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Effects of storytelling on user experience and performance in VR: a case study of *Steady the drums!*

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Introduction: Storytelling is widely recognized as an effective tool for increasing engagement and motivation in digital games and learning environments. However, its application and impact in virtual reality (VR) is still under-researched due to the relative novelty of VR technology. In this study we explore the integration of storytelling elements into the game *Steady the Drums!* and examine their impact on user experience, performance and overall game appeal.

Methods: A comparative analysis was conducted with two groups: one group played a standard version of the game and the other a version enriched with a narrative. As the game aims to improve rhythm perception and skills, its impact on performance improvement in Tapping-PROMS tests was also assessed.

Results: Storytelling improved the perceived hedonic qualities of the game and increased user engagement and interest. However, participants playing the storytelling version showed slightly lower focus and performance on rhythmic tasks compared to the non-storytelling group. Despite this, both groups demonstrated significant improvements in rhythmic skills.

Discussion: The findings suggest that while storytelling enhances enjoyment and engagement, it may slightly reduce task-focused performance in rhythm-based activities. Nevertheless, the observed improvement in rhythmic skills across both groups emphasizes the educational value of the game.

KEYWORDS

virtual reality, storytelling, rhythm training, game, educational technology

1 Introduction

Computer games, traditionally developed for entertainment, have been used for educational purposes for decades (Backlund and Hendrix, 2013; Caitlin Cole and Mackenzie, 2024). They provide users with an engaging and unconventional learning environment that increases motivation and contributes to the success of the learning process. Researchers continue to explore different methods and approaches to improve learner motivation, with a particular focus on educational computer games (Laine and Lindberg, 2020). A major challenge in the development of such games is to find the right balance between educational and entertaining content. In recent years, virtual reality (VR) technology has made remarkable progress, leading to a growing number of educational games and applications that use this medium (Oyelere et al., 2020). VR uses specialized hardware and software to immerse players in a virtual world (Balcerak Jackson and Balcerak Jackson, 2024; McGowin and Fiore, 2024). VR learning games allow players to interact

directly with the learning content in a way that is not possible with traditional methods, promoting learning motivation, understanding and retention of knowledge (Anjos et al., 2024; Liu et al., 2025).

Previous studies have identified the inclusion of a narrative framework and a compelling narrative as elements that significantly increase the appeal of a game and consequently the player's interest in the gameplay (e.g., (Ryan, 2001)). Games with well-crafted stories can introduce an additional layer of extrinsic motivation that complements intrinsic motivation and drives players further. In addition, storytelling can create a parasocial effect where players become emotionally involved in the fate of the game characters (Zichermann and Cunningham, 2011). Most studies that have examined the effects of storytelling on the appeal of games have focused on children, although research suggests that adults, particularly younger generations, also value this aspect of games (Bormann and Greitemeyer, 2015). Furthermore, these studies are predominantly concerned with games developed for the PC, although VR devices are becoming more widespread and are being further developed. As VR already offers users a more immersive and interactive 360-degree gaming environment, it cannot be assumed that storytelling plays the same role as it does on less stimulating platforms.

Our study examines the effects of storytelling in a VR educational game, focusing on young adult participants — a population that has been relatively under-researched in this context. To this end, we have extended the existing VR game *Steady the Drums!* (Pesek et al., 2024), which aims to improve rhythmic skills. The research explores how the addition of a narrative affects the user experience and skill-related outcomes of users.

The paper is structured as follows: Section 2 provides an overview of the current state of the art. In Section 3, we present the original version of the game, highlight the improvements made based on previous user feedback, describe the storytelling elements integrated into the game, and give a brief overview of the storyline. The design of the experiment is described in Section 4, followed by a detailed presentation of the results in Section 5. Finally, we conclude the paper with a discussion and a summary of the results.

2 State-of-the-art review

2.1 Virtual reality

VR is a three-dimensional computer-generated simulated environment, which attempts to replicate real world or imaginary environments and interactions (Abbas et al., 2023). By using visual, auditory, haptic and sometimes even olfactory elements, VR allows users to feel physically present in a digital world, which enhances their engagement and interactivity (Kim et al., 2017; Cowan et al., 2023).

Devices such as VR head-mounted displays (HMDs) were primarily used in specialized areas such as military simulations, space agency training and medical visualizations, where the high costs and technical limitations were justified by specific requirements and benefits (Li et al., 2020; Popov et al., 2021). Today, VR technology continues to play an important role in military training as it allows soldiers to practice different

scenarios in a safe and controlled environment (Liu et al., 2018; Soni and Kaur, 2023). This approach enables realistic training without the risk of injury or equipment damage. In healthcare, VR now also offers innovative methods for rehabilitation and therapy (Kouijzer et al., 2023; Wang et al., 2023). Patients recovering from injuries can perform exercises in a controlled virtual environment where sensors accurately track their movements to aid and enhance the recovery process. In addition, therapists can develop customized therapies for patients struggling with phobias or anxiety, allowing them to face their fears safely in a virtual environment (McIntosh, 2022; Gaina et al., 2024).

VR is also becoming more widely used for educational purposes. It enables simulations and interactive learning experiences that go beyond traditional methods (Petersen et al., 2022; Al-Ansi et al., 2023). Research in VR technology has shown that VR can significantly improve learning outcomes and student engagement. A study by Mazhar and Riffaee (2023) found that VR technology creates a strong sense of presence and effective immersion, which positively impacts the learning experience, enabling students to better understand complex concepts and acquire practical skills in a safe and controlled environment. Their research shows that such interactive learning methods can increase student engagement and improve their understanding of complex concepts.

In addition, educational video games (EVGs) are increasingly being used as teaching tools in public schools and other educational institutions. Their main advantages include a high level of intrinsic motivation to play, clear goals and rules, a meaningful learning context, an engaging story with elements of surprise, immediate feedback, and a high level of interactivity, challenge and competition (Law et al., 2008). These features are also in line with Merrill's Principles of instruction (Merrill, 2012).

Games such as *Beat Saber*, *Golf 5*, and *Pistol Whip* have shown how VR can combine physical activity with fun and gaming. Beyond video games, VR also enables new forms of film and theater production, where viewers are placed within the world of the story that surrounds them with the scene, allowing them to decide which elements they want to focus on by turning their heads. Films such as *The Hunger Games*, *The Lion King*, *The Invisible Man*, *Allumette* and many others can be experienced in this modern form of presentation. Some film productions even go so far with VR technology that they allow viewers to influence the plot and outcome of the movie (e.g., the series *Vader Immortal: A Star Wars VR Series*, *Wolves in the Walls*, and *Baba Yaga*).

Over the past decade, technological advances and innovations such as high-resolution displays, advanced motion sensors, and more powerful software have enabled the creation of realistic and high-quality VR experiences. The release of new generations of VR devices from companies such as Oculus Rift, HTC Vive, and PlayStation VR has further enhanced user experiences, made these technologies more accessible and increased public adoption.

2.2 Examples of rhythm games and music learning applications

We provide examples of existing games and applications for learning music to contextualize our study. These examples illustrate the range of interaction styles, learning mechanisms and

gamification strategies currently used in music-based digital experiences.

Beat Saber (Meta.com, 2019) is a popular VR rhythm game that combines virtual reality with rhythmic challenges. In 2023, it became the most profitable VR app, selling 6.2 million copies (Nair et al., 2023). Players use VR headsets and controllers to slice blocks to the beat of the music, requiring precision and speed. The game's dynamic, physical gameplay promotes fitness, motor skills, and reflexes (Nair et al., 2023). Its simple mechanics make it accessible for beginners, but also offers challenges for experienced players. *Beat Saber* contains both official and user-uploaded tracks and is constantly expanding its song library.

Osu! (Dean Herbert, 2007) is a rhythm game developed for the computer. It is designed so that players use the mouse to click, turn and move objects on the screen in time with the music. Each song has its own polygon that determines the exact timing and position of the clicks to match the song being played. The polygons are created by the community so that the song library can be constantly expanded. *Osu!* offers different levels of difficulty, allowing players to gradually improve their skills. The game also contains competitive elements, as players can compare their results with others.

Guitar Hero is a popular rhythm game series that simulates guitar playing and was first released in 2005 for the Sony PlayStation 2. Players use a guitar-shaped controller with color-coded buttons and a strum switch to hit the notes displayed on the screen. The game offers different levels of difficulty, with the higher levels featuring faster tempi and more complex patterns. Performance is measured by accuracy and a multiplier for consecutive successful hits, which requires precision and quick reactions. Several modern VR games (most popular one being *Beat Saber*) use similar techniques to visualize rhythmic patterns and engage the user.

Rhythm Heaven, developed by Nintendo, is a series of rhythm-based games that began in 2006 with *Rhythm Tengoku* for the Game Boy Advance and was later expanded to the DS, Wii and 3DS. Players take part in rhythm-based mini-games that require precise timing and synchronization with the music. Success depends on accuracy, with different difficulty levels encouraging skill improvement. The series features unique tracks from different genres, composed by Japanese producer Tsunku. Several studies (e.g., (Webber, 2022)) investigated the game as a tool to gain rhythm skills among students.

The open-source platform *Trubadur* aims to improve musical ear training through gamification and offers tasks such as interval, chord, rhythm, and melody recognition tailored to the skill level of the users (Pesek et al., 2020). Students transcribe musical phrases using tools such as rhythm selectors or digital keyboards, with penalties for incorrect attempts and a timed assessment providing additional challenge. Features such as leaderboards, badges, and detailed feedback encourage engagement and address weaknesses, with targeted exercises provided for areas that need improvement. Evaluations also showed improved knowledge among users (Pesek et al., 2022; Pesek et al., 2020).

The application *Teach me drums* was developed as part of a study exploring the use of virtual reality (VR) to improve rhythmic understanding in percussion lessons. The application was designed to teach drumming from a teacher's perspective and uses VR headsets to display a stereoscopic 3D video of a teacher playing

an African *djembe* drum, synchronized with the user's real drumming. While the application is innovative, it could potentially be even more effective if it used additional VR features beyond the 3D representation of the drum beats, such as interactive feedback or immersive learning aids.

2.3 The role of storytelling in educational games

Storytelling is a structured narrative practice that communicates events, ideas, or values through text, voice, visuals, or interactive media to create meaning and engagement. Beyond simple narration, effective storytelling integrates depth—such as complex plotlines and character development—with environmental cues that situate characters within vivid, context-rich worlds. Storytelling has become an important component in the development of computer games, as research has shown that it increases player engagement, motivation and the overall user experience. A compelling narrative fosters a deeper connection to the game, engages players emotionally and increases their persistence and commitment to the gaming experience (Ryan, 2001; Zichermann and Cunningham, 2011). In educational contexts, it supports cognitive and socio-emotional growth: conventional role-playing games foster soft skills and world-building tied to curricular content (Segarra et al., 2024), digital storytelling enhances early childhood cognitive abilities through multimedia and games (Manullang et al. 2021). Game-based storytelling further demonstrates how collaborative design and narrative construction can stimulate critical thinking and media literacy (Judson et al. 2025).

In educational contexts, storytelling is an effective way to present learning content and make it more accessible and memorable. Humans naturally organize information in the form of stories, so structuring educational material in this way can facilitate comprehension and retention. Studies have shown that storytelling not only increases motivation and engagement, but also improves retention of learning content (Bruner, 2002).

While much of the research has focused on children and adolescents who are more receptive to game-based learning (Gee, 2003), findings suggest that storytelling in games stimulates both intrinsic and extrinsic motivation. For some players, well-crafted stories even evoke a unique form of extrinsic motivation—a virtual external motivation—triggered by the consequences of actions within the game world (Bopp, 2008). This phenomenon is often associated with parasocial relationships, where players form emotional bonds with game characters and strive to positively influence their fate. This leads to greater engagement, longer play sessions and better learning outcomes.

Although fewer studies have been conducted with adults, existing research confirms that older people also appreciate well-told stories in video games, regardless of whether they are educational or not (Griffiths, 2019).

The research most closely related to our study is presented by Chen (2024), who conducts a comparative analysis of storytelling in VR games versus traditional games. This study highlights how VR can transform gaming narratives through interactivity and immersion. It creates a deep sense of presence by engaging multiple senses and allowing players to directly influence the

story through physical interaction. Through case studies and user experience reviews, the author also highlights the potential of VR to enhance learning and emotional engagement.

3 Steady the drums! 2.0

3.1 The original game

Steady the Drums! (Pesek et al., 2024) is a rhythm-based VR game that combines immersive gameplay with rhythmic training. Set in a medieval scenario with defensive towers, players drum rhythmic patterns with VR controllers and command their military units to defend a city against waves of attacking enemies. The game provides immediate visual and haptic feedback motivating players to perform the rhythms accurately. The progression includes several levels, each increasing in difficulty with new waves of enemies. In the original version of *Steady the Drums!* the player stands on a defensive wall where they must fend off 10 waves of monsters by drumming commands that control their army. Five different rhythmic patterns correspond to orders such as attack, defense, retreat or creation of new soldiers. Two types of soldiers, infantry and archers, differ in their resistance and attack abilities, with archers being able to deal more damage from a distance. During the game, instrumental music composed by a Slovenian musician named Tschimy is played in the background, starting with a single instrument and gradually introducing others. Players synchronize their drumming with the music to execute orders and increase the *damage* multiplier, thus improving the attack power of their soldiers. Properly drummed commands build up a combo meter, which unlocks the ability to create new soldiers. Creating soldiers, however, resets the combo counter and *damage* multiplier, incentivizing precise and consistent drumming. Eight monster types (including a bat, dragon, golem, orc and slime) of varying strength and durability appear in waves, growing in strength as the 10 levels progress. Victory depends on the player's ability to command their army effectively by maintaining rhythmic precision. In a study focused on learning rhythm through VR, an adapted version of the game was developed to target specific rhythmic skills, such as maintaining tempo and pattern replication. In this version, free play was replaced by scenarios tailored to rhythmic challenges. A 14-day training program for elementary school students showed significant improvements in their rhythmic skills, but it has revealed the need to expand the training scenarios to maintain participants' motivation over a longer period (Pesek et al., 2024).

3.2 Enhancing the original game

We enhanced the original game with additional functionalities and the integration of a storyline. We developed two versions of the game: one without a storyline and one with a narrative as the main feature.

3.2.1 Expanding the game

We expanded the game scenario to allow for 2 weeks of gameplay by increasing the number of levels and introducing new enemy characters. Each level corresponds to a wave of

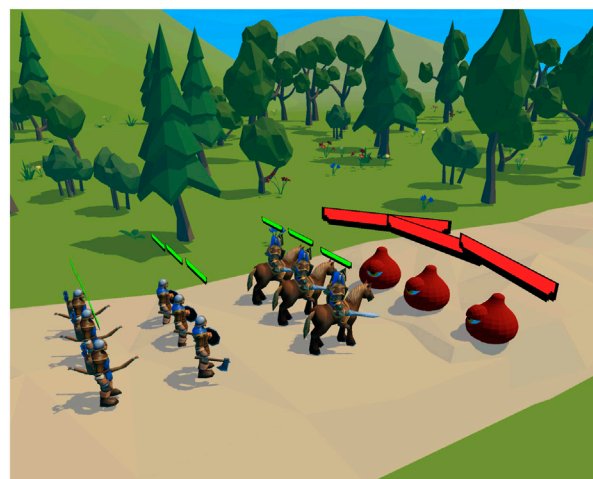


FIGURE 1
Troops prepared for the battle with the enemies.



FIGURE 2
Rhythmic commands and related actions.

enemy monsters attacking the defensive wall, which the player must fend off in order to progress. In the story version, narrative elements reveal the characters' backstories and motivations at each five-level milestone. To balance the difficulty and accommodate the study participants, who were tasked with playing the game for at least 10 min per day, we included options for saving the game progress and starting from one of the previously reached milestone levels.

To increase engagement and game difficulty, we also improved the rhythmic patterns. While the original version used simple, evenly spaced sequences in a four-beat rhythm, the updated game includes patterns of varying length and tempo. Complex structures, such as rests and simultaneous drum beats, require better coordination and lead to more advanced rhythmic exercises.

To diversify the gameplay, we added cavalry units to the player's army, complementing the existing infantry and archers (represented



FIGURE 3
Storytelling in the game.

in Figure 1). Cavalry units, the fastest and strongest soldiers, require a more complicated rhythmic mastery of six beats with different tempi for creation. We also added two cannons to the defensive wall. Their use is limited by the fact that a player has to craft the cannonballs in a mini-game that is only accessible every 90 s. Both the cavalry units and the cannonball mechanic are interwoven with the game's storyline, adding to the immersion and depth of the game.

3.2.2 Improving user experience

To improve the intuitiveness and accessibility of the game, we made improvements based on feedback from the initial tests and Meta App Store reviews. Testers pointed out that they needed clearer instructions for the game mechanics and drumming tempo. In response, we introduced detailed instructions for rhythmic commands and crafting cannonballs (shown in Figure 2). To assist players during gameplay, we added visual aids including a counter of remaining cannonballs, a timer for crafting cannonballs and a visual tempo indicator to help players maintain the correct drum tempo. In addition, correctly executed rhythmic patterns are now highlighted in yellow to give players immediate and clear feedback. To visually enrich the game, we introduced different animations for events such as new monster waves, defeated enemies and cannon fire. We also fixed issues such as incorrect soldier responses to commands and collision detection errors.

The medieval theme of the game is reflected in its soundtrack. The music's beats-per-minute (BPM) are synchronized with the intended drumming tempo, helping players to execute the rhythm correctly.

3.2.3 Incorporating the storyline

The game's storyline provides the context for the battle and the protagonist's background. The player assumes the role of the son who uses hammers to strike the drums, aligning with the narrative. At the urging of his friend, the cavalryman Azriel, the protagonist rushes to the tower to replace the absent military drummer Cassian. Cassian, who accompanies the king and the main army to the east,

has left behind a parchment with basic troop commands, that are performed by drumming. This parchment is represented in the game as a rhythmic command display. The medieval city of Velaris, seen in the background, is besieged by the dark wizard Amaranth, the main enemy in the game. Amaranth seeks control of Velaris in order to exploit the abundant magical crystals that are a source of his malevolent power. At key milestones—levels 5, 10, and 15—players learn the backstories and motivations of Amaranth's three key allies, deepening the narrative (shown in Figure 3). The story also motivates players at each level, emphasizing their proximity to victory. Before the final battle at level 20, a dramatic narrative section sets the stage for the showdown with Amaranth. The narrator emphasizes that Velaris' existence depends on the player's actions to increase player engagement.

The story is conveyed through text and voice narration. Visually, the game looks like an animated book, with each page containing text and corresponding illustrations. The game pauses during the narrative so that attention is not interrupted. Players can skip the narrative at any time using a controller button. This prevents possible frustration caused by forced listening.

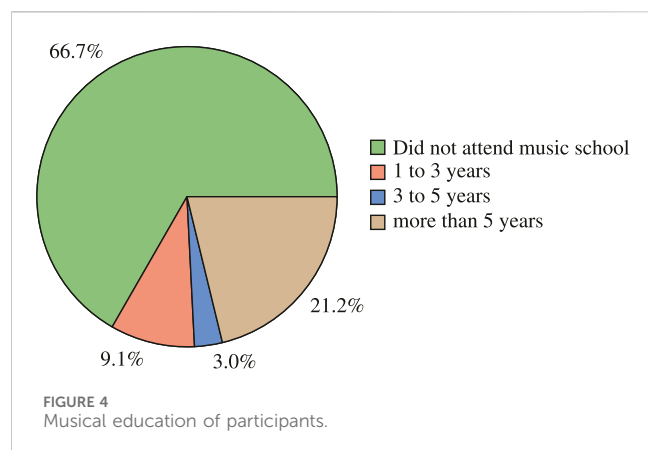
3.3 Technologies and tools used

For the game upgrade, we built on the technologies used in the original version. The game was developed in Unity, using C# to implement complex game mechanics. Integration with VR devices was achieved through OpenXR, which enables compatibility with multiple VR and AR devices without device-specific customizations. To ensure a smooth VR experience, we optimized the game for performance using low-poly models, shadow and rendering optimizations, occlusion culling, and an event-driven architecture that activates scripts only when needed. These technical decisions were critical to maintaining seamless interaction and avoiding motion sickness, which directly supports the results of the study.

To evaluate the impact of storytelling on the user experience, it was crucial to ensure that the game was well designed in both versions (with and without storytelling elements). Since both versions of the game were used in an experiment, we implemented tracking logic for multiple data points that were sent to the server in real time. Sending data frequently could put a heavy load on the processor, so we made sure to consolidate the data before sending it to avoid duplication. To avoid possible data loss due to less frequent server updates, we have also built local data storage logic into the game, which is activated at the end of the game or when there are problems with server transmission.

4 Materials and methods

Our study examined the effects of storytelling on the user experience in a virtual game, focusing on playability, player performance and improvement of rhythmic skills. The attractiveness of the game was assessed based on gameplay duration and responses to the user experience questionnaire. Data collection included rhythmic pattern performance, user experience ratings and player engagement. We used the Tapping-PROMS test to assess rhythmic skills, a questionnaire that profiled



participants' previous music and gaming experience, and a survey on user experience with the game. Additional metrics such as play time, performance and time spent engaging with the story were also tracked and analyzed.

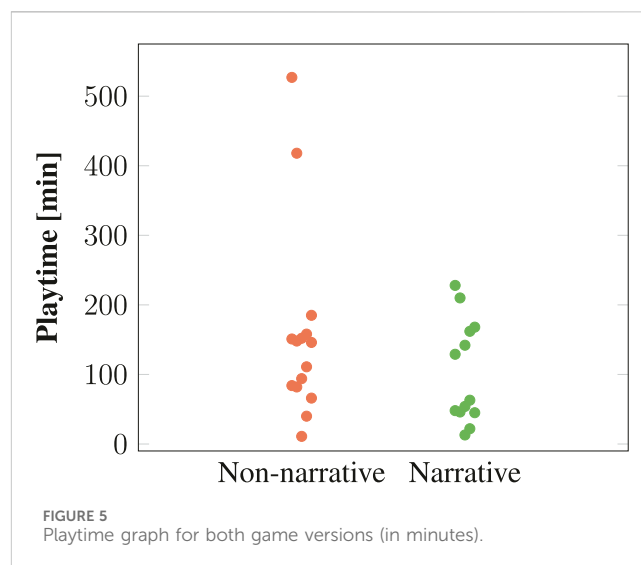
The participants were randomly divided into two groups—one played a game with storytelling, the other without. Both groups used Meta Quest 2 or 3 VR devices, with the versions evenly distributed to reduce device-related bias. The experiment consisted of three phases.

4.1 First in-person meeting

Participants completed a profiling questionnaire at the start of the study and completed the Tapping-PROMS baseline test. The questionnaire, which was developed specifically for this study, collected information about the participants' musical background, their experience with digital and VR games, and their preferences for these games. To measure changes in the participants' rhythmic skills, we used a shortened version of the PROMS (Profile of Music Perception Skills) test (Georgi et al., 2023). The shortened format was designed to reduce participant fatigue during the lengthy initial and final phases of the test. Each Tapping-PROMS session therefore included three rhythmic patterns and three tempo patterns of varying difficulty, selected from the official patterns available at <https://osf.io/df2gr/>, and provided data on the number of correctly reproduced rhythm and tempo items, absolute synchronization of rhythm or tempo, and relative synchronization of rhythm. The test was conducted using a Python-based application developed for the Tapping-PROMS study (Georgi et al., 2023). During the first meeting, participants were also informed about how to use the device, basic troubleshooting, and how to access technical support.

4.2 Gameplay period

A 14-day period in which the device was used at home for at least 10 min per day. Both versions of the game included logic to track various data points during the game, which were used to evaluate the player's interaction with the game. During gameplay, we recorded



the start and end level of each game session, total play time, and the number of successfully executed rhythmic patterns. In addition, all drum beats were logged so that we could calculate the proportion of beats that were part of correctly executed rhythmic sequences compared to the total number of beats. In the version of the game with a storyline, we also tracked whether players watched or skipped the story sections. This data allowed for a thorough analysis of the impact of the two versions of the game on user experience and player engagement. This data was stored on the device and sent to a server when the device accessed a wireless network so that player activity and data collection could be monitored.

4.3 Second in-person meeting

Participants completed the user experience questionnaire and performed the final Tapping-PROMS test. The original UEQ, which contains 26 items divided into six scales, provides a comprehensive assessment of the different aspects of user experience (Laugwitz et al., 2008). However, to ensure efficiency and ease of use, we used the shorter version of the UEQ, known as UEQ-S, which contains only eight items targeting two meta-dimensions: pragmatic quality and hedonic quality (Schrepp et al., 2017). The UEQ-S has been validated and is used in various areas, including mobile applications, stand-alone software and information systems. The items of the questionnaire are: obstructive/supportive, complicated/easy, inefficient/efficient, boring/exciting, not interesting/interesting, conventional/inventive, usual/leading edge. The participants rated these on a five-point Likert scale.

In addition, open-ended questions outside of the UEQ-S were added to evaluate specific aspects of the game, such as the storyline, physical effects, and general interest. These questions related to the frequency of nausea, headaches or sweating while playing the game, willingness to purchase the game and rate its value, opinion on the appropriateness of the storyline, its impact on interest in the game and possible disturbance from replaying the game. The complete set of additional questions was as follows.

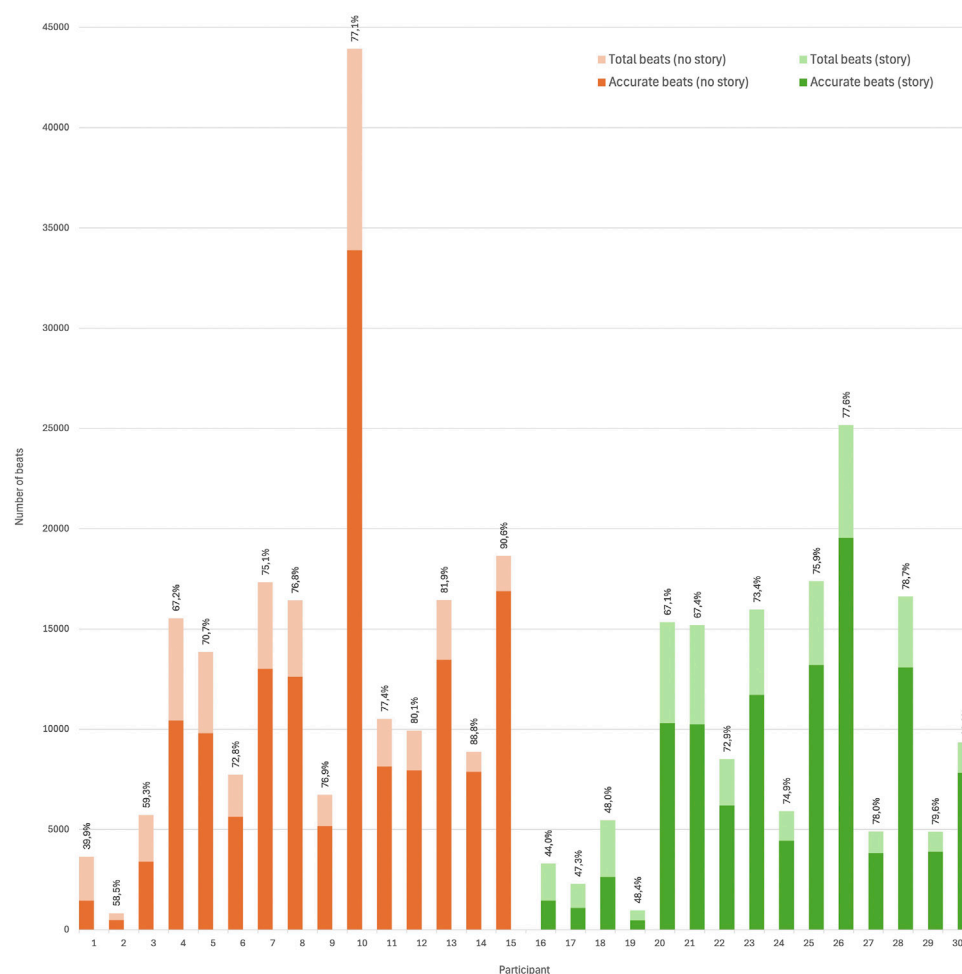


FIGURE 6
Comparison of successful vs. total drum hits for participants.

1. Have you ever felt sick or experienced a headache while playing?
2. Have you ever sweated while playing?
3. Would you be willing to buy the game?
4. If so, how much would you be willing pay?
5. What did you like about the game?
6. What did you not like about the game?
7. Do you think the game's main story was presented in sufficient detail?
8. Did the story make the game more interesting?
9. Did it bother you that the story was shown to you even after you had already seen it?

To assess the changes between the initial and final Tapping-PROMS tests, we assumed a normal distribution of the data and used the Levene test to check the equality of variances. For homogeneous variances ($p \geq 0.05$), we applied paired t -tests (Ross and Willson, 2017) and if the variance homogeneity was not met, we used the non-parametric Wilcoxon signed-rank test (Randles, 2006).

5 Results

5.1 Demographics

The study included 30 participants, of whom 18 were women and 12 were men. Their ages ranged from 17 to 26 years, with a mean age of 21.6 years).

All but two of the participants had previous experience with video games, with 10 of them still actively playing. The frequency of gaming varied from less than 3 h per month to 15 h per month. Most participants used gaming consoles such as Nintendo Switch, PlayStation, or Xbox, while some played on PCs or smartphones. The most frequently played game genres included action, adventure, simulation, strategy, and sports games.

The prior usage of VR devices among participants was relatively low. Seven participants had used virtual reality headsets like Oculus Quest, Oculus Rift, or Steam Index, while two participants had experience with augmented reality (AR) glasses. One participant used the VR headset daily, while others had only tried them out or

TABLE 1 Absolute asynchrony results in the rhythmic PROMS test (all participants).

Rhythmic pattern difficulty	Absolute asynchrony				T-Test	p
	Initial Test		Final Test			
	μ	σ	μ	σ		
Low	0.411	0.358	0.167	0.112	2.512	0.012*
Medium	1.897	1.199	1.177	0.840	3.118	0.003*
High	3.525	1.572	3.171	1.218	1.177	0.127

TABLE 2 Relative asynchrony results in the rhythmic PROMS test (all participants).

Rhythmic pattern difficulty	Relative asynchrony				T-Test	W Test	<i>p</i>
	Initial Test		Final Test				
	μ	σ	μ	σ			
Low	0.265	0.204	0.092	0.035	—	0.036**	<0.001*
Medium	1.246	0.969	0.858	0.819	1.841	—	0.041*
High	2.270	1.318	1.650	1.323	2.673	—	0.0075*

**Ranks between 1 and 16.

had not used them at all. Four of these participants reported experiencing nausea during VR use.

Two-thirds of the participants had not attended a music school. Among those who had, the duration of attendance varied from a few years to over a decade (see Figure 4). Thirteen participants played one or more instruments, with piano being the most common, followed by guitar, flute, and violin. Twenty participants confirmed involvement in other formal or informal music-related activities, with dancing being the most common (9 participants), followed by singing, playing in a band, and other musical activities. Most of these individuals pursued music through formal training or courses, while some were self-taught. Half of those who were musically active are still actively involved.

5.2 Playtime

The results of the playtime tracker are displayed in Figure 5. While most participants followed the instructions and played the game for at least 10 min per day, a few did not. Two participants from the non-narrative group had a significantly higher playtime than the others. To avoid biasing the average results and to ensure accurate interpretation of the data, we decided to exclude these outliers from the comparison. These anomalies may be due to factors such as extreme enthusiasm for the game or technical problems in playtime tracking.

The results indicate that the non-narrative version was played on average 10 min longer than the narrative version. Furthermore, the gender of the participants and the monthly playtime, which was collected at the beginning of the study using a profiling questionnaire, do not appear to significantly influence the time spent playing our game.

In the storytelling version of the game, we also implemented a mechanism that allowed us to track how often players viewed the story. Players could skip the story at any time by clicking the Continue button, and the story sections were only displayed when certain levels (1, 5, 10, 15, and 20) were reached. All participants watched the story in its entirety the first time, but skipped it on subsequent playthroughs. Watching the story, which takes about 10 min in total, did not significantly increase the overall playtime.

5.3 Player performance

To compare player performance in both versions of the game, we analyzed the percentage of successful drum hits and the frequency of reaching various game levels. Figure 6 shows the percentage of correctly executed drum hits compared to the total hits for the participants of both groups. The darker sections of the bars represent successful hits, while the lighter sections cover the total number of hits per participant. In addition, the percentages of the success rate are indicated at the top of the bars. The average success rate for the non-narrated version was higher (72.9%) than for the narrated version (67.8%). The data reveals that some participants achieved very high success rates in both versions of the game, however the overall performance was slightly better in the non-narrative version, possibly indicating easier cognitive processing (due to the lack of story interruptions) or higher motivation and concentration of players in this group.

According to the tracking data the players of the story-free version reached higher levels more frequently, with six players reaching the final level. In the story version, five players reached the final level and those who play video games regularly tend to

TABLE 3 Absolute asynchrony results in the PROMS tempo test (all participants).

Rhythmic pattern difficulty	Absolute asynchrony				T-Test	p
	Initial Test		Final Test			
	μ	σ	μ	σ		
Low	0.051	0.018	0.052	0.021	−0.108	0.542
Medium	0.077	0.057	0.060	0.029	1.710	0.050
High	0.064	0.027	0.058	0.025	1.022	0.159

TABLE 4 Absolute asynchrony results in the rhythmic PROMS test (separated by game version played).

Rhythmic pattern difficulty	Storytelling (S) / no storytelling (W)	Absolute asynchrony				T-Test	W Test	p
		Initial Test		Final Test				
		μ	σ	μ	σ			
Low	W	0.338	0.172	0.183	0.128	2.384	—	0.022*
	S	0.505	0.512	0.145	0.093	1.740	—	0.066
Medium	W	1.927	1.183	1.116	0.863	2.489	—	0.014*
	S	1.842	1.323	1.291	0.851	1.941	—	0.048*
High	W	2.796	1.689	2.743	1.069	—	30**	0.452
	S	4.415	0.826	3.695	1.239	1.791	—	0.056

**Ranks between 1 and 11.

reach higher levels. In both versions, most of the successful games that reached the final level started at the first level, which is probably due to the fact that the cannon function, which makes it easier to defeat enemies, is only activated if the player starts the game from the beginning.

5.4 Rhythmic test

The results of the Tapping-PROMS test helped to identify differences in rhythmic and tempo synchronization before and after the 2 week trial. We first examined all participants as a whole, followed by subgroup comparisons based on the version of the game they played. Before comparing the differences between the groups' initial and final measurements, we applied Levene's test to check for equality of variances. Based on the results, we applied either the Wilcoxon signed-rank test or a paired-samples t-test to compare the PROMS test results and analyze statistically significant differences in the test scores. From the initial and final PROMS test scores of all participants who completed both tests, we excluded invalid results from improperly administered tests (unfinished or unattended – four participants in total). The size of the refined test sample was 26 cases. In all results tables, we used the symbol * to indicate statistical significance at $p < 0.05$.

Large improvements were observed in rhythmic synchronization, particularly in relative asynchrony. Absolute

asynchrony (Table 1), which measures the accuracy of taps compared to ideal time intervals, showed an improvement in easier and moderately difficult rhythmic patterns ($p = 0.012$ and $p = 0.003$, respectively). These results suggest that participants became more adept at synchronizing with the rhythm in less complex patterns, while they struggled to make similar progress on more challenging rhythms.

Relative asynchrony (Table 2), which measures the consistency of taps relative to the rhythmic pattern, showed improvement across all difficulty levels. The most pronounced and consistent improvement occurred with the easiest rhythmic patterns, indicating that participants followed the rhythm more accurately after playing the game, even if they did not maintain perfect tempo synchronization.

In terms of tempo synchronization (Table 3), participants showed slight improvements. A significant reduction in absolute asynchrony was observed for the moderately difficult tempo ($p = 0.050$), while the easier and most difficult tempi showed no significant changes. These results suggest that participants were able to somewhat improve their ability to synchronize tempo, although the improvements were less robust compared to rhythmic synchronization.

5.4.1 Effects of storytelling

To examine the effects of game narratives on rhythmic skills, participants were divided into two groups: those who played the version with a story ($N = 11$) and those who played

TABLE 5 Relative asynchrony in the rhythmic PROMS test for both groups.

Rhythmic pattern difficulty	Storytelling (S) / no storytelling (W)	Relative asynchrony				T-Test	p
		Initial Test		Final Test			
		μ	σ	μ	σ		
Low	W	0.203	0.065	0.095	0.033	5.926	<0.001*
	S	0.345	0.292	0.089	0.041	2.371	0.028*
Medium	W	1.332	0.967	0.794	0.798	1.715	0.056
	S	1.087	1.030	0.976	0.907	0.842	0.216
High	W	1.637	1.190	1.237	1.100	2.198	0.026*
	S	3.043	1.062	2.155	1.456	1.908	0.046*

TABLE 6 Tempo asynchrony in the PROMS test (separated by game version played).

Rhythmic pattern difficulty	Storytelling (S) / no storytelling (W)	Tempo asynchrony				T-Test	ρ
		Initial Test		Final Test			
		μ	σ	μ	σ		
Low	W	0.053	0.018	0.049	0.017	0.518	0.307
	S	0.049	0.018	0.055	0.027	-0.576	0.711
Medium	W	0.077	0.052	0.061	0.029	1.435	0.087
	S	0.078	0.067	0.059	0.031	0.950	0.183
High	W	0.067	0.029	0.055	0.018	1.429	0.087
	S	0.059	0.024	0.062	0.034	-0.446	0.666

the version without a story ($N = 15$). This comparison allowed us to assess whether the inclusion of a story influenced the extent of improvement in rhythmic and tempo synchronization. In the tables, the group that played the game without the storytelling element is labeled with the letter W, while the group that played with the storytelling element is labeled with the letter S.

Both groups showed improvements in rhythmic synchronization, but the group playing the no-storytelling version of the game showed greater overall progress. In terms of absolute asynchrony Table 4, the no-storytelling group showed highest improvements in the easier and moderately difficult rhythmic patterns ($p = 0.022$ and $p = 0.014$, respectively), with a smaller, but non-significant reduction in the most difficult pattern. In contrast, the group playing the storytelling game version only showed a visible improvement in the moderately difficult rhythms ($p = 0.048$), with less pronounced changes in the easier and most difficult patterns.

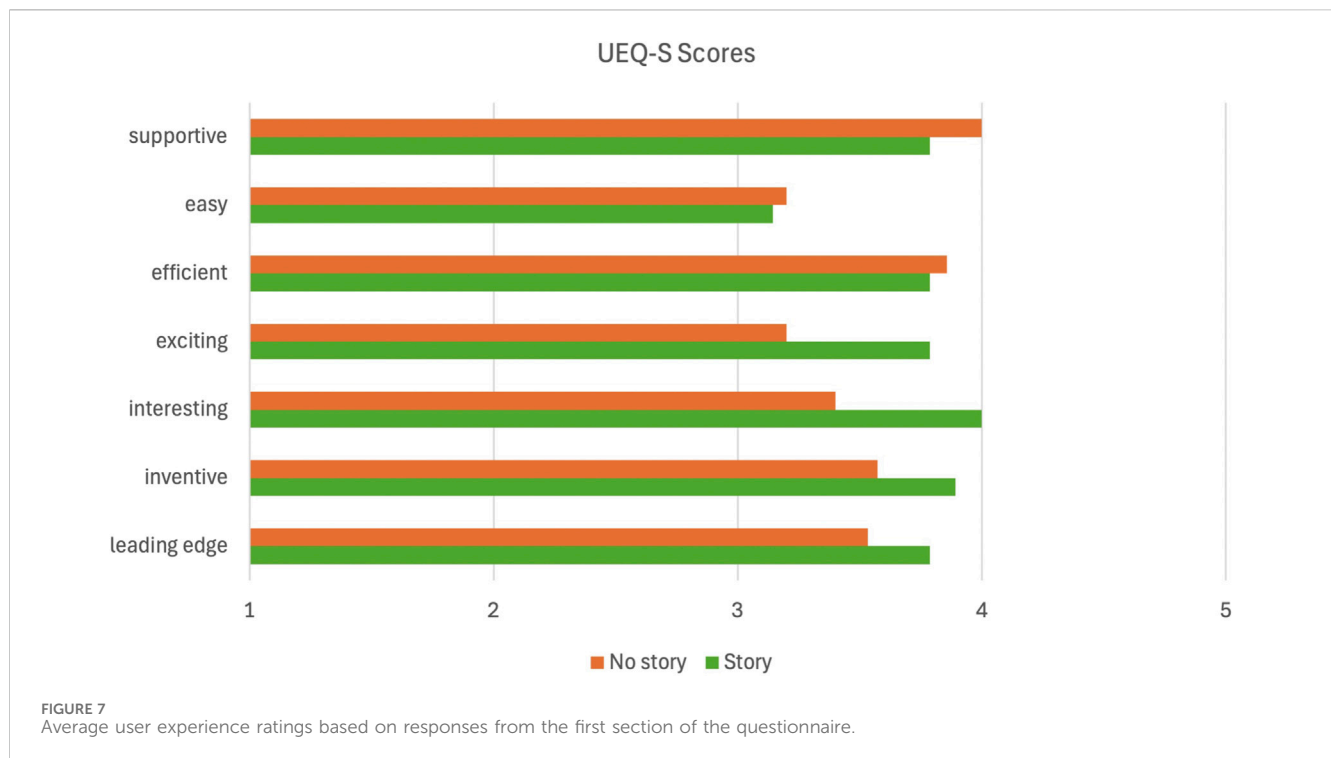
The results of relative asynchrony tests Table 5 also showed greater progress in the group without story. In this group, a significant reduction in relative asynchrony was observed for low and high difficulty rhythms ($p < 0.001$ and $p = 0.026$, respectively). The group playing the story version of the game also showed

improvements, but the changes were less substantial and less consistent, with significant improvements limited to certain patterns ($p = 0.028$ for low difficulty and $p = 0.046$ for high difficulty).

Improvements in synchronization of tempo Table 6 were more modest compared to synchronization of rhythm. The no-storytelling group showed slight improvements in all three tempo patterns, with lower standard deviations suggesting more consistent post-test performance. The story group showed improvements in the moderately difficult tempi, but showed slight declines in the easier and most difficult tempi, although these changes were also not statistically significant.

5.4.2 Summary

The results show that the participants who played the non-narrated version of the game generally improved more in absolute and relative rhythm asynchrony than the participants who played the version with the narrative. In terms of tempo asynchrony, slight improvements were observed in both groups, but these changes were not statistically significant. The group without the narration achieved greater improvements in synchronization, which could indicate that the tasks were less cognitively demanding and allowed for better concentration while playing.



5.5 User experience questionnaire

In the final phase of the research, participants completed a questionnaire about their experience of playing the game. The questionnaire was divided into three sections.

1. The evaluation of the game using items from the short UEQ, focusing on whether participants found the game to be more obstructive or supportive, complicated or easy, inefficient or efficient, boring or exciting, conventional or inventive, and usual or leading-edge.
2. Evaluation of certain aspects of the game in relation to the story (only for the group with the story version of the game).
3. General comments and opinions.

In [Figure 7](#), participants rated both versions of the game consistently on attributes such as being supportive, easy, and efficient, with the version without storytelling element slightly outperforming the version with the story. On the other hand, the storytelling version received higher average ratings for being exciting, interesting, inventive, and leading-edge.

The qualitative data from the open-ended questions were analyzed using thematic analysis. A recurring theme among participants who played the storytelling version was that the story provided enough content, but it became slightly bothersome when repeated in subsequent playthroughs. This perception is supported by the gameplay data, which shows that most participants viewed the story only once and then skipped it.

Further feedback showed that several participants particularly appreciated the narrative function. However, many felt that the game would be even more interesting if it contained a greater variety of levels, as the repetitive gameplay led to a loss of interest. In terms of their willingness to pay for the game, most participants indicated a

price range of 5–10 €, with players of the storytelling version showing a slightly higher willingness to pay on average.

6 Discussion

This study investigated the influence of storytelling on performance and user experience within the virtual game *Steady the Drums!* The participants were divided into two groups—one experienced the game with a narrative framework while the other interacted with a version devoid of storytelling elements. The evaluation encompassed various dimensions of user experience, including game attractiveness, player performance, and enhancements in rhythmic skill acquisition.

Interestingly, participants engaged with the non-narrative version for a slightly longer duration, averaging 110 min, compared to 100 min for their counterparts in the narrative version, even when extreme values were excluded. Questionnaire responses evidenced generally positive feedback across both groups; however, subtle distinctions emerged in the ratings. The non-narrative version received marginally better evaluations in pragmatic quality aspects, while the narrative variant excelled in hedonic quality, indicating that while storytelling can captivate and engage players, it may also introduce a repetitive experience. This aligns with findings from studies indicating that additional narrative elements can enhance engagement but may sometimes detract from gameplay depth and variety ([Chen, 2024](#); [Naul and Liu, 2020](#)).

Performance analysis revealed that players of the non-narrative version achieved a higher accuracy rate in rhythmic pattern execution and frequently reached advanced game levels. These patterns suggest a potential link between immersive environments and performance metrics, although some studies

emphasize the role of narrative in improving engagement and retention (Naul and Liu, 2020; Rowe et al., 2010). Furthermore, players with prior gaming experience consistently outperformed their less experienced peers across both game versions, highlighting the impact of player familiarity with gaming mechanics (Rodriguez et al., 2022).

The Tapping-PROMS test further emphasized the educational efficacy of the game, indicating universal improvements in performance metrics. However, comparative analysis suggested greater advancements in both absolute and relative rhythm asynchrony among non-narrative players. These results underscore the dual nature of storytelling in games; while it may enrich player engagement and satisfaction, it appears less effective in augmenting specific skill sets such as rhythm when compared to non-narrative counterparts (Feng and Murakami, 2025).

A notable limitation of this study is that participants played the game at home and not in a controlled environment. This may have introduced uncontrolled variables — such as distractions, different devices or environmental factors — into the study that could have affected performance and user experience, potentially impacting the results. The participant sample was also relatively small and homogeneous, which limits external validity and generalizability. To improve the results, future research will include participants from different age groups, cultural backgrounds and levels of familiarity with VR. Furthermore, the short duration of play may not fully reflect the long-term effects of storytelling on skill acquisition and engagement.

In summary, storytelling in virtual games appears to be associated with differences in user experience and performance outcomes. The findings suggest that the absence of narrative tends to be associated with higher performance and skill acquisition, while the presence of storytelling is associated with higher engagement and enjoyment. These observations are exploratory and should be interpreted with caution.

Future research should explore these dynamics further, investigating how narrative design can be optimized to balance engagement with effective learning outcomes (Ip, 2011). Beyond entertainment, the findings have potential applications in educational games, training programs, and therapeutic interventions, where a careful balance between narrative elements and task demands could help maintain motivation while supporting learning or rehabilitation outcomes.

7 Conclusion

In this research, we explored the effects of storytelling on user experience and the improvement of rhythmic skills in the virtual game *Steady the Drums!* We developed two versions of the game—one with and one without storytelling elements. Our aim was to investigate whether the inclusion of a story increases the appeal of the game, improves rhythmic skills and influences other aspects of the user experience.

The analysis of the playing time showed that the participants in the version without story played slightly longer on average than the participants in the version with story. The survey results showed that while the storyless version was perceived as easier and more straightforward, the story version performed better in terms of

the hedonic qualities of the user experience questionnaire. However, players of the story version of the game initially engaged with the story but skipped it on subsequent playthroughs, suggesting that the appeal was only temporary.

In terms of performance, the participants who played the version without the story showed greater accuracy in executing the rhythmic commands and progressed further in the game than the participants who played the version with the storytelling elements. However, both groups showed an improvement in rhythmic skills according to the Tapping-PROMS test. The greatest progress was seen with the easier and moderately difficult rhythms. The addition of storytelling elements to *Steady the Drums!* was associated with higher attractiveness ratings of the game and the interest of the players, but seemed to affect the players' concentration and performance in rhythmic tasks.

Storytelling can be associated with higher engagement in games. However, it is important to find an optimal balance between storytelling and gameplay to minimize distractions and maintain player concentration and performance. Further research with larger samples and longer test periods is needed to validate these findings and explore more sophisticated methods of integrating storytelling into games. Such research should aim to improve the user experience while maximizing educational outcomes.

Future studies could investigate the impact of storytelling on different age groups and varying types of educational content to identify age-appropriate and context-specific strategies. In addition, research could focus on developing personalized learning experiences by tailoring story elements to players' individual preferences and needs. Personalization could include adjusting the difficulty level of tasks, changing the length and complexity of stories, and incorporating different narrative themes and styles, all of which can help improve motivation, engagement, and learning effectiveness.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because Ethical approval was not required for this study as it only collected anonymized age and performance data from participants during gameplay, without gathering any personally identifiable or sensitive information. 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.

Author contributions

KŽ: Data curation, Investigation, Project administration, Writing – review and editing. ZP: Conceptualization, Formal Analysis, Methodology, Software, Visualization, Writing – original draft. MP: Conceptualization, Funding acquisition, Methodology,

Resources, Supervision, Validation, Writing – original draft, Writing – review and editing.

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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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