Title
STORYTELLING AND GAMING: UNPACKING THE IMPACT OF NARRATIVE ON OBJECT-LOCATION MEMORY

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Publication Date
2026-06-15

STORYTELLING AND GAMING: UNPACKING THE IMPACT OF NARRATIVE ON OBJECT-LOCATION MEMORY

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A capstone project submitted for Graduation with University Honors

May 07, 2026

University Honors

University of California, Riverside

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ABSTRACT

Spatial memory, the ability to encode and recall information about an environment, plays an important role in everyday tasks such as locating objects and navigating space. Object-location memory, a component of spatial memory, involves remembering both what an object is and where it is located. Although strategies such as storytelling have been suggested to support memory, and video game experience has been linked to enhanced spatial cognition, it remains unclear how these factors interact. This study examined whether gaming experience is associated with differences in object-location memory performance within a fictional narrative condition. Participants ($N = 40$) watched a narrative-based video in a Minecraft environment in which an avatar located objects, and then completed the Minecraft Memory and Navigation Task-2 (MMN-2), which assessed object accuracy, spatial location accuracy, and object-location binding. Results showed that Gamers demonstrated significantly higher object accuracy and spatial location accuracy compared to Non-Gamers, indicating stronger performance in remembering objects and their locations. However, no significant differences were observed in object-location binding or perceived mental effort. These findings suggest that gaming experience is associated with advantages in simpler components of spatial memory, but not in more complex integrative processes. As the study examined only a single narrative-based condition, conclusions cannot be drawn about the effectiveness of storytelling itself. Ultimately, the results indicate that prior experience influences spatial memory performance and that different components of memory are affected in distinct ways.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my faculty mentor, Dr. Kinnari Atit, for her continuous support, guidance, and encouragement throughout this research process. Her ability to challenge my thinking, provide constructive feedback, and inspire me to approach problems like a researcher has helped me become the researcher I am today. I am truly grateful for her mentorship every step of the way. I would also like to sincerely thank Nicole Colchete, whose work this study builds upon. As my mentor over the past few years, she has been instrumental in shaping my growth as a researcher. She guided me through every stage of the research process - from learning how to write and design studies to conducting analyses and interpreting results. She also generously shared her data and taught me the foundational concepts behind this study. Her mentorship made this project possible, and I am incredibly thankful for her time, patience, and guidance. I am grateful to Robert Wilbur for his unwavering kindness and for welcoming me into the research team. His guidance in helping me understand and run correlation and t-test analyses was invaluable, and his encouragement throughout the process meant a great deal to me. I would also like to thank Dr. Begoña Echeverria, Assistant Director Jane Kim, Dr. David Cocker, Amanda Herbert, and the entire University Honors program for providing the resources, support, and opportunities that made this journey possible. Their commitment to student growth allowed me to pursue my interest in research. Lastly, I would like to extend my appreciation to Provost and Executive Vice Chancellor Watkins for supporting the University Honors program through funding, including the HEIR Scholarship, which made my research experience possible.

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Introduction

Have you ever looked for your car keys on the coffee table, your phone in the kitchen, or your wallet on the nightstand? It's a daily memory challenge that shows the importance of recalling not just what we are looking for but also where it's located. This everyday task is made possible through your spatial memory. Spatial memory refers to the ability to encode, store, and retrieve information about an environment, allowing individuals to remember where things are and navigate through space. Although spatial memory supports navigation, the two are not the same, as navigation involves actively moving through an environment using remembered information and cues (Postma et al., 2008). Therefore, spatial memory is an essential cognitive process that shapes how we interact with the world. Spatial navigation refers to the process of moving through an environment using remembered layouts and cues. Object-location memory is a type of spatial memory that refers to the cognitive ability to remember and recall the locations of objects within a given space (Postma, Kessels, & van Asselen, 2008).

Although some individuals may appear to have above-average talent or skill when recalling spatial information, research indicates that spatial memory is malleable and can be shaped by cognitive and environmental factors such as video game experience, cognitive training, and narrative engagement (Clemenson et al., 2019; Granic et al., 2014; Pallavicini et al., 2018; Postma et al., 2008). Spatial memory has been shown to be trainable through approaches including virtual simulations, spatial reasoning exercises, and video game exposure, with effectiveness influenced by training type, duration, and individual differences (Uttal et al., 2013).

One particularly promising method for strengthening spatial memory involves immersive digital environments. For example, Clemenson et al. (2019) found that Minecraft's open-world, exploratory design strengthens hippocampal-dependent memory, suggesting that interactive virtual settings can effectively train spatial cognition and cognitive flexibility. These findings show that game-based environments can be useful tools for studying and improving spatial learning. Immersive digital platforms allow researchers to carefully manipulate elements of an environment while maintaining a high level of ecological validity (Slater & Sanchez-Vives, 2016). This helps bridge the gap between controlled laboratory experiments and real-world navigation, as virtual reality can simulate realistic scenarios while still allowing precise experimental control. These environments can also be used to create flexible, accessible programs that improve spatial learning for diverse groups of people, while offering scalable opportunities to design targeted interventions that support spatial learning across populations.

Another strategy for strengthening memory retention is fictional stories, which help individuals encode and retrieve information through meaningful associations, making it easier to remember important details, events, or concepts (Bruner, 1991; Riessman, 2008). While storytelling has been widely studied in educational and psychological fields, its direct impact on object-location memory remains underexplored, particularly regarding fictional narratives and their effects on gamers vs. non-gamers (Postma et al., 2004). Despite growing evidence supporting the cognitive benefits of video games and storytelling, research has largely focused on navigation skills rather than object-location memory (Clemenson et al., 2019; Granic et al., 2014; Simon et al., 2022). Consequently, it is still unclear whether embedding spatial information within a fictional narrative improves object-location memory, particularly when comparing individuals with different levels of gaming experience.

Research on video games and cognition expanded significantly following the pioneering work of Green and Bavelier (2003), who were among the first to demonstrate that playing action video games can modify fundamental spatial attentional processes. Importantly, they addressed concerns about selection bias by using experimental designs rather than relying solely on observational comparisons between gamers and non-gamers. Their findings showed that action video game training improved spatial selective attention and visual processing abilities. Subsequent research built on these findings, showing that action games enhance low-level perceptual functions such as spatial resolution and contrast sensitivity, as well as more complex spatial skills like mental rotation (Li et al., 2009). Compared to other genres, action video games appear to provide particularly strong benefits because they require players to rapidly locate targets, expand their attentional visual field, and process dynamic spatial information. Together, this work suggests that action video games may uniquely strengthen core cognitive processes that support spatial cognition.

Video game experience has been increasingly linked to stronger spatial cognition, especially in action-based and spatially demanding genres. Spence and Feng (2010) note that playing action video games has been shown to improve performance on complex spatial tasks such as mental rotation, indicating that the cognitive benefits of gaming often extend beyond the specific activities practiced in-game. Experimental findings further demonstrate that action game play can induce measurable changes in sensory, perceptual, and attentional abilities that support spatial thinking and memory. Early studies suggest that these spatial benefits may apply across genders. For example, research has shown that both men and women can equally improve on spatial tasks such as mental rotation and visual pursuit following training with shooter and other spatially demanding video games (Spence & Feng, 2010). These results suggest that gamers may enter object-location memory tasks with different cognitive strengths than non-gamers.

Examining differences between gamers and non-gamers is essential for understanding spatial memory because gaming experience has been linked to enhanced spatial skills such as navigation, memory, and problem-solving (Granic et al., 2014; Pallavicini et al., 2018). Video games often require players to track object locations, recall spatial layouts, and make rapid decisions based on environmental cues (Clemenson et al., 2019; Simon et al., 2022). This experience may provide gamers with an advantage in object-location memory tasks. However, it remains unclear whether storytelling strengthens or diminishes this advantage. Gamers who frequently engage in navigational and problem-solving tasks within virtual environments may exhibit differences in cognitive and behavioral responses to fictional stories compared to non-gamers. Understanding which factors support spatial memory across individuals can clarify how gamers and non-gamers differ in their responses to storytelling and whether narrative engagement can serve as an effective mechanism for improving object-location memory across groups (Postma et al., 2008).

One effective way to study spatial memory at the mechanistic level is to look at object-location memory, the building blocks and foundation of spatial memory. Object-location memory refers specifically to the ability to remember which object is in which location; it is simply "what is where." According to Postma, Kessels, and van Asselen (2008), this ability process relies on multiple components: object processing, spatial location processing, and binding objects to locations. Therefore, successful object-location memory requires more than remembering objects or locations separately; it depends on accurately integrating both into a unified memory representation. When any of these components fail, performance in object-location memory will decline. By isolating these components, researchers can better understand the mechanisms underlying spatial memory as a whole.

This study examines whether storytelling influences object-location recall differently for Gamers and Non-Gamers by considering various aspects of gaming experience and exploring whether fictional stories benefit these groups differently. I will analyze how a fictional story influences the various components of object-location memory and explore how narrative engagement and prior gaming experience interact to influence performance on a spatial memory task. These results could inform the development of educational tools, virtual training programs, and game-based learning strategies designed to optimize memory retention while guiding game developers in creating more effective and engaging educational games. This study is guided by the following research questions:

1. Do Gamers and Non-Gamers differ in MMN-2 object-location recall performance following fictional narration?

Secondary Research Questions

2. Is the level of gaming experience associated with spatial cognition outcomes (e.g., MMN-2 performance, spatial task scores)?
3. Do Gamers and Non-Gamers differ in perceived mental effort during the task?
4. Is perceived mental effort related to object-location recall performance?

For Research Question 1, I hypothesize that Gamers would demonstrate higher object-location recall performance on the MMN-2 task following fictional narration compared to Non-Gamers, reflecting advantages associated with prior experience navigating virtual environments. For the secondary research questions, it is hypothesized that greater gaming experience will be positively associated with spatial cognition outcomes. Additionally, Gamers are expected to report lower perceived mental effort than Non-Gamers during the task. Finally, I predict that lower perceived mental effort will be associated with higher object-location recall performance.

Methodology

All study procedures were approved by the Institutional Review Board at the University of California, Riverside (IRB: #30551) and are designed to meet ethical standards for research involving human participants, with participant confidentiality and data security maintained throughout the study in accordance with IRB guidelines.

Participants

The sample for this study consisted of 40 undergraduate students from the University of California, Riverside (UCR) who were randomly recruited to participate in a broader study examining how different types of narrative engagement influence object-location memory. All participants are undergraduate students enrolled at UCR, and this sample reflects the diversity of the university. A substantial proportion identified as Hispanic/Latinx or Asian/Asian American, which is consistent with institutional demographics. Race and ethnicity were reported using the same category labels employed by UCR's Institutional Research office (University of California, Riverside, Institutional Research, 2025). Participant race and ethnicity distributions are summarized in Table 1.

Table 1

Participants' Reported Race/Ethnicity

Race/Ethnicity	*N*	% total
Hispanic/Latinx	15	37.5
Asian/Asian American	12	30.0
Black/African American	5	12.5
White/European	2	5.0
Other	6	15.0

Note. Sex at birth: Female (n = 20), Male (n = 20). Total N = 40.

Participants were recruited through flyers, classroom announcements, word-of-mouth, and online postings distributed across campus. Eligibility criteria specify that participants must be at least 18 years of age and capable of providing informed consent. Participants were paid a $25 e-gift card for their participation in the study.

Measures and Materials

Demographics and Video Game Questionnaire

The Demographics and Video Game Questionnaire was adapted from Chrastil (2013) and designed to collect background information that may be relevant to spatial memory and narrative engagement. The questionnaire included seven demographic and background items, two items about video game experience, and two items about participants' behavior and interests regarding movies and books. All items were researcher-created and asked about the participants' top 3 favorite genres of video games, if they play video games for fun/leisure, the age they began playing video games, video game skill level, experience playing Minecraft, Minecraft skill level, and number of years of Minecraft experience.

Guay's Visualization of Views

The Guay's Visualization of Views (Guay & McDaniels, 1976; modified by Lippa et al., 2002) is a validated spatial task used to test an individual's perspective-taking skills. The task consists of 24 problems to be completed within 8 minutes. Each problem presents a three-dimensional transparent cube containing a figure. This is followed by a second image that shows the exact figure from a different angle, called the target figure. Participants must identify the correct corner of the cube that shows the figure from the same perspective as the target figure. Scoring followed Hegarty et al.'s (2009) method: each correct answer receives 1 point and each incorrect or skipped answer receives 0 points. The participant's total score is then calculated by the number of correct problems minus the number of incorrect problems, divided by 6 to adjust for guessing. The maximum possible score on the assessment is 24.

Corsi Block Task

The Corsi Block Task is a short-term spatial memory task designed to measure an individual's ability to encode, store, and immediately retrieve spatial information. In the virtual version, nine square blocks in one color appear on the screen against a black background. When the task begins, a subset of the blocks blinks in a different color in a random sequence. When the sequence of blinking blocks is complete, the participant is instructed to recreate the sequence by clicking the same blocks in the correct order. After the participant is finished clicking the block sequence they remember, they select the "done" button. Immediate feedback was provided to indicate whether their attempt was correct or incorrect. The sequence length begins with two blocks and increases after each correct trial. If the participant makes two consecutive errors, the task will end and the final score will be recorded. The final score is the Corsi block span, which is the number of blocks in the longest correctly recalled sequence. The Corsi Block Task (Corsi, 1972) is administered online through PsychToolkit (Stoet, 2010, 2017).

Passive Instructional Video

In the fictional passive instructional video, participants observed a Minecraft avatar navigating the Minecraft world to locate 12 objects placed in corresponding chest locations. The object and chest location information are embedded within a structured, plot-driven fantasy story narrated from the avatar's first-person perspective. The avatar followed a predetermined route to all 12 chests with each containing a unique object. Object and chest locations were clearly described and integrated throughout the story so that spatial information becomes part of the unfolding plot.

Fictional Story Narration Script

The fictional story condition used an original researcher-written script structured according to the Hero's Journey framework (Campbell, 1968). The script followed a protagonist through a sequential adventure and was designed to immerse participants in a narrative context while they viewed the passive instructional video. The story incorporated the 12 stages of the Hero's Journey, with each stage corresponding to one object-location combination presented in the video (Campbell, 2003). For example, the first object-location pair was introduced during the "Ordinary World" stage, followed by the second pair during the "Call to Adventure" stage, and so forth.

The narration was synchronized with the presentation of object-location pairs in the environment, embedding each spatial cue within a specific stage of the hero's journey. This design structured spatial information within a coherent narrative progression rather than presenting object locations as isolated details. The script was recorded as an audio narration and played concurrently with the video. By integrating spatial cues into the unfolding plot and character progression, the narration was intended to provide contextual support to facilitate memory for object locations.

Minecraft Memory and Navigation Task-2

The Minecraft Memory and Navigation Task (MMN; Simon et al., 2021) was adapted to assess the three components of object-location memory in this study. The original MMN task is a large-scale spatial memory and navigation task set in an open-field Minecraft environment. For the purposes of this study, the task was modified to measure object accuracy, spatial location accuracy, and object-location binding accuracy. In our adapted MMN task (i.e., MMN-2), participants first watched a passive learning video in which an avatar navigated a Minecraft environment and encountered 12 objects placed at specific locations. During the task, participants were then presented with an inventory containing 24 objects: 12 objects from the video and 12 new distractor objects (not shown in the video). Participants were instructed to select the 12 objects they remembered from the video and place each one in the location where they believed it had originally appeared.

Modifying the MMN task to require the participant to identify the correct object and place it in the location that the object was presented to them in the video measures all three components of object-location memory (object processing, spatial location processing, and object-location binding; Postma et al., 2004). Object accuracy was assessed based on how accurately participants identified the correct objects from the inventory. This was scored as the number of correctly selected objects. Spatial location accuracy was measured based on how accurately participants navigated to the correct locations in the environment, regardless of whether they selected the correct object. A placement was considered accurate if the chest was within ten blocks of the original location, following prior research (Simon et al., 2022). Object-location binding was measured by whether participants correctly matched each object to its original location. This was scored as the number of correct object-location pairings.

Object locations were placed at least 30 blocks apart to ensure that each object-location pair was learned independently and that one location would not cue another (Simon et al., 2022). Additionally, the environment was designed so that participants could not follow a simple or straight path between locations. Instead, they had to navigate through winding routes and varied terrain, increasing the reliance on spatial memory rather than simple route-following.

The task was conducted on a custom Minecraft server that housed the experimental environment. The server included custom plugins: programs that modify the rules and conditions of the environment to direct the tasks while simultaneously tracking data. The MMN-2 task plugin is programmed to track the objects participants choose from the inventory and the exact coordinates of where participants place each object in the environment. An additional tracker plugin also tracks the participants' step-by-step movements in the environment. As a result, comprehensive data on participants' behavior pertinent to their spatial memory is automatically generated when each subtask is completed.

Perceived Mental Effort and Post-Task Interview

Perceived mental effort was assessed using a self-report measure administered immediately following completion of the task. Participants were asked to rate the amount of mental effort they invested during the task on a 9-point scale, ranging from 1 (very low effort) to 9 (very high effort). Following this rating, participants were asked to describe what they remembered from the story and the strategies or thought processes they used while completing the task. They were also prompted to recall any specific details from the narration. Participants' responses were recorded for exploratory qualitative analysis and to provide additional context for their performance on the spatial memory tasks.

Procedures

The study took place during a single 90-minute in-person session at the University of California, Riverside's STEM Teaching and Learning Lab. Upon arrival, participants were provided informed consent and were assigned a participant identification number. Participants in the fictional narrative condition were balanced by gender. Participants first completed a set of individual-difference measures, including a demographics questionnaire, a video game experience questionnaire, Guay's Visualization of Views test, and the Corsi Block Task. After completing these measures, participants took a brief five-minute break.

Continuing into the second segment, participants received an explanation of the MMN-2 task and a tutorial on basic Minecraft commands that included the use of the W, A, S, and D keys, placing chests, opening the inventory, and placing an object in the first hotbar slot. Participants were instructed not to intentionally kill their avatar, as doing so would end the session. Participants then completed a practice task on a separate Minecraft server to become familiar with navigating the virtual environment and the MMN-2 task requirements. Next, participants watched a fictional passive instructional video featuring a Minecraft avatar that located 12 objects in specific chest locations. Immediately afterward, participants had ten minutes to complete the MMN-2 task by recreating the sequence of objects and locations within the same environment.

The study concluded with a recorded verbal post-task interview in which participants rated their mental effort on a scale from 1 (low) to 9 (high) and described what they remembered from the story, their thought process during the task, and details from the narration.

Composite Measure of Gaming Experience

Participants were classified into Gamer and Non-Gamer groups using a composite measure derived from the Demographics and Video Game Questionnaire. Classification was based on multiple indicators of gaming experience, including self-reported video game skill level, self-reported Minecraft skill level, and preferred top three video game genres. Self-reported video game skill level (N/A, Novice, Intermediate, Advanced, and Expert) served as the primary classification variable. Responses of N/A and Novice were categorized as Non-Gamers, whereas Advanced and Expert responses were categorized as Gamers. Participants who reported an Intermediate skill level were further classified using additional indicators, as this group had the highest frequency and did not clearly fit within either the Gamer or Non-Gamer categories.

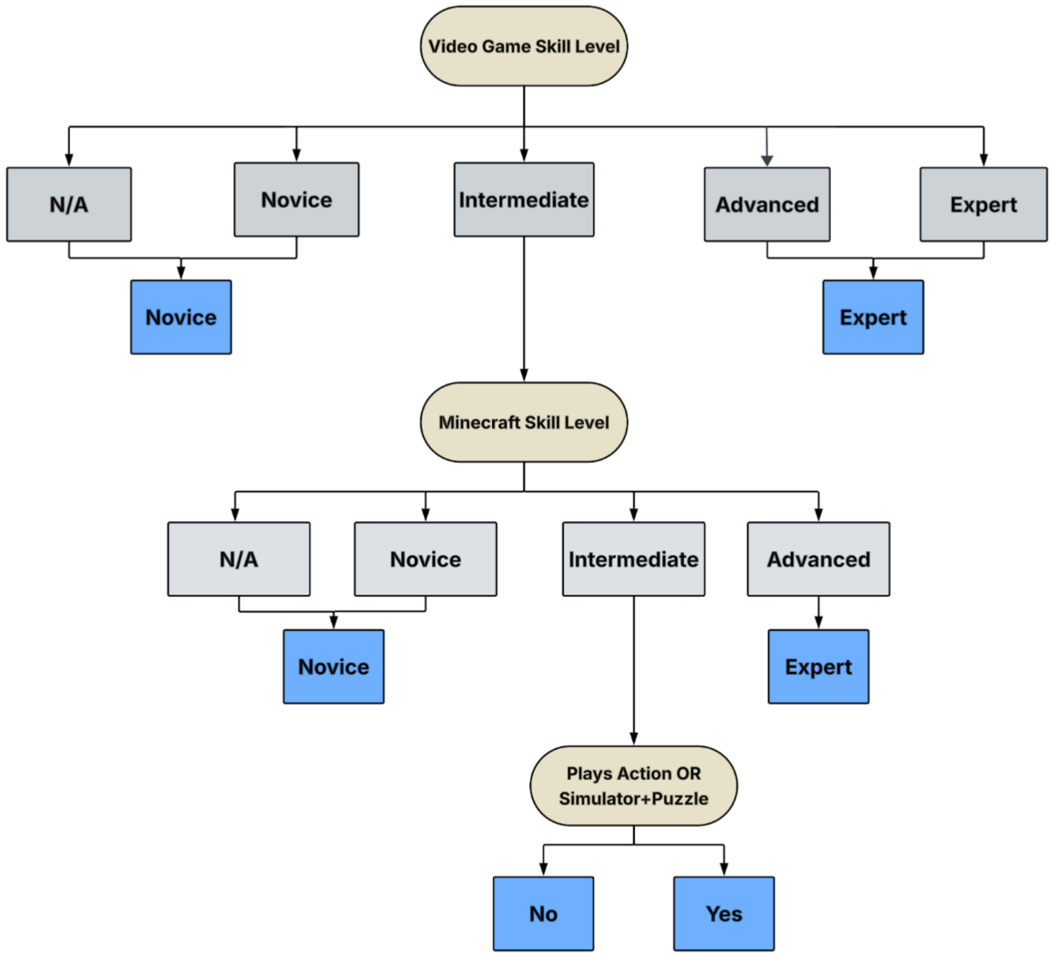
For participants reporting Intermediate video game skill level, Minecraft skill level (N/A, Novice, Intermediate, Advanced) was used as a secondary criterion. N/A and Novice responses were categorized as Non-Gamers, whereas Advanced responses were categorized as Gamers. Participants who remained in the Intermediate category were then classified by their preferred top three video game genres, as this group had the highest frequency again. For this final step, prior research was used to guide how different video game genres relate to spatial cognition.

Action video games are strongly associated with spatial cognition because they require players to track multiple objects, respond quickly to dynamic environments, and shift attention across locations (Spence & Feng, 2010). These demands enhance spatial attention by training players to selectively focus on relevant stimuli while filtering out irrelevant information, particularly in complex and rapidly changing visual environments. In addition, they strengthen visual processing by improving basic perceptual abilities such as detecting subtle differences, monitoring peripheral events, and coordinating visual input with motor responses, all of which are essential for object-location memory. Based on this, participants who reported playing action games were automatically classified as Gamers. Participants who did not report playing action games were still classified as Gamers if they reported playing both spatially demanding genres, specifically driving (or simulation) and puzzle (or maze) games, as these also involve spatial processing, though at a lower intensity. Participants who did not report playing any of these genres were categorized as Non-Gamers. This approach allowed for classification based on the cognitive demands of gaming experience rather than relying solely on self-reported skill level.

Following the application of these criteria, the final sample consisted of 15 Non-Gamers (Novice) and 25 Gamers (Expert). The decision process for categorizing participants into Gamer and Non-Gamer groups is illustrated in Figure 1.

Figure 1

Decision Procedure for Assigning Participants to Gamer and Non-Gamer Groups



Note. Beige circles indicate the Demographic Questionnaire used. Blue boxes represent combined categories used in analysis. N/A and Novice were classified as Non-Gamers, whereas Expert and Yes responses were classified as Gamers.

Results

Descriptives

At the end of data collection, the original sample consisted of 47 participants. Prior to analysis, 7 participants were excluded due to technical difficulties with the MMN-2 task, resulting in a final analytics sample of $N = 40$ undergraduate students from the University of California, Riverside. The sample was evenly distributed by sex at birth, with 20 males (50%) and 20 females (50%). Participants ranged in age from 18 to 31 years ($M = 20.25$, $SD = 2.67$), which is consistent with the age distribution of the undergraduate population.

Participants were also categorized by gaming experience. Of the final sample, 25 participants (62.5%) were classified as Gamers (Experts), while 15 participants (37.5%) were classified as Non-Gamers (Novices). Overall performance on the spatial cognition measures showed moderate variability. For the Object Accuracy score, participants obtained scores ranging from 0 to 12 ($M = 6.80$, $SD = 3.76$), indicating variability in participants' ability to recall objects encountered in the task. For the Visualization of Views (VoV) measure, scores ranged from -3.17 to 24.00 ($M = 13.30$, $SD = 7.59$), suggesting differences in spatial visualization ability across participants. The Spatial Memory measure scores ranged from 4 to 8 ($M = 6.22$, $SD = 1.03$), indicating variability in participants' spatial recall performance. Descriptive statistics for all study variables are presented in Table 2.

Screening and Assumptions

Prior to primary analyses, the dataset was screened for accuracy, missing values, potential outliers, and adherence to statistical assumptions. Descriptive statistics and visual inspection of boxplots were used to identify potential univariate outliers across the outcome variables, including perceived mental effort, spatial location accuracy, object accuracy, and binding accuracy. The interquartile range (IQR) method identified two potential high-value observations for the Binding Accuracy variable. However, these values fell within the expected range of the measure and were retained in the dataset. No extreme outliers were detected for the remaining variables. Assumptions of normality were evaluated by inspecting skewness and kurtosis for each variable; all variables fell within acceptable ranges, suggesting that the distributions were approximately normal within the sample. Independence of observations was assumed based on the study design, as each participant contributed data to only one group (Gamer or Non-Gamer). Since group sizes were unequal and variance differences between groups were possible, Welch's independent samples t-tests were used. This approach is appropriate when the assumption of equal variances between groups may not be met. Given that these assumptions were reasonably satisfied, Independent Samples *t*-tests were conducted to examine differences between Gamers and Non-Gamers on the MMN-2 spatial cognition outcomes and perceived mental effort.

Table 2

Descriptive Statistics for Study Variables

Variable	*N*	*M*	*SD*	Min	Max
Binding Accuracy Score	40	3.42	3.92	0	17.72
Object Accuracy Score	40	6.80	3.76	0	12
Spatial Location Accuracy Score	40	2.22	2.31	0	8
Spatial Memory	40	6.22	1.03	4	8
Perceived Mental Effort (Rating)	40	7.19	1.02	5	9
VoV	40	13.30	7.59	-3.17	24

Note. M = mean; *SD* = standard deviation.

Correlational Analyses

Pearson correlation analyses were conducted to examine relationships among the spatial cognition measures and perceived mental effort. It was hypothesized that perceived mental effort would be negatively associated with object-location recall performance. Spatial Memory was positively correlated with Spatial Location Accuracy, $r = 0.41$, $p < .01$. Object Accuracy was strongly positively correlated with Spatial Location Accuracy, $r = 0.65$, $p < .001$. Additionally, Spatial Location Accuracy was positively associated with Binding Accuracy, $r = 0.40$, $p < .05$. However, perceived mental effort was not significantly correlated with any spatial cognition measures, and thus, this hypothesis was not supported. No other correlations were statistically significant. All correlation values are presented in Table 3.

Table 3

Correlations Among Study Variables (N = 40)

Variable	1	2	3	4	5	6
1. Spatial Memory	—	—	—	—	—	—
2. VoV	0.07	—	—	—	—	—
3. Object Accuracy	0.30	0.13	—	—	—	—
4. Spatial Location Accuracy	0.41**	0.13	0.65***	—	—	—
5. Binding Accuracy	0.04	0.04	0.25	0.40*	—	—
6. Perceived Mental Effort	0.22	0.12	-0.05	0.25	0.29	—

Note. Values represent Pearson correlations. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

T-Test Analysis

Independent samples *t*-tests using Welch's correction were conducted to examine whether Gamers and Non-Gamers differed in perceived mental effort and MMN-2 spatial cognition outcomes. It was hypothesized that Gamers would demonstrate higher object-location recall performance and report lower perceived mental effort compared to Non-Gamers.

Results indicated that perceived mental effort did not significantly differ between Gamers (M = 7.16, SD = 1.08) and Non-Gamers (M = 7.23, SD = 0.94), $t(32.80) = -0.23$, p = .823, suggesting that both groups experienced similar levels of effort while completing the task. In contrast, significant differences emerged for some spatial memory measures. Gamers demonstrated significantly higher spatial location accuracy (M = 2.96, SD = 2.41) than Non-Gamers (M = 1.00, SD = 1.56), $t(37.70) = 3.12$, p = .003. Similarly, Gamers scored significantly higher on object accuracy (M = 7.76, SD = 3.71) compared to Non-Gamers (M = 5.20, SD = 3.36), $t(31.97) = 2.24$, p = .032.

However, no significant difference was found for binding accuracy, $t(22.75) = 0.92$, p = .365, although Gamers showed slightly higher mean scores (M = 3.91, SD = 3.38) than Non-Gamers (M = 2.62, SD = 4.70). Overall, these findings partially support the hypothesis, indicating that Gamers outperformed Non-Gamers on certain components of spatial memory, particularly object recall and spatial location accuracy, but not in perceived mental effort or binding accuracy. Full *t*-test results are presented in Table 4.

Table 4

Independent Samples t-Test Results Comparing Gamers and Non-Gamers

Measure	Gamers *M (SD)*	Non-Gamers *M (SD)*	*t*	*df*	*p*
Perceived Mental Effort	7.16 (1.08)	7.23 (0.94)	-0.23	32.80	0.823
Spatial Location Accuracy Score	2.96 (2.41)	1.00 (1.56)	3.12	37.70	0.003
Object Location Accuracy Score	7.76 (3.71)	5.20 (3.36)	2.24	31.97	0.032
Binding Accuracy Score	3.91 (3.38)	2.62 (4.70)	0.92	22.75	0.365

Note. Values represent means and standard deviations for each group. Welch's independent samples *t*-tests were used to compare Gamers and Non-Gamers.

Discussion

These findings suggest that Gamers and Non-Gamers do differ in MMN-2 object-location recall performance following fictional narration, but only for certain components. Specifically, Gamers demonstrated significantly higher object accuracy and spatial location accuracy compared to Non-Gamers, indicating an advantage in both object and spatial processing. However, no significant differences were observed in object-location binding accuracy or perceived mental effort. Additionally, perceived mental effort was not associated with spatial cognition outcomes. This may be because perceived mental effort is a subjective measure that does not always reflect actual cognitive performance, and the fictional narrative structure may have made the task feel similarly manageable for participants regardless of their performance. Overall, these results suggest that gaming experience plays a role in shaping specific aspects of object-location memory.

Taken together, these findings indicate that gaming experience improves simpler components of object-location memory more than complex processes that require integrating information. Specifically, the advantage observed in object and spatial location accuracy indicates that Gamers may be more efficient at encoding and retrieving individual elements of spatial information. This builds on prior research by Green and Bavelier (2003) and Spence and Feng (2010), which showed that video game experience enhances spatial attention, visual processing, and navigation-related skills. These cognitive processes are closely related to spatial memory, as spatial attention supports the ability to detect and track locations, visual processing helps with recognizing and encoding object information, and navigation experience contributes to forming mental representations of environments. Together, these processes support remembering “what” objects are present and “where” they are located, which helps explain the observed advantages in object and spatial location accuracy among Gamers. This study expands on past research by focusing on a more specific aspect of spatial cognition, specifically object-location memory, and identifying which components are most influenced by gaming experience.

In contrast, no significant differences were observed in object-location binding between Gamers and Non-Gamers. This suggests that while gaming experience may improve the ability to process “what” and “where” information separately, it does not necessarily improve the ability to combine these elements into a single memory representation. One possible explanation is that the cognitive processes strengthened by gaming, such as attention and visual tracking, primarily operate on individual elements rather than on integrating them. By isolating these components, this study adds to the spatial memory literature by showing that gaming-related advantages are not uniform across all aspects of spatial cognition. Instead, it highlights that different components of spatial memory are influenced in different ways, providing a more detailed understanding of how gaming experience shapes cognitive performance.

The absence of differences in binding accuracy and perceived mental effort further suggests that these aspects of performance may be influenced by different mechanisms than object or location memory alone. This may be because object-location binding requires more complex coordination across cognitive systems, making it less sensitive to the effects of gaming experience alone. Additionally, the fictional narrative may have provided a shared structure that helped all participants organize the information similarly, reducing differences in perceived effort. The lack of a relationship between perceived mental effort and performance also indicates that subjective effort may not be a reliable indicator of actual cognitive processing in this context. These findings suggest that while gaming experience improves certain spatial skills, other aspects of memory and perceived effort are influenced by different factors.

Understanding how gaming experience and fictional narration influence spatial memory is important because spatial memory is a fundamental cognitive process involved in navigation, environmental awareness, and everyday object-location recall. The results show that object-location memory is not a single process, but is made up of different components that are affected differently by experience. This matters because it suggests that improvements in memory do not apply equally to all aspects of spatial thinking. For example, experience such as gaming may help with remembering objects and locations, but may have less effect on more complex processes like binding objects to their correct locations.

This study has important implications for education and cognitive development. While interactive and narrative-based learning tools have been shown to increase engagement and support memory for meaningful, structured, and sequential information, such as story events and conceptual relationships (Bruner, 1991; Riessman, 2008), this study does not directly test whether storytelling improves learning outcomes. Instead, the findings demonstrate that within the same narrative-based task, Gamers outperformed Non-Gamers on certain components of object-location memory, suggesting that prior experience can influence learning outcomes even when the learning environment is consistent. This indicates that engagement alone may not be sufficient to support more complex memory processes. Rather, effective learning strategies may need to incorporate targeted activities, such as spatial recall or object-location matching tasks, that directly train these skills. This is particularly relevant for students, as spatial memory plays an important role in subjects like science, mathematics, and geography, where students need to visualize and remember where things are and how they fit together. For example, in biology, students need to remember where different parts of a cell are located.

These findings also have broader implications for real-world challenges related to cognitive health and technology use. Spatial memory difficulties are among the early indicators of conditions such as Alzheimer's disease and age-related cognitive decline, particularly impairments in spatial navigation and the formation of mental representations of environments (Lithfous et al., 2013). Such deficits can affect an individual's ability to navigate familiar environments and maintain independence, often emerging before more severe memory symptoms are observed. At the same time, increased reliance on tools such as GPS may reduce opportunities for active spatial processing, potentially weakening these skills over time. Additionally, differences in experience or educational exposure may contribute to variability in spatial abilities among children, which can influence performance in STEM-related fields.

Addressing these challenges requires more than simply increasing engagement. Instead, interventions should be designed to target specific components of memory. For individuals with memory impairments, structured environments, including narrative-based or virtual tools, may support learning. However, these should be combined with targeted practice to strengthen more complex skills. This study highlights the importance of designing educational tools and cognitive interventions that align with how memory works, combining engagement with structured, skill-based training to support effective learning and real-world memory performance.

Limitations

Despite these contributions, several limitations should be considered when interpreting the results. First, the sample size was relatively small ($N = 40$) and consisted of students only from the University of California, Riverside, which may limit the generalizability of the findings to broader populations. Second, gaming experience was measured using self-reports and grouped into categories, which may not fully capture individual differences in actual skill or experience. Third, the study examined only a single exposure to the task within the fictional narrative condition, making it difficult to determine the long-term effects of repeated engagement on spatial memory. Finally, although the MMN-2 task was conducted in a controlled and immersive Minecraft environment, this setting may not fully reflect how spatial memory operates in real-world contexts. These limitations suggest that future research should include more diverse samples, incorporate repeated exposure designs, and compare multiple learning conditions to better understand how these factors influence spatial memory.

Conclusion

Ultimately, this study shows that gaming experience was associated with better performance in remembering objects and their locations, but not in linking them together. This suggests that different components of spatial memory are influenced differently by experience. Importantly, Gamers outperformed Non-Gamers on the same task, indicating that prior experience continues to shape performance even within a consistent learning environment. However, because this study examined only a single narrative-based condition, no conclusions can be drawn about the effectiveness of storytelling itself. These findings highlight the importance of considering both prior experience and the distinct components of memory when evaluating learning and designing interventions.

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