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Study on empathy, individual resilience, and training of speech-language pathology students using structural equation modeling

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Introduction: In Latin America, considerable variability has been observed in the distribution of empathy levels between sexes, as well as across different years of study and specialties among undergraduate students from various professions. This variability remains insufficiently explained. This study aims to predict empathy based on the resilience observed in Colombian speech therapy students.

Methods: A descriptive cross-sectional design was employed. The sample consisted of 217 speech therapy students, representing 94% of the population. Instruments used included the Jefferson Empathy Scale (Health Professions Student version) and the Individual Resilience Trait Scale. The sample underwent a multivariate outlier analysis using Mahalanobis distances. Descriptive analyses of univariate and multivariate normality (Mardia's test) were conducted. Means, standard deviations, skewness, and kurtosis were calculated for each dimension of the constructs. For the empathy scale, a confirmatory factor analysis (CFA) was conducted using the robust maximum likelihood estimator (MLR). For the resilience scale, the weighted least squares estimator was applied. The cut-off points for the goodness-of-fit indices were CFI > 0.90, TLI > 0.90, RMSEA < 0.08, and SRMR < 0.10. Omega and alpha coefficients were calculated. The explanatory model was tested using Structural Equation Modeling. Analyses were performed with SPSS 27 and R (R Studio interface), employing the lavaan package version 0.6–17, psych version 2.4.1, semTools version 0.5–6, and MVN version 5.9.

Results: The perspective-taking dimension of empathy was significantly predicted by the ecological dimension (positively) and the adaptation dimension (negatively) of resilience. The other dimensions did not show predictive capacity.

Conclusion: This study concludes that resilience partially predicts empathy in the population studied. Therefore, resilience could be considered an attribute to incorporate into teaching-learning processes aimed at increasing empathy levels. The scope and implications of these findings are discussed.

KEYWORDS

empathy, individual resilience, speech-language pathology, university students, structural equations

1 Introduction

Training speech-language pathology students requires understanding complex teaching and learning phenomena. For example, phonetic transcription is a skill that can assist patients with speech difficulties (Shaw and Yanushevskaya, 2022), help them comprehend academic and scientific papers related to their field (Guarinello et al., 2023), support evidence-based practice (Witko et al., 2021), enable training for specific populations (Watermeyer and Barratt, 2013), and aid in hearing loss therapy (Erdman et al., 2019), among other conditions. Moreover, patient care depends not only on knowledge and clinical skills but also heavily on communication skills. Successful communication with patients relies on the quality of the teaching and learning processes students have experienced. However, research on communication skills within speech-language pathology training remains scarce (Goosse et al., 2023), and even fewer studies focus on empathic training (Dores et al., 2021; Goosse et al., 2023).

Empathy is a vital part of the communication process because it helps the speech-language pathologist and patient achieve inter subjectivity (Díaz-Narváez et al., 2020; Díaz-Narváez et al., 2022a). Additionally, providing an empathetic environment by health sciences professionals leads to better clinical outcomes, improved treatment adherence, fewer complaints, and greater patient trust in their providers, among other benefits documented in the literature (Díaz-Narváez et al., 2022b; Ulloque et al., 2023).

The concept of empathy is complex and lacks a single, precise definition (Ulloque et al., 2023). Some scholars view empathetic care mainly as a cognitive process (Díaz-Narváez et al., 2020; Díaz-Narváez et al., 2022a), while others believe empathy involves a combination of cognitive and emotional elements that work together, actively contributing to empathetic care (Ulloque et al., 2023). However, the natural relationship between these elements has been shown to change under certain conditions (Ulloque et al., 2023; Díaz-Narváez et al., 2022b).

The interaction between speech-language pathology professionals and patients is inherently complex (Gunawan et al., 2022; Wu and Volker, 2012) and must be rooted in humanistic principles (Sousa et al., 2019; Taghinezhad et al., 2022). This complexity stems from two ontogenetic developmental processes. First, emotionality, which involves the limbic system as its neurological foundation, begins developing very early in life (Hoemann et al., 2019). Second, cognitive activity develops in parallel but starts later, with the cortical system as its basis. As both systems mature, regulatory mechanisms form, with emotionality (limbic system) maturing in late adolescence and solidifying its core aspects (Huerta-González et al., 2024). During this stage, growth of the limbic system slows, while the subcortical system continues to develop into young adulthood (Díaz-Narváez et al., 2022a). The development of these neural structures involves forming neural networks that connect the systems, allowing the cortical system to regulate emotions.

The growth of neural networks, as well as the limbic and cortical systems, is influenced by external factors that can impact the structural development of these systems and affect the quality and size of the components that form the networks (Estrada-Méndez et al., 2023; Suazo et al., 2020; Zarei et al., 2019; Cameron et al., 2022). Additionally, internal factors such as individual resilience (Taylor et al., 2020; Díaz-Narváez et al., 2021) and personality traits (Dávila-Pontón et al., 2020) play important roles. Based on these ideas, empathy can be viewed as

a complex trait that is shaped by multiple factors interacting in intricate ways, making it difficult to measure or describe precisely (Ulloque et al., 2023; Díaz-Narváez et al., 2022b; Hoemann et al., 2019; Huerta-González et al., 2024).

Resilience is another key trait for health professionals, enabling them to handle disruptions from patient care and other external factors that might impair their performance (Díaz-Narváez et al., 2022a; Mak et al., 2022; Gold and Gold, 2024). As a complex construct, resilience is challenging to define in operational terms. It can be assessed through measures of buffering resilience (which evaluates psychological processes using binomial questions) and individual resilience. These traits help understand how professionals cope with disruptions and their capacity to recover. Resilience can also be seen as a system with three interacting dimensions that work together to help individuals manage negative external events effectively. These traits suggest that individual resilience might be a positive predictor of empathy, helping counteract external pressures and sustain the empathy system, thus reducing the risk of empathic erosion (Díaz-Narváez et al., 2020; Ulloque et al., 2023).

Despite limited research on empathy among speech-language pathology students, studies exploring the link between empathy and resilience are virtually nonexistent. It is essential to determine whether resilience can serve as an independent variable that predicts empathy as a dependent variable, a question that remains unanswered both theoretically and empirically (Mak et al., 2022). Another issue is the variability in empathy levels among students across different specialties in Latin America (Díaz-Narváez et al., 2022b), which could impact the predictive assessment of resilience in relation to empathy.

Various studies on empathy in students from different health fields suggest that empathy is inherently influenced by multiple personal factors, especially during ontogenetic development (Castillo et al., 2021; Ameh et al., 2022).

Most research aiming to link resilience and empathy considers resilience as an independent variable (Taylor et al., 2020; Waddimba et al., 2021; Cao and Chen, 2021). However, more empirical studies are needed to confirm the role of resilience in predicting empathy. This raises the crucial question: Do the dimensions of resilience significantly predict the dimensions of empathy in speech-language pathology students? Therefore, empirical research on the relationship between resilience and empathy is vital. This study aims to predict empathy based on resilience in Colombian speech-language pathology students.

2 Methods

Design. A quantitative research method and a cross-sectional descriptive design were used. The design is quantitative because the variables are numerical, and it is cross-sectional because a group of students was studied at a single point in time. This design has limitations because the associations that may be identified do not allow for the assumption of causality, at least not directly.

2.1 Study participants

The sample included 217 speech-language pathology students ($n = 217$) from the School of Health Sciences at the Universidad de

Santiago de Cali, Cali, Colombia. This sample accounts for 94% of the population, consisting of first- to sixth-year students—19 men (8.7%) and 198 women (91.3%) aged 18–37 years ($M = 21.9$, $SD = 3.44$). The entire population was evaluated, although participation was voluntary. The final sample ($n = 217$) excluded 13 students using methods that will be explained in the “data analysis” section. Therefore, it can be said that the sample closely matches the population ($N = 230$).

2.2 Instruments

The Jefferson Scale of Empathy, Health Professions Students' version (JSE-HPS) (Hojat et al., 2001), includes 20 items. It measures empathy levels toward patients among health sciences students from all specialties. Items are rated on a 7-point Likert scale, from 1 (strongly disagree) to 7 (strongly agree).

The instrument evaluates three dimensions: Compassionate Care (CC, items 1, 7, 8, 11, 12, 14, 18, 19), Perspective Adoption (PA, items 2, 4, 5, 9, 10, 13, 15, 16, 17, 20), and “Walking in the patient's shoes” (WIPS, items 3 and 6). The scale has demonstrated good internal consistency ($\alpha = 0.70$ – 0.86 ; $w = 0.73$ – 0.96) and shows appropriate correlations with other psychological measures.

Resilience Trait Scale (EEA) (Maltby et al., 2015; Maltby et al., 2016) assesses three resilience dimensions: engineering, ecological, and adaptive. It features a 12-item Likert-type format with five response levels per item, from “Strongly disagree” [1] to “Strongly agree” [5]. The scale has shown solid internal and test–retest reliability, a cross-culturally stable factor structure, and convergent and construct validity through associations with personality, along with a positive impact on both clinical and non-clinical psychological health states (Maltby et al., 2015; Maltby et al., 2016). It also demonstrates good internal consistency ($\alpha = 0.72$ – 0.85 ; $w = 0.75$ – 0.96).

Before administration, both scales (Empathy and Resilience) were reviewed by experts. They assessed the translation and back-translation processes carried out by Spanish and English teachers, respectively. Once the translation and back-translation results were approved, the experts examined the content of the instrument in Spanish and conducted a pilot test with a randomly selected group, including students from all academic years, to ensure clarity and understanding of the questions in both versions.

2.3 Procedure

All students who agreed to participate did so voluntarily and signed an informed consent form before completing the instruments, ensuring their information remained confidential. Furthermore, they experienced the same general pedagogical approach, with differences only in methods and didactics specific to each course and academic year. Data collection occurred in September 2022. The instruments were administered in groups using a pencil-and-paper format during students' regular class hours. They were collected by faculty members from the School of Health Sciences, who were not involved in this research but had received the necessary training to provide the instruments, address any student questions, and ensure the accurate collection of responses.

The study adhered to the ethical principles outlined in the Declaration of Helsinki (2013). The research project and informed

consent form received approval from the Institutional Ethics Committee of Universidad Andrés Bello (Chile), under File 020-2022. All sociodemographic and personal data, as well as responses to the administered instruments, were kept confidential.

2.4 Data analysis

There was no missing data in the instrument responses due to the pedagogical actions conducted with the students and described in the “Procedure” section.

The process began by verifying the psychometric properties of the instruments used; therefore, the original database, which contained 230 applications, was subjected to multivariate outlier analysis ($p < 0.001$) using Mahalanobis distances (Hair et al., 2018), resulting in the elimination of 13 responses and leaving 217 final observations.

Descriptive analyses of univariate (skewness and kurtosis) and multivariate normality (Mardia) were performed for both instruments. Means, standard deviations, skewness, and kurtosis were calculated for empathy and resilience, including the dimensions of each construct. Confirmatory factor analysis (confirmation of internal validity) (CFA) with the robust maximum likelihood estimator (MLR) was applied to the empathy scale, considering that it includes items with seven response options and can therefore be treated as numerical variables (Rhemtulla et al., 2012). For the resilience scale, the weighted least squares mean, and variance adjusted estimator (WLSMV) was used, as it is suitable for handling ordinal indicators based on the polychoric correlation matrix (Kline, 2016), given that its items include five response options. Furthermore, robust methods are crucial when deviations from multivariate normality occur.

The cutoff points for the goodness-of-fit indices were CFI > 0.90 , TLI > 0.90 , RMSEA < 0.08 , and SRMR < 0.10 (Whittaker and Schumacker, 2022).

For internal consistency, the omega coefficient was used, with values above 0.70 considered adequate (Campo-Arias and Oviedo, 2008).

Regarding the explanatory model analysis, structural equation modeling was conducted using the WLSMV estimator, with the same cutoff points for the fit indices as those used in the CFA of the instruments.

The analyses were conducted using SPSS 27 (IBM Corp, 2021) and R (CRAN Team, 2025) with its R Studio interface (Posit Software, 2025), along with the lavaan package, version 0.6–17 (Rosseel, 2012), psych, version 2.4.1 (Revelle, 2025), semTools, version 0.5–6 (Jorgensen et al., 2025), and MVN, version 5.9 (Korkmaz et al., 2014).

3 Results

Initially, 13 responses were identified as multivariate outliers using the Mahalanobis distance test ($p < 0.001$), and therefore, they were removed to ensure cleaner data.

Table 1 shows that the items from both scales fall within the expected ranges for skewness and kurtosis. Additionally, Mardia's test was used to evaluate multivariate normality, and it indicated that neither instrument met this criterion ($p < 0.001$).

The reliability of the empathy variable was $\alpha = 0.78$ and $w = 0.83$. The reliability for resilience was $\alpha = 0.81$ and $w = 0.87$.

TABLE 1 Univariate descriptive statistics of empathy and resilience items.

Items	M	SD	Sk	Ku
Empathy scale				
1	4.01	2.43	−0.01	−1.61
2	6.04	1.56	−1.34	0.25
3	4.07	1.93	−0.09	−1.27
4	6.08	1.55	−1.46	0.70
5	5.26	1.86	−0.72	−0.77
6	4.06	1.87	−0.15	−0.99
7	4.98	2.44	−0.74	−1.17
8	4.69	2.26	−0.53	−1.21
9	5.66	1.66	−0.90	−0.62
10	5.67	1.68	−0.97	−0.48
11	4.88	2.02	−0.65	−0.86
12	4.89	2.24	−0.65	−1.11
13	5.69	1.73	−1.07	−0.09
14	5.44	2.08	−1.11	−0.22
15	5.17	1.90	−0.63	−0.90
16	5.53	1.65	−0.75	−0.78
17	5.03	1.81	−0.58	−0.80
18	3.31	1.98	0.31	−1.19
19	5.15	2.00	−0.84	−0.58
20	5.98	1.57	−1.26	0.08
Resilience scale				
1	3.55	1.27	−0.70	−0.56
2	3.19	1.22	−0.27	−0.86
3	3.41	1.24	−0.58	−0.63
4	3.37	1.23	−0.57	−0.66
5	4.12	1.05	−1.62	2.49
6	3.84	1.04	−0.92	0.49
7	3.89	1.00	−1.19	1.33
8	3.91	0.98	−1.16	1.44
9	3.89	1.11	−1.03	0.55
10	3.55	1.18	−0.55	−0.47
11	3.35	1.15	−0.53	−0.35
12	3.57	1.12	−0.75	0.04

M, mean; SD, standard deviation; Sk, skewness; Ku, kurtosis.

The initial model with three correlated factors for empathy was tested and showed acceptable fit indices [CFI = 0.91, TLI = 0.90, RMSEA (90% CI) = 0.07 (0.06–0.08), and SRMR = 0.09]. However, the SRMR value was slightly above the expected range.

Regarding reliability, the omega coefficient produced values of 0.86, 0.94, and 0.80 for the dimensions of compassionate care, perspective adoption, and walking in the patient's shoes, respectively.

For the resilience model, the original three-factor correlated structure was tested with the WLSMV estimator, showing acceptable fit levels for CFI and TLI [$\chi^2 = 543.57$, $df = 50$, CFI = 0.98, TLI = 0.97, RMSEA (90% CI) = 0.20 (0.19–0.22), and SRMR = 0.09]. Nonetheless,

the RMSEA and SRMR values were higher than expected. Internal consistency, assessed with the omega coefficient, yielded values of 0.96, 0.95, and 0.86 for the engineering, ecological, and adaptation dimensions, respectively.

In the initial fit, some indices were clearly unsatisfactory (e.g., RMSEA = 0.20; SRMR = 0.09). Following the recommendation to use robust estimators, we re-estimated the model with MLR (RMSEA = 0.137; SRMR = 0.12) and ULS (RMSEA = 0.086, SRMR = 0.09); although these showed some improvement, the indices still did not meet conventional thresholds. Item-by-item inspection revealed that items 3 and 4 had extremely high factor loadings ($\lambda \approx 0.98$), but the modification indices did not suggest they should be correlated. These findings suggest that the misfit mainly originates from the measurement structure rather than sample size alone. For transparency, we retain the measurement model used in the primary analyses but acknowledge its fit remains inadequate.

Verifying factorial invariance for both instruments was not possible due to the highly imbalanced male-to-female ratio in the sample.

Table 2 presents the means, standard deviations, skewness, and kurtosis for empathy and resilience, including each dimension within these constructs.

3.1 Explanatory model

Table 3 displays the descriptive statistics and correlations among the study variables. The results show that only the perspective adoption dimension of empathy has a positive correlation with the ecological dimension ($r = 0.17$, $p < 0.05$). Multivariate normality was assessed using Mardia's test, which indicated that the data do not meet this condition ($p < 0.001$).

This study's structural model achieved acceptable fit indices [$\chi^2 = 1132.37$, $df = 449$, $p < 0.001$, CFI = 0.98, TLI = 0.98, RMSEA = 0.08 (90% CI: 0.07–0.09), and SRMR = 0.09].

Figure 1 shows that only the ecological dimension positively predicted perspective adoption ($\beta = 0.46$; $p < 0.01$), while the adaptation dimension negatively predicted it ($\beta = -0.29$; $p < 0.05$). The other resilience dimensions did not significantly predict empathy.

4 Discussion

The results of the psychometric analysis indicate that the data for the empathy construct align well with the three-dimensional theoretical model, with items fitting into the appropriate dimensions. However, this was not the case for the individual resilience construct, where some statistical measures used to evaluate model fit did not produce satisfactory results. Notably, fit indices, especially the RMSEA, are sensitive to sample size and model misspecifications (Morata-Ramírez et al., 2015; Reyes-Reyes et al., 2021); in this case, items 3 and 4 were highly correlated. Even after addressing this in the model, the fit indices did not improve. Future research should determine whether this issue is specific to this sample or reflects a broader problem with the instrument. The relatively small sample size in this study may have contributed to less favorable values for some fit indices, so the results should be interpreted cautiously. Population

TABLE 2 Values of means, standard deviations, skewness, and kurtosis for empathy and resilience.

Symbols	<i>n</i>	M	SD	Sk	Ku
CC	217	37.36	12.474	−0.913	0.05
PA	217	56.01	14.199	−1.142	−0.003
WIPS	217	8.05	3.483	−0.158	−1.034
E	217	101.42	16.01	0.199	−1.186
ENG	217	13.81	4.465	−0.781	−0.172
ECO	217	15.92	3.337	−1.32	2.933
ADA	217	14.46	3.489	−0.759	0.99
R	217	44.19	9.907	−0.971	1.477

CC, compassionate care; PA, perspective adoption; WIPS, walking in the patient's shoes; E, empathy; ENG, engineering; ECO, ecology; ADA, adaptation; R, individual resilience. M, mean; SD, standard deviation; Sk, skewness; Ku, kurtosis.

skills are inherently determined by formation and development processes.

Furthermore, human populations cannot be artificially generated; we must work with them and consider any constraints that arise without disrupting the process of knowledge acquisition (0).

In this context, many authors emphasize the importance of psychometric studies in assessing how well data fit theoretical models (Díaz-Narváez et al., 2020; Whittaker and Schumacker, 2022; Morata-Ramírez et al., 2015; Branchadell et al., 2024) and in using those results when drawing conclusions based on the observed data.

The findings indicate that the ecological dimension positively and significantly predicts the Perspective Adoption (PA) dimension, while the adaptive dimension of resilience negatively and significantly predicts the same empathy dimension. To understand these findings, it is important to recognize that the PA component of empathy involves the intellectual or imaginative understanding that speech-language pathology student's need regarding a patient's situation or mental state (Heydrich et al., 2021; VanMeter and Cicchetti, 2020).

Individual ecological resilience (Perry et al., 2023) refers to a system's ability to withstand negative and disruptive external effects, reorganize essential resilience mechanisms, and maintain a stable state. This ensures that the student's role as a speech-language pathologist remains intact, preserving their purpose and identity as a future healthcare professional. This finding has significant implications. First, ecological resilience acts as a "wall of resistance" against adverse effects, preventing these events from impacting the student's ability to understand the patient's mind. It provides empirical evidence that resilience is an independent variable related to empathy (at least for the PA dimension). However, the opposite occurs in the adaptation dimension, concerning the empathy dimension (PA). The pessimistic prediction suggests that even if the speech-language pathology student endures the adverse event, they have not yet developed the capacity to adapt when it persists over time. This may happen because resilience operates sequentially: resisting the negative event, returning to the pre-event state (equilibrium), and then adapting to the ongoing presence of the adverse event (meaning the negative event no longer affects the student). The pessimistic outlook for adaptive resilience could be explained by a lack of traits associated with adapting to turbulence.

Table 2 shows that the average PA scores (56.01 points) represent 80% of the maximum possible score in this area (70 points). Students

scored 37.36 points in compassionate care (CC), which is 67% of the total possible (56 points), and 8.05 points in putting oneself in the patient's shoes (WIPS), which is 58% of the total possible (14 points). If empathy cut-off points were established for speech therapy students in Latin America, similar to other specialties (Díaz-Narváez et al., 2022a; Branchadell et al., 2024), it could be determined that empathy levels are moderate, with specific (non-critical) weaknesses in CC and WIPS.

The results also indicate that the ecological and adoption resilience dimensions do not predict CC or WIPS, and the engineering dimensions do not predict any empathy areas. Engineering resilience describes a system's ability to recover equilibrium if temporarily lost. In contrast, adaptive resilience refers to a speech-language pathology student's capacity to manage the immediate effects of a disruptive event and adapt efficiently and effectively.

Therefore, the correlation results cannot be understood solely from a statistical perspective. The lack of significant positive or negative correlations may reflect consistent responses from students, indicating the absence of certain resilience traits. Additionally, since the resilience measurement model was not entirely adequate, these findings should be approached with caution.

Furthermore, the relationship between complex variables like empathy and resilience is very intricate. Many authors hypothesize that empathy results from the influence of multiple factors, which ultimately shape an individual's empathetic structure (Díaz-Narváez et al., 2020; Díaz-Narváez et al., 2022b; Huerta-González et al., 2024; Estrada-Méndez et al., 2023; Díaz-Narváez et al., 2021; Dávila-Pontón et al., 2020; Castillo et al., 2021; Perry et al., 2023). As such (even if it seems repetitive), the results should be interpreted carefully and viewed as empirical trends.

Finally, when designing an empathetic intervention to boost empathy levels in speech-language pathology students, resilience should also be taken into account. This shows that training students only in empathy is not enough; training them in resilience is just as important to develop traits related to each resilience dimension.

4.1 Limitations

This study has some limitations that should be acknowledged. First, the sample size is relatively small, which impacts the accuracy of the goodness-of-fit estimates. As the sample size increases, these estimates tend to improve in accuracy. The resilience measurement model was not satisfactory, which could have influenced the outcome of the explanatory model as a predictor of empathy. Finally, the results are specific to the population studied and should be viewed as trends unique to this group. Therefore, the particularities of these findings cannot be generalized to other populations.

5 Conclusion

The ecological and adaptation aspects of resilience could predict the perspective-taking component of empathy. However, it is important to note that the resilience measurement tool used faced some issues, so further research is necessary to confirm or challenge these findings and to determine whether this was a very specific problem or if the instrument fails to capture the construct in

TABLE 3 Descriptive statistics and correlations between variables.

Symbols	Min	Max	M	SD	Sk	Ku	1	2	3	4	5	6	7
1. ENG	4	20	13.81	4.46	−0.77	−0.22							
2. ECO	4	20	15.92	3.34	−1.30	2.78	0.62**						
3. ADA	4	20	14.46	3.49	−0.75	0.90	.66**	0.68**					
4. RES	12	60	44.19	9.91	−0.96	1.38	0.89**	0.85**	0.88**				
5. CC	8	56	37.36	12.47	−0.90	−0.01	−0.06	−0.06	−0.04	−0.06			
6. PA	20	70	56.01	14.20	−1.13	−0.06	0.10	0.17*	0.05	0.12	−0.36**		
7. WIPS	2	14	8.05	3.48	−0.16	−1.06	−0.07	−0.07	−0.08	−0.08	0.65**	−0.43**	
8. EMP	78	140	101.42	16.01	0.20	−1.20	0.02	0.10	−0.01	0.04	0.60**	0.51**	0.34**

ENG, engineering; ECO, ecological; ADA, adaptation; RES, resilience; CC, compassionate care; PA, perspective adoption; WIPS, walking in the patient's shoes; EMP, empathy. M, mean; SD, standard deviation; Sk, skewness; Ku, kurtosis, * $p < 0.05$, ** $p < 0.01$.

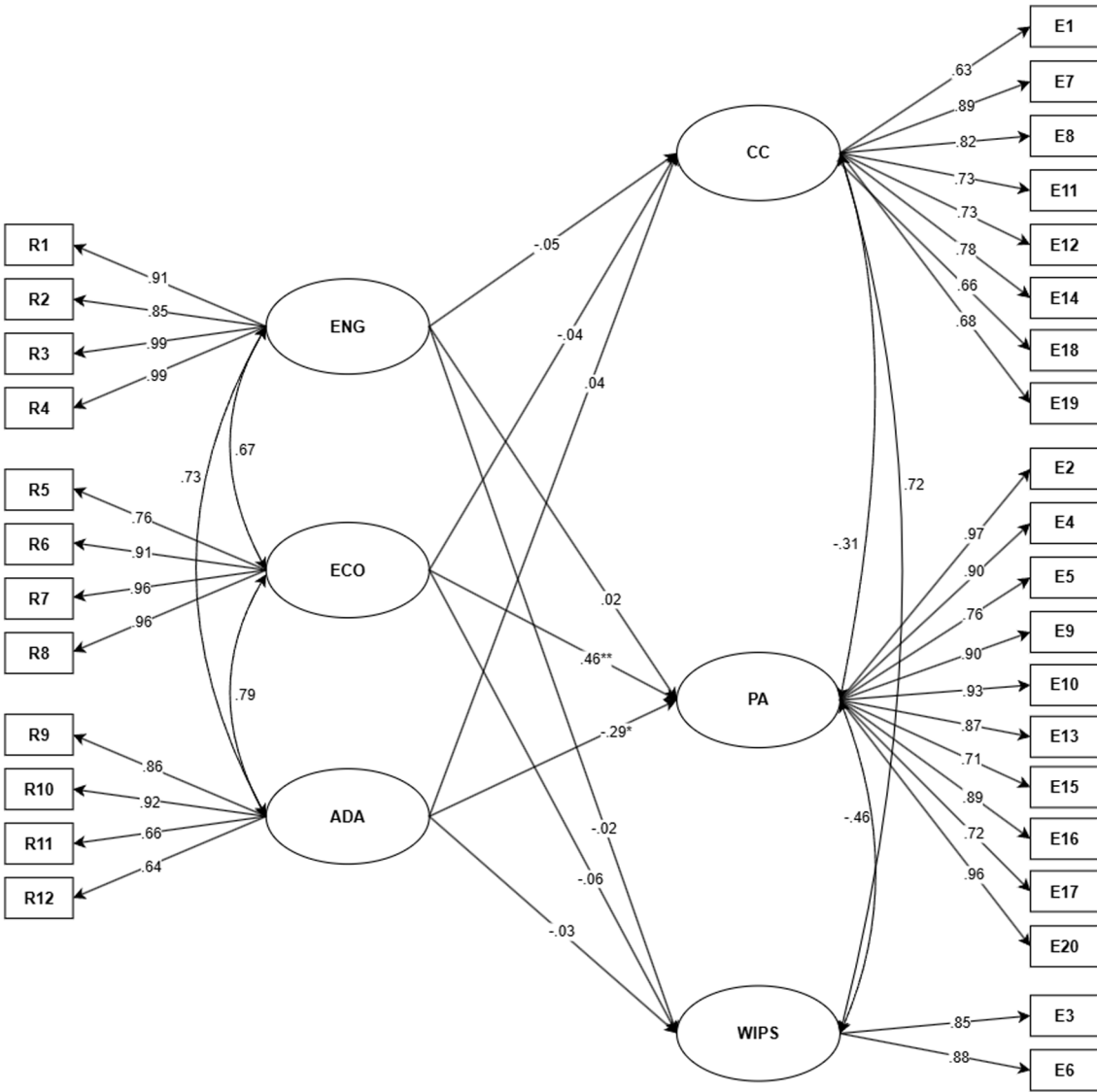


FIGURE 1
Explanatory model of resilience dimensions as predictors of empathy dimensions. CC, compassionate care; PA, perspective adoption; WIPS, walking in the patient's shoes; E, empathy; ENG, engineering; ECO, ecology; ADA, adaptation; R, individual resilience; * $p < 0.05$.

speech-language pathology students accurately. Therefore, this study should be viewed as exploratory, and its results should be regarded as trends that need further confirmation.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repository and accession number(s) can be found in the article/[Supplementary material](#).

Ethics statement

The studies involving humans were approved by Universidad Santiago De Cali Scientific Committee of Ethics and Bioethics—“CEB-USC” Faculty of Health. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

YM-H: Writing – review & editing, Methodology, Investigation, Writing – original draft, Formal analysis, Conceptualization, Resources, Validation. PG: Writing – original draft, Investigation, Conceptualization, Methodology, Writing – review & editing, Validation, Formal analysis. JG-M: Validation, Methodology, Writing – review & editing, Visualization, Conceptualization, Writing – original draft, Investigation. VD-N: Writing – original draft, Visualization, Formal analysis, Validation, Conceptualization, Supervision, Writing – review & editing, Investigation, Methodology.

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Conflict of interest

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.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2025.1677602/full#supplementary-material>

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