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Performance In VR

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PERFORMANCE IN VR

by

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ABSTRACT

Psychologists once believed that memory was the result of a single-unitary memory system, and that memory was representative of a video recording. However, recent research has found that memory is malleable, and different factors can attribute to the accuracy of memory. Factors include internal bias, time since event, level of rehearsal, and outside influences. Specifically, the concept of false memories in regards to eyewitness testimony has garnered the attention of researchers. Prior research regarding false memories has looked at the impact of leading questions on memory accuracy. This study aims to explore the impact of leading questions on false memories utilizing virtual reality. The purpose of this study is to explore the impact virtual reality has on memory accuracy. It is believed that an immersive environment- such as a virtual reality scene- can affect how present an individual feels in the environment. The current study hypothesizes that the more present an individual feels in the environment, the less likely is it for them to be susceptible to false memories. This study used a 2×2×2 independent groups factorial design, with participants randomly assigned to each condition. The factors were immersion level (immersive vs. non-immersive display), virtual agent speed (accelerated vs. mirrored), and type of questions (leading vs. neutral). The results showed an association between leading questions and level of immersion, with the false memory effect apparent in the screen-based condition. The results of this study can help with the reliability in eyewitness testimony.

DEDICATION

To my incredible support system, for always supporting me, and encouraging me to be the better version of myself.

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Table of Contents

List of Figures

INTRODUCTION

As the years have progressed, the concept of memory has grown increasingly complex. In Squire's (2004) review of memory systems, it was noted that psychologists once believed that memory were the result of a single-unitary memory system. It was not until the mid 1980s that the concept of multiple memory systems was introduced (Tulving, 1985b). Declarative memory, a specific memory system, is best defined as memory that encompasses facts or events that an individual consciously remembers (Squire, 1987). For further memory classification, declarative memory is composed of semantic memory and episodic memory (Tulving, 1985a).

In the simplest terms, semantic memory is composed of an individual's knowledge about the world (Tulving, 1993). While, episodic memory is generally considered an individual's personal experience related to an event (Tulving, 1993). According to Tulving (1993), semantic memory can function separately from episodic memory, but the reverse cannot occur. Tulving (1993) identified a key component of episodic memory known as autonoetic awareness. Autonoetic awareness is described as the conscious awareness an individual possess when recalling a personal event (Tulving, 1993). It can be argued that conscious awareness is present in virtual reality due to how present the individual feels during the event.

Virtual Reality

The term virtual reality is best defined as the use of computer science and behavioral knowledge to simulate 3D objects in a virtual environment (Fuchs, Moreau, & Guitton, 2011). There are a variety of virtual reality systems: desktop-VR, headset-VR, and simulator-VR (Smith, 2019). The main difference between the three systems is the way participants view the virtual environment, otherwise known as level of immersion (Smith, 2019). There are two main

components of virtual reality: immersion and presence. Immersion is defined as a measurable level of sensory accuracy within a virtual environment, while presence is defined as an individual's personal psychological response to a virtual reality system (Slater, 2003). Since the level of immersion is based on the hardware/software used, its levels are controllable (Slater, 2003). Benefits of immersion include better spatial understanding, decrease in information clutter, increase in peripheral awareness, and an increase in useful information (Bowman & McMahan, 2007).

Compared to level of immersion, measuring presence can be difficult because it is subjective and based on the user's perception of presence. For this reason, presence can be divided into two main subgroups: descriptive and structural models. Descriptive models of presence are primarily concerned with exact measures of presence such as involvement, realness, and spatial presence (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015; Schubert, Friedmann, & Regenbrecht, 2001). While structural models of presence focus on the user's interpretation of presence through cognitive methods such as a mental representation of the environment (Diemer et al., 2015). It was concluded that an increase in the quality of immersion, resulted in an increase in presence when emotion was not a factor (Diemer et al., 2015).

Active vs. passive experience. Several studies have looked at the role of an active vs. passive experience in regard to memory (Cohen, 1989; Engelkamp & Zimmer, 1989). Literature on the subject has concluded that an active experience is closely aligned with the enactment effect: in which individuals that perform an action have a higher likelihood of recalling the event compared to individuals that view the action (Smith, 2019). For the purpose of this study, an active experience is defined as manipulating the VR system to reflect intended actions. This can

be expressed by moving a joystick. While a passive experience can best be defined as the subject merely taking in information. An example of a passive experience would be watching a video or listening to an audio recording.

False Memory Research

The term false memory is relatively new in the field of psychology. For the purpose of this study, false memory refers to the misremembering of events due to external factors; this is often referred to as the "misinformation effect" (Loftus & Hoffman, 1989). Loftus and Palmer (1974) discovered that misleading information alters an individual's memory of an event by replacing the original memory. Several research studies confirm these findings (Loftus, 1975; Loftus, 1991; Loftus & Hoffman, 1989). However, McCloskey and Zaragoza (1985) concluded that misleading information does not affect the original memory. There are two main theories of misinformation interference that can lead to false memories: memory impairment and source misattribution (Belli, 1989; Loftus & Hoffman, 1989).

Memory impairment refers to the idea that accessing the original event is made difficult due to the presence of the after-event. While source misattribution is the idea that both the original event and the after-event can be accessed (Belli, 1989). There are multiple factors that can influence the accessibility of a memory. These factors include "conditions of encoding, retention, and retrieval; individual differences; and their interactions" (Belli, 1989, p. 79). According to the source misattribution hypothesis, false memories may originate due to an attributing source error in which individuals misclassify or fail to remember a source and the corresponding information (Belli, 1989). When this occurs, individuals may use inference techniques to determine the correct origin of the information (Belli, 1989).

Current Study

This study aimed to explore the relationship between virtual reality and false memories. Prior research on false memories has explored the role of misleading information in memory impairment (Loftus & Hoffman, 1989). In Loftus and Palmer's (1974) research, the effect of leading questions on memory recall were examined using a passive experience approach. Participants were instructed to watch a video of a car accident and estimate the speed of the car after a series of misleading or neutral questions were asked. Results indicated that the way a question is presented influences the memory of the event (Loftus & Palmer, 1974). Previous research has not yet examined the role of false memories with virtual reality. This study utilized virtual reality to measure immersion and presence to determine if an active experience plays a role in memory accuracy when exposed to misleading information. It is hypothesized that the more 'present' an individual feels in the virtual environment, the less likely false memories are to occur. Findings may influence the role of eyewitness testimony in legal proceedings.

METHOD

Participants

Undergraduate students (n = 41) at the University of Central Florida were recruited using the Sona participant management system. Participants received extra or partial course credit in exchange for participation. Participants were at least eighteen years of age or older and had normal or corrected to normal vision. Ages ranged from eighteen years of age to thirty-six years of age, the majority of participants were eighteen years of age (n = 14). This sample included both genders, with males (n = 23) more represented than females (n = 18). The majority of participants indicated they were White (n = 25). The second highest sample of participants were Black or African American (n = 6). Mixed (n = 4), Asian (n = 4), and Other (n = 2) were among the least represented in this sample. Additionally, Hispanics (n = 16) represented slightly above a third of the participants.

Materials and Procedure

This study used a 2×2×2 independent groups factorial design, with participants randomly assigned to each condition. The factors were immersion level (immersive vs. non-immersive display), virtual agent speed (accelerated vs. mirrored), and type of questions (leading vs. neutral). The immersive display consisted of a virtual reality simulation using an Oculus Rift CV1 head-mounted display, while the non-immersive display was a standard 23 in. LCD desktop display. The virtual reality environment consisted of an outdoor scene in which there was an open field with rocks of various sizes on the ground. The environment also contained multiple green trees and a large tree in the center of the field (Figure 1a-c). In the virtual environment, a computer-controlled agent was shown on one side of the field and participant-controlled agent

was placed opposite of the computer-controlled agent. The objective of the simulation was to have both agents walk towards the large tree in the center of the field. Participants used the Oculus Touch controller to navigate the virtual environment. The virtual agent either mirrored the acceleration of the participant or accelerated by 10% over the participants' acceleration.

Following exposure to the simulation, participants were instructed to answer a series of questions. Participants were randomly assigned to answer leading questions or neutral questions. The questions were similar in concept, but varied in the words used. The leading question was "What color was the virtual agent that was racing you toward the tree?" while the neutral question was "What color was the virtual agent that was moving toward the tree?" Next, participants completed the Slater-Usoh-Steed presence questionnaire (Slater, Usoh, & Steed, 1994) and a demographic questionnaire. The Slater-Usoh-Steed presence questionnaire consisted of six items such as "to what extent were there times during the experience when the virtual environment was the reality for you" and "during the time of your experience, did you often think to yourself that you were actually in the virtual environment." Participants completed these surveys using pencil and paper. Participants then completed a three-back working memory test. The three-back test required participants to memorize a sequence of stimulus letters and determine if a given stimulus was identical to the one presented three trials prior. The three-back test was useful because it made it difficult for participants to actively rehearse the information presented in the virtual reality simulation. Finally, participants completed a memory test in which multiple questions were asked to determine if neutral or leading questions affected their memory of the simulation. The first test question was "estimate the speed of the agent." Participants selected a response based on a 5-point Likert type scale with 1 indicating "Very

slow", 2 indicating "Slow", 3 indicating "Neutral", 4 indicating "Fast" and 5 indicating "Very Fast". The second test question asked participants to "rate the degree to which they believe the virtual agent was behaving in a competitive manner." They selected a response on a 5-point Likert type scale with 1 indicating "Not at all competitive" and 5 indicating "Very competitive. The experimental session lasted approximately 30 minutes.

Figure 1. Virtual Environment Screenshot Part 1

Figure 2. Virtual Environment Screenshot Part 2

Figure 3. Virtual Environment Screenshot Part 3

ANALYTICAL APPROACH

After data collection, the percentage of correct responses will be calculated and used to complete a 2x2 independent groups ANOVA. The first factor in the 2x2 independent groups ANOVA is the presence vs. absence of leading questions. The second factor is the degree of immersion, the Oculus Rift CV1 head-mounted display vs. the standard 23 in. LCD desktop display. Two main effects will be examined. A main effect between the percentage of correct responses and the presence/absence of leading questions are both expected based on the hypotheses. Specifically, the expectation is a higher percentage of correct responses associated with the absence of a leading question, and a higher percentage of correct responses in the VR condition.

The hypotheses would also predict an interaction between these factors, showcasing that the effect of leading questions on false memories depended on the degree of immersion during the interaction period. Additional tests examining individual differences are anticipated using ANCOVA. Covariates will be gender and performance on the 3back test.

DISCUSSION

The purpose of this study was to determine if the presence of a virtual reality environment affected on memory accuracy when exposed to a leading or neutral question. The results from this study were consistent with the original hypothesis that stated the more immersive the environment, the less likely false memories are to occur. Findings concluded that false memory occurred in the LCD desktop display due to the non-immersive passive experience of the screen-based condition. Whereas the Oculus Rift CV1 head-mounted display was a more immersive active experience and therefore did not adhere to the false memory effect. This can be attributed to the fact that due to the immersive, active experience of the Oculus Rift CV1 head-mounted display, participants were able to visually take in the virtual surroundings-with limited outside interference- mimicking a real-life environment. In addition, participants in the Oculus Rift condition were able to physically control the movements of the virtual agent through the Oculus Touch controller; this is consistent with the enactment effect (Smith, 2019).

Limitations and Future Research

A limitation of this study was that demographic questions pertaining to participants' previous experience with VR were not asked. This would have been an important covariate to examine because participants with mild to extensive VR experience could potentially influence the results of the study. Future research should explore this avenue to determine if previous VR experience and if the type of VR equipment used had a role in the potential for false memories to occur. Another limitation of the study was that the sample size was made up of university undergraduate students. Utilizing only undergraduate students may influence the generalizability of the results.

Another limitation of this study was the length of the virtual reality simulation. Participants-on average- took about 2 to 3 minutes to complete the virtual reality simulation and were asked the leading vs. neutral question within 20 minutes of completing the simulation. Future directions of this research should look at the time between the simulation and the leading vs. neutral question response. Results may vary if the participant was questioned several days later vs. hours after the simulation.

Future research should examine if having the researcher orally ask the leading or neutral question has any impact on participant memory. Researcher intonation and word stress can be looked at as a possible covariate to determine if memory recall is affected. This would mirror the line of questioning used by police officials and lawyers to potential key eyewitnesses.

Conclusion

The goal of the current study was to determine if presence and immersion had a role in memory accuracy when subjected to a leading or neutral question. The study used virtual reality equipment to test different immersion levels. The results confirmed the original hypothesis, thus suggesting that false memories are less likely to occur in real-life.

APPENDIX A: SLATER-USOH-STEED QUESTIONNAIRE

Slater-Usoh-Steed Questionnaire (SUS)

1. Please rate your *sense of being in the* virtual environment, on a scale of 1 to 7, where 7 represents your *normal experience of being in a place*.
2. To what extent were there times during the experience when the virtual environment was the reality for you?
3. When you think back to the experience, do you think of the virtual environment more as *images that you saw* or more as *somewhere that you visited*?
4. During the time of the experience, which was the strongest on the whole, your sense of being in the virtual environment or of being elsewhere?
5. Consider your memory of being in the virtual environment. How similar in terms of the *structure of the memory* is this to the structure of the memory of other *places* you have been today? By 'structure of the memory' consider things like the extent to which you have a visual memory of the virtual environment, whether that memory is in color, the extent to which the memory seems vivid or realistic, its size, location in your imagination, the extent to which it is panoramic in your imagination, and other such *structural* elements.
6. During the time of your experience, did you often think to yourself that you were actually in the virtual environment?

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