE 3 | Differentiation rates for native[a] and immigrant[b] students and percentage of students non-retained (NR) and retained (R) in Mathematics and Spanish Language and Literature.

	Chi-Square	*df*	*p*	%fe≤5	Cramer's V	NR (%)	R (%)
Mathematics	222.943[a]	1	0.001	0	0.468[a]	90.1[a]	9.9[a]
	28.806[b]	1	0.001	0	0.333[b]	69.2[b]	30.8[b]
Spanish language and literature	222.943[a]	1	0.001	0	0.477[a]	90.3[a]	9.7[a]
	28.806[b]	1	0.001	0	0.440[b]	75.0[b]	25.0[b]

Both the factorial structure and the reliability indices of this third scale can be considered acceptable for the goals set out in this study (see **Table 2**). The general α index was 0.871, the satisfaction α index was 0.827, and the learning environment α index was 0.782.

Procedure

For the application of the questionnaire, which is anonymous, the educational authorities were instructed to initially request permission, and subsequently the families were informed. The questionnaire was administered collectively in the classroom, using tutors of each group that were especially trained, not only for this task, but also within the framework of a broader data collection for an educational research project.

Data Analysis

As independent variables, (native or immigrant) students' ethno-cultural background and being a retained student or not are used. The choice of the latter is given by the powerful connection between being a retained student and obtaining low academic results in two subjects: Mathematics and Spanish Language and Literature (see **Table 3**). As dependent variables, their perception of support and control by parents, their school satisfaction and their assessment of the learning environment are taken into account.

Descriptive analyses were conducted using the sociodemographic variables. Next, three exploratory factor analyses (EFA) were carried out in order to understand the factorial structure and reliability of the used scales. In addition, the differences among the participating groups were analyzed using ANOVA, in which the independent variables related to being native or immigrant, and being a retained student or not. The dependent variables are the perception of family control and support, and the assessment made by the students of their school environment. Finally, two separate logistic regression analyses (native/immigrant) were performed with the aim of studying which variables can predict whether a student will be retained or not.

RESULTS

Analysis of Differences with Respect to Family Control

In this dimension (see **Table 4**), there are significant differences on the four indices, with different results in each of them. In the first index (C1), which refers to the "paternal and maternal control over the behavior outside the home," significant differences on the two factors were recorded, which is not the case when analyzing the interaction. In pairwise comparisons, significant differences were found with regard to being retained, both in native (M_retained − Non_retained = −2.69, $p < 0.001$), and immigrant students (M_retained − Non_retained = −1.99, $p < 0.01$). In this index, both native and immigrant non-retained students are those who perceived a greater control of their behavior, by their parents, when outside the home.

Significant differences were also observed in both factors and the interaction [$F_{(1,\ 1315)} = 4.67$, $p < 0.01$] in the second index (C2) "father and mother's control over their children's money." This indicates that there are differences between native retained and non-retained students [$F_{(1,\ 1315)} = 1.08$, $p < 0.01$], but this is not the case with immigrant students when observing the pairwise comparison. Nevertheless, those who have a better academic performance are more aware of their parents' control over their money.

The third index (C3) relating to "paternal and maternal control over their attendance at school," also reported significant main differences [ethno-cultural origin, $F_{(1,\ 1315)} = 9.75$, $p < 0.01$; being a retained student, $F_{(1,\ 1315)} = 15.32$, $p < 0.001$], but the interaction is not significant. In the pairwise comparison (M_Non-retained − M_retained = 81, $p < 0.001$) differences were recorded only between native retained and non-retained students, with the latter perceiving the paternal and maternal control over their school attendance more intensely.

In the last index (C4), referring to the "paternal and maternal control over the hours devoted to daily study," significant differences only refer to being a retained student or not [$F_{(1,1315)} = 30.82$; $p < 0.001$]. In this case, the native students are those who acutely felt their parents control in this aspect (M_Non-retained − M_retained = 1.09, $p < 0.001$).

Analysis of Differences with Respect to Family Support

The first thing to highlight (see **Table 5**) is the lack of significant differences in the five indices of family support, in the "ethno-cultural origin" (native or immigrant) factor.

However, a significant difference on the factor of being a retained student or not was observed, as well as some pairwise comparisons which should be pointed out.

As for the PS1 index corresponding to the perception of "paternal support and encouragement when dealing with both school work and problematic situations," the significative

TABLE 4 | Results of the analysis of variance (ANOVA) for variables related to maternal and paternal control (NS-Native students; IS-Immigrant students).

Factors	Ethno-cultural origin		Being retained		Interaction		Pairwise comparison
	Mean	*F*	Mean	*F*	Mean	*F*	Difference of means
C1	NS (22.08) IS (20.07)	$F_{(1, 1315)} = 7.81^{**}$ $\eta^2 = 0.013, 1 - \beta = 0.92$	No (22.49) Yes (19.77)	$F_{(1, 1315)} = 27.87^{***}$ $\eta^2 = 0.021, 1 - \beta = 1.00$	NS-No (22.75) NS-Yes(20.05) IS-No (21.15) IS-Yes (19.16)	$F_{(1,1315)} = 0.61$ (ny)	NS No-Yes = 2.69*** IS No-Yes = 1.99***
C2	NS (7.06) IS (6.09)	$F_{(1, 1315)} = 12.86^{***}$ $\eta^2 = 0.01, 1 - \beta = 0.95$	No (7.15) Yes (6.15)	$F_{(1, 1315)} = 11.11^{**}$ $\eta^2 = 0.008, 1 - \beta = 0.91$	NS-No (7.33) NS-Yes (6.25) IS-No (6.20) IS-Yes (5.97)	$F_{(1, 1315)} = 4.67^{**}$ $\eta^2 = 0.004, 1 - \beta = 0.58$	NS No-Yes = 1.08**
C3	NS (8.81) IS (8.15)	$F_{(1, 1315)} = 9.75^{**}$ $\eta^2 = 0.007, 1 - \beta = 0.88$	No (8.91) Yes (8.11)	$F_{(1, 1315)} = 15.32^{***}$ $\eta^2 = 0.012, 1 - \beta = 0.97$	NS-No (9.01) NS-Yes (8.20) IS-No (8.33) IS- Yes (7.90)	$F_{(1, 1315)} = 1.47$ ny	NS No-Yes = 0.81***
C4	NS (7.99) IS (7.47)	$F_{(1, 1315)} = 3.00$ ny	No (8.18) Yes (7.12)	$F_{(1, 1315)} = 30.82^{***}$ $\eta^2 = 0.022, 1 - \beta = 1.00$	NS-No (8.26) NS-Yes (7.17) IS-No (7.79) IS-Yes (7.07)	$F_{(1, 1315)} = 1.33$ ny	NS No-Yes = 1.09***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 5 | Results of the analysis of variance (ANOVA) for variables related to maternal and paternal support (NS, Native students; IS, Immigrant students).

Factors	Ethno-cultural origin		Being retained		Interaction		Pairwise comparison
	Mean	*F*	Mean	*F*	Mean	*F*	Difference of means
PS1	NS (16.57) IS (15.84)	$F_{(1, 1200)} = 0.94$ ny	No (16.82) Yes (15.37)	$F_{(1, 1200)} = 11.72^{**}$ $\eta^2 = 0.010, 1 - \beta = 0.93$	NS-No (16.97) NS-Yes (15.25) IS-No (15.98) IS-Yes (15.66)	$F_{(1, 1200)} = 5.49^{**}$ $\eta^2 = 0.005, 1 - \beta = 0.65$	NS No-Yes = 1.71** IS No-Yes = 0.35 ny
PS2	NS (17.33) IS (17.00)	$F_{(1, 1200)} = 0.06$ ny	No (17.72) Yes (16.05)	$F_{(1, 1200)} = 34.33^{***}$ $\eta^2 = 0.0228, 1 - \beta = 1.00$	NS-No (17.65) NS-Yes (15.94) IS-No (17.51) IS-Yes (16.30)	$F_{(1, 1200)} = 1.40$ ny	NS No-Yes = 1.82*** IS No-Yes = 1.21**
PS3	NS (17.50) IS (16.91)	$F_{(1, 1200)} = 1.86$ ny	No (17.67) Yes (16.65)	$F_{(1, 1200)} = 10.55^{**}$ $\eta^2 = 0.009, 1 - \beta = 0.90$	NS-No (17.76) NS-Yes (16.63) IS-No (17.06) IS-Yes (16.70)	$F_{(1, 1200)} = 12.84$ ny	NS No-Yes = 1.26*** IS No-Yes = 0.35 ny
PS4	NS (8.44) IS (8.36)	$F_{(1, 1200)} = 0.65$ ny	No (8.54) Yes (8.10)	$F_{(1, 1200)} = 3.97$ ny	NS-No (8.57) NS-Yes (8.00) IS-No (8.37) IS-Yes (8.34)	$F_{(1, 1200)} = 2.70$ ny	NS No-Yes = 0.57*** IS No-Yes = 0.03 ny
PS5	NS (9.33) IS (9.16)	$F_{(1, 1200)} = 0.40$ ny	No (9.49) Yes (8.80)	$F_{(1, 1200)} = 21.92^{***}$ $\eta^2 = 0.018, 1 - \beta = 0.99$	NS-No (9.52) NS-Yes (8.75) IS-No (9.33) IS-Yes (8.94)	$F_{(1, 1200)} = 2.17$ ny	NS No-Yes = 0.76*** IS No-Yes = 0.39 ny

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 6 | Results of the analysis of variance (ANOVA) for the variables related to the assessment of school environment (NS-Native students; IS-Immigrant students).

Factors	Ethno-cultural origin		Being retained		Interaction		Pairwise comparison
	Mean	*F*	Mean	*F*	Mean	*F*	Difference of means
V1	NS (9.72) IS (6.68)	$F_{(1,\ 1338)} = 4.53^{**}$ $\eta^2 = 0.003,\ 1-\beta = 0.57$	No (9.22) Yes (10.94)	$F_{(1,\ 1338)} = 40.91^{***}$ $\eta^2 = 0.030,\ 1-\beta = 1.00$	NS-No (9.21) NS-Yes (11.26) IS-No (9.25) IS-Yes (10.22)	$F_{(1,\ 1338)} = 5.25^{**}$ $\eta^2 = 0.004,\ 1-\beta = 0.63$	NS No-Yes = −2.05** IS No-Yes = −0.97**
V2	NS (6.35) IS (6.02)	$F_{(1,\ 1338)} = 8.80^{**}$ $\eta^2 = 0.007,\ 1-\beta = 0.84$	No (6.09) Yes (6.76)	$F_{(1,\ 1338)} = 9.23^{**}$ $\eta^2 = 0.007,\ 1-\beta = 0.86$	NS-No (6.12) NS-Yes (7.04) IS-No (5.93) IS-Yes (6.13)	$F_{(1,\ 1338)} = 3.66^{**}$ $\eta^2 = 0.003,\ 1-\beta = 0.49$	NS No-Yes = −0.92**
V3	NS (7.30) IS (7.15)	$F_{(1,\ 1338)} = 1.65$ ny	No (7.22) Yes (7.38)	$F_{(1,\ 1338)} = 4.27$ ny	NS-No (7.22) NS-Yes (7.51) IS-No (7.19) IS-Yes (7.02)	$F_{(1,\ 1338)} = 1.01$ ny	
V4	NS (5.39) IS (5.07)	$F_{(1,\ 1338)} = 7.91^{**}$ $\eta^2 = 0.006,\ 1-\beta = 0.80$	No (5.20) Yes (5.64)	$F_{(1,\ 1338)} = 8.96^{**}$ $\eta^2 = 0.007,\ 1-\beta = 0.86$	NS-No (5.26) NS-Yes (5.80) IS-No (4.91) IS-Yes (5.28)	$F_{(1,\ 1338)} = 0.26$ ny	NS No-Yes = −0.54**
V5	NS (3.12) IS (3.30)	$F_{(1,\ 1338)} = 0.37$ ny	No (3.02) Yes (3.50)	$F_{(1,\ 1338)} = 15.74^{***}$ $\eta^2 = 0.012,\ 1-\beta = 0.98$	NS-No (2.99) NS-Yes (3.51) IS-No (3.17) IS-Yes (3.47)	$F_{(1,\ 1338)} = 1.03$ ny	NS No-Yes = −0.51**

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

differences lies with the non-retained students [$F_{(1,\ 1200)} = 11.72$; $p < 0.01$]. Similarly, significant differences were observed in the interaction [$F_{(1,\ 1200)} = 5.49$; $p < 0.01$]. The pairwise comparisons showed differences between retained and non-retained students (M_retained − Non_retained = 1.71, $p < 0.01$), with the latter sensing more support from their parents.

The second index (PS2) collects the perception of "respect and trust of both fathers and mothers," showing a significative differences on the factor of being a retained student or not [$F_{(1,\ 1200)} = 34.33$; $p < 0.001$], but the interaction between factors is not significant. In the pairwise comparisons there are significant differences between native (M_retained − Non_retained = 1.82; $p < 0.001$) and immigrant students (M_retained − Non_retained = −1.21; $p < 0.01$), with non-retained students obtaining the highest score.

In the third factor, focused on the perception of "maternal support and encouragement when dealing with both school work and in problematic situations" (PS3), significant results were found [$F_{(1,\ 1200)} = 10.55$; $p < 0.01$] the factor relating to being a retained student or not, where only the native non-retained students [$F_{(1,\ 1200)} = 10.55$; $p < 0.01$] perceived more support and encouragement.

By analyzing their perception that "their father and mother clearly communicate their expectations" (PS4), no significant differences were observed in either the main effects or interaction. There is a greater presence of this index recorded in native non-retained students only within the pairwise comparison (M_retained − Non_retained = −0.57, $p < 0.01$).

Finally, the perception that their parents "care about their academic success" (PS5), is significant in the factor referred to being a retained student or not [$F_{(1,\ 1200)} = 21.92$, $p < 0.001$]. No significant differences were obtained in the interaction, although in the pairwise comparison, differences [$F_{(1,\ 1200)} = 21.92$; $p < 0.001$] regarding greater presence of this concern are noted, from the maternal and paternal side, in native non-retained students.

Analysis of Differences with Respect to the Assessment of the School Environment

In this case significant differences were also found in four of the indices that make up this dimension and are summarized in **Table 6**.

The first of these (V1), called "satisfaction with external feedback" refers to the reinforcements received from influential adults, when focused on their academic performance. Both factors and interaction were significant [$F_{(1,\ 1338)} = 5.25$, $p < 0.01$]. In the pairwise comparisons, significant differences were found in both native (M_retained − Non_retained = −2.05, $p < 0.01$) and immigrant students (M_retained − Non_retained = −0.97, $p < 0.01$), and the retained students from both groups

are those who are said to receive greater external reinforcement, given the obtained academic results.

The same applies to the second index (V2), "satisfaction with school rules," in which significant differences were observed in the factors [$F_{(1,\ 1338)} = 8.80$, $p < 0.01$ regarding the ethno-cultural origin and $F_{(1,\ 1338)} = 9.23$, $p < 0.01$ being a retained student or not], and the interaction between them [$F_{(1,\ 1338)} = 3.66$, $p < 0.01$]. As it can be noted in the pairwise comparison, the native retained students (M_retained − Non_retained = −0.92, $p < 0.01$) are those who show more satisfaction with their school's rules.

Table 6 shows that index V3, referring to "satisfaction and positive evaluation of the teaching styles," does not show significant differences due to factors, or to the interaction between them. In the index comprising "satisfaction with the work performed in the classroom" (V4), significant differences were detected in both factors [$F_{(1,\ 1338)} = 7.91$, $p < 0.01$ for ethnic-cultural origin and $F_{(1,\ 1338)} = 8.96$, $p < 0.01$ for being a retained student or not], but not in the interaction between them. The native retained students (M_retained − Non_retained = 0.54, $p < 0.01$) are again those who, in the pairwise comparison, show greater satisfaction with the work performed in the classroom.

In the last factor (V5), whose content focuses on the "satisfaction with their relationships with their classmates and, in general, with the school," the only factor showing significant differences [$F_{(1,\ 1338)} = 15.74$, $p < 0.001$] is being a retained student or not, although in the pairwise comparison, it was noted that the native retained students (M_retained − Non_retained = −0.51, $p < 0.01$) are the most satisfied with the treatment between peers and with the school in general.

Regression Analysis

Two stepwise logistic regressions were carried out to understand which of the analyzed variables can predict whether a student will be retained (1) or not (0). The obtained results are presented separately for native and immigrant students.

Predictors for Immigrant Students

First, the collinearity statistics were analyzed and tolerance values (T) ranging between 0.35 and 0.94 were observed; the variance inflation factor (VIF) obtained values between 1.06 and 2.85, indicating the lack of collinearity. On the other hand, using the Durbin–Watson test, a value of 1.93 was obtained, indicating independence of the residuals. Second, the Hosmer–Lemeshow statistic ($\chi^2 = 10.81$; $n = 274$; $df = 8$; $p = 0.213$) reflects a good fit of the model with an effect size that, according to Cohen (1988), is acceptable (Cox-Snell $R^2 = 0.44$; Nagelkerke $R^2 = 0.59$). **Table 7** shows the results of the model including the regression coefficients, the Wald statistic and odds ratio Exp (B).

The results show that a higher perceived paternal and maternal control over the hours devoted to daily study (Control 4) is associated with better academic performance ($B = -0.049$). In contrast, a greater concern of parents for academic success (Support 4) ($B = 146$) and satisfaction with the reinforcements they receive from influential adults (Rating 1) ($B = 0.\ 094$) are associated with being a retained student or not, which is why it is believed that both their family and teachers focus more on strengthening this group of retained students. The poor results obtained in Spanish Language and Literature ($B = -1.01$) are associated with retained students, who are generally older students ($B = 1.95$), with those in the lower grades (5th and 6th grade of Primary Education) showing a higher performance ($B = -2.41$) in this subject. Lastly, the students who are retained more times ($B = 0.301$) are those with a higher number of siblings.

The classification table shows that overall 82.1% of the participants are correctly classified and out of these the highest ranked are those who are not retained (84.2%) compared with retained students (79.5%).

TABLE 7 | Results of logistic regression analysis for immigrant students.

Predictors	*B*	SE	Wald	*p*	Exp(B)
Control 4	−0.049	0.026	3.60	0.050	0.95
Support 4	0.146	0.074	3.86	0.049	1.15
Rating 1	0.094	0.039	5.91	0.015	1.09
Spanish Language and Literature	−1.010	0.216	21.91	0.001	0.36
Age	1.950	0.305	40.85	0.001	7.03
Grade	−2.410	0.448	28.93	0.001	0.09
Siblings	0.301	0.141	4.55	0.033	1.35

CLASSIFICATION TABLE

Observed	Predicted		Correct %
	Non-retained	Retained	
Non-retained	128	24	84.2
Retained	25	97	79.5
Overall %			82.1

Predictors for Native Students

The collinearity statistics were analyzed and tolerance values (T) ranging between 0.21 and 0.97 were observed; the variance inflation factor (VIF) obtained values between 1.02 and 4.76, indicating the lack of collinearity. On the other hand, using the Durbin–Watson test, a value of 1.86 was obtained, indicating independence of the residuals. Second, the Hosmer–Lemeshow statistic ($\chi^2 = 9.29$; $n = 1080$; $df = 8$; $p = 0.318$) indicates a good fit of the model with a good size effect (Cox-Snell $R^2 = 0.54$; Nagelkerke $R^2 = 0.81$). **Table 8** shows the results of the model including the regression coefficients, the Wald statistic and odds ratio Exp (B).

In this case, the poor academic performance (retained students) is associated with poor paternal and maternal control over the hours devoted to daily study (Control 4) ($B = -1.21$), with a lower level of encouragement and assistance with school work and in problematic situations (Support 1) ($B = -0.048$), a low perception of respect and trust of parents (Support 2) ($B = -0.066$), a low perception of paternal and maternal concern regarding academic success (Support 5) ($B = -0.096$), with low grades in Spanish Language and Literature ($B = -0.793$) and Mathematics ($B = -0.417$) and a negative evaluation of the teaching styles of teachers for these subjects (Rating 3) ($B = -0.103$). At the same time, this group of students is the one receiving more external reinforcement from family and teachers when they are assessed (Rating 1) ($B = 0.175$). Contrary to what happens with the immigrant students, in this case, better academic performance (not being retained), lies with older students ($B = 4.84$); however, when analyzing the academic year, the 5th and 6th-grade Primary Education students ($B = -5.72$) are again those who obtain better academic results.

The classification table shows that 94.5% of the participants are correctly classified, out of whom the non-retained students (96.4%) are the most numerous compared with retained students (88.8%).

DISCUSSION

The analyses carried out allowed us to identify the variables related to family support and control, school satisfaction, and evaluation of the learning environment, which distinguish between the retained and non-retained native and immigrant students; and which of the selected variables clearly differentiate the two groups. The results are consistent with the scientific literature on the subject.

The data related to family control allow us to state that students with better performance (non-retained), both native and immigrant, perceived greater control from their parents, of their behavior outside the home. The native students with good performance are those who perceive, from both parents, greater control over the money spent, their school attendance, and the hours devoted to daily study, with this aspect being essential for their study habits. The results indicate the relationship between both parents' control and overall performance, especially in the case of Spanish children. It is well-known that the absence of psychological control, behavioral control, and autonomy support has positive effects on the academic achievement of adolescents and their behavioral adjustment (Barber et al., 2006; Wang et al., 2007). Santos Rego et al. (2016) consider that parental involvement (control and supervision) will be beneficial for the child when it supports the development of autonomy, when it focuses on the process and entails

TABLE 8 | Results of logistic regression analysis for native students.

Predictors	*B*	SE	Wald	*p*	Exp(B)
Control 4	−0.121	0.039	9.85	0.002	0.88
Support 1	−0.048	0.024	4.05	0.044	0.95
Support 2	−0.066	0.023	8.3	0.004	0.94
Support 5	−0.096	0.045	4.37	0.034	0.91
Rating 1	0.175	0.033	28.88	0.001	1.19
Rating 3	−0.103	0.037	7.76	0.005	0.90
Spanish Language and Literature	−0.793	0.113	49.09	0.001	0.45
Mathematics	−0.417	0.106	15.62	0.001	0.66
Age	4.84	0.382	160.85	0.001	126.10
Grade	−5.72	0.521	120.85	0.001	0.003

CLASSIFICATION TABLE

Observed	Predicted		Correct %
	Non-retained	Retained	
Non-retained	783	29	96.4
Retained	30	238	88.8
Overall %			94.5

affection and positive beliefs; and, to the contrary, it may be detrimental if it is controlling, person-centered (emphasizing stable attributes) and characterized by negative affection and beliefs. Suárez et al. (2011) claimed that parental involvement in children's education had positive effects on their academic performance, as long as it was adequate, and involved support for the students.

Following the same line of research, Manrique et al. (2014) analyzed the association between negative parental control and positive parenting with achievement in spelling, arithmetic and reading in sixth-grade Primary Education students from Peru, concluding that the support and appropriate interactions can contribute to cognitive and psychological development during childhood. These authors also associated the high socioeconomic status with a lower negative parental control. Su et al. (2015) found in a sample of 310 Primary Education children from Germany that intrusive parental control was adversely associated with school performance.

Regarding study habits, recent studies have attempted to delve into the reasons why some students with good intellectual abilities perform worse on tests than others with lower abilities; these studies have confirmed the relationship between study habits and students' results in evaluation tests (Razia, 2015). More precisely, one of the variables that best predicts retention, both for native and immigrant students, is poor parental control over the hours devoted to daily study.

With respect to the support, the two groups of students with the best performance are again those who perceive greater respect and trust from their parents. The native students who were never retained feel supported and encouraged by both parents to carry out their school work and to address problematic situations, in addition to perceiving to a greater extent that their parents clearly communicate their expectations for them, and show a greater concern for their academic success.

Studies in other contexts and populations have confirmed similar results, showing the association between performance and family support. Bazán and Castellanos (2015) used a sample of Elementary Education 5th grade students from Mexico to conclude that perceived family support, especially from mothers, influences students' performance. In a sample of Primary Education students from Pakistan, Iqbal and Masrur (2010) examined the relationship between academic success and the educational support that children receive at home, and the effects of this support in their self-concept. The results showed that the parental support had a consistent and positive effect on academic success and self-concept (see Bean et al., 2003, 2006; Santana and Feliciano, 2011; Álvarez et al., 2015). According to Carbonero et al. (2015), students with a positive self-concept are effectively oriented toward learning (Cabanach et al., 2014).

The support variables that best predict retention in the case of native students are greater support and encouragement in school work and problematic situations, low perception of respect, and confidence from their parents, and the lack of parental concern for their academic successes. However, they receive greater external reinforcement (from family and teachers) when evaluated.

In the case of immigrant students, parents' biggest concern for academic success and the greatest satisfaction with the external reinforcements from influential adults (family and teachers) are also associated with retention.

Our results agree with those from other studies where it was proven that students with poorer performance received more family support (Chen, 2008; Bazán and Castellanos, 2015). This is explained by the fact that families and teachers are more focused on students who fail, in order to reinforce their knowledge. That is, families offer support when they realize that their children have learning difficulties. In any case, Alonso-Tapia and Simón (2012) suggest that immigrant students have a motivational profile associated with low self-esteem, which leads them to require a greater degree of external support than native students, from both teachers and their families, in order to help them overcome the lack of confidence.

On the other hand, the results show that the students most satisfied with school and the learning environment are precisely those who have poorer academic performance, especially among the native students. This suggests that these variables have no role in their poor performance.

When referring to immigrant students, it should be taken into account that our study involved a sample from Latin America. According to the results obtained in the study conducted by Santana et al. (2016), with Compulsory Secondary Education students of different origins, the level of support received by those from Latin America is higher than the one perceived by the other study groups. This may be associated with a higher educational level of the parents of this origin (Bazán et al., 2007; Lorenzo et al., 2012).

However, Schnell and Azzolini (2015) argue, contrary to most authors, on differences in achievement between immigrant and native students, that the parents' educational level plays a secondary role in explaining the performance differences, as adult immigrants in southern Europe generally have education levels similar to adult natives of those countries; thus, attention should be paid to the economic and material resources of these families. The same results were found in studies conducted in other countries (new immigration destinations) such as Finland (Harinen and Sabour, 2014) or Ireland (Fanning et al., 2011).

In short, it seems that the main differences focus on the individual dimensions (perception of family support and control) and, to a lesser extent, on the contextual dimensions (assessment of the school and its learning environments), which agrees with the results of other studies (Núñez et al., 2014). In any case, as argued by Santana et al. (2016), there have been few studies on the academic expectations, perceived family support, the decision-making process, and the life plan of immigrant students.

EDUCATIONAL IMPLICATIONS AND STUDY LIMITATIONS

After performing this work, the need for studies that expand the sample size of participants should be considered, taking into

account students of other ethno-cultural origins, with native languages other than Spanish. It would also be important to work with new variables, such as the time that these students have been living in Spain or levels of family involvement.

However, the results provide solid evidence aimed at designing programs for family involvement to help improve students' educational performance and contribute to the solution of school failure and dropouts, which is one of the main problems that education systems have to face today and, therefore, prevent the social exclusion of many young people in the future.

AUTHOR CONTRIBUTIONS

AG and ML collected data, analyzed data, and wrote the paper. MF and MS analyzed data and wrote the paper.

ACKNOWLEDGMENTS

This work was developed through the funding of the research project PGIDIT 07SEC009214PR of the Government of Galicia (Xunta de Galicia), Spain.

REFERENCES

Alonso-Tapia, J., and Simón, C. (2012). Differences between immigrant and national students in motivational variables and classroom-motivational-climate perception. *Span. J. Psychol.* 15, 61–74. doi: 10.5209/rev_SJOP.2012.v15.n1.37284

Álvarez, A., Suárez, N., Tuero, E., Núñez, J. C., Valle, A., and Regueiro, B (2015). Family involvement, adolescent self-concept and academic achievement [Implicación familiar, autoconcepto del adolescente y rendimiento academico]. *Eur. J. Invest. Health Psychol. Educ.* 5, 293–311. doi: 10.1989/ejihpe.v5i3.133

Areepattamannil, S., Melkonian, M., and Khine, M. S. (2015). International note: exploring differences in native and immigrant adolescents' mathematics achievement and dispositions towards mathematics in Qatar. *J. Adolesc.* 40, 11–13. doi: 10.1016/j.adolescence.2014.12.010

Barber, B., Stoltz, H., and Olsen, J. (2006). Parental support, psychological control, and behavioural control: assessing relevance across the time, culture, and method. *Monogr. Soc. Res. Child Dev.* 70, 1–137. doi: 10.1111/j.1540-5834.2005.00365.x

Barbero, M. I., Holgado, F. P., Vila, E., and Chacón, S. (2007). Attitudes, study habits and performance in Mathematics: gender differences. [Actitudes, hábitos de estudio y rendimiento en matemáticas: Diferencias por género.] *Psicothema* 19, 413–421. Retrieved from: http://www.psicothema.com

Barca, A., Almeida, L., Porto, A. M., Peralbo, M., and Brenlla, J.C. (2012). School motivation and performance: the impact of academic goals, learning strategies and self-efficacy. [Motivación escolar y rendimiento: impacto de metas académicas, de estrategias de aprendizaje y autoeficacia.] *Anal. Psicol.* 28, 848–859. doi: 10.6018/analesps.28.3.156221

Bazán, A., and Castellanos, D. (2015). Parents' support and achievement in a mexican elementary school: child's perception and parents' self-evaluation. *Int. J. Psychol. Stud.* 7, 59–69. doi: 10.5539/ijps.v7n4p59

Bazán, A., Sánchez, B., and Castañeda, S. (2007). Structural relationship between family support, parents' education level, teachers' characteristics and performance of written language. [Relación estructural entre apoyo familiar, nivel educativo de los padres, características del maestro y desempeño de la lengua escrita.] *Rev. Mexicana Invest. Educ.* 12, 701–729. Retrieved from: http://www.redalyc.org/articulo.oa?id=1400331

Bean, R., Bush, K., McKenry, P., and Wilson, S. (2003). The impact of parental support, behavioral control, and psychological control on the academic achievement and self-esteem of african american and european american adolescents. *J. Adolesc. Res.* 18, 523–541. doi: 10.1177/0743558403255070

Bean, R. A., Barber, B., and Crane, D. (2006). Parental support, behavioral control, and psychological control among african american youth the relationships to academic grades, delinquency, and depression. *J. Fam. Issues* 27, 1335–1355. doi: 10.1177/0192513X06289649

Cabanach, R., Souto, A., Freire, C., and Ferradás, M. (2014). Links between self-esteem and perceived stressors in university student [Relaciones entre autoestima y estresores percibidos en estudiantes universitarios]. *Eur. J. Educ. Psychol.* 7, 43–57. doi: 10.1989/ejep.v7i1.151

Calero, J., and Escardibúl, J. O. (2013). *The Performance of Students of Immigrant Origin in PISA-2012. [El Rendimiento del Alumnado de Origen Inmigrante en PISA-2012.]* Ministry of Education, Culture, and Sports, PISA 2012. Spanish Report, Vol. II: Secondary analysis [Informe español. Vol II: Análisis secundario], Ministry of Education, Culture, and Sports, Madrid, 4–31.

Carbonero, M. A., Martín-Antón, L. J., Monsalvo, E., and Valdivieso, J. A. (2015). School performance and persona latitudes and social responsability in preadolescent students. *Anal. Psicol.* 31, 990–999. doi: 10.6018/analesps.31.3.181161

Casquero, A., Sanjuán, J., and Antúnez, A. (2012). School dropout by gender in the European Union: evidence from Spain. *Estud. Educ.* 23, 117–139. doi: 10.15581/004.23.117-139

Chen, J. (2008). Grade-level differences: relations of parental, teacher, and peer support to academic engagement and achievement among hong kong students. *School Psychol. Int.* 29, 183–198. doi: 10.1177/0143034308090059

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences, 2nd Edn*. Hillsdale, NJ: Erlbaum.

Coleman, J. S., Campbell, E., Hobson, C., McPartland, J. M., Mood, A., Weinfeld, F. D., et al. (1966). *Equality of Educational Opportunity*. Washington, DC: National Center for Educational Statistics U.S. Department of Health, Education, and Welfare.

Cordero, J., Crespo, E., and Pedraja, F. (2013). Educational performance and determinants according to PISA: a review of the literature in Spain. *[Rendimiento educativo y determinantes según PISA: una revisión de la literatura en España.] Rev. Educ.* 362, 273–297. doi: 10.4438/1988-592X-RE-2011-362-161

Covington, M. (2000). Goal theory, motivation, and school achievement: an integrative review. *Annu. Rev. Psychol.* 51, 171–200. doi: 10.1146/annurev.psych.51.1.171

Creemers, B., and Kyriakides, L. (2008). *The Dynamics of Educational Effectiveness*. London: Routledge.

Dufur, M., Parcel, T., and Troutman, K. (2013). Does capital at home matter more than capital at school? Social capital effects on academic achievement. *Res. Soc. Strat. Mob.* 31, 1–21. doi: 10.1016/j.rssm.2012.08.002

Eccles, J. S. (2005). Influences of parents' education on their children's educational attainments: the role of parent and child perceptions. *Lond. Rev. Educ.* 3, 191–204. doi: 10.1080/14748460500372309

Fanning, B., Haase, T., and O'Boyle, N. (2011). Well-being, cultural capital and social inclusion: immigrants in the republic of ireland. *J. Int. Migr. Integr.* 12, 1–24. doi: 10.1007/s12134-010-0166-0

González-Pienda, J., Núñez, J. C., Álvarez, L., Roces, C., González-Pumariega, S., González, P et al. (2003). Adaptability and family cohesion, parental involvement in self-regulatory behaviors, student's self-concept and academic achievement. [Adaptabilidad y cohesión familiar, implicación parental en conductas autoregulatorias, autoconcepto del estudiante y rendimiento académico.] *Psicothema* 15, 471–477. Retrieved from: http://www.psicothema.com

Grayson, J.P. (2011). Cultural capital and academic achievement of first generation domestic and international students in Canadian universities. *Br. Educ. Res. J.* 37, 605–630. doi: 10.1080/01411926.2010.487932

Han, W.-J. (2006). Academic achievements of children in immigrant families. *Educ. Res. Rev.* 1, 286–318. Retrieved from: http://www.academicjournals.org/ERR

Harinen, P., and Sabour, M.H. (2014). "Finland," in *The Palgrave Handbook of Race and Ethnic Inequalities in Education*, eds P. A. Stevens and G. A. Dworkin (Basingstoke: Palgrave MacMillan), 308–317.

Iqbal, B., and Masrur, R. (2010). Impact of parental support on the academic performance and self concept of the student. *J. Res. Reflect. Educ.* 4, 14–26. Retrieved from: http://www.ue.edu.pk/jrre

Levels, M., Dronkers, J., and Kraaykamp, G. (2008). Immigrant children's educational achievement in western countries: origin, destination, and community effects on mathematical performance. *Am. Sociol. Rev.* 73, 835–853. doi: 10.1177/000312240807300507

López, G. R., Scribner, J. D., and Mahitivanichcha, K. (2001). Redefining parental involvement: lessons from high-performing migrant-impacted schools. *Am. Educ. Res. J.* 38, 253–288. doi: 10.3102/00028312038002253

Lorenzo, M., Godás, A., Priegue, D., and Santos Rego, M. A. (2009). *Immigrant Families in Galicia. The Socio-Educational Dimension of Integration. [Familias Inmigrantes en Galicia. La Dimensión Socioeducativa de la Integración]*. Madrid: Ministry of Education.

Lorenzo, M., Santos Rego, M.A., and Godás, A. (2012). Immigration and education. Does parental educational level influence their children's academic performance? [Inmigración y educación. Influye el nivel educativo de los padres en el rendimiento académico de los hijos?] *Teor. Educ.* 24, 129–148. Retrieved from: http://revistas.usal.es/index.php/1130-3743/article/view/10358

Manrique, D., Ghesquière, P., and Van Leeuwen, K. (2014). Relationship among parenting behavior, SES, academic achievement and psychosocial functioning in peruvian children. *Univ. Psychol.* 13, 639–650. doi: 10.11144/javeriana.upsy13-2.rpba

Ministry of Education, Culture, and Sports (2013). *PISA 2012*. Spanish Report, Ministry of Education, Culture, and Sports, Madrid.

Ministry of Education, Culture, and Sports (2015). *Data from: Non-University Education. Students Enrolled. Course 2014-2015. Advance Data. [Datos de: Enseñanzas no universitarias. Alumnado matriculado. Curso 2014-2015. Datos Avance]*. Available online at: http://www.mecd.gob.es/servicios-al-ciudadano-mecd/estadisticas/educacion/no-universitaria/alumnado/matriculado/2014-2015-Datos-Avances.html

Núñez, J., Vallejo, G., Rosário, P., Tuero, E., and Valle, A. (2014). Variables of the student, teacher and context in predicting academic performance in biology: an analysis from a multilevel perspective. [Variables del estudiante, del profesor y del contexto en la predicción del rendimiento académico en Biología: análisis desde una perspectiva multinivel.] *Rev. Psicodidáctica* 19, 145–172. doi: 10.1387/RevPsicodidact.7127

OECD (2012). *Equity and Quality in Education: Supporting Disadvantaged Students and Schools*. Paris: OECD Publishing.

OECD (2015). *International Migration Outlook 2015*. Paris: O*ECD Publishing.*

Razia, B. (2015). Study habits of secondary school students in relation to their socio-economic status and gender. *Int. J. Soc. Sci. Manage.* 2, 68–73. doi: 10.3126/ijssm.v2i1.11815

Santana, L., and Feliciano, L. (2011). Perception of support from parents and teachers, self-concept and decision making in upper-secondary education. [Percepción de apoyo de padres y profesores, autoconcepto y toma de decisiones en bachillerato]. *Rev. Educ.* 355, 493–519. doi: 10-4438/1988-592X-RE-2011-355-034

Santana, L., Feliciano, L., and Jiménez, A. (2016). Family support and life plan of immigrant Secondary Education students. [Apoyo familiar y proyecto de vida del alumnado inmigrante de Educación Secundaria]. *Rev. Educ.* 372, 35–62. doi: 10.4438/1988-592X-RE-2015-372-314

Santos Rego, M. A., Godás, A., and Lorenzo, M. (2012). The profile of the retained and non-retained students in a sample of Spanish and Latin-American students: a study on academic determinants. [El perfil del alumnado repetidor y no repetidor en una muestra de estudiantes españoles y latinoamericanos: un estudio sobre los determinantes académicos]. *Estud. Educ.* 23, 43–62. Retrieved from: https://www.unav.edu/publicaciones/revistas/index.php/estudios-sobre-educacion/article/view/2048

Santos Rego, M. A., Godás Otero, A., and Lorenzo Moledo, M. (2013). Academic performance and cultural diversity: linguistic axis. [Rendimiento académico y diversidad cultural: el eje lingüístico.] *Rev. Española Pedagogía* 256, 461–478. Retrieved from: http://reunir.unir.net/handle/123456789/3765

Santos Rego, M.A., Godás, A., and Lorenzo, M. (2016). Can parents' involvement improve their children's study skills in school? Evidence of an pedagogical program. [Puede la implicación de los padres mejorar el estudio de sus hijos en la escuela? La evidencia de un programa pedagógico.] *Estud. Educ.* 30, 9–30. doi: 10.15581/004.30.9-30

Schnell, P., and Azzolini, D. (2015). The academic achievements of immigrants youths in new destination countries: evidence from southern Europe. *Migr. Stud.* 3, 217–240. doi: 10.1093/migration/mnu040

Su, Y., Doerr, H.S., Johnson, W., Shi, J., and Spinath, F.M. (2015). The role of parental control in predicting school achievement independent of intelligence. *Learn. Indiv. Diff.* 37, 203–209. doi: 10.1016/j.lindif.2014.11.023

Suárez, N., Tuero-Herrero, E., Bernardo, A., Fernández, E., Cerezo, R., González-Pienda, J.A., et al. (2011). School failure in secondary education: analysis of the role of family involvement. [El fracaso escolar en educación secundaria: análisis del papel de la implicación familiar.] *Rev. Formación Prof. Invest. Educ.* 24, 49–64. Retrieved from: https://dialnet.unirioja.es/ejemplar/296682

Suárez-Orozco, C., and Suárez-Orozco, M. (2008). *Immigration Stories: Understanding the Patterns of School Performance of Young Immigrants. [Històries D'immigració: la Comprensió dels Patrons de Rendiment Escolar dels Joves Immigrants.]* Barcelona: Jaume Bofill Foundation.

Valle, A., Rodríguez, S., Cabanach, R., Núñez, J.C., González-Pienda, J., and Rosário, P. (2009). Differences in academic performance according to levels of cognitive strategies and self-regulation strategies. [Diferencias de rendimiento académico según los niveles de las estrategias cognitivas y de las estrategias de autorregulación.] *SUMMA Psicológica UST* 6, 31–42. Retrieved from: http://www.summapsicologica.cl/index.php/summa/article/view/60

Vaquera, E., and Kao, G. (2012). Educational achievement of inmigrants adolescents in Spain: do gender and region of origin matter? *Child Dev.* 83, 1560–1576. doi: 10.1111/j.1467-8624.2012.01791.x

Wang, Q., Pomerantz, E., and Chen, H. (2007). The role of parent's control in early adolescents psychological functioning: a longitudinal investigation in the United States and China. *Child Dev.* 78, 1592–1610. doi: 10.1111/j.1467-8624.2007.01085.x

Winne, P. H., and Nesbit, J. C. (2010). The psychology of academic achievement. *Annu. Rev. Psychol.* 61, 653–678. doi: 10.1146/annurev.psych.093008.100348

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer MI and the handling Editor declared their shared affiliation, and the handling Editor states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2016 Santos, Godás, Ferraces and Lorenzo. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 07 October 2016
doi: 10.3389/fpsyg.2016.01538

Academic Failure and Child-to-Parent Violence: Family Protective Factors

Izaskun Ibabe *

Social Psychology and Behavioral Sciences Methodology, University of the Basque Country, Donostia-San Sebastián, Spain

A reduction in academic achievement over the course of adolescence has been observed. School failure is characterized by difficulties to teaching school goals. A variety of other behavioral problems are often associated with school failure. Child-to-parent violence has been associated with different school problems. The main objective of current study was to examine the contribution of family variables (parental education level, family cohesion, and positive family discipline) on academic failure and child-to-parent violence of adolescents from a community sample. Moreover, a goal was to explore if academic failure was a valid predictor of child-to-parent violence. To this end, it has been developed a comprehensive statistical model through Structural Equation Modeling (SEM). Participants were 584 children from eight secondary schools in the Basque Country (Spain) and aged between 12 and 18. Among other scales Conflict Tactics Scale and Family Environment Scale were administrated for measuring child-to-parent violence and family cohesion environment, respectively. The structural model revealed that parental education level is a relevant protective factor against academic failure. Positive family discipline (inductive discipline, supervision, and penalty) show a significant association with child-to-parent violence and academic failure. Disciplinary practices could be more efficient to prevent child-to-parent violence or school failure if children perceive a positive environment in their home. However, these findings could be explained by inverse causality, because some parents respond to child-to-parent violence or academic failure with disciplinary strategies. School failure had indirect effects on child-to-parent violence through family cohesion. For all that, education policies should focus on parental education courses for disadvantaged families in order to generate appropriate learning environments at home and to foster improvement of parent-child relationships.

Keywords: academic failure, academic achievement, school adjustment, family environment, gender differences, child-to-parent violence

OPEN ACCESS

Edited by:
José Carlos Núñez,
University of Oviedo, Spain

Reviewed by:
María Del Carmen Pérez Fuentes,
University of Almería, Spain
Candido J. Ingles,
Universidad Miguel Hernández de Elche, Spain
Francisca Fariña,
Universidad de Vigo, Spain

***Correspondence:**
Izaskun Ibabe
izaskun.ibabe@ehu.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *07 July 2016*
Accepted: *21 September 2016*
Published: *07 October 2016*

Citation:
Ibabe I (2016) Academic Failure and Child-to-Parent Violence: Family Protective Factors. Front. Psychol. 7:1538. doi: 10.3389/fpsyg.2016.01538

INTRODUCTION

School failure refers to students' difficulties for fulfilled teaching goals (fully or partially; Kalogridi, 1995), which can in extreme cases lead to their dropping out of school. Academic failure implies both poor academic performance and school maladjustment. It implies negative effects on social cohesion and mobility, and involves extra expenses on community budgets as a result of, for example, more public health problems, lack of social support, or criminality (OECD, the Organisation for Economic Co-operation Development, 2012). Thus, high academic failure and

dropout rates remain significant issues in some countries. In the United States about 25% of public school students fail to earn a diploma (Stillwell, 2009). Rates of school failure in Spanish students are above the other European student and OECD countries average (Fernández et al., 2010). In Spain during the school year 2008/2009 the number of school children who not achieved a Certificate in Compulsory Secondary Education was 26%, and the goal for school dropout in 2020 is 15% (Organisation for Economic Co-operation Development, 2011). A decrease in academic achievement during adolescence has been found in previous research (e.g., Barber and Olsen, 2004; Hernando et al., 2012), while in many countries has been increased the attention to the underachievement of boys in comparison with girls (Jackson, 1998; Van Houtte, 2004). Van Houtte (2004) found that boys' culture is less study-oriented than girls, and that this difference could be the explanation of gender differences in school achievement, at least in secondary school. However, Harris (1998) explained this gender difference as based on the process of development during puberty, whereby girls begin to be disciplined and to take care in the planning and execution of their work earlier than boys.

Theoretical models of school performance developed in recent years have focused on students' personal characteristics (specific skills, motivation, or learning strategies; e.g., Loe and Feldman, 2007; Niepel et al., 2014), family variables (demographics, affective relationships, parenting styles, family educational involvement; Marchant et al., 2001; Sibley and Dearing, 2014), and school variables (school environment and education quality; Marchant et al., 2001; Organisation for Economic Co-operation Development, 2012). The present study is focused on family variables of school failure. The individual influences of family-related factors on students' achievement are well-documented in the literature: student's achievement is related to parenting style and parental involvement (e.g., Paulson, 1994; Sibley and Dearing, 2014). But recent studies have focused on how various risk factors come together to produce negative outcomes (Lucio et al., 2012). Family variables can be classified in demographic (socioeconomic level, parents' educational level and family structure) and dynamic (family environment, parenting style and family educational involvement).

Socio-Demographics Family Variables

Extensive research in the sociology of education has found a strong support for a positive association between family socio-economic status and academic achievement (Sirin, 2005; Caro et al., 2009). There is no strong agreement on the conceptual of socio-economic status, but it is generally operationalized through measures such as parents' education, parental occupational prestige, and family income (Hauser, 1994). It has been observed that poor parental care with serious deprivation of children's needs tends to yield poor academic performance (Osonwa et al., 2013). On the other hand, according to Caro et al.'s study (2009), academic performance among students from varying socio-economic backgrounds is similar during primary school. However, from the middle-school years to the beginning of high school, the gap is widening.

Students from advantaged socio-economic families are exposed to a diverse learning environment because the parents are more involved in their education; hence, their learning outcomes tend to be better. In any case, scholars from low-level socio-economic condition are twice as likely to present low achievement (Organisation for Economic Co-operation Development, 2012). In addition, it should be pointed out that today, many children living in disadvantaged families are from minorities or have an immigrant background (Heckman, 2011).

According to Li-Grining (2007), the problem of low school performance begins with parents' lack of education and a poor understanding of children's needs. In Spain, children of parents who completed only compulsory education (to age 16) constitute the majority of school failure cases (74% in the case of father's education; 71% in that of mother's education), according to studies with secondary education pupils (Fernández et al., 2010). Even so, the positive effects of parental education on school success of children might not be significant until parental education reaches at least high school diploma (Jensen, 2007). In any case, it seems obvious that higher levels of parents' education will result in greater involvement in their children's education, and this will promote school completion and success (Unger et al., 2000; Mapp, 2004). Epstein (2011) indicated some subtypes of parental participation in children's education, such as involvement in children's homework, high parental expectations or extracurricular activities with achievement outcomes. However, despite the extensive literature, particularly in relation to elementary and middle-school contexts, findings about the effects of family educational involvement on high-school students' outcomes are inconclusive (Strayhorn, 2010). What emerges, though, is that parenting style may have meditational effect in the relationship between parental involvement and academic achievement (Blondal and Adalbjarnardottir, 2009).

In recent years, research linking family structure and children's educational outcomes has done a great deal to elucidate how family disparities can create educational inequalities (Crosnoe and Wildsmith, 2011). Children living in a nuclear family achieve more academically than those living in other types of family structure (single-parent or blended family; Fernández et al., 2010; Córdoba et al., 2011). This finding was supported in Zill's (1996) review of research results from extensive longitudinal data: students from intact nuclear families showed better academic performance than students from other type of family. It seems that children benefit from family stability for emotional and psychological development.

Dynamic Family Variables

Positive family environment (parents-children affective cohesion, parental support, parental monitoring, confidence and openness, and empathic family communication) has been positively related to children's better behavioral and psychological adjustment (Moreno et al., 2009; Jaureguizar and Ibabe, 2012). Furthermore, indirect effects of family cohesion on academic performance were found through parental involvement in school activities for children (Unger et al., 2000) and through children's academic self-concept (Rodríguez-Fernández et al.,

2012). In childhood parents have a major influence on the school performance of their children. However, Spera (2005) indicated that in adolescence findings of previous studies are not consistent. Given an increased need for autonomy, adolescents could respond negatively to high levels of parental involvement.

On the other hand, the relation between family environment and academic performance can be considered bidirectional, since a positive family environment promotes good academic achievement, while family climate is often impaired by school failure (Hernando et al., 2012). Research on parenting has ignored the bidirectional interactive process in parent-child relationship (see Collins et al., 2000).

The complex process of socialization of children by parents includes both discipline and supervision from childhood to adulthood. The purpose of socialization is to promote and prevent certain behaviors in the children. Within the family context, children gradually internalize social standards and expectations, a process that facilitates greater self-regulation skills and responsibility for their own behaviors (Halpenny et al., 2010) and means that when they are adolescents they will need fewer family discipline strategies than in previous periods. Nevertheless, there is little research on the relationships between strategies of positive discipline or partly-punitive discipline and school achievement. Weiss and Schwarz (1996) found that academic aptitude and achievement results of college students from nondirective families (parents who showed low directive control, low assertive control and midhigh, or high supportiveness), excelled scholastically.

Child-to-Parent Violence

Child-to-parent violence has been associated with different school problems as school maladjustment (Ibabe, 2015), learning difficulties and disruptive behavior (Ibabe and Jaureguizar, 2010), less student involvement and less task orientation (Ibabe et al., 2013). In general, juveniles who abused their parents compared to other young offenders besides external symptomatology showed internal symptomatology (Ibabe et al., 2014).

In the current study child-to-parent violence (CPV) is defined as violent behavior by adolescent children toward their parents which includes physical and psychological violence with zero tolerance criterion. Abuse of parents by their children has been a hidden family problem, but the last decade it was displayed. One of the peculiarities of CPV is that parents are seeking protection from their children when they have socially and economically more power, and in some cases they are stronger physically.

Taking into account the Gallagher (2008)'s review, CPV is not related to socio-economic (SES) status or is more common in families with higher SES. In general, children from socially disadvantaged families are found to consistently be more aggressive (Hill and Maughan, 2001), and low income is associated with higher rates of intimate partner violence (Hotaling and Sugarman, 1986). Why would children in families with higher socio-economic status be more likely to be violent to parents? It is possible that children of better educated parents to utilize mental health services when they have behavior problems of their children increasing the prevalence rates of CPV (Goodman et al., 1997).

Adolescents from traditional families showed more violent behavior than single-mother families with mother (Kennair and Mellor, 2007), blended families other type of families (Ibabe, 2014). Single-parent families and blended families are more vulnerable than traditional families, by possible conflict with her former partner or adjustment to new family members. All this means that in these families have a higher level of distress and limited resources to address the adolescent stage of the child.

Generally, family relationships characterized by support, warmth, communication, and autonomy are key for promoting appropriate development in adolescents (Oliva et al., 2008). So that, the positive parent-child relationships is considered as a protective factor of adolescents' verbal or physical abuse of their parents (Estévez and Navarro, 2009; Ibabe, 2015). Similarly, there are several evidences that support the relationship between victimization from parents toward children and violence from children toward parents taking into account community samples (e.g., Ibabe and Jaureguizar, 2011; Gámez-Guadix and Calvete, 2012) and offenders samples (child-to-parent offenders and other offenders; Contreras and Cano, 2016). Child-to-parent violence was strongly associated with the lack of emotional support (Calvete et al., 2014a), as well as with parents with unrealistic expectations, or deficit in communication skills (Paulson et al., 1990; Kennedy et al., 2010).

There are empirical evidences that poor parental discipline and supervision are a relevant risk factor for the antisocial behaviors in adolescence (Loeber et al., 1993; Yoshikawa, 1994). Although some authors (e.g., Beyers and Goossens, 1999; Estévez and Navarro, 2009) noted that parental discipline based on markedly permissive or authoritarian control is linked with child-to-parent violence or psychological maladjustment, there are not consistent empiric evidences for violent behavior toward parents. Family discipline strategies have been classified as power-assertive and inductive. Power-assertive disciplinary methods involve following a child's inappropriate behavior with a negative consequence (smacking, threats, or deprivation of privileges) without explanation or justification. Inductive discipline involves setting limits, setting up logical consequences, reasoning, and explaining (Holden, 2002). It has been found that parents of adolescents who perpetrated CPV made fewer attempts to make sure there were consequences for inappropriate behavior and exerted less supervision (Calvete et al., 2014b). Surprisingly, Ibabe and Bentler (2015) found that supervision and penalty (medium-level power-assertive discipline) were linked to more violent behavior of adolescents. At the same time, inductive discipline was not associated with less violence against parents. These findings could be due to some parents respond to CPV with coercive strategies.

They are noteworthy potential bidirectional effects between family environment and child-to-parent violence. Research on child development indicates bidirectional effects between parent–child relationships and child temperament (e.g., Chess and Thomas, 1996; DeHart et al., 2004). Additionally, children with difficult temperaments (i.e., with externalizing symptoms) are more vulnerable to inappropriate discipline than children with relatively easy temperaments (Van Zeijl et al., 2007). In

any study was found that discipline strategies administrated inconsistently or different parenting styles (Maccoby and Martin, 1983; Baumrind, 1991) applied by father and mother can be related to violent behavior toward parents (e.g., Calvete et al., 2014a). It is remarkable that there is little research on acceptable discipline strategies such as inductive discipline, supervision, or penalty, as protective factors of adolescents' violent behavior toward their parents or academic failure.

Objectives and Hypothesis

The main goal of this study was to analyze the contribution of family socio-demographic and family dynamic variables (family cohesion and positive family discipline) on two indicators of adolescent maladjustment (academic failure and child-to-parent violence) from community sample. Moreover, other goal was to explore the relationship between school failure and child-to-parent violence. To this end, it has been developed a comprehensive statistical model of family protective factors through Structural Equation Modeling (SEM).

The hypotheses were as follows:

(a) Parents' education and family cohesion will have some direct effects on academic failure. This hypothesis is based on studies indicating a lower level of academic failure when parents have a higher level of education (Li-Grining, 2007; Caro et al., 2009; Fernández et al., 2010), or when family environment is positive (Unger et al., 2000).

(b) Positive family discipline strategies will be associated with academic failure and child-to-parent violence. This hypothesis was based on Ibabe and Bentler (2015)'s finding: penalty and supervision were positively related to violent behavior of adolescent against parents. The explanations could be in an inverse causality, that parents may more frequently apply discipline strategies when children show child-to-parent violence or have low academic achievement.

(c) Children who live in nuclear families will present lower levels of academic failure and child-to-parent violence than those living in other types of family structure (single-parent families, step-families). This hypothesis is consistent with the previous findings on academic achievement (e.g., Zill, 1996; Córdoba et al., 2011) and child-to-parent violence (Kennair and Mellor, 2007). The decline in children's psychosocial well-being after parental separation could explain their lower academic performance (Potter, 2010) and violent behavior against parents.

(d) School failure will have direct effects on child-to-parent violence and indirect effects through family cohesion. In previous studies school maladjustment has been associated with child-to-parent violence (Ibabe et al., 2013; Ibabe, 2014), both variables could be indicators of psychological distress in adolescents. Taking into account that we will study a community sample, school failure could be a source of considerable family tension which might interfere with satisfactory relations between adolescents and parents (Hurrelmann et al., 1988). In several previous studies low family cohesion has been found as an important risk factor of child-to-parent violent (e.g., Ibabe et al., 2013).

METHOD

Participants

A total of 584 adolescents participated in the study from eight secondary schools in the Basque Country (Spain) of both sexes (48% boys), and aged 12–18 years ($M = 14.55$; $SD = 1.53$). Forty-three percent of the participants were attended state (public) schools and the rest were private schools. Seventy-five percent lived in nuclear families, 14% in single-mother families, 7% in step-families, and 4% in extended families or other types. Forty-seven percent of the participants had passed all their subjects in the previous term. The distribution of sample by age and sex is uniform, $\chi^2_{(N=528,6)} = 5.89$, $p = 0.44$ (see **Table 1**).

Instruments

Socio-Demographic Data

A questionnaire was applied to assess socio-demographic variables of the children. Among the characteristics measured were sex, age, family structure, parental education level (none, only compulsory education –ESO-, further education/job training or university), parents' occupation, and country of origin.

Academic Failure

This was defined as the extent to which the child had failed to attain the minimum goals set by the school at every level of education, together with lack of learning motivation. Academic performance was measured through the number of subjects the participant had failed. The question about number of failed subjects in the previous term had 4 answer options (0 fail, 1–4 fails, 5–10 fails, 10 or more fails). As regards lack of motivation for school work, participants were required to indicate their interest in their studies on a Likert scale (1 = Very low; 4 = Very high). In this study alpha coefficient of the scale was 0.63. This coefficient value was below recommended value and it could be questionable. However, it is not due to the absence of correlation between items (inter-item correlation $r = 0.47$) but the relatively small number of items of the scale. Spearman-Brown prophecy formula (for estimating the increased reliability expected to result from increase in scale length) indicated an adequate reliability coefficient for the scale, if it would have additional two parallel

TABLE 1 | Distribution of the sample Sex × Age.

		Sex		Total
		Boy	Girl	
Age	12	26	20	46
	13	53	49	102
	14	56	66	122
	15	49	57	106
	16	48	45	93
	17	15	28	43
	18	7	9	16
Total		254	274	528

items ($\alpha = 0.77$). In attempting to increase the coefficient alpha of a scale, the quality of items may be more important than the quantity of items (Netemeyer, 2001). The principal components analysis yielded a one-factor structure with an eigenvalue greater than 1 (1.46), and this factor accounted for 73% of the total variation.

Family Environment

Three subscales (cohesion, conflict, and organization) of the Family Environmental Scale (FES; Moos and Moos, 1981; Spanish version by TEA Ediciones, 1984) were applied. Each subscale contains 9 items (e.g., "In my family we really help and support each other") with true/false response format. Cohesion is defined as the degree of commitment and support family members provide for each other. In this study cohesion showed an acceptable internal consistency ($\alpha = 0.76$). However, taking into account that conflict ($\alpha = 0.61$) and organization ($\alpha = 0.52$) subscales are not reliable (alpha < 0.70; Nunnally, 1978), these measures of family environment were discarded of all data analyses.

Family Discipline

Family discipline strategies were measured by the Dimensions of Discipline Inventory (DDI-C; Straus and Fauchier, 2007; Spanish adaptation by Calvete et al., 2010). This inventory includes 26 items in order to assess family discipline from children point of view in their relationship with their father and mother (e.g., "How often do your parents give you extra chores?"). Although the inventory contents four general dimensions, in this study were applied three: *Penalty* (deprivation of privileges and restorative behavior), *Supervision* (ignoring misbehavior and monitoring) and *Inductive discipline* (diversion, explanation, and reward). Its items describe different situations related to family life and upbringing, which children are required to answer on a 5-point Likert-type scale (0 = Never; 4 = Almost always). In this study the internal consistency for three general dimensions varied from 0.82 (Inductive discipline) to 0.77 (Supervision).

Child-to-Parent Violence

Conflict Tactics Scale Child-Parents (CTS1; Straus et al., 1998). This instrument is composed of 13 items (e.g., Insult or threaten my father/mother) and includes three subscales: psychological violence, mild physical violence, and serious physical violence. Children had to answer taking into account the last year and using a scale with 5-point Likert-type scale (0 = Never; 4 = Almost always). Reliability results for this study are acceptable (serious physical violence $\alpha = 0.83$, mild physical violence $\alpha = 0.79$, psychological violence $\alpha = 0.85$).

Procedure

The sample of adolescents was obtained by means of cluster sampling from all secondary schools in the Basque Country (Spain). Firstly, schools were randomly selected, and then they had to confirm their availability and the willingness of their staff to collaborate in the research. Two schools denied their participation and were replaced by others with similar characteristics. After that into each selected school some classrooms were chosen taking into account the linguistic model (monolingual vs. bilingual) and the education level of participants, in order to get a balanced and representative sample. Head teachers of each school were informed about the objectives of the study in a 1-h presentation. A letter was sent to the parents about research project, after they had to inform whether or not they agreed to their children participate in the study. Students were informed about the confidentiality and anonymity of their answers. Before students filled out the questionnaire, the instructions for each scale were explained carefully. The questionnaires were administered during normal class time in 1-h sessions. Data collection was conducted during 2011, and administration time for the instruments was approximately 45 min. Initially, the 5% of children couldn't join in the study because their parents didn't give their consent to participate. After collecting data, the 4% of participants were discarded of the sample by errors or omissions in its answers to the tests or were outside of age range (12–18 years old).

Data Analysis

Univariate data analyses were carried out using PASW Statistics version 20. The first of these analyses included percentages corresponding to the socio-demographic characteristics of the sample and a matrix of correlation between academic failure and family variables (see **Table 2** in which 12 observed variables were included with their means and standard deviations). Spearman rank correlation was used to measure the degree of association between number of failed subjects and school hypo-motivation with the rest of variables, being ordinal variables. Moreover, point-biserial correlation coefficient was applied when these variables were correlated with one dichotomous variable (immigrant or nuclear family).

The adequacy of the proposed model was assessed using EQS 6.1 Structural Equations Program. Confirmatory factor analysis (CFA) assessed the adequacy of the hypothesized measurement model which included four latent factors and one observed variable (family cohesion). The first-order latent variables included in the CFA were: Parental Education Level (indicators: father's educational level and mother's educational level), Positive Family Discipline (indicators: penalty, supervision and inductive), Academic Failure (indicators: number of failed subjects and hypo-motivation), and Child-to-Parent Violence (indicators: psychological violence and physical violence).

Next, a structural model posited family cohesion with direct effects on Family Discipline, Academic Failure, and Child-to-Parent Violence. It was indicated direct and indirect effects of Parental Education on Academic Failure through family cohesion. Moreover, the model included two bidirectional relations: Positive Family Discipline with Academic Failure and Child-to-Parent Violence. Finally, in this model was indicated an association between Academic Failure and Child-to-Parent Violence.

The Yuan-Bentler scaled chi-square (χ^2) (Yuan and Bentler, 2000) was calculated and the practical fit indexes (*IFI*, *CFI*, and *NNFI*) above 0.90 or higher were considered an indication of acceptable fit (Bentler, 2006). The *RMSEA* index values 0.01, 0.05,

TABLE 2 | Means, standard deviations and correlations between academic failure, child-to-parent violence, and family context variables.

	M/%	*DT*	1	2	3	4	5	6	7	8	9	10	11
ACADEMIC FAILURE													
1. Number of subjects failed	1.68	0.74	–										
2. Hypo-motivation	2.29	0.88	0.47**	–									
CHILD-TO-PARENT VIOLENCE													
3. Physical violence	0.27	1.13	0.15*	0.12**	–								
4. Psychological violence	4.25	3.63	0.02	0.09*	0.22**	–							
PARENTAL EDUCATION													
5. Father's educational level	1.88	0.86	−0.27**	−0.18**	−0.07	−0.01	–						
6. Mother's educational level	1.93	0.89	−0.24**	−0.17**	−0.06	0.01	0.58**	–					
POSITIVE FAMILY ENVIRONMENT													
7. Family cohesion	6.74	2.22	−0.19**	0.18**	−0.24**	−0.41**	0.12**	0.13**	–				
POSITIVE FAMILY DISCIPLINE													
8. Penalty	0.85	0.69	0.13*	−0.01	0.11*	0.27**	0.05	−0.03	−0.06	–			
9. Parental supervision	0.65	0.65	0.19**	0.13**	0.17**	0.42**	0.02	−0.01	−0.23**	0.56**	–		
10. Inductive discipline	1.39	0.67	−0.05	−0.02	−0.05	0.21**	0.07	0.06	0.11**	0.53**	0.39**	–	
DEMOGRAPHICS													
11. Immigrant (Yes, No)	23%	–	0.27**	0.04	0.19**	0.01	−0.15**	−0.14**	−0.11**	0.15**	0.16**	−0.01	–
12. Nuclear family (Yes, No)	75%	–	−0.19**	−0.07	−0.18**	−0.11*	0.14**	0.08	0.19**	0.01	−0.07	0.09	0.34**[a]

**Correlation is significant $p < 0.01$; *$p < 0.05$.

[a]Contingency coefficient because two variables are qualitative.

and 0.08 were interpreted as excellent, good, and mediocre fit, respectively (MacCallum et al., 1996).

Of the total participants 74% had complete data ($n = 433$) and the rest had at least one missing value. In total there were 36 patterns of missing values. Full-information maximum likelihood estimation method for missing data was carried out (e.g., Arbuckle, 1996; Jamshidian and Bentler, 1998). While the maximum likelihood estimates were accepted, since the Yuan et al. (2004) normalized coefficient of kurtosis (49.41) indicated a lack of normal distribution, the Yuan and Bentler (2000) robust methodology was used. All the observed variables had skewness and kurtosis coefficients below 1.8, except physical child-to-parent violence (skewness = 6.71 and kurtosis = 56.41). It is assumed that absolute values less than 1 indicate non-normality, and values between 1 and 2.3 indicate moderate non-normality (Lei and Lomax, 2005). Fit indexes based on robust statistics will be reported.

RESULTS

Forty-seven percent of participants had passed all their courses in the prior term, 41% had failed between 1 and 4 courses and 12% had failed 5 or more. As regards learning motivation, 8% of students reported low or very low interest in their studies, while 20% reported high or very high interest.

Relation between Academic Failure, Child-to-Parent Violence and Family Characteristics

In order to explore the relationship between academic failure and variables associated with family context, a correlation matrix was drawn up (see **Table 2**). On the one hand, it is found that academic failure (number of failed subjects and school hypo-motivation) is related to father's educational level ($r = -0.27$ and $r = -0.18$), mother's educational level ($r = -0.24$ and $r = -0.17$), family cohesion ($r = -0.19$ and $r = -0.18$), and degree of parental supervision ($r = 0.19$ and $r = 0.13$). On the other hand, number of failed subjects is associated with being an immigrant ($r = 0.27$) and living in a type of family that is not nuclear (single-parent family, step family, extended family, or other type; $r = -0.19$). On the other hand, child-to-parent violence (physical and psychological) was inversely associated with cohesion ($r = -0.24$ and $r = -0.41$). However, psychological child-to-parent violence was related to more penalty ($r = 0.27$), supervision ($r = 0.42$), and inductive discipline ($r = 0.21$).

In some complementary analysis on the relationship socio-economic level and academic failure, it was found that the number of failed subjects was associated with lower professional category of parents (father $r = -0.21$, $p < 0.001$; mother $r = -0.27$, $p < 0.001$), and parents' unemployment (father $r = -0.12$, $p < 0.01$; mother $r = -0.18$, $p < 0.01$). However, school hypo-motivation was related only to mother's unemployment ($r = -0.12$, $p < 0.01$). In general, these correlations were lower those found for parental education.

Confirmatory Factor Analysis

A confirmatory factor analysis (CFA) assessed the adequacy of the hypothesized measurement model and the associations among the latent variables and one observed variable, *Y-B ML* $\chi^2_{(27,\ N = 584)} = 102.77$, $CFI = 0.94$, $NNFI = 0.89$, $IFI = 0.94$, $RMSEA = 0.063$. After adding one correlated errors path (family cohesion and inductive discipline, $r = 0.22$, $p < 0.001$), fit indexes

for the CFA were all acceptable. *Y-B ML* $\chi^2_{(25,\ N = 584)} = 81.46$, $CFI = 0.96$, $NNFI = 0.92$, $IFI = 0.96$, $RMSEA = 0.054$. All factor loadings were highly significant ($p < 0.001$). **Table 3** shows the correlations between latent factors and family cohesion as an observed variable. Academic failure correlated moderately with less parental education ($r = -0.44$, $p < 0.001$). In addition, child-to-parent violence is related to less family cohesion ($r = -0.54$, $p < 0.001$) and more positive family discipline ($r = 0.56$, $p < 0.001$) with moderate correlations. It is noteworthy the lack of relation between academic failure and child-to-parent violence ($r = 0.11$, $p = 0.11$).

Structural Model

The structural model was acceptable, *Y-B ML* $\chi^2_{(27,\ N = 584)} = 60.68$, $CFI = 0.98$, $NNFI = 0.96$, $IFI = 0.98$, $RMSEA = 0.038$, and this model accounted for 23% of the variance in academic failure and 34% of child-to-parent violence. All factor loadings were highly significant ($p < 0.001$). This structural equation model is presented in **Figure 1**, with standardized coefficients and associated probability.

On the one hand, family cohesion inversely predicted the use of Positive Family Discipline ($\beta = -0.20$, $p < 0.001$), School Failure ($\beta = -0.19$, $p < 0.001$), and Child-to-Parent Violence, ($\beta = -0.59$, $p < 0.001$). Parental education showed direct effects on Academic Failure ($\beta = -0.42$, $p < 0.001$), and indirect effects through family cohesion on Child-to-Parent Violence ($\beta = -0.027$, $p < 0.01$). In addition, school hypomotivation was related to child-to-parent violence ($\beta = 0.15$, $p < 0.05$). On the other hand, Positive Family Discipline was associated significantly with higher level of Academic Failure ($r = 0.19$, $p < 0.01$), and more Child-to-Parent Violence ($r = 0.63$, $p < 0.001$). An alternative model based on reverse causality between family cohesion and Academic Failure was also acceptable, *Y-B ML* $\chi^2_{(27,\ N = 584)} = 67.72$, $CFI = 0.97$, $NNFI = 0.95$, $IFI = 0.97$, $RMSEA = 0.043$, $R^2 = 0.20$. The fit of this model was a little bit worse than previous one, and the model accounted less explained variance in academic failure. In this model family cohesion was predicted significantly by less Academic Failure ($\beta = -0.20$, $p < 0.01$). At the same time, family cohesion presented mediational effects between Academic Failure and Child-to-Parent Violence ($\beta = 0.11$, $p < 0.01$).

TABLE 3 | Correlations between latent variables and one observed variable.

Latent variables	1	2	3	4
1. Academic failure	–			
2. Child-to-parent violence	0.11	–		
3. Parental education level	−0.44**	−0.03	–	
4. Positive family discipline	0.16*	0.56**	0.04	–
Observed variable				
5. Family cohesion	−0.23**	−0.54**	0.14*	−0.20**

$^{**}p < 0.001$; $^{*}p < 0.01$.

DISCUSSION

The objective of this study was to examine the contribution of several family variables on academic failure and child-to-parent violence in adolescents through a SEM model. As predicted, parental education level and family cohesion had some direct effects on academic failure. Previous findings indicated that higher parental education level was associated with less academic failure (e.g., Jensen, 2007; Li-Grining, 2007). The results of this study are fully consistent with those of previous research insofar as they show that students perform better academically the higher the levels of family economy and education, because they have more family resources, these being significant predictors of school industriousness (Shavit and Blossfeld, 1993; Caro et al., 2009; Córdoba et al., 2011). This may be due to greater parental involvement in their children's education, as previous work has shown a significant association between parental involvement and school performance of children (González-Pineda and Núñez, 2005).

It is also well-known that positive family relationships predict children's academic performance (Spera, 2005) and children's adjustment (Moreno et al., 2009; Jaureguizar et al., 2013). According to Blondal and Adalbjarnardottir (2009), the quality of the parent-child relationship seems to better predict the likelihood of the child staying in school than do specific parental actions aimed directly at the child's education. Moreover, the results of the present study highlight the higher association between parental education level (compared to professional category or unemployed status) and academic failure.

As hypothesized, positive family discipline strategies were associated with academic failure and child-to-parent violence. It seems that parents may apply discipline strategies to try and solve the academic achievement problems of their children. Taking into account **Table 3**, control or coercive strategies even moderate-level ones (penalty and supervision), are related to higher levels of academic failure, while positive family relationships predict greater academic success. These results are consistent with the conclusions of some studies in the Spanish context which indicate that adolescents from "indulgent" families (low control and high affect) present the same or better psychological adjustment than adolescents from authoritative families (high control and high affect; Musitu and García, 2004; García and García, 2010). Spera (2005), in his review, found that authoritative parenting style is often related to higher levels of academic performance of children, although this result is not consistent across cultures, ethnicity, or socioeconomic status. It should be highlighted that culture plays a meditational effect in the association between parenting styles and school achievement of adolescents. On the other hand, in this study inductive discipline was not associated with less academic failure. In a previous study by Ibabe (2015), inductive discipline was not associated with less child-to-parent violence, whereas coercive strategies did predict such behavior. These results are not contradictory with the importance of family discipline strategies as control strategies in order to have a positive influence on general indicators of adjustment and competence in adolescents, such as self-esteem or life satisfaction (Steinberg and Silk, 2002).

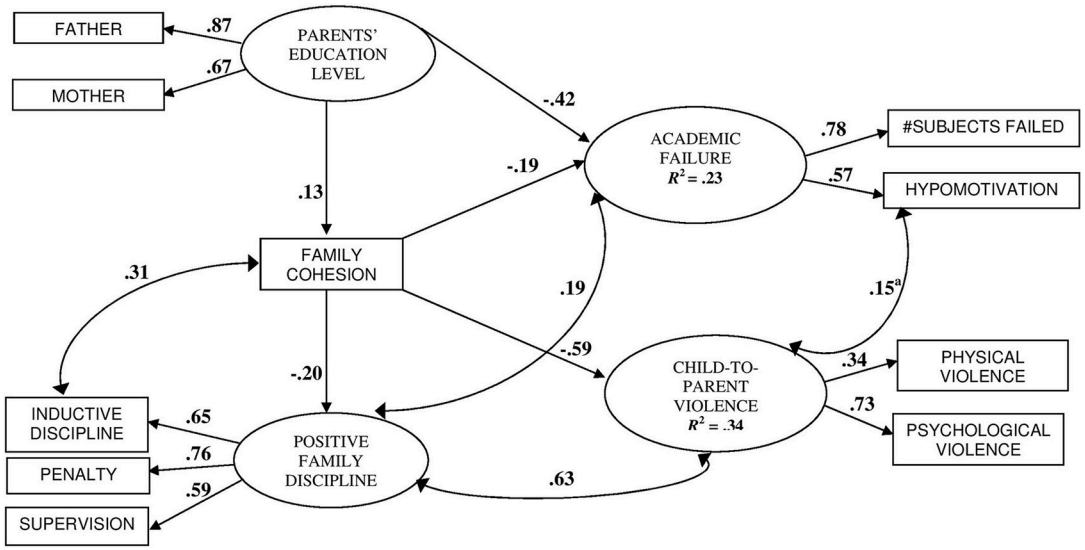


FIGURE 1 | Structural model predicting academic failure and child-to-parent violence. Goodness of fit: $N = 584$; *ML* $\chi^2_{(27)} = 60.68$; *CFI* = 0.98; *NNFI* = 0.96; *IFI* = 0.98; *RMSEA* = 0.038. All factor loadings, regression coefficients and correlations are significant, $p < 0.01$, except[a] $= p < 0.05$.

With regard to the third hypothesis, the results of this study confirm that children from one-parent-families or step-families show higher rates of academic failure than those living in nuclear families. This result is in line with the findings of previous studies (e.g., Córdoba et al., 2011). It was also observed that parents' divorce is related to poor academic self-concept (Orgilés et al., 2012). Fernández et al. (2010) suggest that marital separation processes are associated with at least four factors of family life which in turn can be associated with poorer school results: (1) lack of one parent, (2) parents with traumatic experiences, (3) economic impoverishment linked to dissolution of the marital relationship, and (4) other sources of instability in family life. Parental separation is associated to low psychosocial well-being of children, and it could explain their lower academic performance (Potter, 2010). However, if family give their children sufficient support or caring in the educational context they could have academic success.

The fourth hypothesis was partially fulfilled respect to direct effect of school failure on child-to-parent violence, because the academic failure predicted physical child-to-parent violence. This result is consistent with the study by Ibabe (2014) in which school maladjustment was not correlated with psychological child-to-parent violence, otherwise that physical, emotional and financial violence against parents. The positive association between physical child-to-parent violence and academic failure could be explained because both are indicators of children maladjustment. Adolescents who behave disruptively at home exhibit also behavior problems in school context. For example, disruptive behavior at school is an important predictor for aggression by adolescents toward their mothers (Pagani et al., 2004). In a study by Ibabe et al. (2013) was confirmed the importance of family environment over school environment for antisocial and violent behavior in adolescents. Taking into account the magnitude of relationship found in different studies, it seems that school maladjustment rather than academic failure is associated with child-to-parent violence.

As it was hypothesized school failure had indirect effects on child-to-parent violence through family cohesion. In this study school failure predicted low family cohesion and at the same time low family cohesion was a predictor of child-to-parent violence. This means that school failure has indirect effects on child-to-parent violence. On the one hand, school performance can be a social stressor for families producing family conflict and low cohesion, because it is associated with the parents' expectations about the children's scholastic achievements and prospective aspirations (Hurrelmann et al., 1988). On the other hand, family cohesion was a significant protective factor of child-to-parent violence. It is well-known that when there is negative environment in families, as indicated by having family conflict, marital violence, or parent-to-child violence, will be more probably that children use violence against parents, as indicated some previous studies (Gámez-Guadix and Calvete, 2012; Jaureguizar et al., 2013; Ibabe, 2015; Contreras and Cano, 2016).

In summary, this study highlights the effects of family context on academic achievement in adolescence, with parental education level to the fore. When students have difficulties to reach the teaching goals and they are characterized by behavioral problems as child-to-parent violence. Implications for professional in schools would be the focus on courses for parents in order to generate appropriate learning environments at home, and on the improvement of parent-child relationships. When parental education level is low, educational programs should be designed at the community level to target students with a view to improving their habits relating to studying, eating, and leisure activities (Córdoba et al., 2011).

The most important limitation of this study is that, as is the case in cross-sectional studies, the direction of causality

cannot be established. Moreover, there is a risk that participants' motivation to respond may be affected by social desirability, so that they may overestimate their parental education level or their own academic achievement and study motivation, as socially acceptable features. Finally, all variables were based on children's self-reports.

AUTHOR CONTRIBUTIONS

II makes substantial contributions to conception and design of the work, and/or acquisition of data, and/or analysis and interpretation of data; Drafting the work or revising it critically for important intellectual content; Final approval of the version to be published; and Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

ACKNOWLEDGMENTS

This research was supported by a grant from the Basque Country Government (Spain) M115/10.

REFERENCES

Arbuckle, J. L. (1996). "Full information estimation in the presence of incomplete data," in *Advanced Structural Equation Modeling: Issues and Techniques*, eds G. A. Marcoulides and R. E. Schumacker (Mahwah, NJ: Lawrence Erlbaum Associates), 243–277.

Barber, B. K., and Olsen, J. A. (2004). Assessing the transitions to middle and high school. *J. Adolesc. Res.* 19, 3–30. doi: 10.1177/0743558403258113

Baumrind, D. (1991). "Parenting styles and adolescent development," in *The Encyclopedia of Adolescence*, eds J. Brooks-Gun, R. Lerner, and A. C. Petersen (New York, NY: Garland), 746–758.

Bentler, P. M. (2006). *EQS 6 Structural Equations Program Manual*. Encino, CA: Multivariate Software, Inc.

Beyers, W., and Goossens, L. (1999). Emotional autonomy, psychosocial adjustment and parenting: interactions, moderating and mediating effects. *J. Adolesc.* 22, 753–769. doi: 10.1006/jado.1999.0268

Blondal, K. S., and Adalbjarnardottir, S. (2009). Parenting practices and school dropout: a longitudinal study. *Adolescence* 44, 729–749.

Calvete, E., Gámez-Guadix, M., and Orue, I. (2010). El Inventario de Dimensiones de Disciplina (DDI), versión niños y adolescentes: estudio de las prácticas de disciplina parental desde una perspectiva de género [The Dimensions of Discipline Inventory (DDI)-child and adolescent version: analysis of the parental discipline from a gender perspective]. *Anal. Psicol.* 26, 410–418.

Calvete, E., Gámez-Guadix, M., and Orue, I. (2014a). Características familiares asociadas a las agresiones ejercidas por adolescentes contra sus progenitores [Family characteristics associated with child-toparent aggression in adolescents]. *Anal. Psicol.* 30, 754–771. doi: 10.6018/analesps.30.3.166291

Calvete, E., Orue, I., Bertino, L., Gonzalez-Díez, Z., Montes, Y., Padilla, P., et al. (2014b). Child-to-parent violence in adolescents: the perspectives of the parents, children, and professionals in a simple of Spanish focus group participants. *J. Fam. Violence* 29, 343–352. doi: 10.1007/s10896-014-9578-5

Caro, D., McDonald, J. T., and Willms, J. D. (2009). Socio-economic status and academic achievement trajectories from childhood to adolescence. *Can. J. Educ.* 32, 558–590.

Chess, S., and Thomas, A. (1996). *Temperament: Theory and Practice*. New York, NY: Brunner/Mazel.

Collins, W. A., Maccoby, E. E., Steinberg, L., Hetherington, E. M., and Bornstein, M. H. (2000). Contemporary research on parenting. The case for nature and nurture. *Am. Psychol.* 55, 218–232. doi: 10.1037/0003-066X.55.2.218

Contreras, L., and Cano, M. C. (2016). Child-to-parent violence: the role of exposure to violence and its relationship to social-cognitive processing. *Eur. J. Psychol. Appl. Legal Context* 8, 43–50. doi: 10.1016/j.ejpal.2016.03.003

Córdoba, L. G., García, V., Luengo, L. M., Vizuete, M., and Feu, S. (2011). Determinantes socioculturales: su relación con el rendimiento académico en alumnos de Enseñanza Secundaria Obligatoria [Sociocultural factors: their relation with academic performance of compulsory secondary school students]. *Rev. Invest. Educ.* 29, 83–96.

Crosnoe, R., and Wildsmith, E. (2011). Nonmarital fertility, family structure, and the early school achievement of young children from different race/ethnic and immigration groups. *Appl. Dev. Sci.* 15, 156–170. doi: 10.1080/10888691.2011.587721

DeHart, G. B., Sroufe, L. A., and Cooper, R. G. (2004). *Child Development: Its Nature and Course*. New York, NY: McGraw Hill Companies.

Epstein, J. L. (2011). *School, Family, and Community Partnership: Preparing Educators and Improving Schools, 2nd Edn*. Philadelphia, PA: Westview Press.

Estévez, E., and Navarro, J. (2009). "Adolescent aggression towards parents: Factors associated and intervention proposals," in *Handbook of Aggressive Behaviour Research*, eds C. Quin and S. Tawse (New York, NY: Nova), 215–239.

Fernández, J., Mena, L., and Riviere, J. (2010). *Fracaso y Abandono Escolar en España [School Failure Dropout and in Spain]*. Barcelona: Fundación La Caixa.

Gallagher, E. (2008). *Children's Violence to Parents: A Critical Literature Review*. Master thesis. Monash University. Available online at: http://www.eddiegallagher.com.au/Child%20Parent%20Violence%20Masters%20Thesis%20Gallagher%202008.pdf

Gámez-Guadix, M., and Calvete, E. (2012). Violencia filioparental y su asociación con la exposición a la violencia marital y la agresión de padres a hijos [Child-to-parent violence and its association with exposure to marital violence and parent-to-child Violence]. *Psicothema* 24, 277–283.

García, F., and García, E. (2010). ¿Qué estilo de socialización parental es el idóneo en España? Un estudio con niños y adolescentes de 10 a 14 años? [What is the optimum parental socialisation style in Spain? A study with children and adolescents aged 10–14 years]. *Infancia Aprendizaje* 33, 365–384. doi: 10.1174/021037010792215118

González-Pineda, J. A., and Núñez, J. C. (2005). La implicación de los padres y su incidencia en el rendimiento de los hijos [Parents involvement and its impact on the performance of children]. *Rev. Psicol. Educ.* 1, 115–134.

Goodman, S. H., Lahey, B. B., Fielding, B., Dulcan, M., Narrow, W., and Regier, D. (1997). Representativeness of clinical samples of youths with mental disorders: a preliminary population -based study. *J. Abnorm. Psychol.* 106, 3–14. doi: 10.1037/0021-843x.106.1.3

Halpenny, A. M., Nixon, E., and Watson, D. (2010). Summary Report on Parents' and Children's Perspectives on Parenting Styles and Discipline in Ireland. Dublin: Office of the Minister for Children and Youth Affairs. Available online at: http://arrow.dit.ie/cgi/viewcontent.cgi?article=1016&context=aaschsslrep

Harris, J. R. (1998). *The Nurture Assumption*. Nueva York, NY: Free Press.

Hauser, R. M. (1994). Measuring socioeconomic status in studies of child development. *Child Dev.* 655, 1541–1545. doi: 10.2307/1131279

Heckman, J. J. (2011). The American family in black & white: a post-racial strategy for improving skills to promote equality. *Daedalus* 140, 70–89. doi: 10.1162/daed_a_00078

Hernando, A., Oliva, A., and Pertegal, M. A. (2012). Variables familiares y rendimiento académico en la adolescencia [Family variables and academic achievement in adolescent]. *Estud. Psicol.* 33, 51–65. doi: 10.1174/021093912799803791

Hill, J., and Maughan, B. (eds.). (2001). *Conduct Disorders in Childhood and Adolescence*. Cambridge, UK: Cambridge University Press.

Holden, G. W. (2002). Perspectives on the effects of corporal punishment: comment on Gershoff (2002). *Psychol. Bull.* 128, 590–595. doi: 10.1037//0033-2909.128.4.590

Hotaling, G. T., and Sugarman, D. B. (1986). An analysis of risk markers in husband to wife violence: the current state of knowledge. *Violence Vict.* 1, 101–124.

Hurrelmann, K., Engel, U., Holler, B., and Nordlohne, E. (1988). Failure in school, family conflicts, and psychosomatic disorders in adolescence. *J. Adolesc.* 11, 237–249. doi: 10.1016/S0140-1971(88)80007-1

Ibabe, I. (2014). Direct and indirect effects of family violence on child-to-parent violence. *Estud. Psicol.* 35, 137–167. doi: 10.1080/02109395.2014.893647

Ibabe, I. (2015). Variables familiares asociadas a la violencia filio-parental: el papel de la disciplina familiar [Family predictors of child-to-parent violence: the role of family discipline]. *Anal. Psicol.* 31, 615–625. doi: 10.6018/analesps.31.2.174701

Ibabe, I., Arnoso, A., and Elgorriaga, E. (2014). The European journal of psychology applied to legal context. *Eur. J. Psychol. Appl. Legal Context* 6, 53–61. doi: 10.1016/j.ejpal.2014.06.004

Ibabe, I., and Bentler, P. M. (2015). The contribution of family relationships to child-to-parent violence. *J. Fam. Viol.* 31, 259–269. doi: 10.1007/s10896-015-9764-0

Ibabe, I., and Jaureguizar, J. (2010). Child-to-parent violence: profile of abusive adolescents and their families. *J. Crim. Just.* 38, 616–624. doi: 10.1016/j.jcrimjus.2010.04.034

Ibabe, I., and Jaureguizar, J. (2011). Hasta qué punto la violencia filio-parental es bidireccional? *[To what extent is child-to-parent violence bi-directional?]. Anales de Psicología*, 27, 265–277.

Ibabe, I., Jaureguizar, J., and Bentler, P. M. (2013). Protective factors for adolescent violence against authority. *Spanish J. Psychol.* 16, 1–13. doi: 10.1017/sjp.2013.72

Jackson, D. (1998). "Breaking out of the binary trap: boys' underachievement, schooling and gender relations," in *Flailing Boys? Issues in Gender and Achievement*, eds D. Epstein, J. Elwood, V. Hey, and J. Maw (Buckingham; Philadelphia, PA: Open University Press), 77–95.

Jamshidian, M., and Bentler, P. M. (1998). A quasi-Newton method for minimum trace factor analysis. *J. Stat. Comput. Simul.* 62, 73–89. doi: 10.1080/00949659808811925

Jaureguizar, J., and Ibabe, I. (2012). Conductas violentas de los adolescentes hacia las figuras de autoridad: el papel mediador de las conductas antisociales [Adolescents' violent behaviours toward authority: the mediating effect of antisocial behaviours]. *Rev. Psicol. Soc.* 27, 7–24. doi: 10.1174/021347412798844088

Jaureguizar, J., Ibabe, I., and Straus, M. A. (2013). Violent and prosocial behavior by adolescents toward parents and teachers in a community sample. *Psychol. Sch.* 50, 451–470. doi: 10.1002/pits.21685

Jensen, B. T. (2007). The relationship between Spanish use in the classroom and the mathematics achievement of Spanish-speaking kindergarteners. *J. Latinos Educ.* 6, 267–280. doi: 10.1080/15348430701312909

Kalogridi, E. (1995). School failure–low self-esteem. Juvenile delinquency. *Modern Educ.* 82, 157–161.

Kennair, N., and Mellor, D. (2007). Parent abuse: a review. *Child Psychiatry Hum. Dev.* 38, 203–219. doi: 10.1007/s10578-007-0061-x

Kennedy, T. D., Edmonds, W. A., Dann, K. T. J., and Burnett, K. F. (2010). The clinical and adaptive features of young offenders of child–parent violence. *J. Fam. Violence* 25, 509–520. doi: 10.1007/s10896-010-9312-x

Lei, M., and Lomax, R. G. (2005). The effect of varying degrees of nonnormality in structural equation modeling. *Struct. Equat. Model.* 12, 1–27. doi: 10.1207/s15328007sem1201_1

Li-Grining, C. P. (2007). Effortful control among low-income preschoolers in three cities: stability, change, and individual differences. *Dev. Psychol.* 43, 208–221. doi: 10.1037/0012-1649.43.1.208

Loe, I. M., and Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *J. Pediatr. Psychol.* 32, 643–654. doi: 10.1093/jpepsy/jsl054

Loeber, R., Wung, P., Keenan, K., Giroux, B., Stouthamer–Loeber, M., Van Kammen, W. B., et al. (1993). Developmental pathways in disruptive child behavior. *Dev. Psychopathol.* 5, 103–133. doi: 10.1017/S0954579400004296

Lucio, R., Hunt, E., and Bornovalova, M. (2012). Identifying the necessary and sufficient number of risks in predicting academic failure. *Dev. Psychol.* 48, 422–428. doi: 10.1037/a0025939

MacCallum, R. C., Browne, M. W., and Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychol. Methods* 1, 130–149. doi: 10.1037/1082-989X.1.2.130

Maccoby, E. E., and Martin, J. A. (1983). "Socialization in the context of the family: parent–child interaction," in *Handbook of Child Psychology*, Vol. 4, ed P. H. Mussen (New York, NY: Wiley), 1–101.

Mapp, K. (2004). "Family engagement," in *Helping Students Graduate: A Strategic Approach to Dropout Prevention*, eds F. P. Schargel and J. Smink (Larchmont, NY: Eye on Education), 99–113.

Marchant, G. J., Paulson, S. E., and Rothlisberg, B. A. (2001). Relations of middle school students' perceptions of family and school contexts with academic achievement. *Psychol. Sch.* 38, 505–519. doi: 10.1002/pits.1039

Moos, R., and Moos, B. (1981). *Family Environment Scale. Manual*. Palo Alto, CA: Consulting Psychologist Press.

Moreno, D., Estévez, E., Murgui, S., and Musitu, G. (2009). Relación entre el clima familiar y el clima escolar: el rol de la empatía, la actitud hacia la autoridad y la conducta violenta en la adolescencia [Relationship between family and school environments: The role of empathy, attitude to authority and violent behavior in adolescence]. *Int. J. Psychol. Psychol. Ther.* 9, 123–136.

Musitu, G., and García, J. F. (2004). Consecuencias de la socialización familiar en la cultura española [Consequences of the family socialization in the Spanish culture]. *Psicothema* 16, 288–293.

Netemeyer, R. (2001). Measurement. *J. Consumer Psychol.* 10, 55–69. doi: 10.1207/S15327663JCP1001&2_05

Niepel, C., Brunner, M., and Preckel, F. (2014). The longitudinal interplay of students' academic self-concepts and achievements within and across domains: replicating and extending the reciprocal internal/external frame of reference model. *J. Educ. Psychol.* 106, 1170–1191. doi: 10.1037/a0036307

Nunnally, J. C. (1978). *Psychometric Theory*. New York, NY: Mc-Graw-Hill; Oaks, CA: Sage.

Oliva, A., Parra, A., and Arranz, E. (2008). Estilos relacionales parentales y ajuste adolescente [Parenting styles and adolescent adjustment]. *Infancia Aprendizaje* 31, 93–106. doi: 10.1174/021037008783487093

Organisation for Economic Co-operation and Development (2011). *Overcoming School Failure: Policies that Work Spanish National Report*. Gobierno de España. Ministerio de Educación. Available online at: http://www.oecd.org/spain/48631820.pdf

Organisation for Economic Co-operation and Development (2012). *Equity and Quality in Education: Supporting Disadvantaged Students and Schools.* Paris: OECD Publishing.

Orgilés, M., Johnson, B. T., Huedo-Medina, and Espada, J. P. (2012). Autoconcepto y ansiedad social como variables predictoras del rendimiento académico de los adolescentes con padres divorciados [Self-concept and social anxiety as predictor variables of academic performance of Spanish adolescents with divorced parents]. *Electron. J. Res. Educ. Psychol.* 1, 057–072.

Osonwa, O. K., Adejobi, A. O., Iyam, M. A., and Osonwa, R. H. (2013). Economic status of parents, a determinant on academic performance of senior secondary schools students in Ibadan, Nigeria. *J. Educ. Soc. Res.* 3, 115–122. doi: 10.5901/jesr.2013.v3n1p115

Pagani, L. S., Tremblay, R. E., Nagin, D., Zoccolillo, M., Vitaro, M., and Mcduff, P. (2004). Risk factor models for adolescent verbal and physical aggression toward mothers. *Int. J. Behav. Dev.* 28, 528–537. doi: 10.1080/01650250444000243

Paulson, M. J., Coombs, R. H., and Landsverk, J. (1990). Youth who physically assault their parents. *J. Fam. Violence* 5, 121–133. doi: 10.1007/BF00978515

Paulson, S. E. (1994). Relations of parenting style and parental involvement with ninth grade students' achievement. *J. Early Adolesc.* 14, 250–267. doi: 10.1177/027243169401400208

Potter, D. (2010). Psychosocial well-being and the relationship between divorce and children's academic performance. *J. Marriage Family* 72, 933–946. doi: 10.1111/j.1741-3737.2010.00740.x

Rodríguez-Fernández, A., Droguett, L., and Revuelta, L. (2012). School and personal adjustment in adolescence: the role of academic self-concept and perceived social support. *Rev. Psicodidáctica* 17, 397–414. doi: 10.1387/RevPsicodidact.3002

Shavit, Y., and Blossfeld, H. P. (1993). "Persisting barriers: changes in educational opportunities in thirteen countries," in *Persisting Inequality*, eds H. P. Blossfeld and Y. Shavit (Boulder, CO: Westview Press), 1–23.

Sibley, E., and Dearing, E. (2014). Family educational involvement and child achievement in early elementary school for American-born and immigrant families. *Psychol. Sch.* 51, 814–831. doi: 10.1002/pits.21784

Sirin, S. R. (2005). Socioeconomic status and academic achievement: a meta-analytic review of research. *Rev. Educ. Res.* 75, 417–453. doi: 10.3102/00346543075003417

Spera, C. (2005). A review of the relationship among parenting practices, parenting styles, and adolescent school achievement. *Educ. Psychol. Rev.* 17, 125–146. doi: 10.1007/s10648-005-3950-1

Steinberg, L., and Silk, J. S. (2002). "Parenting adolescents," in *Handbook of Parenting. Vol. I. Children and Parenting*, ed I. Bornstein (Mahwah, NJ: Erlbaum), 103–134.

Stillwell, R. (2009). *Public School Graduates and Dropouts from the Common Core of Data: School Year 2006–2007. (NCES 2010–313)*. Washington, DC: U.S. Department of Education, National Center for Educational Statistics, Institute for Educational Sciences.

Straus, M. A., and Fauchier, A. (2007). *Manual for the Dimensions of Discipline Inventory (DDI)*. Durham, NH: Family Research Laboratory, University of New Hampshire.

Straus, M. A., Hamby, S. L., Finkelhor, D., Moore, D. W., and Runyan, D. (1998). Identification of child maltreatment with the parent-child conflict tactics scales: development and psychometric data for a national sample of American parents. *Child Abuse Neglect* 22, 249–270. doi: 10.1016/S0145-2134(97)00174-9

Strayhorn, T. L. (2010). When race and gender collide: social and cultural capital's influence on the academic achievement of African American and Latino males. *Rev. Higher Educ.* 33, 307–332. doi: 10.1353/rhe.0.0147

TEA Ediciones (1984). *Escalas de Clima Social: Familia, Trabajo, Instituciones Penitenciarias, Centro Escolar [Social Environment Scales: Family, Work, Correctional Institutions and School]*. Madrid: TEA.

Unger, D. G., McLeod, L. E., Brown, M. B., and Tressell, P. A. (2000). The role of family support in interparental conflict and adolescent academic achievement. *J. Child Fam. Stud.* 9, 191–202. doi: 10.1023/A:1009419005136

Van Houtte, M. (2004). Why boys achieve less at school than girls: the difference between boys' and girls' academic culture. *Educ. Stud.* 30, 159–173. doi: 10.1080/0305569032000159804

Van Zeijl, J., Mesman, J., Stolk, M. N., Alink, L. R. A., Van Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., et al. (2007). Differentialsusceptibility to discipline: the moderating effects of child temperament on the association between maternal discipline and early childhood externalizing problems. *J. Family Psychol.* 21, 626–636. doi: 10.1037/0893-3200.21.4.626

Weiss, L. H., and Schwarz, J. C. (1996). The relationship between parenting types and older adolescents' personality, academic achievement, adjustment, and substance use. *Child Dev.* 67, 2101–2114. doi: 10.2307/1131612

Yoshikawa, H. (1994). Prevention as cumulative protection: effects of early family support and education on chronic delinquency and its risks. *Psychol. Bull.* 115, 28–54. doi: 10.1037/0033-2909.115.1.28

Yuan, K. H., and Bentler, P. M. (2000). "Three likelihood-based methods for mean and covariance structure analysis with nonnormal missing data," in *Sociological Methodology 2000*, eds M. E. Sobel and M. P. Becker (Washington, DC: American Sociological), 165–200.

Yuan, K.-H., Lambert, P. L., and Fouladi, R. T. (2004). Mardia's multivariate kurtosis with missing data. *Multivariate Behav. Res.* 3, 413–437. doi: 10.1207/S15327906MBR3903_2

Zill, N. (1996). "Family change and student achievement: what we have learned, what it means for schools," in *Family-school links: how do they affect educational outcomes?*, eds A. Booth and J. Dunn (Mahwah, NJ: Lawrence Erlbaum Associates), 139–174.

Conflict of Interest Statement: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Ibabe. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 04 October 2016
doi: 10.3389/fpsyg.2016.01517

Homework Involvement and Academic Achievement of Native and Immigrant Students

Natalia Suárez[1], Bibiana Regueiro[2], Joyce L. Epstein[3], Isabel Piñeiro[2], Sara M. Díaz[1] and Antonio Valle[2]*

[1] Department of Psychology, University of Oviedo, Oviedo, Spain, [2] Department of Developmental and Educational Psychology, University of A Coruña, A Coruña, Spain, [3] Center on School, Family and Community Partnerships, Johns Hopkins University, Baltimore, MD, USA

Homework is a debated issue in society and its relationship with academic achievement has been deeply studied in the last years. Nowadays, schools are multicultural stages in which students from different cultures and ethnicities work together. In this sense, the present study aims to compare homework involvement and academic achievement in a sample of native and immigrant students, as well as to study immigrant students' relationship between homework involvement and Math achievement. The sample included 1328 students, 10–16 years old from Spanish families (85.6%) or immigrant students or students of immigrant origin (14.4%) from South America, Europe, Africa, and Asia. The study was developed considering three informants: elementary and secondary students, their parents and their teachers. Results showed higher involvement in homework in native students than in immigrant. Between immigrants students, those who are more involved in homework have better academic achievement in Math at secondary grades. There weren't found gender differences on homework involvement, but age differences were reported. Immigrant students are less involved in homework at secondary grades that students in elementary grades. The study highlights the relevance of homework involvement in academic achievement in immigrant students.

Keywords: immigrants, homework, homework involvement, quality of homework, academic achievement

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Alejandro Veas, University of Alicante, Spain
Mar Lorenzo Moledo, University of Santiago de Compostela, Spain

****Correspondence:***
Natalia Suárez
suareznatalia@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *12 July 2016*
Accepted: *20 September 2016*
Published: *04 October 2016*

Citation:
Suárez N, Regueiro B, Epstein JL, Piñeiro I, Díaz SM and Valle A (2016) Homework Involvement and Academic Achievement of Native and Immigrant Students. Front. Psychol. 7:1517. doi: 10.3389/fpsyg.2016.01517

INTRODUCTION

Schools are complex places in which students of many races, ethnicities, cultures, religions, and economic conditions work together. They and their families bring many characteristics to school that provide opportunities to enrich student learning every day. The diversity of students is increasing in schools in many countries. In the last decade, immigration has been an important and socially debated issue. Particularly, in the US, more than 40% of all public school students are from diverse cultures, doubling the percentage of 1980s (Hutchins et al., 2012). One in five children in the US has at least one foreign-born parent (Hernandez et al., 2007). In Spain, in the last 20 years, the number of immigrants has increased considerably. In 1998, there were 500,000 people, 1.6% of the total Spanish population. That number has increased to 4.5 million people in 2007, 10% of the total Spanish population (Encuesta Nacional de Inmigrantes, 2007).

At school, as in society, immigrant students live and work side by side with native-born students. Immigration can be a stressful event which brings changes to the family system (Suárez-Orozco and Suárez-Orozco, 2001). Some immigrant families are well educated and their children achieve high levels in school, whereas other families are unfamiliar with schools and educational requirements, and often have children in under-resourced schools. These students tend to experience greater stress in school, and are less likely to graduate from high school or attend and complete college (Cooper et al., 2006).

Some studies have reported that, on average, students from immigrant families lag behind other students in reading, writing, math, science, and other subjects (Bang et al., 2009). However, other researchers have report that there is more diversity in achievement within groups than between groups of immigrant students (De Jong et al., 2000; Cooper and Valentine, 2001). Variations in student achievement may depend on pre-immigration factors, such as family income and parents' education levels (Núñez et al., 2014).

Despite racial or ethnic background, families differ in their beliefs, values, needs, and resources (Trautwein, 2007; Tam, 2009). It is well known that socio-economic status is one of the most important demographic factors related to children's development and learning. Parents who are employed and in higher-paying jobs are more capable of providing the educational resources and support children needs (Bang et al., 2009).

Other variables also affect student success in school. Students' attitude toward schoolwork and homework are associated with achievement. Homework patterns have been extensively studied in students in general, but few studies have examined immigrant students' investments in homework. Their home environments should be taken into account to understand immigrant students' homework behaviors and their parents' involvement in students' homework. This study addresses this gap in knowledge about the homework process with analyses of selected variables regarding homework in native and immigrant boys and girls.

Homework and Academic Achievement

Homework assignments have multiple purposes. Some are instructional but others have behavioral goals. Teachers may assign some homework to enable students to practice specific skills, but they also may aim to help students develop their responsibility, perseverance, and time management (Epstein and Van Voorhis, 2001). Teachers also assign homework to assess the extent to which students have mastered specific skills in order to plan new lessons that will meet students learning levels (Bang et al., 2009; Rodríguez et al., 2014).

Over past few decades, many studies of homework processes have been conducted, mainly to clarify the importance of homework for students' academic achievement (Valle et al., 2015b).

Prior studies have raised several issues that need more attention in new research. We need to better understand such questions as: *What is the relationship between homework and students' academic achievement? Is the quantity of homework completed a good predictor of academic achievement? Are time spent on homework and homework time management important indicators of student learning?* Different studies have reported a variety of results to these questions.

About homework completion, the amount of homework that students complete seems to be positively related to academic achievement (Cooper et al., 1998; Cooper et al., 2001; Cooper et al., 2006; Núñez et al., 2013, 2015). However, there are significant discrepancies about the relationship between time spent on homework and academic achievement. Some studies report positive connections, suggesting the more time spent on homework, the higher students' academic achievement (Cooper, 1989; Walberg, 1991; Cooper and Valentine, 2001; Cooper et al., 2006). Others report that relationship is weak or negative (De Jong et al., 2000; Trautwein et al., 2002, 2006, 2009; Trautwein, 2007; Tam, 2009; Fernández-Alonso et al., 2014). Xu (2007) explained a null relationship by noting that when students spend more time on homework they may not be managing homework efficiently. In fact, students' homework time management also determines the quantity of homework students do from those assigned by their teachers even better that time spent on homework (Regueiro et al., 2014). Recent studies reinforce that finding. Núñez et al. (2013) reported that homework time management was a crucial variable for determining students' academic achievement—more important than the quantity of homework completed or the quantity of time spent doing homework—. Another study showed that the quantity of homework done was associated with better academic results (Núñez et al., 2015).

Students' gender and grade level also have been related to homework involvement as important variables. Most studies confirm that girls are more committed to doing homework than boys (Younger and Warrington, 1996; Xu, 2006, 2007; Núñez et al., 2013). Many studies also confirm that homework is more strongly related to academic achievement in high school than in middle and elementary school (Cooper and Valentine, 2001), but other authors maintain that there are interesting reasons for this relationship. For example, some older students are less engaged (Núñez et al., 2013), persisted less and enjoyed less doing homework than their younger colleagues (Hong et al., 2009). Epstein (2011) contends that the connection of homework and achievement at the high school level is exaggerated because some high school students stop doing homework and because teachers give advanced students more homework to complete.

Most studies of homework have been conducted with samples of native students, who complete their work without having to face the difficulties of attending school in a new country in a new educational system, and without having to learn a new language. Presently, in many countries, native and new immigrant students attend school together. The changing populations of students in schools raise important questions about native and immigrant students' homework behaviors and results of homework for learning outcomes.

Homework and Immigrant Students

It is common, due to challenges related to relocation in a new country that immigrant students lag behind native students in academic achievement. Homework, which can be completed slowly, thoughtfully, and with assistance, can be one way to

close the achievement gap between these groups of students. Homework may provide opportunities for immigrant students to practice and review lessons. Or, homework may disadvantage immigrant students and widen the achievement gap if, due to language difficulties, they are unable to comprehend and complete their assignments (Bang et al., 2009).

Studies of immigrant students' homework experiences are scarce. One of the few studies on the topic reported that individual characteristics such as student interest, engagement, and learning style were the most important factors associated with immigrant students' homework completion (Bang, 2011b). This study also found that some measures of family and school environments also contributed to immigrant students' homework behaviors. For example, students who paid attention in class and followed school rules, recognized that homework would help them perform better in school (Bang et al., 2009), just as native students do (Trautwein, 2007). A study of 9th– 12th grade newcomer immigrant students in the US showed that students who had stronger interest in class and more structured homework environments were more likely to complete their homework than were their less engaged peers (Bang, 2011a). The same study found that students who had received instruction to fully understand their course materials and who attended homework coaching sessions were more likely to do their homework.

These findings echo that of previous research indicating that students who carried out behaviors conducive to academic success were more likely to complete homework than their peers who were less engaged in school (Goslin, 2003; National Research Council, 2004).

Given the links between homework, report card grades, and achievement, it is important to understand the factors that facilitate and impede students' homework completion in order to support immigrant students' academic endeavors (Bang et al., 2011).

A study of a sample of recently arrived immigrants to the US, aged 9–14, highlighted the important role of completing homework on grades and achievement (Bang et al., 2009). The authors reported that completing homework was even more important for predicting grades than students' English language proficiency or teachers' ratings of their understanding and behavior.

Students' gender also may be a significant predictor of homework completion by immigrant students (Xu, 2006; Bang et al., 2009). Bang (2011b) showed that in general girls were more likely than boys to complete homework, in line with findings in native students' samples (Xu, 2006; Núñez et al., 2013; Suárez-Orozco and Qin-Hilliard, 2015).

The Current Study

The few extant studies on homework patterns of immigrant students (Mau and Lynn, 1999; Bang et al., 2009; Bang, 2011a) identify an important agenda but only roughly explored connections of students' homework engagement and academic achievement. These studies did not analyze details of the homework process such as the amount of homework completed, the time spent on homework, and the quality of the homework and its relationship with academic achievement.

The present research has three main objectives: (i) to explore, compare, and contrast homework behaviors of immigrant and native-born students in Spain; (ii) to examine relationships of homework engagement (i.e., amount of homework completed, time spent, time management, and quality of homework completed) and benefit from doing homework with immigrant students' math achievement; (iii) to analyze whether the homework engagement variables and academic achievement are associated with the gender and grade level of immigrant students, as was reported in studies of native student populations.

MATERIALS AND METHODS

Participants

The study involved 1328 students, 10–16 years old ($M = 13.11$, $SD = 1.75$) attending 29 public schools in Spain. The students are from Spanish families ($n = 1137$, 85.6%) or are immigrant students or students of immigrant origin ($n = 192$, 14.4%). The immigrant students came from South America ($n = 127$), Europe ($n = 54$), Africa ($n = 9$), and Asia ($n = 2$).

The sample includes 617 students in the Elementary Grades (i.e., 5th and 6th grade, 487 native, and 130 immigrant students), and 712 students in the Secondary Grades (Compulsory Secondary Education, i.e., grades 1–4, 650 native, 62 immigrant students). The parents of these students also participated as informants as well as one teacher of each class of students.

This study was carried out in accordance with the recommendations of The Declaration of Helsinki. All the subjects gave written informed consent.

Measures

Time spent on homework, homework time management, amount of homework completed, quality of homework done, and *benefit of doing homework*.

To measure these five variables, we used the Homework Survey (e.g., Rosário et al., 2009; Núñez et al., 2013, 2015; Valle et al., 2015a), which is composed of three parts, using three sources of information for some of its variables.

One survey part is answered by students, other survey part by parents and the third one by teachers.

The studied variables had different respondents: students, teachers, and parents were asked about *students' amount of homework done*; students and parents were asked about *students' time spent doing homework* and *students' homework time management*; and teachers were asked about *students' quality of homework done* and *students' benefit of doing homework*.

Amount of homework completed by students (from the total homework assigned by teachers) was collected considering the three agents and was obtained through responses to an items about the amount of homework usually done, using a 5-point Likert-type scale (1 = none, 2 = some, 3 = one half, 4 = almost all, and 5 = all).

Time spent on homework was measured through information provided by parents and students, responding to the item with the general formulation, "How much time do you/the student usually spend on homework?" Response options were: 1 = less

than 30 min, 2 = 30 min to 1 h, 3 = 1 h to an hour and a half, 4 = 1 h and a half to 2 h, and 5 = more than 2 h.

Homework time management was measured through information provided by parents and students, responding to the item with the general formulation, "How do you/the student manage the time normally spent doing homework?" Response options were: 1 = I waste it completely (I am constantly distracted), 2 = I waste it more than I should, 3 = regular, 4 = I manage it pretty well, and 5 = I optimize it completely (I concentrate and until I finish, I don't think about anything else). In case of parents' item, the formulation was the opposite; the item refers to waste of time instead of good time management, "My child wastes time when doing homework".

In addition to these variables, two variables informed by the teacher were considered: *Quality of homework done* and *Benefit of doing homework for the students*. Both variables were responded by teachers. *Quality of homework done* was measured by the item "How does the student do his homework?" Response options were: 1 = Very good, 2 = Good, 3 = Fair, 4 = Poor, and 5 = Very poor.

Benefit of doing homework was measured by the item "Does the student take benefit from doing homework?" Response options were: 1 = Strongly disagree, 2 = Disagree, 3 = Undecided, 4 = Agree, and 5 = Strongly agree.

Academic Achievement. Assessment of academic achievement was obtained through students' report card grades in Mathematics.

Procedure

The data on the students' survey were collected in one class period during regular school hours by external staff, after obtaining the consent of the school directors and the students' teachers. Data on teachers' survey were collected while students were answering their survey in class. Parents' survey was sent to home and brought it back to school when done.

Prior to the administration of the surveys, the participants were informed of the importance of responding sincerely to the items. They were told that their reports were confidential and would be used only for research purposes.

Data Analysis

Taking into account the goals of this study, the data were analyzed with Student's *t*-test for independent samples to determine differences between native-born students and immigrant students, and to analyze gender differences and differences related to the educational stage. The existence or nonexistence of variance homogeneity was taken into account when interpreting the results. For this was taken as reference value "*p*" in the Levene test, which involves taking the existence of equal variances when $p > 0.05$, whereas when $p < 0.05$ is considered that the variances are not equal. Based on this criterion, the value of "*t*" is also selected. We used Pearson correlational analysis to study the relation between homework-related variables and academic achievement in the sample of immigrant students.

RESULTS

Analysis of the Differences between Native and Immigrant Students in the Dependent Variables

Table 1 shows the descriptive statistics on the homework measures for native-born and immigrant students in the full sample of students, parents, and teachers, and on the achievement measures at the elementary and secondary levels.

Amount of homework done (of the assigned homework). The data indicate that, although there were no significant differences between native and immigrant students in their own reports about homework completed, $t(1316) = 0.864$, $p > 0.05$, both the parents and the teachers for the two groups of students reported statistically significant differences on homework completed by the children [parents: $t(144) = 4.150$, $p < 0.001$, $d = 0.58$, medium effect size; teachers: $t(243) = 3.738$, $p < 0.001$, $d = 0.32$, small effect size]. Parents and teachers reported that native-born students completed more homework than did immigrant students. The students' reports were in the same direction, but the differences of native and immigrant students' reports were not significant.

Weekly Homework Time

Native and immigrant students report similar amounts of time spent on homework, but their parents' reports show a different pattern. Parents of native students report that their children spend more time on homework [($t(162) = 3.113$, $p < 0.001$, and $d = 0.35$, small effect size].

Time Management (Use of Time Dedicated to Homework)

As seen in the data provided in **Table 1**, whereas the native students state that they concentrate more on their homework than the immigrants, $t(1313) = 2.340$, $p < 0.05$, and $d = 0.18$, with a small effect size, the parents of the native students indicate that their children waste more time than that indicated by the parents of immigrant children, $t(709) = 1.941$, $p < 0.05$, and $d = 0.18$, with a small effect size.

Quality of Homework Done

The teachers indicate that the quality of the native students' homework is better than that of the immigrant students, $t(1282) = 3.369$, $p < 0.001$, and $d = 0.26$, with a small effect size.

Benefit of Doing Homework

The teachers also think that homework benefits the native students more than the immigrants, $t(250) = 2.992$, $p < 0.01$, and $d = 0.25$, with a small effect size.

Academic Achievement (Students' Grades in Mathematics).

Whereas at the elementary school level, there were no statistically significant differences in mathematical academic achievement between the two groups of students, $t(178) = -1.174$, $p > 0.05$, the groups differed at the Secondary level. Native-born students

TABLE 1 | Descriptive statistics on homework measures for native and immigrant students.

	Group	*N*	*M*	*SD*
Student: *How much homework do you do?*	Native	1127	4.31	0.996
	Immigrant	191	4.25	0.887
Student: *Daily homework time Monday to Friday*	Native	1125	3.06	1.122
	Immigrant	191	2.97	1.147
Student: *When doing homework, I concentrate until I finish*	Native	1125	2.80	1.182
	Immigrant	190	2.59	1.103
Parents: *My child wastes time when doing homework*	Native	662	2.51	1.497
	Immigrant	130	2.23	1.626
Parents: *Daily homework time from Monday to Friday*	Native	661	3.04	1.247
	Immigrant	130	2.58	1.589
Parents: *How much homework do you do?*	Native	664	4.59	0.992
	Immigrant	130	3.91	1.815
Primary Mathematics grade	Native	471	4.09	1.691
	Immigrant	129	4.32	2.050
Secondary Mathematics grade	Native	650	5.71	2.345
	Immigrant	61	4.67	2.014
Teachers: *Does he/she do his/her homework?*	Native	1094	3.94	1.156
	Immigrant	191	3.56	1.328
Teachers: *Does homework benefit him/her?*	Native	1092	3.95	1.171
	Immigrant	191	3.65	1.263
Teachers: *How is his/her homework?*	Native	1093	3.80	1.168
	Immigrant	191	3.49	1.252

had significantly higher math scores than immigrant students, $t(709) = 3.345$, $p < 0.001$, and $d = 0.26$, with a small effect size.

Relation between Homework Engagement and Mathematical Achievement in Immigrant Students

Table 2 shows the correlations among the variables involved in the study for immigrant students.

The results obtained indicated that the amount of homework done positively correlated with academic achievement in mathematics, according to the students, at secondary level ($r = 0.355$, $p < 0.01$, and $d = 0.34$, small effect size) and the teachers, at elementary and secondary levels ($r = 0.267$, $p < 0.05$, and $d = 0.73$, medium effect size). The relation between homework quality and mathematical achievement was also statistically significant, albeit at a lower level ($r = 0.248$, $p = 0.054$, and $d = 0.81$, large effect size). Neither time dedicated to doing homework nor time management had a significant association with immigrant students' mathematical achievement.

In general, there were no significant connections of gender and any homework-related variables or math achievement.

In terms of parents' reports, they are more consistent with teachers' reports than with their own students' reports. Parents' and students' reports are only consistent regarding time spent on homework ($r = 0.300$ and $p < 0.01$). But, parents' *homework time* report and *amount of homework done* report are strongly associated with all teachers' reports (*amount of homework done*, *quality of homework*, and *benefit from homework*).

Gender and Educational Stage Differences in Immigrant Students' Homework Engagement

Results obtained after performing the corresponding analysis of differences (through Student's *t*) showed that the gender of the immigrant students was not significantly associated with any of the dependent variables.

Table 3 presents data on immigrant students' homework behaviors by educational level: elementary grades (5th and 6th) and secondary grades (1st to 4th grade of Compulsory Secondary Education).

Students and teachers informed of a greater amount of homework done in Primary compared to Secondary Education [students: $t(189) = 4.429$, $p < 0.001$, and $d = 1$, large effect size; teachers: $t(189) = 2.202$, $p < 0.05$, and $d = 0.34$, small effect size], although the parents indicated that the differences favor Secondary Education, $t(31) = -2.031$, $p = 0.051$, and $d = 0.33$, with a small effect size. Likewise, students and parents informed of statistically significant differences in homework time optimization [students: $t(188) = -5.148$, $p < 0.001$, and $d = 0.81$, large effect size; parents: $t(128) = -2.441$, $p < 0.05$, and $d = 0.69$, medium effect size] but in the opposite direction: whereas secondary students believed they make better use of their time, their parents thought they waste time the most. Lastly, the teachers thought that, although there were no statistically significant differences with regard to quality by educational stage, doing homework benefits Primary students more, $t(189) = 2.425$, $p < 0.05$, and $d = 0.38$, with a small effect size.

TABLE 2 | Matrix Zero-order correlations of the variables of the study from immigrant students.

	Gender	Stage/ Level	Student V1	Student V2	Student V3	Parents V1	Parents V2	Parents V3	Teacher V1	Teacher V2	Teacher V3	AMP	AMS
Gender	1												
Stage	0.025	1											
Student_V1	−0.013	−0.417**	1										
Student_V2	0.121	−0.093	0.158*	1									
Student_V3	0.019	0.292**	−0.244**	−0.016	1								
Parents_V1	−0.072	0.139	0.025	0.024	0.06	1							
Parents_V2	0.003	0.082	0.102	0.300**	−0.054	0.524**	1						
Parents_V3	−0.029	0.109	0.145	0.031	−0.087	0.533**	0.704**	1					
Teachers_V1	0.031	−0.190**	0.323**	0.112	−0.115	0.021	0.357**	0.457**	1				
Teachers_V2	0.062	−0.176*	0.299**	0.094	−0.101	0.097	0.343**	0.437**	0.743**	1			
Teachers_V3	0.014	−0.070	0.258**	0.136	−0.127	0.083	0.320**	0.413**	0.831**	0.787**	1		
AMP	0.009	−0.017	0.167	0.054	−0.162	−0.258**	−0.133	−0.139	0.323**	0.195*	0.371**	1	
AMS	−0.024	−0.180	0.355**	0.100	0.041	0.224	0.243	0.442	0.267*	0.21	0.248	a	1

*The sizes of the correlations are not directly comparable because the sample sizes are different in many cases. Gender (1 = Male, 2 = Female); Stage (1 = Elementary, 2 = Secondary); Student_V1 (amount of homework done, informed by students); Student_V2 (homework time, informed by students); Student_V3 (time management, informed by students); Parents_V1 (waste of time, informed by parents); Parents_V2 (homework time, informed by parents); Parents_V3 (amount of homework done, informed by parents); Teachers_V1 (amount of homework done, informed by teachers); Teachers_V2 (benefit from homework, informed by teachers); Teachers_V3 (quality of homework done, informed by teachers); AMP (academic achievement in mathematics in Elementary Education); AMS (academic achievement in mathematics in Secondary Education). N = 192. **p < 0.01 and *p < 0.05.*

[a]*Correlation between AMP and AMS is not studied because there are two different samples (secondary and elementary students).*

TABLE 3 | Descriptive statistics by school level (elementary/secondary) for immigrant students.

	School Level	*N*	*M*	*SD*
Student: Amount of homework done	Elementary	129	4.43	0.748
	Secondary	62	3.85	1.022
Student: Weekly homework time	Elementary	129	3.01	1.169
	Secondary	62	2.89	1.103
Student: Time management	Primary	128	2.32	1.057
	Secondary	62	3.15	0.989
Parents: Waste of time	Primary	116	2.11	1.592
	Secondary	14	3.21	1.626
Parents: Weekly homework time	Primary	116	2.53	1.618
	Secondary	14	3.00	1.301
Parents: Amount of homework done	Primary	116	3.84	1.891
	Secondary	14	4.43	0.852
Teachers: Amount of homework done	Primary	129	3.71	1.325
	Secondary	62	3.26	1.292
Teachers: Benefit obtained	Primary	129	3.81	1.269
	Secondary	62	3.34	1.200
Teachers: Quality of homework	Primary	129	3.53	1.293
	Secondary	62	3.42	1.167

DISCUSSION

The main goal of this research was to shed some light on the influence of doing homework on the academic achievement of immigrant students in Spain.

The study aimed to extend general patterns of the value of homework reported in prior investigations (Mau and Lynn, 1999; Bang et al., 2009; Bang, 2011a). The study also benefited from unique data on homework behaviors from native and immigrant students in Spanish elementary and secondary grades.

General findings highlight that:

1. When comparing native and immigrant student, the full sample in this study indicated that on all measure of homework (time, time management, and homework done) and on Math achievement, student, parent, and teacher mean scores were slightly higher for native students than for immigrant students.
2. When focusing only on immigrant students, all homework measures from all reporters (immigrant students, parents, and their teachers) were positive correlated with student achievement at the secondary level. In particular, there were significant correlations of math achievement with student and teacher reports about the immigrant students' homework completion.
3. These results suggest that among immigrant students, those who take the role of student seriously and do their homework have higher math achievement than immigrant students who do not complete their assignments. Independent reports from students and from teachers indicate that doing homework benefits immigrant students, much as prior studies report doing homework benefits other students (mainly native students in prior studies).
4. There were no significant patterns of gender differences among immigrant students on these measures.
5. Statistically significant differences were found as a function of grade in immigrant students (**Table 3**). As they progress through the grades, older immigrant students report lower mean scores for the amount of homework done, time on homework, and time management while doing homework. Teachers report similar patterns that immigrant students

at the secondary level do less homework, do lower quality work, and benefit less from homework than do students at the elementary level.

This study contributed new ideas for studies of the homework patterns of immigrant students of Spain or other countries. It was possible, then to contrast patterns of homework behavior for native-born and immigrant students, and then, within the immigrant student sample, the implications of doing homework on student achievement.

Summing up, this study strongly suggests that doing homework is beneficial for immigrant students, although, presently, they involve less in homework and lag on achievement compared to native-born students.

The data were particularly interesting because they included reports from students, parents, and teachers about immigrant students' homework behaviors, and included other useful data on students' Math achievement. Parents' reports differenced from student and teacher reports about students at the elementary and secondary levels. Parents reported that they observed that their secondary students spent more time, and completed more homework than students in the elementary grades, but secondary students waste more the time spent on homework that elementary students. Students and teachers disagree and they consider elementary students do more homework and spend more time than secondary students but their time management is worse than in higher levels. Other studies considered that secondary students were less engaged and enjoyed less doing homework (Hong et al., 2009; Núñez et al., 2013) where the informants were the students.

Results indicated that there were no significant differences of immigrant male and female students on the detailed homework variables. These results contrast with prior studies of both native (Núñez et al., 2015) and immigrant populations (Trautwein, 2007; Bang, 2011a), that typically indicate that female students do more and better on homework. Future studies with larger populations of immigrant groups may reveal clearer patterns of homework behavior of male and female students. There may be some clues about this, as noted by Bang et al. (2011). For example, immigrant families may have fewer financial resources, and may demand more help from their children with housework, such as caring for younger siblings. This may leave students with less time for doing homework, or reduce girls' advantages in doing more school work and make their patterns of homework similar to boys.

Limitations and Future Research

There still were some inconsistent results of this study that will need attention in future research. In particular, larger samples of immigrant students at specific grade levels are needed. Information also is needed on how long the students have been in a country so that researchers can account for those who are becoming assimilated compared to those whose families have been settled for several generations.

Several variables have been pointed out that can affect student engagement in school and on homework. These include: mastery of the language (Bang et al., 2011); the culture of origin (Keith et al., 1998; Mau and Lynn, 1999); the help offered by the parents (Sibley and Dearing, 2014; Núñez et al., 2015; Madjar et al., 2016); the feedback given by the teacher (Núñez et al., 2014; Rosário et al., 2015).

Also, the type of homework assigned to the students should also be examined, because not every kind of homework is equally effective for improving subject specific academic achievement.

In this study, the data were exploratory due to the size and composition of the immigrant student sample. Future studies with larger and more coherent samples of students from the same continent or country of origin will be able to establish a predictive model to isolate the independent effects and mediating effects of particular background, grade level, and homework variables on student achievement.

AUTHOR CONTRIBUTIONS

All authors have contributed to this study, collecting the sample, doing the data analysis and writing and discussing the results.

FUNDING

This work has been funded by the research project EDU2013-44062-P, of the National Plan of Scientific and Technical Research and Innovation 2013-2016 (MINECO) and by the financing received by one of the co-authors in the FPU program of the Ministry of Education, Culture, and Sport of Spain. The study was also done in collaboration with JE as a result of the funding received by two of the co-authors (NS and BR) from Spanish Government to spend several months in the Center on School, Family and Community Partnerships at Johns Hopkins University in Baltimore.

REFERENCES

Bang, H. J. (2011a). Newcomer immigrant students' perspectives on what affects their homework experiences. *J. Educ. Res.* 104, 408–419. doi: 10.1037/a0018201

Bang, H. J. (2011b). What makes it easy or hard for you to do your homework? An account of newcomer immigrant youths' afterschool academic lives. *Curr. Issues Educ.* 14, 1–26.

Bang, H. J., Suárez-Orozco, C., and O'Connor, E. (2011). Immigrant students' homework: ecological perspective on facilitators and impediments to task completion. *Am. J. Educ.* 118, 25–55. doi: 10.1086/662008

Bang, H. J., Suárez-Orozco, C., Pakes, J., and O'Connor, E. (2009). The importance of homework in determining immigrant students' grades in schools in the USA context. *J. Educ. Res.* 51, 1–25. doi: 10.1080/00131880802704624

Cooper, H. (1989). *Homework*. New York, NY: Longman.

Cooper, H., Jackson, K., Nye, B., and Lindsay, J. J. (2001). A model of homework on the performance evaluations of elementary school students. *J. Exp. Educ.* 69:181–199. doi: 10.1080/00220970109600655

Cooper, H., Lindsay, J. J., Nye, B., and Greathouse, S. (1998). Relationships between attitudes about homework, amount of homework assigned and completed, and student achievement. *J. Educ. Psychol.* 90, 70–83. doi: 10.1037/0022-0663.90.1.70

Cooper, H., Robinson, J., and Patall, E. (2006). Does homework improve academic achievement? A synthesis of research, 1987-2003. *Rev. Educ. Res.* 76, 1–62. doi: 10.3102/00346543076001001

Cooper, H., and Valentine, J. C. (2001). Using research to answer practical questions about homework. *Educ. Psychol.* 36, 143–153. doi: 10.1207/S15326985EP3603_1

De Jong, R., Westerhof, K. J., and Creemers, B. P. M. (2000). Homework and student math achievement in junior high schools. *Educ. Res. Eval.* 6, 130–157. doi: 10.1076/1380-3611(200006)6:2;1-E;F130

Encuesta Nacional de Inmigrantes (2007). *Encuesta Nacional de Inmigrantes 2007*. España: Instituto Nacional de Estadística (INE).

Epstein, J. L. (2011). "Homework practices, achievements, and behaviors of elementary school students," in *School, Family, and Community Partnerships: Preparing Educators and Improving Schools*, ed. J. L. Epstein (Boulder, CO: Westview Press).

Epstein, J. L., and Van Voorhis, F. L. (2001). More than minutes: teachers' roles in designing homework. *Educ. Psychol.* 36, 181–193. doi: 10.1207/S15326985EP3603_4

Fernández-Alonso, R., Suárez-Álvarez, J., and Muñiz, J. (2014). Homework and academic performance in mathematics: a multilevel approach with primary school student. *Revista Psicol. Educ.* 9, 15–29.

Goslin, D. A. (2003). *Engaging Minds: Motivation and Learning in America's Schools*. Lanham, MD: Scarecrow Press.

Hernandez, D. J., Denton, N. A., and Macartney, S. E. (2007). *Children in Immigrant Families-the U.S. and 50 States: National Origins, Language, and Early Education*. Albany, NY: Child Trends Center for Social and Demographic Analysis at SUNY.

Hong, E., Peng, Y., and Rowell, L. L. (2009). Homework self-regulation: grade, gender, and achievement-level differences. *Learn. Individ. Differ.* 19, 269–276. doi: 10.1016/j.lindif.2008.11.009

Hutchins, D. J., Greenfeld, M. D., Epstein, J. L., Sanders, M. G., and Galindo, C. L. (2012). *Multicultural Partnerships: Involve All Families*. New York, NY: Library of Congress.

Keith, T. Z., Keith, P. B., Quirk, K. J., Sperduto, J., Santillo, S., and Killings, S. (1998). Longitudinal effects on parent involvement on high school grades: similarities and differences across gender and ethnic groups. *J. School Psychol.* 36, 335–363. doi: 10.1016/S0022-4405(98)00008-9

Madjar, N., Shklar, N., and Moshe, L. (2016). The role of parental attitudes in children's motivation toward homework assignments. *Psychol. Sch.* 53, 173–188. doi: 10.1002/pits.21890

Mau, W., and Lynn, R. (1999). Racial and ethnic differences in motivation for educational achievement in the United States. *Pers. Individ. Dif.* 27, 1091–1096. doi: 10.1016/S0191-8869(99)00051-3

National Research Council (2004). *Engaging Schools: Fostering High School Students' Motivation to Learn*. Washington, DC: National Academies Press.

Núñez, J. C., Suárez, N., Cerezo, R., González-Pienda, J. A., Rosário, P., Mourao, R., et al. (2013). Homework and academic achievement across Spanish Compulsory Education. *Educ. Psychol.* 35, 726–746. doi: 10.1080/01443410.2013.817537

Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Cerezo, R., and Valle, A. (2014). Teachers' feedback on homework, homework-related behaviors and academic achievement. *J. Educ. Res.* doi: 10.1080/00220671.2013.878298

Núñez, J. C., Suárez, N., Rosário, P., Vallejo, G., Valle, A., and Epstein, J. L. (2015). Relationships between parental involvement in homework, student homework behaviors, and academic achievement: differences among elementary, junior high, and high school students. *Metacogn. Learn.* 10, 375–406. doi: 10.1007/s11409-015-9135-5

Regueiro, B., Suárez, N., Rodríguez, S., and Piñeiro, I. (2014). Predictor variables of homework involvement on compulsory secondary education students. *Revista Psicol. Educ.* 9, 45–55.

Rodríguez, S., Regueiro, B., Blas, R., Valle, A., Piñeiro, I., and Cerezo, R. (2014). Teacher self-efficacy and its relationship with students' affective and motivational variables in higher education. *Eur. J. Educ. Psychol.* 7, 107–120.

Rosário, P., Mourão, R., Baldaque, M., Nunes, T., Núñez, J. C., González-Pienda, J. A., et al. (2009). Homework, self-regulation of learning and math performance. *Revista Psicodidáctica* 14, 179–192.

Rosário, P., Núñez, J. C., Vallejo, G., Cunha, J., Nunes, T., Suárez, N., et al. (2015). The effects of teachers' homework follow-up practices on students' EFL performance: a randomized-group design. *Front. Psychol.* 6:1528. doi: 10.3389/fpsyg.2015.01528

Sibley, E., and Dearing, E. (2014). Family educational involvement and child achievement in early elementary school for American born and immigrant families. *Psychol. Sch.* 51, 814–831. doi: 10.1002/pits.21784

Suárez-Orozco, C., and Suárez-Orozco, M. M. (2001). *Children of Immigration*. Cambridge, MA: Harvard University Press.

Suárez-Orozco, M. M., and Qin-Hilliard, D. B. (2015). Globalization: culture and education in the New Millenium. *J. Sociol. Soc. Welf.* 32, 159–162.

Tam, V. C. (2009). Homework involvement among Hong Kong primary school students. *Asian Pac. J. Educ.* 29, 213–227. doi: 10.1080/02188790902859004

Trautwein, U. (2007). The homework-achievement relation reconsidered: differentiating homework time, homework frequency, and homework effort. *Learn. Instr.* 17, 372–388. doi: 10.1016/j.learninstruc.2007.02.009

Trautwein, U., Köller, O., Schmitz, B., and Baumert, J. (2002). Do homework assignments enhance achievement? A multilevel analysis in 7th grade mathematics. *Contemp. Educ. Psychol.* 27, 26–50. doi: 10.1006/ceps.2001.1084

Trautwein, U., Lüdtke, O., Schnyder, I., and Niggli, A. (2006). Predicting homework effort: support for a domain-specific, multilevel homework model. *J. Educ. Psychol.* 98, 438–456. doi: 10.1037/0022-0663.98.2.438

Trautwein, U., Schnyder, I., Niggli, A., Neumann, M., and Lüdtke, O. (2009). Chameleon effects in homework research: the homework–achievement association depends on the measures used and the level of analysis chosen. *Contemp. Educ. Psychol.* 34, 77–88. doi: 10.1016/j.cedpsych.2008.09.001

Valle, A., Pan, I., Núñez, J. C., Rosário, P., Rodríguez, S., and Regueiro, B. (2015a). Deberes escolares y rendimiento académico en Educación. *Anales Psicol.* 31, 562–569. doi: 10.6018/analesps.31.2.171131

Valle, A., Regueiro, B., Estévez, I., Piñeiro, I., Rodríguez, S., and Freire, C. (2015b). Implicación y motivación hacia los deberes escolares en los estudiantes de Primaria según el rendimiento académico y el curso. *Eur. J. Investig. Health Psychol. Educ.* 5, 345–355.

Walberg, H. J. (1991). Does homework help? *Sch. Community J.* 1, 13–15.

Xu, J. (2006). Gender and homework management reportd by high school students. *Educ. Psychol.* 26, 73–91. doi: 10.1080/01443410500341023

Xu, J. (2007). Middle-school homework management: more than just gender and family involvement. *Educ. Psychol.* 27, 173–189. doi: 10.1080/01443410601066669

Younger, M., and Warrington, M. (1996). Differential achievement of girls and boys at GCSE: some observations from the perspective of one school. *Br. J. Sociol. Educ.* 17, 299–313. doi: 10.1080/0142569960170304

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Suárez, Regueiro, Epstein, Piñeiro, Díaz and Valle. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 27 September 2016
doi: 10.3389/fpsyg.2016.01438

Differences in Learning Strategies, Goal Orientations, and Self-Concept between Overachieving, Normal-Achieving, and Underachieving Secondary Students

*Juan L. Castejón *, Raquel Gilar, Alejandro Veas and Pablo Miñano*

Department of Developmental Psychology and Didactic, University of Alicante, Alicante, Spain

The aims of this work were to identify and establish differential characteristics in learning strategies, goal orientations, and self-concept between overachieving, normal-achieving and underachieving secondary students. A total of 1400 Spanish first and second year high school students from the South-East geographical area participated in this study. Three groups of students were established: a group with underachieving students, a group with a normal level of achievement, and a third group with overachieving students. The students were assigned to each group depending on the residual punctuations obtained from a multiple regression analysis in which the punctuation of an IQ test was the predictor and a measure composed of the school grades of nine subjects was the criteria. The results of one-way ANOVA and the Games-Howell *post-hoc* test showed that underachieving students had significantly lower punctuations in all of the measures of learning strategies and learning goals, as well as all of the academic self-concept, personal self-concept, parental relationship, honesty, and personal stability factors. In contrast, overachieving students had higher punctuations than underachieving students in the same variables and higher punctuations than normal-achieving students in most of the variables in which significant differences were detected. These results have clear educational implications.

Keywords: underachievement, overachievement, identification, individual variables, differential characteristics

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Carbonero Martín Miguel Angel, University of Valladolid, Spain
Olivia López Martínez, University of Murcia, Spain

****Correspondence:***
Juan L. Castejón
jl.castejon@ua.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *21 June 2016*
Accepted: *08 September 2016*
Published: *27 September 2016*

Citation:
Castejón JL, Gilar R, Veas A and Miñano P (2016) Differences in Learning Strategies, Goal Orientations, and Self-Concept between Overachieving, Normal-Achieving, and Underachieving Secondary Students. Front. Psychol. 7:1438. doi: 10.3389/fpsyg.2016.01438

INTRODUCTION

No definition for underachievement has been accepted by the entire scientific community (McCoach and Siegle, 2011). In the scientific literature, there is general agreement that underachievement is a discrepancy between what can be expected and what is actually achieved (McCoach and Siegle, 2003b, 2011). However, there has been a diversification of assumptions, as regarding studies related to the operationalization of the concept (Ziegler et al., 2012), the possible inclusion of students with learning disabilities into the underachievement framework (Fletcher et al., 2005) and the analysis of underachieving students with emotional and behavior disorders (Lane et al., 2002).

Given the multiple and specific conceptions of the construct, underachievement is a multidimensional construct that involves several variables. Analyses of these variables have been

focused on underachieving gifted students (Chan, 1999; Ziegler and Stoeger, 2003; Dixon et al., 2006; Obergriesser and Stoeger, 2015), especially in the United States (Reis and McCoach, 2000; McCoach and Siegle, 2003a; Figg et al., 2012; Reis and Greene, 2014); however, the authors of the present work, in agreement with Dittrich (2014), support the assertion that underachievement is not reserved to gifted students but to all students situated at various intelligence levels, as they are also influenced by personal factors, family-related factors, and school-related factors. The treatment of these factors through educational interventions could lead to a better self-concept and academic achievement (Rodríguez et al., 2014; Álvarez et al., 2015; Veas et al., 2015).

The identification of underachieving students emerges as the principal basis to define its differential characteristics and to reverse the intervention. From a methodological perspective, the traditional statistical methods include the *absolute split method*, the *simple difference method* and the *regression method* (Lau and Chan, 2001; McCoach and Siegle, 2011).

When using the absolute split method, the researcher uses an arbitrary limit for the highest academic performance (e.g., top 5%) and the bottom academic performance (e.g., bottom 5%) after the conversion of punctuations to standard scores. This method has been used specifically in studies on gifted underachieving students (Peterson and Colangelo, 1996; Vlahovic-Stetic et al., 1999).

The simple difference score method is based on the discrepancy between the standardized performance score and the standardized ability score. When this difference is greater than an arbitrary limit (normally 1 standard deviation), a student could be regarded as underachieving ($d < -1$) or overachieving ($d > 1$). According to Lau and Chan (2001), this method is more appropriate than the absolute method for the identification of underachievement at all levels of ability. However, some researchers (McCall et al., 1992) have noted that this method may overestimate the number of underachieving students of above-average ability and underestimate the number of underachieving students of below-average ability.

The regression method is one of the most common methods to quantify the discrepancy between ability or expected achievement and actual achievement (Lau and Chan, 2001; McCoach and Siegle, 2011). This method is based on the deviation of the students' score from the regression line of the achievement measure based on the ability measure. Students are considered to be underachieving if this deviation is negative and greater than one standard error of the estimate. This method appears to have better reliability than the method of simple difference scores; however, it also generates a constant proportion of underachieving students (Plewis, 1991; Ziegler et al., 2012). Using this approach, over 15% of students would be identified as underachievers. However, Lau and Chan (2001) found a high degree of congruence among the three statistical methods (absolute split, difference score, and regression-based methods).

Others researchers (Anastasi, 1976; Fletcher et al., 2005; Ziegler et al., 2012) also highlighted ongoing issues of reliability and validity. They argued that underachievement is a latent variable and hence imperfectly measured using test instruments such as tests of intellectual ability and achievement. The assessment of underachievement must take into account problems of test reliability and measurement errors arising out of questions such as assumed normality. Furthermore, these measurement errors are compounded when two or more tests are used concurrently in assessing underachievement (Phillipson, 2008).

Adherence to the requirements of fundamental measurement is needed when using instruments that address underachievement. These measurement requirements include the need for unidimensionality of the measurement instrument and units of measurement that correspond to an interval scale.

When underachievement is defined as the discrepancy between expected achievement and actual achievement, the measurement of academic achievement must also meet the above requirements. There are two primary methods to assess achievement: standardized achievement tests and classroom or academic grades. External evaluations of the Autonomous Communities in Spain evaluate the skills mandated by existing legislation, particularly Constitutional Law 8/2013 on Improving Educational Quality (LOMCE, 2013[1]); however, schools continue to evaluate these skills using other methods and/or measurement instruments (written exams, oral exams, group work, etc.), which in turn are based on the evaluation criteria of regional regulations.

Standardized achievement tests are used to provide objective, reliable, and valid measures with greater use in the field of educational evaluation on a large scale. However, although school grades provide less evidence of reliability than standardized measures of academic achievement, they provide the most valid indication of a student's current level of achievement within a classroom environment, given that they are the closest assessment to the students' actual instruction (McCoach and Siegle, 2011). Using school grades to assess academic achievement also poses several problems, such as a lack of inter-rater reliability or comparability across teachers or schools (Marzano, 2000). The Spanish legal codes on curriculum and specific evaluation criteria do not resolve this question; however, this legal issue could be addressed.

Notably, knowledge of the differential characteristics of underachieving students is the basis to reverse underachievement (Renzulli and Reis, 1997; Chan, 1999, 2005). In the USA and to a lesser extent in China, studies have determined the factors that differentiate underachieving and normal-achieving students, both on the capacity continuum and for higher levels of cognitive ability (Baker et al., 1998; McCoach and Siegle, 2003b; Colangelo et al., 2004).

The scientific literature indicates that the primary reasons for underachievement in the majority of cases are (a) emotional problems (Siegle and McCoach, 2005); (b) difficulties in adapting to school or to the family context (Baker et al., 1998; McCoach and Siegle, 2003a); and (c) personal characteristics, such as low motivation, low self-regulation, or low self-concept (Reis

[1]Ley Orgánica 8/2013, de 9 de diciembre, para la Mejora de la Calidad Educativa [Organic Law 8/2013, from 9 December, for the Improvement of Education Quality]. *Boletín Oficial del Estado (España)*, 10 de diciembre de 2013 (10 December 2013), 295, 97858–97921.

and McCoach, 2000; Peixoto and Almeida, 2010; Dunlosky and Rawson, 2012).

Therefore, the differences between high ability students with high achievement and those with low achievement are explained by personal factors related to the use of self-regulation strategies, learning strategies and study techniques (McCelland et al., 1991; Colangelo et al., 2004).

A minor motivation in underachieving students is reflected in studies implemented both in the USA and China (McCelland et al., 1991; Schick and Phillipson, 2009; Hodis et al., 2011; Dunlosky and Rawson, 2012).

McCoach and Siegle (2003b) found that high ability students with high achievement and those with low achievement differ in their school attitudes and attitudes toward teachers, motivation, self-regulation, and valuation objectives. The last three factors contributed more in explaining the achievement differences between the two groups.

Results are inconsistent with respect to self-concept of underachieving students (Preckel and Brunner, 2015). Several studies report lower academic self-concept in underachieving students compared with non-underachieving students (Rimm, 2003), and gifted underachieving students have a lower general self-concept than non-underachieving students but not a lower academic self-concept (McCoach and Siegle, 2003a,b).

Baker et al. (1998) tested models related to personal, familiar, and scholar factors that explain underachievement in American adolescent students, finding that the model with three factors had a higher explanatory factor. Individual factors related to planning and the use of self-regulation strategies, self-perception of own abilities, and the quality of teacher-student relations were the variables that contributed more to explaining the differences between students with higher and lower achievement.

Therefore, although some of these factors have been identified, systematic studies in the Spanish cultural context are lacking. There are very few works on underachievement despite high failure and dropout rates. In Spain, the percentage of school failure or dropout during 2012–2014 was 23.5% (Eurostat, 2014), which is double the percentage for the European Union (11.9% for the same period). This considerable percentage of students experiencing school failure could be related to underachievement. Estimations of the percentage of underachieving students can vary depending on the socio-cultural context of the students involved. For example, in the USA, Rimm (1987) estimated that 50% of students have low achievement and high potential in Elementary Secondary Education, whereas Colangelo et al. (2004) made a lower estimate of 10% in a sample of high school students. In China, Phillipson (2008) calculated an empirical percentage of underachieving students that moved from 10% in the 50–59 capacity percentile bands (measured with a frequency distribution of the difference between ability and potential) to 32% in the higher 95 percentile bands in Primary Education. In Secondary Education, the percentage of underachieving students reached 53% in those whose capacity was in the higher bands.

Based on the above information and because most of the research on underachievement have been made in gifted underachievers and has not included overachieving students, the objectives of the present work were (1) to identify underachieving, normal-achieving, and overachieving students in Compulsory Secondary Education, (2) to identify the differential characteristics in each group of students based on personal factors, and (3) to analyze the educational implications of these characteristics in each group of students.

METHOD

Ethics Statement

This study was carried out in accordance with the recommendations of Ethics Committee of Alicante University with written informed consent from all subjects.

Participants

The cluster sampling technique was used with the school as the sampling unit. A total of 8 schools in the province of Alicante were included. A total of 1456 students in the first and second years of Compulsory Secondary Education (Educación Secundaria Obligatoria—E.S.O.) participated in the study. Of these, 56 were excluded due to coding errors or a lack of qualifications because they had special education needs or because they did not have parental consent, resulting in a total of 1400 students ($n = 1400$). A total of 53% of the students were male (47% female) with an average age of 12.5 years with a standard deviation of 0.67. A total of 52.4% of the students were from the first grade of E.S.O., and 47.6% were from the second grade of E.S.O. Due to the racial and ethnic homogeneity of the country, the majority of children were Caucasian (98%).

TABLE 1 | Descriptive statistics by gender, grade, and achievement group.

	Gender Frequencies		Grade/Year Frequencies		Total Freq.	Mean IQ	Mean Grades
	Boys	Girls	First	Second			
Underachieving	137	81	127	91	218	101.78	4.30
Normal-achieving	532	437	496	473	969	100.29	6.30
Overachieving	70	143	111	102	213	101.11	8.39
Total	739	661	734	666	1400	100.00	6.30
	$\chi^2 = 44.51$*		$\chi^2 = 3.57$		$F = 1.06$	$F = 541.0$*	

*$p < 0.001$.

Childhood socioeconomic status (SES) was indexed according to parental occupation. There was a wide range of socioeconomic status with a predominance of middle class children. This classification was based on the level of incomes and the level of studies of the families. The regional education counselors determined the childhood socioeconomic statuses (SES) through a questionnaire registered with the responses of the students. The variables used were parents' professions, professional situation, and level of studies, number of books at home, cultural and sporting activities and availability of technological means at home. The Chi-square test was used to determine differences between the gender of the sample (51.2% boys and 48.8% girls) and the gender of the national student population (51.3% boys and 48.7% girls), supporting the absence of gender differences between the sample and population ($\chi^2 = 0.29$, $df = 1$, $p > 0.05$).

Measures

Measures of intelligence, learning strategies, goal orientations, and self-concept were collected during the academic year.

To measure intellectual ability, two tests were used: a general factor test and an aptitude test. Scale 2 of the Factor G test by Cattell (1994) and adapted into Spanish by TEA Ediciones was used to measure general and abstract intelligence. This scale produces an intelligence quotient (IQ) that measures general fluid intelligence. The reliability, obtained using the two-halves method and corrected with the Spearman-Brown formula, was 0.78 in first-year participants and 0.70 in second-year participants.

The other intelligences test used was the Battery of Differential and General Abilities (BADyG, Yuste et al., 2005). This Spanish battery measures the capacities and academic abilities of students. There are six subscales: Analogies (A), Series (S), Matrices (M), Completing sentences (C), Numerical Problems (P), and Figures Fit (E). Each subscale is measured with 32 items with five response options; only one option is correct, producing a total of 192 items. For this study, Cronbach's alpha values for each subscale were 0.83, 0.89, 0.79, 0.83, 0.77, and 0.87, respectively. Furthermore, a general intelligence quotient (IQ) could be obtained based on the punctuations from the distinct differential skills. The Cronbach's alpha of the total IQ was 0.83.

To measure learning strategies, we used the CEA *[Learning Strategies Questionnaire]* produced by Beltrán et al. (2006). The test evaluates four large strategies (Sensitization, Elaboration of information, Personalization, and Meta-cognitive strategies), from which only the last three were used in this study, as the sensitization scale refers to motivational and attitude-related aspects. The three scales employed for the evaluation of strategies include some subscales. The Elaboration scale is composed of the selection, organization, and information processing subscales. The Personalization scale includes the Creative and Critic Thinking subscale, the Recovering Information subscale and the Transference subscale. The Metacognition scale is composed of the Planning and Evaluation subscale and the Control and Monitoring Information subscale. To obtain the scores for these scales, students answered a total of 50 items indicating the extent to which each formulated strategy was true on a Likert scale from

TABLE 2 | Descriptive statistics of the punctuations obtained in learning strategies and goal orientations for each group.

Variable	Group	*N*	*M*	*SD*
Selection	1	218	13.01	3.30
	2	969	13.66	3.22
	3	213	14.71	3.07
Organization	1	218	11.62	3.82
	2	969	13.09	3.83
	3	213	13.89	3.59
Elaboration	1	218	28.90	6.44
	2	969	30.78	6.33
	3	213	32.49	5.93
Elaboration scale	1	218	53.54	11.40
	2	969	57.53	11.24
	3	213	61.11	10.14
Creative and critical thinking	1	218	34.25	7.27
	2	969	35.52	7.22
	3	213	37.00	6.80
Recovering information	1	218	12.51	3.20
	2	969	13.31	3.22
	3	213	13.71	3.09
Transference	1	218	20.74	5.36
	2	969	22.26	5.35
	3	213	22.91	5.36
Personalization scale	1	218	67.52	13.59
	2	969	71.11	13.75
	3	213	73.62	13.03
Planning/evaluation	1	218	21.08	5.29
	2	969	22.47	5.32
	3	213	24.20	4.92
Regulation/monitoring	1	218	13.78	3.34
	2	969	14.78	3.24
	3	213	16.36	3.13
Meta-cognition scale	1	218	34.86	6.45
	2	969	37.25	6.38
	3	213	40.56	6.24
Learning goals	1	218	23.24	11.42
	2	969	25.46	11.23
	3	213	25.56	12.15
Achievement goals	1	218	25.68	7.40
	2	969	25.66	7.92
	3	213	24.93	9.15
Reinforcement goals	1	218	11.20	9.29
	2	969	11.15	9.18
	3	213	10.28	9.67

Group 1, Underachieving students; Group 2, Normal achieving students; Group 3, Overachieving students; M, Mean; SD, Standard deviation.

1 to 5; we obtained sample Cronbach's alpha values between 0.87 and 0.71.

Goal orientation was measured through the CMA *[Academy Goal Questionnaire]* (García et al., 1998). This self-report instrument is a Spanish adaptation of the AGTD *[Achievement Goal Tendencies Questionnaire]* made by Hayamizu and Weiner (1991). The instrument contains 20 items and measures three types of goal orientations identified through factor analysis: learning goals, performance goals, and reinforcement goals. Students must answer on a Likert scale from 1 to 5 depending on the frequency of performance with each statement *(1 = never; 5 = always)*. The psychometric properties of the CMA have been analyzed with Spanish students at the primary, secondary, and university levels and have good levels of reliability and construct validity (González-Pienda et al., 2000; Navas et al., 2002). In our sample, the Cronbach's alpha values were 0.75 for learning goals 0.72 for reinforcement goals and 0.85 for performance goals.

To evaluate self-concept, we used the ESEA-2 *[Self-concept Evaluation Scale for Adolescents]* as expanded by González-Pienda et al. (2002). This questionnaire is a Spanish adaptation

TABLE 3 | Results of ANOVA for learning strategies and goal orientations.

Variable	Source	*SS*	*df*	*MS*	*F*	*p*	Sense of differences[a]
1	Between	324.25	2	162.13	15.70	0.00	3 > 2 > 1
	Within	14425.04	1397	10.32			
2	Between	590.73	2	295.36	20.50	0.00	3 > 2 > 1
	Within	20,124.08	1397	14.40			
3	Between	1388.99	2	694.50	17.56	0.00	3 > 2 > 1
	Within	55,249.69	1397	39.55			
4	Between	6167.84	2	3088.92	25.01	0.00	3 > 2 > 1
	Within	172,505.65	1397	123.48			
5	Between	814.33	2	407.17	7.93	0.00	3 > 2 > 1
	Within	71,763.48	1397	51.37			
6	Between	166.79	2	83.39	8.14	0.00	2 > 1, 3 > 1
	Within	14,318.23	1397	10.25			2 = 3
7	Between	565.89	2	282.95	9.86	0.00	2 > 1, 3 > 1
	Within	40,074.85	1397	28.68			2 = 3
8	Between	4113.81	2	2056.91	11.08	0.00	3 > 2 > 1
	Within	259,179.78	1397	185.53			
9	Between	1054.82	2	527.41	19.09	0.00	3 > 2 > 1
	Within	38,589.04	1397	27.62			
10	Between	737.69	2	368.85	35.02	0.00	3 > 2 > 1
	Within	14,712.68	1397	10.53			
11	Between	3548.31	2	1774.16	43.62	0.00	3 > 2 > 1
	Within	56,811.92	1397	40.66			
12	Between	1284.53	2	642.26	4.94	0.00	2 > 1, 3 > 1
	Within	181,784.99	1397	130.12			2 = 3
13	Between	98.00	2	49.00	0.76	0.47	1 = 2 = 3
	Within	90,454.42	1397	64.75			
14	Between	139.77	2	69.89	0.81	0.44	1 = 2 = 3
	Within	120,238.28	1397	86.07			

Variables 1, Selection; 2, Organization; 3, Elaboration; 4, Information processing scale; 5, Creative and critic thinking; 6, Information recovering; 7, Transference; 8, Personalization Scale; 9, Planning/evaluation; 10, Regulation/Monitoring; 11, Meta-cognition Scale; 12, Learning goals; 13, Performance goals; 14, Reinforcement goals.
[a] $p < 0.05$.

of the SDQ-II *[Self-Description Questionnaire]* by Marsh (1990a), which was validated in a study with 503 students in compulsory secondary education. The version employed in this study is composed of 70 items measuring 11 specific self-concept dimensions, which students must answer on a Likert scale from 1 to 6 depending on the extent to which they agree or disagree with each statement. The 11 specific dimensions are grouped in 4 general dimensions: academic self-concept, social self-concept, private/personal self-concept, and one general dimension of self-concept. In the authors' evaluation, all Cronbach's alpha values were between 0.73 and 0.91.

School grades were used as an indicator of academic achievement. Teachers provided full-term grades from nine subjects: Spanish language and literature, Natural sciences, Valencian/regional language, Social Sciences, Mathematics, English, Technology, Art Education, and Physical Education. The scores of the subjects of each course present a high reliability, with Cronbach's alpha values of 0.93 for the first course participants and 0.94 for the second course participants. In the present study, all of the subjects were compulsory for the students; thus, no choice of examination could affect the measurement of the latent construct (Korobko et al., 2008). A punctuation of academic achievement was calculated based on the factor scores obtained in a unique factor from the factor analysis of the grades in the nine subjects.

Once the viability of factor analysis was demonstrated (Barlett's $\chi^2 = 9707.51$, $df = 36$, $p = 0.000$; KMO $= 0.95$), an Exploratory Factor Analysis using maximum likelihood estimation identified a one-factor solution for the school grades that explained 69.57% of the variance; this indicates the unidimensionality of the model. All of the estimated factorial loadings remained over 0.78, with the exception of physical education, which was 0.66. Therefore, a single *factor score* was estimated using the regression method as a compound measure of current academic achievement.

Procedure

Prior to data collection, the necessary permission was requested from the educational administration and school boards of the various schools. After obtaining these permits, the parents or legal guardians of the students had to provide the corresponding informed consent. Data collection was performed in the schools themselves during normal school hours. Data were collected by collaborating researchers previously trained in the standards and guidelines for data collection. Students and their parents participated voluntarily, and the parents signed an informed consent form that ensured data confidentiality at all times. The study was conducted from November to March over four sessions that each lasted an hour.

Data Analysis

First, a multiple regression analysis was performed to determine which of the two ability tests more accurately predicted academic achievement (Factor g test or BADyG). The regression analysis was made with the stepwise method, and the factor score

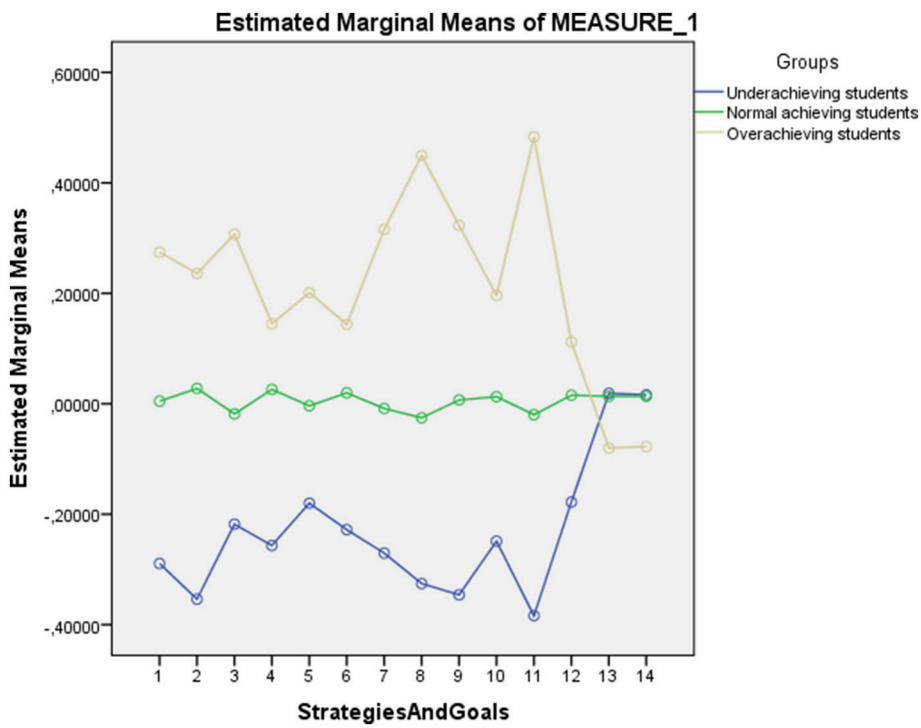


FIGURE 1 | Graphic representation of the standard scores in learning strategies and goal orientation measures for each group.

was considered as a compound measure of current academic achievement as the criteria.

The multiple regression analysis used punctuations of IQ from the Factor G test and BADyG as predictors; the factor score obtained from the factor analysis made on the students' school grades in the nine subjects were taken as the criteria. The analysis showed that only the BADyG test significantly contributed to predicting the punctuation composed of academic achievement ($R = 0.601$, $\beta = 0.60$, $p = 0.00$), whereas the contribution of the Factor G test was not significant ($\beta = 0.02$, $p = 0.43$).

The regression method was employed to identify underachieving students along an all-capacity continuum. The regression method was calculated employing the IQ from BADyG as the predictor; the factor score was used as a compound measure of current academic achievement in the nine school grades as the criteria. The residual score or the difference between each individual's actual achievement score and his or her predicted achievement score were then examined. Three groups of students were formed using this method. Students with a residual punctuation higher than +1 were considered as overachieving, whereas students with a residual punctuation lower than −1 were classified as underachieving. The group with expected levels of achievement obtained punctuations between ±1.

To determine whether there were differences between the three groups, a one-way ANOVA was employed, followed by the *post-hoc* Games-Howell test, which is appropriate when there are groups with differing numbers of subjects and equal variances are not assumed.

RESULTS

The exploratory analysis of the data shows that all of the variables followed a normal distribution with values of skewness and kurtosis between +1/−1.

Table 1 shows the number of identified students in each subgroup with underachievement (1), normal achievement (2), and overachievement (3), according to the course and gender.

As can be observed in **Table 1**, the total numbers of underachieving, normal-achieving and overachieving students were 218, 969, and 213, respectively, which represent 15.6, 69.2, and 15.2% of the students. The percentages of first and second course students were similar ($\chi^2 = 3.57$, $df = 2$, $p = 0.17$), whereas the percentage of boys and girls significantly differed between each group ($c^2 = 44.51$, $df = 2$, $p = 0.00$), showing a higher number of girls than boys in the overachieving group and a lower number of girls in the underachieving group. IQ punctuations were very similar for the three groups with no statistically significant differences ($F = 1.06$, $df = 2$, $p = 0.64$). However, there were significant differences between the academic qualifications with a higher mean in the overachieving group than the underachieving group ($F = 541.0$, $df = 2$, $p = 0.00$).

Table 2 shows the descriptive statistics of the measures in the learning strategies and goal orientations variables for each group. Students from group 3 (overachieving) obtained higher levels than students from groups 1 or 2 in all of the learning strategies variables, as well as goal orientations, whereas underachieving

TABLE 4 | Descriptive statistics of the punctuations obtained in self-concept for each group.

Self-concept	Group	*N*	*M*[a]	*SD*
Mathematic	1	218	3.12	1.44
	2	969	3.61	1.45
	3	213	4.17	1.25
Verbal	1	218	3.22	1.07
	2	969	3.81	1.09
	3	213	4.45	1.00
Academic	1	218	3.50	1.12
	2	969	4.49	1.11
	3	213	5.31	0.71
Physical capacity	1	218	4.61	1.23
	2	969	4.51	1.23
	3	213	4.36	1.21
Physical appearance	1	218	4.06	1.29
	2	969	4.07	1.15
	3	213	4.25	1.07
Parent relationship	1	218	4.56	1.18
	2	969	4.94	0.99
	3	213	5.24	0.81
Honesty	1	218	4.04	1.05
	2	969	4.65	0.84
	3	213	4.99	0.73
Emotional stability	1	218	4.62	1.16
	2	969	4.87	0.97
	3	213	4.98	0.90
Peers relationship	1	218	4.89	1.01
	2	969	4.90	0.86
	3	213	4.92	0.83
Relation with peers of the same gender	1	218	5.01	0.74
	2	969	5.00	0.78
	3	213	5.06	0.72
Relation with peers of the opposite gender	1	218	4.11	1.05
	2	969	3.80	1.09
	3	213	3.54	1.09
General academic self-concept	1	218	3.28	0.90
	2	969	3.97	0.91
	3	213	4.74	0.73
General social self-concept	1	218	4.53	0.79
	2	969	4.45	0.72
	3	213	4.42	0.71
General private/personal self-concept	1	218	4.48	0.87
	2	969	4.82	0.83
	3	213	5.07	0.65
General self-concept measure	1	218	4.55	0.97
	2	969	4.89	0.84
	3	213	5.21	0.70

Group 1, Underachieving students; Group 2, Normal-achieving students; Group 3, Overachieving students; M, Mean; SD, Standard deviation.

[a] *Punctuations rescaled from 1 to 6.*

students received higher measures in performance goals and reinforcement goals.

One-way ANOVA was performed to determine differences between the three groups in learning strategies and goal orientations (**Table 3**). There were statistically significant differences between the groups for all of the variables, with the exception of performance goals and reinforcement goals.

Games-Howell *post hoc* test for mean differences showed that group 3 (overachieving students) obtained higher measures than group 2, which had higher measures than group 1 (underachieving students) in all of the learning strategies variables with the exception of Information Recovering and Transference, for which no differences were detected between groups 3 and 2. However, overachieving students had higher punctuations than underachieving students.

On the goal orientation scales, the underachieving students had a significantly lower punctuation in learning goals than overachieving and normal-achieving students, whereas there were no differences between normal-achieving and overachieving students.

Therefore, the underachieving students showed significantly lower punctuations than the other two groups in all of the learning strategies variables and goal orientations variables. There were no significant differences for performance goals or reinforcement goals; however, underachieving students showed higher punctuations.

The punctuations of the three groups are represented in **Figure 1**. To facilitate the comparison, all of the variables were converted into standard punctuations. The overachieving group had higher scores for all of the variables, with the exception of performance goals and reinforcement goals, for which they had lower punctuations, whereas the underachieving group had the opposite profile, with lower punctuations in all of the variables with the exception of performance goals and reinforcement goals, for which they had higher punctuations. The normal-achieving group had a flat profile with punctuations between groups 1 and 3 for all of the variables.

Tables 4, **5** show the results from the descriptive analysis and the mean differences of the self-concept variables, respectively. For many of the 15 self-concept evaluated factors in **Table 4**, students from group 1 had lower punctuations in the three second-order factors, especially in the factors related with academic self-concept, relation with parents, honesty, emotional stability, and private/personal general self-concept. In contrast, they received higher punctuations for physical capacity, relations with peers of the opposite gender and general social self-concept.

The one-way ANOVA results presented in **Table 5** indicate that significant differences were found for most of the self-concept variables, with the exception of that related to physical capacity, physical appearance, relation with peers, relation with peers of the same gender, and social general self-concept.

The *post hoc* test indicated that underachieving students had lower punctuations than the other two groups in all of the cases in which significant differences were detected, with the exception of the punctuation obtained for relations with the opposite gender; this difference was higher than that for group 2, which in turn was higher than that in group 3. Overachieving students had lower punctuations in this self-concept aspect, whereas underachieving students had higher punctuations than the rest.

As shown in **Figure 2**, underachieving students' punctuations were below the majority of self-concept aspects, with the exception of physical capacity (4), relations with the opposite gender (11), and social general self-concept (13); however, these differences were only statistically significant for the relations with peers of the opposite gender. Notably, there was a flat profile in the normal-achieving group as well as higher punctuations in the overachieving group for most of the self-concept factors.

DISCUSSION

The regression method employed to identify underachieving students indicated a percentage of 16%, which is similar to rates in other studies (Lau and Chan, 2001; Colangelo et al., 2004; Phillipson, 2008); a nearly identical percentage was found for overachieving students. Although the regression method is considered the most adequate compared with other methods (such as the simple difference method, Lau and Chan, 2001; Phillipson, 2008), it tends to identify under- and overachieving students at a percentage near 16% when the standard residual value is fixed at 1 for the identification criteria (Ziegler et al., 2012). In general terms, the results from the different identification proceedings are not entirely coincident (McCoach and Siegle, 2011; Veas et al., 2016a). The results of this work indicate the construct validity of underachievement because the under- and overachieving groups showed defined characteristics according to theoretical expectations. They had nearly identical intellectual levels, demonstrated significantly distinct academic achievement, and showed significant differences in regard to most of the variables included in this study.

However, gender distribution differed between the groups, with a significantly higher number of boys than girls in the underachieving group and the opposite in the overachieving group. These results are similar to other studies reporting a higher risk for underachievement in boys (Reis and McCoach, 2000); however, some studies indicate no differences (Preckel and Brunner, 2015).

The results of this study also indicated significant differences between the under-, normal-, and overachieving students in most of the individual variables considered. In relation to learning strategies, underachieving students self-reported a lower use of all strategies, specifically, and generally considered, than the under and overachieving groups. When learning, underachieving students process less information and recover it with more difficulty; they also transfer or apply less of what they learn. When underachieving students plan, they evaluate and control the learning rhythm to a lesser extent. These results were found for a large sample of students that included the entire range of capacities; the results are similar to those obtained in studies with gifted underachieving students (Dowdall and Colangelo, 1982; McCoach and Siegle, 2003a; Colangelo et al., 2004) in

TABLE 5 | Results of ANOVA for self-concept variables.

Variable	Source	*SS*	*df*	*MS*	*F*	*p*	Sense of differences[a]
1	Between	119.51	2	59.75	29.55	0.00	3 > 2 > 1
	Within	2824.80	1397	2.02			
2	Between	116.27	2	82.14	70.33	0.00	3 > 2 > 1
	Within	1631.47	1397	1.17			
3	Between	353.68	2	176.84	154.42	0.00	3 > 2 > 1
	Within	1599.75	1397	1.14			
4	Between	7.02	2	3.51	2.31	0.10	1 = 2 = 3
	Within	2123.73	1397	1.52			
5	Between	6.12	2	3.06	2.24	0.11	1 = 2 = 3
	Within	1908.74	1397	1.36			
6	Between	69.01	2	34.50	34.26	0.00	3 > 2 > 1
	Within	1406.80	1397	1.01			
7	Between	37.78	2	18.89	25.16	0.00	3 > 2 > 1
	Within	1049.04	1397	0.75			
8	Between	15.49	2	7.75	7.79	0.00	2 > 1, 3 > 1
	Within	1388.99	1397	0.99			2 = 3
9	Between	0.07	2	0.04	0.05	0.95	1 = 2 = 3
	Within	1104.91	1397	0.79			
10	Between	0.72	2	0.36	0.61	0.54	1 = 2 = 3
	Within	823.87	1397	0.59			
11	Between	35.44	2	17.72	14.92	0.00	1 > 2 > 3
	Within	1658.86	1397	1.18			
12	Between	200.51	2	100.25	126.95	0.00	3 > 2 > 1
	Within	1103.25	1397	0.79			
13	Between	1.45	2	0.73	1.34	0.26	1 = 2 = 3
	Within	754.83	1397	0.54			
14	Between	36.39	2	18.19	32.71	0.00	3 > 2 > 1
	Within	777.16	1397	0.55			
15	Between	46.86	2	23.43	32.93	0.00	3 > 2 > 1
	Within	993.86	1397	0.71			

Variables 1, Mathematic self-concept; 2, Verbal; 3, Academic (other subjects); 4, Physical capacity; 5, Physical appearance; 6, Relation with parents; 7, Honesty; 8, Emotional stability; 9, Relation with peers; 10, Relation with peers of the same gender; 11, Relation with peers of the opposite gender; 12, General academic self-concept; 13, General social Self-concept; 14, General private Self-concept; 15, General Self-concept measure.

[a] $p < 0.05$.

which underachieving students show a systemic reduction in these strategies.

In contrast, overachieving students exhibited significant higher use of all of the learning strategies than underachieving and normal-achieving students. There were no differences for only the Information Recovering and Transfer strategies between normal and overachieving students. These results are interesting because they indicate that higher academic achievement in overachieving students is due to a major use of learning strategies; however, few studies have compared overachieving students with normal and underachieving students at all ranges of intellectual ability. Likewise, these results indicate that learning strategies represent a key variable in understanding the characteristics of under- and overachieving students and the role that these characteristics play for academic achievement. However, interventions to reverse underachievement should

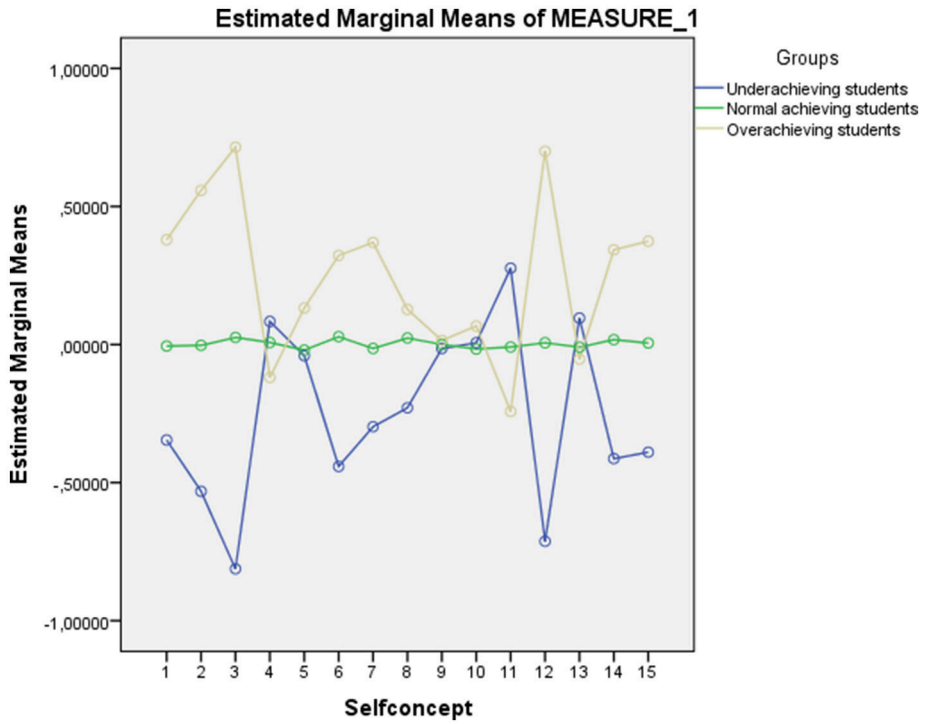


FIGURE 2 | Graphic representation of the standard scores obtained from the self-concept measures for each group.

first focus on improving strategies before fostering motivational variables or academic self-concept (Preckel and Brunner, 2015).

The results of goal orientations as motivational variables indicate that the differences between under-, normal- and overachieving students are produced only for learning goals. Underachieving students showed minor punctuation compared with normal and overachieving students, whereas there were no differences in performance goals or social reinforcement goals. These results are similar to those obtained by Preckel and Brunner (2015), who only found positive relations for mastery goals and under- or overachieving students. Although there is a lack of studies comparing the goal orientations of under, normal- and over achieving students, findings regarding the general relationships between goal orientations and academic achievement are heterogeneous (Hulleman et al., 2010; Niepel et al., 2014).

With respect to self-concept, underachieving students showed lower punctuations than normal and overachieving students in all of the academic self-concept dimensions (mathematic, verbal, other areas, and in general academic self-concept). These results are primarily consistent with studies on academic self-concept in underachieving students (Rimm, 2003; Çakır, 2014; Preckel and Brunner, 2015). In the same manner, underachieving students showed lower scores than over and normal-achieving students in the dimensions of parent relationship, honesty and emotional stability; however, there was no difference between underachieving students and normal-achieving students for the last factor. All of these were specific dimensions of general personal self-concept, which also showed significantly lower punctuations; the same was noted for general self-concept. This minor private/personal general self-concept is in line with the results of McCoach and Siegle (2003a,b), which were obtained with the SAAS-R, an instrument for assessing characteristics in underachieving students, which was also employed in a study by Çakır (2014).

Underachieving students did not differ from the other groups in the self-concept dimensions related to parents' relationship, relation with peers of the same gender, or social general self-concept. However, they showed a higher self-concept with respect to relations with the opposite gender and physical capacity (not significant for the last component). Some studies showed that the relations perceived by the opposite gender do not have negative effects on achievement and that they appear to be mediated by the level of school engagement, which plays an important role in mediating these peer relationship effects, particularly for academic, and non-academic functioning (Liem and Martin, 2011).

In general, underachieving students' self-concept profile is lower than normal and overachieving students in all of the academic and personal dimensions, including relationship with parents. Underachieving students have a social self-concept that is similar to normal and overachieving students but higher in relations with the opposite gender and physical capacity. More studies are needed to determine if this self-concept in underachieving students is a result of compensation due to the lower academic and personal self-concept (Marsh, 1990a).

In summary, underachieving students appear to employ all of the learning strategies considered but to a lesser extent than normal and overachieving students. They also have fewer learning goals available and lower academic and personal self-concept. In contrast, overachieving students excel compared with under- and normal-achieving students in all of the above factors. If the three groups have similar intellectual levels, these differences in academic achievement appear to be associated with differential characteristics in learning strategies, goals, and academic and personal self-concept. The fact that overachieving students had superior performance compared with normal-achieving students appears to support this conclusion.

Therefore, in agreement with other studies (Gallagher, 1991; Emerick, 1992; Baum et al., 1995), any educational intervention focused on reverting the minor academic achievement in underachieving students must lead to simultaneously encouraging learning strategies, developing learning goals, and favoring the distinct general academic and personal self-concept dimensions. Self-regulating models in which goals, strategies and self-concept are integrated and have mutual relations and effects on academic achievement (Marsh, 1990b; Garcia and Pintrich, 1994; Pintrich, 2000; Zimmerman and Moylan, 2009; Valle et al., 2015a,b) appear adequate to guide educational interventions to reverse underachievement.

These interventions should follow certain criteria: to implement simultaneous changes in all of the factors in which underachieving students are at a lower level, to consider the main goal of the learning strategies; to focus on both enhancing specific self-efficacy and the general academic and personal self-concept, to positively influence academic achievement, and to be durable to produce the desired effects.

Other social and familiar variables are also important beyond those treated in this work. This is a limitation to our work that should be considered in future research.

Additionally, it is important to highlight the possibility to calibrate the school grades of students as the main measure of underachievement in Spanish schools (Veas et al., 2016b).

The inter-subject comparability approach is an appropriate model in which the influence of the difficulty level of the subjects and the proficiency level of the students can be adjusted according to Rasch's parameters. This approach has been tested (with some variation in the procedures) in various countries with positive results (Tasmanian Qualification Authority, 2006, 2007; Coe, 2007, 2008; Korobko et al., 2008).

However, it would also be necessary to determine whether these differences between groups are maintained when using other identification methods, such as the Rasch model, given that the percentage of underachieving students identified in a Spanish sample with the Rasch method was not the same compared with the simple difference method and the regression method (Veas et al., 2016a).

AUTHOR CONTRIBUTIONS

JC Quantitative methods. Analysis of the sample. Reliability of the instruments. RG Theoretical review of the topic. Review of the references.

FUNDING

The present work was supported by the Spanish Ministry of Economy and competitiveness (Award number: EDU2012-32156) and the Vice Chancellor for Research of the University of Alicante (Award number: GRE11-15). The third author is funded by the Spanish Ministry of Economy and Competitiveness (Reference of the grant: BES-2013-0 64331).

REFERENCES

Álvarez, A., Suárez, N., Tuero, E., Núñez, J. C., Valle, A., and Regueiro, B. (2015). Implicación familiar, autoconcepto del adolescente y rendimiento académico. *Eur. J. Investig. Health Psychol. Educ.* 5, 293–311. doi: 10.1989/ejihpe.v5i3.133

Anastasi, A. (1976). *Psychological Testing*. New York, NY: McMillan.

Baker, J., Bridger, R., and Evans, K. (1998). Models of underachievement among gifted preadolescents: the role of personal, family, and school factors. *Gifted Child Q.* 42, 5–15. doi: 10.1177/001698629804200102

Baum, S. M., Renzulli, J. S., and Hébert, T. P. (1995). Reversing underachievement: creative productivity as a systematic intervention. *Gifted Child Q.* 39, 224–235. doi: 10.1177/001698629503900406

Beltrán, J., Pérez, L., and Ortega, M. (2006). *CEA. Cuestionario de Estrategias de Aprendizaje [CEA. Learning Strategies Questionnaire]*. Madrid: TEA Ediciones.

Çakır, L. (2014). The relationship between underachievement of gifted students and their attitudes toward school environment. *Procedia Soc. Behav. Sci.* 152, 1034–1038. doi: 10.1016/j.sbspro.2014.09.269

Cattell, R. (1994). *Test de Factor "g" de Cattell, escala 2(forma A) [Cattell Factor "g" test, scale 2 form A]. Institute for Personality and Ability Testing*. Madrid: TEA Ediciones.

Chan, D. (1999). Reversing underachievement: can we tap unfulfilled talents in Hong Kong? *Educ. Res. J.* 14, 177–190.

Chan, D. (2005). Family environment and talent development of Chinese gifted students in Hong Kong. *Gifted Child Q.* 49, 211–221. doi: 10.1177/001698620504900303

Coe, R. (2007). "Common examinee methods for monitoring the comparability of examination standards," in *Techniques for Monitoring the Comparability of Examination Standards,* eds P. Newton, J. Baird, H. Goldstein, H. Patrick, and P. Tymms (London: Qualifications and Curriculum Authority), 331–367.

Coe, R. (2008). Comparability of GCSE examinations in different subjects: an application of the Rasch model. *Oxford Rev. Educ.* 34, 609–636. doi: 10.1080/03054980801970312

Colangelo, N., Kerr, B., Christensen, P., and Maxey, J. (2004). A comparison of gifted underachievers and gifted high achievers. *Gifted Child Q.* 37, 155–160.

Dittrich, E. (2014). Underachievement leading to downgrading at the highest level of secondary education in the Netherlands: a longitudinal case study. *Roeper Rev.* 36, 104–113. doi: 10.1080/02783193.2014.884201

Dixon, R. M., Craven, R., and Martin, A. (2006). Underachievement in a whole city cohort of academically gifted children: what does it look like? *Australas. J. Gifted Educ.* 15, 9–15.

Dowdall, C. B., and Colangelo, N. (1982). Underachieving gifted students: review and implications. *Gifted Child Q.* 26, 179–184. doi: 10.1177/001698628202600406

Dunlosky, J., and Rawson, K. A. (2012). Overconfidence produces underachievement: inaccurate self-evaluations undermine student's learning and retention. *Learn. Instr.* 22, 271–280. doi: 10.1016/j.learninstruc.2011.08.003

Emerick, L. J. (1992). Academic underachievement among the gifted: students' perceptions of factors that reverse the pattern. *Gifted Child Q.* 36, 140–146. doi: 10.1177/001698629203600304

Eurostat (2014). *Being Young in Europe Today*. Available online at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Being_young_in_Europe_today_-_education

Figg, S. D., Rogers, K. B., McCormick, J., and Low, R. (2012). Differentiating low performance of the gifted learner. Achieving, underachieving, and selective consuming students. *J. Adv. Acad.* 23, 53–71. doi: 10.1177/1932202X11430000

Fletcher, J. M., Denton, C., and Francis, D. J. (2005). Validity of alternative approaches for the identification of learning disabilities: operationalizing unexpected underachievement. *J. Learn. Disabil.* 38, 545–552. doi: 10.1177/00222194050380061101

Gallagher, J. J. (1991). Personal patterns of underachievement. *J. Educ. Gifted* 14, 221–233. doi: 10.1177/016235329101400304

García, M., González-Pienda, J. A., Núñez, J. C., González, S., Álvarez, L., Roces, C., et al. (1998). El cuestionario de metas académicas (CMA). Un instrumento para la evaluatión de la orientación motivacional de los alumnos de educación secundaria [Academic Goals Questionnaire (CMA). An instrument to evaluate motivational goals of students in secondary education]. *Aula Abierta* 71, 175–199.

Garcia, T., and Pintrich, P. R. (1994). "Regulating motivation and cognition in the classroom: the role of self-schemas and self-regulatory strategies," in *Self-Regulation of Learning and Performance: Issues and Educational Applications,* eds D. H. Schunk and B. J. Zimmerman (Hillsdale, NJ: Erlbaum), 127–154.

González-Pienda, J. A., Núñez, J. C., González-Pumariega, S., Álvarez, L., Roces, C., and García, M. (2002). A structural equation model of parental involvement, motivational and aptitudinal characteristics, and academic achievement. *J. Exp. Educ.* 70, 257–287.

González-Pienda, J. A., Núñez, J. C., González-Pumariega, S., Roces, C., García, M., González, P., et al. (2000). Autoconcepto, procesos de atribución causal y metas académicas en niños con y sin dificultades de aprendizaje [Self-concept, process of causal attribution and academic goals in children with and without learning disabilities]. *Psicothema* 12, 548–556.

Hayamizu, T., and Weiner, B. (1991). A test of Dweck's model of achievement goals as related to perceptions of ability. *J. Exp. Educ.* 59, 226–234. doi: 10.1080/00220973.1991.10806562

Hodis, F. A., Meyer, L. H., McClure, J., Weir, K. F., and Walkey, F. H. (2011). A longitudinal investigation of motivation and secondary school achievement using growth mixture modeling. *J. Educ. Psychol.* 103, 312–323. doi: 10.1037/a0022547

Hulleman, C. S., Schrager, S. M., Bodmann, S. M., and Harackiewitcz, J. M. (2010). A meta-analytic review of achievement goal measures: different labels for the same constructs or different constructs with similar labels? *Psychol. Bull.* 136, 422–449. doi: 10.1037/a0018947

Korobko, O. B., Glas, C. A., Bosker, R. J., and Luyten, J. W. (2008). Comparing the difficulty of examination subjects with item response theory. *J. Educ. Meas.* 45, 139–157. doi: 10.1111/j.1745-3984.2007.00057.x

Lane, K. L., Greshman, F. M., and O'Shaughnessy, T. E. (2002). Serving students with or at-risk for emotional and behavior disorders: future challenges. *Educ. Treat. Child.* 25, 507.

Lau, K., and Chan, D. W. (2001). Identification of underachievers in Hong Kong: do different methods select different underachievers? *Educ. Stud.* 27, 187–200. doi: 10.1080/03055690120050419

Liem, G. A., and Martin, A. J. (2011). Peer relationships and adolescents' academic and non-academic outcomes: same-sex and opposite-sex peer effects and the mediating role of school engagement. *Br. J. Educ. Psychol.* 81, 183–206. doi: 10.1111/j.2044-8279.2010.02013.x

Marsh, H. W. (1990a). A multidimensional, hierarchical model of self-concept: theoretical and empirical justification. *Educ. Psychol. Rev.* 2, 77–172. doi: 10.1007/BF01322177

Marsh, H. W. (1990b). The influence of internal and external frames of reference on the formation of math and English self-concepts. *J. Educ. Psychol.* 82, 107–116. doi: 10.1037/0022-0663.82.1.107

Marzano, R. J. (2000). *Transforming Classroom Grading*. Alexandria, VA: The Association for Supervision and Curriculum Development.

McCall, R., Evahn, C., and y Kratzer, L. (1992). *High School Underachievers: What Do They Achieve As Adults?* Newbury Park, CA: Sage Pub.

McCelland, R., Yewchuk, C., and Mulcahy, R. (1991). Locus of control in underachieving and achieving gifted students. *J. Educ. Gift* 14, 380–392. doi: 10.1177/016235329101400404

McCoach, D. B., and Siegle, D. (2003a). Factors that differentiate underachieving gifted students from high-achieving gifted students. *Gifted Child Q.* 47, 144–154. doi: 10.1177/001698620304700205

McCoach, D. B., and Siegle, D. (2003b). The school attitude assessment survey-revised: a new instrument to identify academically able students who underachieve. *Educ. Psychol. Meas.* 63, 414–429. doi: 10.1177/0013164403063003005

McCoach, D. B., and Siegle, D. (2011). "Underachievers," in *Encyclopedia of Adolescence,* ed R. J. Levesque (New York, NY: Springer Science and Business Media), 3025–3032.

Navas, L., González, C., and Torregrosa, G. (2002). Metas de aprendizaje: un análisis transversal de las estructuras factoriales que presentan [Learning goals: a cross-sectional analysis of the factor structures which present]. *Rev. Psicol. Gen. Apl.* 55, 553–564.

Niepel, C., Brunner, M., and Preckel, F. (2014). Achievement goals, academic self-concept, and school grades in mathematics: longitudinal reciprocal relations in above average ability secondary school students. *Contemp. Educ. Psychol.* 39, 301–313. doi: 10.1016/j.cedpsych.2014.07.002

Obergriesser, S., and Stoeger, H. (2015). The role of emotions, motivation, and learning behavior in underachievement and results of an intervention. *High Ability Stud.* 26, 167–190. doi: 10.1080/13598139.2015.1043003

Peixoto, F., and Almeida, L. S. (2010). Self-concept, self-steem and academic achievement. Strategies for maintaining self-steem in students experiencing academic failure. *Eur. J. Psychol. Educ.* 25, 157–175. doi: 10.1007/s10212-010-0011-z

Peterson, J. S., and Colangelo, N. (1996). Gifted achievers and underachievers: a comparison of patterns found in school files. *J. Couns. Dev.* 74, 399–407. doi: 10.1002/j.1556-6676.1996.tb01886.x

Phillipson, N. S. (2008). The optimal achievement model and underachievement in Hong Kong: an application of the Rasch model. *Psychol. Sci. Q.* 50, 147–172.

Pintrich, P. R. (2000). "The role of goal orientation in self-regulated learning," in *Handbook of Self-Regulation,* eds M. Boekaerts, P. R. Pintrich, and M. Zeidner (San Diego, CA: Academic Press), 452–502.

Plewis, I. (1991). Underachievement: a case of conceptual confusion. *Br. Educ. Res. J.* 17, 377–385. doi: 10.1080/0141192910170407

Preckel, F., and Brunner, M. (2015). Academic self-concept, achievement goals, and achievement: is their relation the same for academic achievers and underachievers? *Gifted Talented Int.* 30, 68–84. doi: 10.1080/15332276.2015.1137458

Reis, S. M., and Greene, M. J. (2014). *Using Self-Regulated Learning to Reverse Underachievement in Talented Students*. Available online at: http://www.figted.uconn.edu/general/faculty/reis/Self-Regulated_Learning_Reverse_Underachievement.html

Reis, S. M., and McCoach, D. B. (2000). The underachievement of gifted students: what do we know and where do we go? *Gifted Child Q.* 44, 158–170. doi: 10.1177/001698620004400302

Renzulli, J. S., and Reis, S. M. (1997). *The Schoolwide Enrichment Model: A Comprehensive Plan for Educational Excellence,* 2nd Edn. Mansfield Center, CT: Creative Learning Press, Inc.

Rimm, S. B. (1987). Why bright children underachieve: the pressures they feel. *Gifted Child. Today.* 10, 30–36.

Rimm, S. B. (2003). "Underachievement: a National Epidemic," in *Handbook of Gifted Education*, eds N. Colangelo and G. A. Davis (New York, NY: Allyn and Bacon), 424–443.

Rodríguez, S., Regueiro, B., Blas, R., Valle, A., Piñeiro, I., and Cerezo, R. (2014). Teacher self-efficacy and its relationship with students' affective and motivational variables in higher education. *Eur. J. Educ. Psychol.* 7, 107–120. doi: 10.1989/ejep.v7i2.183

Schick, H., and Phillipson, S. N. (2009). Learning motivation and performance excellence in adolescents with high intelligence potential: what really matters? *High Ability Stud.* 20, 15–37. doi: 10.1080/13598130902879366

Siegle, D., and McCoach, D. B. (2005). *Motivating Gifted Students*. Waco, TX: Prufrock Press.

Tasmanian Qualification Authority (2006). *An Introduction to Rasch Modelling and the TCE*. Available online at: http://www.tqa.tas.gov.au/4DCGI/_WWW_doc/003675/RND01/Rasch_intro.pdf

Tasmanian Qualification Authority (2007). *How the Scaled Awards Are Calculated and Used to Determine the Tertiary Entrance Score*. Available online at : http://www.tqa.tas.gov.au/0477

Valle, A., Regueiro, B., Estévez, I., Piñeiro, I., Rodríguez, S., and Freire, C. (2015b). Implicación y motivación hacia los deberes escolares en los estudiantes de Primaria según el rendimiento académico y el curso. *Eur. J. Invest. Health Psychol. Educ.* 5, 345–355.doi: 10.1989/ejihpe.v5i3.137

Valle, A., Regueiro, B., Rodríguez, S., Piñeiro, I., Freire, C., Ferradás, M., et al. (2015a). Perfiles motivacionales como combinación de expectativas de autoeficacia y metas académicas en estudiantes universitarios. *Eur. J. Educ. Psychol.* 8, 1–8. doi: 10.1016/j.ejeps.2015.10.001

Veas, A., Castejón, J. L., Gilar, R., and Miñano, P. (2015). Academic achievement in early adolescence: the influence of cognitive and non-cognitive variables. *J. Gen. Psychol.* 142, 273–294. doi: 10.1080/00221309.2015.1092940

Veas, A., Gilar, R., Castejón, J. L., and Miñano, P. (2016a). Underachievement in compulsory secondary education in spain: a comparison of statistical methods for identification. *Eur. J. Invest. Health Educ. Psychol.* 6, 107–122.

Veas, A., Gilar, R., Miñano, P., and y Castejón, J. L. (2016b). Estimation of the proportion of underachievers in Compulsory Secondary Education in Spain: An application of the Rasch model. *Front. Psychol.* 7:303. doi: 10.3389/fpsyg.2016.00303.

Vlahovic-Stetic, V., Vidovic, V. V., and Arambasic, L. (1999). Motivational characteristics in mathematical achievement: a study of gifted high-achieving, gifted underachieving and non-gifted pupils. *High Ability Stud.* 10, 37–49. doi: 10.1080/1359813990100104

Yuste, C., Martínez, R., and Galve, J. L. (2005). *Batería de Aptitudes Diferenciales y GENERALES BADYG [Battery of General and Differential Aptitudes]*. Madrid: CEPE.

Ziegler, A., and Stoeger, H. (2003). Identification of underachievement: an empirical study on the agreement among various diagnostic sources. *Gifted Talented Int.* 18, 87–94. doi: 10.1080/15332276.2003.11673019

Ziegler, A., Ziegler, A., and Stoeger, H. (2012). Shortcoming of the IQ construct of underachievement. *Roeper Rev.* 34, 123–132. doi: 10.1080/02783193.2012.660726

Zimmerman, B. J., and Moylan, A. R. (2009). "Self-regulation: where metacognition and motivation intersect," in *Handbook of Metacognition in Education,* eds D. J. Hacker, J. Dunlosky and A. C. Graesser (New York, NY: Routledge), 299–315.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Castejón, Gilar, Veas and Miñano. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 27 September 2016
doi: 10.3389/fpsyg.2016.01447

Sensation-Seeking and Impulsivity as Predictors of Reactive and Proactive Aggression in Adolescents

María Del Carmen Pérez Fuentes, Maria del Mar Molero Jurado, José J. Carrión Martínez, Isabel Mercader Rubio and José J. Gázquez*

University of Almería, Almería, Spain

In adolescence, such matters as substance use and impulsiveness may give rise to problematic behavior repertoires. This study was therefore done to analyze the predictive value of sensation-seeking and impulsiveness dimensions related to the functions of aggression (reactive/proactive) and types of expression (physical/relational). A total of 822 high school students in Almeria (Spain) aged 13–18, were administered the Sensation-Seeking Scale, the State Impulsiveness Scale and Peer Conflict Scale. The results show the existence of a positive correlation of the majority of factors analyzed, both in impulsiveness and sensation-seeking, with respect to the different types of aggression. Furthermore, aggressive behavior is explained by the combination of a sensation-seeking factor (Disinhibition) and two impulsiveness factors (Gratification and Automatism). This study shows the need to analyze aggression as a multidimensional construct.

Keywords: sensation-seeking, impulsivity, proactive aggression, reactive aggression, adolescent

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Alejandro Veas, University of Alicante, Spain
Antonio Valle, University of A Coruña, Spain

****Correspondence:***
María Del Carmen Pérez Fuentes
mpf421@ual.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *03 August 2016*
Accepted: *09 September 2016*
Published: *27 September 2016*

Citation:
Pérez Fuentes MDC, Molero Jurado MdM, Carrión Martínez JJ, Mercader Rubio I and Gázquez JJ (2016) Sensation-Seeking and Impulsivity as Predictors of Reactive and Proactive Aggression in Adolescents. Front. Psychol. 7:1447. doi: 10.3389/fpsyg.2016.01447

INTRODUCTION

Adolescence is a stage of change in which the individual must make decisions and respond to a diversity of situations. Such matters as substance use (Gázquez et al., 2015a) or how to interact with others (Inglés et al., 2014) could thus become repertoires of problem behavior in adolescents. In addition to individual factors (Gázquez et al., 2015b; Valle et al., 2015), adopting certain risk and/or problem behaviors also depends on other family (Martínez-Loredo et al., 2016) or peer group (Monahan et al., 2009) factors which are determining for the construction of self-concept and personal wellbeing (Nacimiento and Mora-Merchán, 2014; Álvarez et al., 2015; Azpiazua et al., 2015; Goñi et al., 2015).

Adolescence is also characterized by premature experimentation of new experiences and sensations. Jessor et al. (1998) argue that sensation-seeking can interfere with healthy adolescent development, and has been shown to be one of the most important risk factors in behavior problems. For many adolescents, the social setting inhibits imprudence, but for others it promotes risk-taking and emotion-seeking. These experiences sometimes include drug use, with negative consequences for their development that later become evident (Pérez-Fuentes et al., 2015). MacPherson et al. (2010) found that assuming risks was an important predictor of adolescent drinking. Curran et al. (2010) observed that adolescents who drive while under the effects of alcohol were strongly correlated with sensation-seeking factors, specifically with emotions and excitement, disinhibition and susceptibility to boredom.

An important matter related to the increase in sensation-seeking during adolescence and also aggressive behavior is impulsivity (Archer and Webb, 2006). This is defined as an expression of uninhibited behavior characterized by lack of control of behavior (Cardoso-Moreno et al., 2015). Given the role of impulsivity in involvement in risk behaviors by adolescents, the positive effect of interventions during childhood to prevent the first forms of impulsivity, which continue into adolescence if not treated, is clear.

Impulsivity and aggression maintain a pattern of consistent relationship. However, not everyone who is impulsive has aggressive behavior, nor is it manifested in the same way. For example, Hatfield and Dula (2014) found that high scores on impulsivity were associated with higher levels of physical or direct aggression. Grimaldi et al. (2014) suggest that relational aggressors may be more exposed to negative consequences related to alcohol when they respond impulsively to negative emotions.

Aggression, currently conceived as a multidimensional construct, can take many forms (García-Sancho et al., 2016). The functions of aggression refer to the aggressor's motivation, and historically, two types have been distinguished, proactive and reactive (Hartup, 1974; Dodge and Coie, 1987). Proactive aggression refers to deliberate actions directed at achieving a goal, while reactive aggression refers to emotional response to attack. Thus different theoretical approaches postulate the intervention of different cognitive and social processes for each function (Gifford-Smith and Rabiner, 2004). The problem in detecting the relationships of the different aspects of proactive and reactive aggression is that the measures of these two functions are often intercorrelated (Dodge et al., 1990). However, later studies have shown that the two functions of aggression behave like two independent constructs (Poulin and Boivin, 2000), although they often occur at the same time (Bushman and Anderson, 2001). For example, reactive aggression is often related to problems with emotional regulation, internalization symptoms, rejection by classmates or victimization (Card and Little, 2006). In some cases this type of effect is seen in youth who reject school (Inglés et al., 2015). Subjects who show proactive aggression overestimate the positive consequences of aggression and minimize the probability of being punished for it (Marsee and Frick, 2007). In this respect, scientific evidence suggests that there is a relationship between proactive aggression and certain traits of insensitivity and lack of empathy or guilt (Frick and Dickens, 2006).

Thus both reactive and proactive aggression have been associated with negative effects for development of the individual (Hubbard et al., 2010), even with consequences in later stages (Cleverley et al., 2012). For example, such consequences as anxiety and depression in reactive aggressors (Fite et al., 2014) or the proliferation of antisocial/delinquent behavior with impulse control in proactive aggressors (Scarpa et al., 2010) have been observed.

Sensation-seeking has been related to the development of aggressive behavior (Wilson and Scarpa, 2011). Risk-taking, as proneness to acting impulsively to achieve reward even though there are negative consequences, would also be associated with aggression and delinquency (Romer, 2010). Previous studies on the relationship between personality and antisocial behavior have shown that both failure to control impulses and sensation-seeking are related to aggression and rule-breaking (Newcomb and McGee, 1991). Similarly, little inhibition in childhood leads to rule-breaking and becomes a risk factor for aggression in adolescents (Moeller et al., 2001).

Raine et al. (2006) found that low levels of inhibition and high sensation-seeking were present in adolescents with both reactive and proactive aggression. Findings such as these report the association between impulsive tendencies and the reactive and proactive forms of aggression. However, proactive aggressive individuals can show a stronger ability to regulate immediate aggressive impulses, channeling them into planned aggression (Dodge et al., 2006). Other authors, such as Steinberg et al. (2008) observed specific effects (not general) of sensation-seeking on deviant behavior and attitudes in adolescents who years before has used drugs and/or had participated in delinquent activities.

Recently, authors like Cui et al. (2016) have concluded that children whose high levels of reactive and proactive aggression persisted over time also had high levels of sensation-seeking and risk-taking, as well as low levels of moral reasoning.

Moreover, two forms of aggression related to interpersonal relationships may be distinguished (Buss, 1961; Valzelli, 1983; Grotpeter and Crick, 1996), physical (direct) and relational (indirect) aggression. Some studies (Stickle et al., 2012) mention that males and females show signs of relational aggression in different ways. Centifanti et al. (2015) suggested that individual factors are associated with participation in relational aggression by girls and may therefore be an indicator of problem behavior.

The purpose of this study was to find out the predictive value of variables related to sensation-seeking and impulsivity related to the functions of aggression (reactive/proactive) and its forms of expression (physical/relational) in adolescents.

MATERIALS AND METHODS

Participants

A sample of 822 high school students was selected by cluster sampling from eight high schools in the province of Almeria (Spain). The participants were aged 13–18 with a mean of 14.84 years ($SD = 0.87$). Of the total simple, 51.8% ($n = 426$) were males and 48.2% ($n = 396$) females, with mean ages of 14.85 ($SD = 0.87$) and 14.82 years ($SD = 0.86$), respectively. The distribution of our sample by academic year was: 43.7% were 3rd year high school students ($n = 359$) and the remaining 56.3% were in 4th year ($n = 463$).

Instruments

Escala de Búsqueda de Sensaciones [*Sensation-Seeking Scale*] (Pérez and Torrubia, 1986). This scale measures the tendency to seek new risky experiences. It consists of a total of 40 items with dichotomous answers (yes/no) on four subscales: Emotion-seeking (BEM), Excitement-seeking (BEX), Disinhibtion (DES) and Susceptibility to Boredom (SAB). The authors found

TABLE 1 | Descriptive statistics of impulsivity and sensation-seeking factors and correlation coefficients with form of aggression (*N* = 822).

	Mean	*SD*	Correlation with AgPA	Correlation with AgPR	Correlation with AgRA	Correlation with AgRR
Impulsivity						
GRA	13.19	4.00	0.31***	0.30***	0.35***	0.31***
AUTO	11.86	4.08	0.26***	0.26***	0.32***	0.26***
ATEN	14.14	4.35	0.24***	0.24***	0.32***	0.25***
Sensation-seeking						
BEM	6.10	2.57	0.06*	0.04	0.13***	0.07*
BEX	5.24	1.72	0.04	0.02	0.09**	0.05*
DES	4.34	2.30	0.35***	0.31***	0.40***	0.31***
SAB	4.22	1.95	0.17***	0.16***	0.22***	0.19***

**Significant correlation at 0.05; **Significant correlation at 0.01; ***Significant correlation at 0.001. AgPA, Physical Proactive Aggression; AgPR, Relational Proactive Aggression; AgRA, Physical Reactive Aggression; AgRR, Relational Reactive Aggression; GRA, Gratification; AUTO, Automatism; ATEN, Attentional; BEM, Emotion-seeking; BEX, Excitement-seeking; DES, Disinhibition; SAB, Susceptibility to boredom.*

reliability coefficients over 0.87 for the whole questionnaire scale and Cronbach's alpha of 0.70–0.87 on the subscales.

Escala de Impulsividad Estado [*State Impulsivity Scale*] (EIE; Iribarren et al., 2011). This scale was developed to evaluate impulsive behavior defined as a state, that is, impulsivity as a manifest behavior that can vary in the short term. It consists of 20 items, with a response format based on a four-point Likert-type scale in which the subject is asked to evaluate the frequency with which each of the statements is true. The items that make up the scale are grouped into three subscales: Gratification (urgency in satisfying impulses, preference for immediate reward, intolerance to frustration and tendency to act without thinking of negative consequences); Automatism (repeated, rigidly expressed behavior, with no attention to contextual variables); and Attentional (presence of unplanned behavior which takes place too soon without considering all the information available). The authors found high reliability for the complete scale ($\alpha = 0.88$) and each of its dimensions: Gratification ($\alpha = 0.84$), Automatism ($\alpha = 0.80$) and Attentional ($\alpha = 0.75$).

Peer Conflict Scale (PCS; Marsee et al., 2004). This is a self-report scale developed to evaluate the forms and functions of aggression. It consists of 40 items distributed among four subscales: Physical Proactive Aggression, Physical Reactive Aggression, Relational Proactive Aggression and Relational Reactive Aggression. The response format is based on a four-point Likert-type scale (0 = not at all true, 1 = somewhat true, 2 = very true and 3 = definitely true), and the elements are grouped in four subscales, scoring 0–30 on each. The authors (Marsee et al., 2011), found satisfactory internal consistency for each of the subscales (Physical Reactive $\alpha = 0.87$; Reactive Relational $\alpha = 0.77$; Physical Proactive $\alpha = 0.79$; Relational Proactive $\alpha = 0.76$).

Procedure

This study was exempt from ethical approval, because the study did not involve any potential risk for the participants. All participants provided written consent. Before collecting data, a meeting was held with the school directors/counselors where they were informed of the purposes, procedure and use of research data. When the tests were administered, the participants were guaranteed confidential data processing and given instructions for their completion. They were also informed that they were voluntary, anonymous and that their data were protected by applicable legislation. Two members of the research team traveled to the high schools to administer the tests.

Data Analysis

First, to identify the variables related to the different forms of aggression analyzed (Physical Proactive, Physical Reactive, Relational Proactive, and Relational Reactive), the Pearson's correlation coefficient was calculated as well as the corresponding descriptive statistics.

Stepwise multiple linear regression analysis was performed to find out how the predictor variables (Sensation-seeking: Gratification, Automatism and Attentional; Impulsivity: Emotion-seeking, Excitement-seeking, Disinhibition and Susceptibility to boredom) were related to each of the criterion variables.

RESULTS

Sensation-Seeking and Impulsivity Factors Related to Forms of Aggression

The correlation coefficients found show the existence of positive correlations between impulsivity (Gratification, Automatism and Attentional) and sensation-seeking (Emotion-seeking, Excitement-seeking, Disinhibition and Susceptibility to boredom) factors and the forms of aggression analyzed.

As observed in **Table 1**, adolescents with high scores in physical proactive aggression (AgPA) showed high levels of Gratification ($r = 0.31$; $p < 0.001$), Automatism ($r = 0.26$; $p < 0.001$), Attentional impulsivity ($r = 0.24$; $p < 0.001$), Emotion-seeking ($r = 0.06$; $p < 0.05$), Disinhibition ($r = 0.35$; $p < 0.001$) and Susceptibility to boredom ($r = 0.17$; $p < 0.001$).

Furthermore, high scores on Relational Proactive Aggression (AgPR) correlated positively with all the Impulsivity factors (Gratification: $r = 0.30$; $p < 0.001$; Automatism: $r = 0.26$; $p < 0.001$; Attentional: $r = 0.24$; $p < 0.001$), Disinhibition

TABLE 2 | Stepwise multiple linear regression (Physical Proactive Aggression).

Model	R	R^2	Corrected R^2	Change statistics				Durbin Watson
				Standard error of estimate	Change in R^2	Change in F	Significance of change in F	
1 (DES)	0.35	0.12	0.12	3.75	0.12	116.41	0.00	1.78
2 (DES, GRA)	0.39	0.15	0.15	3.69	0.02	28.05	0.00	
3 (DES, GRA, AUTO)	0.40	0.16	0.15	3.67	0.00	8.45	0.00	

Model	Unstandardized coefficients		Standardized coefficients	T	Sig.	Collinearity	
	B	Standard error	Beta			Tol.	VIF
(Constant)	−2.47	0.47		−5.26	0.00		
DES	0.44	0.06	0.25	7.01	0.00	0.76	1.30
GRA	0.12	0.04	0.12	2.99	0.00	0.55	1.80
AUTO	0.11	0.04	0.11	2.90	0.00	0.65	1.51

DES, Disinhibition; GRA, Gratification; AUTO, Automatism.

TABLE 3 | Stepwise multiple linear regression (Relational Proactive Aggression).

Model	R	R^2	Corrected R^2	Change statistics				Durbin Watson
				Standard error of estimate	Change in R^2	Change in F	Significance of change in F	
1 (DES)	0.31	0.10	0.10	3.54	0.10	92.21	0.00	1.68
2 (DES, AUTO)	0.36	0.13	0.13	3.47	0.03	30.73	0.00	
3 (DES, AUTO, GRA)	0.37	0.14	0.13	3.46	0.00	7.08	0.00	

Model	Unstandardized coefficients		Standardized coefficients	T	Sig.	Collinearity	
	B	Standard error	Beta			Tol.	VIF
(Constant)	−1.88	0.44		−4.25	0.00		
DES	0.36	0.06	0.22	6.01	0.00	0.76	1.30
AUTO	0.12	0.03	0.13	3.33	0.00	0.65	1.51
GRA	0.10	0.04	0.11	2.66	0.00	0.55	1.80

DES, Disinhibition; GRA, Gratification; AUTO, Automatism.

($r = 0.31$; $p < 0.001$) and Susceptibility to boredom ($r = 0.16$; $p < 0.001$). Physical Reactive Aggression (AgRA) as a component of aggression may be seen in **Table 1** to be correlated with all the components of Impulsivity (Gratification: $r = 0.35$; $p < 0.001$; Automatism: $r = 0.32$; $p < 0.001$; Attentional: $r = 0.32$; $p < 0.001$ and sensation-seeking (Emotion-seeking: $r = 0.13$; $p < 0.001$; Excitement-seeking: $r = 0.09$; $p < 0.01$; Desinhibition: $r = 0.40$; $p < 0.001$; Susceptibility to boredom: $r = 0.22$; $p < 0.001$).

Finally, as shown by the correlation coefficients found for Relational Reactive Aggression (AgRR), adolescents who showed this form of aggression were also observed to have high scores on Gratification ($r = 0.31$; $p < 0.001$), Automatism ($r = 0.26$; $p < 0.001$), Attentional ($r = 0.25$; $p < 0.001$), Emotion-seeking ($r = 0.07$; $p < 0.05$), Excitement-seeking ($r = 0.05$; $p < 0.05$), Desinhibition ($r = 0.31$; $p < 0.001$) and Susceptibility to boredom ($r = 0.19$; $p < 0.001$).

Proactive Aggression (Physical/Relational) Predictor Variables

Regression analysis yielded three models for Physical Proactive Aggression (**Table 2**) of which Model 3 has the most explanatory power with 16.2% ($R^2 = 0.16$) of the variance explained by the factors included in the model.

To confirm model validity, independence of residuals was analyzed. The Durbin–Watson D statistic found was $D = 1.78$, which confirms the absence of positive and negative autocorrelation.

TABLE 4 | Stepwise multiple linear regression (Physical Reactive Aggression).

Model	*R*	R^2	Corrected R^2	Change statistics				Durbin Watson
				Standard error of estimate	Change in R^2	Change in *F*	Significance of change in *F*	
1 (DES)	0.40	0.16	0.16	5.03	0.16	159.96	0.00	1.85
2 (DES, AUTO)	0.45	0.21	0.20	4.89	0.04	48.89	0.00	
3 (DES, AUTO, GRA)	0.46	0.21	0.21	4.87	0.00	7.76	0.00	

Model	Unstandardized coefficients		Standardized coefficients	*T*	Sig.	Collinearity	
	B	Standard error	Beta			Tol.	VIF
(Constant)	−2.46	0.62		−3.95	0.00		
DES	0.71	0.08	0.29	8.41	0.00	0.76	1.30
AUTO	0.24	0.05	0.17	4.50	0.00	0.65	1.51
GRA	0.15	0.05	0.11	2.78	0.00	0.55	1.80

DES, Disinhibition; GRA, Gratification; AUTO, Automatism.

TABLE 5 | Stepwise multiple linear regression (Relacional Reactiva Agresión).

Model	*R*	R^2	Corrected R^2	Change statistics				Durbin Watson
				Standard error of estimate	Change in R^2	Change in *F*	Significance of change in *F*	
1 (DES)	0.31	0.10	0.10	3.96	0.10	91.98	0.00	1.65
2 (DES, GRA)	0.36	0.13	0.13	3.88	0.03	32.63	0.00	
3 (DES, GRA, AUTO)	0.38	0.14	0.14	3.86	0.00	8.60	0.00	

Model	Unstandardized coefficients		Standardized coefficients	*T*	Sig.	Collinearity	
	B	Standard error	Beta			Tol.	VIF
(Constante)	−1.27	0.49		−2.57	0.01		
DES	0.38	0.06	0.21	5.76	0.00	0.76	1.30
GRA	0.14	0.04	0.14	3.33	0.00	0.55	1.80
AUTO	0.12	0.04	0.11	2.93	0.00	0.65	1.51

DES, Disinhibition; GRA, Gratification; AUTO, Automatism.

As shown in **Table 2**, the *T* was associated with a probability of error below 0.05 in all the variables included in the model. Furthermore, the standardized coefficients revealed that the variables with the most explanatory weight were Disinhibition, Automatism and Gratification, and the first of them (Disinhibition) was the strongest predictor of Physical Proactive Aggression. Finally, the absence of collinearity between variables included in the model may be assumed as tolerance is high and VIF is low.

The three Relational Proactive Aggression models resulting from the regression analysis are shown in **Table 3**, where Model 3 found 14.1% explained variance ($R^2 = 0.14$). In this case, the Dubin–Watson *D* confirmed no correlation of residuals ($D = 1.68$).

The *T* statistic shows an association with a probability of error below 0.05 for all the variables included in the model, Gratification, Desinhibition and Automatism. According to the standardized coefficients found in this case, the Disinhibition variable is the strongest predictor of relational proactive aggression.

In view of the values found for the Tolerance and VIF indicators, in this case, collinearity of variables is assumed to be absent, since tolerance is high and VIF is low.

Reactive Aggression (Physical/Relational) Predictor Variables

As shown in **Table 4**, three models were found when Physical Reactive Aggression was the variable entered, the third of

which had the most explanatory power. The Automatism, Gratification and Disinhibition variables included in the model explained 21.5% of the variance ($R^2 = 0.21$) in physical reactive aggression. The validity of the model is also reflected in the independence of the residuals with a Durbin–Watson $D = 1.85$.

The T statistic is associated with a probability of error of less than 0.05 in the five variables in the model (**Table 4**). And according to the standardized coefficients, the variables with the highest explanatory weight are Disinhibition, Automatism and Gratification. These coefficients show the Disinhibition variable to be the strongest predictor of physical reactive aggression. In this case, collinearity of variables is assumed to be absent as indicated by high tolerance and low VIF.

As the result of multiple regression analysis, three models are also found for Relational Reactive Aggression, of which Model 3 is the one with the highest explanatory power, with 14.4% ($R^2 = 0.14$) of the variance explained by the factors included in the model (**Table 5**).

To confirm the validity of the model, the independence of residuals was analyzed. The Durbin–Watson D was $D = 1.65$, confirming absence of positive and negative autocorrelation.

Table 5 shows that the T value is associated with a probability of error of less than 0.05 in all the variables included in the model. Furthermore, the standardized coefficients reveal that the Disinhibition factor is the strongest predictor of relational reactive aggression.

Finally, collinearity of the variables included in the model is assumed to be absent since tolerance indicators are high and VIF is low.

DISCUSSION AND CONCLUSION

In the first place, results show the existence of a positive correlation of most of the impulsivity and sensation-seeking factors analyzed with the different forms of aggression (Newcomb and McGee, 1991; Raine et al., 2006). The exceptional cases in which there is no correlation refer to proactive aggression and emotion/excitement-seeking. It is reasonable to argue that sensation-seeking and risk-taking become more evident in children with reactive aggression, since they tend to seek excitement and act on their impulses in the rush of the moment, while children with proactive aggression are able to channel their aggressive behavior in a more calculated manner (Dodge et al., 2006). According to Steinberg et al. (2008), sensation-seeking could have specific effects on deviant behavior. Thus the expression of a certain type of aggression could be mediated by individual factors (Centifanti et al., 2015; Gázquez et al., 2015b), cognitive and social processes (Gifford-Smith and Rabiner, 2004; Monahan et al., 2009; Martínez-Loredo et al., 2016) and even characterization of the various expressions of aggression itself (Stickle et al., 2012).

The purpose of this study was to find out the predictive value of sensation seeking and impulsivity for the functions of aggression (reactive/proactive) and its forms of expression (physical/relational) in adolescents. The results of multiple regression analysis reveal that in all cases, aggressive behavior is explained by the combination of a sensation-seeking factor (Disinhibition) and two impulsivity factors (Gratification and Automatism). The fact that they are the same components that combine to construct the model of each of the forms of aggression analyzed (García-Sancho et al., 2016) supports the idea of interrelation of the functions of aggression (Dodge et al., 1990).

The presence of the Disinhibition component as one of the aggression predictor variables (Wilson and Scarpa, 2011) demonstrates the tendency to experience new sensations during adolescence (Jessor et al., 1998). This orientation toward sensation-seeking is present not only in the development of aggressive behavior, but is also found as a predictor in other adolescent problem behavior such as substance use (Curran et al., 2010). The inclusion of impulsivity factors, which are also present in other adolescent risk behaviors (MacPherson et al., 2010), in the models reflects their association with aggression in all its forms (Moeller et al., 2001; Romer, 2010).

Relatively few studies have considered sensation-seeking and impulsivity in relation to reactive and proactive aggression (Cui et al., 2016). Findings such as these show the need to give the analysis of aggression as a multidimensional construct more attention (García-Sancho et al., 2016) to the extent that its different functions and forms of expression have been identified as responsible for a variety of effects in adolescent development (Hubbard et al., 2010; Scarpa et al., 2010; Fite et al., 2014), and even afterward (Cleverley et al., 2012).

The main limitations of the study are that: (1) The sample, although representative, is comprised only of high school students and cannot be generalized to other grade levels, and therefore, one of the future lines of research is the replication of this study in other years; and, (2) the biases typical of self-report techniques, for example, the associations found with the effects of social desirability, which with age show positive relationships to certain desirable characteristics in the self-report.

However, although this study does have some limitations which should be kept in mind for future research, it may be considered a precursor, and is of great interest for the relevant data it contributes to the design of interventions which make it possible to work on reducing risk factors and strengthening those which protect against aggressive behavior.

Therefore, progress made in research along this line requires development of future analyses based on causal models and the analysis of mediating factors in aggressive behavior in all of its forms. In other words, adolescent intervention must be able to counteract the tendency to sensation-seeking and any other form of impulsivity related to the origin and/or maintenance of aggressive behavior.

AUTHOR CONTRIBUTIONS

MP and MJ (Drafting and analysis of data). JM and IR (bibliographic search). JG (Reviewers made changes).

FUNDING

This study was done with the collaboration of the Almeria Provincial Government.

REFERENCES

Álvarez, A., Suárez, N., Tuero, E., Núñez, J., Valle, A., and Regueiro, B. (2015). Implicación familiar, autoconcepto del adolescente y rendimiento académico [Family involvement, adolescent self-concept and academic achievement]. *Eur. J. Invest.* 5, 293–311. doi: 10.1989/ejihpe.v5i3.133

Archer, J., and Webb, I. A. (2006). The relation between scores on the buss-perry aggression questionnaire and aggressive acts, impulsiveness, competitiveness, dominance, and sexual jealousy. *Aggress. Behav.* 32, 464–473. doi: 10.1002/ab.20146

Azpiazua, L., Esnaola, I., and Sarasa, M. (2015). Capacidad predictiva del apoyo social en la inteligencia emocional de adolescentes [Predictive capacity of social support on emotional intelligence in adolescence]. *Eur. J. Educ. Psychol.* 8, 23–29. doi: 10.1016/j.ejeps.2015.10.003

Bushman, B. J., and Anderson, C. A. (2001). Is it Time to pull the plug on the hostile versus instrumental aggression dichotomy? *Psychol. Rev.* 108, 273–279. doi: 10.1037/1076-8971.13.2.143

Buss, A. H. (1961). *The Psychology of Aggression*. Oxford: Wiley.

Card, N. A., and Little, T. D. (2006). Proactive and reactive aggression in childhood and adolescence: a meta-analysis of differential relations with psychosocial adjustment. *Int. J. Behav. Dev.* 30, 466–480. doi: 10.1177/0165025406071904

Cardoso-Moreno, M. J., Tomás-Aragonés, L., and Rodríguez-Ledo, C. (2015). Socio-emotional intervention in attention déficit hyperactive disorder. *Eur. J. Educ. Psychol.* 8, 53–59. doi: 10.1016/j.ejeps.2015.07.001

Centifanti, L. C. M., Fanti, K. A., Thomson, N. D., Demetriou, V., and Anastassiou-Hadjicharalambous, X. (2015). Types of relational aggression in girls are differentiated by callous-unemotional traits, peers and parental overcontrol. *Behav. Sci.* 5, 518–536. doi: 10.3390/bs5040518

Cleverley, K., Szatmari, P., Vaillancourt, T., Boyle, M., and Lipman, E. (2012). Developmental trajectories of physical and indirect aggression from late childhood to adolescence: sex differences and outcomes in emerging adulthood. *J. Am. Acad. Child Adolesc. Psychiatry* 51, 1037–1051. doi: 10.1016/j.jaac.2012.07.010

Cui, L., Colasante, T., Malti, T., Ribeaud, D., and Eisner, M. P. (2016). Dual trajectories of reactive and proactive aggression from mid-childhood to early adolescence: relations to sensation seeking, risk taking, and moral reasoning. *J. Abnorm. Child Psychol.* 44, 663–675. doi: 10.1007/s10802-015-0079-7

Curran, M. F., Fuertes, J. N., Alfonso, V. C., and Hennessy, J. J. (2010). The association of sensation seeking and impulsivity to driving while under the influence of alcohol. *J. Addict. Offender Couns.* 30, 84–98. doi: 10.1002/j.2161-1874.2010.tb00059.x

Dodge, K. A., and Coie, J. D. (1987). Social information-processing factors in reactive and instrumental aggression in children's playgroups. *J. Pers. Soc. Psychol.* 53, 1146–1158. doi: 10.1037/0022-3514.53.6.1146

Dodge, K. A., Coie, J. D., and Lynam, D. (2006). "Aggression and antisocial behavior in youth," in *Handbook of Child Psychology. Social, Emotional, and Personality Development*, Vol. 3, eds N. Eisenberg, D. William, and R.M. Lerner (Hoboken, NJ: Wiley), 719–788.

Dodge, K. A., Price, J. M., Bachorowski, J. A., and Newman, J. P. (1990). Hostile attributional biases in severely aggressive adolescents. *J. Abnorm. Psychol.* 99, 385–392. doi: 10.1037/0021-843X.99.4.385

Fite, P. J., Rubens, S. L., Preddy, T. M., Raine, A., and Pardini, D. A. (2014). Reactive/proactive aggression and the development of internalizing problems in males: the moderating effect of parent and peer relationships. *Aggress. Behav.* 40, 69–78. doi: 10.1002/ab.21498

Frick, P. J., and Dickens, C. (2006). Current perspectives on conduct disorder. *Curr. Psychiatry Rep.* 8, 59–72. doi: 10.1007/s11920-006-0082-3

García-Sancho, E., Salguero, J. M., Vasquez, E. A., and Fernández-Berrocal, P. (2016). Validity and reliability of the Spanish version of the displaced aggression questionnaire. *Psicothem* 28, 96–101. doi: 10.7334/psicothema 2015.222

Gázquez, J. J., Pérez-Fuentes, M. C., Carrión, J. J., Luque, A., and Molero, M. M. (2015b). Interpersonal value profiles and analysis to adolescent behavior and social attitudes. *J. Psychodidact.* 20, 321–337. doi: 10.1387/RevPsicodidact.12978

Gázquez, J. J., Pérez-Fuentes, M. C., Molero, M. M., Martos, A., Cardila, F., Barragán, A. B., et al. (2015a). Adaptación española del cuestionario de expectativas del alcohol en adolescentes [Spanish adaptation of the alcohol expectancy-adolescent questionnaire, brief]. *Eur. J. Invest.* 5, 357–369. doi: 10.1989/ejihpe.v5i3.138

Gifford-Smith, M. E., and Rabiner, D. L. (2004). "Social information processing an children's social adjustment," in *Children's Peer Relations: From Development to Intervention*, eds J. B. Kupersmidt and K. A. Dodge (Washington, DC: American Psychological Association), 61–79.

Goñi, E., Esnaola, I., Rodríguez, A., and Ortiz de Barrón, I. (2015). Personal self-concept and satisfaction with life in adolescence, youth and adulthood. *Psicothema* 27, 52–58. doi: 10.7334/psicothema2014.105

Grimaldi, E. M., Napper, L. E., and LaBrie, J. W. (2014). Relational aggression, positive urgency and negative urgency: predicting alcohol use and consequences among college students. *Psychol. Addict. Behav.* 28, 893–898. doi: 10.1037/a0037354

Grotpeter, J. K., and Crick, N. R. (1996). Relational aggression, overt aggression, and friendship. *Child Dev.* 67, 2328–2338. doi: 10.2307/1131626

Hartup, W. W. (1974). Aggression in childhood: developmental perspectives. *Am. Psychol.* 29, 336–341. doi: 10.1037/h0037622

Hatfield, J., and Dula, C. S. (2014). Impulsivity and physical aggression: examining the moderating role of anxiety. *Am. J. Psychol.* 127, 233–243. doi: 10.5406/amerjpsyc.127.2.0233

Hubbard, J. A., McAuliffe, M. D., Morrow, M. T., and Romano, L. J. (2010). Reactive and proactive aggression in childhood and adolescence: precursors, outcomes, processes, experiences, and measurement. *J. Pers.* 78, 95–118. doi: 10.1111/j.1467-6494.2009.00610.x

Inglés, C. J., Gonzálvez-Maciá, C., García-Fernández, J. M., Vicent, M., and Martínez-Monteagudo, M. C. (2015). Current status of research on school refusal. *Eur. J. Educ. Psychol.* 8, 37–52. doi: 10.1016/j.ejeps.2015.10.005

Inglés, C. J., Torregrosa, M. S., García-Fernández, J. M., Martínez-Monteagudo, M. C., Estévez, E., and Delgado, B. (2014). Conducta agresiva e inteligencia emocional en la adolescencia [Aggressive behavior and Emotional Intelligence in adolescence]. *Eur. J. Educ. Psychol.* 7, 29–41. doi: 10.1989/ejep.v7i1.150

Iribarren, M. M., Jiménez-Giménez, M., García-de Cecilia, J. M., and Rubio-Valladolid, G. (2011). Validación y propiedades psicométricas de la escala de impulsividad estado (EIE) [Validation and psychometric properties of the state impulsivity scale (SIS)]. *Actas Esp. Psiquiatr.* 39, 49–60.

Jessor, R., Turbin, M. S., and Costa, F. M. (1998). Protective factors in adolescent health behavior. *J. Pers. Soc. Psychol.* 75, 788–800. doi: 10.1037/0022-3514.75.3.788

MacPherson, L., Magidson, J. F., Reynolds, E. K., Kahler, C. W., and Lejuez, C. W. (2010). Changes in sensation seeking and risk-taking propensity predict increases in alcohol use among early adolescents. *Alcohol. Clin. Exp. Res.* 34, 1400–1408. doi: 10.1111/j.1530-0277.2010.01223.x

Marsee, M. A., Barry, C. T., Childs, K. K., Frick, P. J., Kimonis, E. R., Muñoz, L. C., et al. (2011). Assessing the forms and functions of aggression using self-report: factor structure and invariance of the Peer Conflict Scale in youths. *Psychol. Assess.* 23, 792–804. doi: 10.1037/a0023369

Marsee, M. A., and Frick, P. J. (2007). Exploring the cognitive and emotional correlates to proactive and reactive aggression in a sample of detained girls. *J. Abnorm. Child Psychol.* 35, 969–981. doi: 10.1007/s10802-007-9147-y

Marsee, M. A., Kimonis, E. R., and Frick, P. J. (2004). *Peer Conflict Scale*. New Orleans, LA: University of New Orleans.

Martínez-Loredo, V., Fernández-Artamendi, S., Weidberg, S., Pericot, I., López-Núñez, C., Fernández-Hermida, J., et al. (2016). Parenting styles and alcohol use among adolescents: a longitudinal study. *Eur. J. Invest.* 6, 27–36.

Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M., and Swann, A. C. (2001). Psychiatric aspects of impulsivity. *Am. J. Psychiatry* 158, 1783–1793. doi: 10.1176/appi.ajp.158.11.1783

Monahan, K. C., Steinberg, L., and Cauffman, E. (2009). Affiliation with antisocial peers, susceptibility to peer influence, and antisocial behavior during the transition to adulthood. *Dev. Psychol.* 45, 1520–1530. doi: 10.1037/a0017417

Nacimiento, R. L., and Mora-Merchán, J. A. (2014). El uso de estrategias de afrontamiento y habilidades metacognitivas ante situaciones de bullying y cyberbullying [The use of coping strategies and metacognitive skills in situations of bullying and cyberbullying]. *Eur. J. Educ. Psychol.* 7, 121–129. doi: 10.1989/ejep.v7i2.184

Newcomb, M. D., and McGee, L. (1991). Influence of sensation seeking on general deviance and specific problem behaviors from adolescence to young adulthood. *J. Pers. Soc. Psychol.* 61, 614–628. doi: 10.1037/0022-3514.61.4.614

Pérez, J., and Torrubia, R. (1986). Fiabilidad y validez de la versión española de la escala de búsqueda de sensaciones (Forma V) [Reliability and validity of the Spanish version of the sensation seeking scale (Form V)]. *Rev. Latinoam. Psicol.* 18, 7–22.

Pérez-Fuentes, M., Gázquez, J., Molero, M., Cardila, F., Martos, A., Barragán, A., et al. (2015). Impulsividad y consumo de alcohol y tabaco en adolescentes [Adolescent impulsiveness and use of alcohol and tobacco]. *Eur. J. Invest.* 5, 371–382. doi: 10.1989/ejihpe.v5i3.139

Poulin, F., and Boivin, M. (2000). Reactive and proactive aggression: evidence of a two-factor model. *Psychol. Assess.* 12, 115–122. doi: 10.1037/1040-3590.12.2.115

Raine, A., Dodge, K., Loeber, R., Gatzke-Kopp, L., Lynam, D., Reynolds, C., et al. (2006). The reactive-proactive aggression questionnaire: differential correlates of reactive and proactive aggression in adolescent boys. *Aggress. Behav.* 32, 159–171. doi: 10.1002/ab.20115

Romer, D. (2010). Adolescent risk taking, impulsivity, and brain development: implications for prevention. *Dev. Psychobiol.* 52, 263–276. doi: 10.1002/dev.20442

Scarpa, A., Haden, S. C., and Tanaka, A. (2010). Being hot-tempered: autonomic, emotional, and behavioral distinctions between childhood reactive and proactive aggression. *Biol. Psychol.* 84, 488–496. doi: 10.1016/j.biopsycho.2009.11.006

Steinberg, L., Albert, D., Cauffman, E., Banich, M., and Graham, S. (2008). Age differences in sensation seeking and impulsivity as indexed by behavior and self-report: evidence for a dual systems model. *Dev. Psychol.* 44, 1764–1778. doi: 10.1037/a0012955

Stickle, T. R., Marini, V. A., and Thomas, J. N. (2012). Gender differences in psychopathic traits, types, and correlates of aggression among adjudicated youth. *J. Abnorm. Child Psychol.* 40, 513–525. doi: 10.1007/s10802-011-9588-1

Valle, A., Regueiro, B., Rodríguez, S., Piñeiro, I., Freire, C., Ferradás, M. M., et al. (2015). Perfiles motivacionales como combinación de expectativas de autoeficacia y metas académicas en estudiantes universitarios [Motivational profiles as a combination of self-efficacy expectations and academic goals in university students]. *Eur. J. Educ. Psychol.* 8, 1–8. doi: 10.1016/j.ejeps.2015.10.001

Valzelli, L. (1983). *Psicobiología de la Agresión y la Violencia [Psychobiology of Aggression and Violence]*. Madrid: Alhambra.

Wilson, L. C., and Scarpa, A. (2011). The link between sensation seeking and aggression: a meta-analytic review. *Aggress. Behav.* 37, 81–90. doi: 10.1002/ab.20369

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Pérez Fuentes, Molero Jurado, Carrión Martínez, Mercader Rubio and Gázquez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 22 September 2016
doi: 10.3389/fpsyg.2016.01385

Effect of a Mindfulness Training Program on the Impulsivity and Aggression Levels of Adolescents with Behavioral Problems in the Classroom

Clemente Franco[1], Alberto Amutio[2], Luís López-González[3], Xavier Oriol[4] and Cristina Martínez-Taboada[2]*

[1] Department of Psychology, Faculty of Educational Sciences, University of Almería, Almería, Spain, [2] Department of Social Psychology and Methodology of the Behavioral Sciences, Faculty of Psychology, University of the Basque Country, San Sebastian, Spain, [3] Institute of Educational Sciences, University of Barcelona, Barcelona, Spain, [4] Department of Management and Public Policies, Universidad de Santiago de Chile, Santiago, Chile

Objective: The aim of the present study was to analyze the effects of a mindfulness training psycho-educative program on impulsivity and aggression levels in a sample of high school students.

Methods: A randomized controlled trial with pre-test–post-test measurements was applied to an experimental group and a control group (waiting list). The Barratt Impulsivity Scale (BIS-11) Patton et al. (1995) and the Aggression Questionnaire (Buss and Perry, 1992) were used.

Results: Statistical analyses showed a significant decrease in the levels of impulsivity and aggressiveness in the experimental group compared with the control group. These results have important implications for improving the level of academic engagement and self-efficacy of students and for reducing school failure.

Conclusion: This is one of the first studies showing the effectiveness of mindfulness training at reducing impulsive and aggressive behaviors in the classroom. The efficacy of mindfulness-based programs is emphasized.

Keywords: mindfulness, impulsivity, aggressiveness, school failure, students

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Claudio Longobardi, University of Turin, Italy
Ramos Díaz Natalia, University of Málaga, Spain

***Correspondence:**
Alberto Amutio
alberto.amutio@ehu.eus

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *22 June 2016*
Accepted: *30 August 2016*
Published: *22 September 2016*

Citation:
Franco C, Amutio A, López-González L, Oriol X and Martínez-Taboada C (2016) Effect of a Mindfulness Training Program on the Impulsivity and Aggression Levels of Adolescents with Behavioral Problems in the Classroom. Front. Psychol. 7:1385. doi: 10.3389/fpsyg.2016.01385

INTRODUCTION

Aggressive behavior in both children and adolescents is considered a complex phenomenon that involves multiple factors and manifests in a variety of forms. Among the variables related to this phenomenon are personal traits (e.g., psychopathy, neuroticism, impulsivity, search for sensations), socio-emotional (lack of empathy, self-esteem, personal values), and cognitive variables (e.g., maladaptive schemas and dysfunctional thoughts) (Condon et al., 2013; Estévez et al., 2016; Orue et al., 2016; Pellerone et al., 2016).

Diverse sources and causes of impulsivity and aggressiveness in students are discussed in the literature, including parental style and insecure attachment, peer pressure (Estévez et al., 2016), conflictual relations with the teachers (Settanni et al., 2015), lack of emotional self-control,

especially of negative affectivity (Peters et al., 2015; Sanger and Dorjee, 2015), emotional avoidance (Mestre et al., 2012), low compassion (Morley et al., 2016), and even neuroanatomical (Thijssen et al., 2015), among others. Students with aggressive behavior show deficiency in emotional self-control and empathy, features pertaining to the emotional intelligence trait. Therefore, these students will face more difficulties to deal with social situations and their incapacity to adequately managing their emotions may lead them to behave in aggressive ways before uncertain situations (Mestre et al., 2012; Inglés et al., 2014).

Impulsivity is a risk factor associated with reactive aggression and antisocial behavior during adolescence (Orue et al., 2016). In particular, impulsive motor behavior appears to be the factor that seems to discriminate better between aggressive and non-aggressive adolescents (Oberle et al., 2011; Andreu et al., 2013). Thus, impulsive adolescents without sufficient emotional control and no ability to delay gratification are driven by the emotional momentum and little or inadequate forethought. Furthermore, impulsivity and aggressiveness are related, on the one hand, to maladaptive or risk-taking behaviors such as substance abuse or sexual promiscuity (Paydary et al., 2016) and, on the other hand, to mental disorders, attention-deficit hyperactivity disorder, reading problems, and poor academic results (Fix and Fix, 2013; Nelson et al., 2015).

School related tasks require the ability to use and regulate emotions in order to increase concentration, develop intrinsic motivation, and control impulsive thinking and hostility. Adolescents with high levels of aggression use non-productive coping strategies to a greater extent, whereas less aggressive adolescents mainly focus on strategies aimed at solving problems and relating to others in more adaptive way (Samper et al., 2008; Mestre et al., 2012).

In Spain, the percentage of school failure or dropout (i.e., those students who leave the educational system) during the 2012–2013 course was 23.5% (Eurostat, 2014), the double of the European Union percentage (11.9%) for the same period and higher than in other countries, such as the United States and China. Some regions in Spain even reached 29.8% (Veas et al., 2016). The considerable percentage of students that fail school or underachieve can be related, in part, to personal problems, including anxiety, depression, and behavioral problems such as impulsivity and aggression (Broderick and Metz, 2009). Furthermore, school failure is related to alcohol consumption. A study conducted by Goldberg-Looney et al. (2016) found that academic problems explained 5.1% of the variance in adolescents' alcohol use in a sample of 567 adolescents in Spain.

Impulsivity and risk-taking behavior increase from childhood to adolescence (Oberle et al., 2011; Mestre et al., 2012). The high rate of school failure, along with the increase of emotional disorders, related to stress, anxiety, and aggressive behavior found in Secondary Education and High School students, and even among university students (Amutio and Smith, 2008; Inglés et al., 2014), requires the implementation of psycho-educational programs and emotional self-regulation strategies aimed at activating students' internal resources, including self-efficacy in order to promote the improvement of interpersonal relationships and academic performance (León, 2008; Amutio et al., 2015a; Gouda et al., 2016), and reducing the risk of school failure. All of the above also implies the need for providing special training to teachers (Kaspereen, 2012; Kemeny et al., 2012; Gouda et al., 2016).

The number of programs to assess and prevent aggressive behavior in adolescence is scarce. In Spain there is a program directed to prevent different types of school violence and aggressiveness, including bullying and cyberbullying (Cyberprogram 2.0; Garaigordobil et al., 2015; Garaigordobil and Martínez-Valderrey, 2016). It consists of different activities to develop coping strategies and other transversal goals, such as developing interpersonal skills (empathy, active listening, social skills, constructive conflict resolution, etc). Additional techniques to reduce aggressiveness include emotional education, improving self-control and problem-solving skills, especially with adolescents showing impulsivity and reactive aggression (Orue et al., 2016).

Another type of intervention, whose effectiveness has been proven are mindfulness techniques. Mindfulness-based interventions have been associated with numerous beneficial outcomes in emotional regulation, including decreased anxiety (Amutio et al., 2015b), depression (Condon et al., 2013), and anger expression reduction (Fix and Fix, 2013; Zenner et al., 2014; Gouda et al., 2016). In the last decade, the practice of mindfulness has proven effective to the development of healthier habits and the generation of better classroom climate (Schonert-Reichl and Lawlor, 2010; López-González et al., 2016), which, in turn, have led to improvements on students' performance (Franco et al., 2011; Wisner, 2013; López-González and Oriol, 2016). Consequently, a range of mindfulness programs is taking place nowadays in schools as, for example, the *Mindfulness Based Wellness Education (MBWE)* of Toronto University, the Mindfulness in Schools Project (MISP) in England, the *Inner Kids Program, Cultivating Awareness and Resilience in Education* (CARE) and *Stress Management and Relaxation Techniques* (SMART) in the USA. In Spain, it is worth noting the *TREVA Program* (López-González et al., 2016), *Aulas Felices* (Arguís, 2014), and the *Meditación Fluir* Program (Franco et al., 2011).

One definition of mindfulness is to pay attention in a particular way, on purpose, in the present moment, and non-judgmentally (Kabat-Zinn, 2009). Furthermore, mindfulness implies observing the thoughts and emotional reactions that occur at each moment by distancing from them (decentering), that is, not reacting before their presence in the automatic usual way (Krishnakumar and Robinson, 2015; Peters et al., 2015), thus, breaking the thinking-feeling-acting typical pattern. Thereby, and through continuous practice, students learn to concentrate on the task they are performing, without allowing their minds to digress or get distracted. This provides students with a new perspective that facilitates reflection and learning.

Currently, extensive data support the use of mindfulness in the achievement of greater levels of relaxation, well-being, and improvement of academic performance (Beauchemin et al., 2008; León, 2008; Schonert-Reichl and Lawlor, 2010; Franco et al., 2011; Choi et al., 2012; Amutio et al., 2015c). In addition, recent neurodevelopmental findings show that mindfulness and social-emotional learning programs

implemented in regular school curricula improve executive functions in children and adolescents in terms of inhibitory control, enabling them to manage excessive levels of negative emotions that interfere with academic performance (Davidson et al., 2012; Sanger and Dorjee, 2015). Studies conducted on both clinical and non-clinical samples (Zenner et al., 2014) include children and adolescents with attention deficit hyperactivity disorder (van de Weijer-Bergsma et al., 2012; Van der Oord et al., 2012; Cardoso-Moreno et al., 2015), anxiety (Beauchemin et al., 2008), hostility (Sibinga et al., 2011), and externalizing disorders, such as impulsivity (Bögels et al., 2008), as well as adolescents at risk (Bluth et al., 2016).

In spite of these findings, meditation treatment effects among youth are relatively unknown (Black et al., 2009). Currently, controlled studies measuring the impact of mindfulness training on reducing impulsivity and hostility levels of adolescents in the classroom barely exist. Moreover, little is known about the association of mindfulness with decreased emotional reactivity and improved impulse-control, especially in adolescents. Among the few studies conducted, we highlight those of Oberle et al. (2011) and Fishbein et al. (2016). These studies consisted of an intervention in adolescents with high-risk behaviors and are among the first ones assessing the effectiveness of a mindfulness-training program to reduce impulsivity and aggression levels of adolescents in the classroom.

Given the current situation, the aim of this study is to prove the effect of a mindfulness training psycho-educational program applied to a group of adolescents with behavioral problems in the classroom on their impulsivity and aggression levels, assuming the following hypothesis:

H1: Those adolescents with behavioral problems in the classroom and participating in a mindfulness training psycho-educational program will experience a significant decrease in their impulsivity levels compared to the group of adolescents with behavioral problems in the classroom that were not part of the intervention program.

H2: Those adolescents with behavioral problems in the classroom and participating in a mindfulness training psycho-educational program will experience a significant decrease in their aggression levels compared to the group of adolescents with behavioral problems in the classroom that were not part of the intervention program.

MATERIALS AND METHODS

Participants

Twenty seven students with ages from 12 to 19 years (Mean = 15.85; Standard deviation = 2.38), who were attending a public high school center located in the province of Granada participated in this study. In this sample, 59% of the participants were boys and 41% girls. The control group was made up of 14 individuals (57% boys and 43% girls), while the 13 individuals remaining were sent to the experimental group (62% boys and 38% girls).

Instruments

Barratt Impulsivity Scale (BIS-11) (Patton et al., 1995)

This questionnaire is composed of 30 items grouped in three impulsivity sub-scales:

- Cognitive impulsivity (8 items): tendency to make quick decisions.
- Motor impulsivity (10 items): propensity to act solely on the spur of the moment, without thinking of the consequences.
- Non-planned impulsivity (12 items): indicates lack of planning of future actions.

Each item comprises four Likert-type answer options: rarely/never, occasionally, often, and almost always/always. The score of each sub-scale is calculated by adding up the partial scores obtained in each item. The total score is the sum of all the items.

The Spanish version of this scale, created by Oquendo et al. (2001) was administered. The internal consistency of the different scales used in the study sample was obtained using Cronbach's alpha, which presented values ranging from 0.77 to 0.92.

Aggression Questionnaire (AQ) (Buss and Perry, 1992)

This instrument is used to measure aggressiveness. In this study, the Spanish version created by Rodríguez et al. (2002) was used. The questionnaire is composed of 29 items with five Likert-type answer options (1 = *very few times*, 5 = *lots of times*) that form the following scales:

- Physical aggressiveness (9 items): it refers to physical behaviors that hurt or harm other people.
- Verbal aggressiveness (5 items): it is related to verbal behaviors that hurt or harm other people.
- Hostility (8 items): assesses the cognitive aspects of aggression.
- Anger (7 items): assesses the emotional and affective aspects of aggression.

Regarding the reliability coefficients for the studied sample, these range from 0.72 in the verbal aggression scale to 0.85 in the physical aggression scale.

Procedure

Firstly, to obtain the sample, an interview with the principal, the head of studies and the head of the counseling department of the high school center was conducted in order to explain the study objectives and to ask permission and collaboration for the application of the questionnaires. Subsequently, 27 students that had been sent more than five times to the counseling room during the first term of the school year due to misbehavior in the classroom were selected as the sample. All parents provided informed consent. The study was approved by the Committee of Bioethics of the University of Almería, Spain. The registered data for each of the instruments was alphanumerically coded, ensuring confidentiality and anonymity, in order to comply with the Personal Data Protection Act by the Ethics Committee for Research related to Human Beings (CEISH). International ethical guidelines for studies

with human subjects described in the Nuremberg Code and in the Declaration of Helsinki were applied (Kim, 2012).

Students were randomly assigned to the control ($n = 14$) and experimental groups ($n = 13$), controlling for sex and grade to avoid the interference of these variables in the results. Once the sample was obtained, pre-test measurements for the different dimensions of the impulsivity and aggressiveness variables were obtained by asking the participants to individually complete the questionnaires.

Subsequently, the intervention program was applied to the experimental group over 10 weekly sessions that took place during the counseling hours of the students. This intervention program consisted in the learning and daily practice of a mindfulness technique named *Meditación Fluir* for 15 min (Franco et al., 2011, 2014). The principal goal of this practice is attempting neither to control thoughts, sensations or feeling nor altering or change them by new ones, but the contrary, i.e., let them free to come and go, and accepting any personal sensation and feeling that may arise spontaneously.

Therefore, the essence of this technique is being aware of what happens in the mind and body in a passive way, without exerting any effort on modifying or changing the situation, perceiving things as they truly are and as they occur in every moment. Thus, this mindfulness practice enables the capacity to observe thoughts and other mental activity without getting involved in it—i.e., without analyzing, judging, or evaluating it—, breaking people's habit of being carried away and dragged by automatic and uncontrolled thoughts. In other words, students become aware of the presence of thoughts during the practice, but do not reflect upon their content or truthfulness, realizing that thoughts and sensations change at every moment and are constantly flowing. Consequently, through this technique, students understand from experience that thoughts continuously appear and disappear in a constant flow. In this way, students learn to be present, open and balanced against any mental or emotional phenomenon or process.

Another aspect of the mindfulness program that was learned and put into practice during the 10 sessions was the performance of *body-scan* exercises (Kabat-Zinn, 2009). Body-scan is a technique in which attention is orderly and systematically paid to different body parts, subsequently expanding consciousness to the whole body, thereby achieving holistic awareness of the body without making value judgments nor trying to change or eliminate anything (e.g., proprioceptive and interoceptive sensations, mental reactions, etc.), that is, being always present.

Once mindfulness training was completed in the experimental group, post-test measurements for the different dimensions of the impulsivity and aggressiveness variables were obtained by the same method used in the pre-test stage. Once the study, was completed the mindfulness-based training program was delivered to the control group.

Design and Data Analysis

A quasi-experimental comparison group pre-test–post-test design with experimental and control groups was used to analyze the effects of the mindfulness training program (independent variable) on the different dimensions of the impulsivity and aggressiveness variables (dependent variables).

The existence of statistically significant differences between the mean scores of the control and experimental group in the different dimensions of impulsivity and aggression in each stage of the study was proved by means of the non-parametric statistical test *Mann–Whitney U* for independent samples, since data did not adjust to the normal probability distribution.

Next, non-parametric statistical test *Wilcoxon* for comparing related samples was used in order to prove the existence of statistically significant differences between the mean scores of the different dimensions of impulsivity and aggression in each stage of the study, for both the control and experimental groups.

Finally, Cohen's *d* and the percentage of change in the pre-test–post-test scores were used to determine the magnitude of the change experienced after the intervention program in the different impulsivity and aggression dimensions in the

TABLE 1 | Pre-test and post-test means and standard deviations corresponding to the different impulsivity and aggressiveness dimensions for the control and experimental groups.

	Pre-test				Post-test			
	Control		Experimental		Control		Experimental	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Impulsivity								
Cognitive	22.98	4.84	23.48	4.79	23.45	4.28	18.93	3.95
Motor	28.81	5.17	27.94	4.93	27.53	5.34	24.36	4.56
Non-planning	32.43	6.93	31.07	6.44	31.91	5.52	27.91	5.87
Total	84.22	11.04	82.49	10.27	82.89	11.04	71.2	9.16
Aggressiveness								
Physical	27.21	5.28	28.07	5.49	26.87	4.51	24.17	4.14
Verbal	15.45	3.75	16.04	4.11	16.09	4.68	12.12	3.84
Hostility	25.18	5.30	23.95	4.88	26.36	3.98	19.36	4.01
Anger	23.04	5.53	23.89	6.04	24.11	6.87	20.03	5.31

TABLE 2 | Mann-Whitney U test for independent samples of the pre-test and post-test differences between the control and experimental groups for the different dimensions of impulsivity and aggressiveness.

	Pre-test		Post-test	
Variable	***z***	***p***	***z***	***p***
Impulsivity				
Cognitive	0.345	0.733	3.81	0.006**
Motor	0.423	0.637	2.38	0.031*
Non-planned	0.516	0.475	3.31	0.014*
Total	0.741	0.309	3.68	0.008**
Aggressiveness				
Physical	0.629	0.543	3.16	0.019*
Verbal	1.02	0.248	2.74	0.026*
Hostility	693	0.494	3.39	0.013*
Anger	0.759	0.328	3.94	0.005***

****p = 0.005; **p < 0.01; *p < 0.05.*

TABLE 3 | Wilcoxon test for related samples of the pre-test and post-test differences between the control and experimental groups for the different dimensions of impulsivity and aggressiveness.

	Control		Experimental	
Variable	***z***	***p***	***z***	***p***
Impulsivity				
Cognitive	0.928	0.375	−4.36	0.002***
Motor	−0.829	0.244	−2.29	0.038*
Non-planned	−0.468	0.614	−3.17	0.019*
Total	−0.679	0.438	−3.43	0.012*
Aggressiveness				
Physical	−0.619	0.456	−3.97	0.005**
Verbal	0.731	0.314	−2.46	0.033*
Hostility	0.132	0.842	−3.16	0.019*
Anger	0.607	0.557	−4.44	0.003**

****p < 0.005; **p = 0.005; *p < 0.05.*

experimental group. All the statistical analyses were computed using the SPSS 22.0 package.

RESULTS

Firstly, variable means and standard deviations corresponding to the control and experimental group in each stage of the study were calculated (**Table 1**).

Mann-Whitney U test for independent samples on the pre-test scores revealed no statistically significant differences between the control and experimental pre-test mean scores in the study variables. Contrarily, statistically significant differences did appear between the control and experimental groups at post-test in all the dimensions of impulsivity and aggressiveness (**Table 2**).

After conducting *Wilcoxon* test for related samples on the experimental group scores, statistically significant differences were observed when comparing the pre-test and post-test scores in all the dimensions of impulsivity and aggressiveness. No significant differences were found in such variables after the pre-test and post-test comparisons for the control group (**Table 3**).

TABLE 4 | Cohen's *d* and pretest-post-test percentage change in the experimental group for the different dimensions of impulsivity and aggressiveness.

Variable	***d* Pre-Post**	**% Pre-Post**
Impulsivity		
Cognitive	1.04	−19.38
Motor	0.753	−12.81
Non-planned	0.514	−10.17
Total	1.16	−13.69
Aggressiveness		
Physical	0.803	−13.91
Verbal	0.995	−24.44
Hostility	1.03	−19.17
Anger	0.679	−16.16

With the purpose of assessing the magnitude of the change occurred in the experimental group between pre-test and post-test scores, Cohen's *d* (1988) was used, with values above 1.5, between 1.5 and 1, and between 1 and 0.5 indicating very important, important and medium changes, respectively. Cohen's *d* showed the existence of very important changes in the cognitive impulsivity, total impulsivity and hostility dimensions, and medium to high changes in the other dimensions of impulsivity and aggressiveness (**Table 4**).

Finally, the percentage of change between pre-test and post-test scores in the experimental groups for the different impulsivity and aggressiveness dimensions was calculated. **Table 4** shows reductions of approximately from 24% in the verbal aggression dimension and to around 10% in the non-planned impulsivity dimension.

DISCUSSION

As a result of the application of the *Fluir meditation technique* (Franco et al., 2011) during 10 weeks, significant reductions in all the dimensions of impulsivity and aggressiveness levels occurred in the experimental group composed of high school students, thus, confirming the hypotheses. The obtained results are in line with the findings of other studies (Oberle et al., 2011; Fishbein et al., 2016). There may be different explanations for the obtained results, namely decrease in rumination (Borders et al., 2010; Peters et al., 2015; Orue et al., 2016), reduction in hostile affect, including frustration and anger feelings (Kemeny et al., 2012; Krishnakumar and Robinson, 2015) and increase in self-control before stressors (Broderick and Metz, 2009; Yusainy and Lawrence, 2014), amongst others. In this way, the capacity to regulate attention and emotion are forms of self-regulation that support dispositions conducive to learning and maintaining positive social relationships (Flook et al., 2015).

Aggressiveness is a complex phenomenon involving multiple factors, including psychosocial. Aggressive behavior is seen by some adolescents as a strategy to avoid future victimization or rejection, while for others it is interpreted as an opportunity to

achieve the desired popularity among peers (Estévez et al., 2014). Our data confirm the efficacy of the *Meditación Fluir-mindfulness technique*. However, integrative psycho-educational intervention programs oriented to promote emotional education and in values within the school centers (Peña and Canga, 2009; Sanger and Dorjee, 2015) are needed in order to reduce the high rates of violent behavior in adolescence, improve classroom climate and diminish the risk of school failure. The development of the ability to delay gratification, along with an adequate emotional self-regulation that includes rumination control and a negative assessment of the consequences of using aggression, would be key elements to be addressed by psycho-educational programs directed to adolescent population in school and community environments.

The practice of mindfulness can help students focus on the present, thus, reducing obsessive ruminations and enhancing the experience of positive emotions, as well as diminishing the probability of involvement in impulsive behaviors, which, in general, tend to aggravate the same emotional problems that want to be alleviated or solved by the use of aggression (Fix and Fix, 2013; Amutio et al., 2015a). In turn, this training allows recognizing the first signs of aggressive impulses in such a way that they are more likely to be inhibited by using the skills developed through the practice of mindfulness (i.e., acceptance and equanimity). Additionally, mindfulness has also been linked to increased compassion for both the self and others, which may foster a great sense of interconnectedness and facilitate the response to potential conflict with non-aggressive approaches (Condon et al., 2013).

There are hardly any studies in Spain on the influence of mindfulness in aggression or impulsivity in adolescents, since a majority are focused on stress or anxiety and are mainly directed to the adult population. Although research on mindfulness, especially with children and adolescents, is still in relatively early stages, an increasing number of studies have shown the potential benefits of mindfulness practices to students' physical health and psychosocial well-being, enhancing academic performance and diminishing the risk of school failure (Franco et al., 2011, 2014; Amutio et al., 2015a; López-González et al., 2016). This is a very important concern given that school failure in adolescence is a strong predictor of other high-risk behaviors, including delinquency, substance abuse and adolescent pregnancy (Stratton, 2006; Morley et al., 2016). More generally, a negative attitude toward school is, in fact, a risk factor for aggressive behaviors (Estévez et al., 2014). Conversely, school connectedness, engagement, academic achievement, and academic enjoyment may protect against alcohol use, suspension, lower educational aspirations, and poor academic performance (Goldberg-Looney et al., 2016)

CONCLUSION

The main limitation of this study is the reduced size of the sample. Further studies need to be carried out with bigger samples in order to determine specific causal mechanisms (e.g., changes in prefrontal brain structures, decrease in ruminations, emotional self-regulation, development of compassion) of the observed effects. However, this is one of the first studies showing the effectiveness of a mindfulness program for reducing impulsive and aggressive behaviors in the classroom. In an era of budget cuts, this type of group psycho-educational programs implies a considerable optimization of the economic and social resources invested on education in order to improve academic performance and decrease school failure.

AUTHOR CONTRIBUTIONS

CF: Data collection and analyses. AA: Data interpretation, introduction, and discussion. LLG: Bibliography, literature review, and corrections. XO: Literature review and procedure. CMT: Literature review and article revision.

ACKNOWLEDGMENT

This study is part of the project "*Education for Cross-cultural Health in Immigrant and Native Adolescents from Almeria: Analysis and intervention for optimization and improvement*" supported by the National R+D Plan of the Ministry of Economy and Finance (Ref: EDU2011-26887).

REFERENCES

Amutio, A., Franco, C., Mañas, I., and Gázquez, J. J. (2015a). Aprendizaje y práctica de la conciencia plena (Mindfulness) en estudiantes de Bachillerato para potenciar la relajación y la autoeficacia en el rendimiento escolar. *Univ. Psicol.* 14, 15–25. doi: 10.11144/Javeriana.upsy14-2.apcp

Amutio, A., Franco, C., Pérez-Fuentes, M. C., Gázquez, J. J., and Mercader, I. (2015b). Mindfulness training for reducing anger, anxiety and depression in fibromyalgia patients. *Front. Psycol* 5:1572. doi: 10.3389/fpsyg.2014.01572

Amutio, A., Martínez-Taboada, C., Hermosilla, D., and Delgado, L. C. (2015c). Enhancing relaxation states and positive emotions in physicians through a mindfulness training program: a one-year study. *Psychol. Health Med.* 20, 720–731. doi: 10.1080/13548506.2014.986143

Amutio, A., and Smith, J. C. (2008). Stress and irrational beliefs in college students. *Ansiedad Estrés* 14, 211–220.

Andreu, J. M., Peña, M. E., and Penado, M. (2013). Impulsividad cognitiva, conductual y no planificadora en adolescentes agresivos reactivos, proactivos y mixtos. *Anal. Psychol.* 29, 734–740. doi: 10.6018/analesps.29.3.175691

Arguís, R. (2014). "Mindfulness y educación: aprendiendo a vivir con atención plena," in *Mindfulness y Ciencia*, eds A. Cebolla, J. García, and M. Demarzo (Madrid: Alianza), 129–149.

Beauchemin, J., Hutchins, T. L., and Patterson, F. (2008). Mindfulness meditation may lessen anxiety, promote social skills, and improve academic performance among adolescents with learning disabilities. *Complement. Health Pract. Rev.* 13, 34–45. doi: 10.1177/1533210107311624

Black, D. S., Milam, J., and Sussman, S. (2009). Sitting-meditation interventions among youth: a review of treatment efficacy. *Pediatrics* 124, e532–e541. doi: 10.1542/peds.2008-3434

Bluth, K., Campo, R. A., Pruteanu-Malinici, S., Reams, A., Mullarkey, M., and Broderick, P. C. (2016). A school-based mindfulness pilot study for ethnically diverse at-risk adolescents. *Mindfulness* 7, 90–104. doi: 10.1007/s12671-014-0376-1

Bögels, S., Hoogstad, B., van Dun, L., de Schutter, S., and Restifo, K. (2008). Mindfulness training for adolescents with externalizing disorders and their parents. *Behav. Cogn. Psychother.* 36, 193–209. doi: 10.11124/JBISRIR-2016-2314

Borders, A., Earleywine, M., and Jajodia, A. (2010). Could mindfulness decrease anger, hostility, and aggression by decreasing rumination? *Aggress. Behav.* 36, 28–44. doi: 10.1002/ab.20327

Broderick, P. C., and Metz, S. (2009). Learning to BREATHE: a pilot trial of a mindfulness curriculum for adolescents. *Adv. Sch. Ment. Health Promot.* 2, 35–46. doi: 10.1080/1754730X.2009.9715696

Buss, A. H., and Perry, M. P. (1992). The aggression questionnaire. *J. Pers. Soc. Psychol.* 63, 452–459. doi: 10.1037/0022-3514.63.3.452

Cardoso-Moreno, M. J., Tomás-Aragonés, L., and Rodríguez-Ledo, C. (2015). Socio-emotional intervention in attention deficit hyperactive disorder. *Eur. J. Educ. Psychol.* 8, 53–59. doi: 10.1016/j.ejeps.2015.07.001

Choi, Y., Karremans, J. C., and Barendregt, H. (2012). The happy face of mindfulness Meditation is associated with perceptions of happiness as rated by outside observers. *J. Posit. Psychol.* 7, 30–35. doi: 10.1080/17439760.2011.626788

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Erlbaum.

Condon, P., Desbordes, G., Miller, W. B., and DeSteno, D. (2013). Meditation increases compassionate responses to suffering. *Psychol. Sci.* 24, 2125–2127. doi: 10.1177/0956797613485603

Davidson, R. J., Dunne, J., Eccles, J. S., Engle, A., Greenberg, M., Jennings, P., et al. (2012). Contemplative practices and mental training: prospects for American education. *Child Dev. Perspect.* 6, 146–153. doi: 10.1111/j.1750-8606.2012.00240.x

Estévez, E., Emler, N. P., Cava, M. J., and Inglés, C. J. (2014). Psychosocial adjustment in aggressive popular and aggressive rejected adolescents at school. *Psychosoc. Interv.* 23, 57–67. doi: 10.5093/in2014a6

Estévez, E., Jiménez, T. I., and Cava, M. J. (2016). A cross-cultural study in Spain and Mexico on school aggression in adolescence examining the role of individual, family, and school variables. *Cross-Cult. Res.* 50, 123–153. doi: 10.1177/1069397115625637

Eurostat (2014). *Being Young in Europe Today*. Available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Being_young_in_Europe_today_-_education

Fishbein, D., Miller, S., Herman-Stahl, M., Williams, J., Lavery, B., Markovitz, L., et al. (2016). Behavioral and psychophysiological effects of a yoga intervention on high-risk adolescents: a randomized control trial. *J. Child Fam. Stud.* 25, 518–529. doi: 10.1007/s10826-015-0231-6

Fix, R. L., and Fix, S. T. (2013). The effects of mindfulness-based treatments for aggression: a critical review. *Aggress. Violent Behav.* 18, 219–227. doi: 10.1016/j.avb.2012.11.009

Flook, L., Goldberg, S. B., Pinger, L., and Davidson, R. J. (2015). Promoting prosocial behavior and self-regulatory skills in preschool children through a mindfulness-based kindness curriculum. *Dev. Psychol.* 51, 44–51. doi: 10.1037/a0038256

Franco, C., Mañas, I., Cangas, A., and Gallego, J. (2011). Exploring the effects of mindfulness program for students of secondary school. *Int. J. Knowl. Soc. Res.* 2, 14–28. doi: 10.4018/jksr.2011010102

Franco, C., Mañas, I., and Soriano, E. (2014). Improving the graphic creativity levels of latin american high school students currently living in spain by means of a mindfulness program. *Proc. Soc. Behav. Sci.* 132, 229–234.

Garaigordobil, M., and Martínez-Valderrey, V. (2016). Impact of Cyberprogram 2.0 on different types of school violence and aggressiveness. *Front. Psychol.* 7:428. doi: 10.3389/fpsyg.2016.00428

Garaigordobil, M., Martínez-Valderrey, V., and Aliri, J. (2015). Autoestima, empatía y conducta agresiva en adolescentes víctimas de bullying presencial. *Eur. J. Invest Health Psychol. Educ.* 3, 29–40. doi: 10.1989/ejihpe.v3i1.21

Goldberg-Looney, L. D., Sánchez-San Segundo, M., Ferrer-Cascales, R., Albaladejo-Blazquez, N., and Perrin, P. B. (2016). Adolescent alcohol use in spain: connections with friends, school, and other delinquent behaviors. *Front. Psychol.* 7:269. doi: 10.3389/fpsyg.2016.00269

Gouda, S., Luong, M. T., Schmidt, S., and Bauer, J. (2016). Students and teachers benefit from Mindfulness-Based Stress Reduction in a school-embedded pilot study. *Front. Psychol.* 7:590. doi: 10.3389/fpsyg.2016.00590

Inglés, C. J., Torregrosa, M. S., García-Fernández, J. M., Martínez-Monteagudo, M. C., Estévez, E., and Delgado, B. (2014). Conducta agresiva e inteligencia emocional en la adolescencia. *Eur. J. Educ. Psychol.* 7, 29–41. doi: 10.1989/ejep.v7i1.150

Kabat-Zinn, J. (2009). *Wherever You Go, There You are: Mindfulness Meditation in Everyday Life*. New York, NY: Hyperion.

Kaspereen, D. (2012). Relaxation intervention for stress reduction among teachers andstaff. *Int. J. Stress Manage.* 19, 238–250. doi: 10.1037/a0029195

Kemeny, M. E., Foltz, C., Cavanagh, J. F., Cullen, M., Giese-Davis, J., Jennings, P., et al. (2012). Contemplative/emotion training reduces negative emotional behavior and promotes prosocial responses. *Emotion* 12, 338–350. doi: 10.1037/a0026118

Kim, W. O. (2012). Institutional review board (IRB) and ethical issues in clinical research. *Korean J. Anesthesiol.* 62, 3–12. doi: 10.4097/kjae.2012.62.1.3

Krishnakumar, S., and Robinson, M. D. (2015). Maintaining an even keel: an affect- mediated model of mindfulness and hostile work behavior. *Emotion* 15, 579–589. doi: 10.1037/emo0000060

León, B. (2008). Atención plena y rendimiento académico en estudiantes de enseñanza secundaria. *Eur. J. Educ. Psychol.* 1, 17–26.

López-González, L., Amutio, A., Oriol, X., and Bisquerra, R. (2016). Habits related to relaxation and mindfulness in high school students: influence on classroom climate and academic performance. *J. Psychodidact.* 21, 121–138. doi: 10.1387/RevPsicodidact.13866

López-González, L., and Oriol, X. (2016). The relationship between emotional competence, classroom climate and school achievement in high school students. *Cult. Educ.* 28, 130–156. doi: 10.1080/11356405.2015.1120448

Mestre, V., Samper, P., Tur-Porcar, A. M., Richaud de Minzi, M. C., and Mesurado, B. (2012). Emociones, estilos de afrontamiento y agresividad en la adolescencia. *Univ. Psychol.* 11, 1263–1275.

Morley, R. H., Terranova, V., Cunningham, S., and Vaughn, T. (2016). The role that self-compassion and self-control play in hostility provoked from a negative life event. *J. Indian Psychol.* 3, 125–141.

Nelson, H. J., Kendall, G. E., Burns, S., and Schonert-Reichl, K. (2015). Protocol for the design of an instrument to measure preadolescent children's self-report of covert aggression and bullying. *BMJ Open* 5:e009084. doi: 10.1136/bmjopen-2015-009084

Oberle, E., Schonert-Reichl, K. A., Lawlor, M. S., and Thomson, K. C. (2011). Mindfulness and inhibitory control in early adolescence. *J. Early Adolesc.* 32, 565–588. doi: 10.1177/0272431611403741

Oquendo, M. A., Baca-Garcia, E., Graver, R., Morales, M., Montalvan, V., and Mann, J. J. (2001). Spanish adaptation of the Barratt impulsiveness scale (BIS-11). *Eur. J. Psychiatry* 15, 147–155.

Orue, I., Calvete, E., and Gamez-Guadix, M. (2016). Gender moderates the association between psychopathic traits and aggressive behavior in adolescents. *Pers. Individ. Dif.* 94, 266–271. doi: 10.1016/j.paid.2016.01.043

Patton, J., Stanford, M., and Barrat, E. (1995). Factor structure of the Barratt impulsiveness scale. *J. Clin. Psychol.* 51, 768–774. doi: 10.1002/1097-4679(199511)51:6<768::AID-JCLP2270510607>3.0.CO;2-1

Paydary, K., Toraby, S. M., SeyedAlinaghi, S., Noori, M., Noroozi, A., Ameri, S., et al. (2016). Impulsivity, sensation seeking, and risk-taking behaviors among HIV-positive and HIV-negative heroin dependent persons. *AIDS Res. Treat.* 2016, 1–8. doi: 10.1155/2016/5323256

Pellerone, M., Craparo, G., and Tornabuoni, Y. (2016). Relationship between parenting and cognitive schemas in a group of male adult offenders. *Front. Psychol.* 7:302. doi: 10.3389/fpsyg.2016.00302

Peña, A. M., and Canga, M. C. (2009). La educación emocional en el contexto escolar con alumnado de distintos países. *Eur. J. Educ. Psychol.* 2, 199–210.

Peters, J. R., Smart, L. M., Eisenlohr-Moul, T. A., Geiger, P. J., Smith, G. T., and Baer, R. A. (2015). Anger rumination as a mediator of the relationship between mindfulness and aggression: the utility of a multidimensional mindfulness model. *J. Clin. Psychol.* 71, 871–884. doi: 10.1002/jclp.22189

Rodríguez, J. M., Peña, E., and Graña, J. L. (2002). Adaptación psicométrica de la versión española del Cuestionario de Agresión. *Psicothema* 14, 476–482.

Samper, P., Tur, A. M., Mestre, V., and Cortés, M. T. (2008). Agresividad y afrontamiento en la adolescencia. Una perspectiva intercultural. *Int. J. Psychol. Psychol. Ther.* 8, 431–440.

Sanger, K. L., and Dorjee, D. (2015). Mindfulness training for adolescents: a neurodevelopmental perspective on investigating modifications in attention

and emotion regulation using event-related brain potentials. *Cogn. Affect. Behav. Neurosci.* 15, 696–711. doi: 10.3758/s13415-015-0354-7

Schonert-Reichl, K. A., and Lawlor, M. S. (2010). The effects of a mindfulness-based education program on pre- and early adolescentsẃell-being and social and emotional competence. *Mindfulness* 1, 137–151. doi: 10.1007/s12671-010-0011-8

Settanni, M., Longobardi, C., Sclavo, E., Fraire, M., and Prino, L. E. (2015). Development and psychometric analysis of the student–teacher relationship scale – short form. *Front. Psychol.* 6:898. doi: 10.3389/fpsyg.2015.00898

Sibinga, E. M., Kerrigan, D., Stewart, M., Johnson, K., Magyari, T., and Ellen, J. M. (2011). Mindfulness-based stress reduction for urban youth. *J. Altern. Complement. Med.* 17, 213–218. doi: 10.1089/acm.2009.0605

Stratton, K. J. (2006). Mindfulness-based approaches to impulsive behaviors. *New School Psychol. Bull.* 4, 49–71.

Thijssen, S., Ringoot, A. P., Wildeboer, A., Bakermans-Kranenburg, M. J., El Marroun, H., Hofman, A., et al. (2015). Brain morphology of childhood aggressive behavior: a multi-informant study in school-age children. *Cogn. Affect. Behav. Neurosci.* 15, 564–577. doi: 10.3758/s13415-015-0344-9

van de Weijer-Bergsma, E., Formsma, A. R., de Bruin, E. I., and Bögels, S. M. (2012). The effectiveness of mindfulness training on behavioral problems and attentional functioning in adolescents with ADHD. *J. Child Fam. Stud.* 21, 775–787. doi: 10.1007/s10826-011-9531-7

Van der Oord, S., Bögels, S. M., and Peijnenburg, D. (2012). The effectiveness of mindfulness training for children with ADHD and mindful parenting for their parents. *J. Child Fam. Stud.* 21, 139–147. doi: 10.1007/s10826-011-9457-0

Veas, A., Gilar, R., Miñano, P., and Castejón, J. L. (2016). Estimation of the proportion of underachieving students in compulsory secondary education in Spain: an application of the rasch model. *Front. Psychol.* 7:303. doi: 10.3389/fpsyg.2016.00303

Wisner, B. L. (2013). An exploratory study of mindfulness meditation for alternative school students: perceived benefits for improving school climate and student functioning. *Mindfulness* 5, 626–638. doi: 10.1007/s12671-013-0215-9

Yusainy, C., and Lawrence, C. (2014). Relating mindfulness and self-control to harm to the self and to others. *Pers. Individ. Dif.* 64, 78–83. doi: 10.1016/j.paid.2014.02.015

Zenner, C., Herrnleben-Kurz, S., and Walach, H. (2014). Mindfulness-based interventions in schools-a systematic review and meta-analysis. *Front. Psychol.* 5:603. doi: 10.3389/fpsyg.2014.00603

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Franco, Amutio, López-González, Oriol and Martínez-Taboada. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 21 September 2016
doi: 10.3389/fpsyg.2016.01406

Attention Deficit/Hyperactivity Disorder (ADHD) Diagnosis: An Activation-Executive Model

Celestino Rodríguez, Paloma González-Castro, Marisol Cueli, Debora Areces and Julio A. González-Pienda*

Department of Psychology, Faculty of Psychology, University of Oviedo, Oviedo, Spain

Attention deficit with, or without, hyperactivity and impulsivity (ADHD) is categorized as neuro-developmental disorder. ADHD is a common disorder in childhood and one of the most frequent conditions affecting school ages. This disorder is characterized by a persistent behavioral pattern associated with inattention, over-activity (or hyperactivity), and difficulty in controlling impulses. Current research suggests the existence of certain patterns of cortical activation and executive control, which could more objectively identify ADHD. Through the use of a risk and resilience model, this research aimed to analyze the interaction between brain activation variables (nirHEG and Q-EEG) and executive variables (Continuous performance test -CPT-) in subjects with ADHD. The study involved 499 children, 175 females (35.1%) and 324 males (64.91%); aged from 6 to 16 years ($M = 11.22$, $SD = 1.43$). Two hundred and fifty six of the children had been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) and 243 were without ADHD. For the analysis of this objective, a causal model was designed to include the following different measures of task-execution: CPT TOVA (omissions, commissions, response time, variability, D prime and the ADHD Index); electrical activity (using Q-EEG); and blood-flow oxygenation activity (using nirHEG). The causal model was tested by means of structural equation modeling (SEM). The model that had been constructed was based upon three general assumptions: (1) There are different causal models for children with ADHD and those without ADHD; (2) The activation measures influence students' executive performance; and (3) There are measurable structural differences between the ADHD and control group models (executive and activation). In general, the results showed that: (a) activation measures influence executive patterns differently, (b) the relationship between activation variables (nirHEG and Q-EEG) depends on the brain zone being studied, (c) both groups showed important differences in variables correlation, with a good fit in each model (with and without ADHD). Lastly, the results were analyzed with a view to the diagnosis procedure. Therefore, we discuss the implications for future research.

Keywords: activation, execution, ADHD, diagnosis, blood-flow oxygenation, structural equation modeling

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Ana Miranda, University of Valencia, Spain
Raquel Fidalgo, University of León, Spain

****Correspondence:***
Celestino Rodríguez
rodriguezcelestino@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *09 July 2016*
Accepted: *02 September 2016*
Published: *21 September 2016*

Citation:
Rodríguez C, González-Castro P, Cueli M, Areces D and González-Pienda JA (2016) Attention Deficit/Hyperactivity Disorder (ADHD) Diagnosis: An Activation-Executive Model. Front. Psychol. 7:1406. doi: 10.3389/fpsyg.2016.01406

INTRODUCTION

Attention deficit with, or without, hyperactivity and impulsivity (ADHD) is one of the disorders that most affects academic performance. Current research suggests the existence of certain patterns of cortical activation and executive control, which could more objectively identify ADHD. To detect these patterns, brain activation variables are recorded in the areas of central and prefrontal

cortex through electro-encephalographic techniques such as quantified EEG (Q-EEG) to measure beta-theta electrical activity ratios (González-Castro et al., 2013), as well as oxygenated blood-flow in the brain (hemo-encephalography: nirHEG) (Toomim et al., 2005; Toomim and Carmen, 2009). In addition, executive control is evaluated with tests to verify levels of cortical activation by measuring performance during a lengthy repetitive task known as the Continuous Performance Test (CPT).

On the other hand, with the publication of the new DSM-5 classification manual (American Psychiatric and Association [APA], 2013), ADHD is now categorized as neuro-developmental disorder. While there were no significant changes in terms of the main symptoms of the disorder, with respect to classification there are now three types of presentations (instead of subtypes) of ADHD: predominantly hyperactive/impulsive; predominantly inattentive; and combined presentation. However, regardless of the names used for classification, much research has investigated if ADHD subtypes (or types of presentation) differ in their development or in their epidemiology (Willcutt et al., 2012), and also whether different comorbidities generally associated with the disorders are dependent upon the subtype (Sciberras et al., 2014).

ADHD, Cortical Activation and Execution

Although there is a substantial body of symptom-based evidence highlighting the neurologic nature the disorder, the primary causal factors underlying this problem remain unclear to date (Rubia et al., 2011; Tsujimoto et al., 2013; Congdon et al., 2014).

Within this context, some investigations point to a delay in myelination formation during brain development (Sowell et al., 2003), or insufficient white matter in the frontal lobe (Mostofsky et al., 2002). A further potential factor may be early dysfunctions in executive functions associated with fronto-thalamic circuits (Brown, 2006), which have a direct impact on cortical activation levels (Lubar et al., 1995; Álvarez et al., 2008; Cortese et al., 2012; Orinstein and Stevens, 2014).

From a general perspective, ADHD has been associated with a dysfunction in the central nervous system, characterized by a developmental delay and cortical hypo-activation related to a deficit in the dopaminergic and noradrenergic systems (Bledsoe et al., 2011). The noradrenergic system is primarily responsible for the modulation of selective attention and the levels of general activation that an individual needs to perform a task (Brown, 2006). The dopaminergic system, in turn, is associated with the ability to control one's behavior, both at an executive and motivational level. Thus, this low cortical activation associated with dopaminergic and noradrenergic systems would at least partially explain the inhibitory and attentional deficits that characterize ADHD (Cubillo et al., 2012). Furthermore, the investigation of González-Castro et al. (2013) showed that the low activation in prefrontal areas was reflected in different patterns of executive control measured in a CPT.

The above hypothesis is supported by neo-connectionist learning models, which have also linked cortical activation (measured by means of frequency fields) with the cortical areas involved in ADHD (Congedo and Lubar, 2003; Orlando and Rivera, 2004; Mazaheri et al., 2014; Orinstein and Stevens, 2014). When the subject is distracted, frequency fields are characterized by delta or theta waves, with a frequency of 0.5–4 Hz and 4–8 Hz, respectively. When the subject is relaxed with scattered attention, brain theta waves have values between 8 and 12 Hz. Finally, when the subject is in an alert state, beta waves with frequency ranges from 15 to 35 Hz are dominant. These waves are produced by brain metabolism and blood flow, as shown by Lubar et al. (1995). In this sense, an increase in theta activity would be accompanied by decreases in blood flow and brain metabolism. Hence, high frequencies of theta activity are commonly observed in brain areas with low activation (Álvarez et al., 2008).

Concerning ADHD, a differential pattern of electro-cortical activity has been observed in a state of rest, and it is characterized by increased theta -and decreased beta- activity (Lansbergen et al., 2011). This profile has been reflected in different studies with a low cortical activity associated with decreased beta activity in central and prefrontal brain regions in students with ADHD (Ernst et al., 2003). The detection of this pattern of cortical hypo-activation has been made using different neuro-imaging techniques, such as functional magnetic resonance imaging (fMRI) (Logothetis and Wandell, 2004; Solanto et al., 2009), electro-encephalography (EEG) (Mazaheri et al., 2014), or hemo-encephalography (HEG) (Schecklmann et al., 2009).

On the other hand, increasing cortical activation has been observed in students with ADHD who have had positive responses to intervention, and this has led to a decrease in inattention, impulsivity and hyperactivity according to previous research (Monastra et al., 2005; Kropotov et al., 2007; Arns et al., 2009). For example, a study conducted by Thompson and Thompson (1998) involving 111 subjects (children and adults) with ADHD observed significant improvements in cortical activation (measured by Q-EEG) and symptomatology (measured by CPT), following an intervention involving neurofeedback techniques.

Other studies have also found that, by increasing cortical activation with neurofeedback techniques or pharmacological support, individuals with ADHD significantly improved their performance in attention tasks, apparently as a consequence of a decrease in the core symptoms of the disorder (Othmer et al., 2000; Fuchs et al., 2003; Rossiter, 2004). Also, Monastra et al. (2005), in a review, analyzed the empirical evidence of the intervention with neurofeedback, according to the Association of Applied Psychophysiology and Biofeedback and the International Society for Neuronal Regulation. They concluded that neurofeedback is "probably an efficacious instrument" for treatment of ADHD, as clinically significant improvement is observed in approximately 75% of the cases analyzed.

In sum, previous research supports the relationship between ADHD symptoms and decreased cortical activation. Nevertheless, although it has been argued that low activation occurs in prefrontal and frontal areas, the specific areas involved in these processes have not been adequately defined (Orinstein and Stevens, 2014). The most frequently reported areas in this case have been in the pre-frontal (e.g., Fp1, Fp2, Fp3) and central (e.g., Cz) regions (Hale et al., 2007; González-Castro et al., 2013).

The difficulties in the detection of specific brain areas have been associated with the presence of differential profiles

or presentations in the disorder (Nikolas and Burt, 2010; Willcutt et al., 2012). Thus, the relevance of these areas would be dependent on the presence of inattentive or hyperactive/impulsive symptomatology (Depue et al., 2010; Mazaheri et al., 2014). Considering the different presentations of ADHD, previous studies have shown that while the hyperactive/impulsive presentation is related to poor activation in left prefrontal areas, the inattentive presentation is commonly accompanied by less activation in central and central-prefrontal areas (González-Castro et al., 2013). Similarly, it has been observed that students with low levels of activation in left prefrontal areas show more commission errors and higher variability in CPTs, while students with low central activation show more omissions and slower response time than the other group.

The empirical evidence concerning the different categories of symptomatology in ADHD, and their new conceptualization in DSM-5 (American Psychiatric and Association [APA], 2013), makes it necessary to define the relationship among the levels of activation in specific brain areas, executive functions, and diagnosis-related variables (i.e., distinction between ADHD and controls, and among different ADHD presentations).

It is important to consider that this disorder not only leads to impairments in the academic context (Frazier et al., 2007; Barnard-Brak et al., 2011), but also in the social and familiar contexts (Anastopoulos et al., 2009; Schroeder and Kelley, 2009). It is therefore crucial to have appropriate evaluation strategies that are able to minimize error in the diagnosis process (Skounti et al., 2007). This particular aspect was the key stimulus for the present study. Although the exact cause of the disease has not yet been identified, it is thought to be caused by a complex interaction between the neuro-anatomical system and neuro-biochemistry rather than a single cause. Overall, an increased number of findings suggest that ADHD is a disease of the brain (Swanson and Castellanos, 2002). Thus, genetic factors, neuro-developmental factors, psychosocial factors, and neuro-physiological factors all have an influence on behavior, activity and task-execution.

By using a risk and resilience model, this research aims to analyze the interaction between brain activation variables and executive function in students with ADHD. For the analysis of this objective, a causal model (relationship between pre-frontal cortex activation and task-execution) was formulated in which different measures were included (CPT-TOVA, Q-EEG and nirHEG; Toomim et al., 2005).

Purposes of This Study

By means of a structured equation model (SEM) we expect to deepen our knowledge of the relationship between activation measures and executive function measures. The SEM designed was fit using two samples of data (control group without ADHD and ADHD group). The first sample (without ADHD) was utilized to fit the model, and the second sample (with ADHD) to analyze the consistency of the data with predictive differences. We also performed multi-group analysis to verify the consistency of the results from both samples, to know which variables differentiate subjects with and without ADHD.

Considering the data provided by literature findings, the causal model was tested using structural equation modeling (SEM). This model was built based on three general assumptions (see **Figure 1**):

(1) There are different causal models for children with ADHD and those without ADHD.

(2) The activation measures influence a student's executive performance. Specifically, certain task-execution variables will be related to activation in the left pre-frontal cortex, and others with central zone pre-frontal cortex activation.

(3) There are important structural differences between the models for the ADHD and control groups.

When estimating the dependent variables of the model (latent variables), we also assume that the measured errors are not inter-correlated in the model, and that there is no relationship between the types of errors committed. Lastly, although previous research indicates reciprocal relationships among the dependent variables measured in this model (omissions, commission, and response time -RT-, variability and D prime), in the current investigation it is theoretically unacceptable to expect that reciprocal relationships between causal measures have been observed at a single temporal moment.

Our model has two parts: one of measurement, which corresponds to the relationship between the latent variables and their respective observed variables (activation), and a structural part, which involves the relationship between the independent and the dependent variables of the model (execution). The effects of the independent on the dependent variables are indicated with gamma (γ), whereas the relationships among the dependent variables are represented as beta (β).

MATERIALS AND METHODS

Participants

The participants included in the study comprised 499 students aged between 8 and 16 years ($M = 11.22$, $SD = 1.43$). There were 324 males (64.9%) and 175 females (35.1%). As one of the goals of this research was the cross-validation of the study-model developed, the final calibration sample was split into two subgroups [243 (48.7%) in the Control Group, and 256 (51.3%) in the ADHD group]. All participants had an IQ higher than 80 (WISC-IV; Wechsler, 2005), were attending public and subsidized schools in northern Spain. Statistical analysis revealed no significant between-group differences concerning IQ, though there were slight differences in mean ages and gender ratios (**Table 1**).

Inclusion Criteria

For ADHD the diagnosis involved: (a) clinical diagnosis of Attention Deficit Disorder with Hyperactivity according to the Diagnostic and Statistical Manual of Mental Disorders-IV-R (American Psychiatric and Association [APA], 2002); (b) symptom duration of more than 1 year; (c) the problem began before the age of 7 years; and, (d) the children had no associated disorders. Subjects who presented with a cognitive deficit, Asperger's syndrome, Guilles de la Tourette syndrome or

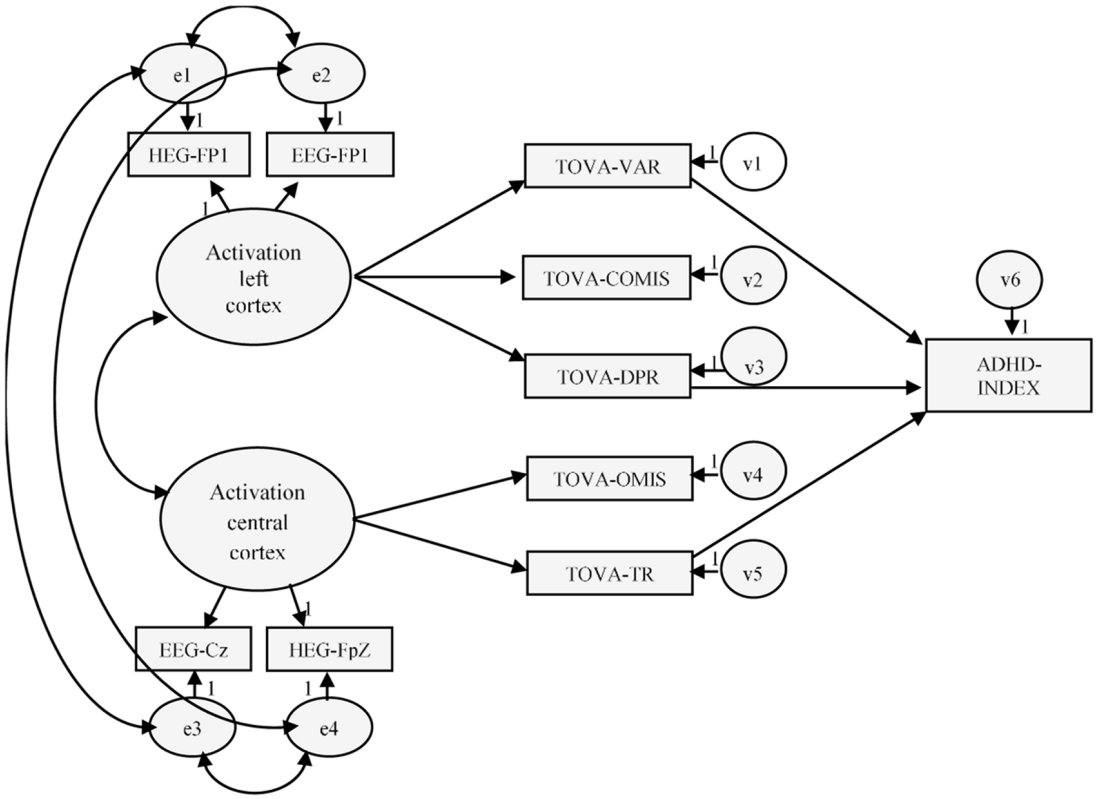


FIGURE 1 | Hypothetical model of activation and executive function. Variables in the model: HEG-Fp1 (nirHEG ratio: left pre-frontal cortex); HEG-FpZ (nirHEG ratio: central zone pre-frontal cortex); Q-EEG-Fp1 (beta-theta ratio: left pre-frontal cortex); Q-EEG-CZ (beta-theta ratio: central cortex); TOVA-OMIS (CPT: omissions); TOVA-COMIS (CPT commissions); TOVA-VAR (CPT: variability); TOVA-TR (CPT: response time); TOVA-DPR (CPT: D prime); ADHD-INDEX (CPT: ADHD index).

extensive anxious depressive disorders were excluded from the study, (e) to confirm the diagnosis and rule out other associated disorders, all students underwent a semi-structured interview for parents Diagnostic Interview Schedule for Children DISC-IV (Shaffer et al., 2000), and (f) were administered the WISC-IV (Wechsler Intelligence Scale for Children-IV; Wechsler, 2005) to evaluate the presence of specific (or other) cognitive deficits.

All healthy controls underwent the same diagnostic assessment to rule out any psychiatric disorders. To ensure the correct assignment of the students to their respective groups, Farré and Narbona's (1997) Spanish Scale or the adaptation by Sánchez et al. (2010) for ADHD (EDAH) was administered to the participants' parents.

Instruments and Measures

The variables included in the hypothesized model were grouped into two categories: activation measures (nirHEG Fp1, nirHEG FpZ, Q-EEG Fp1 and Q-EEG Cz), and executive measures (omissions, commissions, variability, RT, D prime and ADHD Index).

TABLE 1 | Means (M) and standard deviations (SD) of IQ scores, age in months, and EDAH percentile scores of the two groups in the sample (Control and ADHD group).

		Control group	ADHD group	*Total sample*	
N		243	256	499	
IQ *M (SD)*		98.30 (10.28)	98.95 (10.15)	98.64 (10.21)	$F(1,497) = 0.496$, $p = 0.481$, $\eta^2 = 0.001$
Age (months) M (SD)		136.67 (17.51)	132.88 (16.77)	134.72 (17.22)	$F(1,497) = 6.102$, $p = 0.014$, $\eta^2 = 0.012$
Sex (male/female)		146/97	178/78	324/175	χ^2 (1) = 4.888, $p = 0.027$
EDAH scores	*ADHD-I*	73.84 (10.71)	90.96 (5.44)	82.62 (12.01)	$F(1,497) = 514.33$, $p = 0.000$, $\eta^2 = 0.509$
	ADHD-HI	74.49 (10.59)	92.05 (5.20)	83.50 (12.06)	$F(1,497) = 561.34$, $p = 0.000$, $\eta^2 = 0.530$
	ADHD-C	75.77 (9.90)	91.46 (6.17)	83.82 (11.34)	$F(1,497) = 456.27$, $p = 0.000$, $\eta^2 = 0.479$

(ADHD-I) subtype with predominance of attention deficit; (ADHD-HI) subtype with predominance of hyperactivity–impulsivity; and (ADHD-C) combined subtype, with predominance both of inattention and hyperactivity-impulsivity.

Activation Measures

The nirHEG (Toomim et al., 2005) is a tool used to measure blood oxygenation in expressly selected areas. The nirHEG employs the translucent properties of biological tissue, and low-frequency red and infrared light from light emitting diodes (LEDs). The source of light and the light receptor (optode) are mounted on a headband 3 cm apart. The band should be carefully placed so that no external light enters. It is important to highlight that, in contrast with the EEG method, low muscular tension or small subject movements do not affect nirHEG measurements. Other possible sources of error were researched and were found to be minimal (Toomim et al., 2005). Only around 5–10% of nirHEG readings come from the skull skin or tissue because these regions of the body have little blood flow in comparison with brain tissue. The depth of effective penetration in the highly vascular cortical tissue is approximately 1.5 cm below the midpoint between the light source and the receptor optode. The entrance and exit light areas are 0.052 cm^2 at the skin surface. The light entrance and exit points and the refractive and scattering qualities of the tissue form a banana-shaped light field.

The lights are emitted alternately onto the surface of the skin. The emitted light penetrates these tissues and is scattered, refracted, and reflected. A small amount of light modified by absorption of the tissue returns to the surface and is measured. The ratio is calculated by comparing the red light (at 660 nm wavelength), which is not absorbed as much by oxygenated hemoglobin, with infrared light (at 850 nm wavelength), which is less affected by oxygenation (Toomim et al., 2005). Capillary oxygenation is barely affected by peripheral blood pressure and is mainly controlled by tissue demand for energy. The concentration of oxygenated hemoglobin is therefore a useful measurement of local blood flow. Thus, mathematically, the formula for the nirHEG ratio is as follows: nirHEG Ratio = Red light (variable)/infrared light (less affected by oxygenation).

The nirHEG Ratio or proportion between red and infrared light has a useful property. The numerator and denominator in the relationship are influenced in the same way by attenuation of the skin, the skull, and the length of the path. In this relationship, these variables are therefore discarded. The standardized reference value was established at 100 ($SD = 20$) and used to calibrate all new spectrophotometers (Toomim et al., 2005).

In addition to this measure, nirHEG provides an Attention Index (AI), indicating malfunctioning of the ability to increase the nirHEG ratio; that is, the participant is incapable of increasing the ratio and, thereby, brain activation. This apparently indicates a lapse in the attentional process, which, according to Toomim et al. (2005), is equivalent to a measure of sustained attention or concentration capacity.

Q-EEG (quantified electroencephalogram), Biocomp 2010 (Developed by The Biofeedback Institute of Los Angeles[1]) was used to record electrical activity. Q-EEG (quantified electroencephalogram) is a computerized EEG system, adapted by Toomim et al. (2005), which provides levels of cortical activation through the beta/theta ratio. It measures attention in general, independently of the task to be performed. For this purpose, an electrode is placed on the subject's corresponding cortical area (Cz, Fp1) to record the beta/theta ratio, and two more control electrodes are placed on the subject's left and right earlobe. The Q-EEG is administered to each participant, with open eyes, for a maximum duration of 10 min and after receiving instructions of smooth and steady abdominal breathing, in order to carry out the test under the best possible performance conditions. Lastly, an EMG system is placed on the right forearm to identify the degree of movement. Once the electrodes are in place, participants are asked to remain relaxed, without moving, breathing slowly and evenly, concentrating exclusively on the computer screen on which the theta and beta waves emitted by them are displayed successively. After assessment, the results obtained are interpreted. When the beta/theta ratio is lower than 50% at Cz, there is an associated deficit of sustained attention and if the ratio is also lower at Fp1, then the attentional deficit is associated with a lack of executive control, attributable to hyperactivity (González-Castro et al., 2013).

Latent Variables (Pre-frontal Cortex Activation)

Activation left cortex was estimated as a latent variable in the SEM from two indicators of activation measures. One of the indicators was nirHEG in Fp1 and the other was Q-EEG in Fp1. Thus, our latent variable takes into account the commonalities between these two ratio-index measures of the of the student's cortical activation.

Activation central cortex was estimated as a latent variable. One of the indicators was nirHEG in FpZ and the other was Q-EEG in Cz. So, our latent variable subsumes the communalities between this two ratio measures indexes of the students' activation.

Executive Functioning Variables

Test of Variables of Attention (TOVA; Greenberg and Waldman, 1993) is a CPT that presents two simple images. The first one presents the stimulus at the top of the screen and the second one at the bottom of the screen. The subject is given a push-button that should only be pressed when the first image appears. Subjects are trained for 3 min before testing, and the test lasts between 20 and 24 min. The following profile is obtained: omissions, RT, commissions, variability, D prime (performance and/or concentration quality during the test, based on the number of errors) and ADHD Index. In the current study, the Cronbach's alpha for this executive factor was 0.877.

Procedure

The identification of the participants was carried out according to the DSM-IV-TR criteria in the Hospital Pediatric Service by a neurologist with experience in ADHD diagnosis. It was confirmed by the EDAH with parent–teacher agreement equal to or higher than 90% following previous studies (González-Castro et al., 2015). Once the ADHD group was established, we proceeded to select the students who made up the group without ADHD, so that the groups would be as equivalent as

[1]http://www.biocompresearch.org/

possible. For this purpose, all the participants completed the WISC-IV (Wechsler, 2005), and their age was also taken into account. Once identified, if their IQ was equal or higher than 80, they completed the TOVA. Both tests (WISC-IV and TOVA) were interpreted according to their corresponding instruction manuals. Participants were not undergoing pharmacological treatment during the study. It was withdrawn 48 h to perform the tests.

After psychological assessment and the appraisal of executive control, the level of cortical activation was identified by means of the Q-EEG analysis, using the Biocomp 2010. The surface electrodes were placed at points Fp1 and Cz. To control participants' movement, an Electromyogram (EMG) electrode was placed on the right fore-arm and the reference electrodes were placed on the ear lobes. The recording was carried out in a sound-proof and electrically isolated room with low illumination, and the test always at the same time of day (between 4 p.m. and 6 p.m). The Q-EEG was administered to each participant (with their eyes open), and for a maximum duration of 10 min. The nirHEG was administered in the same circumstances of q-EEG. With a measurement of 35 seconds in Fp1 and FpZ duly counterbalancing the order with the characteristics of the band measurement described above. The TOVA measures were standardized, interpreting scores lower than 1.2 standard deviations as negative measures. Lastly, a general executive control index showing recorded readings lower than −1.80 was interpreted as ADHD. For the partial correlations, we took age into account because activation and executive control both tend to decrease with age.

The study was conducted in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki), which reflects the ethical principles for research involving humans (Williams, 2008). All subjects and their parents gave written informed consent after receiving a comprehensive description of the study protocol. Participants had volunteered to be involved in this study and they were not given any incentive to take part in it. The participants came from families of medium socio-economic status and were Caucasian

Data Analysis

The adequacy of the model was analyzed with SEM, using the AMOS.22 program (Arbuckle, 2009). Firstly, the data matrix (control group and ADHD group samples) was analyzed to determine whether there were any values that violated any of the assumptions required for the use of SEM (e.g., multivariate normality, linear relations among variables, absence of multi-collinearity), or simply whether there were any missing data or outliers. Subsequently, the fit of the model was examined utilizing the control group sample and, although the hypothesized model fitted well, potential areas of misfit in the model were scrutinized (by examining the standardized residuals and the modification indexes). Secondly, we followed an invariance-testing strategy to test the structural paths across groups to determine whether the models of the Control Group and of the ADHD Group were equivalent. In order to cross-validate our data-analysis, we fitted the model to an independent clinical sample of students (the ADHD sample).

RESULTS

Initial Data Screening

Table 1 shows the descriptive data as well as the two Pearson correlations matrixes corresponding to the Control Group and the ADHD group. Before conducting the statistical analyses, we examined the matrixes with regard to missing data, the presence of outliers, linearity and normality of the data. We examined the data to determine whether any of the variables or subjects presented a significant amount of missing values. Considering the variables with respect to Kline's (2013) suggestions, the number of absences was found to be less than 1.4% in all cases, which was not significant.

One of the important assumptions of SEM is that the variables taken must follow a normal distribution. As maximum likelihood (ML) can produce biases when this assumption is violated (West et al., 1995), we examined the distribution of the variables (i.e., kurtosis and skewness). Following the criteria of Finney and DiStefano (2006), the allowable values for skewness and kurtosis are ±2 and ±7 respectively (outside of which, ML should not be used). All the variables in this study respected those criteria (see **Table 2**). Therefore, with normality conditions being met, we decided to fit the model using ML.

Another important aspect in the initial analysis of the data matrix is to verify that the variables are significantly correlated, although such correlations should not be excessively high ($r > 0.85$). The pattern of correlations (e.g., size; ± tendency) was similar both groups.

Testing and Adjusting Model (Control Group)

In a first assessment of the model (**Figure 1**), the estimated parameters did not show the expected magnitudes and mathematical sign (consistent with the theory underlying the model), and excessive standard errors were observed (Bentler, 1995). The data provided by the analyses performed with AMOS.22 indicated that the fit of the hypothesized model to the data matrix was not acceptable, $\chi^2(28) = 81.11$, $\chi^2/df = 2.89$, $p < 0.001$, GFI = 0.939, AGFI = 0.881, TLI = 0.928, CFI = 0.928, RMSEA = 0.089 (0.066–0.111), $p = 0.003$.

Re-specification of the Model

After examining the residuals and modification index (although the hypothesized model did not show a good fit), we considered the possibility of including covariance effect between Commissions and RT in the TOVA test (leaving the parameter free) as well as the indirect effect contained in the initially hypothesized model. At the theoretical level, this effect is negative, indicating that a higher number of commissions the response time will be less in TOVA.

The results indicated that the fit of the re-specified model was good, [$\chi^2(27) = 57.924$; $\chi^2/df = 2.145$; $p \leq 0.001$; GFI = 0.954; AGFI = 0.907; CFI = 0.974; TLI = 0.956; RMSEA = 0.069 (0.044–0.093), $p = 0.098$], and the improvement over the initial model was statistically significant ($\Delta\chi^2(1) = 23.192$). As expected, the new estimated parameter was statistically significant and negative ($r = -0.39$). Neither the residuals nor the

TABLE 2 | Correlation matrix corresponding to the variables included in the model (Control group and ADHD group) and descriptive data (means, standard deviation, skewness and kurtosis).

	1	2	3	4	5	6	7	8	9	10
1	–	0.499**	0.594**	0.330**	0.306**	0.435**	0.514**	0.213**	0.213**	0.222**
2	0.441**	–	0.315**	0.743**	0.471**	0.258**	0.304**	0.366*	0.183*	0.218**
3	0.848**	0.303**	–	0.376**	0.238**	0.290**	0.330**	0.125	0.108	0.090
4	0.428**	0.842**	0.387**	–	0.447**	0.193**	0.203**	0.380**	0.122	0.159*
5	0.456**	0.757**	0.371**	0.795**	–	0.342**	0.449**	0.667**	0.389**	0.447**
6	0.720**	0.378**	0.660**	0.398**	0.453**	–	0.505**	0.132*	0.428**	0.358**
7	0.811**	0.309**	0.816**	0.356**	0.425**	0.722**	–	0.428**	0.380**	0.458**
8	0.411**	0.731**	0.339**	0.753**	0.852**	0.441**	0.409**	–	0.339**	0.479**
9	0.698**	0.475**	0.703**	0.559**	0.571**	0.678**	0.725**	0.525**	–	0.813**
10	0.644**	0.492**	0.670**	0.580**	0.631**	0.614**	0.750**	0.596**	0.874**	–
Control group										
M	101.64	105.50	0.58	0.59	98.76	100.90	97.44	99.37	0.49	1.51
SD	12.40	17.45	0.07	0.07	8.01	10.09	8.65	10.45	1.05	2.29
Skewness	0.970	1.192	1.181	0.909	0.216	0.097	0.708	0.506	0.572	0.461
Kurtosis	0.926	1.158	4.314	1.331	−0.150	1.024	0.913	1.839	−0.089	−0.238
ADHD group										
M	78.52	79.82	0.43	0.43	77.05	82.83	76.55	77.67	−1.49	−3.39
SD	10.71	12.04	0.07	0.07	10.82	10.82	10.13	10.06	0.89	1.89
Skewness	0.501	1.138	−0.070	−0.033	−0.017	−0.052	−0.058	0.528	−0.207	−0.548
Kurtosis	2.399	4.048	0.118	0.457	1.469	1.321	0.544	2.702	0.008	−0.097

In the correlation matrix, the upper matrix corresponds to the without ADHD sample and the lower matrix to the ADHD group sample. 1, nirHEG-Fp1; 2, nirHEG-FpZ; 3, Q-EEG-Fp1; 4, Q-EEG-CZ; 5, TOVA omissions; 6, TOVA commissions; 7, TOVA variability; 8, TOVA response time; 9, TOVA D prime; 10, TOVA ADHD index.
$^{*}p < 0.05$; $^{**}p < 0.001$.

modification indices recommended carrying out more changes in the model (**Figure 2**). **Table 3** shows the coefficients of the relationships in the measurement model and the structural model, as well as their corresponding estimation errors, critical ratios, and associated probabilities.

With regard to the assessment of the predictions implicit in the re-specified model without ADHD, the results indicated that almost all hypotheses were confirmed in measurement part. Latent variable named *Activation left cortex* was significantly and positively explained by Q-EEG-Fp1 ($\beta = 0.40$), however, in contrast to our prediction, its relation with nirHEG-Fp1 ($\beta = 0.59$) was not statistically significant. Activation central cortex was significantly and positively explained by Q-EEG-Cz ($\beta = 0.51$) and not by nirHEG-FpZ ($\beta = 0.55$).

In the structural part of the model, Activation left cortex significantly and positively explained TOVA variability ($\gamma = 0.78$), TOVA Commissions ($\gamma = 0.67$) and TOVA D prime ($\gamma = 0.53$). Also, as predicted, Activation central cortex positively and significantly influenced both TOVA Omissions ($\gamma = 0.87$) and TOVA response time ($\gamma = 0.75$). Moreover, like hypothesized TOVA IGCE was significantly and positively explained by TOVA variability ($\beta = 0.11$), TOVA response time ($\beta = 0.19$) and TOVA D prime ($\beta = 0.71$). Lastly, as a consequence of the re-specification of the initial model, a direct negative relation between TOVA Commissions and TOVA response time was found ($\beta = -0.39$).

Due to the goodness-of-fit and the confirmation of our predictions, this model is considered adequate to explain the relations of the data matrix. Nevertheless, as the initial model had been modified (freeing a parameter), and some of the initial hypotheses had not been confirmed, we decided to specifically test this model with the sample of subjects with ADHD to verify the results obtained.

Multi-Group Analysis

Multi-group analysis was carried out as a cross-validation strategy to verify whether a model that has been re-specified in one sample (without ADHD) can be replicated in a second independent sample (with ADHD), which was the key aim of this study. Specifically, we used an invariance-testing strategy to test the replicability of structural paths across groups.

In the above analysis, assuming that the unconstrained model is similar in both groups, the results showed statistically significant differences concerning the five criteria examined (**Table 4**). However, no statistically significant differences were found to structural weights, [$\chi^2(3) = 6.411$, $p = 0.093$, NFI = 0.002, IFI = 0.002, RFI = −0.001, TLI = −0.001]. Moreover, assuming the absence of differences in structural weights, no statistically significant differences were found in structural co-variances, structural residuals, and in measurement residuals.

However, as these data revealed the equality of the models between samples taken as a whole, we determined the extent to which the model is invariant in all its parameters. Summing up, the results obtained were cross-validated and thus indicated that the re-specified model of the sample without ADHD was replicated in an independent sample (with ADHD).

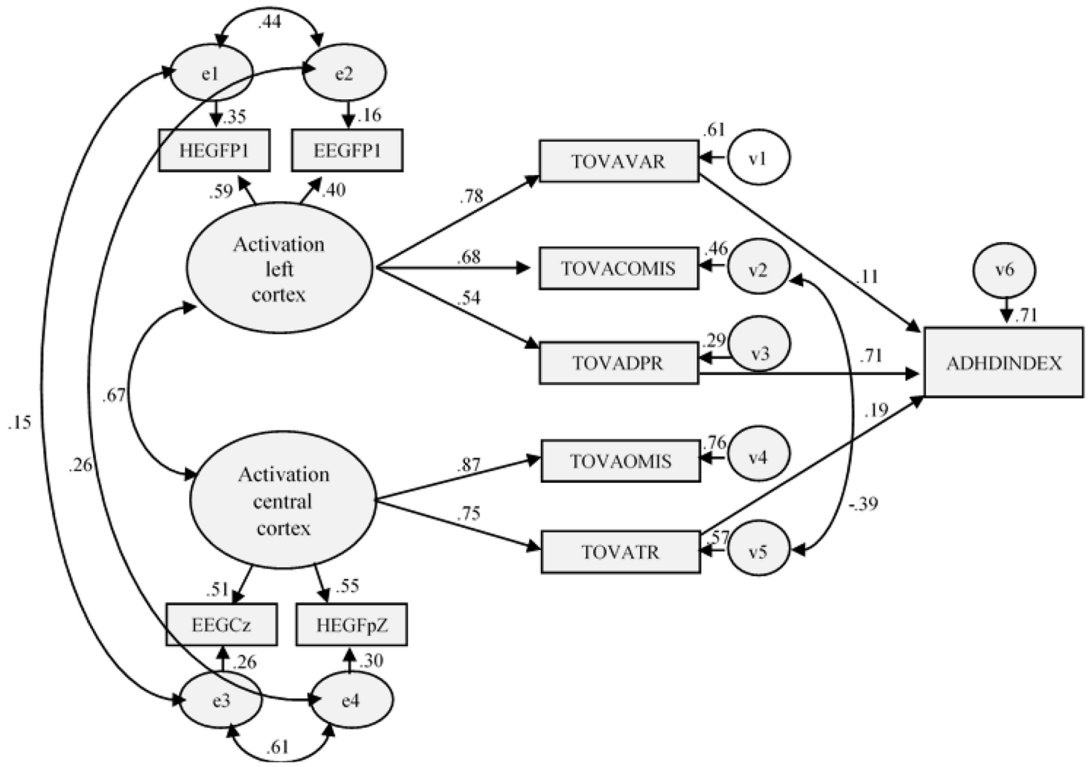


FIGURE 2 | Re-specified model (Control Group): structural and measurement coefficients.

Testing the Previous Goodness-of-Fit Model in ADHD Group

In the ADHD Group, the goodness-of-fit of the hypothesized model was not adequate [$\chi^2(27) = 98.684$; $\chi^2/df = 3.655$; $p = 0.000$; GFI = 0.931; AGFI = 0.860; CFI = 0.973; TLI = 0.954; RMSEA = 0.102(0.081–0.124), $p \leq 0.001$]. Considering the criteria used to judge the goodness-of-fit indices, the RMSEA index revealed that the previous model did not optimally represent the relationships observed in the empirical data matrix. After examining the co-variance matrix and the modification indices, we considered including (in our model) the direct effect of the latent variable *Activation central cortex* on TOVA and D

TABLE 3 | Results of testing the re-specified model (sample without ADHD).

	Standardized Coefficients	*SE*[1]	CR[2]	*P*<[3]
Structural Model[4]				
Activation left cortex → TOVA variability	0.783	0.114	8.308	0.001
Activation left cortex → TOVA D prime	0.537	0.012	6.601	0.001
Activation central cortex → TOVA response time	0.753	0.102	8.041	0.001
Activation left cortex → TOVA Commissions	0.678	0.125	7.687	0.001
Activation central cortex → TOVA Omissions	0.870	0.088	8.337	0.001
TOVA D prime → TOVA ADHD Index	0.712	0.083	18.539	0.001
TOVA variability → TOVA ADHD Index	0.108	0.011	2.689	0.007
TOVA response time → TOVA ADHD Index	0.193	0.008	5.104	0.001
Measurement Model[5]				
Activation left cortex → nirHEG-Fp1	0.589	–	–	–
Activation left cortex → Q-EEG-Fp1	0.399	0.001	6.785	0.000
Activation central cortex → nirHEG-FpZ	0.552	–	–	–
Activation central cortex → Q-EEG-Cz	0.511	0.000	10.371	0.000

[1]*Standardized errors,* [2]*Critical ratio,* [3]*Probability,* [4]*structural model (relation between the independent and the dependent variables in the model),* [5]*measurement model (relation between the latent variables in the model and the observed variables).*

TABLE 4 | Nested model comparison (assuming model unconstrained correct).

	[1]*MW*	[2]*SW*	[3]*SC*	[4]*SR*	[5]*MR*
χ^2	45.104	51.515	93.428	133.575	510.189
Df	7	10	13	14	28
P	0.000	0.000	0.000	0.000	0.000
NFI	0.012	0.013	0.024	0.034	0.131
IFI	0.012	0.013	0.024	0.035	0.133
RFI	0.009	0.008	0.019	0.032	0.121
TLI	0.010	0.008	0.020	0.032	0.124

[1]*Measurement Weights,* [2]*Structural Weights,* [3]*Structural Covariance,* [4]*Structural Residuals,* [5]*Measurement Residuals.*

Prime. From a theoretical perspective, the inclusion of this effect seemed to be logical, because D prime is a measure of the quality of concentration obtained from the total number of omission and commission errors. Also, the central cortex area allows which is affected in students with ADHD reflected in a lower quality of the concentration given the higher number of errors. As well as eliminate indirect effect between TOVA commissions and TOVA response time (with a not significant effect $p = 0.251$). This relationship can be found in students without ADHD, but not in students with ADHD. It is because commissions are related to impulsivity, and RT is related to inattention. Thus, when both variables (impulsivity and RT) are affected, these variables can be clearly distinguished.

Re-specification of the Model

Like inControl Group, statistically and theoretically it seemed appropriate to slightly modify the initial model in the ADHD sample by including the direct effect *Activation central cortex* on TOVA and D Prime, and thus eliminate one indirect effect. With this minimal change, the results indicated that the fit of the re-specified model was good, [$\chi 2(27) = 98.684$; $\chi^2/\text{df} = 2.476$; $p \leq 0.001$; GFI = 0.952; AGFI = 0.902; CFI = 0.985; TLI = 0.975; RMSEA = 0.076 (0.053–0.099), $p = 0.031$], and also that the improvement over the initial model was statistically significant [$\Delta\chi^2(1) = 31.820$]. As expected, this newly estimated parameter was found to be statistically significant and positive ($r = 0.27$). Neither the residuals, nor the modification indices, indicated that any further changes to the model were necessary (see **Figure 3**).

The results are presented in **Table 3**. In both samples, the estimated parameters approximated the expected magnitudes and sign, and the standard errors were neither excessively large nor small. In the control Group, with the exception χ^2 and its associated probability, the fit-indices indicated that the hypothesized model optimally represented the relationships of in the empirical data matrix. However, the data concerning fit were somewhat lower than in the first analysis. For example,

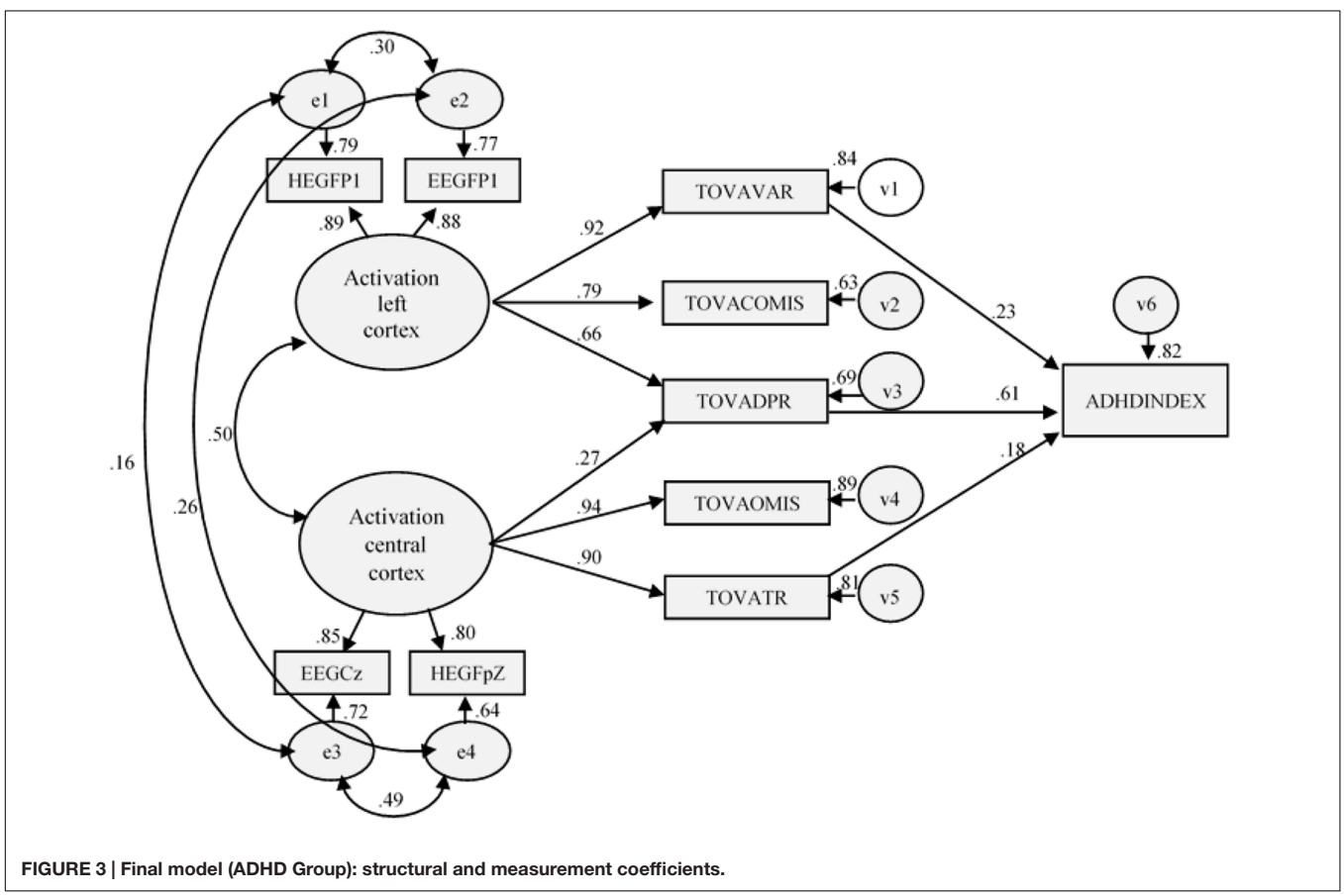


FIGURE 3 | Final model (ADHD Group): structural and measurement coefficients.

TABLE 5 | Results of testing the re-specified model in the ADHD sample).

	Standardized Coefficients	*SE*[1]	CR[2]	*P*<[3]
Structural Model[4]				
Activation left cortex → TOVA variability	0.918	0.045	21.557	0.001
Activation left cortex → TOVA D prime	0.662	0.005	13.364	0.001
Activation central cortex → TOVA response time	0.900	0.055	17.427	0.001
Activation central cortex → TOVA D prime	0.272	0.004	5.780	0.001
Activation left cortex → TOVA Commissions	0.794	0.055	16.459	0.001
Activation central cortex → TOVA Omissions	0.944	0.058	18.387	0.001
TOVA D prime → TOVA ADHD Index	0.608	0.091	14.251	0.001
TOVA variability → TOVA ADHD Index	0.233	0.007	5.929	0.001
TOVA response time → TOVA ADHD Index	0.179	0.006	5.601	0.001
Measurement Model[5]				
Activation left cortex → nirHEG-Fp1	0.889	–	–	–
Activation left cortex → Q-EEG-Fp1	0.877	0.000	25.201	0.000
Activation central cortex → nirHEG-FpZ	0.803	–	–	–
Activation central cortex → Q-EEG-Cz	0.847	0.000	23.173	0.000

[1]*Standardized errors,* [2]*Critical ratio,* [3]*Probability,* [4]*structural model (relation between the independent and the dependent variables in the model),* [5]*measurement model (relation between the latent variables in the model and the observed variables).*

χ^2 was higher than the value of the calibration sample [e.g., $\Delta\chi^2(1) = 40.76$, and the χ^2/df ratio rose from 2.145 to 2.476]. **Table 5** shows the coefficients of the relationships in the measurement and structural models, as well as their corresponding estimation errors, critical ratio, and associated probability.

With regard to the predictions of the model, the results obtained in ADHD model are higher than without ADHD sample, except that the relationship between TOVA and IGCE was significantly and positively explained by TOVA variability ($\beta = 0.23$), TOVA response time ($\beta = 0.18$) and TOVA D prime ($\beta = 0.61$). Globally there were small variations that were higher in than the magnitude of the statistics obtained. *Activation left cortex* significantly and positively explained TOVA variability ($\gamma = 0.92$), TOVA Commissions ($\gamma = 0.79$), and TOVA D prime ($\gamma = 0.66$). *Activation central cortex* also positively and significantly explained both TOVA Omissions ($\gamma = 0.94$) and TOVA response time ($\gamma = 0.90$), both of which are related to attention and concentration. Lastly, as a likely consequence of the re-specification of the *with ADHD* model, a relationship between TOVA Commissions and TOVA RT was not found.

DISCUSSION AND CONCLUSION

The current research attempted to deepen our knowledge of the relationship between *activation* and *executive function* measures, by examining the relationship between brain activation in selected areas and differences in executive measures. To achieve this aim we employed SEM measures, which also included latent variables such as left and central cortex activation. Although previous studies have analyzed the relationship between activation and execution, SEM has seldom been used in the past. In general, the results showed a different model for ADHD group and control group. So, one conclusion of the study is the presence of a model in which is related in a particular way, the activation in specific areas and the profile of execution of students with ADHD.

Relationship of the Variables in the Model

In general, the data provided by the fit of the model (both in the ADHD and Control groups) provided evidence supporting some of the hypotheses proposed in the model. Therefore, the findings of this study appear to agree with those obtained in previous studies based on more conventional strategies of data analysis, such as hierarchical regression analysis and analysis of variance. The major findings discussed below concern the relationship between activation and execution, and the difference between the ADHD model and the Control model (Arns et al., 2009; Cubillo et al., 2012).

In this study, it was especially noteworthy that the relationship between activation (central and left prefrontal) and execution was stronger in ADHD subjects than in the control group. The explanation could be that subjects with ADHD show lower cortical activation (Lansbergen et al., 2011; González-Castro et al., 2013) and blood oxygenation with scores ranging between 0.38 and 0.41 for electrical activation, and between 65 and 80 for blood oxygenation, the latter of which directly affects performance patterns (in small ranges between 40 and 80). The activation levels of the control group were found to be within normal limits, however, they showed greater variations (e.g., scores ranged from 0.51 to 0.99 for electrical activation, and from 86 to 120 for blood oxygenation). All of that can be reflected in different executive patterns (large ranges of scores ranging between 85 and 120). This finding highlights the importance of analyzing electrical activation and/or blood oxygenation in the cortex. Since it is an issue that is directly related to the executive function of the subject.

Moreover, the relationship between cortical activation and executive function shows differential results depending on the brain area assessed (i.e., a low activation in a specific area can be related to a particular pattern of execution). Regarding left cortical activation, is highlighted the results indicated that differing beta-theta ratios and low blood oxygenation in area Fp1 can be related to hyperactivity and impulsivity symptomatology.

Furthermore, when the electric activation shows low levels in Fp1, these data are also supported by nirHEG results and a low performance in TOVA tests. Similarly, when the electrical activation is within normal ranges blood oxygenation and TOVA test results are also normal. While these results have been observed in previous studies analyzing the relationship between Q-EEG and TOVA, and between nirHEG and TOVA (González-Castro et al., 2013), the present research was focused on the relationships of all electrical-activation variables through a latent variable.

On the other hand, in the case of central activation, this relationship shows lower rates, and although it is observed that those who present low activation levels measured by the beta-theta ratio in Cz, also present a low oxygenation measured by nirHEG in FpZ, as well as a greater number of omission errors and worst response time; the findings do not reach so high interaction as the previous case. In any case, it has to be emphasized that being different points (Cz/FpZ), is logical that correlations decrease slightly in spite of still showing a significant relationship. Furthermore, it is possible that FpZ is also influenced by other variables besides inattention, such as emotion or anxiety control, that many studies have located in Fp2.

Firstly, given these results, the relationship between activation and execution seems to be a reliable measure for ADHD symptoms. Secondly, with regard to the differences between models from ADHD group and the control group, could be necessary its incorporation into assessment protocols in order to achieve more reliable and accurate diagnosis. Control group model shows a relationship between commissions and RT. In this sense, it is expected that an increasing of the number of commissions leads, in turn, to a low response time. By contrast, in the case of ADHD, the presence of a high commissions do not lead to a lower RT levels, since this student group also present a deficit in this variable (Leth-Steensen et al., 2000).

In the ADHD Group model, it can be observed a relationship between central activation of the cortex and D prime variable offered by TOVA. This fact makes sense, because D prime variable is obtained from the number of omissions and commission errors. Both are produced by a low level of activation in central cortical and left prefrontal brain areas. In this way, ADHD Group showed a greater number of errors both by omission and commission. Nevertheless, subjects from control group do not make omission errors, at least not significantly (González-Castro et al., 2013). Finally, comparation of both models showed differences between central and prefrontal activation relationship. While in the Control Group this relationship is 0.67, in the ADHD group decreases to 0.50. In this sense, in children without ADHD there is a relationship between different brain areas. But in the case of ADHD, the alteration in the cortical activation might present only in a specific area (Hart et al., 2013). This aspect has relevance for ADHD assessment, supported the idea about the alteration in the cortical activation and its measured through both electrical activity and blood oxygenation (Toomim and Carmen, 2009). Likewise, it is also relevant for intervention, since an improvement in the symptomatology would pass by an increase in the activation levels in the area which specifically is found more altered (Duric et al., 2014; Holtmann et al., 2014; González-Castro et al., 2016). This would imply a significant improvement because as has been reflected in this study, low activation levels in a specific area (central or left prefrontal) is particularly related to an executive profile (inattentive or impulsive/hyperactive).

Implications for Practice

Our results have important implications in ADHD diagnosis. An Activation-Executive diagnosis model was tested to improve the assessment process in ADHD, also explained variables interactions. Moreover, this study lends support to prior studies stating that the prefrontal area is essential in ADHD assessment (Rubia et al., 2011). This leads to a model of activation in which the central prefrontal and left prefrontal areas present lower activation in children with ADHD compared to controls (González-Castro et al., 2013). These results suggest the importance of including different measures for the symptoms analysis with the aim to stablish a specific intervention and differentiate those cases that may need pharmacological support, or other interventions such as behavior therapy, neurofeedback or combine treatment. In this sense, the analysis of the activation allows professionals to determine the severity of the disorder and the intervention required.

Limitations of the Study

Although the present study has produced interesting results, the implications derived from them should be taken cautiously as some theoretical and methodological limitations can be pointed out.

Firstly, it would have been convenient to compare the results obtained by these tests with those provided by other empirically validated tests as SPECT or fMRI, in order to compare the levels of cortical activation through blood flow and their correlations with the values provided by the HEG. Secondly, in future research, it would be appropriate to consider not only the differences between controls and ADHD subjects, but also between the subtypes of the disorder (which could reveal that different activation and execution models are needed). It would be desirable control variables and problems related to ADHD (such as anxiety or depression) which could affect the obtained results (Rodríguez et al., 2014) and specially, taking into account that the presence of a pure ADHD group is an infrequent situation. Finally, we have to note the broad age range of the sample as another limitation and highlight the interest of analyzing these measures as function of age.

AUTHOR CONTRIBUTIONS

CR, PG-C, MC, DA, and JG-P: Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work. Drafting the work or revising it critically for important intellectual content. Final approval of the version to be published. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FUNDING

Grants awarded to the authors from the Council of Economy and Employment of the Princedom of Asturias (Spain) (Ref. GRUPIN 14-053).

ACKNOWLEDGMENTS

The authors thank Stephen Loew for his review of text and advice pertaining to this article.

REFERENCES

Álvarez, L., González-Castro, P., Núñez, J. C., González-Pienda, J. A., and Bernardo, A. (2008). Evaluación y control de la activación cortical en el déficit de atención sostenida. *Int. J. Clin. Health Psychol.* 8, 509–524.

American Psychiatric and Association [APA] (2002). *Diagnostic and Statistical Manual of Mental Disorders*, 4h Edn. Washigton, DC: American Psychiatric and Association.

American Psychiatric and Association [APA] (2013). *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edn. Washington, DC: American Psychiatric and Association.

Anastopoulos, A. D., Sommer, J. L., and Schatz, N. K. (2009). ADHD and family functioning. *Curr. Atten. Disord. Rep.* 1, 167–170. doi: 10.1007/s12618-009-0023-2

Arbuckle, J. L. (2009). *SPSS (Version 22.0) [Computer Program]*. Chicago, IL: SPSS.

Arns, M., De Ridder, S., Strehl, U., Breteler, M., and Coenen, A. (2009). Efficacy of neurofeedback treatment in ADHD: the effects on inattention, impulsivity and hyperactivity: a meta-analysis. *Clin. EEG Neurosci.* 40, 180–189. doi: 10.1177/155005940904000311

Barnard-Brak, L., Sulak, T. N., and Fearon, D. D. (2011). Coexisting disorders and academic achievement among children with ADHD. *J. Atten. Disord.* 15, 506–515. doi: 10.1177/1087054710369667

Bentler, P. M. (1995). *EQS Structural Equations Program Manual*. Encino, CA: Multivariate Software.

Bledsoe, J. C., Semrud-Clikeman, M., and Pliszka, S. R. (2011). Neuroanatomical and neuropsychological correlates of the cerebellum in children with attention-deficit/hyperactivity disorder–combined type. *J. Am. Acad. Child Adolesc. Psychiatry* 50, 593–601. doi: 10.1016/j.jaac.2011.02.014

Brown, E. T. (2006). *ADHD Handbook for Children and Adults*. Barcelona: Masson.

Congdon, E., Altshuler, L. L., Mumford, J. A., Karlsgodt, K. H., Sabb, F. W., Ventura, J., et al. (2014). Neural activation during response inhibition in adult attention-deficit/hyperactivity disorder: preliminary findings on the effects of medication and symptom severity. *Psychiatry Res.* 222, 17–28. doi: 10.1016/j.pscychresns.2014.02.002

Congedo, M., and Lubar, J. F. (2003). Parametric and non-parametric analysis of QEEG: normative database comparisons in electroencephalography, a simulation study on accuracy. *J. Neurother.* 7, 1–29. doi: 10.1300/J184v07n03_01

Cortese, S., Kelly, C., Chabernaud, C., Proal, E., DiMartino, A., Milham, M. P., et al. (2012). Toward systems neuroscience of ADHD: a meta-analysis of 55 fMRI studies. *Am. J. Psychiatry* 169, 1038–1055. doi: 10.1176/appi.ajp.2012.11101521

Cubillo, A., Halari, R., Smith, A., Taylor, E., and Rubia, K. (2012). Are view of fronto-striatal and fronto-cortical brain abnormalities in children and adults with attention deficit hyperactivity disorder (ADHD) and new evidence for dysfunction in adults with ADHD during motivation and attention. *Cortex* 48, 194–215. doi: 10.1016/j.cortex.2011.04.007

Depue, B. E., Burgess, G. C., Willcutt, E. G., Bidwell, L. C., Ruzic, L., and Banich, M. T. (2010). 12:38 19/11/2014 Symptom-correlated brain regions in young adults with combined-type ADHD: their organization, variability, and relation to behavioral performance. *Psychiatry Res.* 182, 96–102. doi: 10.1016/j.pscychresns.2009.11.011

Duric, N. S., Abmus, J., and Elgen, I. B. (2014). Self-reported efficacy of neurofeedback treatment in a clinical randomized controlled study of ADHD children and adolescents. *Neuropsychiatr. Dis. Treat.* 10, 1645–1654. doi: 10.2147/NDT.S66466

Ernst, M., Kimes, A. S., London, E. D., Matochik, J. A., Eldreth, D., Tata, S., et al. (2003). Neural substrates of decision making in adults with attention deficit hyperactivity disorder. *Am. J. Psychiatry* 160, 1061–1070. doi: 10.1176/appi.ajp.160.6.1061

Farré, A., and Narbona, J. (1997). *Attention Deficit/Hyperactivity Disorder Scales (E.D.A.H)*. Madrid: TEA Ediciones.

Finney, S. J., and DiStefano, C. (2006). "Non-normal and categorical data in structural equation modeling," in *Structural Equation Modeling: A Second Course*, eds G. R. Hancock and R. O. Muller (Greenwich, CT: Information Age), 269–314.

Frazier, T. W., Youngstrom, E. A., Glutting, J. J., and Watkins, M. W. (2007). ADHD and achievement: meta-analysis of the child, adolescent, and adult literatures and a concomitant study with college students. *J. Learn. Disabil.* 40, 49–65. doi: 10.1177/00222194070400010401

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J. H., and Kaiser, J. (2003). Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: a comparison with methylphenidate. *Appl. Psychophysiol. Biofeedback* 28, 1–12. doi: 10.1023/A:1022353731579

González-Castro, P., Cueli, M., Rodríguez, C., García, T., and Alvarez, L. (2016). Efficacy of neurofeedback versus pharmacological support in subjects with ADHD. *Appl. Psychophysiol. Biofeedback* 41, 17–25. doi: 10.1007/s10484-015-9299-4

González-Castro, P., Rodríguez, C., Cueli, M., García, T., and Alvarez-García, D. (2015). Anxiety and selective attention differences in ADHD subtypes. *Int. J. Clin. Health Psychol.* 15, 105–112. doi: 10.1016/j.ijchp.2014.10.003

González-Castro, P., Rodríguez, C., López, A., Cueli, M., and Álvarez, L. (2013). Attention deficit hyperactivity disorder, differential diagnosis with blood oxygenation, beta/theta ratio, and attention measures. *Int. J. Clin. Health Psychol.* 13, 101–109. doi: 10.1016/S1697-2600(13)70013-9

Greenberg, L. M., and Waldman, I. D. (1993). Developmental normative data on the Test of Variables of Attention (T.O.V.A.). *J. Child Psychol. Psychiatry* 34, 1019–1030. doi: 10.1111/j.1469-7610.1993.tb01105.x

Hale, T. S., Bookheimer, S., McGough, J. J., Phillips, J. M., and McCracken, J. T. (2007). Atypical brain activation during simple & complex levels of processing in adult ADHD: an fMRI study. *J. Atten. Disord.* 11, 125–140. doi: 10.1177/1087054706294101

Hart, H., Radua, J., Nakao, T., Mataix-Cols, D., and Rubia, K. (2013). Meta-analysis of functional magnetic resonance imaging studies of inhibition and attention in attention-deficit/hyperactivity disorder exploring task-specific, Stimulant medication, and age effects. *JAMA Psychiatry* 70, 185–198. doi: 10.1001/jamapsychiatry.2013.277

Holtmann, M., Sonuga-Barke, E., Cortese, S., and Brandeis, D. (2014). Neurofeedback for ADHD: a review of current evidence. *Child Adolesc. Psychiatr. Clin. N. Am.* 23, 789–806. doi: 10.1016/j.chc.2014.05.006

Kline, R. B. (2013). Assessing statistical aspects of test fairness in structural equation modeling. *Educ. Res. Eval.* 19, 204–222. doi: 10.1080/13803611.2013.767624

Kropotov, D., Grin-Yatsenko, A., Ponomarev, A., Chutko, S., Yakovenko, A., and Nikishena, S. (2007). Changes in EEG spectrograms, event-related potentials and event-related desynchronization induced by relative beta training in ADHD children. *J. Neurother.* 11, 3–11.

Lansbergen, M. M., Arns, M., Van Dongen-Boomsma, M., Spronk, D., and Buitelaar, J. K. (2011). The increase in theta/beta ratio on resting-state EEG in boys with attention-deficit/hyperactivity disorder is mediated by slow alpha peak frequency. *Prog. Neuropsychopharmacol. Biol. Psychiatry* 35, 47–52. doi: 10.1016/j.pnpbp.2010.08.004

Leth-Steensen, C., Elbaz, Z. K., and Douglas, V. I. (2000). Mean response times, variability, and skew in the responding of ADHD children: a response time distributional approach. *Acta Psychol.* 104, 167–190. doi: 10.1016/S0001-6918(00)00019-6

Logothetis, N. K., and Wandell, B. A. (2004). Interpreting the BOLD signal. *Annu. Rev. Physiol.* 66, 735–769. doi: 10.1146/annurev.physiol.66.082602.092845

Lubar, J. F., Swartwod, M. O., Swartwood, J. N., and O'Donell, P. (1995). Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical settings as measured by changes in TOVA scores, behavioral ratings, and WISK-R performance. *Biofeedback Self Regul.* 20, 83–99. doi: 10.1007/BF01712768

Mazaheri, A., Fassbender, C., Coffey-Corina, S., Hartanto, T. A., Schweitzer, J. B., and Mangun, G. R. (2014). Differential oscillatory electroencephalogram between attention-deficit/hyperactivity disorder subtypes and typically developing adolescents. *Biol. Psychiatry* 76, 422–429. doi: 10.1016/j.biopsych.2013.08.023

Monastra, V. J., Lynn, S., Linden, M., Lubar, J. F., Gruzelier, J., and LaVaque, T. J. (2005). Electroencephalographic biofeedback in the treatment of attention-deficit/hyperactivity disorder. *Appl. Psychophysiol. Biofeedback* 30, 95–114. doi: 10.1007/s10484-005-4305-x

Mostofsky, S. H., Cooper, K. L., Kates, W. R., Denckla, M. B., and Kaufman, W. E. (2002). Smaller prefrontral and premotor volumes in boys with attention-deficit/hyperactivity disorder. *Biol. Psychiatry* 52, 785–794. doi: 10.1016/S0006-3223(02)01412-9

Nikolas, M. A., and Burt, S. A. (2010). Genetic and environmental influences on ADHD symptom dimensions of inattention and hyperactivity: a meta-analysis. *J. Abnorm. Psychol.* 119, 1–17. doi: 10.1037/a0018010

Orinstein, A. J., and Stevens, M. C. (2014). Brain activity in predominantly-inattentive subtype attention-deficit/hyperactivity disorder during an auditory oddball attention task. *Psychiatry Res.* 223, 121–128. doi: 10.1016/j.pscychresns.2014.05.012

Orlando, P. C., and Rivera, R. O. (2004). Neurofeedback for elementary students with identified learning problems'. *J. Neurother.* 8, 5–19. doi: 10.1300/J184v08n02_02

Othmer, S., Othmer, S. F., and Kaiser, D. A. (2000). "EEG biofeedback: an emerging model for its global efficacy," in *Introduction to Quantitative EEG and Neurofeedback*, eds J. R. Evans and A. Abarbanel (San Diego, CA: Academic Press), 244–310.

Rodríguez, C., González-Castro, P., García, T., Núñez, J. C., and Álvarez, L. (2014). Trait anxiety effects in the attentional functions of children with ADHD compared with peers. *Learn. Individ. Differ.* 36, 147–152. doi: 10.1016/j.lindif.2014.07.010

Rossiter, T. (2004). The effectiveness of neurofeedback and stimulant drugs in treating AD/HD: part II. Replication. *Appl. Psychophysiol. Biofeedback* 29, 233–243. doi: 10.1007/s10484-004-0383-4

Rubia, K., Halari, R., Cubillo, A., Smith, A. B., Mohamed, A., Brammer, M., et al. (2011). Methylphenidate normalizes fronto-striatal underactivation during interference inhibition in medication-naïve boys with attention-deficit hyperactivity disorder. *Neuropsychopharmacology* 36, 1575–1586. doi: 10.1038/npp.2011.30

Sánchez, C. R., Díaz, F., and Ramos, C. (2010). Attention deficit hyperactivity disorder in teenagers: appraisal of the EDAH (a) scale. *Rev. Neurol.* 51, 337–346.

Schecklmann, M., Ehilis, A., Plichta, M. M., Romanos, J., Heine, M., Boreatti-Hümmer, A., et al. (2009). Diminished prefrontal oxygenation with normal and above-average verbal fluency performance in adult ADHD. *J. Psychiatr. Res.* 43, 98–106. doi: 10.1016/j.jpsychires.2008.02.005

Schroeder, V. M., and Kelley, M. L. (2009). Associations between family environment, parenting practices, and executive functioning of children with and without ADHD. *J. Child Fam. Stud.* 18, 227–235. doi: 10.1007/s10826-008-9223-0

Sciberras, E., Lycett, K., Efron, D., Mensah, F., Gerner, B., and Hiscock, H. (2014). Anxiety in children with attention-deficit/hyperactivity disorder. *Pediatrics* 133, 801–808. doi: 10.1542/peds.2013-3686

Shaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., and Schwab-Stone, M. E. (2000). Diagnostic interview schedule for children version IV (NIMH DISC-IV): description, differences from previous versions and reliability of some common diagnoses. *J. Am. Acad. Child Adolesc. Psychiatry* 39, 28–38. doi: 10.1097/00004583-200001000-00014

Skounti, M., Philatithis, A., and Galanakis, E. (2007). Variations in prevalence of Attention Deficit Hyperactivity Disorder world wide. *Eur. J. Pediatr.* 166, 117–123. doi: 10.1007/s00431-006-0299-5

Solanto, M. V., Schulz, K. P., Fan, J., Tang, C. Y., and Newcorn, J. H. (2009). Event-related fMRI of inhibitory control in the predominantly inattentive and combined subtypes of ADHD. *J. Neuroimaging* 19, 205–212. doi: 10.1111/j.1552-6569.2008.00289.x

Sowell, E. R., Thompson, P. M., Welcome, S. E., Henkenius, A. L., Toga, A. W., and Peterson, B. S. (2003). Cortical abnormalities in children and adolescents with Attention-Deficit Hyperactivity Disorder. *Lancet* 362, 1699–1707. doi: 10.1016/S0140-6736(03)14842-8

Swanson, J. M., and Castellanos, F. X. (2002). "Biological bases of ADHD—Neuroanatomy, genetics, and pathophysiology," in *ADHD State of the Science, Best Practices*, eds P. S. Jensen and J. R. Cooper (Kingston, NJ: Civic Research Institute), 7–20.

Thompson, L., and Thompson, M. (1998). Neurofeedback combined with training in metacognitive strategies: effectiveness in students with ADD. *Appl. Psychophysiol. Biofeedback* 23, 243–263. doi: 10.1023/A:1022213731956

Toomim, H., and Carmen, J. (2009). "Hemoencephalography: photon-based blood flow neurofeedback," in *Introduction to Quantitative EEG and Neurofeedback: Advanced Theory and Applications*, 2nd Edn, eds T. Budzynski, H. Budzynski, J. Evans, and A. Abarbanel (New York, NY: Academic Press), 169–194.

Toomim, H., Mize, W., Yeekwong, P., Toomim, M., Marsh, H., Kozlowski, G. P., et al. (2005). Intentional increase of cerebral blood oxygenation using hemoencephalography: an efficient brain exercise therapy. *J. Neurother.* 8, 5–21. doi: 10.1300/J184v08n03_02

Tsujimoto, S., Yasumura, A., Yamashita, Y., Torii, M., Kaga, M., and Inagaki, M. (2013). Increased prefrontal oxygenation realated to distractor-resistant working memory in children with attention-deficity/hyperactivity disorder (ADHD). *Child Psychiatry Hum. Dev.* 44, 678–688. doi: 10.1007/s10578-013-0361-2

Wechsler, D. (2005). *Intelligence Scales Wechsler (WISC-IV)*, 4th Edn. Madrid: TEA.

West, S. G., Finch, J. F., and Curran, P. J. (1995). "Structural equation models with non-normal variables: Problems and remedies," in *Structural Equation Modeling: Concepts, Issues, and Applications*, ed. R. Hoyle (Thousand Oaks, CA: Sage), 56–75.

Willcutt, E. G., Nigg, J. T., Pennington, B. F., Solanto, M. V., Rohde, L. A., Tannock, R., et al. (2012). Validity of DSM-IV attention déficit/hyperactivity disorder symptom dimensions and subtypes. *J. Abnorm. Psychol.* 121, 991–1010. doi: 10.1037/a0027347

Williams, J. R. (2008). Revising the declaration of Helsinki. *World Med. J.* 54, 120–125.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Rodríguez, González-Castro, Cueli, Areces and González-Pienda. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 21 September 2016
doi: 10.3389/fpsyg.2016.01384

Limited Near and Far Transfer Effects of Jungle Memory Working Memory Training on Learning Mathematics in Children with Attentional and Mathematical Difficulties

Michel Nelwan[1] and Evelyn H. Kroesbergen[2]*

[1] Lucertis Kinder- en Jeugdpsychiatrie, Rotterdam, Netherlands, [2] Department of Special Education, Utrecht University, Utrecht, Netherlands

The goal of this randomized controlled trial was to investigate whether Jungle Memory working memory training (JM) affects performance on working memory tasks, performance in mathematics and gains made on a mathematics training (MT) in school aged children between 9–12 years old ($N = 64$) with both difficulties in mathematics, as well as attention and working memory. Children were randomly assigned to three groups and were trained in two periods: (1) JM first, followed by MT, (2) MT first, followed by JM, and (3) a control group that received MT only. Bayesian analyses showed possible short term effects of JM on near transfer measures of verbal working memory, but none on visual working memory. Furthermore, support was found for the hypothesis that children that received JM first, performed better after MT than children who did not follow JM first or did not train with JM at all. However, these effects could be explained at least partly by frequency of training effects, possibly due to motivational issues, and training-specific factors. Furthermore, it remains unclear whether the effects found on improving mathematics were actually mediated by gains in working memory. It is argued that JM might not train the components of working memory involved in mathematics sufficiently. Another possible explanation can be found in the training's lack of adaptivity, therefore failing to provide the children with tailored instruction and feedback. Finally, it was hypothesized that, since effect sizes are generally small, training effects are bound to a critical period in development.

Keywords: working memory, training, mathematics, attention deficits, ADHD, dyscalculia

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Thomas James Lundy, virtuallaboratory.net, inc., USA
Ludmila Nunes, Purdue University, USA

****Correspondence:***
Michel Nelwan
m.nelwan@lucertis.nl

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *02 June 2016*
Accepted: *30 August 2016*
Published: *21 September 2016*

Citation:
Nelwan M and Kroesbergen EH (2016) Limited Near and Far Transfer Effects of Jungle Memory Working Memory Training on Learning Mathematics in Children with Attentional and Mathematical Difficulties. Front. Psychol. 7:1384. doi: 10.3389/fpsyg.2016.01384

INTRODUCTION

Studies have shown that persistent difficulties in mathematics develop in approximately 5% of school-aged children. An even larger number of children struggle with math on a day-to-day basis, without meeting the criteria for developmental dyscalculia. The underpinnings for math difficulties are manifold, with both cognitive as well as emotional factors contributing to its manifestation and maintenance over time. Recent literature can be divided in multiple foci of interest. Attentional resources (Marzocchi et al., 2002; Dormal et al., 2014), memory processes (Perna et al., 2015), basic number sense (Piazza, 2010; Brankaer et al., 2014; Vanbinst et al., 2015), as well as math anxiety (i.e., Maloney and Beilock, 2012) hold their own in what seems to be a still unintegrated field of research.

Mathematics disabilities are recognized as complex neuro-psychological syndromes related to many distinct neurocognitive constructs (Perna et al., 2015) and underlying brain activation (Arsalidou and Taylor, 2011; Metcalfe et al., 2013; Demir et al., 2014). However, relationships between these constructs remain largely unclear.

A large body of research, however, has been conducted in the field of executive functions and their relationship to mathematics. Predominantly, the role of working memory has been a topic of interest. Following the most influential model proposed by Baddeley and Hitch (1977), elaborated upon by Miyake et al. (2000), working memory can be viewed as a cognitive buffer system that allows the temporary storage and manipulation of incoming information necessary for complex tasks. The model describes two slave systems: a visuo-spatial sketchpad and an auditory-verbal component, called the phonological loop. Both slave systems are supervised by a flexible control system, the Central Executive (CE), that is thought to monitor and update information as well as inhibit incoming irrelevant information.

A slightly different approach to working memory has been advocated by Cowan (1988). In this model, working memory is conceptualized as a memory storage in the center of attention, that is limited in both duration and load, so that its contents can be operated on and be integrated with information in long-term memory. Compared to the model of the Baddeley and Hitch model, emphasis is placed on awareness and both voluntary as well as involuntary attentional processes. In this view, not only processing errors of updating can lead to mathematical difficulties. Problems with activating previously learned information or attentional problems would lead to the same behavioral results. This approach is relevant for the present study, as it incorporates attentional processes.

Regarding the role of working memory in the development of mathematical competency the *updating* component of working memory plays an important part (Lee et al., 2012; Van der Ven et al., 2012; Kolkman et al., 2013a). *Updating* represents the ability to update relevant information in working memory and the concurrent ability to inhibit irrelevant information. The construct is part of the CE component of working memory in the Baddeley and Hitch model. Updating seems to be the process involved in keeping track of intermediate outcomes of mental arithmetic and problem solving (Passolunghi and Pazzaglia, 2004, 2005). Involvement of working memory in mental arithmetic in children might follow a developmental path, with the contribution of verbal working memory increasing with age, while that of visuospatial working memory decreases (Van de Weijer-Bergsma et al., 2015c). Children with less working memory capacity tend to perform worse on general mathematical tasks than typically developing peers (Friso-van den Bos et al., 2013).

Despite the fact that most recent contemporary reviews consider working memory to be a relevant factor in mathematics learning and development, contrasting views are advocated by different authors. Considering different aspects of working memory, some authors have found deficits in visual working memory, but no apparent problems in verbal working memory (McLean and Hitch, 1999). Furthermore, Landerl et al. (2004) describe a group of children with mathematics learning disorder in the absence of difficulties in working memory. In this same vein, Temple and Sherwood (2002) found no relationship between working memory and number sense, or working memory and arithmetic capabilities. Working memory is considered by these authors to be neither a necessary, nor a sufficient factor in explaining mathematical difficulties. They advocate a standpoint in which number sense abilities play the most prominent role in a developmental model of mathematical difficulties. Other authors, however, propose a double deficit model: Number sense and working memory both lead to weaker performance in tasks involving mathematical problem solving. Children that exhibit both number sense as well as working memory difficulties, obtain lowest results (Östergren and Träff, 2013; Kroesbergen and van Dijk, 2015). In addition to contrasting research findings, variation in research design, usage of working memory tasks involving counting and covariance of working memory with other domain-general factors, like processing speed, make interpreting results quite difficult (Cowan and Powell, 2014).

Relationship between Attention Problems and Mathematics

Both clinical observations as well as scientific research have pointed out a high incidence of comorbidity between attention problems and learning disorders. Estimations currently revolve around 30% (DuPaul and Volpe, 2009). Recent evidence from twin-studies suggests a genetic link between symptoms of ADHD, primarily the inattentive symptoms, and mathematic disabilities (Greven et al., 2014). Inattentive children tend to make more mistakes when calculating than attentive children, quite possibly due to working memory deficits frequently found in groups of children with both ADHD and persistent math disabilities. Both working memory and attention are neurocognitive traits that can be viewed as dimensional constructs, with - at the lower end of the continuum- the deficits common in children with ADHD (e.g., Larsson et al., 2012; Martin et al., 2015) and developmental dyscalculia. Based on the above, it could be concluded that a group of children with mild or moderate problems in attention or working memory, in the presence of normal general intelligence, is struggling with mathematics, but doesn't meet the formal criteria for ADHD or developmental dyscalculia. This is, however, a highly interesting group that is often overlooked and that is -at least in the Netherlands- not eligible for specialized treatment. Teachers could benefit from knowledge on this subject, as well as methods describing how to remediate difficulties with mathematics. However, scientific knowledge about cognitive underpinnings of learning problems is not frequently transferred to the classroom or remediation programs in school.

Working Memory Training and Mathematics

One of the possible training programs that could possibly find, and has found, its way into the schools is working memory training. Some research suggests beneficial effects of

working memory training on mathematics (Bergman-Nutley and Klingberg, 2014; Söderqvist and Bergman Nutley, 2015), but effect sizes are generally small and studies have their methodological limitations, mostly because of a small sample size. The largest sample size to date can be found in a study by Holmes and Gathercole (2013). These authors used Cogmed Working Memory Training in a classroom setting and found considerable long term effects on both working memory as well as mathematics. There is, however, debate in the literature on transfer of working memory training in general. Meta-analyses carried out recently point out effects of training on both verbal and non-verbal working memory, but authors disagree on the matter of far transfer. Melby-Lervåg and Hulme (2013) conclude that at follow-up limited near transfer effects could be measured and there is no clear evidence of generalization of training to other skills. Specifically, for arithmetic, effect sizes are generally low and non-significant. On the other hand, two recent meta-analyses showed long term effects of working memory training on measures of attention in everyday functioning (Shinaver et al., 2014; Spencer-Smith and Klingberg, 2015), which should be beneficial for learning behavior and for outcomes of academic performance, including mathematics. Possibly, effects of working memory training on mathematics are indirect and depend on instructions and training of mathematical skills after gains in working memory have been made. The present study elaborates existing literature by addressing this issue. The questions raised by existing literature are whether children with attentional problems and problems in working memory (a) profit from training working memory and (b) show more gain in a training of mathematical abilities than their untrained peers.

To address these two questions, we trained working memory in a sample of children in primary schools using Jungle Memory training (JM) for 8 weeks, before training basic arithmetic abilities (addition, subtraction, multiplication, and dividing) using a Dutch computer based adaptive arithmetic training (Math Garden) for 8 weeks and compared this group to two control groups. We measured transfer to both verbal and non-verbal working memory tasks and a speeded arithmetic task. Based on some previous studies, we expected a limited transfer to mathematical abilities directly after working memory training but a larger training effect of the arithmetic training compared to our control groups. Current literature, however, is not clear about this issue and the direction this hypothesis is leading, giving us other concurring hypotheses to consider. Based on the meta-analysis by Melby-Lervåg and Hulme (2013) one could hypothesize that all groups would profit equally from the mathematics training. A third possibility would be that performance in mathematics depends on working memory as a base engine, in which case both groups training working memory would perform equally well and better than the group training mathematics only.

MATERIALS AND METHODS

Participants

Children ($N = 64$) were recruited from regular elementary schools in The Netherlands, primarily in the Rotterdam area. Teachers of different schools were asked to participate and they selected the children based on the inclusion criteria provided to them. Children were eligible to participate if they were 9–12 years old when training started (Grades 4–6), had difficulties in mathematics (scores on standardized school based tests below or far below average), and were observed to have attentional difficulties (above average scores on a standardized rating scale – Scholte and van der Ploeg, 2005) as rated by their teachers. Working memory was evaluated by the teachers as well. They were asked to fill out the BRIEF (Behavior Rating Inventory of Executive Function), a rating scale measuring a variety of executive functions, including working memory (Huizinga and Smidts, 2010). Children were, however, not excluded when they did not exhibit specific working memory problems as rated by their teachers. Descriptive statistics can be found in **Table 1**. Children with below average scores on reading or reading comprehension or known psychiatric disorders other than ADHD were excluded from participation.

Parents received written information on the study and we obtained their written consent, in accordance with the Declaration of Helsinki, before starting the assessments and training. The study was approved by the ethics committee of the Faculty of Social and Behavioral science, Utrecht University (FETC14-022).

Tests

There were three main variables of interest in this study: verbal and spatial working memory and mathematical ability. The tests that were used for measuring working memory were (1) a visuospatial working memory task called 'Lion Game,' and (2) a verbal working memory task called 'Monkey Game' (Van de Weijer-Bergsma et al., 2015b,c). Tasks were administered on a computer with headphones in the school setting, supervised by a student who was present the whole time.

The Lion Game is a visual-spatial complex span task, in which children have to search for colored lions. Children are presented with a 4×4 matrix containing 16 cells. In each trial, eight lions of different colors (red, blue, green, yellow, and purple) are consecutively presented at different locations for 2000 ms. Children have to remember the last location where a lion of a certain color has appeared and use the mouse to click on that location after the sequence has ended. The tasks consist of five levels each of four items, in which working memory load is manipulated by the number of colors children have to remember and update. No cut-off rules are applied (Van de Weijer-Bergsma et al., 2015b). Proportion correct responses were collected. Reliability and validity of The Lion Game have been studied recently (Van de Weijer-Bergsma et al., 2015b). Good internal consistency reliability (Cronbach's $\alpha = 0.87$), satisfactory test–retest reliability ($\alpha = 0.71$) and good concurrent ($\alpha = 0.51$) and predictive validity have been found. Scores on The Lion Game appear to be a significant predictor of math ability.

The Monkey Game is a verbal span-backward task, in which children have to remember and recall different words backward. Children hear spoken words (i.e., moon, fish, rose, eye, house,

TABLE 1 | Means of the groups on descriptive measures.

Condition	JM+MT (*N* = 21)	MT+JM (*N* = 24)	MT only (*N* = 19)		
Measure	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**	***F***	***p***
Sex (M/F)	13/8	13-Nov	15/4		
Age	11.03 (0.96)	10.50 (0.90)	10.86 (1.00)	1.823	0.170
Working memory teacher*	20.31 (6.12)	19.33 (5.68)	20.45 (5.48)	0.776	0.465
Attention teacher**	9.5 (7.04)	9.94 (7.07)	9.60 (6.27)	0.036	0.967
Mathematical abilities***	87.14 (22.92)	83.00 (27.70)	85.11 (25.12)	0.146	0.864
Symbolic number comp.	0.95 (0.05)	0.96 (0.04)	0.96 (0.04)	0.030	0.971
Non-symb. number comp.	0.73 (0.09)	0.71 (0.04)	0.74 (0.06)	0.801	0.454
Number Line	0.87 (0.14)	0.79 (0.22)	0.87 (0.17)	0.092	0.913
Go/NoGo	5.19 (3.17)	5.95 (4.27)	6.10 (3.70)	0.350	0.706

*JMT, Jungle Memory training; MG, Math Garden. *Behavior Rating Inventory of Executive Function (BRIEF) raw score. **ADHD-questionnaire (AVL) raw score. ***Arithmetic Tempo Test (TTR) raw total score.*

ice, fire, cat, and coat). In Dutch, these words are some of the words first learned in reading by children in first grade. Children have to remember the words and recall them backward, by clicking on the written words presented visually in a 3×3 matrix. The task consists of five levels each of four items, in which working memory load is manipulated by the number of words children have to remember and recall backward, ranging from two words in level 1 to six words in level 5. No cut-off rules were applied (Van de Weijer-Bergsma et al., 2015c). Proportion correct responses were collected. The Monkey Game has good internal consistency (Cronbach's α ranging from 0.78–0.89) and shows good concurrent and predictive validity (Van de Weijer-Bergsma et al., 2015a).

The test used to measure mathematical abilities was the Arithmetic Tempo Test (Tempo Toets Rekenen, de Vos, 1992), a fast paper-and-pencil screening instrument. Five columns are presented, each with 40 arithmetic exercises: addition, subtraction, multiplication, division, and mixed, slowly increasing in difficulty. All problems consist of two-operant equations with outcomes smaller than 100. Pupils are instructed to solve as many problems as they can within a 1-min limit per column. Test–retest reliability was computed in a study by Van de Weijer-Bergsma et al. (2015c) and ranged from $\alpha = 0.84$–0.87 after 4 months and from $\alpha = 0.82$–0.86 after 8 months. Combined number of correct answers in the five columns was used as an outcome measure in this study.

To check whether there were group differences in number sense abilities or inhibition, four tasks were administered during the first assessment only. Children were given (1) a symbolic number task that asked them to evaluate which of two numbers was greatest, (2) a non-symbolic number task on which they were asked to evaluate the number of dots presented on either end of the screen. (3) A number line task was presented on which participants had to place a given number on a line that ranged from 0 to 100. A further description of these tasks, as well as information on reliability and validity can be found in an article by Kolkman et al. (2013b). (4) An inhibition task following a Go–NoGo paradigm (De Weerdt et al., 2013) concluded the assessment. Speed and accuracy were measured in these tasks. These tasks were administered individually. As can be seen in **Table 1**, groups did not differ meaningfully in performance on these tasks.

Intervention

Jungle Memory™ (2008) is a web-based memory training program aimed at 7–16 year-old children. In comprises of three interactive computer games with up to 30 levels of difficulty in each game to train working memory. Each game trains different aspects of working memory and provides the student with regular feedback of progress, both during training and in the back-end of the program. Game 1 (Quicksand) involves memory for and later use of word endings, Game 2 (Code Breaker) features mental rotation of letters, and Game 3 (River Crossing) involves sequential memory of mathematical solutions. Motivational features in the program included positive verbal feedback, a display of the user's best scores, percentile rankings, and the number of 'super monkeys' collected as a result of successfully completing training levels (Alloway et al., 2013). Completion of all three tasks can be obtained in 20–25 min. The program can be found on a website by Memosyne Ltd (2011) – http://lb.junglememory.com.

The Math Garden (Van der Maas et al., 2009) is an adaptive web-based game in which children are able to train their math skills. It comprises of different games of which five calculation-based games (addition, subtraction, multiplication, division, and speed) were used during this study. Children are presented with 10 math problems per game during which they received direct feedback on their answers. To encourage motivation, children are presented with a virtual garden that grows and blooms depending on the effort and progress. The website for Math Garden can be found on http://www.rekentuin.nl.

Procedure

First, children were randomly assigned to three groups. These groups were given three different treatment procedures: (1) the experimental group received Jungle Memory Training (JM) first (8 weeks), before starting mathematics training [MT (mathematics training), 8 weeks]; (2) one control group that received the mathematics training first, before commencing JM, and (3) a second control group that received education

as usual in the first period and MT the second period. Assessment occurred three times: prior to training, after 8 weeks and post training. This was done in a group setting on individual computers with headphones. The assessment and treatment procedures are depicted schematically in **Figure 1**.

During training periods, progress and effort was monitored by trained undergraduate students visiting schools. In the back-end of both training programs, number of times trained as well as quality of the training can be easily monitored. Undergraduate students visited schools at least once every 2 weeks, giving children feedback on the obtained results, showing their progress and thereby trying to motivate the children. Both children training with JM as well as those training with MT were encouraged to complete four sessions a week by their teachers, as well as the undergraduate students. They were provided training time and a quiet place to train by their teacher during school days. Furthermore, they were provided with training schedules stating the days and the time on which they were supposed to train. Children were given no further rewards or incentives. Both teachers and undergraduate students looked for motivational or technical problems occurring during training. These problems were reported to the corresponding author who attempted to solve the issues. Motivational issues most commonly arose when training or assessment times were planned during a specific activity that was liked by the pupil. These were easily adjusted and no children dropped out. The most common technical issue was a temporary problem with the server of the web-based training programs or the working memory tasks. Sometimes appointments for assessment or training times had to be rescheduled. Children training with JM received feedback and were provided with strategies by the undergraduate students to improve their skills on the training tasks when they failed to pass the task three times in a row. This feedback was based on a protocol that was provided to us by LerendBrein, an organization based in The Netherlands, specializing in training professionals in healthcare and education. Children training with MT received no further feedback; The training program provided all the necessary feedback.

Data Screening

Missing data showed a number of missing data points, most probably due to server problems during the administration of one the working memory tasks. Missing value counts ranged from 3.1 to 10.1% in one instance, randomly distributed ($\chi^2 = 6.011$, $\sigma = 1.00$). Since the software for the data analysis does not allow for missing data, single imputation based on the series mean was used to replace missing values. The data contained no significant outliers.

Main Analyses

First, to examine the relationship between progress during JM and gains on the external working memory tasks, Pearson's *r* correlations were calculated between the working memory pre-test and the reported improvement within the game. Correlations were calculated both for the first and for the second training period, as we were interested in both short and long term effects of JM.

To be able to test the multiple hypothesis formulated without the loss of power, Bayesian evaluation of informative hypotheses was used to examine the relationship between working memory and mathematical abilities. For a detailed introduction to Bayesian statistics, one is directed to Klugkist et al. (2005) and Van de Schoot et al. (2011). This type of analysis is confirmative and provides a quantification of support in the data for each hypothesis discussed and is therefore especially useful in studies with smaller sample sizes. The posterior model probability (PMP) is computed for each hypothesis to quantify the support in the data. If the PMP of one hypothesis is larger than the PMP of the unconstrained hypothesis (H_u), the constraints used to describe the hypotheses are supported by the data. If the PMP of a first hypothesis is larger than the PMP of a second hypothesis, the support in the data is largest for the first. Mark that the sum of the PMPs for a given set of competitive hypothesis is always one.

Next, the Bayes-factor was computed. This is a measure for the degree of support for each hypothesis compared to a hypothesis without constraints. This Bayes-factor was computed by dividing the PMP-value of a hypothesis by the PMP-value of the unconstrained hypothesis, which results in a value showing the evidence in favor of one hypothesis compared with the unconstrained hypothesis.

For effect of JM on gains in working memory we considered two competing hypotheses, for both short and long term effects. All four hypotheses were translated into statistical hypotheses with (in)equality constrained parameters (Klugkist et al., 2005). In this case, the parameters were group means on a verbal and a visual working memory task. For the first training period, the first hypothesis stated that the children that received the JM first would outperform other groups on the working memory tasks, i.e., $\mu_1 > \mu_2 = \mu_3$ (Model 1). The second hypothesis was that all groups would perform equally well $\mu_1 = \mu_2 = \mu_3$ (Model 2). For the second training period, the second group -now receiving JM- would have gained more at the working memory measures: $\mu_2 > \mu_1 = \mu_3$. The alternative hypothesis we formulated was $\mu_1 = \mu_2 = \mu_3$, stating that all groups would perform equally well.

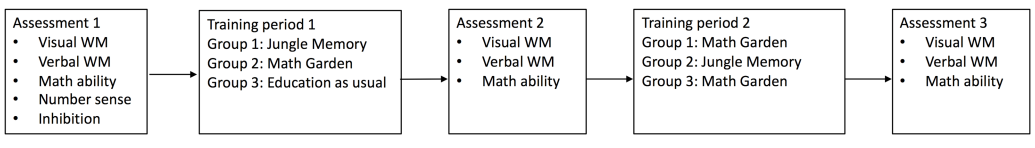


FIGURE 1 | Assessment and treatment procedures.

For effect of JM on gains made in the MT, three hypotheses were formulated for both the first and second training period. During the first training period, the group receiving MT was thought to perform best, with the group receiving JM performing better than the group receiving no training at all: $\mu_2 > \mu_1 > \mu_3$ (Model 1). Alternative hypotheses were as follows: $\mu_2 > \mu_1 = \mu_3$ (Model 2, no direct effect of JM on mathematical abilities), and $\mu_1 = \mu_2 = \mu_3$ (Model 3, no effect of both trainings). During the second period, the formulated hypotheses were the following: $\mu_1 > \mu_3 > \mu_2$ (Model 1, stating that the experimental group would outperform the other groups, with the third group - now receiving MT- would gain more than the second group), $\mu_1 = \mu_3 > \mu_2$ (Model 2, no added effect of JM on MT), and $\mu_1 = \mu_2 = \mu_3$ (Model 3, suggesting no effects of both MT and JM).

The main question of this study was assessed by examining the total gains on the mathematical abilities outcome measure over both training periods. The first hypothesis stated that children that received the JM first, before the MT, would outperform the groups that either received the JM after the MT or received the MT only, i.e., $\mu_1 > \mu_2 > \mu_3$ (Model 1). The second hypothesis stated that both groups that trained their working memory would outperform the third group training mathematical abilities only $\mu_1 = \mu_2 > \mu_3$ (Model 2). The last hypothesis stated that all groups would perform equally well on the last test for mathematical abilities $\mu_1 = \mu_2 = \mu_3$ (Model 3). All informative hypotheses stated in the section above were compared to the alternative empty hypothesis: μ_1, μ_2, μ_3 (Model 0), to protect against incorrectly choosing the hypotheses.

RESULTS

Descriptive Statistics

Table 2 shows the descriptive statistics considering the outcome measures of mathematical abilities, visual, and verbal working memory of our three groups.

Table 3 shows the descriptive statistics considering the training periods.

Relationship between Gains Made in JM and Generalization to Non-trained Tasks

Table 4 shows the Pearson's *r* correlations between gains obtained in JM by the experimental group, as shown in the stats tab provided by the program, and scores on the non-trained working memory tasks, both after the first (short term) and after the second (long term) period of training. No significant correlations could be obtained. Generalization of the training thus seemed negligible.

Working Memory Training and Gains in Working Memory

Table 5 depicts the results of Bayesian analysis of the group effects on the working memory outcome measures, BFs (Bayes Factors) and PMPs are presented. It was expected that during the first training period ($t = 1$), the experimental group would gain most on working memory outcome measures, $\mu_1 > \mu_2 = \mu_3$ (Model 1). Model 2 stated that all groups would perform equally well, $\mu_1 = \mu_2 = \mu_3$ (Model 2). These were compared to the empty Model 0 (μ_1, μ_2, μ_3). For visual working memory, no support was found for our first hypothesis. For verbal working memory, however, the data showed some support for effects of JM. Both the first and the second model received substantial support by our data, but the first model was more likely.

During the second period (t2), it was expected that our second group, training with JM, would show more gains in working memory: $\mu_2 > \mu_1 = \mu_3$ (Model 1), while the alternative hypothesis was that all groups would gain equally well: $\mu_1 = \mu_2 = \mu_3$ (Model 2). Both for visual and for verbal working memory, most support was found for the second hypothesis, respectively, receiving weak and substantial support by our data.

Working Memory Training and Mathematical Abilities

Table 6 shows the results of Bayesian analysis for the mathematics training. During the first training period it was hypothesized that the group training with MT would perform best on the mathematical abilities outcome measure and a smaller training effect could be found for the JM as well ($\mu_2 > \mu_1 > \mu_3$,Model 1). Alternative hypotheses were formulated: $\mu_2 > \mu_1 = \mu_3$ (Model 2) and $\mu_1 = \mu_2 = \mu_3$ (Model 3). Most, but only weak support was found for the second hypothesis, indicating a training effect for MT and not for JM on mathematical abilities.

During the second period, the experimental group trained with the MT. It was hypothesized that this group would show most gains in mathematical abilities after this period, followed by the third group, also training with MT: $\mu_1 > \mu_3 > \mu_2$ (Model 1). Alternative hypotheses were formulated: $\mu_1 = \mu_3 > \mu_2$ (Model 2) indicating no added effect of JM, and $\mu_1 = \mu_2 = \mu_3$ (Model 3) suggesting no effect of both JM and MT during the second period. Our data provided most and substantial support for the first model.

Table 7 shows the results of the analysis on group differences on the mathematical abilities outcome measure, to examine which group benefited most from both trainings, regarding mathematical abilities: BFs and PMPs are presented. Recall that Model 0 represents the alternative (empty) hypothesis (μ_1, μ_2, μ_3). Model 1 stated that the children training with JM first would benefit most from the MT: $\mu_1 > \mu_2 > \mu_3$. Model 2 stated both groups training with JM would show most improvement on the MT: $\mu_1 = \mu_2 > \mu_3$, while Model 3 stated that all three groups would perform equally and profit equally from training mathematics. Model 1 received most support from the data, indicating an effect of the working memory training, although the effect seems small and weak compared to the empty Model 0.

DISCUSSION

This intervention study compared three groups of children with math difficulties and attentional problems on effects of both a working memory training (Jungle Memory) and a math training (Math Garden). To our knowledge this is the first attempt to

TABLE 2 | Means and standard deviations on pre-, between and post-tests of mathematical abilities and visual and verbal working memory.

Condition	JM+MT ($N = 21$)	MT+JM ($N = 24$)	MT only ($N = 19$)
Measure	***M* (*SD*)**	***M* (*SD*)**	***M* (*SD*)**
Mathematical abilities ($t = 0$)	87 (23)	83 (27)	85 (25)
Mathematical abilities ($t = 1$)	90 (24)	95 (26)	93 (25)
Mathematical abilities ($t = 2$)	97 (24)	95 (26)	95 (28)
Visual WM ($t = 0$)	0.77 (0.09)	0.66 (0.15)	0.73 (0.12)
Visual WM ($t = 1$)	0.74 (0.12)	0.71 (0.18)	0.78 (0.12)
Visual WM ($t = 2$)	0.75 (0.14)	0.70 (0.18)	0.72 (0.18)
Verbal WM ($t = 0$)	0.53 (0.10)	0.54 (0.10)	0.60 (0.09)
Verbal WM ($t = 1$)	0.54 (0.11)	0.52 (0.12)	0.56 (0.11)
Verbal WM ($t = 2$)	0.53 (0.12)	0.52 (0.10)	0.56 (0.10)

TABLE 3 | Means and standard deviations of total training intensity of both JM and MT in three groups.

	JM	MT
JM+MT	15.9 (8.3)	21.90 (19.37)
MT+JM	7.55 (5.72)	28.71 (9.00)
MT only	N/A	12.42 (9.11)

TABLE 4 | Progression during JM on the three trained tasks in the JM+MG condition and correlations with both short and long term scores on non-trained working memory tasks (visual and verbal WM).

	Visual ST	Verbal ST	Visual LT	Verbal LT
Quicksand	0.272	−0.088	−0.205	0.039
Code breaker	0.176	0.014	−0.207	0.007
River crossing	0.397	−0.016	−0.157	0.167

combine both training procedures to investigate the effects of working memory training on both measures of working memory and learning mathematics. Prior research has been inconsistent regarding the effects of working memory training and low effect sizes are reported, especially on mathematical abilities, so multiple hypotheses were tested in this study, using Bayesian statistics.

Regarding the immediate and long term effects of working memory training on closely related working memory tasks, mathematical abilities and learning mathematics, results were discouraging. Gains made in JM showed little or no relationship with gains on non-trained working memory tasks. Some support was found for short term gains in verbal working memory only, but long-term retention was not supported by our data. Children generally trained less during the second training period, most likely due to holiday periods and extracurricular activities that occurred during this period or motivational issues. The experimental group, however, trained relatively often, compared to the control groups. It was observed that individual children that trained most, gained most in both verbal working memory and mathematical abilities, but on a group level this could not be confirmed.

Support was found for an effect of MT on gains in speeded mathematics, as was expected. Also, an added effect of JM was found. Children training with JM improved their mathematical abilities directly after training. After completing both JM and MT, the group training with JM first, showed most improvement. The effects, however, are small and were possibly mediated by the amount of training (our experimental group trained more frequently than our control groups that did not train with JM first). Furthermore, it could be argued that JM contains a task in which pupils are required to solve (and retain and update) mathematical problems. Therefore, these children had more practice time, solved more problems, than children that did not train with JM. This fact confounded the results obtained by this study.

Theoretically, working memory is a considerable factor in predicting math problems. However, training working memory with Jungle Memory does not seem to have a profound effect on mathematical abilities, requires supervised practice, and has to be accompanied by specific feedback by a trainer. Several explanations, both theoretical and practical, could be given for these results. It could be argued that Jungle Memory does not specifically train the aspects of working memory relevant to mathematics. Since Jungle Memory does train the updating component of working memory and has a processing speed component, it could be argued that attentional focus and activation of long-term memory, not directly trained by Jungle Memory, would play a crucial role in mathematics. This would give indirect support for the model proposed by Cowan (1988), that emphasized these components of working memory. Another explanation, and one that fits the Baddeley model of working memory, would be that Jungle Memory does not provide the trainee with the adequate components necessary for training working memory efficiently. Regarding this issue, lack of the program's ability to adapt efficiently to the level of the trainee - as has been proposed by Klingberg et al. (2002, 2005)- could be an explanation for the results obtained by this study.

In studies that found transfer effects of working memory training in mathematical abilities, authors generally describe a small effect. In these studies, speeded arithmetic tasks were used (St Clair-Thompson et al., 2010; Bergman-Nutley and Klingberg, 2014), just like in the present study, but only addition and subtraction problems were administered. It could be argued that other operations of calculation, specifically division, could load

TABLE 5 | Bayes Factors (BF) and Posterior Model Probabilities (PMP) of the three models and the visual and verbal working memory outcome measures ($t = 1$ and $t = 2$).

	Model 0		Model 1		Model 2	
	BF	*PMP*	*BF*	*PMP*	*BF*	*PMP*
Visual working memory (first period)	1	0.65	0.06	0.04	0.48	0.31
Verbal working memory (first period)	1	0.12	3.99	0.5	3.06	0.38
Visual working memory (second period)	1	0.29	0.83	0.24	1.65	0.48
Verbal working Memory (second period)	1	0.12	3.31	0.39	4.15	0.49

*First Period: Model 0: μ_1, μ_2, μ_3; Model 1: $\mu_1 > \mu_2 = \mu_3$; Model 2: $\mu_1 = \mu_2 = \mu_3$.
*Second Period: Model 0: μ_1, μ_2, μ_3; Model 1: $\mu_2 > \mu_1 = \mu_3$; Model 2: $\mu_1 = \mu_2 = \mu_3$.

TABLE 6 | Bayes Factors and Posterior Model Probabilities of the four models and gains on mathematics outcome measure (t1–t0 and t2–t1).

	Model 0		Model 1		Model 2		Model 3	
	BF	*PMP*	*BF*	*PMP*	*BF*	*PMP*	*BF*	*PMP*
Mathematical abilities (first period)	1	0.36	0.33	0.12	1.4	0.51	0.001	0.00
Mathematical abilities (second period)	1	0.12	3.70	0.44	2.59	0.31	1.12	0.13

*First Period: Model 0: μ_1, μ_2, μ_3; Model 1: $\mu_1 > \mu_2 = \mu_3$; Model 2: $\mu_1 = \mu_2 = \mu_3$; Model 3: $\mu_1 = \mu_2 = \mu_3$.
*Second Period: Model 0: μ_1, μ_2, μ_3; Model 1: $\mu_1 > \mu_2 > \mu_3$; Model 2: $\mu_1 = \mu_3 > \mu_2$; Model 3: $\mu_1 = \mu_2 = \mu_3$.

TABLE 7 | Bayes Factors and Posterior Model Probabilities of the four models and improvement after mathematics training.

	Model 0		Model 1		Model 2		Model 3	
	BF	*PMP*	*BF*	*PMP*	*BF*	*PMP*	*BF*	*PMP*
Mathematical abilities	1	0.28	1.35	0.38	0.47	0.13	0.77	0.22

Model 0: μ_1, μ_2, μ_3; Model 1: $\mu_1 > \mu_2 > \mu_3$; Model 2: $\mu_1 = \mu_2 > \mu_3$; Model 3: $\mu_1 = \mu_2 > \mu_3$.

on working memory more heavily, because of the fact that most pupils are less familiar with dividing. The effect of training could therefore be somewhat larger than has yet been shown. However, although this study used a composite score of four basic operations, it is not likely that this kind of effect would have been found, given the small and noisy effects that were obtained. A study by Alloway and Alloway (2009), that did administer a division task, has shown effects on mathematical ability, using the same working memory training as in the present study. This study, however, was underpowered and effects on improvement in mathematics were small. Another study (Holmes et al., 2009) only found long term effects (6 months) of WMT on mathematics and used a mathematical reasoning task that measures number sense, in contrast to basic calculating operations. This finding could be similar to the effect that was found in this study, whereas children that trained with JM first, performed slightly better during the second period than their peers. A last study (Kroesbergen et al., 2012) also found effects of working memory training on early numeracy, but was conducted with pupils in kindergarten. This leads to the hypothesis that there might be a sensitive period for working memory training, during earlier development, and that no great effects of working memory training are to be expected when pupils are trained during later classes of primary school.

Limitations

The present findings are to be viewed in light of several shortcomings. It proved to be very difficult to plan the intervention periods within a school setting. Training periods were interrupted frequently by vacations, sports activities, preparations for end-of-year activities, and other extracurricular enterprises. After the month of May, training compliance dropped both with pupils as well as teachers. Both lack of continuity as well as decreasing training compliance will have influenced our results in several ways. First, training compliance might have caused gains to be less than they could have been. Second, some children expressed their boredom with the tasks that were used during the assessments. This might have led to less effort on the part of the pupils during the last measurement especially.

Another hazard was the fact that pupils were selected from several different schools, which might have had consequences for standardization of child-teacher relationships and teaching material. Different schools use different methods of teaching mathematics, all with slightly different contents and possible effects on outcome measures. The study design doesn't allow to control for this effect.

The sample size was lower than expected, due to a lower number of eligible children in the different classes, and due to time restrictions. Bayesian analysis was used to control for

this issue. Even though the sample size was small, the feedback system provided to us by LerendBrein was quite difficult to carry out, because schools were far apart and only few pupils per school were eligible to participate in this study due to strict inclusion criteria. Feedback provided to the pupils therefore might have been less than optimal during this study. This might have negatively affected both the intensity and efficacy of the training and therefore the obtained results regarding working memory gains and possibly mathematical abilities.

CONCLUSION

In sum, this study provides a limited contribution to the literature of working memory training and its near and far transfer effects, by directly examining the effects on mathematics training. On the positive side, computerized mathematics training has a desirable effect on mathematical abilities in children, in higher grades of elementary school, with difficulties in mathematics and attentional problems. Working memory training, specifically Jungle Memory, did seem to have a positive and added effect on outcomes, but it is still unclear if these effects are mediated by improvement of verbal and/or visual working memory. Unfortunately, this could not be confirmed by our study. These findings are in concordance with existing literature. Based on observations during the study, increasing the amount of effort in working memory training might improve the outcomes in working memory and ultimately mathematics. More research would be needed on this matter. The role of working memory and its mechanisms in mathematical abilities remain unclear. Due to its limitations, the results of this study must be considered with caution. Further research has to account for the precise planning of the intervention program, proper support of the children during their training periods and probably a reward system encouraging the children to do their best during measurements. Furthermore, it is recommended that other outcome measures of mathematical abilities are used concurring with the speeded tests used in most studies. More theoretically, training of attention and strategies aiding retrieval from long term memory might be beneficial for children with mathematical difficulties and attentional problems in higher grades of elementary school. Further research is needed to test these hypotheses.

AUTHOR CONTRIBUTIONS

All authors listed have made substantial, direct, and intellectual contributions to the work, and approved for publication. EK and MN construed the study together, EK provided the master students that gathered the data. Analyses were carried out by MN while receiving feedback from EK. MN wrote the paper and EK gave constructive feedback an suggestions on improving the paper.

ACKNOWLEDGMENTS

The authors would like to thank all pupils, parents, and schools that participated in this study. Furthermore, the authors acknowledge the contribution of LerendBrein, providing us with necessary training and the feedback protocol used in the study. Parts of the results in this paper have been presented at the 2016 International Neuropsychological Society Mid-Year Meeting on the eight of July 2016.

REFERENCES

Alloway, T. P., and Alloway, R. G. (2009). The efficacy of working memory training in improving crystallized intelligence. *Nat. Proc.* doi: 10.1038/npre.2009.3697.1

Alloway, T. P., Bibile, V., and Lau, G. (2013). Computerized working memory training: can it lead to gains in cognitive skills in students? *Comput. Hum. Behav.* 29, 632–638. doi: 10.1016/j.chb.2012.10.023

Arsalidou, M., and Taylor, M. J. (2011). Is 2+2 = 4? Meta-analyses of brain areas needed for numbers and calculations. *NeuroImage* 54, 2382–2393. doi: 10.1016/j.neuroimage.2010.10.009

Baddeley, A. D., and Hitch, G. (1977). "Commentary on working memory," in *Human Memory: Basic Processes*, ed. G. D. Bower (New York, NY: Academic Press), 191–241.

Bergman-Nutley, S., and Klingberg, T. (2014). Effect of working memory training on working memory, arithmetic and following instructions. *Psychol. Res.* 78, 869–877. doi: 10.1007/s00426-014-0614-0

Brankaer, C., Ghesquière, P., and De Smedt, B. (2014). Numerical magnitude processing deficits in children with mathematical difficulties are independent of intelligence. *Res. Dev. Disabil.* 35, 2603–2613. doi: 10.1016/j.ridd.2014.06.022

Cowan, N. (1988). Evolving conceptions of memory storage, selective attention, and their mutual constraints within the human information-processing system. *Psychol. Bull.* 104, 163–191. doi: 10.1037/0033-2909.104.2.163

Cowan, R., and Powell, D. (2014). The contributions of domain-general and numerical factors to third-grade arithmetic skills and mathematical learning disability. *J. Educ. Psychol.* 106, 214–229. doi: 10.1037/a0034097

Demir, Ö. E., Prado, J., and Booth, J. R. (2014). The differential role of verbal and spatial working memory in the neural basis of arithmetic. *Dev. Neuropsychol.* 39, 440–458. doi: 10.1080/87565641.2014.939182

de Vos, T. (1992). *Tempo Test Rekenen (TTR)*. Nijmegen: Berkhout.

De Weerdt, F., Desoete, A., and Roeyers, H. (2013). Behavioral inhibition in children with learning disabilities. *Res. Dev. Disabil.* 34, 1998–2007. doi: 10.1016/j.ridd.2013.02.020

Dormal, V., Schuller, A. M., Nihoul, J., Pesenti, M., and Andres, M. (2014). Causal role of spatial attention in arithmetic problem solving: evidence from left unilateral neglect. *Neuropsychologia* 60, 1–9. doi: 10.1016/j.neuropsychologia.2014.05.007

DuPaul, G. J., and Volpe, R. J. (2009). ADHD and learning disabilities: research findings and clinical implications. *Curr. Atten. Disord. Rep.* 1, 152–155. doi: 10.1007/s12618-009-0021-4

Friso-van den Bos, I., van der Ven, S. H. G., Kroesbergen, E. H., and van Luit, J. E. H. (2013). Working memory and mathematics in primary school children: a meta-analysis. *Educ. Res. Rev.* 10, 29–44. doi: 10.1016/j.edurev.2013.05.003

Greven, C. U., Kovas, Y., Willcutt, E. G., Petrill, S. A., and Plomin, R. (2014). Evidence for shared genetic risk between ADHD symptoms and reduced mathematics ability: a twin study. *J. Child Psychol. Psychiatry Allied Disciplines* 55, 39–48. doi: 10.1111/jcpp.12090

Holmes, J., and Gathercole, S. E. (2013). Taking working memory training from the laboratory into schools. *Educ. Psychol.* 34, 440–450. doi: 10.1080/01443410.2013.797338

Holmes, J., Gathercole, S. E., and Dunning, D. L. (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Dev. Sci.* 12, 9–16. doi: 10.1111/j.1467-7687.2009.00848.x

Huizinga, M., and Smidts, D. P. (2010). Age-related changes in executive function: a normative study with the dutch version of the Behavior Rating Inventory of Executive Function (BRIEF). *Child Neuropsychol.* 17, 51–66. doi: 10.1080/09297049.2010.509715

Klingberg, T., Fernell, E., Olesen, P. J., Johnson, M., Dahlstr, K., Om, €, et al. (2005). Computerized training of working memory in children with ADHD—a randomized, controlled trial. *J. Am. Acad. Child Adolesc. Psychiatry* 44, 177–186. doi: 10.1097/00004583-200502000-00010

Klingberg, T., Forssberg, H., and Westerberg, H. (2002). Training of working memory in children with ADHD. *J. Clin. Exp. Neuropsychol.* 24, 781–791. doi: 10.1076/jcen.24.6.781.8395

Klugkist, I., Laudy, O., and Hoijtink, H. (2005). Inequality constrained analysis of variance: a Bayesian approach. *Psychol. Methods* 10, 477–493. doi: 10.1037/1082-989X.10.4.477

Kolkman, M. E., Hoijtink, H. J. A., Kroesbergen, E. H., and Leseman, P. P. M. (2013a). The role of executive functions in numerical magnitude skills. *Learn. Individ. Differ.* 24, 145–151. doi: 10.1016/j.lindif.2013.01.004

Kolkman, M. E., Kroesbergen, E. H., and Leseman, P. P. M. (2013b). Early numerical development and the role of non-symbolic and symbolic skills. *Learn. Instr.* 25, 95–103. doi: 10.1016/j.learninstruc.2012.12.001

Kroesbergen, E. H., and van Dijk, M. (2015). Working memory and number sense as predictors of mathematical (dis-)ability. *Z. Psychol.* 223, 102–109. doi: 10.1027/2151-2604/a000208

Kroesbergen, E. H., van 't Noordende, J. E., and Kolkman, M. E. (2012). Training working memory in kindergarten children: effects on working memory and early numeracy. *Child Neuropsychol.* 20, 23–37. doi: 10.1080/09297049.2012.736483

Landerl, K., Bevan, A., and Butterworth, B. (2004). Developmental dyscalculia and basic numerical capacities: a study of 8 – 9-year-old students. *Cognition* 93, 99–125. doi: 10.1016/j.cognition.2003.11.004

Larsson, H., Anckarsater, H., Råstam, M., Chang, Z., and Lichtenstein, P. (2012). Childhood attention-deficit hyperactivity disorder as an extreme of a continuous trait: a quantitative genetic study of 8,500 twin pairs. *J. Child Psychol. Psychiatry Allied Disciplines* 53, 73–80. doi: 10.1111/j.1469-7610.2011.02467.x

Lee, K., Ng, S. F., Pe, M. L., Ang, S. Y., Hasshim, M. N. A. M., and Bull, R. (2012). The cognitive underpinnings of emerging mathematical skills: executive functioning, patterns, numeracy, and arithmetic. *Br. J. Educ. Psychol.* 82, 82–99. doi: 10.1111/j.2044-8279.2010.02016.x

Maloney, E. A., and Beilock, S. L. (2012). Math anxiety: who has it, why it develops, and how to guard against it. *Trends Cogn. Sci.* 16, 404–406. doi: 10.1016/j.tics.2012.06.008

Martin, J., Hamshere, M. L., Stergiakouli, E., O'Donovan, M. C., and Thapar, A. (2015). Neurocognitive abilities in the general population and composite genetic risk scores for attention-deficit hyperactivity disorder. *J. Child Psychol. Psychiatry* 56, 648–656. doi: 10.1111/jcpp.12336

Marzocchi, G. M., Lucangeli, D., De Meo, T., Fini, F., and Comoldi, C. (2002). The disturbing effect of irrelevant information on arithmetic problem solving in inattentive children. *Dev. Neuropsychol.* 21, 73–92. doi: 10.1207/S15326942DN2101_4

McLean, J. F., and Hitch, G. J. (1999). Working memory impairments in children with specific arithmetic learning difficulties. *J. Exp. Child Psychol.* 74, 240–260. doi: 10.1006/jecp.1999.2516

Melby-Lervåg, M., and Hulme, C. (2013). Is working memory training effective? A meta-analytic review. *Dev. Psychol.* 49, 270–291. doi: 10.1037/a0028228

Memosyne Ltd (2011). *Jungle Memory*. Retrieved from http://lb.junglememory.com

Metcalfe, A. W. S., Ashkenazi, S., Rosenberg-Lee, M., and Menon, V. (2013). Fractionating the neural correlates of individual working memory components underlying arithmetic problem solving skills in children. *Dev. Cogn. Neurosci.* 6, 162–175. doi: 10.1016/j.dcn.2013.10.001

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., and Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. *Cogn. Psychol.* 41, 49–100. doi: 10.1006/cogp.1999.0734

Östergren, R., and Träff, U. (2013). Early number knowledge and cognitive ability affect early arithmetic ability. *J. Exp. Child Psychol.* 115, 405–421. doi: 10.1016/j.jecp.2013.03.007

Passolunghi, M. C., and Pazzaglia, F. (2004). Individual differences in memory updating in relation to arithmetic problem solving. *Learn. Individ. Differ.* 14, 219–230. doi: 10.1016/j.lindif.2004.03.001

Passolunghi, M. C., and Pazzaglia, F. (2005). A comparison of updating processes in children good or poor in arithmetic word problem-solving. . *Learn. Individ. Differ.* 15, 257–269. doi: 10.1016/j.lindif.2005.03.001

Perna, R., Loughan, A. R., Le, J., Hertza, J., and Cohen, M. J. (2015). Spectrum of mathematical weaknesses: related neuropsychological correlates. *Appl. Neuropsychol. Child* 4, 157–165. doi: 10.1080/21622965.2013.827573

Piazza, M. (2010). Neurocognitive start-up tools for symbolic number representations. *Trends Cogn. Sci.* 14, 542–551. doi: 10.1016/j.tics.2010.09.008

Scholte, E. M., and van der Ploeg, J. D. (2005). *Handleiding ADHD-Vragenlijst (Avl)*. Houten: Bohn Stafleu van Loghum.

Shinaver, C. S., Entwistle, P. C., and Söderqvist, S. (2014). Cogmed WM training: reviewing the reviews. *Appl. Neuropsychol. Child* 3, 163–172. doi: 10.1080/21622965.2013.875314

Söderqvist, S., and Bergman Nutley, S. (2015). Working memory training is associated with long term attainments in math and reading. *Front. Psychol.* 6:1711. doi: 10.3389/fpsyg.2015.01711

Spencer-Smith, M., and Klingberg, T. (2015). Benefits of a working memory training program for inattention in daily life: a systematic review and meta-analysis. *PLoS ONE* 10:e0119522. doi: 10.1371/journal.pone.0119522

St Clair-Thompson, H., Stevens, R., Hunt, A., and Bolder, E. (2010). Improving children's working memory and classroom performance. *Educ. Psychol.* 30, 203–219. doi: 10.1080/01443410903509259

Temple, C. M., and Sherwood, S. (2002). Representation and retrieval of arithmetical facts: developmental difficulties. *Q. J. Exp. Psychol. A* 55, 733–752. doi: 10.1080/02724980143000550

Van de Schoot, R., Hoijtink, H., and Jan-Willem, R. (2011). Moving beyond traditional null hypothesis testing: evaluating expectations directly. *Front. Psychol.* 2:24. doi: 10.3389/fpsyg.2011.00024

Van de Weijer-Bergsma, E., Kroesbergen, E. H., Jolani, S., and Van Luit, J. E. H. (2015a). The monkey game: a computerized verbal working memory task for self-reliant administration in primary school children. *Behav. Res. Methods* 48, 756–771. doi: 10.3758/s13428-015-0607-y

Van de Weijer-Bergsma, E., Kroesbergen, E. H., Prast, E. J., and Van Luit, J. E. H. (2015b). Validity and reliability of an online visual–spatial working memory task for self-reliant administration in school-aged children. *Behav. Res. Methods* 47, 708–719. doi: 10.3758/s13428-014-0469-8

Van de Weijer-Bergsma, E., Kroesbergen, E. H., and Van Luit, J. E. H. (2015c). Verbal and visual-spatial working memory and mathematical ability in different domains throughout primary school. *Mem. Cogn.* 43, 367–378. doi: 10.3758/s13421-014-0480-4

Van der Maas, H., Straatemeijer, M., and Klinkenberg, S. (2009). Rekenen in rekentuin: ook voor zwakke rekenaars? *Tijdschr. voor Remedial Teach.* 3, 18–21.

Van der Ven, S. H. G., Kroesbergen, E. H., Boom, J., and Leseman, P. P. M. (2012). The development of executive functions and early mathematics: a dynamic relationship. *Br. J. Educ. Psychol.* 82, 100–119. doi: 10.1111/j.2044-8279.2011.02035.x

Vanbinst, K., Ceulemans, E., Ghesquière, P., and De Smedt, B. (2015). Profiles of children's arithmetic fact development: a model-based clustering approach. *J. Exp. Child Psychol.* 133, 29–46. doi: 10.1016/j.jecp.2015.01.003

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Nelwan and Kroesbergen. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 14 September 2016
doi: 10.3389/fpsyg.2016.01403

Profiles of Perfectionism and School Anxiety: A Review of the 2 × 2 Model of Dispositional Perfectionism in Child Population

Cándido J. Inglés[1], José Manuel García-Fernández[2], María Vicent[2], Carolina Gonzálvez[2] and Ricardo Sanmartín[2]*

[1] Department of Health Psychology, Miguel Hernandez University of Elche, Elche, Spain, [2] Department of Developmental Psychology and Didactics, University of Alicante, Alicante, Spain

The 2 × 2 model of dispositional perfectionism has been very well received by researchers of the topic, leading to the creation of new studies that have analyzed the way in which the four proposed subtypes are distinctly associated with measures of adaptation and maladjustment. The goal of this study was to determine the possible existence of four profiles of child perfectionism that are congruent with the subtypes proposed by the 2 × 2 model, and whether these subtypes are associated with school anxiety, in accordance with the hypotheses established by the model. The sample was composed of 2157 students from Spanish Primary Education aged between 8 and 11 years (M = 9.60, SD = 1.24). The *Child and Adolescent Perfectionism Scale* was used to assess Socially Prescribed Perfectionism and Self-Oriented Perfectionism, and the School Anxiety Inventory for Primary Education was used to measure school anxiety. The results of cluster analysis identified four differential groups of perfectionists similar to the subtypes defined by the 2 × 2 model: Non-Perfectionism, Pure Personal Standards Perfectionism (Pure PSP), Pure Evaluative Concerns Perfectionism (Pure ECP), and Mixed Perfectionism. The four groups presented a differentiable pattern of association with school anxiety, with the exception of Pure PSP and Pure ECP, which showed no significant differences. Participants classified as Non-perfectionists presented the most adaptive outcomes, whereas subjects included in the Mixed Perfectionism group scored significantly higher on school anxiety than the three remaining groups. To conclude, the results partially supported the hypotheses of the 2 × 2 model, questioning the consideration of Self-Oriented Perfectionism as a positive manifestation of perfectionism and showing that it is the combination of high scores in both perfectionist dimensions, Self-Oriented Perfectionism and Socially Prescribed Perfectionism that implies higher levels of school anxiety. These findings should be taken into account when generalizing the 2 × 2 model to child population.

Keywords: 2 × 2 model of perfectionism, school anxiety, cluster analysis, Primary Education, socially prescribed perfectionism, self-oriented perfectionism

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Leandro S. Almeida, University of Minho, Portugal
María Del Mar Molero, University of Almeria, Spain

****Correspondence:***
Cándido J. Inglés
cjingles@umh.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *16 June 2016*
Accepted: *01 September 2016*
Published: *14 September 2016*

Citation:
Inglés CJ, García-Fernández JM, Vicent M, Gonzálvez C and Sanmartín R (2016) Profiles of Perfectionism and School Anxiety: A Review of the 2 × 2 Model of Dispositional Perfectionism in Child Population. Front. Psychol. 7:1403. doi: 10.3389/fpsyg.2016.01403

Abbreviations: CAPS, Child and Adolescent Perfectionism Scale; EC, Evaluative Concerns; IAEP, Inventario de Ansiedad Escolar para Educación Primaria [School Anxiety Inventory for Primary Education]; FMPS, Multidimensional Perfectionism Scale of Frost et al. (1990); HMPS, Multidimensional Perfectionism Scale of Hewitt and Flett (2004); PS, Personal Standards; Pure ECP, Pure Evaluative Concerns Perfectionism; Pure PSP, Pure Personal Standards Perfectionism.

INTRODUCTION

Perfectionism is a complex personality trait of an intra- and interpersonal nature, without a unanimously accepted definition. In fact, the inherent complexity of the construct has led to the existence of multiple conceptualizations of it (Stairs et al., 2012), and there is an intense ongoing debate about the facets that compose it, as well as about its adaptive and/or maladaptive nature (e.g., Flett and Hewitt, 2006; Owens and Slade, 2008). Both perfectionism heads have important implications from an educational point of view, especially due to its differentiating association with motivational variables and achievement-related behaviors and beliefs (Bong et al., 2014).

In an attempt to integrate the conceptualizations of perfectionism, diverse studies (Frost et al., 1993; Dunkley et al., 2000; Stoeber and Otto, 2006) proposed to group the various dimensions attributed to perfectionism into two dimensions, called, predominantly, Personal Standards (PS) and Evaluative Concerns (EC), which have been associated with indicators psychological adaptation and maladjustment, respectively (Stoeber and Otto, 2006). Thus, EC integrates those perfectionist facets associated with fear and concern about making mistakes or being judged negatively by others, a tendency to react negatively to manifestations of imperfection, and with feelings of discrepancy between one's self-expectations and one's performance. On another hand, PS includes perfectionist traits such as the tendency to strive and be motivated by achieving perfection and setting excessively high performance standards (Stoeber, 2012). The consideration of these two perfectionist dimensions simplifies the complexity of perfectionism and allows us to compare studies that have used different scales to evaluate it.

Gaudreau and Thompson (2010) developed the 2 × 2 model of dispositional perfectionism, which postulates the existence of four prototypical subtypes of perfectionism, according to the possible combinations of high and low levels of EC and PS: Non-Perfectionism (low EC and low PS), Pure Evaluative Concerns Perfectionism (hereafter Pure ECP; high EC and low PS), Pure Personal Standards Perfectionism (hereafter Pure PSP; low EC and high PS), and Mixed Perfectionism (high EC and high PS). This model is based on the following hypotheses: compared with the Non-Perfectionism subtype, the Pure PSP subtype is associated with healthier results (Hypothesis 1a), with less healthy results (Hypothesis 1b), or alternatively, the results do not differ significantly (Hypothesis 1c); Pure ECP leads to the most maladaptive results of all the subtypes (Hypothesis 2); the Mixed Perfectionism subtype is related to better results than the Pure ECP subtype (Hypothesis 3); and lastly, the Mixed Perfectionism subtype is related to worse results than the Pure PSP subtype (Hypothesis 4). Gaudreau and Thompson (2010) tested their model in a sample of 397 Canadian university students with a mean age 20.39 years, using moderate hierarchical regression methodology. Perfectionism was evaluated using the reduced versions (Cox et al., 2002) of the two Multidimensional Perfectionism Scales (FMPS; Frost et al., 1990; HMPS; Hewitt and Flett, 2004). The results revealed that the Pure PSP subtype was significantly associated with higher academic self-determination, satisfaction, positive affect, and goal progress than the Non-Perfectionist subtype, supporting Hypothesis 1a. In contrast, and in consistency with Hypothesis 1c, no significant differences were found between the two subtypes in negative affect. Likewise, Hypotheses 2, 3, and 4 were also supported by the results of the study. The Mixed subtype was associated with higher levels of negative affect and lower levels of academic self-determination, satisfaction, positive affect, and goal progress than the Pure PSP subtype, and the opposite occurred in the Pure ECP subtype, which was associated with more negative results in terms of maladjustment.

The 2 × 2 model follows a multidimensional conceptualization of perfectionism and defends that the subtypes cannot be understood without taking into account the continuous distribution of the facets and dimensions of perfectionism. Nevertheless, this model attempted to offer a harmonious perspective between the categorical vs. the dimensional currents of research (Gaudreau, 2013). Thus, various studies have recently tested the hypotheses of the model, most of them with a dimensional approach, using either the moderate hierarchical regression analysis method (Gaudreau and Verner-Filion, 2012; Hill, 2013; Crocker et al., 2014; Damian et al., 2014; Hill and Davis, 2014; Mallison et al., 2014; Méndez-Giménez et al., 2014; Speirs-Neumeister et al., 2015) or structural equations (Franche et al., 2012), but also grouping approaches through cluster analysis (Cumming and Duda, 2012; Li et al., 2014). In addition, the possibility of grouping the perfectionist dimensions into two higher dimensions (EC and PS) has allowed researchers to test the hypotheses of the model using different measures of perfectionism. Thus, for example, we highlight the use of the HMPS (Franche et al., 2012; Gaudreau and Verner-Filion, 2012; Speirs-Neumeister et al., 2015) or its version for children and adolescents: the CAPS (Flett et al., 2000, un published; Damian et al., 2014), the FMPS (Cumming and Duda, 2012) or the simultaneous employment of both (Hill, 2013; Hill and Davis, 2014). In contrast, Li et al. (2014) used the Almost Perfect Scale-Revised (Slaney et al., 2001), whereas Mallison et al. (2014) employed the Sport Multidimensional Perfectionism Scale 2 (Gotwals and Dunn, 2009). Méndez-Giménez et al. (2014) used the *Inventario de Perfeccionismo Infantil* [Child Perfectionism Inventory] (Lozano et al., 2012).

As mentioned, diverse studies tested the hypotheses formulated by Gaudreau and Thompson (2010). Even though some of them use different terms to refer to the subtypes proposed by the model, in the present review, we decided to always use the original terminology proposed by Gaudreau and Thompson (2010) in order to facilitate the comparison of the investigations.

With a sample of 208 Canadian athletes aged between 14 and 28 years, Gaudreau and Verner-Filion (2012) compared the associations between the four perfectionist subtypes and positive affect, subjective vitality, and life satisfaction. The results supported Hypotheses 1c, 2, and 3. However, differences were only observed between the Pure PSP subtype and the Mixed subtype with regard to life satisfaction, partially supporting Hypothesis 4. Likewise, Cumming and Duda (2012), using 194 English dance students aged between 14 and 20 years, found that

the participants classified as Pure PSP and the Non-perfectionists did not differ significantly in the levels of social anxiety, negative affect, physical symptoms, and physical and emotional exhaustion, in accordance with Hypothesis 1c but they did differ in positive affect, in favor of the Pure PSP group, thus supporting Hypothesis 1a. Pure PSP obtained significantly lower scores than the Mixed subtype in all the measures of maladjustment but not in positive affect, whose differences did not reach statistical significance, partially supporting Hypothesis 4. Lastly, the results did not support Hypotheses 2 and 3 because the Mixed group and the Pure ECP did not differ significantly in terms of adaptation and maladjustment. In a cross-cultural study, comparing 697 university Canadian students of Asian and European origin aged between 16 and 54 years, Franche et al. (2012) obtained support for Hypotheses 1a, 2, and 3 with regard to academic achievement. However, regarding the degree of school satisfaction, differences were found between the participants of Asian and European origin. Thus, whereas the results for the university students of European origin supported Hypotheses 1a, 2, 3, and 4, there were no significant differences between the Mixed prototype and Pure PSP, or between Pure ECP and Non-Perfectionism in the sample of Asian origin, contradicting Hypotheses 2 and 4.

Subsequently, in a sample of 171 English soccer players aged between 13 and 19, Hill (2013) found support for Hypotheses 1a, 2, 3, and 4 regarding the variables of burnout and a decreased feeling of sport achievement. With regard to physical exhaustion and the devaluation of sport, the results supported Hypotheses 1c and 2. Conversely, they found no differences in the association between the Pure ECP and the Mixed subtype and physical exhaustion, or between the PSP subtype and the devaluation of sport. Recently, Hill and Davis (2014) tested the 2 × 2 model in 238 English coaches aged between 18 and 69 years. The results showed that the Pure PSP subtype was associated with more adaptive results in cognitive reappraisal and control of anger expression, both control-out and control-in, in comparison with the Non-Perfectionism subtype. Conversely, no significant differences were observed in the way in which both subtypes were associated with expressive suppression. Hypotheses 2, 3, and 4 were supported by the comparisons between the perfectionist subtypes and the variables of control-out and -in anger expression; as was Hypothesis 2 in the case of cognitive reappraisal and Hypothesis 4 in the case of expressive suppression. No significant differences were found between the Pure ECP subtype and Non-Perfectionism, or between Non-Perfectionism and Pure PSP, in their relation with cognitive reappraisal, contradicting Hypotheses 2 and 4. Likewise, in the case of expressive suppression, no differences were found between the Pure ECP subtype and Non-Perfectionism. However, there were differences between Pure ECP and the Mixed subtype, but not in the expected direction because the Mixed subtype showed more maladaptive results, contradicting Hypothesis 3.

Subsequently, Crocker et al. (2014) evaluated the hypotheses of the 2 × 2 model by means of a longitudinal design composed of 179 Canadian university athletes aged between 17 and 24 years. They found that the Pure PSP subtype was significantly associated with higher levels than the Non-Perfectionism group in control, challenge and threat appraisal during a competition, as well as in positive affect and goal progress. In contrast, they found no significant differences between these two subtypes for the variables of coping and negative affect. In addition, it was observed that the Pure ECP group only obtained more maladaptive results in the variables of challenge and control appraisal and goal progress. Pure ECP also scored significantly higher than the Mixed group in the control and challenge appraisal, goal progress, and positive affect. Lastly, the Mixed subtype, except for the results for the variables of positive affect and problem- and emotion-focused coping, generally obtained significantly more maladaptive results than Pure PSP. In a study with 345 Chinese employees aged between 19 and 42, Li et al. (2014) found no differences in the total scores of burnout between the Non-perfectionists and the Pure PSP group, or between the Pure ECP and Mixed Perfectionism groups but they did find differences between the Mixed and the Pure PSP groups, thereby supporting only Hypotheses 1c and 4 of the 2 × 2 model. Also, Mallison et al. (2014), using 241 English athletes between 11 and 19 years, found evidence in favor of Hypotheses 1a, 2, 3, and 4 of the 2 × 2 model, about the interaction effects of the variables enjoyment, physical self-esteem, and for most of the dimensions of quality of sports friendship. However, for friendship conflicts, only Hypotheses 1c and 3 were confirmed, and for things in common and conflict resolution, the results only supported Hypotheses 1c, 2, and 3. In Romanian adolescent population aged between 15 and 19 years ($N = 576$), Damian et al. (2014) obtained results supporting Hypotheses 1a, 2, 3, and 4 with regard to positive affect. In contrast, the results for negative affect showed that the Pure PSP and the Non-perfectionist groups did not differ, nor did the Pure ECP group and the Mixed subtype, although differences were observed between the Mixed subtype and the Pure PSP group. Thus, only Hypotheses 1c and 4 were confirmed. In the context of Physical Education, using 331 Spanish adolescents, between 12 and 16 years, Méndez-Giménez et al. (2014) found support for Hypotheses 1a, 2, 3, and 4 regarding the dimensions of physical condition, physical skill, life satisfaction, and positive affect. Nevertheless, support was only found for Hypothesis 1a for group differences in the levels of physical self-concept. Likewise, with regard to general self-concept, the results supported Hypotheses 1c, 2, 3, and 4.

Recently, using 393 high-performing American university students ($M_{age} = 19.7$), Speirs-Neumeister et al. (2015) compared the predictive values of each perfectionist subtype for achievement goals. The results, in general, partially supported the hypotheses of the model. Thus, for example, only Hypotheses 1a and 3 were confirmed for approach goals, whereas for avoidance goals, support was only found for Hypothesis 1b, observing higher levels for the Pure PSP subtype than for Non-Perfectionism. Lastly, Gaudreau (2015) developed a measure called Self-Assessment of Perfectionism Subtypes (SAPS) to assess the four subtypes of perfectionism previously proposed by the 2 × 2 model. The correlational analyses supported Hypotheses 1a, 2, 3, and 4 of the model for the variables of self-determination, academic goal progress, and academic joy, as well as Hypotheses 1c, 2, 3, and 4 for life satisfaction.

The review of the scientific literature of the 2 × 2 model of dispositional perfectionism has revealed diverse limitations.

Firstly, regarding the participant's characteristics, the studies that have evaluated the 2 × 2 model have mainly used samples of university students (Gaudreau and Thompson, 2010; Franche et al., 2012; Crocker et al., 2014; Gaudreau, 2015; Speirs-Neumeister et al., 2015), although they also used athletes and coaches (Gaudreau and Verner-Filion, 2012; Hill, 2013; Hill and Davis, 2014; Mallison et al., 2014), dancers (Cumming and Duda, 2012), actively working adults (Li et al., 2014) and adolescents (Damian et al., 2014; Méndez-Giménez et al., 2014). However, the hypotheses of the model have not been contrasted in child population, an aspect that would be great interest because childhood is considered a key stage for the development of perfectionism (Flett et al., 2002). Also, with the exception of the works conducted by Damian et al. (2014), Li et al. (2014) and Méndez-Giménez et al. (2014) with Chinese, Romanian, and Spanish participants, respectively, the above-mentioned investigations employed American or English population. Nevertheless, diverse studies assert that perfectionism may be influenced by the culture of origin (Marten and Rendón, 2012). As a result, the 2 × 2 model might not be generalizable to other populations with different cultural traits, an aspect about which the work of Franche et al. (2012) cast some doubt.

Thirdly, the viability of the hypotheses of the 2 × 2 model has been proven by comparing the results obtained by the four perfectionist subtypes and diverse variables of adaptation and maladjustment, obtaining, in most cases, results that support the 2 × 2 model, although also some contradictory results. Therefore, further research is required to deepen our knowledge in this sense, analyzing the relation between the perfectionist subtypes and other variables of interest, in order to continue enriching the literature on model.

The present study aims to contribute to solving some of the limitations detected by examining the validity of the 2 × 2 model of Gaudreau and Thompson (2010) in a sample of Spanish students aged between 8 and 11 years. This objective is specified in two parts: (a) to determine whether it is possible to find four child perfectionism profiles that match the subtypes proposed by the 2 × 2 model and (b) to confirm the criterion validity of the identified profiles by contrasting the differences in the mean school anxiety scores reported by each profile. This second goal is of great interest because, although perfectionism has been considered an underlying process that can broadly contribute to the development of anxiety in child population (Affrunti and Woodruff-Borden, 2014), to our knowledge, there are no studies that have previously analyzed the relation between perfectionism and anxiety, specifically school anxiety, understood as a set of symptoms grouped into cognitive, psychophysiological, and motor responses emitted by an individual in school situations that are perceived as threatening and/or dangerous (García-Fernández et al., 2008; Inglés et al., 2015).

Based on prior empirical evidence, it is expected that (a) the results of cluster analysis will reveal the existence four perfectionist profiles characterized by combinations in the scores of Socially Prescribed Perfectionism and Self-Oriented Perfectionism equivalent to the four perfectionist subtypes proposed by the 2 × 2 model, in accordance with the works of Cumming and Duda (2012) and Li et al. (2014), which replicated the subtypes of the 2 × 2 model using cluster analysis. Likewise, regarding the second goal of this study, it is expected that (b) the comparisons of the mean score reported by each cluster in the different factors of school anxiety will support Hypotheses 1a, 2, 3, and 4 of the 2 × 2 model, in accordance with most of the studies that have tested the model of Gaudreau and Thompson (2010).

MATERIALS AND METHODS

Participants

The sample was selected through random cluster sampling, taking as primary units the geographical areas of the province of Alicante: central, north, south, east, and west; and as secondary units, the schools each area (selecting between one and three schools in each area with proportional random sampling). Lastly, the tertiary units were the classrooms. By means of this method, we selected a total 25 schools from urban and rural areas, 19 public schools and 6 private ones, from which four classrooms were randomly chosen, 1 for each course from 3rd to 6th grade of Primary Education, obtaining approximately 95 participants per school. We thereby recruited an initial sample of 2157 students, of whom 83(4.57%) were excluded from the study for not having the minimum reading level required to do the tests, 57 (3.14%) for being repeaters, 97 (5.34%) due to lack of parental consent, and 105 (5.79%) because of errors or omissions in the applied tests. Thus, the final sample was composed of 1815 students aged between 8 and 11 years ($M = 9.60$, $SD = 1.24$), enrolled from 3rd to 6th grade of Primary Education. The ethnic composition of the sample was: 87.65 Spaniards, 6.29% South American, 3.57% Arab, 2.14% European, and 0.35% Asian. The 50.36% of participants were males and the 49.64% females. Regarding the sample distribution across age, it was obtained that the 32.34, 27.99, 18.13% and the 21.54% of participants were 8, 9, 10, and 11 years old, respectively. The Chi-squared test showed the uniform frequency distribution of the eight groups by age and sex ($\chi^2 = 6.55$, $p = 0.08$).

Measures

Child and Adolescent Perfectionism Scale (CAPS; Flett et al., 2000, un published)

The CAPS was developed from the HMPS (Hewitt and Flett, 2004) and is a 22-item self-report measure of perfectionism in children and adolescents as of age 8. It has two dimensions, Self-Oriented Perfectionism, considered as the application of unrealistic performance standards to oneself and the motivation to be a perfectionist (e.g., "I get upset if there is even one mistake in my work," "I try to be perfect in everything I do"); and Socially Prescribed Perfectionism, which assesses the belief that your loved ones expect you to be perfect (e.g., "My teachers expect my work to be perfect"). The items are rated on a five-point Likert-type scale, with higher scores indicating more perfectionism.

In its original validation with a population of 247 Canadian students aged between 8 and 17, acceptable scores of internal consistency were found ($\alpha = 0.85$ for Self-Oriented Perfectionism

and α = 0.81 for Socially Prescribed Perfectionism), as well as adequate indexes of temporal stability that ranged between 0.66 and 0.74 for the dimensions of Self-Oriented Perfectionism and Socially Prescribed Perfectionism, respectively. The concurrent and discriminant validity of the scale were also supported by the results of the correlations between the two perfectionist dimensions and diverse measures of adaptation and maladjustment (Flett et al., 2000, un published).

The CAPS is the most used measure of child perfectionism (García-Fernández et al., 2016). Moreover, the scale has been adapted for application in Scottish (O'Connor et al., 2009), Turkish (Uz-Baş and Siyez, 2010), French (Douilliez and Hénot, 2013), Portuguese (Bento et al., 2014), and Chinese (Yang et al., 2015) population. Castro et al. (2004) applied a Spanish translation of the scale in a clinical and non-clinical sample of female adolescents, obtaining adequate rates of internal consistency (α = 0.88 for Self-Oriented Perfectionism, α = 0.87 for Socially Prescribed Perfectionism, and α = 0.89 for the total scale) and temporal stability (*tr* = 0.83). Also, Vicent et al. (2016) obtained appropriate reliability rates for Socially Prescribed Perfectionism dimension (α = 0.88) in a study of 804 Spanish students aged between 8 and 11 years. However, as the scale still has not yet been validated in Spanish population, the Spanish version of the CAPS was established using the back-translation method. Firstly, the original English version of the CAPS was translated into Spanish by a Spanish interpreter with a college degree in English, who was familiar with the English culture. Then, the Spanish translation of the CAPS was back-translated into English by another native Spanish translator with a degree in English language and knowledge of both cultures. The original version was compared with the back-translation and the translators made corrections and drafted the final Spanish translation. No item was deleted or significantly changed during the translation process.

Internal consistency, Cronbach's alpha, calculated for the present study was 0.84, for the total CAPS, 0.78 for Socially Prescribed Perfectionism, and 0.71 for Self-Oriented Perfectionism.

Inventario de Ansiedad Escolar para Educación Primaria [Inventory of School Anxiety for Primary Education] (IAEP; García-Fernández et al., 2014)

The IAEP was developed from of the *Inventario de Ansiedad Escolar para alumnos de Educación Secundaria y Bachillerato* [Inventory of School Anxiety for Students of Secondary Education and High School] (García-Fernández et al., 2011) to assess school anxiety in children aged 8–11 years. It consists of 22 items about four school situations that can frequently cause anxiety, and 15 items that present diverse responses of school anxiety. The four situational factors are: (I) School Punishment Anxiety, measuring anxiety in situations of explicit punishment at school or situations that could lead to punishment (e.g., "The teacher asks for my homework and I did not do it"); (II) Victimization Anxiety, which assesses anxiety caused by situations in which the student feels physically or psychologically abused by peers (e.g., "They insult me or threaten me at school"); (III) Social Evaluation Anxiety, which reflects anxiety in anticipation of being negatively judged by others at school (e.g., "Going to the black board"); (IV) School Evaluation Anxiety, in reference to anxiety associated with exams (e.g., "When I'm taking an exam"). The three response scales present cognitive (e.g., "I feel guilty"), behavioral (e.g., "I cannot sit still"), and psychophysiological (e.g., "I breathe faster") anxiety responses.

García-Fernández et al. (2014) analyzed the validity of the scale by means of exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) in a sample of 1003 Spanish children between 8 and 11 years, supporting the factor structure of the instrument. The levels of reliability were acceptable both for the total scale (α = 0.92) and for the four situational factors (α = between 0.85 and 0.90) and the three response scales (α = between 0.80 and 0.84).

Internal consistency, Cronbach's alpha, calculated for the present study was 0.92 for the total IAEP, 0.89 for Factors I (School Punishment Anxiety) and II (Victimization Anxiety), 0.87 for Factor III (Social Evaluation Anxiety), 0.88 for Factor IV (School Evaluation Anxiety), 0.74 for the Cognitive Scale, 0.71 for the Behavioral Scale, and 0.73 for the Psychophysiological Scale.

Procedure

A meeting was held with the headmasters of the selected schools to explain the purpose of our work and request their collaboration. All the headmasters of the selected schools agreed to participate in our work. After selecting the classrooms, we requested the parents' written informed consent. Subsequently, we administered the tests to the students during normal school hours, for approximately 40 min, in group format and under the supervision of at least one trained researcher. At the beginning of the administration session of the two instruments, the researcher explained the goal of the work to the participants, focusing on its voluntary and anonymous nature. The participants were treated at all times according to the ethical criteria that govern scientific research.

Statistical Analysis

We applied cluster analysis, using the non-hierarchical method of *quick cluster analysis*, which allows previously specifying the number of clusters to be formed, so that only one cluster solution is given, and it also permits moving subjects from one group to another during the grouping process in order to optimize the cluster solution (Clatworthy et al., 2005). In addition, this procedure is considered the most adequate to establish profiles if the sample of participants is sufficiently large (Hair et al., 1998).

The profiles of child perfectionism were defined based on the different combinations of the dimensions Socially Prescribed Perfectionism and Self-Oriented Perfectionism, which were taken as indicators of the two dimensions proposed by the 2 × 2 model (EC and PS, respectively) as in previous studies (Franche et al., 2012; Gaudreau and Verner-Filion, 2012; Damian et al., 2014; Speirs-Neumeister et al., 2015). Before cluster analysis, we standardized the raw scores because the two subscales did not contain the same number of items. In order to replicate the 2 × 2 model, we defined an initial solution of four clusters. According to the criterion of Nordin-Bates et al. (2011) and Cumming and

Duda (2012), *z* scores below −0.5 are considered to be low levels; *z* scores between −0.5 and +0.5 moderate, and *z* scores over +0.5 are considered high.

We then carried out various analyses of variance (*ANOVA*) to examine the differences between the four groups identified in the school anxiety dimensions, and thus verify the validity of the hypotheses posed by the 2 × 2 model. Subsequently, in those cases that were statistically significant, *post hoc* tests were performed (*Scheffé* method) to determine between which groups such differences were found. In addition, the effect size or standardized mean difference was calculated (*d* index) to obtain the magnitude of the observed differences, considering values between 0.20 and 0.49 indicators of a small effect size, between 0.50 and 0.79, medium or moderate effect, and values equal to or greater than 0.80 as indicators of a large effect size (Cohen, 1988). All the data analyses were carried out with the SPSS/IBM 22.0 statistical package.

RESULTS

Identification of Child Perfectionism Profiles

According to the above criteria, the first group, which included 470 subjects (25.90%), was characterized by high levels of Socially Prescribed Perfectionism and moderate levels of Self-Oriented Perfectionism. Consequently, this group was called Pure ECP. The second cluster was made up of 381 participants (20.99%) who scored low in the two assessed perfectionist dimensions. Therefore, we decided to call this group Non-Perfectionism. The third cluster included 516 students (28.43%) with moderate scores in Self-Oriented Perfectionism and low scores in Socially Prescribed Perfectionism. This group was called Pure PSP. Lastly, we found a fourth group containing 448 participants (24.68%) with high scores in both scales, which was labeled Mixed Perfectionism (see **Figure 1**).

Inter-group Differences in School Anxiety

The results of the *ANOVA* revealed the existence of statistically significant differences among the four groups of perfectionists in the mean scores for total school anxiety and in all the subscales. In all cases, the Non-Perfectionism group obtained the lowest means in school anxiety, whereas the Mixed Perfectionism group obtained the highest scores (see **Table 1**).

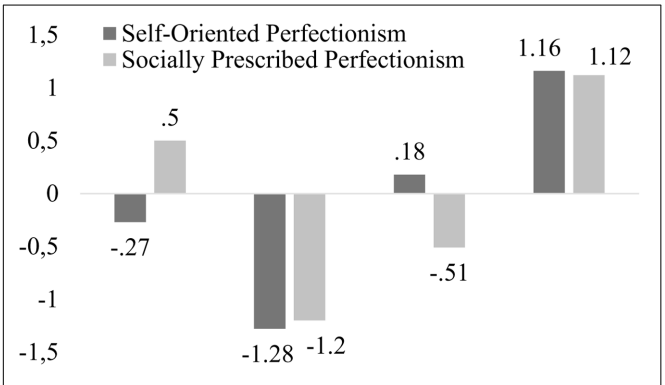


FIGURE 1 | Graphic representation of the profiles of child perfectionism through cluster analysis.

The *post hoc* tests (see **Table 2**) revealed statistically significant differences between the Pure ECP group and the Non-Perfectionist group in all the dimensions of school anxiety and in the total IAEP scores, with small effect sizes that ranged between $d = 0.25$ (for Victimization Anxiety) and $d = 0.43$ (for the total scale). The Pure ECP and Pure PSP groups did not differ significantly in school anxiety. In contrast, differences were observed between the Pure ECP cluster and Mixed Perfectionism, with small effect sizes (between $d = 0.20$ for Social Evaluation Anxiety and the Cognitive Scale, and $d = 0.28$, for School Punishment Anxiety). Likewise, the Non-Perfectionism and Pure PSP groups differed significantly, also with small effect sizes that varied between $d = 0.30$, for the Psychophysiological scale, and $d = 0.42$, for the School Punishment Anxiety scale. However, no significant differences were found between the two groups for Social Evaluation Anxiety and School Evaluation Anxiety. No differences were found between the Pure PSP and Mixed Perfectionism groups in the variable Victimization Anxiety, although differences were observed for the rest of factors and scales of school anxiety, with small effect sizes in all cases, ranging between $d = 0.23$ (Social Evaluation Anxiety, Cognitive and Behavioral Scales) and $d = 0.30$ (School Evaluation Anxiety). Lastly, we found the greatest differences between the Pure PSP cluster and Mixed Perfectionism (between $d = 0.40$, for Victimization Anxiety and $d = 0.67$ for School Punishment Anxiety), with moderate effect sizes for the variables of school anxiety.

DISCUSSION

The first goal of the present work was to analyze the existence of four profiles of child perfectionism in Spanish population and determine whether these profiles coincided with the perfectionist subtypes identified by Gaudreau and Thompson (2010). Accordingly, the results of the cluster analyses revealed four groups that were characterized by combinations of the scores in Socially Prescribed Perfectionism and Self-Oriented Perfectionism similar to the description of the four perfectionist subtypes proposed by the 2 × 2 model, and coherent with other previous studies of clusters that defined these same perfectionism profiles (Cumming and Duda, 2012; Li et al., 2014).

On another hand, the second goal of this investigation involved comparing the mean scores obtained by the four profiles identified in school anxiety, in order to support the hypotheses previously formulated by the 2 × 2 model. The results revealed statistically significant differences among the four groups, except for between the Pure ECP and Pure PSP clusters, comparing the mean scores obtained on the seven subscales and the total school anxiety score. However, these differences were not as expected. In fact, we found that the results did not support most of the hypotheses of the 2 × 2 model, as

TABLE 1 | Means and standard deviations obtained by the four groups, effect size for each dimension of school anxiety.

	Group 1 Pure ECP		Group 2 Non-Perfectionist		Group 3 Pure PSP		Group 4 Mixed Perfectionism		Statistical Significance		
Dimensions	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	$F_{(3,1811)}$	*p*	η^2
FI	25.43	14.11	19.47	14.19	25.63	14.97	29.77	16.33	29.240	<0.001	0.152
FII	15.13	14.29	11.75	12.26	16.20	14.36	17.64	16.46	11.057	<0.001	0.120
FIII	8.50	7.92	6.45	7.37	8.15	8.57	10.46	11.35	12.444	<0.001	0.123
FIV	14.06	8.91	11.28	7.93	12.56	8.68	15.26	9.63	14.366	<0.001	0.126
Cognitive Scale	29.48	13.29	23.43	14.16	29.01	14.34	32.45	16.04	24.506	<0.001	0.144
Behavioral Scale	14.85	10.60	11.01	9.69	15.17	10.80	17.88	12.43	24.237	<0.001	0.144
Psycho-physiogical Scale	19.74	14.01	15.41	12.70	19.66	15.12	23.76	16.77	19.334	<0.001	0.135
Total IAEP	63.14	33.46	48.96	32.38	62.55	36.39	73.14	41.15	27.544	<0.001	0.149

FI, School Punishment Anxiety; FII, Victimization Anxiety; FIII, Social Evaluation Anxiety; FIV, School Evaluation Anxiety.

TABLE 2 | *d* Cohen index to *post hoc* contrasts between the mean scores obtained and the four clusters in the factors of school anxiety.

	Pure ECP vs. Non-Perfectionist	Pure ECP vs. Pure PSP	Pure PSP vs. Mixed Perfectionism	Non-Perfectionist vs. Pure PSP	Non-Perfectionist vs. Mixed Perfectionism	Pure PSP vs. Mixed Perfectionism
FI	0.42	n.s	0.28	0.42	0.67	0.27
FII	0.25	n.s	n.s	0.33	0.40	n.s
FIII	0.27	n.s	0.20	n.s	0.41	0.23
FIV	0.33	n.s	n.s	n.s	0.45	0.30
Cognitive Scale	0.44	n.s	0.20	0.39	0.59	0.23
Behavioral Scale	0.38	n.s	0.26	0.40	0.61	0.23
Psycho-physiogical Scale	0.32	n.s	0.26	0.30	0.56	0.26
Total IAEP	0.43	n.s	0.27	0.39	0.65	0.27

FI, School Punishment Anxiety; FII, Victimization Anxiety; FIII, Social Evaluation Anxiety; FIV, School Evaluation Anxiety.

we had hypothesized. Specifically, we observed that the Pure PSP group obtained significantly higher scores in school anxiety than the Non-Perfectionism group, confirming Hypothesis 1b, except for the results for Factors III (Social Evaluation Anxiety) and IV (School Evaluation Anxiety), whose differences did not reach statistical significance (supporting Hypothesis 1c), and contradicting previous literature on the model, which had mainly found support for Hypothesis 1a (Gaudreau and Thompson, 2010; Franche et al., 2012; Crocker et al., 2014; Hill and Davis, 2014; Mallison et al., 2014; Méndez-Giménez et al., 2014; Gaudreau, 2015). These findings imply that Non-perfectionist students generally have lower levels of anxiety than students with high levels of PS and low levels of EC. In support of Hypothesis 4, we found that the Pure PSP group differed significantly from the Mixed group, with higher school anxiety scores in the latter group. These findings are in the line of prior works that supported the idea that the Pure PSP group is more adaptive than the Mixed subtype (Gaudreau and Thompson, 2010; Cumming and Duda, 2012; Hill, 2013; Crocker et al., 2014; Damian et al., 2014; Hill and Davis, 2014; Li et al., 2014; Mallison et al., 2014; Méndez-Giménez et al., 2014; Gaudreau, 2015). However, in contrast to Hypotheses 2 and 3, the Mixed Perfectionism group scored significantly higher in school anxiety. That is, contrary to the 2 × 2 model, which postulates that Pure ECP is the most harmful subtype (Gaudreau and Thompson, 2010; Franche et al., 2012; Gaudreau and Verner-Filion, 2012; Hill, 2013; Hill and Davis, 2014; Mallison et al., 2014; Méndez-Giménez et al., 2014; Gaudreau, 2015), the results of this study showed that the Mixed subtype is the most negative, in terms of maladjustment, for the specific case of school anxiety.

In general, the results found seem to indicate that Pure ECP and Pure PSP do not present a differentiable pattern of association with school anxiety, and both are more harmful than the Non-Perfectionism group, which proved to be the most adaptive subtype of the four, whereas the combination of high levels in both dimensions (Self-Oriented Perfectionism and Socially Prescribed Perfectionism) is the most harmful manifestation of perfectionism. These results question the idea that Self-Oriented Perfectionism is a positive personality trait, at least regarding its relation with school anxiety. Certainly, taking into account that Self-Oriented Perfectionism is characterized by a tendency to set unrealistic and even impossible goals and a high motivation to pursue them, as well as the tendency to criticize oneself, it is not surprising that students who obtain moderate and high scores in this dimension (i.e., Pure PSP and Mixed Perfectionism clusters) experience higher levels of anxiety related to the academic setting. In fact, previous studies have also shown in child and youth population that this dimension is positively associated with diverse psychopathological variables such as anxiety (Hewitt

et al., 2002; Essau et al., 2012; Nobel et al., 2012), depression (Hewitt et al., 2002; Castro et al., 2004; Christopher and Shewmaker, 2010; Nobel et al., 2012), eating disorders (Castro et al., 2004, 2007; Kirsh et al., 2007; Pamies and Quiles, 2014), a tendency toward shame and guilt (Choy and Drinnan, 2007), narcissisism (Freudenstein et al., 2012), and somatic symptoms (Jungyoon, 2012). Nevertheless, Self-Oriented Perfectionism has sometimes been shown to be associated with adaptive results. Thus, it has also been shown in students of diverse ages that Self-Oriented Perfectionism positively predicts academic achievement (Stoeber et al., 2015) and is positively related to academic self-efficacy and other motivational variables (Bong et al., 2014), to greater optimism about the probability of being successful (Eddington, 2014), and to adaptive problem-solving behaviors (Dry et al., 2015), among others aspects. This dual facet of Self-Oriented Perfectionism has meant that its construct validity has been questioned by diverse studies, which found that the factor structure of the CAPS has a better fit when Self-Oriented Perfectionism is divided into two differentiated scales, Self-Oriented Perfectionism-Efforts and Self-Oriented Perfectionism-Criticism, reflecting, respectively, the positive and negative side of perfectionist introspection (McCreary et al., 2004; O'Connor et al., 2009; Nobel et al., 2012). Therefore, if possible, we recommend replicating the perfectionist subtypes considering Self-Oriented Perfectionism-Efforts as a reflection of the PS dimension, and Self-Oriented Perfectionism-Criticism and Socially Prescribed Perfectionism as a reflection of the EC dimension, as well as analyzing the differences between the groups found, based on various measures of adaptation and maladjustment.

Limitations and Future Research

Some limitations identified and future lines of research should be mentioned before concluding this study. Firstly, given that perfectionism is multidimensional and lacks a unique definition, it should be taken into account that the use of one or another scale may involve subtle differences in the results. In our case, we chose the CAPS as being the most employed instrument to assess perfectionism in children and adolescents and because it evaluates the dimensions of Self-Oriented Perfectionism and Socially Prescribed Perfectionism, which have proven to be valid and reliable indicators of PS and EC (e.g., Frost et al., 1993; Dunkley et al., 2000; Bieling et al., 2004). Nevertheless, it would be interesting for future works to use other instruments validated in child population, for example, the Adaptative/Maladaptative Perfectionism Scale (Rice and Preusser, 2002; Rice et al., 2004), as the results may differ.

Secondly, only two previous studies have examined the 2 × 2 model through cluster analysis. However, these studies were carried out in very different populations from those employed in the present study. Thus, Cumming and Duda (2012) used English dance students aged between 14 and 20 years, whereas Li et al. (2014) focused on Chinese adults working in departments related to computer science. Therefore, as it has been suggested that perfectionism can vary in intensity and manifestation depending on the domain assessed (e.g., work, studies, physical appearance, sport...) (Stoeber and Stoeber, 2009), the results obtained by these works and by this study should be compared with caution.

Thirdly, regarding the methodological aspect, in this study, we chose by non-hierarchical method for the cluster analysis, as our goal was to replicate the four groups identified by the 2 × 2 model. However, it should be noted that small discrepancies were found with regard to the Pure PSP and Pure ECP groups. That is, whereas according to the 2 × 2 model, the Pure ECP group was characterized by high scores in EC and low scores in PS, and the opposite held true for Pure PSP, in our study, the Pure ECP group was characterized by high scores in EC and moderate scores in PS, and the Pure PSP group, by low scores in EC and moderate scores in PS. This could explain why the differences between these two subtypes in school anxiety did not reach statistical significance. Accordingly, we recommend future studies to determine whether another solution of profiles would better represent child perfectionism.

Fourthly, it is important to mention that, despite our sample size and sampling process guarantee the representability of Spanish students between 8 and 11 years old, it is important that future research consider as well relevant information like socioeconomically origin and previous academic performance, because they could play an important role in the relationship between perfectionism and academic anxiety.

Lastly, this study suggests that approximately one fourth of the child population has high scores in perfectionism and is at risk of presenting high levels of school anxiety. However, the cross-sectional design used limits the interpretation of the results about how perfectionism is associated with school anxiety. Therefore, it would be of interest for future works to solve this limitation by means of a longitudinal design that would allow establishing causal relations between the analyzed variables, as well as determining the negative consequences over time of belonging to one or another perfectionist subtype.

Despite the limitations, this is the first study that analyzes the 2 × 2 model in children from Primary Education (between 8 and 11 years), identifying four distinguishable child perfectionism profiles and comparing their association with school anxiety. The present investigation shows that students characterized by being perfectionists, either of an interpersonal or intrapersonal nature or presenting both forms concurrently, make up more than 70% of the students between 8 and 11 years. Therefore, a considerable number of perfectionist children present greater vulnerability for the development of psychological problems such as, for example, school anxiety. Educational institutions should pay more attention to this problem, intervening more actively. Thus, in the context of a society often characterized by a culture of the hyper-competitiveness (Fletcher et al., 2014), schools must take on the challenge of providing the students with the resilience required to be able to self-regulate, cope with adversity and failures, and to consider their errors as possibilities to improve and not as defects inherent to the person (Flett and Hewitt, 2014; Greenspon, 2014). In

short, to form people who are capable of not allowing them to submit to the "tyranny of musts," that need of chimerical perfection that contributes to the development and maintenance a wide variety of psychiatric disorders (Egan et al., 2011).

AUTHOR CONTRIBUTIONS

CI has designed this research. He has also received the study in all its phases. JG-F has designed this research. He has also received the study in all its phases. MV has participated conducting a literature search and writing this manuscript. CG participated conducting a literature search and writing this manuscript. RS has participated performing statistical analyzes.

FUNDING

Part of this investigation is supported by the project "Assessment of school anxiety and its relation with psychoeducational variables in childhood. Study of the efficacy of a preventive program" (EDU2012-35124), awarded to JG-F, as well as by aid for the recruitment of pre-doctorate research staff, Program VALi+d (ACIF/2014/368) granted to MV, and by aid to contracts for the training of doctors -UA FPU 2013-5795 y 2015-5995, granted to CG and RS, respectively.

REFERENCES

Affrunti, N. W., and Woodruff-Borden, J. (2014). Perfectionism in pediatric anxiety and depressive disorders. *Clin. Child. Fam. Psychol. Rev.* 17, 299–317. doi: 10.1007/s10567-014-0164-4

Bento, C., Pereira, A. T., Saraiva, J. M., and Macedo, A. (2014). Children and adolescent perfectionism scale: validation in a Portuguese adolescent sample. *Psicol. Reflexão Crít.* 27, 228–232. doi: 10.1590/1678-7153.201427203

Bieling, P. J., Israeli, A. L., and Antony, M. M. (2004). Is perfectionism good, bad, or both? Examining models of the perfectionism construct. *Pers. Individ. Dif.* 36, 1373–1385. doi: 10.1016/S0191-8869(03)00235-6

Bong, M., Hwang, A., Noh, A., and Sung-il, K. (2014). Perfectionism and motivation of adolescents in academic contexts. *J. Educ. Psychol.* 106, 711–729. doi: 10.1037/a0035836

Castro, J., Gila, A., Gual, P., Lahortiga, F., Saura, B., and Toro, J. (2004). Perfectionism dimensions in children and adolescents with anorexia nervosa. *J. Adolesc. Health* 35, 392–398. doi: 10.1016/j.jadohealth.2003.11.094

Castro, J., Gual, P., Lahortiga, F., Gila, A., Casula, V., Fuhrmann, C., et al. (2007). Self-oriented perfectionism in eating disorders. *Int. J. Eat. Disord.* 40, 562–568. doi: 10.1002/eat.20393

Choy, G., and Drinnan, L. (2007). Perfectionism and self-evaluative emotions in primary school children. *Paper presented in the AARE Annual Conference*, Adelaidem, SA.

Christopher, M. M., and Shewmaker, J. (2010). The relationship of perfectionism to affective variables in gifted and highly able children. *Gifted Child Today* 33, 20–30. doi: 10.1177/107621751003300307

Clatworthy, J., Buick, D., Hankins, M., Weinman, J., and Horne, R. (2005). The use and reporting of cluster analysis in health psychology: a review. *Br. J. Health Psychol.* 10, 329–358. doi: 10.1348/135910705X25697

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Erlbaum.

Cox, B. J., Enns, M. W., and Clara, I. P. (2002). The multidimensional structure of perfectionism in clinically distressed and college student samples. *Psychol. Assess.* 14, 365–373. doi: 10.1037//1040-3590.14.3.365

Crocker, P. R. E., Gaudreau, P., Mosewich, A., and Kljajic, K. (2014). Perfectionism and the stress process in intercollegiate athletes: examining the 2 x 2 model of perfectionism in sport competition. *Int. J. Sport. Psychol.* 45, 325–348. doi: 10.7352/IJSP.2014.45.325

Cumming, J., and Duda, J. L. (2012). Profiles of perfectionism, body-related concerns, and indicators of psychological health in vocational dance students: an investigation of the 2 x 2 model of perfectionism. *Psychol. Sport. Exerc.* 13, 729–738. doi: 10.1016/j.psychsport.2012.05.004

Damian, L. E., Stoeber, J., Negru, O., and Baban, A. (2014). Positive and negative affect in adolescents: an investigation of the 2 x 2 model of perfectionism. *Cogn. Brain Behav.* 18, 1–16.

Douilliez, C., and Hénot, E. (2013). Mesures du perfectionnisme chez l'adolescent: validation des versions francophones de deux questionnaires. *Can. J. Behav. Sci.* 45, 64–71. doi: 10.1037/a0022686

Dry, S. M., Kane, R. T., and Rooney, R. M. (2015). An investigation into the role of coping in preventing depression associated with perfectionism in preadolescent children. *Front. Public Health* 3:190. doi: 10.3389/fpubh.2015.00190

Dunkley, D. M., Blankstein, K. R., Halsall, J., Williams, M., and Winkworth, G. (2000). The relation between perfectionism and distress: hassles, coping, and perceived social support as mediators and moderators. *J. Couns. Psychol.* 47, 437–453. doi: 10.1037//0022-0167.47.4.437

Eddington, K. M. (2014). Perfectionism, goal adjustment, and self-regulation: a short-term follow-up study of distress and coping. *Self Identity* 13, 197–213. doi: 10.1080/15298868.2013.781740

Egan, J., Wade, T. D., and Shafran, R. (2011). Perfectionism as a transdiagnostic process: a clinical review. *Clin. Psychol. Rev.* 31, 203–212. doi: 10.1016/j.cpr.2010.04.009

Essau, C. A., Conradt, J., Sasagawa, S., and Ollendick, T. H. (2012). Prevention of anxiety symptoms in children: results from a universal school-based trial. *Behav. Ther.* 43, 450–464. doi: 10.1016/j.beth.2011.08.003

Fletcher, K. L., Speirs-Neumeister, K. L., and Flett, G. L. (2014). Introduction to the special issue: perfectionism in the school context. *Psychol. Sch.* 51, 897–898. doi: 10.1002/pits.21790

Flett, G. L., and Hewitt, P. L. (2006). Positive versus negative perfectionism in psychopathology. a comment on Slade and Owens's dual process model. *Behav. Modif.* 30, 472–495. doi: 10.1177/0145445506288026

Flett, G. L., and Hewitt, P. L. (2014). A proposed framework for preventing perfectionism and promoting resilience and mental health among vulnerable children and adolescents. *Psychol. Sch.* 51, 899–912. doi: 10.1002/pits.21792

Flett, G. L., Hewitt, P. L., Oliver, J. M., and Macdonald, S. (2002). "Perfectionism in children and their parents: a developmental analysis," in *Perfectionism: Theory, Research, and Treatment*, eds G. L. Flett and P. L. Hewitt (Washington, DC: American Psychological Association), 89–132.

Franche, V., Gaudreau, P., and Miranda, D. (2012). The 2 x 2 model of perfectionism: a comparison across Asian Canadians and European Canadians. *J. Couns. Psychol.* 59, 567–574. doi: 10.1037/a0028992

Freudenstein, O., Valevski, A., Apter, A., Zohar, A., Shoval, G., Nahshoni, E., et al. (2012). Perfectionism, narcissism, and depression in suicidal and nonsuicidal adolescent inpatients. *Compr. Psychiatry.* 53, 746–752. doi: 10.1016/j.comppsych.2011.08.011

Frost, R. O., Heimberg, R. G., Holt, C. S., Mattia, J. I., and Neubauer, A. L. (1993). A comparison of two measures of perfectionism. *Pers. Individ. Dif.* 14, 119–126. doi: 10.1016/0191-8869(93)90181-2

Frost, R. O., Marten, P., Lahart, C., and Rosenblate, R. (1990). The dimensions of perfectionism. *Cognit. Ther. Res.* 14, 449–468. doi: 10.1007/BF01172967

García-Fernández, J. M., Inglés, C. J., and Gómez-Núñez, M. I. (2014). *Inventario de Ansiedad Escolar Para Educación Primaria (IAEP). Manual Interno [Inventory of School Anxiety for Primary Education (IAEP). Internal manual]*. Alicante: Universidad de Alicante.

García-Fernández, J. M., Inglés, C. J., Martínez-Monteagudo, M. C., Marzo, J. C., and Estévez, E. (2011). Inventario de ansiedad escolar: validación en una muestra de estudiantes de educación secundaria [Inventory of school anxiety: validation in a sample of education secondary students]. *Psicothema* 23, 301–307.

García-Fernández, J. M., Inglés, C. J., Martínez-Monteagudo, M. C., and Redondo, J. (2008). Evaluación y tratamiento de la ansiedad escolar en la infancia y la adolescencia [Assessment and treatment of school anxiety in childhood and adolescence]. *Psicol. Conductual.* 16, 413–437. doi: 10.5093/ed2013a5

García-Fernández, J. M., Inglés, C. J., Vicent, M., Gonzálvez, C., Gómez-Núñez, M. I., and Poveda-Serra, P. (2016). Perfeccionismo durante la infancia y la adolescencia. Análisis bibliométrico y temático (2004-2014). [Perfectionism during childhood and adolescence. Bibliometric and thematic analysis (2004-2014)]. *Rev. Iberoam. Psicol. Salud* 7, 79–88. doi: 10.1016/j.rips.2016.02.001

Gaudreau, P. (2013). 2 x 2 model of perfectionism: commenting the critical comments and suggestions of Stoeber (2012). *Pers. Individ. Dif.* 55, 351–355. doi: 10.1016/j.paid.2012.04.029

Gaudreau, P. (2015). Self-assessment of the four subtypes of perfectionism in the 2 x 2 model of perfectionism. *Pers. Individ. Dif.* 84, 52–62. doi: 10.1016/j.paid2014.10.039

Gaudreau, P., and Thompson, A. (2010). Testing a 2 x 2 model of dispositional perfectionism. *Pers. Individ. Dif.* 48, 532–537. doi: 10.1016/j.paid.2009.11.031

Gaudreau, P., and Verner-Filion, J. (2012). Dispositional perfectionism and well-being: a test of the 2 x 2 model of perfectionism in the sport domain. *Sport Exerc. Perform. Psychol.* 1, 29–43. doi: 10.1037/a0025747

Gotwals, J. K., and Dunn, J. G. H. (2009). A multi-method multi-analytic approach to establish internal construct validity evidence: the sport multidimensional perfectionism scale 2. *Meas. Phys. Educ. Exerc. Sci.* 13, 71–92. doi: 10.1080/10913670902812663

Greenspon, T. S. (2014). Is there an antidote to perfectionism? *Psychol. Sch.* 51, 986–998. doi: 10.1002/pits.21797

Hair, J. F., Anderson, R. E., Tatham, R. C., and Black, W. C. (1998). *Multivariate Data Analysis*, 5th Edn. Upper Saddle River, NJ: Prentice-Hall.

Hewitt, P. L., Caelian, C. F., Flett, G. L., Sherry, S. B., Collins, L., and Flynn, C. A. (2002). Perfectionism in children: associations with depression, anxiety, and anger. *Pers. Individ. Dif.* 32, 1049–1061. doi: 10.1016/S0191-8869(01)00109-X

Hewitt, P. L., and Flett, G. L. (2004). *Multidimensional Perfectionism Scale (MPS): Technical Manual*. Toronto, ON: Multi-Health Systems.

Hill, A. P. (2013). Perfectionism and burnout in junior soccer players: a test of the 2 x 2 model of dispositional perfectionism. *Psychol. Sport Exerc.* 35, 18–29. doi: 10.1123/jsep.35.1.18

Hill, A. P., and Davis, P. A. (2014). Perfectionism and emotion regulation in coaches: a test of the 2 x 2 model of dispositional perfectionism. *Mot. Emot.* 38, 715–726. doi: 10.1007/s11031-014-9404-7

Inglés, C. J., Gonzálvez-Maciá, C., García-Fernández, J. M., Vicent, M., and Martínez-Montegudo, M. C. (2015). Current status of research on school refusal. *Eur. J. Educ. Psychol.* 8, 37–52. doi: 10.1016/j.ejeps.2015.10.005

Jungyoon, L. (2012). The relation between perfectionism and somatization among children: the moderating effect of stress-coping behaviors. *Korean J. Couns.* 13, 1029–1042. doi: 10.15703/kjc.13.2.201204.1029

Kirsh, G., McVey, G., Tweed, S., and Katzman, D. K. (2007). Psychosocial profiles of young adolescent females seeking treatment for an eating disorder. *J. Adolesc. Health* 40, 351–356. doi: 10.1016/j.jadohealth.2006.11.003

Li, X., Hou, Z. J., Chi, H. Y., Liu, J., and Hager, M. J. (2014). The mediating role of coping in the relationship between subtypes of perfectionism and job burnout: a test of the 2 x 2 model of perfectionism with employees in China. *Pers. Individ. Dif.* 58, 65–70. doi: 10.1016/j.paid.2013.10.007

Lozano, L. M., García, E., Martín, M., and Lozano, L. (2012). Desarrollo y validación del Inventario de Perfeccionismo Infantil (I.P.I.) [Development and validation of the Inventory of Child Perfectionism (I.P.I.)]. *Psicothema* 24, 149–155.

Mallison, S. H., Hill, A. P., Hall, H. K., and Gotwals, J. K. (2014). The 2 x 2 model of perfectionism and school -and community- based sport participation. *Psychol. Sch.* 51, 972–985. doi: 10.1002/pits.21796

Marten, P., and Rendón, M. J. (2012). A critical examination of the construct of perfectionism and its relationship to mental health in Asian and African Americans using a cross-cultural framework. *Clin. Psychol. Rev.* 32, 139–152. doi: 10.1016/j.cpr.2011.09.007

McCreary, B. T., Joiner, T. E., Schmidt, N. B., and Ialongo, N. S. (2004). The structure and correlates of perfectionism in African American children. *J. Clin. Child. Adolesc. Psychol.* 33, 313–324. doi: 10.1207/s15374424jccp3302_13

Méndez-Giménez, A., Cecchini-Estrada, J. A., and Fernández-Río, J. (2014). El modelo de perfeccionismo disposicional 2x2 en la adolescencia: una comprobación en el contexto de la Educación Física [The 2 x 2 dispositional model of perfectionism in adolescence: a confirmation in the Physical Education context]. *Univ. Psychol.* 13, 15–25. doi: 10.11144/Javeriana.UPSY13-4.mpda

Nobel, R., Manassis, K., and Wilansky-Traynor, P. (2012). The role of perfectionism in relation to an intervention to reduce anxious and depressive symptoms in children. *J. Ration. Emot. Cogn. Behav. Ther.* 30, 77–90. doi: 10.1007/s10942-011-0133-5

Nordin-Bates, S. M., Cumming, J., Aways, D., and Sharp, L. (2011). Imagining yourself dancing to perfection? Correlates of perfectionism among ballet and contemporary dancers. *J. Clin. Sport Psychol.* 5, 58–76. doi: 10.1123/jcsp.5.1.58

O'Connor, R. C., Dixon, D., and Rasmussen, S. (2009). The structure and temporal stability of the child and adolescent perfectionism scale. *Psychol. Assess.* 21, 437–443. doi: 10.1037/a0016264

Owens, R. G., and Slade, P. D. (2008). So perfect it's positively harmful? Reflections on the adaptiveness and maladaptiveness of positive and negative perfectionism. *Behav. Modif.* 32, 928–937. doi: 10.1177/0145445508319667

Pamies, L., and Quiles, Y. (2014). Perfeccionismo y factores de riesgo para el desarrollo de trastornos alimentarios en adolescentes españoles de ambos géneros [Perfectionism and risk factors for the development of eating disorders in Spanish adolescents of both genders]. *An. Psicol.* 30, 620–626. doi: 10.6018/analesps.30.2.158441

Rice, K. G., Kubal, A. E., and Preusser, K. J. (2004). Perfectionism and children's self-concept: further validation of the adaptive/maladaptive perfectionism scale. *Psychol. Sch.* 41, 279–290. doi: 10.1002/pits.10160

Rice, K. G., and Preusser, K. J. (2002). The adaptative/maladaptative perfectionism scale. *Meas. Eval. Couns. Dev.* 34, 210–222.

Slaney, R. B., Rice, K. G., Mobley, M., Trippi, J., and Ashby, J. S. (2001). The revised almost perfect scale. *Meas. Eval. Couns. Dev.* 34, 130–145.

Speirs-Neumeister, K. L., Fletcher, K. L., and Burney, V. H. (2015). Perfectionism and achievement motivation in high-ability students: an examination of the 2 x 2 model of perfectionism. *J. Educ. Gifted* 38, 215–232. doi: 10.1177/0162353215592502

Stairs, A. M., Smith, G. T., Zapolski, T. C. B., Combs, J. L., and Settles, R. E. (2012). Clarifying the construct of perfectionism. *Assessment* 19, 146–166. doi: 10.1177/1073191111411663

Stoeber, J. (2012). The 2 x 2 model of perfectionism: a critical comment and some suggestions. *Pers. Individ. Dif.* 53, 541–545. doi: 10.1016/j.paid.2012.04.029

Stoeber, J., Haskew, A. E., and Scott, C. (2015). Perfectionism and exam performance: the mediating effect of task-approach goals. *Pers. Individ. Dif.* 74, 171–176. doi: 10.1016/j.paid.2014.10.016

Stoeber, J., and Otto, K. (2006). Positive conceptions of perfectionism: approaches, evidence, challenges. *Pers. Soc. Psychol. Rev.* 10, 295–319. doi: 10.1207/s15327957pspr1004_2

Stoeber, J., and Stoeber, F. S. (2009). Domains of perfectionism: prevalence and relationships with perfectionism, gender, age and satisfaction with life. *Pers. Individ. Dif.* 46, 530–535. doi: 10.1016/j.paid.2008.12.006

Uz-Baş, A., and Siyez, D. M. (2010). Adaptation of the child and adolescent perfectionism scale to Turkish: the validity and reliability study. *Elem. Educ. Online* 9, 898–909.

Vicent, M., Inglés, C. J., Gonzálvez, C., Sanmartín, R., and García-Fernández, J. M. (2016). Perfeccionismo socialmente prescrito y los cinco grandes rasgos de la personalidad en niños. [Socially prescribed perfectionism and the Big Five personality traits in children]. *Eur. J. Invest. Health Psychol. Educ.* 6, 107–118. doi: 10.1989/ejihpe.v6i2.162

Yang, H., Hong, C., Tao, X., and Zhu, L. (2015). Revising the child and adolescent perfectionism scale: a test of the four-factor structure in a Chinese sample. *Meas. Eval. Couns. Dev.* 48, 192–203. doi: 10.1177/0748175615578733

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Inglés, García-Fernández, Vicent, Gonzálvez and Sanmartín. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 13 September 2016
doi: 10.3389/fpsyg.2016.01383

Parenting Style Dimensions As Predictors of Adolescent Antisocial Behavior

David Álvarez-García, Trinidad García, Alejandra Barreiro-Collazo, Alejandra Dobarro and Ángela Antúnez*

Department of Psychology, University of Oviedo, Oviedo, Spain

Antisocial behavior is strongly associated with academic failure in adolescence. There is a solid body of evidence that points to parenting style as one of its main predictors. The objective of this work is to elaborate a reduced, valid, and reliable version of the questionnaire by Oliva et al. (2007) to evaluate the dimensions of parenting style and to analyze its psychometric properties in a sample of Spanish adolescents. To that end, the designed questionnaire was applied to 1974 adolescents 12–18 years of age from Asturias (Spain). Regarding construct validity, the results show that the model that best represents the data is composed of six dimensions of parenting style, just as in the original scale, namely affection and communication; promotion of autonomy; behavioral control; psychological control; self-disclosure; and humor. The psychological control factor negatively correlates with the other factors, with the exception of behavioral control, with which it positively correlates. The remaining correlations among the factors in the parenting style questionnaire are positive. Regarding internal consistency, the reliability analysis for each factor supports the suitability of this six-factor model. With regard to criterion validity, as expected based on the evidence available, the six dimensions of parenting style correlate in a statistically significant manner with the three antisocial behavior measures used as criteria (off-line school aggression, antisocial behavior, and antisocial friendships). Specifically, all dimensions negatively correlate with the three variables, except for psychological control. In the latter case, the correlation is positive. The theoretical and practical implications of these results are discussed.

Keywords: family, parenting style, antisocial behavior, adolescence, evaluation

OPEN ACCESS

Edited by:
José Jesús Gázquez, University of Almería, Spain

Reviewed by:
Ricardo Tejeiro, University of Liverpool, UK
Nina L. Powell, National University of Singapore, Singapore

****Correspondence:***
David Álvarez-García
alvarezgardavid@uniovi.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *29 May 2016*
Accepted: *30 August 2016*
Published: *13 September 2016*

Citation:
Álvarez-García D, García T, Barreiro-Collazo A, Dobarro A and Antúnez Á (2016) Parenting Style Dimensions As Predictors of Adolescent Antisocial Behavior. Front. Psychol. 7:1383. doi: 10.3389/fpsyg.2016.01383

INTRODUCTION

Antisocial behavior, which is defined as behavior that violates social norms and the rights of others (Burt, 2012), constitutes an important problem in adolescence. Regarding the most serious, identified, and proven cases of antisocial behavior, the rate of minors between 14 and 17 of age in Spain who were convicted in 2014 is 8.7 per 1000 (National Statistical Institute [Instituto Nacional de Estadística], 2015). However, it is reasonable to assume that the prevalence of antisocial behavior among young people, although difficult to specify, is greater than the data indicate. This type of behavior causes significant personal and social damage. Those who engage in antisocial behavior considerably reduce their educational and employment opportunities; those who suffer it must endure its physical, emotional, or economic consequences. In the social sphere, these problems

consume a large amount of resources related to mental health, education, and juvenile justice (Sawyer et al., 2015).

Among the various factors identified as predictors of antisocial behavior in adolescence, the type of educational and relational practices exercised by parents stand out (Álvarez-García et al., 2015; Cutrín et al., 2015). Although these types of practices may vary in different situations, relatively stable attitudes and behavioral patterns with specific effects on the behavior of children can be identified. These practices are called "parenting styles" (Torío et al., 2008). One of the most commonly used typologies of parenting style is that proposed by MacCoby and Martin (1983) based on a reformulation of the work by Baumrind (1967). This classification distinguishes four types of parenting styles, based on two dimensions (*responsiveness/acceptance* and *demandingness/control*): authoritative (responsive and demanding); indulgent (responsive but not demanding); authoritarian (demanding but not responsive); and neglectful (neither responsive nor demanding).

Previous research offers consistent results regarding the existence of a significant association between parenting style and antisocial behavior in adolescents. Thus, parental practices characterized by affection, communication, and support (responsiveness) are negatively associated with antisocial behavior in children, including drug use (García and Gracia, 2009; Pérez, 2012; Calafat et al., 2014), criminal behavior (García and Gracia, 2009; Ginsburg et al., 2009; Hoeve et al., 2011), inconsiderate and disrespectful treatment of parents (Pérez, 2012), behavioral problems in school (García and Gracia, 2009), and bullying (Kokkinos, 2013; Gómez-Ortiz et al., 2015). These studies point to the neglectful parenting style (low responsiveness and demandingness) as that which is most positively associated with antisocial behavior in adolescents.

Although the role of responsiveness (affection, communication, and support) in child behavior seems to be clear, that of demandingness is less clear. Its effect on general adolescent behavior, particularly on the adolescent's possible antisocial behavior depends on the type of demandingness exercised by parents. In general terms, positive and negative demandingness can be differentiated (Alegre, 2011). Positive demandingness involves parental practices that include the parent's reasoned guidance of children on desirable behavior, empathetic explanations, behavior monitoring, the promotion of autonomy in children, and demands and expectations according to children's degree of maturity. By contrast, negative demandingness involves parental practices that include psychological control that hampers child autonomy through behaviors such as excessive control, emotional blackmail, and the withdrawal of affection and attention or guilt induction if the child does not do what is asked, in addition to punitive (screams, punishments, and threats) and severe discipline. Negative parental demandingness, compared to positive demandingness, is associated with an increased likelihood of internalized and externalized problems and with less emotional competence in children (Alegre, 2011).

Because all of these nuances must be taken into account, more dimensions than the two basic dimensions proposed by MacCoby and Martin (1983) are being considered to define the different types of parenting styles. A good example is the six-dimension model proposed by Oliva et al. (2008). In this model, four parental control-related variables are considered: *behavioral control* (establishing behavioral boundaries and monitoring activities, friendships, and places frequented by the children when the parents are not present); *self-disclosure* (a subtle form of control consisting of children's spontaneous disclosure to their parents of what they do in their free time, typically resulting from an affective and communicative bond between parents and children); *psychological control* (the parental use of manipulative strategies, including guilt induction or emotional blackmail); and the *promotion of autonomy* (the parental stimulation of children's freedom and independence in decision-making processes related to the problems that affect them). The two remaining variables relate to family communication: *affection* (parental attitudes that include listening, supporting, and understanding their children) and *humor* (a relaxed, cheerful, and optimistic parental attitude). From the scores obtained by parents in these six dimensions, Oliva et al. (2008) distinguish three types of parents: democratic, strict, and indifferent.

The diversity of models regarding parenting dimensions and styles has given rise to a variety of instruments to assess them. One of these instruments is the parenting style questionnaire proposed by Oliva et al. (2007), based on the six-dimension model by Oliva et al. (2008). This questionnaire has been chosen by other researchers to analyze the relationship between parenting styles and various aspects in adolescents including reading comprehension development (Carpio et al., 2012), academic failure (Sabán et al., 2013), pregnancy risk (Pérez-López et al., 2015), psychopathological symptoms (Rosa-Alcázar et al., 2014), resilience (Gómez-Ortiz et al., 2015), child-on-parent violence (Calvete et al., 2014), and involvement in bullying (Gómez-Ortiz et al., 2014). The previous studies that use this questionnaire to analyze the relationship between its dimensions and antisocial behavior in adolescents found that affection and communication, promotion of autonomy, behavioral control, and humor perceived by adolescents in their parents and self-disclosure reported by adolescents correlate negatively with external problems and substance abuse (Oliva et al., 2007), and hostility (Rosa-Alcázar et al., 2014); while parental psychological control perceived by adolescents correlate positively with these antisocial behaviors. Calvete et al. (2014), using only the affection and communication factor, found that this dimension is a significant protective factor of both physical and psychological aggression against parents.

The parenting style questionnaire by Oliva et al. (2007) has shown its theoretical and practical utility in the various studies in which it has been used. It is based on a solid theoretical model, and contrasted with the validation test, it displays adequate psychometric properties. It has helped identify the parenting style of the parents evaluated and analyze the relationship of each style with the behavior of children. However, one possible problem with its application can be its length. It consists of 82 items, which, when applied within a battery of tests and particularly when applied to younger people, can be problematic. Developing an abbreviated version of the test and checking whether it can provide researchers with a valid and reliable measure of the

parenting style dimensions that is sufficiently informative and useful for their research purposes would be of great interest.

For all of these reasons, the objective of this work is to elaborate a reduced, valid, and reliable version of the questionnaire to evaluate the parenting style dimensions proposed by Oliva et al. (2007) and to analyze its psychometric properties in a sample of Spanish adolescents. Shortening the test is not expected to adversely affect the validity and reliability of its measurements.

MATERIALS AND METHODS

Participants

A total of 2045 adolescents from 10 schools participated in the study. They were selected through stratified random sampling from all schools in Asturias (Spain) supported with public funds that provide Compulsory Secondary Education (Educación Secundaria Obligatoria – ESO). Schools supported with public funds constitute 95.9% of the schools that provide ESO in Asturias. To select the sample, the schools were divided according to their ownership (public or semi-private), and in each stratum, a number of schools proportionate to the population were selected. In Spain, public schools are those in which both their management and funding are entirely public, and semi-private schools (*centros concertados*) are those with private management but partial public financing. This stratification variable was used as previous studies suggest that public and semi-private schools in Asturias differ in the socioeconomic status of families and students' academic performance (Fernández and Muñiz, 2012). As a result, six public and four semi-private schools were selected. All students under ESO at each school were evaluated.

Once samples with a significant number of blank or void responses were discarded, the final sample comprised 1974 adolescents between 12 and 18 years of age (mean = 14.02; $SD = 1.38$). A total of 49.1% were girls; 28.1% of the students evaluated are in their first year, 25.4% in their second year, 25.0% in their third year, and 21.5% in their fourth year.

Measurement Instruments

Parenting Style

An adaptation of the parenting style scale by Oliva et al. (2007) was developed. The original scale measured six parental dimensions: affection and communication; promotion of autonomy; behavioral control; psychological control; self-disclosure; and humor. To that end, adolescents must respond to 41 items regarding their father's parenting style and 41 regarding their mother's parenting style (82 total). The response format is a six-point Likert-type scale. The adapted version, used in the present work, introduces three modifications to the original scale: after a pilot test, the number of items was reduced from 41 to 24 (four per factor), once factor loadings and item correlations were analyzed; the subject is asked to jointly assess both parents' parenting style, if he or she has two parents (therefore, the subject answers only 24 items); and the response options are reduced from six to four (1 = completely false; 2 = somewhat false; 3 = somewhat true; 4 = completely true). The students had to indicate the extent to which each assertion in the scale was true. The final questionnaire applied to the students is shown in the Appendix.

Off-Line School Aggression

A self-report scale, which was designed and previously used by the research team, was used in this study (Álvarez-García et al., 2016). It has six items involving the frequency with which the subject expressed having behaved aggressively in the physical school environment over the last 3 months: "No he dejado participar en mi grupo a algún compañero, durante alguna actividad de recreo o de Educación Física" ["I excluded some of my classmates from interacting in my group, during some leisure activity or in Physical Education class"], "No he dejado participar en mi grupo a algún compañero en alguna actividad de clase" ["I excluded some of my classmates from participating in some class activities in my group"], "Me he reído y burlado de algún/a compañero/a" ["I laughed at and made fun of a classmate"], "He hablado mal de algún/a compañero/a a sus espaldas" ["I spoke ill of some classmates behind their backs"], "He insultado a la cara a algún/a compañero/a" ["I insulted some of my classmates to their face"], and "He pegado a algún/a alumno/a del centro, dentro o a la salida del recinto escolar" ["I hit a student in school or when leaving school grounds"]. The response is a four-point Likert-type scale (1 = never; 2 = a few times; 3 = many times; 4 = always). The internal consistency of the scale in the sample for this study is high ($\alpha = 0.84$).

Antisocial Behavior

A scale developed *ad hoc* for this study was used adapting some items from the "Antisocial and criminal behavior scale in adolescents" by Andreu and Peña (2013). The scale used consists of six items: "He ensuciado, dañado o destruido conscientemente mobiliario público (por ej., una pared, una papelera, una farola, asientos del autobús)" ["I consciously soiled, damaged, or destroyed public furniture (e.g., a wall, a trashcan, a lamppost, seats on the bus)"], "He robado algo de una tienda, del colegio o de una casa" ["I stole something from a shop, school, or a private home"], "He entrado sin permiso en una propiedad privada" ["I trespassed on private property"], "He golpeado o me he peleado con un desconocido hasta dañarle" ["I have hit or fought with a stranger to the point of harming him/her"], "He consumido drogas ilegales" ["I used illegal drugs"], and "Me he emborrachado" ["I have gotten drunk"]. The requested response is dichotomous (true/false), stating whether the subject has performed these actions over the last year. The internal consistency of the scale in this sample is acceptable (KR20 = 0.73).

Antisocial Friendships

A scale developed *ad hoc* for this study was used. Inspired by some of the indicators of antisocial behavior proposed by Andreu and Peña (2013), it is composed of four items: "Alguno/a de mis mejores amigos/as ha ensuciado, dañado o destruido conscientemente mobiliario público (por ej., una pared, una papelera, una farola, asientos del autobús)" ["One or some of my best friends have soiled, damaged, or destroyed public furniture

(e.g., a wall, a trashcan, a lamppost, seats on the bus)]," "Alguno/a de mis mejores amigos/as ha robado algo de una tienda, del colegio o de casa" ["One or some of my best friends have stolen something from a shop, school, or a private home"], "Alguno/a de mis mejores amigos/as se ha peleado físicamente en serio con otro/a chico/a" ["One or some of my best friends have had a real physical fight with another young person"], and "Alguno/a de mis mejores amigos/as ha consumido drogas ilegales" ["One or some of my best friends have consumed illegal drugs"]. The requested response is dichotomous (true/false), stating whether the subject has performed these actions over the last year. The internal consistency of the scale in this sample is acceptable (KR20 = 0.71).

Procedure

First, the questionnaires used in the study were selected or designed. Subsequently, 10 schools, whose students constitute the study sample, were selected. Then, permission to apply the questionnaires was requested from the schools' respective head management teams. Each management team was informed of the objectives and procedures of the study, its voluntary and anonymous nature, and the confidential treatment of the results. Once the schools agreed to participate, informed consent was requested from the parents or guardians of students because the students are minors. Before answering the questionnaire, the students were also informed of the anonymous, confidential, and voluntary nature of their participation. In general, the students had 20 min to complete the questionnaires, although timing was flexible depending on the age and characteristics of the subjects. The test was applied by the investigating team to all groups in each school during school hours.

Data Analysis

The factorial validity of the scores from the parenting style questionnaire was analyzed using the EQS 6.2 statistical program (Bentler, 2014). Although not severe, given the non-normality of the data and the ordinal nature of the scale, the robust maximum likelihood estimating method was used, and the analyses were conducted based on the polychoric correlations matrix (Hoyle, 2012). Questionnaires with three or more blank or null items were removed (71). To avoid losing more samples and to be able to use all available data, the missing values were treated by computing the covariance matrix through the pairwise method.

To determine the degree of fit of the models tested, the Satorra-Bentler scaled chi-square (SBχ^2)/degrees of freedom (df), the robust comparative fit index (RCFI), the robust Bentler-Bonett non-normed fit index (RNNFI), the root mean square error of approximation (RMSEA), and the robust Akaike information criterion (RAIC) were used. Typically, values indicative of a good fit are CFI $\geq$ 0.95, NNFI $\geq$ 0.95, and RMSEA $\leq$ 0.06 (Hu and Bentler, 1999), and $\chi^2/df < 3$ (Ruiz et al., 2010). The RAIC makes it possible to compare models, and that with the lowest value is preferable.

Once the model with the best fit to the data was identified, its discriminant validity was studied by analyzing the correlation between its factors and each item's factorial weight. Very high correlations ($r \geq 0.85$) warn of potential collinearity or redundancy among factors, thus pointing to poor discriminant validity (Brown, 2015). Factorial weights above 0.30 are typically considered acceptable (Izquierdo et al., 2014).

Reliability for each subscale was analyzed in terms of internal consistency; each subscale's Cronbach alpha coefficient, from the polychoric correlations matrix, was found. The squared multiple correlation of each item was estimated to indicate the variance proportion in the item explained by the latent variable, thus calculating each item's reliability to measure the variable (Bollen, 1989).

Finally, SPSS 21 (IBM Corp, 2012) statistical software was used to analyze criterion validity. To that end, the Spearman coefficient of correlation between the score in each of the six factors in the parenting style questionnaire and the three external criteria was calculated. Regarding the three measures used as criteria, namely, off-line school aggression, antisocial behavior, and antisocial friendships, there is evidence of their association with parenting style. The score in each of these three factors was obtained by adding the scores for each of the items that compose them.

RESULTS

Construct Validity

The goodness of fit of the 6FM (six-factor model; the model that best fitted the data in the validation study of the original questionnaire) was tested with the reduced version of the scale, which was designed and administered in the present study. Subsequently, its fit was compared with that of another model that was also plausible from a theoretical perspective. This alternative model, composed of two factors [2FM (two-factor model)], corresponds to the classical two-dimension distinction that defines parenting styles: affection and control (**Table 1**). In both models, the factors are latent variables that are significantly related to each other and free from error of measurement; each item (observable indicator) is explained only by a factor and is associated with a certain error of measurement. The results obtained show that the 6FM is the model that best fits the empirical data obtained (**Table 2**).

TABLE 1 | Proposed models to analyze the dimensionality of the reduced parenting style questionnaire.

Model	Factors	Items
2FM	Responsiveness/acceptance	1, 2, 3, 4, 21, 22, 23, and 24
	Demandingness/control	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, and 20
6FM	Affection and communication	1, 2, 3, and 4
	Promotion of autonomy	5, 6, 7, and 8
	Behavioral control	9, 10, 11, and 12
	Psychological control	13, 14, 15, and 16
	Self-disclosure	17, 18, 19, and 20
	Humor	21, 22, 23, and 24

2FM, two-factor model; 6FM, six-factor model.

TABLE 2 | Goodness-of-fit indexes of the two models tested for the reduced parenting style questionnaire with the total sample (*N* = 1974).

Model	$SB\chi^2$	*df*	*p*	$SB\chi^2/df$	RCFI	RNNFI	RMSEA (CI 90%)	RAIC
2FM	7437.56	251	<0.001	29.63	0.869	0.856	0.120 (0.118–0.123)	6935.56
6FM	838.33	237	<0.001	3.54	0.989	0.987	0.036 (0.033–0.038)	364.33

2FM, two-factor model; 6FM, six-factor model; $SB\chi^2$, Satorra-Bentler Scaled Chi-Square; df, degrees of freedom; p, probability; RCFI, robust comparative fit index; RNNFI, robust non-normed fit index; RMSEA, root mean square error of approximation; CI, confidence interval; RAIC, robust Akaike information criterion.

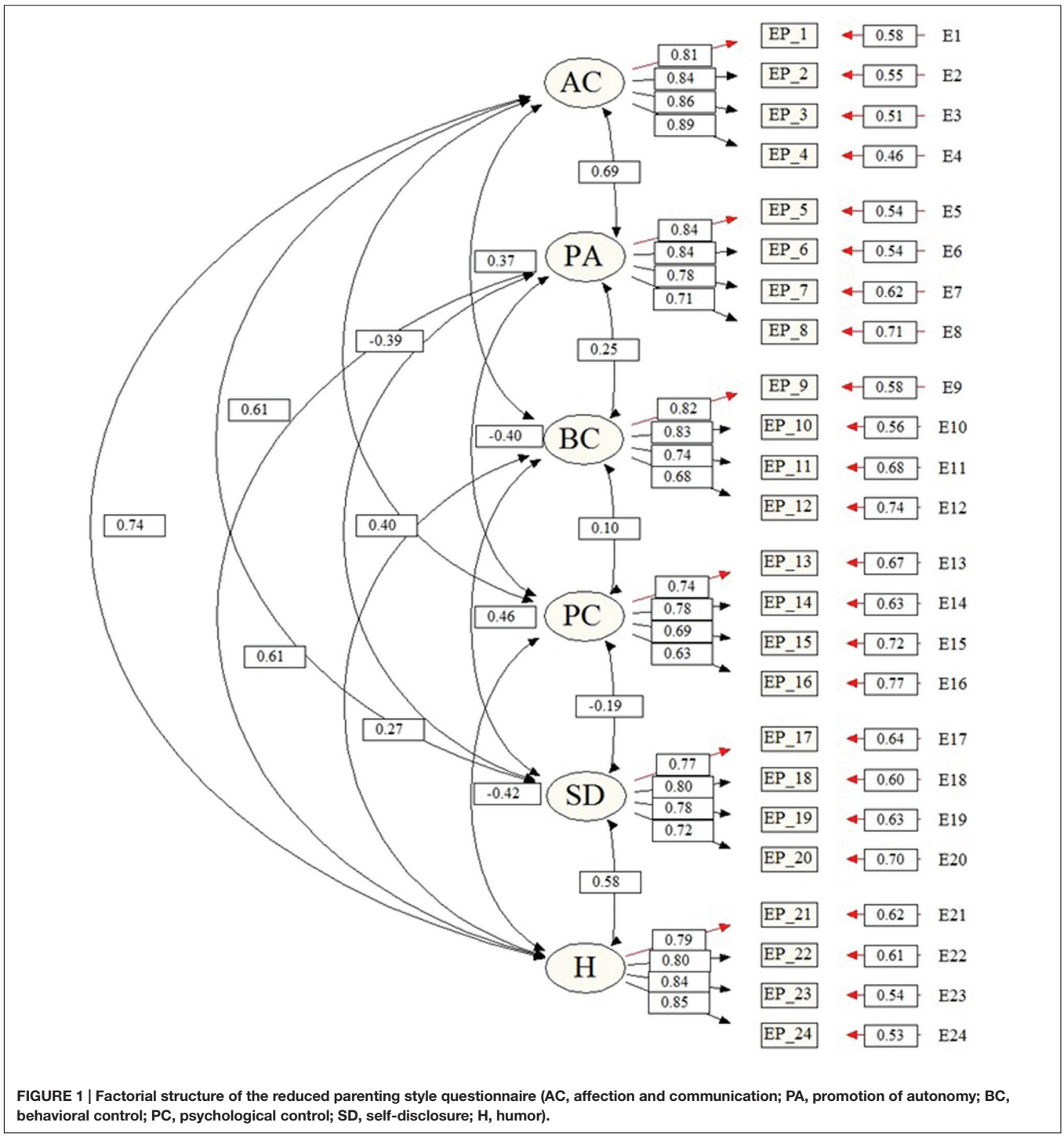


FIGURE 1 | Factorial structure of the reduced parenting style questionnaire (AC, affection and communication; PA, promotion of autonomy; BC, behavioral control; PC, psychological control; SD, self-disclosure; H, humor).

As shown in **Figure 1**, the psychological control factor negatively correlates with the other factors. The only exception is behavioral control, with which it positively correlated. The other correlations among the factors are positive. None of the correlations among the factors is greater than 0.85. The strongest correlation is found between the affection and communication factor and the humor factor ($r = 0.74$), and the weakest correlation is found between behavioral control and psychological control ($r = 0.10$). All correlations are significant.

The factorial weights of each item in its factor generally present high values (**Figure 1**). In 21 of the 24 items, the standardized regression coefficient is greater than 0.70. The three exceptions (items 12, 15, and 16) present values higher than 0.60.

Reliability

The internal consistency of the scores for each factor is high. The Cronbach's alpha coefficient is greater than 0.80 for all factors (**Table 3**). Nonetheless, redundant items do not appear: the polychoric correlations between items of the same factor present values between 0.70 and 0.82 for affection and communication; between 0.56 and 0.79 for promotion of autonomy; between 0.52 and 0.71 for behavioral control; between 0.45 and 0.61 for psychological control; between 0.53 and 0.65 for self-disclosure; and between 0.64 and 0.76 for humor. Item reliability (R^2) is moderate or high. The proportion of item variance explained by the latent variable is between 40.0 and 79.1% (**Table 3**).

TABLE 3 | Reliability for each factor and item in the reduced parenting style questionnaire ($N = 1974$).

Factor	Item	α	R^2
Affection and communication		0.925	
	1		0.663
	2		0.700
	3		0.744
	4		0.791
Promotion of autonomy		0.878	
	5		0.705
	6		0.709
	7		0.611
	8		0.501
Behavioral control		0.854	
	9		0.667
	10		0.689
	11		0.542
	12		0.457
Psychological control		0.806	
	13		0.554
	14		0.609
	15		0.478
	16		0.400
Self-disclosure		0.859	
	17		0.593
	18		0.639
	19		0.607
	20		0.517
Humor		0.902	
	21		0.621
	22		0.633
	23		0.710
	24		0.717

α, *Cronbach's alpha coefficient;* R^2, *Squared multiple correlation.*

Criterion Validity

The scores obtained in each of the six factors of the reduced parenting style questionnaire significantly correlate with the scores in each of the three external criteria analyzed: off-line school aggression, antisocial behavior, and antisocial friendships (**Table 4**). Psychological control positively correlates with these three variables. The other five factors of the parenting style questionnaire negatively correlate with them. The magnitude of the correlation coefficients is, in general terms, weak.

DISCUSSION

The objective of this work was to elaborate a reduced, valid, and reliable version of the questionnaire by Oliva et al. (2007) to evaluate the dimensions of parenting style and to analyze its psychometric properties in a sample of Spanish adolescents. As initially hypothesized, the results obtained show that shortening the test does not adversely affect the validity and reliability of its measurements, presenting suitable metric properties to be administered with the purpose for which it was designed.

Regarding construct validity, the 6FM proposed by Oliva et al. (2007) has shown a good fit to the data obtained when applying the short version designed in the present work. The fit indexes obtained are even better than those obtained by its creators in the validation of the original scale (Oliva et al., 2007). The factorial weight for each item in its factor is high, generally higher than those obtained by Oliva et al. (2007).

The six dimensions of parenting style measured by the questionnaire significantly correlate with each other, with a moderate magnitude. This result supports the discriminant validity of the scores obtained: although the six dimensions are related, they have sufficient entity to be considered distinct constructs. The correlations between factors are not sufficiently

TABLE 4 | Spearman's correlation coefficient between the score in each factor of the reduced parenting style questionnaire and scores in the scales: off-line school aggression, antisocial behavior, and antisocial friendships ($N = 1974$).

	Off-line school aggression	Antisocial behavior	Antisocial friendships
Affection and communication	−0.19*	−0.22*	−0.20*
Promotion of autonomy	−0.14*	−0.08*	−0.10*
Behavioral control	−0.11*	−0.21*	−0.14*
Psychological control	0.15*	0.14*	0.18*
Self-disclosure	−0.26*	−0.34*	−0.29*
Humor	−0.19*	−0.16*	−0.16*

*$p \leq 0.001$.

high to be considered redundant. In general, the pattern of results is very similar to that obtained by Oliva et al. (2007) when validating the original questionnaire. On the one hand, higher correlations are found among affection and communication, humor, promotion of autonomy, and self-disclosure. On the other hand, psychological control negatively correlates with the other factors with the exception of behavioral control, with which it positively correlates. The remaining correlations among factors are positive. These results suggest some important issues. First, although promotion of autonomy and self-disclosure are concerned with parental control, they are closely related to affection and communication and humor, as originally predicted. Although the methodology used does not make it possible to establish causal relationships, prior longitudinal studies (Kearney and Bussey, 2015) suggest that close and optimistic parents may promote greater autonomy in children and create an atmosphere in which adolescents feel confident to spontaneously tell their parents what they have done or how they feel. Second, the results of this study suggest that disclosure is more likely to occur in a context in which adolescents perceive that their parents are interested in what happens to them (behavioral control) and that it is less likely to occur in a context in which the use of excessive control or manipulative strategies (psychological control) is perceived. Previous studies combining transverse and longitudinal analysis coincide with the present work in finding a significant cross association between these variables, although the results of the longitudinal analysis cast doubt on the causal nature of the relationship between control and disclosure (Kearney and Bussey, 2015). This aspect must be further investigated in the future. Third, psychological control, defined as excessive control and the use of manipulative strategies, relates to parental practices characterized by little affection and communication, humor, and promotion of autonomy. Psychological control only positively correlates with behavioral control, most likely because both aim at establishing behavioral boundaries, although the strategies for achieving them are different. However, the correlation between behavioral control and psychological control is the weakest among those found between factors in this study.

The reliability analysis of the scores obtained with the test supports the relevance of the 6FM. The internal consistency for the scores in each factor is high. The alpha values obtained for each factor are similar and in some cases even higher than those found in the original scale (Oliva et al., 2007; Sabán et al., 2013; Calvete et al., 2014; Rosa-Alcázar et al., 2014; Gómez-Ortiz et al., 2015). Therefore, reducing the items by factor to four does not seem to have negatively affected factor internal consistency. Item reliability is also high, suggesting that the observable indicators used are good descriptors of the questionnaire dimensions.

With regard to criterion validity, as expected based on the evidence available, the six dimensions of parenting style present a significant association with the three antisocial behavior measures used as criteria (off-line school aggression, antisocial behavior, and antisocial friendships). In particular, the results obtained show that the greater the affection and communication, promotion of autonomy, behavioral control, and humor perceived by adolescents in their parents and the greater the self-disclosure reported by adolescents, the lower the off-line school aggression, antisocial behavior, and antisocial friendships recognized by adolescents. By contrast, the greater the parental psychological control perceived by adolescents is, the greater the off-line school aggression, antisocial behavior, and antisocial friendships recognized by them. Self-disclosure is the dimension that is most closely related to these three antisocial behavior variables. These results are consistent with previous studies that use the original version of the parenting style questionnaire by Oliva et al. (2007): the same pattern of results regarding the external problems and substance abuse variables (Oliva et al., 2007) and hostility (Rosa-Alcázar et al., 2014) variables is found. Calvete et al. (2014) use only the affection and communication factor in their study, finding that it is a significant protective factor of both physical and psychological aggression against fathers and mothers. As in the present study, correlations magnitude in previous research is commonly weak, due to the existence of additional variables, different from the parenting style dimensions analyzed, that also affect the emergence of antisocial behavior in adolescence (Slattery and Meyers, 2014).

Other studies that have analyzed the relationship between parenting styles and antisocial behavior in adolescence using different assessment instruments have obtained similar results. As indicated in the Introduction, parental practices characterized by affection, communication, and support are negatively associated with antisocial behavior in children, including drug use (García and Gracia, 2009; Pérez, 2012; Calafat et al., 2014), criminal behavior (García and Gracia, 2009; Ginsburg et al., 2009; Hoeve et al., 2011), inconsiderate and disrespectful treatment of their parents (Pérez, 2012), behavioral problems in school (García and Gracia, 2009), and active involvement in bullying (Kokkinos, 2013; Gómez-Ortiz et al., 2015).

In this study, the parenting style dimension most closely associated with low levels of antisocial behavior is self-disclosure. This variable stands out in previous studies as a control method that is potentially more effective in the prevention of antisocial behavior than active parental methods of control (asking questions). In these studies, parent-child closeness is positively related to self-disclosure by adolescents. In turn, self-disclosure positively relates to parental awareness of what children do, and this knowledge is negatively related to antisocial behavior in children (Soenens et al., 2006; Vieno et al., 2009).

Regarding psychological control – the only parental dimension positively associated with antisocial behavior in children – previous meta-analysis studies have emphasized that this variable is a significant predictor of delinquency, even greater than behavioral control (Hoeve et al., 2009). The negative correlation between psychological control and self-disclosure can be found among the varied mechanisms that may explain the relationship between psychological control and delinquency. This negative correlation may affect parental awareness regarding children's behavior, in addition to substance abuse and delinquency (Soenens et al., 2006). Obtaining results that are consistent with prior available evidence supports the criterion validity of the test.

The present work has various theoretical and practical implications. From a theoretical perspective, the results support the relevance of the six-dimension model of parenting styles

considered in the original scale. The dimensions considered have an entity of their own, although they are interrelated, and the observable indicators used are good descriptors of the construct evaluated. From a practical perspective, a brief questionnaire with sufficient metric guarantees for the evaluation of six fundamental dimensions to identify the parenting style from the perspective of the adolescent is made available to researchers and professionals in psychology. The relationship between the parenting style dimensions and the three external criteria observed in this study supports the importance of taking into account parenting styles in the prevention and treatment of antisocial behavior in adolescents. Affection and communication with children constitute an essential variable in preventing and treating this type of behavior.

For all of these reasons, the present work represents a contribution to the study of the relationship between parenting styles and antisocial behavior in adolescents. However, it also presents some limitations. First, the developed and validated short questionnaire does not allow one to distinguish certain aspects related to family context that may affect adolescents' social behavior, including the type of family structure (Breivik and Olweus, 2006), the shared parenting style by both parents (Berkien et al., 2012), and which style in the couple has a greater effect on adolescent behavior (Tur-Porcar et al., 2012). The original questionnaire asked adolescents to evaluate their fathers and mothers separately. By contrast, the abbreviated questionnaire forces adolescents to decide which is the predominant style in their family. Previous studies using the original version of the questionnaire show moderate-to-high correlations between the father and the mother in each factor (between 0.61 and 0.85 in Gómez-Ortiz et al., 2015; between 0.46 and 0.79 for girls and between 0.57 and 0.84 for boys in Oliva et al., 2007). In addition, the metric properties of both versions were almost identical in the validation by Oliva et al. (2007). However, testing the reduced version of the scale for each member of the couple separately would be appropriate in the future due to its practical utility. Second, readers should bear in mind that a significant percentage of young people with antisocial behavior live in shelters or have completely dysfunctional families, with a lack of parental figures and constant changes in guardianship (Orrego et al., 2016). Therefore, this questionnaire would not apply in these cases, although the evaluator should record this circumstance. Third, the questionnaire has been validated with a random and broad sample of adolescents but a sample that is limited to some ages and a specific geographical context. Therefore, any generalization of the study results to other ages and contexts should be made with caution. In the future, validating this scale in other ages and contexts would be of interest. Fourth, the relationship between the questionnaire dimensions and the three antisocial behavior variables was analyzed using a correlational methodology. Thus, the results obtained in this study do not make it possible to establish causal relationships between the variables analyzed. Although the review of evidence has made it possible to refine these results, it would be interesting to use this questionnaire in longitudinal studies in the future. Fifth, some of the questionnaires used were designed *ad hoc* for the present study; thus, they were not previously validated in other samples. Sixth and finally, in analyzing the relationship between parenting style and antisocial behavior, the role of other potentially relevant variables, such as the socioeconomic situation of the family, which can be an important stressor, has not been taken into account.

AUTHOR CONTRIBUTIONS

DA-G: Designed the study, analyzed the data, and wrote the manuscript. TG: Analyzed the data and wrote the manuscript. AB-C, AD, and AA: Recruited the subjects, collected data, and contributed to interpretation of data and critical revision of the article.

FUNDING

This work was financed by the Consejería de Economía y Empleo del Principado de Asturias [Council of Economy and Employment of the Princedom of Asturias] (Spain; Ref. FC-15-GRUPIN14-053).

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: http://journal.frontiersin.org/article/10.3389/fpsyg.2016.01383

REFERENCES

Alegre, A. (2011). Parenting styles and children's emotional intelligence: what do we know? *Fam. J.* 19, 56–62. doi: 10.1177/1066480710387486

Álvarez-García, D., Barreiro, A., Núñez, J. C., and Dobarro, A. (2016). Validity and reliabilitiy of the Cyber-aggression Questionnaire for Adolescents (CYBA). *Eur. J. Psychol. Appl. Legal Context* 8, 69–77. doi: 10.1016/j.ejpal.2016.02.003

Álvarez-García, D., García, T., and Núñez, J. C. (2015). Predictors of school bullying perpetration in adolescence: a systematic review. *Aggress. Violent Behav.* 23, 126–136. doi: 10.1016/j.avb.2015.05.007

Andreu, J. M., and Peña, M. E. (2013). Propiedades psicométricas de la escala de conducta antisocial y delictiva en adolescentes. *An. Psicol.* 29, 516–522. doi: 10.6018/analesps.29.2.135951

Baumrind, D. (1967). Child care practices anteceding three patterns of preschool behavior. *Genet. Psychol. Monogr.* 75, 43–88.

Bentler, P. M. (2014). *EQS 6.2 for Windows (Build* 107)- Structural Equation Modeling Software. Encino, CA: Multivariate Software, Inc.

Berkien, M., Louwerse, A., Verhulst, F., and Van der Ende, J. (2012). Children's perceptions of dissimilarity in parenting styles are associated with internalizing and externalizing behavior. *Eur. Child Adolesc. Psychiatry* 21, 79–85. doi: 10.1007/s00787-011-0234-9

Bollen, K. A. (1989). *Structural Equations with Latent Variables*. New York, NY: John Wiley & Sons, Inc.

Breivik, K., and Olweus, D. (2006). Adolescents' adjustment in four post-divorce family structures: single mother, stepfather, joint physical custody and single father families. *J. Divorce Remarriage* 44, 99–124. doi: 10.1300/J087v44n03_07

Brown, T. A. (2015). *Confirmatory Factor Analysis for Applied Research*, 2nd Edn. New York, NY: The Guilford Press.

Burt, S. A. (2012). How do we optimally conceptualize the heterogeneity within antisocial behavior? An argument for aggressive versus non-aggressive behavioral dimensions. *Clin. Psychol. Rev.* 32, 263–279. doi: 10.1016/j.cpr.2012.02.006

Calafat, A., García, F., Juan, M., Becoña, E., and Fernández-Hermida, J. R. (2014). Which parenting style is more protective against adolescent substance use? Evidence within the European context. *Drug Alcohol Depend.* 138, 185–192. doi: 10.1016/j.drugalcdep.2014.02.705

Calvete, E., Gámez-Guadix, M., and Orue, I. (2014). Family characteristics associated with child-to-parent aggressions in adolescents. *An. Psicol.* 30, 1176–1182. doi: 10.6018/analesps.30.3.166291

Carpio, M. V., García, M. C., and Mariscal, P. (2012). The role of the family in the development of reading comprehension during the transition from Primary to Secondary Education. *Electron. J. Res. Educ. Psychol.* 10, 129–150.

Cutrín, O., Gómez-Fraguela, J. A., and Luengo, M. A. (2015). Peer-group mediation in the relationship between family and juvenile antisocial behavior. *Eur. J. Psychol. Appl. Legal Context* 7, 59–65. doi: 10.1016/j.ejpal.2014.11.005

Fernández, R., and Muñiz, M. (2012). Colegios concertados y selección de escuela en España: un círculo vicioso. *Presupuesto Gasto Público* 67, 97–118.

García, F., and Gracia, E. (2009). Is always authoritative the optimum parenting style? Evidence from Spanish families. *Adolescence* 44, 101–131.

Ginsburg, K. R., Durbin, D. R., García-España, J. F., Kalicka, E. A., and Winston, F. K. (2009). Associations between parenting styles and teen driving, safety-related behaviors and attitudes. *Pediatrics* 124, 1040–1051. doi: 10.1542/peds.2008-3037

Gómez-Ortiz, O., Del Rey, R., Casas, J. A., and Ortega-Ruiz, R. (2014). Parenting styles and bullying involvement. *Cult. Educ.* 26, 132–158. doi: 10.1080/11356405.2014.908665

Gómez-Ortiz, O., Del Rey, R., Romera, E. M., and Ortega-Ruiz, R. (2015). Maternal and paternal parenting styles in adolescence and its relationship with resilience, attachment and bullying involvement. *An. Psicol.* 31, 979–989. doi: 10.6018/analesps.31.3.180791

Hoeve, M., Dubas, J. S., Eichelsheim, V. I., Van der Laan, P. H., Smeenk, W., and Gerris, J. R. M. (2009). The relationship between parenting and delinquency: a meta-analysis. *J. Abnorm. Child Psychol.* 37, 749–775. doi: 10.1007/s10802-009-9310-8

Hoeve, M., Dubas, J. S., Gerris, J. R. M., Van der Laan, P. H., and Smeenk, W. (2011). Maternal and paternal parenting styles: unique and combined links to adolescent and early adult delinquency. *J. Adolesc.* 34, 813–827. doi: 10.1016/j.adolescence.2011.02.004

Hoyle, R. H. (2012). *Handbook of Structural Equation Modeling*. New York, NY: The Guilford Press.

Hu, L., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct. Equ. Modeling* 6, 1–55. doi: 10.1080/10705519909540118

IBM Corp. (2012). *SPSS Statistics for Windows, Version 21.0*. Armonk, NY: IBM Corp.

Izquierdo, I., Olea, J., and Abad, F. J. (2014). Exploratory factor analysis in validation studies: uses and recommendations. *Psicothema* 26, 395–400. doi: 10.7334/psicothema2013.349

Kearney, J., and Bussey, K. (2015). The longitudinal influence of self-efficacy, communication, and parenting on spontaneous adolescent disclosure. *J. Res. Adoles.* 25, 506–523. doi: 10.1111/jora.12148

Kokkinos, C. M. (2013). Bullying and victimization in early adolescence: associations with attachment style and perceived parenting. *J. Sch. Violence* 12, 174–192. doi: 10.1080/15388220.2013.766134

MacCoby, E. E., and Martin, J. A. (1983). "Socialization in the context of the family: parent-child interaction," in *Handbook of Child Psychology: Socialization, Personality and Social Development*, Vol. 4. eds E. M. Hetherington and P. H. Mussen (New York, NY: Wiley), 1–101.

National Statistical Institute [Instituto Nacional de Estadística] (2015). *Estadística de Condenados: Adultos / Estadística de Condenados: Menores. Año 2014*. Available at: http://www.ine.es/prensa/np932.pdf

Oliva, A., Parra, A., and Arranz, E. (2008). Parenting styles and adolescent adjustment. *Infanc. Aprendizaje* 31, 93–106. doi: 10.1174/021037008783487093

Oliva, A., Parra, A., Sánchez-Queija, I., and López, F. (2007). Maternal and paternal parenting styles: assessment and relationship with adolescent adjustment. *An. Psicol.* 23, 49–56.

Orrego, J. M., Paino, M., and Fonseca-Pedrero, E. (2016). «Trampolín» educational programme for adolescents with severe behavioural problems: Participant profile and effect of the intervention. *Aula Abierta* 44, 38–45. doi: 10.1016/j.aula.2015.06.001

Pérez, P. M. (2012). Parenting style in Spanish parents with children aged 6 to 14. *Psicothema* 24, 371–376.

Pérez-López, S., Ortiz-Zaragoza, M. C., Landgrave-Ibáñez, S., and González-Pedraza, A. (2015). Parental educational styles and adolescent pregnancy. *Aten. Fam.* 22, 39–42. doi: 10.1016/S1405-8871(16)30045-1

Rosa-Alcázar, A. I., Parada-Navas, J. L., and Rosa-Alcázar, A. (2014). Psychopatologic symptoms in Spanish adolescents: relationship with perceived parental styles and self-esteem. *An. Psicol.* 30, 133–142. doi: 10.6018/analesps.30.1.165371

Ruiz, M. A., Pardo, A., and San Martín, R. (2010). Structural equation models. *Papeles Psicól.* 31, 34–45.

Sabán, S., Herruzo, F. J., and Raya, A. F. (2013). Relación entre estilos educativos familiares y la inclusión en programas diversificación curricular: un elemento a considerar para la mejora de la convivencia escolar. *Apunt. Psicol.* 31, 237–245.

Sawyer, A. M., Borduin, C. M., and Dopp, A. R. (2015). Long-term effects of prevention and treatment on youth antisocial behavior: a meta-analysis. *Clin. Psychol. Rev.* 42, 130–144. doi: 10.1016/j.cpr.2015.06.009

Slattery, T. L., and Meyers, S. A. (2014). Contextual predictors of adolescent antisocial behavior: the developmental influence of family, peer, and neighborhood factors. *Child Adolesc. Social Work J.* 31, 39–59. doi: 10.1007/s10560-013-0309-1

Soenens, B., Vansteenkiste, M., Luyckx, K., and Goossens, L. (2006). Parenting and adolescent problem behavior: an integrated model with adolescent self-disclosure and perceived parental knowledge as intervening variables. *Dev. Psychol.* 42, 305–318. doi: 10.1037/0012-1649.42.2.305

Torío, S., Peña, J. V., and Rodríguez, M. C. (2008). Parenting styles. Bibliographical revision and theoretical reformulation. *Teoría Educ.* 20, 151–178.

Tur-Porcar, A., Mestre, V., Samper, P., and Malonda, E. (2012). Parenting and children's aggression: are there differences in the influence of the father and the mother? *Psicothema* 24, 284–288.

Vieno, A., Nation, M., Pastore, M., and Santinello, M. (2009). Parenting and antisocial behavior: a model of the relationship between adolescent self-disclosure, parental closeness, parental control, and adolescent antisocial behavior. *Dev. Psychol.* 45, 1509–1519. doi: 10.1037/a0016929

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Álvarez-García, García, Barreiro-Collazo, Dobarro and Antúnez. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 25 August 2016
doi: 10.3389/fpsyg.2016.01243

Emotional Creativity as Predictor of Intrinsic Motivation and Academic Engagement in University Students: The Mediating Role of Positive Emotions

Xavier Oriol[1], Alberto Amutio[2], Michelle Mendoza[3], Silvia Da Costa[4] and Rafael Miranda[5]*

[1] Department of Management and Public Policies, Universidad de Santiago de Chile, Santiago, Chile, [2] Department of Social Psychology and Methodology of the Behavioral Sciences, Faculty of Psychology, University of the Basque Country/Euskal Herriko Unibertsitatea, Donostia-San Sebastian, Spain, [3] Faculty of Education, Universidad Autónoma de Chile, Temuco, Chile, [4] Department of Social Psychology and Methodology of the Behavioral Sciences, University of the Basque Country/Euskal Herriko Unibertsitatea, Donostia-San Sebastian, Spain, [5] Departamento de Psicología, Escuela de Gobierno y Políticas Públicas, Pontificia Universidad Católica del Perú, Lima, Perú

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Carbonero Martín Miguel Angel, University of Valladolid, Spain
Miguel A. Santos Rego, University of Santiago de Compostela, Spain

***Correspondence:**
Alberto Amutio
alberto.amutio@ehu.eus

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *22 June 2016*
Accepted: *04 August 2016*
Published: *25 August 2016*

Citation:
Oriol X, Amutio A, Mendoza M, Da Costa S and Miranda R (2016) Emotional Creativity as Predictor of Intrinsic Motivation and Academic Engagement in University Students: The Mediating Role of Positive Emotions. Front. Psychol. 7:1243. doi: 10.3389/fpsyg.2016.01243

Objective: Emotional creativity (EC) implies experiencing a complex emotional life, which is becoming increasingly necessary in societies that demand innovation and constant changes. This research studies the relation of EC as a dispositional trait with intrinsic motivation (IM) and academic engagement (AE).

Methods: A sample of 428 university Chilean students, 36.5% men and 63.5% women, with ages from 18 to 45 years-old ($M = 20.37$; $DT = 2.71$). Additionally, the mediating function of class-related positive emotions in this relation is explored.

Results: The obtained data indicate that developing high levels of dispositional EC enhances the activation of positive emotions, such as gratitude, love and hope, in the classroom. Furthermore, EC predicts IM and AE of university students by the experience of positive emotions.

Conclusion: These results compel us to be aware of the importance that university students can understand the complexity of the emotional processes they undergo. A greater control of these emotions would allow students to maintain higher levels of interest in their studies at the different educational stages and to avoid the risk of school failure.

Keywords: dispositional emotional creativity, class-related emotions, academic engagement, intrinsic motivation, university students

INTRODUCTION

Based on a socio-constructivist perspective, Averill (1980, 2005) understands creativity as a structure associated with emotion, in which emotions are the result of objective and subjective creative efforts made by the individual. For Averill (2005, 2009), emotional creativity (EC) is a dispositional trait consisting in experiencing a complex emotional life, which depends largely on the social norms that give coherence to the experienced emotions.

Thus, Averill considers that it is possible to foster the development of creativity from early ages.

Today, the impact of EC in the academic level bears particular relevance as we take into account the fundamental role that emotions play in the teaching-learning processes (Pekrun and Perry, 2014; Amutio et al., 2015). There is an increasing tendency to study the influence of emotions on creative processes and, inversely, the impact of creative ideas or products on the generation of emotions (St-Louis and Vallerand, 2015). However, dispositional EC implies, according to Averill (2005), an even greater complexity in terms of emotional processes. This complexity might be crucial to improve students' satisfaction and intrinsic interest in their own learning process.

Emotional creativity is defined as the ability to experience and express original, appropriate, and authentic combinations of emotions. Hence, a person with high EC will experience emotions that are more complex (Averill and Thomas-Knowles, 1991). Averill (2005) believes that this kind of individuals spend more time on recognizing emotions and that they have a preparedness for this. In a different way, emotional intelligence is characterized by the individual's ability to identify, understand and express, regulate and use their own emotions and the emotions of others (Salovey and Mayer, 1990; Bisquerra and Pérez-Escoda, 2007; Peña-Sarrionandia et al., 2015). According to this perspective, the processes of emotional regulation may favor an improvement of thought and enhance creative processes (Gross, 2013; Medrano et al., 2013). However, people with high EC do not need to perform these regulatory processes because they know how to generate their own personalized combinations of emotions. Thus, they create original emotional reactions that benefit creativity (Ivcevic et al., 2007). In sum, the principal difference between EC and emotional intelligence lies in that people with high EC distance themselves from the common reactions to generate original emotional reactions. Furthermore, they can find inspiration in negative affectivity, i.e., becoming inspired and excited when writing about these experiences (Ivcevic et al., 2007; Averill, 2009).

According to Averill's (1980, 2009) tenets, individuals with high EC possess the capacity of being more sensitive to the experienced emotions and devote more time to recognize them, which would arouse these people's enthusiasm for generating a novel emotional reaction. Averill (2009, 2013) defined four dimensions of EC: (1) *Novelty*, which represents the acquisition of new knowledge from former behaviors; (2) *Effectiveness*, implying that to be creative a response has to be of potential use for the person or the group; (3) *Authenticity*, as a creative response that constitutes a reflection of individual values and beliefs of the world and an authentic expression of them, and not merely a copy of others expectations; (4) *Preparedness*, which implies that years of preparation are required before achieving creativity within a specific area.

To assess EC, Averill (1999) created the *Emotional Creativity Inventory (ECI),* a unique 30 items self-perception instrument that evaluates the ability to experience and express emotions in a novel, effective, and authentic way. High scores in the ECI have been related to various personality dimensions, including *Openness to Experience* and *Agreeableness*, but not to Neuroticism, Extraversion, or Conscientiousness. In a closer relation with learning processes, EC is seen as a predictor of the development of creative writing and artistic activities (Ivcevic et al., 2007; Averill, 2009) and has been also been related to cognitive (Averill, 2005; Fuchs et al., 2007) and artistic creativity (Barron and Harrington, 1981; Averill and Thomas-Knowles, 1991; Feist and Barron, 2003). Additionally, people that show high levels of EC would be more likely to enjoy new emotional experiences and learning in addition to higher levels of flow during regular activities (Averill and Nunley, 2010).

A variety of emotional states influences the learning processes, in both the motivational phase, when students are weighing whether to commit or not and to which goal, and the volitional phase, when students are reaffirming their commitment to the selected goal (Järvenoja and Järvelä, 2005; Lüftenegger et al., 2016). Emotions experienced in the classroom affect the performance of students, as well as their interest, commitment and personality development, which, in turn, affects the social climate in the classrooms and educational institutions (Pekrun, 2006; Amutio et al., 2015; López-González and Oriol, 2016). Academic emotions comprise different actors, such as teachers, students, parents, and school employers. They may also vary according to the different learning moments as, for example, when doing homework, house chores, during class or when taking tests or exams (Pekrun, 2000; Pekrun and Perry, 2014).

When academic activities generate satisfaction, happiness, hope or pride, students feel more motivated before a task, pay more attention, and show greater self-control of their own learning process, feel more academically engaged, and tend to make more academic efforts (Roffman, 2004; Davey et al., 2005; Knoop, 2011; Oriol et al., 2016). On the contrary, experiencing negative emotions may cause bad academic adaptation, that is, students can feel bored or develop a feeling of frustration that can lead to school failure (Pekrun et al., 2004; Ruthig et al., 2008; López and Calderon, 2011; D'Mello and Graesser, 2012). Therefore, the experienced emotions are especially relevant to the disaffection or commitment students may feel regarding their own learning process (Skinner et al., 2008; Pekrun and Linnenbrink-García, 2012).

The interest that arouses as an immediate reaction to a new task is an affective state that involves feelings of excitement, concentration and attention and, thus, is a fundamental variable for motivation and commitment to learning. Consequently, the activation of emotions in the classroom is directly related to the perception and behavior of the students in relation to the academic tasks (Pekrun, 2006; Knoop, 2011). Despite all these findings, research on collective or group emotions in the classroom is still scarce (Aritzeta et al., 2015).

Motivation and engagement are studied complementarily, since the literature considers them as key variables in the learning process and for the improvement of academic results (Woolfolk and Margetts, 2007; Parra, 2010; Ainley and Ainley, 2011). Self-determination theory distinguishes between extrinsic and intrinsic motivation (IM) (Ryan and Deci, 2000; Deci and Ryan, 2008; Vallerand et al., 2008). IM correlates positively with academic engagement (AE) (Ryan and Deci, 2009), academic satisfaction (Miquelon et al., 2005; Ratelle et al., 2007), intrinsic

interest (Vallerand et al., 1993, 2008), and enjoyment (Black and Deci, 2000; Álvarez et al., 2009). Unlike extrinsically motivated students, those intrinsically motivated tend to be more creative and to acquire knowledge better, because they engage more and voluntarily devote more time and energy to study (León et al., 2015).

Academic engagement has been conceptualized as the extent to which students are committed to school and motivated to learn (González et al., 2015). The engagement concept has been traditionally applied in the work area, and is understood in terms of task behavior, effort, persistence, participation and work habits (Schaufeli et al., 2002a,b; Kahu, 2013). However, in the last years, this construct has become increasingly complex with the advent of new instruments that define AE in terms of three dimensions: *behavioral* (i.e., time on task), *emotional* (i.e., interest and value), and *cognitive* engagement (i.e., self-regulation and learning strategies; Fredricks et al., 2004; González et al., 2015). Recent research has suggested a fourth dimension of student's engagement in school, namely personal agency, which conceptualizes students as proactive, as agents of action by showing initiative, interest and making suggestions (Veiga et al., 2015). Moreover, AE has been researched from different approaches, focusing on a diversity of topics related to students, including task value, class participation, satisfaction, emotional and academic involvement, achievement, motivation, perceived control and self-efficacy, self-esteem, emotional intelligence, and well-being (Caballero et al., 2007; Appleton et al., 2008; Ros et al., 2012; González et al., 2015; Oriol et al., 2016).

De la Fuente et al. (2010) underline that AE is a positive state of high energy, dedication and fullness during the execution of academic tasks, and it is characterized by favorable and lasting IM toward those tasks. Furthermore, engagement is considered a mediator between motivation and performance (Salanova et al., 2010; González et al., 2015) and is regarded as a vital factor for social-personal development and school success. More generally, positive psychology is interested in psychological adjustment, and considers students' engagement as a major factor of it (Seligman and Csikszentmihalyi, 2000; Fernández-Zabala et al., 2015).

To summarize, one of the key aspects in psychology studies on the educational area over the last few years has been the incorporation of emotions and their connection with the cognitive processes related to learning (Linnenbrink-Garcia and Pekrun, 2011). Emotions play a fundamental role in students' interest in learning as well as in their commitment to the accomplishment of educational tasks. Hence, a deeper understanding of the antecedents that generate the activation of a different set of emotions in the learning process and how they influence the variables related to perseverance and performance is necessary (Pekrun and Perry, 2014).

Emotions are associated with the way in which students perceive learning and may influence both their motivation and their AE, whether inhibiting or promoting the achievement of their goals (Turner et al., 2002; Rozendaal et al., 2005; Amutio et al., 2015). Therefore, people with high EC would develop academic curiosity because of their need to innovate and generate new knowledge (Averill, 2005). In this sense, it is considered that higher levels of EC as a dispositional trait will promote the activation of academic emotions within the classroom and this, in turn, will generate higher levels of IM for studies and AE.

Aims of the Present Study

One of the greatest challenges for the teaching in higher education is to enable students to be more autonomous and to show a firm commitment to constant learning. Therefore, the general aim of this study is to prove the existing relationship between emotional EC and its dimensions, and college students' motivation and engagement to learning.

Based on the cited research, the hypotheses of this study are: (1) EC and its dimensions: *Preparedness*, *Novelty* and *Effectiveness/Authenticity,* will be (positively) related to the activation of positive emotions in university students. (2) EC and its dimensions will predict AE and IM. (3) Positive emotions will mediate the relation between EC and AE. (4) Positive emotions will also mediate the relation between EC and IM. To prove the hypotheses, different multiple mediation models will be tested controlling for the variables of sex and age.

MATERIALS AND METHODS

Participants and Procedure

The sample is composed of students from three Chilean universities: *Universidad Autónoma de Chile*, in Talca (25.5%), and in Santiago (36.7%), *Universidad de Talca* (33.2%), and *Universidad Católica del Maule* (14.6%). In total, the sample was made up of 428 university students, 36.5% men and 63.5% women with ages from 18 to 45 years ($M = 20.37$; $DT = 2.71$).

The sample was selected by convenience, taking into account the ease of access to it by the researchers. Permission from the competent authorities was requested in each university for conducting the study. Approval was obtained by the Committee of Ethics of the corresponding universities, authorizing the students to participate in the study. The registered data was alphanumerically coded, ensuring confidentiality and anonymity, in order to comply with the Personal Data Protection Act by the Ethics Committee for Research related to Human Beings (CEISH).

Prior to the beginning of the study, students were also given an informed consent that explained the study's objectives and stated the confidentially of the gathered data, which would only be used with research purposes.

The instruments were administered in the classroom where students usually attended classes in approximately 25–35 min.

Measures

All the instruments were applied in the classrooms of the respective universities during the last week of the semester, after final examinations.

- *Shortened version of Emotional Creativity Inventory (ECI*-S). This scale evaluates dispositional personal traits (Averill, 1999). The Spanish version of the ECI-S (Soroa et al., 2015) is a self-report questionnaire composed of 17 items and three dimensions, which are: (1) *Preparedness* or

emotional disposition, which is the capacity of understand and learn about ones' own and others' emotions (e.g., "I think about my emotions and try to understand my emotional reactions"). (2) *Novelty*, or the capacity or ability of experiencing new or unusual emotions (e.g., "I have felt a mix of emotions that probably other people have never felt"). Finally, (3) *Effectiveness/Authenticity*, which refers to the capacity or ability of expressing emotions, which, in the end, translates into benefits for the individual or group, directly and honestly (e.g., "the way I live and express my emotions helps me in my relationships with others"). This is a Likert-type scale that ranges from 1 = *totally disagree* to 6 = *totally agree*. In the present sample, reliability was satisfactory for EC, with a total alpha of 0.85, and for the three dimensions *Preparedness* ($\alpha = 0.80$), *Novelty* ($\alpha = 0.84$), and *Effectiveness/Authenticity* ($\alpha = 0.88$). Finally, a CFA was conducted on the scale considering a three-factor solution and the fit was acceptable: $\chi^2 = 244.40$, $p < 0.000$; $\chi^2/gl. = 4.4$; NFI = 0.92; CFI = 0.92; IFI = 0.92; RMSEA = 0.05; SRMR = 0.04.

- *Positivity test* (Fredrickson, 2009). This test evaluates 10 adjectives that describe each positive emotion at different intensity levels (amusement, compassion, gratitude, hope, joy, interest, inspiration, love, pride, and surprise) in a Likert-type scale in which 0 = *nothing* and 4 = *a lot*. Students were asked to respond this scale considering how often they experienced or not those emotions in class during the semester. As for reliability, α was 0.83. However, each emotion was used independently in this study.
- *Academic engagement*. The brief version (nine items) of *Utrech's Work Engagement Scale* (UWESS-9), elaborated by Schaufeli and Bakker (2003), and adapted and validated in Chile by Parra and Pérez (2010) for students (UWES-S), was applied. The scale presents nine statements of vigor, absorption and dedication before studies. An example item is: "I feel strong and vigorous when I'm studying or going to class." The student should respond based on frequency of occurrence of these items over time by selecting one out of the six Likert-type alternatives, i.e., (0 = *Never*, 1 = *A few times a year*, 2 = *Once a month or less*, 3 = *A few times a month*, 4 = *Once a week*, 5 = *A few times a week,* 6 = *Every day*). In this study, the reliability of this scale was 0.89. The CFA show an acceptable fit $\chi^2 = 26.35$, $p < 0.000$; $\chi^2/g.l. = 1.7$; NFI = 0.98; CFI = 0.98; IFI = 0.98; RMSEA = 0.04; SRMR = 0.01.
- *Intrinsic motivation.* The *CEVEAPEU* questionnaire is an instrument to assess the learning strategies of university students elaborated and validated by Gargallo et al. (2009). This scale contains 141 items and 15 dimensions, but only the dimension related to IM was used for this study. This dimension includes three items related to the IM university students feel for their studies (e.g., "I feel satisfied when I understand the contents deeply"). For this work, this dimension showed a reliability of 0.83. Regarding CFA, a unique factor solution was also tested and the results were acceptable, $\chi^2 = 2.799$, $p = 2.47$; $\chi^2/g.l. = 1.4$; NFI = 0.98; CFI = 0.98; IFI = 0.98; RMSEA = 0.03; SRMR = 0.01.

Design and Analyses

This is a cross-sectional study based on different scales applied to university students. Statistical descriptions and bivariate correlations were calculated through the SPSS 20.0. CFA was performed using AMOS. To analyze the effects of positive and negative emotions and EC (multiple mediation) in relation to AE and IM, the bootstrap procedure proposed by Preacher and Hayes (2008) was applied through the SPSS macro MEDIATE for models with multiple independent variables. This analysis estimates the indirect effect, standard errors and confidence intervals. The non-parametric bootstrapping procedure was used with 5000 repetitions to calculate the 95% confidence intervals. The indirect effect is significant if the confidence interval does not exceed zero value (Preacher and Hayes, 2008; Hayes, 2013). To test the indirect effects and calculate the effect size, we used the PROCESS macro that calculated the ratio of the indirect effect to the total effect (Hayes, 2013). Sex and age were used as covariates.

RESULTS

Descriptive and Correlation Analyses

Descriptive statistics of the different variables being studied (**Table 1**) show a medium-high experience of positive emotions, along with the correlation indices of the different variables, which are direct, positive and significant in the expected sense. In fact, it can be noted that EC correlates significantly with IM and AE, while significant correlations were also obtained with *Gratitude*, *Hope,* and *Love*.

Mediation Analyses

We use SPSS macros for indirect effect bootstrapping (Hayes, 2013), which provide indicators for indirect effects, multiple mediations, standard errors, and confidence intervals derived from bootstrap distribution. An indirect effect is significant if the confidence interval does not include the value 0. According to the previous analyses, those emotions that showed a significant relation with the indirect variable (EC) were entered as possible mediators in the tested models. In total, seven multiple mediation models were tested taking EC and its dimensions as indirect variables, AE and IM as direct variables, and controlling for sex and age, which were used as covariates.

The total and direct effects on EC and AE are shown in **Figure 1**. The total effect of EC on AE ($B = 0.25$, $SE = 0.10$, CI [0.057, 0.454]) decreases after entering the mediators, producing a total mediation ($B = 0.14$, $SE = 0.10$, CI [−0.051, 0.343]). In addition, as seen in **Table 2**, EC has an indirect effect on AE through the variable *hope*. In regards to the *preparedness* dimension, there is a significant total effect on AE ($B = 0.33$, $SE = 0.07$, CI [0.185, 0.477]), which decreases after entering the mediators ($B = 0.23$, $SE = 0.07$, CI [0.096, 0.372]), producing partial mediation. In this case, an indirect effect of preparedness on AE through the variable *inspiration* is observed. Finally, a significant total effect can be seen in the relation between *Effectiveness/Authenticity* and AE ($B = 0.29$, $SE = 0.07$, CI [0.116, 0.412]), which decreases when mediators are included ($B = 0.15$, $SE = 0.06$, CI [0.000, 0.267]), as well as an indirect effect of

TABLE 1 | Mean and standard deviation for emotional creativity (EC), intrinsic motivation (IM), academic engagement (AE) and positive emotions and correlations between the main variables.

Predicted variables	Mean and SD	*Emotional creativity*		*Preparedness*		*Novelty*		*Effectiveness*	
		M	*(SD)*	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
		4.00	(0.67)	4.64	(0.89)	3.59	(0.97)	4.28	(0.92)
IM	($M = 4.99$; $SD = 0.911$)	0.299**		0.409**		0.100		0.309**	
AE	($M = 3.83$; $SD = 1.05$)	0.172**		0.313**		−0.034		0.289**	
(1) Amusement	($M = 2.63$; $SD = 0.80$)	0.108		−0.016		0.088		0.129*	
(2) Surprise	($M = 2.26$; $SD = 0.89$)	0.122		0.029		0.092		0.125	
(3) Gratitude	($M = 2.77$; $SD = 0.91$)	0.202**		0.126		0.097		0.242**	
(4) Hope	($M = 2.73$; $SD = 0.81$)	0.181**		0.186**		0.018		0.271**	
(5) Inspiration	($M = 2.64$; $SD = 0.84$)	0.104		0.197**		−0.029		0.193**	
(6) Interest	($M = 2.57$; $SD = 0.78$)	0.075		0.163*		0.011		0.060	
(7) Joy	($M = 2.91$; $SD = 0.75$)	0.040		0.022		−0.032		0.126	
(8) Love	($M = 2.71$; $SD = -0.86$)	0.207**		0.111		0.122		0.190**	
(9) Pride	($M = 2.64$; $SD = 0.94$)	0.101		0.134*		−0.044		0.236**	
(10) Compassion	($M = 2.27$; $SD = 0.85$)	0.083		0.025		0.040		0.120	

*$p < 0.05$; **$p < 0.01$.

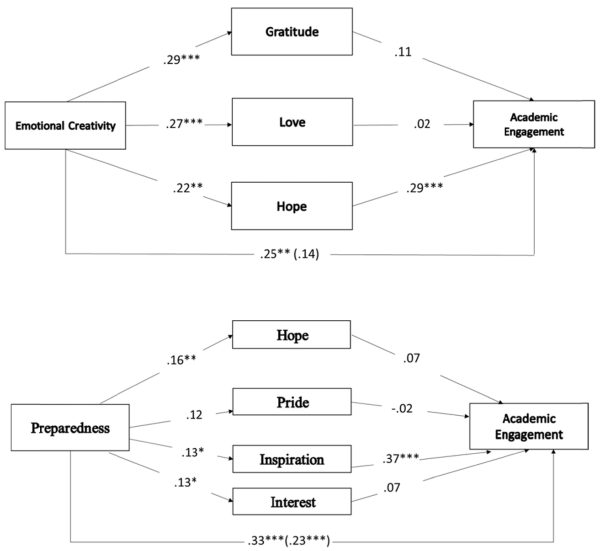


FIGURE 1 | (A) Multiple mediation model of the association between Emotional Creativity and Academic Engagement via class-related emotions. Coefficients are unstandardized. **(B)** A multiple mediation model of the association between preparedness and AE via class-related emotion. Coefficients are unstandardized. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

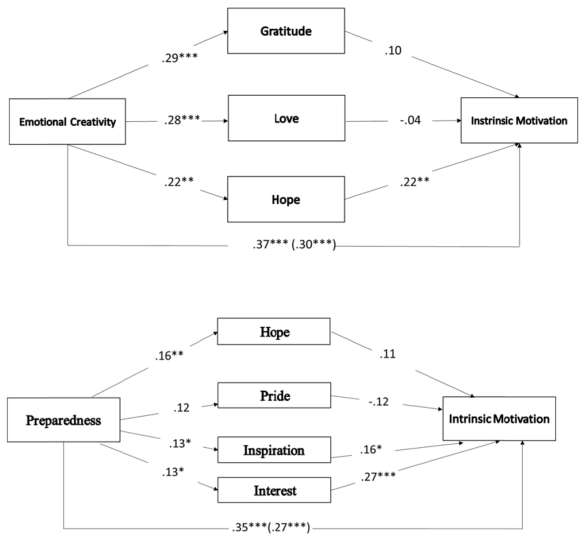


FIGURE 2 | (A) A multiple mediation model of the association between EC and intrinsic motivation via class-related emotions. Coefficients are unstandardized. **(B)** A multiple mediation model of the association between Preparedness, and IM via class-related emotions. Coefficients are unstandardized. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

this dimension of creativity (*Effectiveness/Authenticity)* on AE through *Inspiration* (see **Table 2**).

Regarding the results of the mediations conducted between EC and IM, a total effect ($B = 0.37$, $SE = 0.08$, CI [0.206, 0.538]) which decreases after including the mediators ($B = 0.30$, $SE = 0.08$, CI [0.137, 0.473]) is observed (see **Figure 2**). As shown in **Figure 2**, out of the three emotions entered as mediators, *hope* is the only one that shows a significant indirect effect. In the *preparedness* dimension, the total effect between this variable and IM is also significant ($B = 0.35$, $SE = 0.06$, CI [0.231, 0.478]). The same is true for the indirect effect, although this decreases due to the effect of the mediators ($B = 0.27$, $SE = 0.05$, CI [0.154, 0.387]) and resulting in partial mediation. In addition, in this case, there is an indirect effect through the emotion of *interest*. Lastly, the total effects of *Effectiveness/Authenticity* on IM also presented significant results ($B = 0.26$, $SE = 0.06$, CI [0.115, 0.234]). When entering the emotions as mediators, the effect decreased, yet still being significant ($B = 0.17$, $SE = 0.06$, CI [0.135, 0.311]). Finally, an indirect effect through *inspiration* is seen in this last dimension (see **Figure 2** and **Table 2**).

TABLE 2 | Significant indirect effects of EC on AE and IM.

VI on VD	Mediator	Parameter estimate	*SE*	Lower 95% BC CI	Upper 95% BC CI
EC on AE	Hope	0.065*	0.03	0.012	0.153
Preparedness on AE	Inspiration	0.051*	0.02	0.073	0.123
Effectiveness on AE	Inspiration	0.059*	0.02	0.015	0.134
EC on IM	Hope	0.039*	0.02	0.009	0.119
Preparedness on IM	Interest	0.035*	0.01	0.006	0.084
Effectiveness on IM	Inspiration	0.0059*	0.02	0.015	0.0123

*BC, bias-corrected; CIs, confidence intervals. *$p < 0.05$.*

DISCUSSION

The obtained results provided support for our hypotheses. In the first hypothesis, EC and its dimensions were expected to be related to the positive emotions experienced in the classroom. The results showed that *EC* is associated with the positive emotions of *gratitude*, *hope,* and *love*. Regarding its dimensions, *Preparedness* is positively related to *hope, pride, inspiration,* and *interest.* The second dimension, *Effectiveness/Authenticity,* shows a significant positive relation with *amusement*, *gratitude*, *hope*, *inspiration*, *love,* and *pride*. Finally, the third dimension of *Novelty* did not show any positive association.

Emotions such as *hope, inspiration* and *interest*, which have been related to creativity and its dimensions in this study, are associated with the capacity of being committed and motivated, and of displaying personal competences to change negative circumstances (Tugade and Fredrickson, 2004; Fredrickson, 2009; López and Calderon, 2011). Thus, EC would imply a deployment of complex emotional resources that would enhance the students' coping capacity to the extent that they are able to develop a positive perception of in-class experiences and reduce the experience of negative emotions. Other emotions that appear related to EC in this study, such as *gratitude* and *love,* are more associated with affective experiences involving other persons. In this sense, Averill (2005) emphasizes that EC implies investing time in recognizing other people's emotions, along with being able to express ones' own emotions, facilitating the exchange of emotional experiences in the classroom.

As expected in the second hypothesis, EC and its dimensions were predictors for both IM and AE. These results appear especially relevant if we consider the importance of these two variables to increase academic performance (Woolfolk and Margetts, 2007; De la Fuente et al., 2010; Amutio et al., 2015; López-González et al., 2016). Specifically, college students more instrínsecally motivated show a deeper processing and learning, higher levels of AE and increased performance (Fenollar et al., 2007; Richardson et al., 2012; Moreno-Murcia and Silveira, 2015).

It is also noted that *preparedness*, which would imply the capacity of a person to understand his/her own emotions and be willing to explore them, is the dimension more strongly associated with IM and AE. Students with high levels of *Preparedness* would be more willing to explore new emotions and, thus, would have a better understanding of their emotional processes. This, in turn, would make them perceive the academic tasks as more challenging and motivating (Deci and Ryan, 2014). The results show that EC, understood as the capacity of experiencing complex emotions, allows students to enjoy the learning processes, even to the extent of transforming negative emotional states into inspiration forms (Ivcevic et al., 2007), showing greater commitment to the tasks.

The emotion of *hope* shows a significant mediating effect on the relation between EC and IM, and with AE. *Hope* can emerge before negative or uncertain situations and is associated with a tendency to feel full of energy and inspired to plan some positive actions in order to change negative circumstances (Tugade and Fredrickson, 2004; Fredrickson, 2009). According to our results, EC predicts the activation of hope in the classroom. In turn, experiencing this emotion stimulates motivation and engagement. This result is consistent with other studies' (López and Calderon, 2011). In addition, *hope* is linked to academic achievement. Specifically, hopeful beginning college students have a higher overall GPA. Hopeful students are energetic and full of life. They see the future better than the present and are able to develop many strategies to reach goals as well as to plan contingencies in the event of facing problems along the way. As such, obstacles are viewed as challenges to overcome. High-hope students focus on success and experience greater positive affect and less distress. On the contrary, low-hope students may lack the energy to get things done and experience high anxiety and lowered self-confidence and self-esteem.

In the *Preparedness* dimension it can be observed that the emotion of *inspiration* mediates the relation between EC with AE and IM, while *interest* mediates the relation with IM. *Interest* fosters the feeling of having opportunities of learning something new and *inspiration* enhances transcending the usual and the routine through the perception of new possibilities (Watson, 2000; Fredrickson, 2009). For its part, *inspiration* also mediates the relation between the *Effectiveness/Authenticity* dimension of EC, and IM, and AE.

The results provide support for hypotheses 3 and 4. Recent studies have shown that positive academic emotions are the forerunners of AE, since they promote satisfaction with the activities related to learning in university students (Knoop, 2011; Linnenbrink-Garcia and Pekrun, 2011; Oriol et al., 2016), and this study confirms that experienced emotions act as mediators in the relation between EC with IM and AE. According to Averill's (1980, 2005) socio-constructivist tenets, increasing the levels of EC during early educational stages becomes fundamental to

allow students to experience firm commitment to their studies and, thus, enhancing their autonomous learning. EC implies experiencing a complex emotional life and activating positive emotions in the classroom to face the challenges derived from the complexity of the current educational systems. The lack of congruence between the contents taught and the real interests of students requires reassessing the learning processes in such a way that the new curriculum awakens true interest and generates real satisfaction in students. The development of EC may be one of the greatest challenges for the educational systems to achieve the student's reconnection with their own learning processes and reduce the risk of school failure. To reach this goal, launching social-emotional learning programs (Coelho et al., 2014) and even, programs directly aiming at boosting the experience of positive emotions, like mindfulness programs, for both students and teachers, is crucial (Franco et al., 2014; Amutio et al., 2015; López-González and Oriol, 2016; López-González et al., 2016). Activating positive emotions will allow students to perceive themselves as successful in the tasks execution (self-efficacy), as opposed to negative emotions, which are related to more perceptions of failure (Amutio et al., 2015; Oriol et al., 2016; Tze et al., 2016).

CONCLUSION

The results confirm the need to change teaching methodologies developed at university level to promote IM patterns and higher levels of AE. The constant changes produced in today's society make students loose attention and interest quickly if they are exposed to monotonous activities that do not generate novel emotional experiences. Therefore, activities and tasks conducted by professors must connect with everyday experiences of students in order to activate emotions that help them generate greater meaning to their knowledge. Tasks that involve creative processes are much more attractive, produce greater emotional arousal, greater autonomy and promote self-construction of knowledge. Consequently, activities that are new and surprising and capable of generating rich emotions that stimulate learning and facilitate management of emotional situations are recommended in higher education (e.g., simulations and case studies where students need to face future situations in their respective fields of work) in order to optimize the AE of university students.

As for the limitations and future orientations, it should be noted that research on academic emotions is becoming highly complex. Evaluating specifically these emotions during situations in which students are submitted to different pressure levels and academic requirements (i.e., exams period) becomes necessary. This study in particular focused on the positive emotions that are experienced in the classroom, but it might be replicated in other moments or circumstances of the learning process. Second, the concept of AE comprises behavioral, emotional and cognitive components (Fredricks et al., 2004; González et al., 2015). Nevertheless, this work used a scale that contained the vigor, dedication and absorption dimensions adapted from an engagement construct that has been applied in the work area. Taking into account the complexity of this construct, deeper research on the relation between EC and AE should be carried out using other instruments.

AUTHOR CONTRIBUTIONS

XO: data analyses, results, and discussion; Universidad de Santiago de Chile. AA: introduction, results, and discussion; University of the Basque Country (UPV/EHU). MM: data analyses; Universidad Autónoma de Chile. SC: data analyses; University of the Basque Country (UPV/EHU). RM: review of the literature; Universidad Católica del Perú.

ACKNOWLEDGMENTS

This research was funded by the Basal Financing Program and the Vice-Presidency of Research, Development, and Innovation. Universidad de Santiago de Chile, Usach.

REFERENCES

Ainley, M., and Ainley, J. (2011). Student engagement with science in early adolescence: the contribution of enjoyment to students' continuing interest in learning about science. *Contemp. Educ. Psychol.* 36, 4–12. doi: 10.1016/j.cedpsych.2010.08.001

Álvarez, M., Balaguer, I., Castillo, I., and Duda, J. (2009). Coach autonomy support and quality of sport engagement in young soccer players. *Span. J. Psychol.* 12, 138–148. doi: 10.1017/S1138741600001554

Amutio, A., Franco, C., Gázquez, J. J., and Mañas, I. M. (2015). Aprendizaje y práctica de la conciencia plena en estudiantes de bachillerato para potenciar la relajación y la autoeficacia en el rendimiento escolar. *Univ. Psychol.* 14, 15–25. doi: 10.11144/javeriana.upsy14-2.apcp

Appleton, J., Christenson, S., and Furlong, M. (2008). Student engagement with school: critical conceptual and methodological issues of the construct. *Psychol. Sch.* 45, 369–386. doi: 10.1002/pits.20303

Aritzeta, A., Balluerka, N., Gorostiaga, A., Alonso-Arbiol, I., Haranburu, M., and Gartzia, L. (2015). Classroom emotional intelligence and its relationship with school performance. *Eur. J. Educ. Psychol.* 9, 1–8. doi: 10.1016/j.ejeps.2015.11.001

Averill, J. (2013). Individual differences in emotional creativity: structure and correlates. *J. Pers.* 67, 331–371. doi: 10.1111/1467-6494.00058

Averill, J., and Nunley, E. (2010). "Neurosis: the dark side of emotional creativity," in *The Dark Side of Creativity*, eds D. Cropley, A. Cropley, J. Kaufman, and M. Runco (New York, NY: Cambridge University Press), 255–276.

Averill, J. R. (1980). "A constructivist view of emotion," in *Theories of Emotion*, eds R. Plutchik and H. Kellerman (New York, NY: Academic Press), 305–340.

Averill, J. R. (1999). Individual differences in emotional creativity: structure and correlates. *J. Pers.* 67, 331–371. doi: 10.1111/1467-6494.00058

Averill, J. R. (2005). "Emotions as mediators and ad products of creative activity," in *Creativity across Domains: Faces of the Muse*, eds E. J. Kaufman and J. Baer (Mahwah, NJ: Erlbaum), 225–243.

Averill, J. R. (2009). "Emotional creativity: toward "spiritualizing the passions"," in *Oxford Handbook of Positive Psychology*, eds S. J. López and C. R. Snyder (New York, NY: Oxford University press), 249–257.

Averill, R. J., and Thomas-Knowles, C. (1991). "Emotional creativity," in *International Review of Studies of Emotion*, ed. K. T. Strongman (London: Wiley), 269–299.

Barron, F., and Harrington, D. M. (1981). Creativity, intelligence, and personality. *Annu. Rev. Psychol.* 32, 439–476. doi: 10.1146/annurev.ps.32.020181.002255

Bisquerra, R., and Pérez-Escoda, N. (2007). Las competencias emocionales. *Educación XXI* 10, 61–82. doi: 10.5944/educxx1

Black, A. E., and Deci, E. L. (2000). The effects of instructors' autonomy support and students' autonomous motivation on learning organic chemistry: a self-determination theory perspective. *Sci. Educ.* 84, 740–756. doi: 10.1002/1098-237X(200011)84:6<740::AID-SCE4>3.0.CO;2-3

Caballero, C. C., Abello, R., and Palacio, J. (2007). Relación del burnout y el rendimiento académico con la satisfacción frente a los estudios en estudiantes universitarios. *Av. Psicol. Latinonot.* 25, 98–111.

Coelho, V., Sousa, V., and Figueira, A. P. (2014). The impact of a school-based social and emotional learning program on the self-concept of middle school students. *J. Psychodidactics* 19, 347–365. doi: 10.1016/j.adolescence.2015.05.009

Davey, L., Day, A., and Howells, K. (2005). Anger, over-control and serious violent offending. *Aggress. Violent Behav.* 10, 624–635. doi: 10.1016/j.avb.2004.12.002

De la Fuente, J., Justo, C. F., and Mañas, I. (2010). Efectos de un programa de entrenamiento en conciencia plena (mindfulness) en el estado emocional de estudiantes universitarios. *Estudios Sobre Educación* 19, 31–52.

Deci, E., and Ryan, R. (2008). Self-determination theory: a macrotheory of human motivation, development, and health. *Can. Psychol.* 49, 182–185. doi: 10.1037/a0012801

Deci, E. L., and Ryan, R. M. (2014). "Autonomy and need satisfaction in close relationships: relationships motivation theory," in *Human Motivation and Interpersonal Relationships: THEORY, Research, and Applications*, ed. N. Weinstein (Dordrecht: Springer), 53–73.

D'Mello, S., and Graesser, A. (2012). Dynamics of affective states during complex learning. *Learn. Instr.* 22, 145–157. doi: 10.1016/j.learninstruc.2011.10.001

Feist, G., and Barron, F. (2003). Predicting creativity from early to late adulthood: intellect, potential, and personality. *J. Res. Pers.* 37, 62–88. doi: 10.1016/S0092-6566(02)00536-6

Fenollar, P., Román, S., and Cuestas, P. J. (2007). University students' academic performance: an integrative conceptual framework and empirical analysis. *Br. J. Educ. Psychol.* 77, 873–891. doi: 10.1348/000709907X189118

Fernández-Zabala, A., Goñi, E., Camino, I., and Zulaika, L. M. (2015). Family and school context in school engagement. *Eur. J. Educ. Psychol.* doi: 10.1016/j.ejeps.2015.09.001

Franco, C., Mañas, I., and Soriano, E. (2014). Improving the graphic creativity levels of Latin American high school students currently living in Spain by means of a mindfulness program. *Proc. Soc. Behav. Sci.* 132, 229–234. doi: 10.1016/j.sbspro.2014.04.303

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. (2004). School engagement: potential of the concept: state of the evidence. *Rev. Educ. Res.* 74, 59–119. doi: 10.3102/00346543074001059

Fredrickson, B. (2009). *Positivity*. New York, NY: Crown Publishers.

Fuchs, G., Kumar, V. K., and Porter, J. (2007). Emotional creativity, alexithymia, and sytles of creativity. *Creat. Res. J.* 19, 233–245. doi: 10.1080/10400410701397313

Gargallo, B., Suárez-Rodríguez, J., and Pérez-Perez, C. (2009). El cuestionario CEVEAPEU. Un instrumento para la evaluación de las estrategias de aprendizaje de los estudiantes universitarios. *RELIEVE* 15, 1–31.

González, A., Paoloni, P. V., Donolo, D., and Rinaudo, C. (2015). Behavioral engagement and disaffection in school activities: exploring a model of motivational facilitators and performance outcomes. *Anal. Psychol.* 31, 869–878. doi: 10.6018/analesps.32.176981

Gross, J. J. (2013). Emotion regulation: taking stock and moving forward. *Emotion* 13:359. doi: 10.1037/a0032135

Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based. (Approach)*. New York, NY: The Guilford Press.

Ivcevic, Z., Brackett, M., and Mayer, J. (2007). Emotional intelligence and emotional creativity. *J. Pers.* 75, 199–236. doi: 10.1111/j.1467-6494.2007.00437.x

Järvenoja, H., and Järvelä, S. (2005). How students describe the sources of their emotional and motivational experiences during the learning process: a qualitative approach. *Learn. Instr.* 15, 465–480. doi: 10.1016/j.learninstruc.2005.07.012

Kahu, E. (2013). Framing student engagement in higher education. *Stud. High. Educ.* 8, 758–773. doi: 10.1080/03075079.2011.598505

Knoop, H. H. (2011). "Education 2025: how positive psychology can revitalize education," in *Applied Positive Psychology: Improving Everyday Life, Health, Schools, Work and Society*, eds S. I. Donaldson, M. Csikzentmihalyi, and J. Nakura (New York, NY: Routledge), 97–115.

León, J., Núñez, J. L., Ruiz-Alfonso, Z., and Bordón, B. (2015). Music academic performance: motivation and critical thinking. *J. Psychodidactics* 20, 377–391. doi: 10.1387/revpsicodidact.12673

Linnenbrink-Garcia, L., and Pekrun, R. (2011). Students' emotions and academic engagement: introduction to the special issue. *Contemp. Educ. Psychol.* 36, 1–3. doi: 10.1016/j.cedpsych.2010.11.004

López, S. J., and Calderon, V. J. (2011). "Gallup student poll: measuring and promoting what is right with students," in *Applied Positive Psychology. Improving Everyday Life, Health, Schools, Work, and Society*, eds S. I. Donaldson, M. Csikzenthmihalyi, and J. Nakamura (New York, NY: Routledge).

López-González, L., Amutio, A., and Oriol, X. (2016). Habits related to relaxation and mindfulness in high school students: influence on classroom climate and academic performance. *J. Psychodidactics* 21, 121–138. doi: 10.1387/RevPsicodidact.1386

López-González, L., and Oriol, X. (2016). The relationship between emotional competence, classroom climate and school achievement in high school students. *Cult. Educ.* 28, 130–156. doi: 10.1080/11356405.2015.1120448

Lüftenegger, M., Klug, J., Harrer, K., Langer, M., Spiel, C., and Schober, B. (2016). Students' achievement goals, learning-related emotions and academic achievement. *Front. Psychol.* 7:603. doi: 10.3389/fpsyg.2016.00603

Medrano, L., Moretti, L., Ortiz, A., and Pereno, G. (2013). Validación del cuestionario de regulación emocional cognitiva en Universitarios de Córdoba, Argentina. *Psykhe* 22, 83–96. doi: 10.7764/psykhe.22.1.473

Miquelon, P., Vallerand, R., Grouzet, F., and Cardinal, G. (2005). Perfectionism, academic motivation, and psychological adjustment: an integrative model. *Pers. Soc. Psychol. Bull.* 31, 913–924. doi: 10.1177/0146167204272298

Moreno-Murcia, J. A., and Silveira, Y. (2015). Perfiles motivacionales de estudiantes universitarios. Procesos de estudio y satisfacción con la vida. *Revista Electrónica Interuniversitaria de Formación del Profesorado* 18, 169–181. doi: 10.6018/reifop.18.3.200441

Oriol, X., Lira, M. M., Covarrubias, C. G., and Molina, V. (2016). Positive emotions, autonomy support and academic performance of university students: the mediating role of academic engagement and self-efficacy. *J. Psychodidactics* 21. doi: 10.1387/RevPsicodidact.14280

Parra, P. (2010). Relación entre el nivel de Engagement y el rendimiento académico teórico/práctico. *Revista de Educación en Ciencias de la Salud* 7, 57–63.

Parra, P., and Pérez, C. (2010). Propiedades psicométricas de la escala de compromiso académico, UWES-S (versión abreviada), en estudiantes de psicología. *Revista de Educación de Ciencias de la Salud* 7, 128–133.

Pekrun, R. (2000). "A social-cognitive, control-value theory of achievement emotions," in *Motivational Psychology of Human Development: Developing Motivation and Motivating Development*, ed. J. Heckhausen (New York, NY: Elsevier Science), 143–163.

Pekrun, R. (2006). The control-value theory of achievement emotions: assumptions, corollaries, and implications for educational research and practice. *Educ. Psychol. Rev.* 18, 315–341. doi: 10.1007/s10648-006-9029-9

Pekrun, R., Goetz, T., Perry, R., Kramer, K., Hochstadt, M., and Molfenter, S. (2004). Beyond test anxiety: development and validation of the test emotions questionnaire (TEQ). *Anxiety Stress Coping* 17, 287–316. doi: 10.1080/10615800412331303847

Pekrun, R., and Linnenbrink-García, L. (2012). "Academic emotions and student engagement," in *Handbook of Research on Student Engagement*, eds S. Christenson, A. Reschly, and C. Wylie (New York, NY: Springer), 259–282. doi: 10.1007/978-1-4614-2018-7_12

Pekrun, R., and Perry, R. (2014). "Control-value theory of achievement emotions," in *International Handbook of Emotions in Education*, eds R. Pekrun and L. Linnenbrink-García (New York, NY: Routledge), 120–141.

Peña-Sarrionandia, A., Mikolajczak, M., and Gross, J. J. (2015). Integrating emotion regulation and emotional intelligence traditions: a meta-analysis. *Front. Psychol.* 6:160. doi: 10.3389/fpsyg.2015.00160

Preacher, K., and Hayes, A. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav. Res. Methods* 40, 879–891. doi: 10.3758/BRM.40.3.879

Ratelle, C., Guay, F., Vallerand, R., Larose, S., and Senécal, C. (2007). Autonomous, controlled, and amotivated types of academic motivation: a person-oriented analysis. *J. Educ. Psychol.* 99, 734–746. doi: 10.1037/0022-0663.99.4.734

Richardson, M., Abraham, C., and Bond, R. (2012). Psychological correlates of university students' academic performance: a systematic review and meta-analysis. *Psychol. Bull.* 138, 353–387. doi: 10.1037/a0026838

Roffman, A. (2004). Is anger a thing-to-be-managed? *Psychotherapy* 41, 161–171. doi: 10.1037/0033-3204.41.2.161

Ros, I., Goikoetxea, J., Gairín, J., and Lekue, P. (2012). Student engagement in the school: interpersonal and inter-center differences. *J. Psychodidactics* 17, 291–307. doi: 10.1387/revpsicodidact.4557

Rozendaal, J., Minnaert, A., and Boekaerts, M. (2005). The influence of teacher perceived administration of self-regulated learning on students' motivation and information-processing. *Learn. Instr.* 15, 141–160. doi: 10.1016/j.learninstruc.2005.04.011

Ruthig, J. C., Perry, R. P., Hladkyj, S., Hall, N. C., Pekrun, R., and Chipperfield, J. G. (2008). Perceived control and emotions: interactive effects on performance in achievement settings. *Soc. Psychol. Educ.* 11, 161–180. doi: 10.1007/s11218-007-9040-0

Ryan, R., and Deci, E. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* 55, 68–78. doi: 10.1037/0003-066X.55.1.68

Ryan, R., and Deci, E. (2009). "Promoting self-determined school engagement," in *Handbook of Motivation at School*, eds K. Wentzel and A. Wigfield (New York, NY: Routledge), 171–195.

Salanova, M., Schaufeli, W., Martínez, I., and Bresó, E. (2010). How obstacles and facilitators predict academic performance: the mediating role of study burnout and engagement. *Anxiety Stress Coping* 23, 53–70. doi: 10.1080/10615800802609965

Salovey, P., and Mayer, J. D. (1990). Emotional intelligence. *Imagin. Cogn. Pers.* 9, 185–211. doi: 10.2190/DUGG-P24E-52WK-6CDG

Schaufeli, W. B., and Bakker, A. B. (2003). *The Utrecht Work Engagement Scale (UWES). Test Manual*. Utrecht: Department of Social and Organizational Psychology.

Schaufeli, W. B., Martínez, I., Marques, A., Salanova, M., and Bakker, A. B. (2002a). Burnout and engagement in university students a cross-national study. *J. Cross Cult. Psychol.* 33, 464–481. doi: 10.1177/0022022102033005003

Schaufeli, W. B., Salanova, M., González-Romá, V., and Bakker, A. B. (2002b). The measurement of engagement and burnout: a two sample confirmatory factor analytic approach. *J. Happiness Stud.* 3, 71–92. doi: 10.1023/A:1015630930326

Seligman, M. E., and Csikszentmihalyi, M. (2000). Positive psychology: an introduction. *Am. Psychol.* 55, 5–14. doi: 10.1037//0003-066x.55.1.5

Skinner, E., Furrer, C., Marchand, G., and Kindermann, T. (2008). Engagement and disaffection in the classroom: part of a larger motivational dynamic? *J. Educ. Psychol.* 100, 765–781. doi: 10.1037/a0012840

Soroa, G., Gorostiaga, A., Aritzeta, A., and Balluerka, N. (2015). A shortened spanish version of the emotional creativity inventory (the ECI-S). *Creat. Res. J.* 27, 1–8. doi: 10.1080/10400419.2015.1030313

St-Louis, A., and Vallerand, R. (2015). A successful creative process: the role of passion and emotions. *Creat. Res. J.* 27, 175–187. doi: 10.1080/10400419.2015.1030314

Tugade, M., and Fredrickson, B. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. *J. **Pers**. **Soc**. **Psychol***. 86, 320–333. doi: 10.1037/0022-3514.86.2.320

Turner, J., Husman, J., and Schallert, D. (2002). The importance of students' goals in their emotional experience of academic failure: investigating the precursors and consequences of shame. *Educ. Psychol.* 37, 79–89. doi: 10.1207/S15326985EP3702_3

Tze, V. M. C., Daniels, L. M., and Klassen, R. M. (2016). Evaluating the relationship between boredom and academic outcomes: a meta-analysis. *Educ. Psychol. Rev.* 28, 119–144. doi: 10.1007/s10648-015-9301-y

Vallerand, R., Pelletier, L., Blais, M., Briere, N., Senécal, C., and Vallieres, F. (1993). On the assessment of intrinsic, extrinsic, and amotivation in education: evidence on the concurrent and construct validity of the academic motivation scale. *Educ. Psychol. Meas.* 53, 159–172. doi: 10.1177/0013164493053001018

Vallerand, R., Pelletier, L., and Koestner, R. (2008). Reflections on self-determination theory. *Can. Psychol.* 49, 257–262. doi: 10.1037/a0012804

Veiga, F., García, F., Reeve, J., Wentzel, K., and García, Ó (2015). When adolescents with high self-concept lose their engagement in school. *J. Psychodidactics* 20, 305–320. doi: 10.1387/RevPsicodidact.12671

Watson, D. (2000). *Mood and Temperament*. New York, NY: Guilford Press.

Woolfolk, A., and Margetts, K. (2007). *Educational Psychology*. Melbourne, VIC: Pearson Education.

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Oriol, Amutio, Mendoza, Da Costa and Miranda. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 12 August 2016
doi: 10.3389/fpsyg.2016.01207

Nicotine Dependence as a Mediator of Project EX's Effects to Reduce Tobacco Use in Scholars

María T. González[1], José P. Espada[1], Mireia Orgilés[1], Alexandra Morales[1] and Steve Sussman[2]*

[1] Department of Health Psychology, Miguel Hernández University, Elche, Spain, [2] Department of Preventive Medicine, University of Southern California, Los Angeles, CA, USA

In Spain, 44% of 14–18-year-olds have smoked, and 12.5% have smoked cigarettes in the last 30 days. Nicotine is one of the most addictive substances, and can lead to serious addiction in adulthood with adverse consequences to one's health. School plays a relevant role in health promotion and preventing risk behaviors such as tobacco consumption. Despite the fact that some school-based tobacco cessation and prevention interventions prove to be effective for their purposes, there is a lack of understanding as to why these programs succeed or fail. This longitudinal study aims to test the nicotine dependence (ND) as a mediator of Project EX's effect – a tobacco-use cessation program developed for high school youth to reduce tobacco consumption in scholars. Six high schools located in the Mediterranean coast were randomized for the participation of the program (Spanish version of Project EX) or a waiting-list group with baseline, immediate-posttest, and 12-month follow-up assessments. At baseline, 1,546 adolescents aged 14–21 years old (mean age: 15.28; $SD = 1.20$; 46% were women) were evaluated by self-administered tests on tobacco consumption and ND. A biomarker of smoke inhalation – a measurement of exhaled carbon monoxide (ECM) – was used. Participants who were smokers ($N = 501$; 32%) were selected for this study. Mediation analyses were conducted using the PROCESS v2.12 macro for Windows. The significant criterion was $p \leq 0.05$, and 5,000 samples were used for bias-corrected bootstrap confidence intervals. Results indicated that Project EX indirectly decreased the number of cigarettes smoked in the last month, the number of cigarettes smoked within the last 7 days, the number of daily cigarettes, and ECM level at 12-month follow up through decreasing the level of ND in the short-term. This is the first Spanish study that explores ND as a mediator of the long-term efficacy of Project EX to reduce tobacco consumption in adolescents. Results suggest that interventions that reduce ND at short-term are more likely to be successful to decrease tobacco use at long-term.

Keywords: nicotine dependence, Project EX, tobacco, cessation, prevention, school-based, adolescents, mediation analysis

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Elisardo Becoña, University of Santiago de Compostela, Spain
Sara Weidberg, University of Oviedo, Spain

****Correspondence:***
José P. Espada
jpespada@umh.es

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *24 June 2016*
Accepted: *29 July 2016*
Published: *12 August 2016*

Citation:
González MT, Espada JP, Orgilés M, Morales A and Sussman S (2016) Nicotine Dependence as a Mediator of Project EX's Effects to Reduce Tobacco Use in Scholars. Front. Psychol. 7:1207. doi: 10.3389/fpsyg.2016.01207

INTRODUCTION

Tobacco consumption is the leading preventive cause of disease and early death in developed countries (World Health Organization [WHO], 2014). Teens who experiment with tobacco consumption later become regular users and progress to regular use of other more harmful substances (Botvin and Griffin, 2007). In recent years there has been a growing interest in interventions for teen smoking cessation, since this population comprises the most vulnerable group, as it is at adolescence when addiction starts (Abad and Ruiz-Juan, 2015).

In Spain, tobacco is the second most consumed addictive substance, according to the latest data from the National Drug Plan (Spanish Drugs Observatory, 2015). It is estimated that 44% of adolescents have smoked on at least one occasion, 35% have smoked in the last year, and 12.5% have smoked cigarettes in the last 30 days. Motivations that lead adolescents to smoke are diverse and include the interaction of genetic and environmental factors that favor the initiation, experimentation, and consolidation of a level of nicotine dependence (ND; Cogollo-Milanés and de La Hoz-Restrepo, 2010). Sensation seeking, low risk perception, peer acceptance, and smoking social component favor adolescents risk behaviors (Latorre et al., 2014; Cantó et al., 2015). Also, adolescents who start smoking at a young age have a higher ND (Balboa et al., 2011; Dierker et al., 2015), establishing it as the main factor maintainer of smoking behavior (Villalobos et al., 2015).

Nicotine dependence is considered a construct which brings cognitive, behavioral, and physiological symptoms that characterize compulsive consumption (Villalobos et al., 2015). Dependence level can be considered a continuous variable, scoring from 0 to 19, where scores from 0 to 2 is considered low dependence, scores 3–4 is low dependence, 5 is medium dependence, scores 6–7 is high dependence, and from 8 to 19 very high dependence (Fagerström, 1978; Prokhorov et al., 2000). In turn, these dependence levels are established as a risk factor in the onset of depressive symptoms and negative moods (Gonzálvez et al., 2015), as well as schizophrenia and alcoholism (Becoña and Míguez, 2004), so it is necessary to design interventions to prevent tobacco consumption.

Project EX (Sussman et al., 2004) is an empirically validated school-based smoking-cessation intervention for adolescents developed in the United States (California). The intervention focuses on personal skills (such as assertiveness training), coping withdrawal, and motivational factors. The Project EX clinic version shows consistently positive effects through several controlled studies in the U.S. to prevent and reduce tobacco consumption in adolescents. In order to evaluate the efficacy of the program in other cultures the program was implemented and evaluated in several other countries (Sussman, 2012). The first international pilot study completed was in Wuhan, China (Zheng et al., 2004), with an intent-to-treat 30-day quit rate of 11% at a four-month follow-up in adolescents aged 16–17 years. The second international pilot study was in Bashkortostan (Russia), with adolescents aged from 13 to 19 years. Intent-to-treat 30-day quit rate was 7.5% in the program group versus 0.1% in the control group at a six-month follow-up (Idrisov et al., 2013). In Spain, Project EX effectiveness has also shown a tobacco cessation in adolescents aged 13–19 years old, with a significantly higher 30-day intent-to-treat rate for adolescents who received the program (4.9%) compared to the control group (0%) (McCuller et al., 2006; Espada et al., 2015, 2016). Higher level of motivation to quit smoking was related to higher smoking quit rates; therefore, motivation to quit smoking is considered a mediator of the effects of the intervention.

Mediation analysis are especially useful to know how interventions work by identifying the variables that have the greatest influence on the effectiveness, and what other variables (on which the intervention has no impact) are particularly relevant to achieve the goal of the intervention, and they need to be revised to increase the effectiveness of the intervention (MacKinnon, 2008). McCuller et al. (2006) analyzed the role of motivation to quit smoking as a mediator variable of Project EX; however, more evidence is needed on what mechanisms are underlying this intervention's effects. This longitudinal study aims to test the ND as a mediator of Project EX's effectiveness to reduce tobacco consumption in adolescents from Spain.

MATERIALS AND METHODS

School Recruitment and Experimental Design

The study was approved by the institutional review board at Miguel Hernandez University, Spain. The education authorities were informed of the study goals, and authorization was requested by the parents, who were informed by letter and requested to provide written consent for their children to participate in the study. The written parental consent was provided to all minors participating.

We contacted a convenience sample of 45 schools from 17 towns in the Alicante, a province of Spain. A first meeting with the school boards was held to present the objectives of the intervention, and a total of six high schools from three cities [Elche ($n = 4$), Crevillente ($n = 1$), and San Vicente ($n = 1$)], agreed to participate. The schools recruited were randomly assigned to one of two experimental conditions: treatment or standard care (control).

A total of seventeen Spanish graduate students were interested in implementing the program. A researcher who was previously trained by the program developer provided training to all persons who finally delivered the program.

Two translators were responsible for the translation into Spanish of the original version of the Project EX program content. The final version was revised by two bilingual researchers working at the Miguel Hernandez University by comparing the English and Spanish versions. Before implementing the program, the Spanish version of Project EX was assessed in a focus group ($n = 10$ high school students). This evaluation was helpful to test the feasibility of the program content and verified that it was clearly understood and culturally appropriate. In addition to language adaptations, some changes were made in the Project EX program to adapt it to Spanish culture. The Project EX classroom program is closely adapted from the clinic program (Sussman

et al., 2001; Sun et al., 2007). The learning activities included strategies to quit smoking and learning skills for maintenance without smoking, with an interactive methodology based on motivation. The methodology of Project EX in Spain can be found somewhere else (Espada et al., 2015). The sessions and the objectives of the program are shown in **Table 1**.

Participants

A total of 1,546 scholars aged 14–21 years old (mean age: 15.28; $SD = 1.20$; 46% were women) were evaluated by self-administered tests. Adolescents who were smokers ($N = 501$; 32%) were selected for this study. **Table 2** shows descriptive information about the sample.

Data Collection and Measures

Participants were evaluated at pretest, posttest, and 12-month follow-up using paper-and-pencil questionnaire. Demographic variables included gender, age (years), nationality (born in Spain, or immigrated to Spain from another country), current living situation (with parents, live alone, other situation), and parents' education (mean response across father's (or stepfather's) and mother's (or stepmother's) educational levels based on categories derived from Hollingshead and Redlich (1958).

Smoking behavior was assessed with the fill-in-the blank items asking "How many cigarettes have you smoked in the last month (30 days)?" and "How many cigarettes have you smoked in the last week (7 days)?", and the assessment-day smoking behavior was measured with the item: "Did you smoke tobacco today?" The 8-item modified Fagerstrom Tolerance Questionnaire (mFTQ) was used to measure the level of ND (Prokhorov et al., 1996, 2000; Idrisov et al., 2013). An example of the item is: "How soon after waking do you smoke your first cigarette?" The higher sum score indicates the higher the participant's level of ND. Cronbach alpha for mFTQ in this sample was appropriate ($\alpha = 0.87$). Expired CO was assessed using a breath CO monitor (Micro+ Smokerlyzer; Bedfont Technical Instruments, Kent, UK[1], accessed April 19, 2014) at pretest, posttest and follow-up evaluations. This measure was valuable to validate self-reported assessment-day smoking.

Data Analysis

Descriptive statistics were computed for sociodemographic variables and main outcomes of the present study. Baseline differences between the control and experimental groups were calculated using T-test (quantitative variables) and Chi-square (χ^2) (qualitative variables). Statistical analyses were carried out using SPSS Statistics v23.0.

Mediation analyses were implemented with the SPSS PROCESS macro (Hayes, 2013). We used 5,000 samples for bias-corrected bootstrap confidence intervals; and the significant criterion was $p \leq 0.05$. The single-mediator model described by Hayes (2013) was used (**Figure 1**). The predictor was a binary variable contrasting a tobacco-use cessation program (Project EX) with the control group (non-intervention). Primary outcomes were continuous variables: three self-reported measures - number of cigarettes smoked in the last month, number of cigarettes smoked within the last 7 days, and number of daily cigarettes -, and a biological measure (exhaled CO level). Analyses were controlled for sex, age, school, and baseline measures.

We assigned the mediator as changes in the level of ND. Indirect effect is estimated in simple mediation models as a product of regression weight linking X–Y through M (Ind 1) (Hayes, 2013). Mediation analyses were conducted for the four primary outcomes using a product-of-coefficient approach (Preacher and Hayes, 2008). The effect of the intervention on the level of ND (M) is represented in the path α; while the effect of the level of ND (M) on each primary outcome (Y) is represented in the path β. If indirect effects do not include zero, there is a significant mediation.

RESULTS

Table 3 shows descriptive statistics of the main outcomes and the mediator in each evaluation: baseline, posttest, and 12-month follow-up for the intervention and control groups. The program

[1]http://www.bedfont.com/ch/smokerlyzer/micro

TABLE 1 | Project EX sessions and objectives.

Session name	Contents
Orientation	Imparts the ground rules for the group and discusses reasons for quitting tobacco.
Tobacco affects your life	Discusses how tobacco use can cause, rather than relieve stress.
Health dangers of tobacco use	Discusses the harmful substances in tobacco and how it can injure one's body.
Quitting step 1-Making a commitment about not using tobacco	Discusses addiction to tobacco. Methods of quitting smoking, and physical and psychological aspects of withdrawal are discussed.
Quitting step 2-Managing withdrawal symptoms	Discusses more about nicotine, addiction, and strategies of avoiding addiction or managing withdrawal symptoms. Psychological coping includes self-forgiveness and avoiding false expectations regarding how quitting will and will not affect one's life.
Taking care of a healthy body	Involves learning lifestyle balance strategies, including weight control and practicing a "yoga activity."
Taking care of your piece of mind	Involves learning more coping strategies, including assertiveness training and anger management. Participants also learn the "letting feelings pass" meditation activity.
Not smoking again: commitment and avoiding relapse	Involves learning means to avoid using tobacco, and mentions how topics covered could be applicable to other substances.

TABLE 2 | Baseline characteristics and reports of tobacco consumption measures at 12-month follow-up of participating Spanish adolescents by experimental condition.

Characteristics	Intervention group	Control group	Total	Test statistics[a]
Sample size (*N*)	240	261	501	
No. (%) male	114/240 (47.5)	132/261 (50.6)	246/501 (49.1)	0.473
Mean age (years) (*SD*)	15.66 (1.12)	15.98 (1.44)	15.83 (1.30)	−2.703**
Nationality				
Spanish	214/240 (89.2)	235/261 (90)	449/501 (89.6)	0.102
Other	26/240 (10.8)	26/261 (10)	52/501 (10.4)	
Live with. . . (%)				
Both parents	163/216 (75.5)	208/251 (82.9)	371/467 (79.4)	5.553
Mother	47/216 (21.8)	34/251 (13.5)	81/467 (17.3)	
Father	6/216 (2.8)	9/251 (3.6)	15/467 (15)	
School achievement (number of failed courses/per year)	3.37 (3.82)	2.88 (3.36)	3.11 (3.59)	1.476
Age of first cigarette smoked	13.19 (2.03)	13.47 (1.75)	13.34 (1.89)	−1.698
Number of daily cigarettes	1.88 (3.70)	2.43 (4.37)	2.15 (4.05)	−1.443
Number of cigarettes smoked within the last 7 days	8.45 (18.31)	13.85 (31.67)	11.18 (26.03)	−2.228*
Number of cigarettes smoked in the last month	2.26 (4.65)	3.06 (5.21)	2.66 (4.95)	−1.721
Exhaled carbon monoxide (ECM) (CO) level	2.58 (2.80)	2.56 (3.06)	2.57 (2.93)	0.054
Nicotine dependence (ND)	29.32 (8.58)	28.82 (8.45)	29.06 (8.51)	0.645

*$p \leq 0.05$; **$p \leq 0.01$; SD, standard deviation; [a]T-test was used for significance testing of continuous variables, and χ^2 test was used for significance testing of categorical variables; Higher scores represent higher level of ND.*

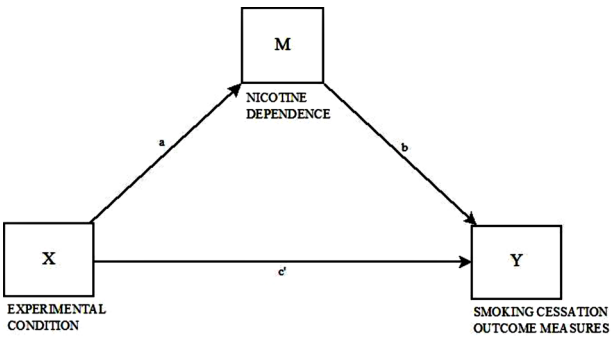


FIGURE 1 | Path diagram of the effect of the intervention on smoking cessation outcome measures at 12-month follow-up (Time 3) via nicotine dependence (ND) (Time 2), after controlling for baseline differences, gender, age, and school. X, Independent variable; Y, Dependent variable; M, Mediator; a, b, c′, Regression coefficients. The 95% CIs for indirect effects were obtained by bootstrapping with 5,000 resamples.

had a significant impact on the level of ND (M) (path α) as shown in **Table 4**. This finding shows that adolescents involved in the intervention group informed lesser level of ND at posttest than those in the control group.

Path β shows the existing significant relationship between the level of ND and all the main outcomes: number of cigarettes smoked in the last month ($p = 0.04$), number of cigarettes smoked within the last 7 days ($p = 0.01$); number of daily cigarettes ($p = 0.01$), and exhaled carbon monoxide (ECM) (CO) level ($p = 0.009$). In all the analyzed models, path β shows that the higher level of ND (posttest) was related to higher number of cigarettes smoked in the last month, higher number of cigarettes smoked within the last 7 days, higher number of daily cigarettes, and higher level of ECM (CO) level at 12-month follow-up.

The intervention positively reduced the number of cigarettes smoked in the last month (ACI = –22.44, –1.14), number of cigarettes smoked within the last 7 days (ACI = –14.09, –1.65); number of daily cigarettes (ACI = –2.07, –0.25), and ECM (CO) level (ACI = –1.29, –0.14) after 12-month period indirectly through reducing the level of ND.

DISCUSSION

This work's objective was to test the ND as mediator of Project EX's effect to reduce tobacco consumption in adolescents from Spain. Findings show that the intervention had a significant impact on the level of ND short-time, and this variable was a mediator of the intervention's effect on several tobacco use measures. Compared to the control group, adolescents who received Project EX reduced their level of ND short-term, and they were more likely to report lesser tobacco use at 12-month follow-up, in terms of number of cigarettes smoked in the last month, number of cigarettes smoked within the last 7 days, number of daily cigarettes, and ECM level. In the present study, there was a significant relationship between the level of ND and all these main outcomes. The results are consistent with other studies that suggest that lower ND corresponds to lower tobacco consumption (González et al., 2016; Ruiz and Miranda, 2016).

Previously, McCuller et al. (2006) evaluated the effects of Project EX on changing motivation to quit smoking. It concludes that motivation to quit smoking is a plausible mediator of cessation program effects since higher level of motivation was statistically significantly related to higher smoking quit rates. In

TABLE 3 | Self-report of tobacco consumption measures, and ND (as mediator) by condition and assessment period.

	Baseline		Posttest		12-month Follow-up	
	Intervention (*N* = 240)	Control (*N* = 261)	Intervention (*N* = 149)	Control (*N* = 196)	Intervention (*N* = 139)	Control (*N* = 113)
Potential mediator mean (±) SD						
mFTQ ND[a]	26.15 (4.59)	25.75 (4.78)	25.56 (5.45)	26.42 (5.02)	26.48 (5.30)	28.44 (3.58)
Outcomes mean (±) SD						
Number of cigarettes smoked in the last month	2.26 (4.65)	3.06 (5.21)	1.50 (2.95)	2.57 (3.79)	1.98 (3.67)	2.83 (4.22)
Number of cigarettes smoked within the last 7 days	8.45 (18.31)	13.85 (31.67)	5.22 (13.57)	14.10 (56.14)	7.34 (18.29)	15.91 (31.90)
Number of daily cigarettes	1.88 (3.70)	2.43 (4.37)	1.42 (3.86)	2.93 (9.82)	1.14 (2.68)	2.47 (4.76)
Exhaled carbon monoxide (CO) level	2.58 (2.80)	2.56 (3.06)	1.97 (2.22)	2.56 (2.91)	1.58 (1.27)	2.14 (2.10)

SD, standard deviation. [a]*Modified Fagerstrom Tolerance Questionnaire score.*

TABLE 4 | Nicotine dependence as a mediator of the effect of Project EX, compared with a control group, on tobacco use measures by the 12-month follow-up among adolescents from Spain.

Main outcome (*Y*)	Effect of the intervention (*X*) on the ND (*M*)[a]			Effect of ND as a mediator (M) on the main outcome (*Y*)[b]			Indirect effect of ND as the mediator on the main outcome (*Y*)
	α Path (SE)	95% CI	*p*-value	β Path (SE)	95% CI	*p*-value	Ind 1[c] [ACI][d]
Model 1	–2.43 (1.20)	–4.83, –0.04	0.046	3.59 (1.27)	1.06,6.13	0.0059	–8.78 [–22.44, –1.45]
Model 2	–2.93 (1.20)	–5.32, –0.54	0.016	2.07 (0.71)	0.65,3.50	0.0048	–6.09 [–14.09, –1.65]
Model 3	–2.93 (1.18)	–5.28, –0.58	0.015	0.30 (0.11)	0.08,0.52	0.0076	–0.89 [–2.07, –0.25]
Model 4	–3.69 (1.37)	–6.44, –0.94	0.009	0.14 (0.05)	0.02,0.26	0.0163	–0.53 [–1.29, –0.15]

[a]*The α path is the Project EX's effect on each potential mediator.* [b]*The β path is the effect of mFTQ ND mediator on the main outcome (Y).* [c]*Ind 1 = X – M1 – Y.* [d]*Asymmetric confidence interval based on bootstrap method with 5,000 replicates. The mediation analyses were adjusted for baseline differences between Project EX and the control group, gender, age, baseline value of the mediator and school. Model 1: Main outcome (Y) = Number of cigarettes smoked in the last month. Model 2: Main outcome (Y) = Number of cigarettes smoked within the last 7 days. Model 3: Main outcome (Y) = Number of daily cigarettes. Model 4: Main outcome (Y) = Exhaled carbon monoxide (CO) level.*

the present study, composed of Spanish adolescents, motivation was discarded as a mediator of the intervention's effects to reduce tobacco consumption because of the characteristics of the sample. At one-year follow-up of the smoking intervention program with Spanish adolescents there was a lack of general readiness to be involved in cessation programming. Evidence of this were the low percentage of schools that agreed to be involved initially, and the groups of young smokers that dropped out before the program started or after the first session (39.3%), as well as a high attrition rate. This results may be explained by the fact of the implementation was held after school, and students did not receive any incentive for participating in the present study (Espada et al., 2016). This suggests that participants were not highly motivated to participate in the program.

In Spain, Project EX is the only school-based tobacco cessation program whose effects have been proven to be positive to reduce tobacco consumption at 6 and 12 months (Espada et al., 2015, 2016). Furthermore, the assessment of expired CO by use of a breath CO monitor validates self-reported smoking responses. It is noteworthy that results were similar when the main outcome was assessed with self-report measures than when biological measures were used. Although ND was a mediator of the intervention's effects on every main outcome, it is curious that the coefficient of mediation was higher in the model with cigarette consumption in the last month as a main outcome compared to the rest of measures. The coefficient of mediation decreased gradually as the main outcome implied a more limited time or more recent use of tobacco (last 7 days, daily). This effect may be explained by memory effect of the participants; in other words, it may be more easily remembered the number of daily cigarettes than the number of cigarettes smoked in the last month. Furthermore, it is important to note that the measurement of CO is a biological measure, and therefore, it is more accurate.

The results of this study have important implications for the tobacco cessation in Spanish adolescents. The results permit identifying the mechanisms involved in the effectiveness of a tobacco cessation program 12 months subsequent to its application. The present study has at least four strengths. This is the first Spanish study that explores ND as a mediator of the long-term efficacy of Project EX to reduce tobacco consumption in adolescents. A considerable sample size was used to explore this issue. The longitudinal design (including 12-month follow-up) is an important strength of the present study since there is a lack of this type of studies in prevention science. A biological measure was used, rather than only self-reported measures, which provides a more direct indicator of tobacco consumption in this population.

Nevertheless, the present study has some limitations. First, although the study involved a large sample, it is not from a varied geographical origin, so it is necessary to expand this study to other regions of the country. Second, U.S. and international survey data reveal that youth are aware of e-cigarettes and use of these products in this population is rapidly increasing (Durmowicz, 2014), and currently unregulated (Dutra and Glantz, 2014). In this study conventional tobacco consumption is evaluated, so it could be that adolescent consumers of e-cigarettes do not identify as tobacco consumers. Future studies on the consumption of tobacco should consider the use of this popular type of electronic nicotine delivery system.

Despite the limitations, this is the first Spanish study that explores ND as a mediator of the long-term efficacy of Project EX to reduce tobacco consumption in adolescents. However, more research is required for a better understanding of the success and/or failure of smoking cessation and prevention programs in adolescent population.

AUTHOR CONTRIBUTIONS

All individuals listed as authors have: Contributed substantially to the conception and design of the work. Drafted the work or revised it critically for important intellectual content. Have given final approval of the version to be published. Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FUNDING

This research was supported by the Spanish Department of Economy and Competitiveness (PSI2011-26819) and by the Program VALi+d for Research Staff training of the Council of Culture, Education and Science of the Valencian Autonomous Government (ACIF/2014/047).

REFERENCES

Abad, J. R. R., and Ruiz-Juan, F. R. (2015). Actividad físico-deportiva y contexto familiar: variables predictoras de consumo de tabaco entre adolescentes españoles [Physical-sports activity and familiar context: predicting variables of tobacco consumption among Spanish adolescents]. *Rev. Iberoam. Psicol. Ejercicio Deporte* 10, 121–131.

Balboa, M. F., Sánchez, J. M. M., López, M. J., Adell, M. N., Soriguera, A. R., and Muñoz, E. F. (2011). Dependencia a la nicotina y preparación para dejar de fumar en la población española [Nicotine dependence and readiness to quit smoking in the Spanish population]. *Adicciones* 23, 103–109. doi: 10.20882/adicciones.153

Becoña, E., and Míguez, M. C. (2004). Consumo de tabaco y psicopatología asociada. *Psicooncología* 1, 99–112.

Botvin, G. J., and Griffin, K. W. (2007). School-based programmes to prevent alcohol, tobacco and other drug use. *Int. Rev. Psychiatry* 19, 607–615. doi: 10.1080/09540260701797753

Cantó, E. G., García, P. L. R., Soto, J. J. P., Villalba, F. J. L., and Guillamón, A. R. (2015). Consumo de tabaco y su relación con el nivel de actividad física habitual y la condición física en adolescentes de la Región de Murcia (España) [Tobacco consumption and its relation to the level of habitual physical activity and psysical fitness in adolescents in the Region of Murcia (Spain)]. *Salud Colect.* 11, 565–573. doi: 10.18294/sc.2015.797

Cogollo-Milanés, Z., and de La Hoz-Restrepo, F. (2010). Consumo de cigarrillo y riesgo de dependencia de la nicotina de estudiantes de secundaria [Cigarette smoking and the risk of high-school students becoming dependen ton nicotine]. *Rev. Salud Pública* 12, 434–445. doi: 10.1590/s0124-00642010000300009

Dierker, L., Hedeker, D., Rose, J., Selya, A., and Mermelstein, R. (2015). Early emerging nicotine dependence symptoms in adolescence predict daily smoking in young adulthood. *Drug Alcohol Depend.* 151, 267–271. doi: 10.1016/j.drugalcdep.2015.03.009

Durmowicz, E. L. (2014). The impact of electronic cigarettes on the paediatric population. *Tob. Control* 23(Suppl. 2), ii41–ii46. doi: 10.1136/tobaccocontrol-2013-051468

Dutra, L. M., and Glantz, S. A. (2014). Electronic cigarettes and conventional cigarette use among US adolescents: a cross-sectional study. *JAMA Pediatr.* 168, 610–617. doi: 10.1001/jamapediatrics.2013.5488

Espada, J. P., Gonzálvez, M. T., Orgilés, M., Guillén-Riquelme, A., Soto, D., and Sussman, S. (2015). Pilot clinic study of Project EX for smoking cessation with Spanish adolescents. *Addict. Behav.* 45, 226–231. doi: 10.1016/j.addbeh.2015.02.009

Espada, J. P., Gonzálvez, M. T., Orgilés, M., and Sussman, S. (2016). One-year effects of Project EX: a smoking intervention pilot program with Spanish adolescents. *J. Health Psychol.* doi: 10.1177/1359105315623628 [Epub ahead of print].

Fagerström, K. O. (1978). Measuring degree of physical dependence to tobacco smoking with reference to individualization of treatment. *Addict. Behav.* 3, 235–241. doi: 10.1016/0306-4603(78)90024-2

González, J. I. Á, Ortega, F. Z., Sanchez, M. C., Martínez, A. M., and Sánchez, S. G. (2016). Relación entre consumo de tabaco y alcohol y el autoconcepto en adolescentes españoles [The relationship between consumption of tobacco and alcohol and self-concept in Spanish adolescents]. *Rev. Complut. Educ.* 27, 533–550.

Gonzálvez, M. T., Espada, J. P., and Orgilés, M. (2015). Estado de ánimo y consumo de tabaco en una muestra de adolescentes españoles [Mood and smoking habits in Spanish adolescents]. *Rev. Latinoam. Psicol.* 47, 86–92. doi: 10.1016/j.rlp.2015.05.001

Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. New York, NY: Guilford Press. doi: 10.1111/jedm.12050

Hollingshead, A. B., and Redlich, F. C. (1958). "Methodological procedures," in *Social Class and Mental Illness: Community Study*, eds A. B. Hollingshead and F. C. Redlich (New York, NY: John Wiley & Sons, Inc.), 18–44.

Idrisov, B., Sun, P., Akhmadeeva, L., Arpawong, T. E., Kukhareva, P., and Sussman, S. (2013). Immediate and six-month effects of Project EX Russia: a smoking cessation intervention pilot program. *Addict. Behav.* 38, 2402–2408. doi: 10.1016/j.addbeh.2013.03.013

Latorre, P. A., Cámara, J. C., and García, F. (2014). Búsqueda de sensaciones y hábitos de tabaquismo, consumo de alcohol y práctica deportiva en estudiantes de Educación Secundaria [Sensation seeking and habits of smoking, alcohol consumption and sport practice in Secondary School students]. *Salud Ment.* 37, 145–152. doi: 10.17711/sm.0185-3325.2014.018

MacKinnon, D. P. (2008). *Introduction to Statistical Mediation Analysis*. New York, NY: Lawrence Erlbaum Associates. doi: 10.4324/9780203809556

McCuller, W. J., Sussman, S., Wapner, M., Dent, C., and Weiss, D. J. (2006). Motivation to quit as a mediator of tobacco cessation among at-risk youth. *Addict. Behav.* 31, 880–888. doi: 10.1016/j.addbeh.2005.07.019

Preacher, K. J., and Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav. Res. Methods* 40, 879–891. doi: 10.3758/BRM.40.3.879

Prokhorov, A. V., De Moor, C., Pallonen, U. E., Hudmon, K. S., Koehly, L., and Hu, S. (2000). Validation of the modified fagerström tolerance questionnaire with salivary cotinine among adolescents. *Addict. Behav.* 25, 429–433. doi: 10.1016/s0306-4603(98)00132-4

Prokhorov, A. V., Pallonen, U. E., Fava, J. L., Ding, L., and Niaura, R. (1996). Measuring nicotine dependence among high-risk adolescent smokers. *Addict. Behav.* 21, 117–127. doi: 10.1016/0306-4603(96)00048-2

Ruiz, C. A. J., and Miranda, J. A. R. (2016). ¿Las guías de tratamiento de la EPOC abordan adecuadamente el tratamiento del tabaquismo? *Arch. Bronconeumol.* 52, 287–344. doi: 10.1016/j.arbres.2016.04.009

Spanish Drugs Observatory (2015). *Encuesta Estatal Sobre Uso de Drogas en Enseñanzas Secundarias (ESTUDES) [National survey on drug use in high school students]*. Madrid: Ministerio de Sanidad, Servicios Sociales e Igualdad.

Sun, P., Miyano, J., Rohrbach, L. A., Dent, C. W., and Sussman, S. (2007). Short-term effects of Project EX-4: a classroom-based smoking prevention and cessation intervention program. *Addict. Behav.* 32, 342–350. doi: 10.1016/j.addbeh.2006.05.005

Sussman, S. (2012). International translation of Project EX: a teen tobacco use cessation program. *SUCHT* 58, 317–350. doi: 10.1024/0939-5911.a000205

Sussman, S., Dent, C. W., and Lichtman, K. L. (2001). Project EX: outcomes of a teen smoking cessation program. *Addict. Behav.* 26, 425–438. doi: 10.1016/S0306-4603(00)00135-0

Sussman, S., McCuller, W. J., Zheng, H., Pfingston, Y. M., Miyano, J., and Dent, C. W. (2004). Project EX: a program of empirical research on adolescent tobacco use cessation. *Tob. Induc. Dis.* 2, 119–132. doi: 10.1186/1617-9625-2-3-119

Villalobos, J. A., Calleja, N., Aguilar, A., and Valencia, A. (2015). Un modelo estructural de la dependencia al tabaco en estudiantes universitarios [A structural model of tobacco dependence in college students]. *Psicol. Salud* 25, 103–109.

World Health Organization [WHO] (2014). *Global Status Report on Alcohol and Health: 2014*. Geneva: World Health Organization.

Zheng, H., Sussman, S., Chen, X., Wang, Y., Xia, J., Gong, J., et al. (2004). Project EX-A teen smoking cessation initial study in Wuhan, China. *Addict. Behav.* 29, 1725–1733. doi: 10.1016/j.addbeh.2004.03.035

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer SW and handling Editor declared their shared affiliation, and the handling Editor states that the process nevertheless met the standards of a fair and objective review.

Copyright © 2016 González, Espada, Orgilés, Morales and Sussman. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

frontiers in Psychology

ORIGINAL RESEARCH
published: 18 July 2016
doi: 10.3389/fpsyg.2016.01062

Untangling the Contribution of the Subcomponents of Working Memory to Mathematical Proficiency as Measured by the National Tests: A Study among Swedish Third Graders

Carola Wiklund-Hörnqvist[1,2], Bert Jonsson[1], Johan Korhonen[3], Hanna Eklöf[4] and Mikaela Nyroos[5]*

[1] Department of Psychology, Umeå University, Umeå, Sweden, [2] Umeå Center for Functional Brain Imaging, Umeå, Sweden, [3] Faculty of Education and Welfare Studies, Åbo Akademi University, Vaasa, Finland, [4] Department of Applied Educational Science, Umeå University, Umeå, Sweden, [5] Department of Education, Umeå University, Umeå, Sweden

The aim with the present study was to examine the relationship between the subcomponents in working memory (WM) and mathematical performance, as measured by the National tests in a sample of 597 Swedish third-grade pupils. In line with compelling evidence of other studies, individual differences in WM capacity significantly predicted mathematical performance. Dividing the sample into four groups, based on their mathematical performance, revealed that mathematical ability can be conceptualized in terms of different WM profiles. Pupils categorized as High-math performers particularly differed from the other three groups in having a significant higher phonological ability. In contrast, pupils categorized as Low-math performers were particularly characterized by having a significant lower visuo-spatial ability. Findings suggest that it is important for educators to recognize and acknowledge individual differences in WM to support mathematical achievement at an individual level.

Keywords: National tests, mathematics, working memory, pupils, education, cognitive profiles

OPEN ACCESS

Edited by:
José Carlos Núñez, University of Oviedo, Spain

Reviewed by:
Thomas James Lundy, Virtuallaboratory.Net, Inc., USA
Ronny Scherer, Centre for Educational Measurement at the University of Oslo, Norway

****Correspondence:***
Carola Wiklund-Hörnqvist
carola.wiklund-hornqvist@umu.se

Specialty section:
This article was submitted to Educational Psychology, a section of the journal Frontiers in Psychology

Received: *30 May 2016*
Accepted: *28 June 2016*
Published: *18 July 2016*

Citation:
Wiklund-Hörnqvist C, Jonsson B, Korhonen J, Eklöf H and Nyroos M (2016) Untangling the Contribution of the Subcomponents of Working Memory to Mathematical Proficiency as Measured by the National Tests: A Study among Swedish Third Graders. Front. Psychol. 7:1062. doi: 10.3389/fpsyg.2016.01062

INTRODUCTION

One topic in education that has been receiving rapidly growing attention is the learning of mathematics. In Sweden, mathematics is one of the subjects in school that has the highest failure rate among students. In a related vein, according to the National Center for Educational Statistics (National Center for Education Statistics [NCES], 2011), only 40 % of fourth-grade students and 35 % of the eight-grade students performed at or above the proficiency level (i.e., solid academic performance for the assessed grade) in math. Likewise, in international comparisons such as Trends in International Mathematics and Science Study (TIMSS, 2007, 2011), Sweden, as well as many other countries, has showed a negative trend for educational achievement in mathematics during the last decade and the Swedish government has allocated a lot of financial resources to find interventions to prevent this trend to continue. Introducing a National test in mathematics in grade three, which is the focus in the current study, is one among other political decisions.

It is widely accepted that there are individual differences in children's cognitive ability to learn and acquire knowledge for scholastic achievement (see e.g., Engle et al., 1999; Hitch et al., 2001). Working memory (WM) is a cognitive concept thought to play a central role for the development of reading and mathematical skills. Mathematics builds on several cognitive abilities and we know from a wealth of literature that individual differences

in working memory capacity (WMC) are related to mathematical performance and further academic success (Hitch et al., 2001; Reukhala, 2001; Bayliss et al., 2003; Jarvis and Gathercole, 2003; Gathercole et al., 2004; Swanson and Kim, 2007; Bull et al., 2008; Swanson et al., 2008; De Smedt et al., 2009; Gathercole and Dunning, 2010; Menon, 2010; Geary, 2011a,b; Dumontheil and Klingberg, 2012; Nyroos and Wiklund-Hörnqvist, 2012; Friso-van den Bos et al., 2013; Li and Geary, 2013; Bergman-Nutley and Klingberg, 2014), above and beyond measures of socio-economic status (Dulaney et al., 2015), language skills (Lee et al., 2004), and general intelligence (Alloway and Alloway, 2010). Despite that individual differences in WMC have been shown to influence behavioral measurements in mathematical proficiency, less is known how corresponding differences exist between the subcomponents in WM, as proposed by Baddeley (2000), and the National subtests in mathematics.

Here, we investigate individual differences in WM in relation to performance at the National curriculum tests in mathematics in a sample of Swedish third grade pupils ($N = 597$). To further investigate if levels of mathematical proficiency can be conceptualized in terms of different WM profiles, we split the sample into four groups derived from overall mathematical performance. The delineation of different WM profiles provides a more complete picture of the influence role of cognitive abilities involved in mathematics. However, it also opens up for an important empirical question: How are the different subcomponents in the original tripartite model of WM (Baddeley, 2000) related to different mathematical proficiency levels?

Working Memory

Working memory refers to our ability to temporarily store and manipulate information needed while executing complex cognitive tasks such as numerical and arithmetic processing, problem solving and reasoning (Alloway and Alloway, 2010; Menon, 2010). The most widely used theoretical model for WM is the multicomponent model initially proposed by Baddeley and Hitch (1974) and later revised by Baddeley (2000). According to Baddeley (2000) revised model, WM is composed by four components: the central executive, the phonological loop, the visuo-spatial sketchpad and the episodic buffer (Baddeley, 2000). The central executive is a domain-general attentional control system involved in several processes such as the simultaneously storing and processing of information while handling complex tasks (e.g., mathematics). It is supported by two domain-specific slave systems: the visuo-spatial sketchpad and the phonological loop. The visuo-spatial sketchpad temporarily store visual and spatial information, whereas the phonological loop is involved in the temporarily storage and rehearsal of auditory and phonological information (Baddeley and Hitch, 1974; Baddeley, 2000). Baddeley (2000) added a fourth component, the episodic buffer. The episodic buffer is hypothesized to be responsible for integrating information from the subsystems and long term memory under the supervision of the central executive (Baddeley, 2000). Hitch et al. (2001) investigated WM through complex WM tasks and the possibility of its ability in predicting children's school performance as measured 1 year later. They found support for the hypothesis that WMC contains a combination of domain-specific and domain-general resources, which in the Bayliss et al. (2003) study has been identified as a general processing component, verbal storage component, and a visuospatial storage component.

Mathematics

Mathematics is one of the fundamental skills a child needs to master to successfully progress through the school years (Parsons and Bynner, 2005; Geary et al., 2012). A meta-analysis using six longitudinal datasets found that children with low mathematical ability when entering school/at school entry mostly stayed behind throughout schooling, independent of gender or socio-economic status (Duncan et al., 2007; see also Andersson, 2010; Dulaney et al., 2015 for related findings). Thus, identifying and understanding factors important for mathematical achievement will provide valuable knowledge aiding in the development of appropriate educational methods aimed at enhancing mathematical learning (Turley-Ames and Whitfield, 2003; Gersten et al., 2005; Holmes et al., 2009; Geary, 2011a; Skolverket [National Board of Education], 2011; Dulaney et al., 2015; Ekstam et al., 2015; Swanson, 2015). In a large-scale study, Bryant et al. (2000), compared how teachers rated the behavioral characteristics of 870 pupils identified as having mathematical difficulties with 854 pupils with other educational difficulties. Results showed that the difficulty in carrying out multi-step problems was one feature that specifically differentiated pupils with mathematical difficulties from the other pupils (Bryant et al., 2000), which corresponds to the function of WM.

Mathematics is an umbrella term encompassing a broad variety of competencies, tapping different rolls/functions such as switching between operations, strategies, and mental models while solving a task (Mayer, 1998; National Council of Teachers of Mathematics [NCTM], 2000; Niss, 2003; Lépine et al., 2005; Alloway, 2006; Abhakorn, 2008; Lithner, 2008; Lithner et al., 2010; Mee-yin Chan and Suk-han Ho, 2010; Lgr 11, 2011) and known to be closely related to WM (see Peng et al., 2016: for a meta analysis; Raghubar et al., 2010 for a review). Up to date, the relation between mathematics and WM has mainly been focused on WM as a potential predictor for overall mathematical performance (see Raghubar et al., 2010 for a review; Swanson and Jerman, 2006). For example Hitch et al. (2001) found that the predictability of the complex WM tasks, a year later, accounted for 27% of the variance in basic mathematical skills. However, when considering the variety of mathematical subdomains it seems likely that the contribution of WM and the different subcomponents, within Baddeley (2000) tripartite model of WM, will vary as a function of mathematical domain.

Working Memory and Mathematics

The importance of the different subcomponents in the tripartite model of WM (Baddeley and Hitch, 1974; Baddeley, 2000) for mathematical achievement has been investigated using different designs and populations. It is widely accepted that the contribution of executive WM resources for mathematic achievement and performance are crucial, but less consistency

exists about the role of the two slave systems for mathematics. Findings from longitudinal studies with young children are mixed. Using a longitudinal design, De Smedt et al. (2009) suggested that mathematical performance in first grade children are related to individual differences in visuo-spatial ability, but with a shift toward reliance on the phonological ability as a function of increased age (i.e., second grade; De Smedt et al., 2009; see also Hecht et al., 2001). In contrast, other studies have emphasized the visuo-spatial ability as crucial (Bull et al., 2008; Geary, 2011b). For example, in a sample of preschoolers (mean age: 4.6 years) Bull et al. (2008) found in their longitudinal study that visuo-spatial WM, but not phonological WM, predicted mathematical performance at the end of the third grade of primary school.

Similar findings have also been obtained in cross-sectional studies with older children (e.g., Holmes and Adams, 2006). In a sample of typically normal developing 8- and 9-year-old children, Holmes and Adams (2006) found that in both age groups, measurements of the central executive and visuo-spatial ability predicted curriculum-based mathematical performance. Moreover, for older children the measurement capturing the phonological loop predicted performance on easy mathematical tasks, but not performance on difficult tasks (Holmes and Adams, 2006). The latter finding might indicate a gradual shift toward the initial use of cognitive strategies relying on a verbal code (McKenzie et al., 2003), but the efficiency of those strategies might still be in its infancy and related to the degree of task demands (Holmes and Adams, 2006; Raghubar et al., 2010) or moderated by individual differences in WMC (Swanson, 2015).

However, some conflicting evidence exists regarding the role of the subcomponents in WM for mathematical performance related to age. Whereas some studies emphasizes the importance of verbal WM for mathematical performance with increasing age (Swanson and Kim, 2007; De Smedt et al., 2009; Van de Weijer-Bergsma et al., 2015), others found evidence for visuo-spatial WM as important (Gathercole and Pickering, 2000; Reukhala, 2001; Jarvis and Gathercole, 2003; Maybery and Do, 2003; Meyer et al., 2010). Using a cross-sectional design, Van de Weijer-Bergsma et al. (2015) found evidence for both verbal and visuo-spatial WM as equally important for mathematical performance up to grade four, but thereafter verbal WM takes over up to grade six. Thus, Meyer et al. (2010) investigated whether the contribution of the WM subcomponents changed for mathematical achievement in children at age 8- (second grade) as compared to 9-year-old children (third grade). The results showed that both the central executive and the phonological loop predicted mathematical reasoning during the second grade, but not in the third grade. Instead, the visuo-spatial component of WM was predictive for mathematical ability in third graders (Meyer et al., 2010). Correlation studies have found that the relation between the visuo-spatial WM and standardized curriculum mathematical tests persists even in older children, ranging from 7 to 14 years old (Gathercole and Pickering, 2000; Reukhala, 2001; Jarvis and Gathercole, 2003; Maybery and Do, 2003) and Reukhala (2001) found a significant correlation between mathematical performance and visuo-spatial WM even when controlling for verbal WM in a sample of adolescents 15–16 years old. Together, those results indicate the potential role of individual differences in the different subcomponents in WM for academic success across ages, but also the inconsistency findings across studies independent of study design.

The relation between the different subcomponents of WM and mathematical achievements has also been studied among children with mathematical learning difficulties (MD). Meta-analytic findings suggest that children with MD have lower verbal WM and visuo-spatial WM compared to normal achievers (Swanson and Jerman, 2006; Swanson et al., 2009). Furthermore, they found that differences in cognitive functioning between children with MD and normal achievers were primarily related to differences in verbal WM. In contrast, other studies have only found differences in visuo-spatial WM when contrasting children with MD against normal achievers (McLean and Hitch, 1999; Andersson, 2010; Andersson and Östergren, 2012), and against children with reading difficulties (Landerl et al., 2009). Based on the literature it is not clear which subcomponent of WM that is most crucial for mathematics achievement but taken together, findings indicate that individual variation in WM is associated differently depending on at least age (De Smedt et al., 2009), mathematical skills (Swanson and Jerman, 2006), and the specific mathematical domain (Träff, 2013; Kyttälä et al., 2014). It is therefore important to further investigate the different subcomponents of WM in relation to mathematical achievements (Alloway et al., 2004; see also; Bayliss et al., 2005) and in relation to different mathematical domains.

Aim with the Current Study

The current study had two goals in mind. The first aim was to investigate the relationship between the WM subcomponents and performance in different mathematics domains (as measured by the National tests in Sweden) in a large and representative sample of Swedish grade 3 pupils. Our secondary aim was to delineate cognitive profiles in relation to mathematics performance by differentiating pupils into mathematical subgroups derived from overall mathematical performance. It was hypothesized that individual differences in WMC would predict mathematical performance overall, but less clear remained how the different subcomponents in WM were predictive for the different subtests in mathematics. Second, we hypothesized that individuals with lower mathematical performance would show a different cognitive profile compared to those performing at a higher level in mathematics. Based on prior studies and the age of the current sample, we expected children with lower mathematical proficiency to be more impaired in both visuo-spatial and phonological WM than children with higher mathematical proficiency.

MATERIALS AND METHODS

Participants

In the present study, a total of 597 Swedish third grade pupils (M = 9.34 years, SD = 0.30) participated, 305 girls (M = 9.35 years, SD = 0.30) and 292 boys (M = 9.34 years,

$SD = 0.30$). The sample came from 39 different regular school classes located in five different municipalities. The schools were chosen in order to represent the larger range of geographic and demographic status, based on a grouping by the Swedish Association of Local Authorities. The head teacher and teacher in, respectively, school were contacted and asked to participate. Written informed consent from parents was obtained according with the Declaration of Helsinki, and all children approved to participate. All pupils were assessed at the end of the spring term. The study was approved by the Region Ethical Review Board, Sweden.

Materials

Mathematical Proficiency

Mathematical proficiency was assessed by the Swedish National tests in mathematics for grade 3 pupils. The National tests are state-mandated, curriculum-based tests given in different core subjects to pupils in grade 3, 6, and 9 in compulsory school. The National tests in mathematics for grade 3 pupils consists of seven different subtests covering several different mathematical domains to evaluate a number of syllabus goals (**Table 1**). The tasks varied in form (from plain numbers to larger tasks) as well as required different methods of expression (e.g., drawing and writing). One subtest was a group assignment and is therefore excluded in the analysis.

As the purpose with the study was to delineate how individual differences in WMC was related to curriculum-based mathematical competencies (see **Table 1**), we analyzed tests validated and designed to assess those skills according to the National Board of Education in Sweden. The six subtests included in the analysis were: *Algorithms and Statistics* (maximum score 20, to reach solid academic performance for the assessed grade a score of 14 was required), *Fraction* (maximum score 13, to reach solid academic performance for the assessed grade a score of 8 was required), *Geometry* (maximum score 14, to reach solid academic performance for the assessed grade a score of 9 was required), *Number understanding and mental arithmetic* (maximum score 21, to reach solid academic performance for the assessed grade a score of 14 was required), *Problem solving* (maximum score 8, to reach solid academic performance for the assessed grade a score of 5 was required) and *Time, area* and *volume* (maximum score 13, to reach solid academic performance for the assessed grade a score of 8 was required). The internal consistency statistic between the subtests was good, with Cronbach's $\alpha = 0.81$ (Kline, 2000). The purpose with the National mathematical tests in Sweden are mainly summative but also intended to be used as a formative instrument in which the teacher uses the results as a pupil's knowledge profile to further support the progress of the pupil's mathematical proficiency at an individual level.

TABLE 1 | Different syllabus goal in mathematics tested by different subtests (Skolverket [National Board of Education], 2012).

The National mathematical subtests	Syllabus goal
Algorithm and statistics	The algorithm and statistics assessment tests the pupil's ability to use and analyze mathematical concepts, use appropriate mathematical methods and to use different mathematical forms of expression to communicate the outcome.
Fraction	The fraction assessment tests the ability to compare, rank, and divide numbers within integers 0–100 by using different types of illustrations. It also tests the ability to divide wholes into fractions, to describe, compare, identify, and naming fraction as simple fraction
Geometry	The geometry assessment tests the ability to use rudimentary geometric concepts to describe the characteristics of geometric objects, their position and compare how they relate to other geometric objects by using mathematical forms of expression to communicate.
Number understanding and Mental arithmetic	The number understanding test the pupils ability to read and write numbers and symbols, and showing digits value in numbers within integers 0–1000. It also assesses pupil's ability to describe simple number sequences, and managing mathematical equalities within integers 0–20. The mental arithmetic assessment tests the pupil's ability to solve mathematical problems in the four rules of arithmetic without using written working out as an aid. Numbers and answers are within integers 0–20 also some simple numbers are within an enlarged number area.
Problem solving	The assessment for problem solving tests the pupil's ability to formulate and solve problems by using mathematical concepts and mathematical reasoning when communicate and explaining the problem as well as its outcome. The tasks require the pupil to use both symbols and words when calculating, describing and communicate the solution.
Time, area, and volume	The time, area, and volume assessment tests the ability of measuring simple comparisons, and estimations of different lengths, areas, volumes, and times, using common and appropriate units of measurement to express the results. The task tests the pupil's ability to initiate and follow a mathematical reasoning.

Working Memory

The measurements for WM consisted of three computerized tasks, representing both content domains of WM (verbal and spatial) and both functional aspects (storage in the context of processing and potential trade-offs between these): Operation span, Digit span, and Block span; each of which primarily evaluates one of the three components of Baddeley's and Hitch (1974) WM model: the central executive, the phonological loop and the visuo-spatial sketchpad, respectively.

Operation Span

Measurements with intention to capture individuals' WMC is often assessed by using complex span tasks, which requires participants to simultaneously process and maintain some information (Conway et al., 2005). The Unsworth et al. (2005) Operation span (Ospan) has shown good internal consistency (0.78) and test–retest reliability (0.83) and is a widely accepted measure of WMC (Turner and Engle, 1989; Klein and Fiss, 1999; Conway et al., 2005; Unsworth et al., 2005; Chein et al., 2011). In the computerized Ospan task the participants are asked to remember a series of letters while performing a concurrent task in which they judge whether a math equation is true or false (for full task descriptions, see Unsworth et al., 2005). In the current study, Ospan was age-adapted such that simpler

mathematical operations were used (i.e., addition, with the sum of integers always in the range of 3–9) but with the same set of high frequency letters in the operation letter strings as in the original version of Ospan (cf. Unsworth et al., 2005). The set-sizes proceeded in fixed level from two sets with no predefined highest level, as long as two consecutive sets at any span length were correctly answered. The dependent variable was the number of correct recalled letters in the correct position (Nyroos et al., 2015).

Digit Span

For the measurement of the phonological WM the digit span (forward and backward) was used (McLean and Hitch, 1999). The computerized digit span was adapted from WISC-IV which has shown to have good internal consistency and re-test reliability ranging from 0.80 to 0.89 (Flanagan and Kaufman, 2004). A composite of forward and backward digit span (number of correct trials across tasks) served as our measurement for phonological WM (Baddeley, 2000; D'Amico and Guarnera, 2005). In the digit span, numbers ranging from 1 to 9 were displayed on the computer screen at a rate of one number per second. The child is asked to respond by recall the numbers in the correct order (forward and backward, respectively) by pressing the corresponding number on the keyboard. Trials increased from two to a maximum of nine numbers in length, with two trials for each span length. Testing continued until a child failed to repeat two sets at any particular span length. The raw scores for both digit span forward and backward were calculated as the number of correct trials, respectively, but collapsed into one score.

Block Span

For the measurement of the visuospatial WM the Block span task (or Corsi block-tapping test) was used (forward and backward). The computerized block span was adapted from WISC-IV which has shown to have good internal consistency and re-test reliability ranging from 0.80 to 0.89 (Flanagan and Kaufman, 2004). A composite of forward and backward block span (number of correct trials across tasks) served as our measurement for visuo-spatial WM (Baddeley, 2000; D'Amico and Guarnera, 2005). Block span measures an individual's capacity to remember blocks, forward and backward, and is a commonly used measure of visuo-spatial WM (McLean and Hitch, 1999). Spatial span forward is a measure of the visual-spatial storage component of WM (i.e., the visuo-spatial sketchpad) and spatial span backward is a measure of the storage and processing components of visual-spatial WM (i.e., the visuo-spatial sketchpad plus central executive components: Lui and Tannock, 2007). In the block span, 16 green blocks were presented at the computer screen, arranged as a four-by-four square, with one block at a time randomly flashing red at a rate of one box per second. The child is then asked to remember the sequence of blocks displayed red and then respond by recall the sequence on a new square with 16 green blocks, either in the same order as presented (block span forward) or in the opposite order (block span backward). Testing continued until a child failed to repeat two sets at any particular span length, and scores were calculated in the same way as in the digit span task.

Procedures

National Tests in Mathematics

The National tests in mathematics were scheduled to be administered within a 10-week period in the end of the spring term at specific dates decided by the school. The different subtests were conducted by the responsible teacher which all had received specific written instructions and scoring guidelines from The Swedish National Agency for Education (2007; in order to maintain equality in the test procedure as well as at the scoring procedure).

Working Memory Battery

The tasks were administered by two trained research assistants. All tasks were assessed individually in front of a computer. The tasks were administered in groups of one to three at the school. Before the session, the participants received information about the confidentiality of individual test results, verbal instructions and each task started with practice trials to ensure they understood the task. To prevent misunderstandings, the pupils were encouraged to ask questions before the assessment took place and written instructions were also provided at the computer screen before each task started during the session. The data collection for the measurements of WM was administered within a 4-month period at the end of the autumn term and ended in the beginning of the spring term just before the period when the National tests in mathematics started.

Statistical Analysis

To investigate how the different WM subcomponents (verbal, visuo-spatial, and central executive) predicted mathematical performance across different mathematical domains, a series of multiple regression analyses were performed. To pursue to what extent mathematical proficiency differed with regard to the specific subcomponents of WM, the sample was divided into quartile groups derived from their overall mathematical performance. Instead of dividing the sample in groups based on cognitive performance, we used the total score of the National tests as cut-off criteria. This resulted in four new groups: *Low* ($n = 144$), *Low-Average* ($n = 133$), *High-Average* ($n = 165$), and *High* mathematical proficiency group ($n = 154$). The cut-off score of quartiles was motivated on the basis of using the same procedure as used in prior studies (Jordan et al., 2003; Swanson and Jerman, 2006; Cirino et al., 2015). We used a score at or below the 25th percentile as the cut-off for the group labeled as *Low*. Given the relatively large sample size in the current study, instead of collapsing children that scored at average (between the 25th and 75th percentile) into one group, we divided those into the *Low- Average* and the *High-Average* group. The *Low-Average* refer to those scoring between the 25th and 50th percentile while the *High-Average* refers to those scoring between the 50th and the 75th percentile. Finally, the fourth group, labeled as *High* scored at or above the 75th percentile. Recent research has emphasized that individual differences in cognitive ability varies a lot within the same educational grade (Van de Weijer-Bergsma et al., 2015).

Here, we focused on the whole range by including a large-scale sample of children in regular schooling and within the same educational grade. Multiple group confirmatory factor analysis (CFA) was used to investigate if the WM measures were invariant (i.e., worked similarly well) across the performance groups. This is done by comparing a series of nested models from the least to the most restrictive model. If the more restrictive model does not significantly worsen the fit of the model, measurement invariance is supported. We used the chi-square (χ^2), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) as overall model fit indices. A non-significant result for the χ^2, values over 0.90 for CFI, and values under 0.08 for the RMSEA indicate good model fit (Marsh et al., 2004). To compare nested models, we calculated the $\Delta\chi^2$, where a non-significant result indicates that the more restrictive model fit the data as good as the comparison model.

To examine whether, and in that case how, the subcomponents in WM differed between the mathematical groups, a multivariate analysis of variance (MANOVA) was conducted for the three WM subcomponents (raw scores, see **Table 2**) with math group as between subject factor. Bonferroni correction was applied to correct for multiple testing. The rationale for this analysis was to get a better understanding of how mathematical ability can be understood in terms of WM profiles.

RESULTS

Descriptive results for the overall WM and its subcomponents as well as overall mathematical proficiency and the different mathematical domains are presented in **Table 2**. One participant was recognized as an outlier (mathematical performance below 2 SDs of the average mean) and therefore excluded from the analysis. A normal distribution analysis showed that the skewness (−1.895) and kurtosis (5.956) for the overall mathematical score was within acceptable normal distribution (Finney and Di Stefano, 2006) but with a tendency for the majority of the pupils to perform well. For the overall WM scores, the analyses of skewness (0.077) and kurtosis (0.046) revealed that the WM scores were normally distributed.

The regression analyses (see **Table 3**) were conducted using each mathematical subtest as the dependent variable and the three WM measurements as independent variables. In addition, the total mathematical score was also examined within the regression analysis.

As can be seen in **Table 3**, individual differences in WMC significantly predicted mathematical performance for all National mathematical subtests. Although, the degree of significant contribution for the different subcomponents in WM varied across mathematical subtests (see **Table 3**).

Next, to identify individual WM profiles, the sample was divided into quartile mathematical groups (*Low*, *Low-Average*, *High-Average,* and *High* mathematical group) as derived from the general mathematical proficiency score (for descriptive statistics, see **Table 2** below). For the four new math groups, there were no significant differences for gender [$\chi^2(3, N = 596) = 1.541$, $p = 0.673$] or chronological age in months [$F(3,592) = 1.194$, $p = 0.31$] between the four groups. To ensure that the WMC measurements were comparable across the four groups, we conducted multiple group CFAs. We used a model that assumed the same factor structure (one overall WM factor, and Ospan, digit span forward and backward, block span forward and backward as factor indicators) across groups but allowed the factor loadings and item intercepts to vary as the comparison model, $\chi^2(20) = 12.35$, $p = 0.90$; CFI = 1.00; RMSEA = 0.00. We then compared this model with a more restricted model were factor loadings were constrained to equality in all groups but item intercepts were allowed to vary, $\chi^2(35) = 25.596$, $p = 0.58$; CFI = 1.00; RMSEA = 0.00. Forcing the factor loadings to equality did not significantly worsen the fit of the model, $\Delta\chi^2(15) = 13.246$, $p = 0.34$. We then compared this model with a fully invariant model were both factor loadings and item intercepts were constrained to equality in all groups, $\chi^2(47) = 39.008$, $p < 0.05$; CFI = 1.00; RMSEA = 0.00. The

TABLE 2 | Descriptive statistics of working memory tasks and the different National mathematical tests for the total sample and the mathematical subgroups.

	Total sample (n = 596)		Low Math (n = 144)		Low-Average (n = 133)		High-Average (n = 165)		High Math (n = 154)	
Measures	***M***	**(*SD*)**	***M***	**(*SD*)**	***M***	**(*SD*)**	***M***	**(*SD*)**	***M***	**(*SD*)**
WM (total score)	17.20	(2.99)	15.34	(2.47)	16.68	(2.96)	17.97	(2.46)	18.57	(3.00)
Operation span	3.02	(1.38)	2.50	(1.33)	2.84	(1.37)	3.27	(1.31)	3.41	(1.34)
Block span	7.51	(1.56)	6.73	(1.37)	7.36	(1.45)	7.90	(1.48)	7.96	(1.62)
Digit span	6.66	(1.28)	6.11	(1.09)	6.47	(1.33)	6.80	(1.11)	7.20	(1.33)
Mathematics (total score)	76.30	(9.41)	63.39	(9.59)	75.33	(1.30)	80.13	(1.41)	85.14	(1.76)
Algorithm and statistic	16.64	(3.03)	13.19	(2.94)	16.03	(2.10)	17.68	(1.71)	19.28	(0.98)
Fraction	11.88	(1.51)	10.42	(2.07)	11.95	(0.92)	12.27	(0.88)	12.76	(0.60)
Geometry	11.18	(1.93)	9.67	(2.18)	10.76	(1.61)	11.54	(1.46)	12.59	(1.04)
Number understanding and mental arithmetic	19.12	(2.56)	16.42	(3.54)	19.38	(1.72)	20.01	(0.99)	20.47	(0.72)
Problem solving	6.04	(1.93)	3.94	(2.13)	5.89	(1.44)	7.53	(0.74)	7.53	(0.74)
Time, area, and volume	11.44	(1.80)	9.75	(2.29)	11.32	(1.39)	12.01	(1.07)	12.51	(0.76)

*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

TABLE 3 | Regression analyses with mathematical subtests as dependent variables and working memory subtests as independent variables.

Dependent variables	Independent variables	*B* (*SE*)	β	R^2	*F* (total model)
Math total score	Digit span	1.40 (0.30)	0.19***		
	Block span	1.41 (0.24)	0.23***		
	Operation Span	1.03 (0.26)	0.15***		
				0.17***	$F(3,593) = 40.19$
Algorithms and statistics	Digit span	0.34 (0.09)	0.14**		
	Block span	0.40 (0.08)	0.20***		
	Operation span	0.23 (0.09)	0.11**		
				0.11***	$F(3,593) = 23.79$
Fraction	Digit span	0.22 (0.05)	0.19***		
	Block span	0.21 (0.04)	0.22***		
	Operation span	0.08 (0.04)	0.07		
				0.13***	$F(3,593) = 28.47$
Geometry	Digit span	0.13 (0.06)	0.08		
	Block span	0.11 (0.05)	0.09*		
	Operation span	0.17 (0.06)	0.12**		
				0.04***	$F(3,593) = 9.16$
Number understanding and mental arithmetic	Digit span	0.33 (0.08)	0.17***		
	Block span	0.29 (0.07)	0.18***		
	Operation span	0.20 (0.08)	0.11**		
				0.11***	$F(3,593) = 23.28$
Problem solving	Digit span	0.20 (0.06)	0.13**		
	Block span	0.20 (0.05)	0.16***		
	Operation span	0.24 (0.06)	0.17***		
				0.11***	$F(3,593) = 23.92$
Time, area, and volume	Digit span	0.17 (0.06)	0.12**		
	Block span	0.20 (0.05)	0.18***		
	Operation span	0.12 (0.05)	0.09*		
				0.08***	$F(3,593) = 17.03$

*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

fully invariant model fitted the data as well as the previous model, which clearly indicates measurement invariance across groups, $\Delta\chi^2(12) = 13.412$, $p = 0.34$. In other words, the WMC measures worked in a similar way in all four groups.

The MANOVA with group (*Low*, *Low-Average*, *High-Average*, and *High*) as the between subject factor and WM (visuospatial, phonological, and executive) as the dependent variables showed a significant group effect for the WM scores, Hotelling's $T^2_{(9,1766)} = 14.382$, $p < 0.001$. Univariate *F*-tests revealed significant group effects for all of the WM subtests. Visuospatial ability [$F(3,592) = 22.31$, $p < 0.001$, $\eta_p = 0.102$], phonological ability [$F(3,592) = 21.74$, $p < 0.001$, $\eta_p = 0.10$] and for the central executive ability [$F(3,592) = 14.33$, $p < 0.001$, $\eta_p = 0.07$]. For multiple comparisons, Bonferroni adjusted *post hoc* analyses were performed for each WM subcomponent, and Cohens *d* is reported for significant group differences. Cohens *d* of 0.2, 0.4, and 0.8 are considered as small, medium and large effect sizes, respectively (Cohen, 1992). **Figure 1** (below) depicts the *z*-transformed WM scores for each group separately.

Visuospatial WM

For visuospatial ability, the Low mathematical group performed significantly lower at the visuospatial tasks when compared to the Low-Average group ($p = 0.003$, $d = 0.45$) and when compared to the other two groups (all *p*'s < 0.001, $d = 0.82$, respectively) indicating an overall lower visuospatial ability in those considered as poor mathematicians. The Low-Average mathematical group had significantly lower scores on the visuospatial task when compared to High-Average ($p = 0.011$, $d = 0.37$) and the High mathematical group ($p = 0.004$, $d = 0.39$) but no significant difference was found between the High-Average group and the High mathematical group ($p > 0.05$).

Phonological WM

For phonological ability, the Low mathematical group did not differ significantly from the Low-Average group ($p = 0.08$), but performed significantly lower when compared to High-Average and the High mathematical group (all *p*'s < 0.001, $d = 0.63$ and $d = 0.90$, respectively). No significant differences between the Low-Average and High-Average ($p = 0.129$) but the High mathematical group performed significantly better at the phonological task when compared to High-Average group ($p = 0.02$, $d = 0.33$) indicating that good phonological ability seems to be important for mathematical achievement.

WM – The Central Executive

For the complex WM task, no significant differences were found between the Low and the Low-Average group ($p = 0.20$)

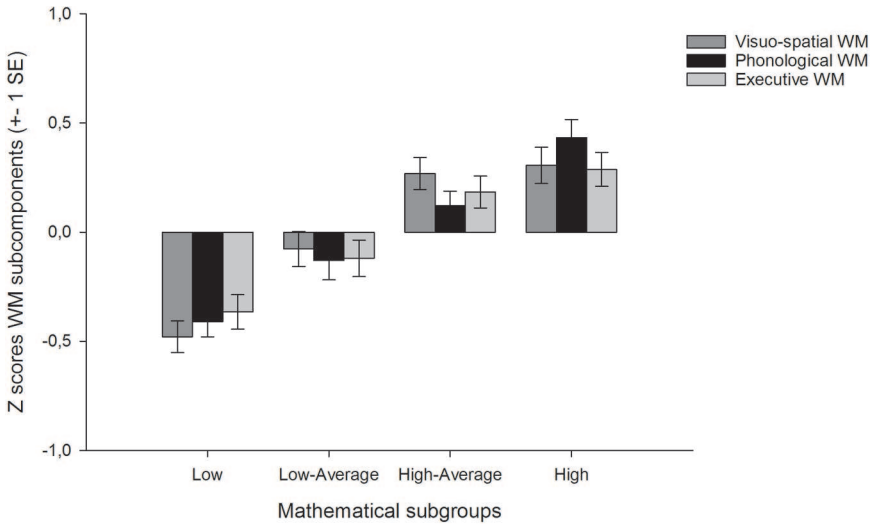


FIGURE 1 | The working memory subcomponents and mathematical subgroups. For illustrative purpose, the figure contains the *z*-transformed working memory scores.

but the Low mathematical group showed significantly lower performance when compared to both the High-Average and the High mathematical group (all *p*'s < 0.001, $d = 0.58$ and $d = 0.68$, respectively). The Low-Average group performed poorer when compared to both the High-Average ($p = 0.039$, $d = 0.32$) and the High mathematical group ($p = 0.002$, $d = 0.42$) but no significant differences between the High-Average and the High mathematical group.

DISCUSSION

The first aim with the study was to investigate the relationship between the subcomponents in WM and performance in different mathematics domains, in a sample of third grade pupils ($N = 596$) in mainstream schools. The predictive role of WM for mathematical performance, as measured by the National tests in Sweden, revealed that individual differences in WMC significantly predicted mathematical performance independent of mathematical domain. This finding confirms prior studies which has suggested a relationship between WM and National curriculum tests (Reukhala, 2001; Jarvis and Gathercole, 2003; Holmes and Adams, 2006; Nyroos and Wiklund-Hörnqvist, 2012; Friso-van den Bos et al., 2013). Our secondary aim was to explore cognitive profiles in relation to mathematics performance by differentiating pupils into mathematical subgroups derived from overall mathematical performance as measured by the National tests in Sweden. Pupils labeled as High mathematical achievers were characterized by having significantly better phonological WM, when compared to the other three groups, whereas those labeled as Low mathematical achievers were characterized by having significantly poorer visuo-spatial WM, as compared to the other three groups. These results are further elaborated below.

Regarding the outcomes from the regression analysis, all three subcomponents in WM (verbal, visuo-spatial, and central executive) significantly predicted overall mathematical performance but the significant contribution varied with respect to mathematical domain. Visuospatial WM, as measured by the Block span task, was the only subcomponent which was a significant predictor across all six mathematical domains. The present findings confirm that individual differences in visuo-spatial ability is crucial for general mathematical proficiency (Gathercole and Pickering, 2000; Reukhala, 2001; Jarvis and Gathercole, 2003; Maybery and Do, 2003; Holmes and Adams, 2006; Meyer et al., 2010; Geary, 2011b). Mathematics as a subject is rather visuo-spatial by nature in which tasks contain diagrams, geometric figures and represent quantities which commonly needs to be mentally visualized to be able to solve a math equation successfully (Li and Geary, 2013). The functional role of the visuo-spatial WM when children solves a mathematical task might be related to the use of mental representations of shapes and/or numbers involved while manipulating mathematical information which clearly put demands on visuo-spatial WM.

Hence, it is worth noting that in the current study the measurement of visuo-spatial WM included both the passive and dynamic aspect of WM (i.e., storage and processing; Meyer et al., 2010) which also might add support for prior findings of the central executive as important for mathematics (Hitch et al., 2001; Bayliss et al., 2003; D'Amico and Guarnera, 2005; Holmes et al., 2008). The predictive value of the visuo-spatial WM found in the current study might be related to the dynamic visuo-spatial WM as the task included both forward and backward block span (see Holmes et al., 2008 for related findings). However, even if there is a differentiation between passive and dynamic visuo-spatial tasks (Raghubar et al., 2010) it seems logic to combine those two when examining its relationship to curriculum-based mathematical tasks, which by nature mostly require some executive resources in terms of simultaneously

maintaining and manipulating information in memory, either by the support of the phonological loop or the visuo-spatial sketchpad.

Surprisingly, the executive part of WM, as measured by a complex span task, was not a significant predictor for fraction. Again, as can be seen in **Table 3**, the strongest predictor for fraction was related to visuo-spatial WM. In line with prior research, it is plausible to suggest this outcome related to the age of the current sample. The children in the current study were all around the age of nine, and it appears as it is a differentiation approximately around this age in which older children rely more on the phonological loop and children younger than 9 years rely more heavily on the visuo-spatial sketchpad (Kyttälä et al., 2010; Van de Weijer-Bergsma et al., 2015). In that sense, chronological age (age based on the calendar) might be less important and instead favor individual differences in mental age (i.e., age based on intellectual development; Henry, 2001; Henry and MacLean, 2003; Van de Weijer-Bergsma et al., 2015).

For geometry, the only non-significant predictor was phonological WM, which probably is related to the mathematical tasks included. The majority of the tasks in geometry required the pupil to identify and simply describe the characteristics of basic geometric shapes, their position and compare how they relate to other geometric objects. Those cognitive processes might rather rely on automatic retrieval of mathematical facts from long-term memory while maintain and manipulate the visuo-spatial task-specific information in WM, and thereby more executive demanding, without specific demands on the phonological loop (Furst and Hitch, 2000; Reukhala, 2001). In sum, the results from the regression analysis confirm prior studies by emphasizing individual differences in WMC as predictive for curriculum-based National tests in mathematics. Do note that the skewness and kurtosis for the mathematical distribution indicated that most pupils performed very well, these psychometric characteristics indicate that the amount of variance explained by the WM measurements in the current study is underestimated.

An interesting result was the closer inspection of the *post hoc* classified subgroups in mathematics. When classifying children into low or high performers within the cognitive psychology research domain, this is commonly made on the basis of individuals' performance derived from cognitive test batteries, and less commonly done on the basis of educational measurements such as the curriculum-based National tests. Therefore, to obtain an ecologically valid profile of mathematical proficiency, the results from the mandatory National curriculum tests in Sweden were used for classification.

Pupils classified as having Low mathematical proficiency performed lower on all WM tasks, but predominantly significant poorer in the task capturing visuo-spatial WM when compared to the other three groups. Those results are important in the light of prior findings from longitudinal studies (e.g., Bull et al., 2008; Geary, 2011b) which has shown that visuo-spatial ability is commonly found as predictive for mathematical ability in children at this age (Bull et al., 2008; Geary, 2011b) and lower visuo-spatial ability has been found as a feature in individuals with mathematical learning difficulties when compared to controls (McLean and Hitch, 1999; D'Amico and Guarnera, 2005; Andersson and Lyxell, 2007; Van der Ven et al., 2013). For example, D'Amico and Guarnera (2005) found evidence for impaired executive and visuo-spatial WM, but not verbal WM in 9-year-old children identified as having poor mathematical ability when compared to normally performing age-matched controls (D'Amico and Guarnera, 2005).

Thus, when delineating the cognitive profile of pupils labeled as High mathematical achievers, another cognitive profile emerged. Compared to the other three mathematical groups, small to large effect sizes between the groups were found (Low, Low-Average, and High-Average, $d = 0.90$, $d = 0.63$, and $d = 0.33$, respectively) indicating that better phonological WM was found among pupils characterized as High mathematical achievers. As indicated by some of the prior research, the relative contribution of the different subcomponents for mathematical performance changes as a function of age. Young children is assumed to rely more on the visuo-spatial component, but as they get older verbal WM gets more involved, thus recruiting the phonological loop. This have mainly been explained in terms of the amplified use of verbal strategies in which children transform numbers and symbols into a verbal code. The trade-off in ages has been suggested to arise around the age of nine, corresponding to the age in the current study.

Notably, performance on the National tests in Sweden is intended to be formative, in the sense that failure to reach set minimum criteria (according to the course syllabi) should alert educators to what mathematical domain which children have difficulties with; subsequently, receiving support in. As indicated by our results, mathematical proficiency could be conceptualized in terms of cognitive profiles indicating cognitive strengths and weakness. Identifying those are of practical significance for educational interventions and methods to further enhance learning by providing a more fine-graded picture of pupils strengths and weakness involved (Bryant et al., 2000; Witt, 2011; Ekstam et al., 2015; Swanson, 2015). Furthermore, we anticipate that this knowledge also will enable the application of appropriate strategies to support children's learning on an individual level.

Recently, Swanson (2015) investigated the effects of an 8-week strategy intervention among third graders ability to solve problems. The results showed that strategy training had a positive impact on both problem solving and visuo-spatial WM, but the effect of strategy was moderated by individuals WMC (Swanson, 2015). Strategies containing verbal instruction in the absence of visual instruction was only beneficial for those with higher WMC (Swanson, 2015). In contrast, strategy training which contained both verbal and visual instructions produced transfer effects to a task capturing visuo-spatial WM independent of individual differences in WMC. Related to the results in the current study, strategy training might be especially beneficial for those labeled as Low mathematical achievers in the current study as they predominantly were characterized by having a lower visuo-spatial WM. In this respect, it is worth noticing that approximately 10% of pupils in the mainstream classroom are at risk of academic progress difficulties related to WM impairment

(Alloway et al., 2009). Teachers play a pivotal role in providing a quality education to support children to be potential learners (Bryant et al., 2000; Gathercole and Alloway, 2008; Ekstam et al., 2015). The teacher's knowledge and ability to identify pupils strengths and weakness is a prerequisite key to successfully progress throughout school for pupils at any level (Korhonen et al., 2014; Ekstam et al., 2015).

Taken together, our results suggest that individual differences in mathematical proficiency reflect different WM limitations and that the level of mathematical proficiency is related to qualitatively different cognitive profiles.

Limitations and Future Challenges

Although we controlled for age related differences within the age group the study design does not warrant any conclusions from a developmental perspective. The positive kurtosis for the National test scores in mathematics pose a source for a type II error when used as the dependent variable. The positive skewness and kurtosis for the mathematical distribution, indicate that most pupils performed very well, and that the amount of variance explained by the WM measurements could be underestimated. The pupils in the current study were within the same educational level and we used curriculum based assessments for group classification. Nevertheless, the results clearly indicate that individual variations in cognitive ability is a crucial factor in determining the scholastic success level. Thus, we suggest that it is important for teachers to recognize the differing abilities pupils' have in terms of cognitive strengths and weaknesses and subsequently tailor the learning support (level of WM load) to the individual child accordingly. Although, further studies are needed to corroborate our findings, the results from the current study suggest that the use of curriculum-based material is a potential way to enhance individual based teaching. Teaching that consider subject and domain specifics in relation to individual variability in cognition will arguable enhance educational attainments and also student's educational engagement.

AUTHOR CONTRIBUTIONS

MN and BJ designed research. CW-H and JK performed research. CW-H, BJ, MN, JK, and HE analyzed the data. CW-H, BJ, MN, JK, and HE wrote the paper.

FUNDING

This work was supported by the Swedish Research Council under Grant number 721-2011-2331.

REFERENCES

Abhakorn, J. (2008). The implications of learner for second or foreign language teaching. *ARECLS* 5, 186–204.

Alloway, T. P. (2006). How does working memory work in the classroom? *Educ. Res. Rev.* 1, 134–139.

Alloway, T. P., and Alloway, R. G. (2010). Investigating the predictive roles of working memory and IQ in academic attainment. *J. Exp. Child Psychol.* 106, 20–29. doi: 10.1016/j.jecp.2009.11.003

Alloway, T. P., Gathercole, S. E., Kirkwood, H., and Elliott, J. (2009). The cognitive and behavioural characteristics of children with low working memory. *Child Dev.* 80, 606–621. doi: 10.1111/j.1467-8624.2009.01282.x

Alloway, T. P., Gathercole, S. E., Willis, C. S., and Adams, A.-M. (2004). A structural analysis of working memory and related cognitive skills in young children. *J. Exp. Child Psychol.* 87, 85–170. doi: 10.1016/j.jecp.2003.10.002

Andersson, U. (2010). Skill development in different components of arithmetic and basic cognitive functions: findings from a three-year longitudinal study of children with different types of learning difficulties. *J. Educ. Psychol.* 102, 115–134. doi: 10.1037/a0016838

Andersson, U., and Lyxell, B. (2007). Working memory deficit in children with mathematical difficulties: a general or specific deficit? *J. Exp. Child Psychol.* 96, 197–228. doi: 10.1016/j.jecp.2006.10.001

Andersson, U., and Östergren, R. (2012). Number magnitude processing and basic cognitive functions in children with mathematical learning disabilities. *Learn. Individ. Differ.* 22, 701–714. doi: 10.1016/j.lindif.2012.05.004

Baddeley, A. D. (2000). The episodic buffer: a new component of working memory? *Trends Cogn. Sci.* 4, 417–423. doi: 10.1016/S1364-6613(00)01538-2

Baddeley, A. D., and Hitch, G. J. (1974). "Working memory," in *The Psychology of Learning and Motivation: Advances in Research and Theory*, ed. G. Bower (New York, NY: Academic Press), 47–90.

Bayliss, D. M., Jarrold, C., Baddeley, A. D., and Leigh, E. (2005). Differential constraints on the working memory and reading abilities of individuals with learning difficulties and typically developing children. *J. Exp. Child Psychol.* 92, 76–99. doi: 10.1016/j.jecp.2005.04.002

Bayliss, D. M., Jarrold, C., Gunn, D. M., and Baddeley, A. D. (2003). The complexities of complex span: explaining individual differences in working memory in children and adults. *J. Exp. Psychol. Gen.* 132, 71–92. doi: 10.1037/0096-3445.132.1.71

Bergman-Nutley, S., and Klingberg, T. (2014). Effect of working memory training on working memory, arithmetic and following instructions. *Psychol. Res.* 78, 869–877. doi: 10.1007/s00426-014-0614-0

Bryant, D. P., Bryant, B. R., and Hammill, D. D. (2000). Characteristic behaviors of students with learning disabilities who have teacher-defined math weaknesses. *J. Learn. Disabil.* 33, 168–179. doi: 10.1177/002221940003300205

Bull, R., Espy, K. A., and Wiebe, S. A. (2008). Short-term memory, working memory, and executive functioning in preschoolers: longitudinal predictors of mathematical achievement at 7 years. *Dev. Neuropsychol.* 33, 205–228. doi: 10.1080/87565640801982312

Chein, J. M., Moore, A. B., and Conway, A. R. A. (2011). Domain-general mechanisms of complex working memory span. *Neuroimage* 54, 550–559. doi: 10.1016/j.neuroimage.2010.07.067

Cirino, P. T., Fuchs, L. S., Elias, J. T., Powell, S. R., and Schumacher, R. F. (2015). Cognitive and mathematical profiles for different forms of learning difficulties. *J. Learn. Disabil.* 48, 156–175. doi: 10.1177/0022219413494239

Cohen, J. (1992). A power primer. *Psychol. Bull.* 112, 155–159. doi: 10.1037/0033-2909.112.1.155

Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., and Engle, R. W. (2005). Working memory span tasks: a methodological review and user's guide. *Psychon. Bull. Rev.* 12, 769–786. doi: 10.3758/bf03196772

D'Amico, A., and Guarnera, M. (2005). Exploring working memory in children with low arithmetical achievement. *Learn. Individ. Differ.* 15, 189–202. doi: 10.1016/j.lindif.2005.01.002

De Smedt, B., Janssen, R., Bouwens, K., Verschaffel, L., Boets, B., and Ghesquière, P. (2009). Working memory and individual differences in mathematics achievement: a longitudinal study from first grade to second grade. *J. Exp. Child Psychol.* 103, 186–201. doi: 10.1016/j.jecp.2009.01.004

Dulaney, A., Vasilyeva, M., and O'Dwyer, L. (2015). Individual differences in cognitive resources and elementary school mathematics achievement: examining the roles of storage and attention. *Learn. Individ. Differ.* 37, 55–63. doi: 10.1016/j.lindif.2014.11.008

Dumontheil, I., and Klingberg, T. (2012). Brain activity during a visuospatial working memory task predicts arithmetical performance 2 years later. *Cereb. Cortex* 22, 1078–1085. doi: 10.1093/cercor/bhr175

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., et al. (2007). School readiness and later achievement. *Dev. Psychol.* 43, 1428–1446. doi: 10.1037/0012-1649.43.6.1428

Ekstam, U., Linnanmäki, K., and Aunio, P. (2015). Educational support for low-performing students in mathematics: the three-tier support model in Finnsih lower secondary schools. *Eur. J. Spec. Needs Educ.* 30, 75–92. doi: 10.1080/08856257.2014.964578

Engle, R. W., Kane, M. J., and Tuholski, S. W. (1999). "Individual differences in working memory capacity and what they tell us about controlled attention, general fluid intelligence, and functions of the prefrontal cortex," in *Models of Working Memory*, eds A. Miyake and P. Shah (Cambridge: Cambridge University Press).

Finney, S. J., and Di Stefano, C. (2006). "Non-normal and categorical data in structural equation modeling," in *Structural Equation Modeling: A Second Course*, eds G. R. Hancock and R. O. Mueller (Charlotte, NC: Information Age Publising), 269–314.

Flanagan, D. P., and Kaufman, A. S. (2004). *Essentials of WISC-IV Assessment*. Hoboken, NJ: John Wiley & Sons.

Friso-van den Bos, I., Van der Ven, S. H. G., Kroesbergen, E. H., and Van Luit, J. E. H. (2013). Working memory and mathematics in primary school children: a meta-analysis. *Educ. Res. Rev.* 10, 29–44. doi: 10.1016/j.edurev.2013.05.003

Furst, A., and Hitch, G. J. (2000). Separate roles for executive and phonological components in mental arithmetic. *Mem. Cogn.* 28, 774–782. doi: 10.3758/BF03198412

Gathercole, S. E., and Alloway, T. P. (2008). *Working Memory and Learning. A Practical Guide for Teachers*. London: Sage Press.

Gathercole, S. E., and Dunning, D. L. (2010). *Developmental Disorders and Interventions. Advances in Child Development and Behavior*, Vol. 39. Amserdam: Elsevier

Gathercole, S. E., and Pickering, S. J. (2000). Working memory deficits in children with low achievements in the national curriculum at 7 years of age. *Br. J. Educ. Psychol.* 70, 177–194. doi: 10.1348/000709900158047 PMID: 10900777

Gathercole, S. E., Pickering, S. J., Knight, C., and Stegmann, Z. (2004). Working memory skills and educational attainment: evidence from national curriculum assessments at 7 and 14 years of age. *Appl. Cogn. Psychol.* 18, 1–16. doi: 10.1002/acp.934

Geary, D. C. (2011a). Consequences, characteristics, and causes of mathematical learning disabilities and persistent low achievement in mathematics. *J. Dev. Behav. Pediatr.* 32, 250–263. doi: 10.1097/DBP.0b013e318209edef PMID: 21285895

Geary, D. C. (2011b). Cognitive predictors of achievement growth in mathematics: a five year longitudinal study. *Dev. Psychol.* 47, 1539–1552. doi: 10.1037/a0025510

Geary, D. C., Hoard, M. K., Nugent, L., and Bailey, D. H. (2012). Mathematical cognition deficits in children with learning disabilities and persistent low achievement: a five-year prospective study. *J. Educ. Psychol.* 104, 206–223. doi: 10.1037/a0025398

Gersten, R., Jordan, N. C., and Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *J. Learn. Disabil.* 38, 293–304. doi: 10.1177/00222194050380040301

Hecht, S. A., Torgesen, J. K., Wagner, R. K., and Rashotte, C. A. (2001). The relations between phonological processing abilities and emerging individual differences in mathematical computation skills: a longitudinal study from second to fifth grades. *J. Exp. Child Psychol.* 79, 192–227. doi: 10.1006/jecp.2000.2586

Henry, L., and MacLean, M. (2003). Relationships between working memory, expressive vocabulary and arithmetical reasoning in children with and without intellectual disabilities. *Educ. Child Psychol.* 20, 51–63.

Henry, L. A. (2001). How does the severity of a learning disability affect working memory performance? *Memory* 2001, 233–247. doi: 10.1080/09658210042000085 *PMID:* 11594349

Hitch, G. J., Towse, J. N., and Hutton, U. (2001). What limits children's working memory span? Theoretical accounts and applications for scholastic development. *J. Exp. Psychol. Gen.* 130, 184–198. doi: 10.1037/0096-3445.130.2.184

Holmes, J., and Adams, J. W. (2006). Working memory and children's mathematical skills: implications for mathematical development and mathematics curricula. *Educ. Psychol.* 26, 339–366. doi: 10.1080/01443410500341056

Holmes, J., Adams, J. W., and Hamilton, C. J. (2008). The relationship between visuospatial sketchpad capacity and children's mathematical skills. *Eur. J. Cogn. Psychol.* 20, 272–289. doi: 10.1080/09541440701612702

Holmes, J., Gathercole, S. E., and Dunning, D. L. (2009). Adaptive training leads to sustained enhancement of poor working memory in children. *Dev. Sci.* 12, 9–15. doi: 10.1111/j.1467-7687.2009.00848.x

Jarvis, H. L., and Gathercole, S. E. (2003). Verbal and nonverbal working memory and achievements on national curriculum tests at 11 and 14 years of age. *Educ. Child Psychol.* 20, 123–140.

Jordan, N. C., Hanich, L. B., Kaplan, D., Klein, K., and Fiss, W. (2003). Arithemtic fact mastery in young children: a longitudinal investigation. *J. Exp. Child Psychol.* 85, 103–119. doi: 10.1016/S0022-0965(03)00032-8

Klein, K., and Fiss, W. (1999). The reliability and stability of the Turner and Engle working memory task. *Behav. Res. Methods Instrum. Comput.* 31, 429–432.

Kline, P. (2000). *The Handbook of Psychology Testing*, 2nd Edn. London: Routledge.

Korhonen, J., Linnanmäki, K., and Aunio, P. (2014). Learning difficulties, academic wellbeing and educational dropout: a person-centred approach. *Learn. Individ. Differ.* 31, 1–10. doi: 10.1016/j.lindif.2013.12.011

Kyttälä, M., Aunio, P., and Hautamäki, J. (2010). Working memory resources in young children with mathematical difficulties. *Scand. J. Psychol.* 51, 1–15. doi: 10.1111/j.1467-9450.2009.00736.x

Kyttälä, M., Aunio, P., Lepola, J., and Hautamäki, J. (2014). The role of the working memory and language skills in the prediction of word problem solving in 4- to 7-year-old children. *Educ. Psychol.* 34, 674–696. doi: 10.1080/01443410.2013.814192

Landerl, K., Fussenegger, B., Moll, K., and Willburger, E. (2009). Dyslexia and dyscalculia: two learning disorders with different cognitive profiles. *J. Exp. Psychol.* 103, 309–324. doi: 10.1016/j.jecp.2009.03.006

Lee, K., Ng, S.-F., Ng, E.-L., and Lim, Z.-Y. (2004). Working memory and literacy as predictors of performance on algebraic word problems. *J. Exp. Child Psychol.* 89, 140–158. doi: 10.1016/j.jecp.2004.07.001

Lépine, R., Bernardin, S., and Barrouillet, P. (2005). Attention switching and working memory spans. *Eur. J. Cogn. Psychol.* 17, 329–345. doi: 10.1080/09541440440000014

Lgr 11 (2011). *Läroplan för Grundskolan, Förskoleklassen Och Fritidshemmet*. Stockholm: Skolverket.

Li, Y., and Geary, D. C. (2013). Developmental gains in visuospatial memory predict gains in mathematics achievement. *PLoS ONE* 8:e70160. doi: 10.1371/journal.pone.0070160

Lithner, J. (2008). A research framework for creative and imitative reasoning. *Educ. Stud. Math.* 67, 255–276. doi: 10.1007/sl0649-007-9104-2

Lithner, J., Bergqvist, E., Bergqvist, T., Boesen, J., Palm, T., and Palmberg, B. (2010). "Mathematical Competencies – a research framework," in *Proceedings of MADIF 7, the Seventh Mathematics Education Research Seminar, Mathematics and Mathematics Education: Cultural and Social Dimensions*, eds Bergsten, Jablonka, and Wedege (Linköping: SMDF), 157–167.

Lui, M., and Tannock, R. (2007). Working memory and inattentive behavior in a community sample of children. *Behav. Brain Funct.* 3, 1–11. doi: 10.1186/1744-9081-3-12

Marsh, H., Hau, K. T., and Wen, Z. (2004). In search for golden rules: comment on the hypothesis testing approaches to setting cutoff values for fit indexes and dangers in overgeneralising Hu & Bentler's (1999) findings. *Struct. Equ. Model.* 11, 320–341. doi: 10.1207/s15328007sem1103_2

Maybery, M. T., and Do, N. (2003). Relationships between facets of working memory and performance on a curriculum-based mathematics test in children. *Educ. Child Psychol.* 20, 77–92.

Mayer, R. (1998). Cognitive, metacognitive, and motivational aspects of problem solving. *Cogn. Sci.* 26, 49–63. doi: 10.1348/2044-8279.002008

McKenzie, B., Bull, R., and Gray, C. (2003). The effects of phonological and visual–spatial interference on children's arithmetical performance. *Educ. Child Psychol.* 20, 93–108.

McLean, J. F., and Hitch, G. J. (1999). Working memory impairments in children with specific arithmetic learning difficulties. *J. Exp. Psychol.* 74, 240–260. doi: 10.1006/jecp.1999.2516

Mee-yin Chan, B., and Suk-han Ho, C. (2010). The cognitive profile of Chinese children with mathematical difficulties. *J. Exp. Child Psychol.* 107, 260–279. doi: 10.1016/j.jecp.2010.04.016

Menon, V. (2010). Developmental cognitive neuroscience of arithmetic: implications for learning and education. *ZDM* 42, 515–525. doi: 10.1007/s11858-010-0242-0

Meyer, M. L., Salimpoor, V. N., Wu, S. S., Geary, D. C., and Menon, V. (2010). Differential contribution of specific working memory components to mathematics achievement in 2nd and 3rd graders. *Learn. Individ. Differ.* 20, 101–109. doi: 10.1016/j.lindif.2009.08.004

National Center for Education Statistics [NCES] (2011). *The Nation's Report Card: Mathematics 2011(NCES 2012–458)*. Washington, D.C: Institute of Education Sciences, U.S. Department of Education.

NCTM [National Council of Teachers of Mathematics] (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM.

Niss, M. (2003). "Mathematical competencies and the learning of mathematics: the Danish: KOM project," in *Proceedings of the Third Mediterranean Conference on Mathematics Education*, eds A. Gagatsis and S. Papastavridis (Athens: Hellenic Mathematical Society and Cyprus Mathematical Society), 115–124.

Nyroos, M., Jonsson, B., Korhonen, J., and Eklöf, H. (2015). Children's mathematical achievement and its relation to working memory, test anxiety, self-regulation: a person-centered approach. *Educ. Inq.* 6, 73–97. doi: 10.3402/edui.v6.26026

Nyroos, M., and Wiklund-Hörnqvist, C. (2012). The association between working memory and educational attainment as measured in different mathematical subtopics in the Swedish national assessment: primary education. *Educ. Psychol. Int. J. Exp. Educ. Psychol.* 32, 239–256. doi: 10.1080/01443410.2011.643578

Parsons, S., and Bynner, J. (2005). *Does Numeracy Matter More?* London: National Research and Development Centre for Adult Literacy and Numeracy.

Peng, P., Namkung, J., Barnes, M., and Sun, C. (2016). A meta-analysis of mathematics and working memory: moderating effects of working memory domain, type of mathematics skill, and sample characteristics. *J. Educ. Psychol. Adv.* 108, 455–473. doi: 10.1037/edu0000079

Raghubar, K. P., Barnes, M. A., and Hecht, S. A. (2010). Working memory and mathematics: a review of developmental, individual difference, and cognitive approaches. *Learn. Individ. Differ.* 20, 110–122. doi: 10.1016/j.lindif.2009.10.005

Reukhala, M. (2001). Mathematical skills in ninth-graders: relationship with visuospatial abilities and working memory. *Educ. Psychol.* 21, 387–399. doi: 10.1080/01443410120090786

Skolverket [National Board of Education] (2011). *Curriculum for the Compulsory School, Preschool Class and Recreation Centre*. Available at: www.skolverket.se/publikationer

Skolverket [National Board of Education] (2012). *Lärarinformation: Ämnesprov, Matematik, Årskurs 3, Vårtermin 2012 [Teacher Information: Subject Test, Mathematics, Grade 3, Spring term 2012]*. Stockholm: Skolverket.

Swanson, H. L. (2015). Cognitive strategy interventions improve word problem solving and working memory in children with math disabilities. *Front. Psychol.* 6:1099. doi: 10.3389/fpsyg.2015.01099

Swanson, H. L., and Jerman, O. (2006). Math disabilities: a selective meta-analysis of the literature. *Rev. Educ. Res.* 76, 249–274. doi: 10.1016/j.ridd.2015.01.002

Swanson, H. L., Jerman, O., and Zheng, X. (2008). Growth in working memory and mathematical problem solving in children at risk and not at risk for serious math difficulties. *J. Educ. Psychol.* 100, 343–379. doi: 10.1037/0022-0663.100.2.343

Swanson, H. L., Jerman, O., and Zheng, X. (2009). Math disabilities and reading disabilities: can they be separated? *J. Psychoeduc. Assess.* 27, 175–196. doi: 10.1177/0734282908330578

Swanson, L., and Kim, K. (2007). Working memory, short-term, and naming speed as predictors of children's mathematical performance. *Intelligence* 35, 151–168. doi: 10.1016/j.intell.2006.07.001

The Swedish National Agency for Education (2007). *Trends in (International) Mathematics and Science Study (TIMSS) Report 323*. Stockholm: Skolverket.

TIMSS (2007). *Assessment. Copyright (2009) International Association for the Evaluation of Educational Achievement (IEA)*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center.

TIMSS (2011). *Assessment. Copyright (2013) International Association for the Evaluation of Educational Achievement (IEA)*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center.

Träff, U. (2013). The contribution of general cognitive abilities and number abilities to different aspects of mathematics in children. *J. Exp. Child Psychol.* 116, 139–156. doi: 10.1016/j.jecp.2013.04.007

Turley-Ames, K. J., and Whitfield, M. M. (2003). Strategy training and working memory task performance. *J. Mem. Lang.* 49, 446–468. doi: 10.1016/S0749-596X(03)00095-0

Turner, M. L., and Engle, R. W. (1989). Is working memory capacity task dependent? *J. Mem. Lang.* 28, 127–154. doi: 10.1016/0749-596X(89)90040-5

Unsworth, N., Heitz, R. P., Schrock, J. C., and Engle, R. W. (2005). An automated version of the operation span task. *Behav. Res. Methods* 37, 498–505. doi: 10.3758/BF03192720

Van de Weijer-Bergsma, E., Kroesbergen, E. H., and Van Luit, J. E. H. (2015). Verbal and visual-spatial working memory and mathematical ability in different domains throughout primary school. *Mem. Cogn.* 43, 367–378. doi: 10.3758/s13421-014-0480-4

Van der Ven, S. H. G., Van der Maas, H. L. J., Straatemeier, M., and Jansen, B. R. J. (2013). Visuospatial working memory and mathematical ability at different ages throughout primary school. *Learn. Individ. Differ.* 27, 182–192. doi: 10.1016/j.lindif.2013.09.003

Witt, M. (2011). School based working memory training: preliminary finding of improvement in children's mathematical performance. *Adv. Cogn. Psychol.* 7, 7–15. doi: 10.2478/v10053-008-0083-3

Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright © 2016 Wiklund-Hörnqvist, Jonsson, Korhonen, Eklöf and Nyroos. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) or licensor are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Advantages of publishing in Frontiers

OPEN ACCESS
Articles are free to read for greatest visibility and readership

FAST PUBLICATION
Around 90 days from submission to decision

HIGH QUALITY PEER-REVIEW
Rigorous, collaborative, and constructive peer-review

TRANSPARENT PEER-REVIEW
Editors and reviewers acknowledged by name on published articles

Frontiers
Avenue du Tribunal-Fédéral 34
1005 Lausanne | Switzerland

Visit us: www.frontiersin.org
Contact us: info@frontiersin.org | +41 21 510 17 00

REPRODUCIBILITY OF RESEARCH
Support open data and methods to enhance research reproducibility

DIGITAL PUBLISHING
Articles designed for optimal readership across devices

FOLLOW US
@frontiersin

IMPACT METRICS
Advanced article metrics track visibility across digital media

EXTENSIVE PROMOTION
Marketing and promotion of impactful research

LOOP RESEARCH NETWORK
Our network increases your article's readership