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# How Different Training Types and Computer Anxiety Influence Performance and Experiences in Virtual Reality

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## Abstract

Virtual reality (VR) can place people in unique environments and facilitate engagement, making it a compelling tool for storytelling and learning. However, experiencing narratives requires immersion, which can be difficult for those who are anxious about technology. Prior research has shown that training new users on how to use VR before they engage in learning tasks housed in VR is critical. The right kind of training and targeted guidance may help people, including those with computer anxiety, better navigate virtual experiences. However, best practices for how training should be administered remain unclear. This study examined how training type (paper, video, and VR) and computer anxiety influenced outcomes using a large sample size ($n = 284$). We measured performance and self-reported outcomes while participants navigated computer-graphic scenes, manipulated three-dimensional objects, and watched a narrative 360° video. Results showed that participants who received training via video or VR mastered more VR functions than those who received training via paper. Additionally, those who trained directly in VR had less of a negative experience using VR for completing tasks. Furthermore, participants who trained in VR perceived the training as more useful and found the VR tasks to be easier compared to those who received training in paper or video. Finally, those with high levels of computer anxiety, regardless of training, had more negative outcomes than those with low computer anxiety, including having less mastery of VR functions and engagement with the 360° video content, perceiving the training as being less useful, completing tasks with more difficulty, and having more of a negative experience. Our results suggest that keeping the medium the same both during training and doing is ideal. We discuss implications for theories of information processing in VR, as well as implications for scaled engagement with narratives and learning in VR.

## Keywords

narrative; recall; storytelling; training; virtual reality

## 1. Introduction

Virtual reality (VR) is a powerful medium that can transport and immerse users into stories within virtual environments. As a result, VR has the ability to place scenes or experiences directly into the minds of users, making it a strong tool for storytelling, journalism, and education, where the feeling of "being there" may play a pivotal role. For instance, in journalism, research has shown that those who experience stories in VR feel more presence, interaction, and perceived source credibility than those who experience stories through text and pictures (Sundar et al., 2017). Similarly, in education, research has shown that those who learn in VR experience more presence, enjoyment, motivation, and learning transfer than those who learn through low-immersion media (Makransky, Borre-Gude, & Mayer, 2019; Meyer et al., 2019; Petersen et al., 2020).

However, VR has also been described as a double-edged sword: While VR may elicit higher arousal and presence, it has also shown to be particularly challenging with narratives, with the medium causing decreased focused attention, recognition, and recall (Ahn et al., 2022; Barreda-Ángeles et al., 2020). VR experiences are often multisensory, meaning viewers are exposed to visual, auditory, and haptic feedback at once. As a result, the cognitive resources required to process presented material may exceed cognitive capacity (Mayer & Pilegard, 2005). The features that make VR attractive, such as interactivity and presence, may reduce their effectiveness by overwhelming users who have to adapt to the technology and leading users to engage in extraneous processing that does not support the intended goal of the material (Mayer et al., 2022). Furthermore, VR has been shown to have a slow learning curve: Providing ample time and training to adjust to the medium is critical prior to expecting users to engage with the presented material (Han et al., 2022).

In this vein, to realize the full potential of the technology, allowing users to familiarize themselves with the medium through training is a critical step (Han & Bailenson, 2024). However, training can come in different forms, such as paper-, video-, and in-person-based instruction, each of which may yield different outcomes for different people. This current study investigates three forms of training prior to using VR to complete various tasks and watch a 360° video, to see how individual differences in computer anxiety influence outcomes.

## 2. Background and Previous Work

### *2.1. Processing Information in Immersive VR*

The cognitive theory of multimedia learning posits that the type of processing that users engage in while learning in immersive VR leads to different outcomes (Mayer & Pilegard, 2005). Similarly, in storytelling, if a viewer experiences cognitive overload, there may be undesirable consequences, such as negative feelings of frustration and confusion (Feng, 2018). Such consequences are a result of extraneous processing, which occurs when there is distracting or irrelevant information. This is a particular concern for VR because it has a higher level of extraneous content compared to other media such as video (Makransky, Terkildsen, & Mayer, 2019; Moreno & Mayer, 2002). VR users may spend more time exploring the environment around them, which may divert their attention away from events that are central to the main narrative—a conflict described as the "narrative paradox" (Aylett, 2000; Barreda-Ángeles et al., 2020). The multisensory nature of VR or the high spatial presence that the medium provides has been shown to lead to users having to process simultaneous streams of information and affect how information is processed (Ahn et al., 2022; de Barros & Lindeman, 2013).

Furthermore, people who are unfamiliar with the technology or those with computer anxiety may have more difficulty learning due to the novelty of figuring out how to use the medium and interact with the environment (Makransky, Terkildsen, & Mayer, 2019; Wu et al., 2020). Additionally, those with computer anxiety tend to have more negative technological experiences (Torkzadeh et al., 2006). A study by Ahn et al. (2022) investigated the role of computer anxiety in users' ability to engage with a narrative about the consequences of ocean acidification either in VR or a video. They found that individuals with high computer anxiety experienced greater spatial presence regardless of media, compared to those with low computer anxiety. Results suggested that those with more computer anxiety have to allocate more processing resources to engage in spatial presence in the media, whereas those with lower computer anxiety were able to allocate fewer processing resources to spatial presence, leaving more resources to process information. Accordingly, those with high spatial presence led to lower recall of the mediated information.

Research has also found that time spent with media and experience can influence both self-reported and nonverbal outcomes (Bailenson & Yee, 2006). For example, Han et al. (2023) investigated how people's experiences may change as they grow more comfortable using VR. The results suggest that, over time, as people grow accustomed to VR, they may be able to focus more on being present and paying attention to their surroundings, and less on learning how to navigate the environment and the medium. Other longitudinal studies have shown similar results, suggesting that without learning how to use VR first, people cannot fully process what they experience in VR (e.g., Han et al., 2022).

### 2.2. The Role of Training Prior to the Use of Technology

The process of training can enable individuals to gain attention, set expectations, and enhance learning via symbolic coding (Mesmer-Magnus & Viswesvaran, 2010). Specifically for training prior to using technology, training can improve perceived self-efficacy, reduce unnecessary cognitive load, and impact confidence (Jung et al., 2019; Saville & Foster, 2021; Torkzadeh & Van Dyke, 2002).

However, training has shown to vary in effectiveness, as it can be impacted by individual differences, method, and content (Arthur et al., 2003; Cannon-Bowers et al., 1998). Given this, there has been limited research focusing on the different modalities of training, such as static paper-based training and animated video-based training (Höffler & Leutner, 2007). Paper-based training has been argued as having increased accessibility, allowing individuals to control their pace and engage in active processing. Meanwhile, with video-based training, both auditory and visual information can be presented to strengthen each other. Video training can additionally provide an easy-to-follow model for the individual to be able to learn and mimic the observed actions (van der Meij & van der Meij, 2014).

Past research examining VR training has shown that it helps the user experience to train people before they enter VR to reduce the novelty effect and help them navigate the environment (Miguel-Alonso et al., 2023). Training prior to VR use has improved satisfaction during learning, lowered cognitive load when presented with novel concepts, and increased retention and transfer (Meyer et al., 2019; Miguel-Alonso et al., 2023). Meanwhile, those without training were more overwhelmed with sensory information, likely because they did not have resources to effectively select, organize, and integrate information into long-term memory (Meyer et al., 2019). Finally, another study by Liu et al. (2021) showed that providing preparatory information to read prior to an embodied immersive VR program promoted transfer of skills.

Similarly, training interventions, which are activities that are performed prior to the task that counteract specific negative aspects, have shown to be successful. For example, providing attentional advice successfully reduced distraction and increased learning during a VR program (Howard & Lee, 2019). However, computer anxiety has been shown to reduce the effectiveness of training. A study by Torkzadeh et al. (2006) examined the relationship between training and computer self-efficacy, and how this was influenced by computer anxiety. Students part of a course learned about computers and interacted with them. Results showed that, while training significantly improved computer self-efficacy, those with low computer anxiety improved their self-efficacy significantly more than those with high computer anxiety (Torkzadeh et al., 2006).

### *2.3. Context-Dependent Memory and Narrative Engagement*

One way to display engagement with a narrative is to examine what users remember following the experience. Prior literature on context-dependent memory shows that people's memory retrieval is better when they are in the same context in which the memory was encoded. According to the encoding specificity principle, a retrieval cue will be effective in prompting recognition if it was encoded with the relevant item during learning (Tulving & Thomson, 1973). For example, in an iconic study by Godden and Baddeley (1975), divers learned passages of prose either on land or underwater, and were then asked to recall the words in the same or different environment. Participants recalled more words when they were tested in the same environment in which they learned them.

Since those early studies, several distinctions have been made related to the context, such as the intrinsic and extrinsic context, which distinguishes the semantic aspects of the stimulus that are processed when it is perceived (i.e., intrinsic context) from characteristics of a situation that are irrelevant to the processing of the stimulus itself (i.e., extrinsic context), with the latter having less of an influence on memory retention (Hewitt, 1977, as cited in Godden & Baddeley, 1980). Similarly, Baddeley (1982) argues that cues during encoding and retrieval can either interact meaningfully (i.e., interactive context) or have no meaningful interaction (i.e., independent context). This research points towards the direction that, not only does the context in which recall or recognition occurs matters, such that being in the same context yields improved performance, but how cues are processed and interact during both processes also matter (Uncapher et al., 2006). As such, training and learning instructions directly in the same context in which these instructions need to be performed may yield better results than having the encoding process be in a different context or medium.

There are unique considerations when it comes to learning in virtual environments, as VR can transport learners to different types of environments that provide varying levels of interactivity. As such, users are actively engaging with, rather than passively receiving material. Unlike media such as paper or video, VR allows for embodied actions and control of environmental attributes and behaviors. As such, this active engagement uses cognitive resources. Such affordances ultimately allow for more engagement, as well as contextual and experiential learning (Dalgarno & Lee, 2009), which are critical during the knowledge-construction process (see work under the constructivist theory). In VR, the level of interactivity during training can be considered a form of context, given how central the feature is to the medium.

## 3. Current Study

While past research focuses on the presence or absence of training or training interventions and how this influences outcomes after a VR experience, very few studies compare the effectiveness of different modalities of training or consider individual differences such as computer anxiety. This study examines the outcomes of people undergoing various types of training prior to engaging with VR-based tasks and narratives. Our research question is as follows: How will training type influence perceptions of using VR for learning for individuals, and will this vary for those with high or low computer anxiety? Participants went through one of three trainings: (a) reading instructions on a paper, (b) watching a video walking through the instructions, or (c) directly experiencing the instructions in VR. Following the training, participants took part in various activities in VR that they had learned in the training and then watched a 360° video. Measures such as recall of VR functions (i.e., mastery of VR functions), content presented in the video (i.e., engagement with the 360° video content), negative VR experience, perception of the effectiveness of training, and ease of completing tasks, were evaluated. Using a large sample size, we consider how individual differences, such as having computer anxiety, may influence perception of VR as well as learning and recall.

## 4. Methods

### *4.1. Participants*

Participants were from a large public university in the eastern United States. A total of 297 participants underwent both the training and the VR-based portion of the study, and 13 were unable to proceed either due to physical constraints, such as the head-mounted display (HMD) not fitting over glasses or technical difficulties. The 284 participants (male = 149, female = 134, non-binary or other = 1) that were included in this current analysis were between 17 and 31 years old ($M = 19.8$, $SD = 1.62$) and identified as African American ($n = 33$), Asian ($n = 57$), Caucasian/White ($n = 139$), Hispanic ($n = 26$), other ($n = 1$), or did not respond ($n = 28$). Most participants had either no prior experience (32.6%) or very little experience with VR (used 5 or fewer times, 52.5%). Some participants had tried VR many times before (used 5–20 times, 11.7%) and very few had a lot of prior experience (used 20–100 times, 3.2%).

### *4.2. Hardware*

Participants either used a Pico Neo 2 (standalone display with 1920 × 2160 resolution per eye, 101° FOV, 75 Hz refresh rate, and six-degree-of-freedom inside-out head and hand tracking, 350 g) or a Meta Quest 2 (standalone display with 1832 × 1920 resolution per eye, 98° FOV, 90 Hz refresh rate, and six-degree-of-freedom inside-out head and hand tracking, 503 g) and two hand controllers (126 g). A total of 97 participants used Pico Neo 2 HMDs. A switch to Meta Quest 2s ($n = 187$) was made due to the experimental software platform no longer being supported by the former HMD in the middle of the study. Headset type was included as a covariate in our models (see Section 4.7 for details about the models) but was trimmed for robustness, as it was insignificant for the majority of the outcomes. While the switch from one HMD to another was based on platform updates, there is a benefit to generalizing findings across two separate hardware systems.

### 4.3. Software

Each participant took part in the VR portion of the study in a social VR platform called ENGAGE. In this platform, participants use avatars—embodied visual representations of the participants—to navigate virtual environments. With the hand controllers, participants can translate or teleport around a virtual environment, sit in a virtual chair, draw, and manipulate 3D objects. Participants can also use a virtual tablet or menu to select and add new 3D objects, take pictures, and react using emojis. A private (password-restricted) session was set up for the participants to enter a virtual environment, the “Rooftop Garden (Night)”.

### 4.4. Independent Variable

In this between-subjects study, participants were randomly assigned to one of three training type conditions: paper, video, or VR. Across all conditions, participants underwent similar training tasks on how to navigate a virtual environment using an HMD. In the paper condition, participants, alongside the research assistant, read a guide that was printed on paper. The guide included relevant figures of the software interface. Additionally, the research assistant demonstrated how to use the hand controllers to complete each task (for the written instructions, see Supplementary Material A). In the video condition, participants viewed a video guide presented on a computer screen. The video included instructions on how to use the controllers to complete each task. In the VR condition, the participant, alongside the research assistant, put on HMDs and went into the virtual environment. Inside the virtual environment, the research assistant walked the participant through the tasks and explained how to use the controllers to complete each task.

### 4.5. Procedure

Before coming to the lab, participants received an information sheet for consent to participate in the university’s Institutional Review Board-approved study. They completed a questionnaire (pre-test) covering demographics, computer anxiety, and prior experience with VR. Once at the lab, participants were given the opportunity to ask any questions or concerns about the study. Participants were randomly assigned to one of the three training types (paper, $n = 95$; video, $n = 93$; or VR, $n = 96$). In all conditions, participants were trained to navigate a virtual environment using an HMD.

Following their training, participants put on the HMD to begin the learned tasks. They were advised to stop the study if they felt uncomfortable, uneasy, or any motion sickness at any point. Participants were given steps on how to join the virtual environment, which was set up prior to the study. The HMD content was mirrored onto a desktop computer to allow the research assistants to see what the participants were seeing. Once in the virtual environment, participants were asked to display mastery of the tasks they had learned in the training (see Figure 1). During this time, the research assistant filled out a questionnaire on their perception of the participant’s experience, including technological difficulties and mastery of tasks.

Following the tasks, the research assistant transported the participant virtually to a different application to watch a 360° video, *Tour Japan’s Ancient History and Modern Marvels in Stunning 360-degree VR* (Discovery, 2017). The 360° video includes graphics displaying cultural historical and contemporary scenes in Japan and includes a narration and walkthrough of the cultural and historic aspects of Japan, such as samurai, fashion, and technology (see Figure 2). This particular 360° video was selected because it is both experientially immersive and has a narrative that presents factual information that is displayed and reinforced in the video. Initial pilot testing showed participants remembered the information presented and were engaged in the video. Once the 360° video was over, the HMD was removed, and participants completed a questionnaire (post-test) on their experience.


**Figure 1.** Participants were instructed to: (a) walk to the back of the virtual environment until they reached a group of benches around a table; (b) teleport up the stairs and stand next to one of the benches; (c) teleport and sit in one of the bench seats; (d) pull up the tablet, close the tablet, and then open the tablet again; (e) open up the menu and add a teapot 3D object into the virtual environment and place it on the table; (f) pick up the teapot; (g) put the teapot down and open the tablet again to take a picture of the teapot; (h) delete the teapot from the virtual environment; and (i) open the tablet again to use one of the emoji reactions.

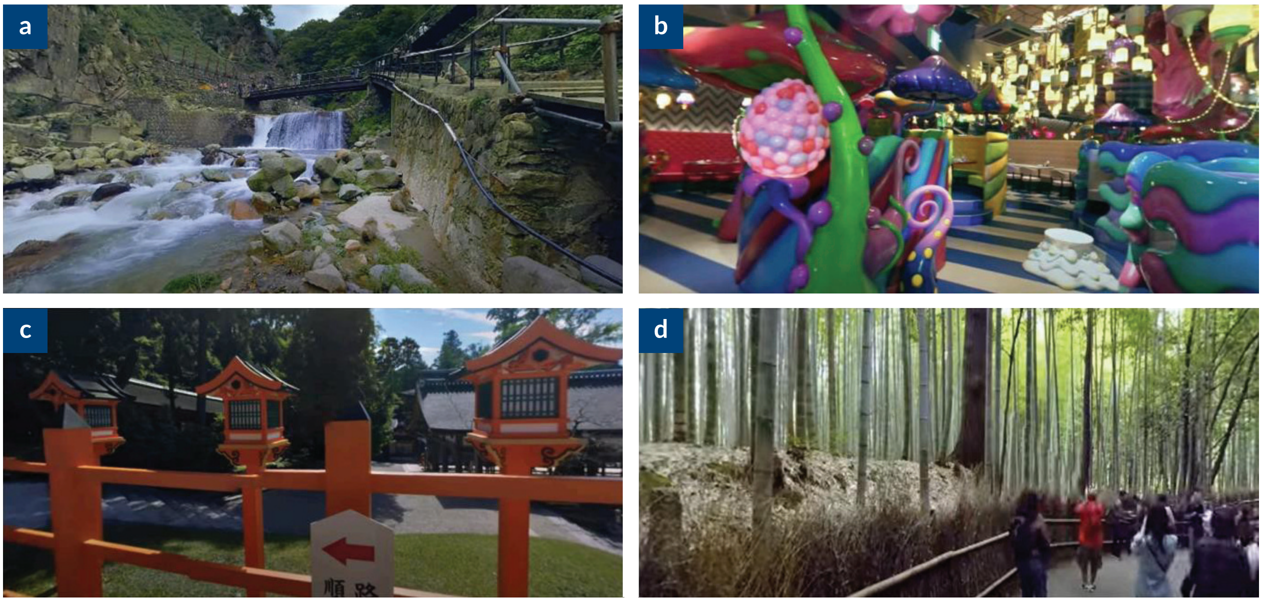


**Figure 2.** Sample panels from the 360° video where scenes depict (a) fresh water and animals, (b) a fashionable spot in Tokyo, (c) a temple, and (d) a bamboo forest.

Two weeks after the lab experience, participants were sent a link to another questionnaire (delayed post-test) about that day's experience (see Figure 3 for the order and medium of each step of the procedure).

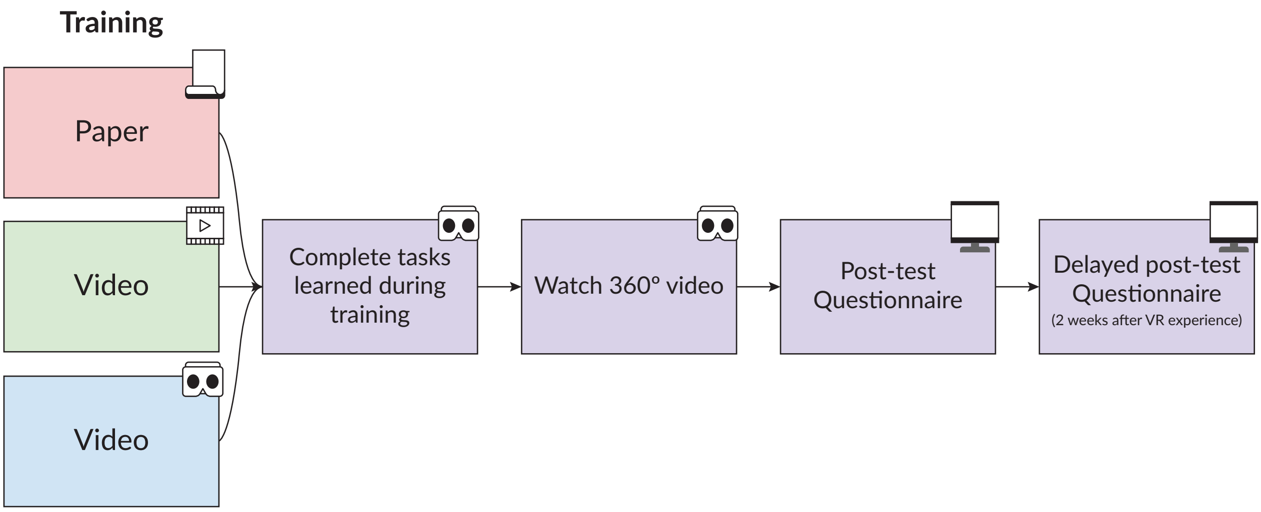


**Figure 3.** The order and medium in which participants completed each task of the study.

### *4.6. Measured Variables*

Various questions were asked prior to, immediately after, and two weeks after the VR HMD experience. Participants were asked questions about their attitudes and experience in VR. There were additional scales administered during the post-test questionnaire or the delayed post-test questionnaire which we tested, but were not statistically significant: five about attitudes towards the medium (enjoyment, usefulness, positive valence, spatial presence, and realism) and one about simulator sickness. We do not include those analyses in the body of the article due to space constraints, but the statistics are reported in Supplementary Material D.

#### 4.6.1. Computer Anxiety

Computer anxiety was measured prior to the study as an individual difference measure. Computer anxiety was measured by nine items adapted from Torkzadeh et al. (2006; which were developed by Heinssen et al., 1987) using a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*). Sample items include "I hesitate to use a computer for fear of making mistakes that I cannot correct" and "I feel insecure about my ability to fix computer-related problems." The means of the nine items were calculated (Cronbach's $\alpha = 0.87$), with higher scores indicating a greater computer anxiety ($M = 2.76$, $SD = 0.93$).

#### 4.6.2. Mastery of VR Functions

Mastery of VR functions was measured as the total number of correct responses to 18 multiple-choice questions about how to perform the tasks participants had learned in the training. These functions were presented during training and participants repeated them during the VR experience. Sample questions included recalling what hand controller was used to teleport, the steps of adding a 3D object into the virtual environment, and the steps of taking a picture. Scores were computed by summing the number of correct answers for each participant ($M = 10.03$, $SD = 4.25$, max = 18, min = 1; for the complete list of questions, see Supplementary Material B).

#### 4.6.3. Engagement with 360° Video Content

Engagement with the 360° video content was measured as the total number of correct responses to nine multiple-choice questions about the material covered by the 360° video. Sample questions included "Which weapon was being crafted by the fire in the video? (Options: Spear, Dagger, Samurai, Katana)" and "The traditional Japanese sport featured in the video is (Options: Jūjitsu, Wrestling, Sumo wrestling, Kendo)." Scores were computed by summing the number of correct answers for each participant ($M = 5.12$, $SD = 1.64$, max = 8, min = 1; for the complete list of questions, see Supplementary Material C).

#### 4.6.4. Negative VR Experience

How negative the participant's experience was in VR was measured by nine items adapted from Torkzadeh et al. (2006) using a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*). The items were adapted to assess whether participants perceived their VR experience as negative. Sample items include "It took a lot of time to figure out how to do things in VR" and "The VR experience was very frustrating." The means of the nine items were calculated (Cronbach's $\alpha = 0.91$), with higher scores indicating a more negative experience ($M = 2.14$, $SD = 0.97$).

#### 4.6.5. Perception of Training

Participants' evaluation of how useful they found the training was measured by six items created for this study using a 5-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*). Sample items include "I learned everything I needed during the training" and "I need more training to be successful" (reverse-coded). The means of the six items were calculated (Cronbach's $\alpha = 0.82$), with higher scores indicating that the training was perceived as more useful ($M = 4.32$, $SD = 0.68$).

#### 4.6.6. Self-Rated Perceived Ease of Tasks

Participants' self-evaluation of the perceived ease of completing each task in the social VR platform was measured using a 5-point Likert scale (1 = *extremely difficult*, 5 = *extremely easy*). Sample tasks included sitting in the bench seat or placing a teapot on the table. The means of the seven tasks were calculated, with higher scores indicating that the tasks were completed with more ease ($M = 4.37$, $SD = 0.49$).

#### 4.6.7. Research Assistant-Rated Perceived Ease of Tasks

Similar to the participants' self-evaluation of the perceived ease of completing each task, the research assistant who was present during the study evaluated their perception of the participant's ease of completing each task using a 5-point Likert scale (1 = *extremely difficult*, 5 = *extremely easy*). The means of the seven tasks were calculated, with higher scores indicating that the tasks were completed with more ease ($M = 4.37$, $SD = 0.49$).

### 4.7. Data Analysis

We used one-way ANOVA with computer anxiety as a covariate (ANCOVA) to model the immediate post-study outcome variables as a function of the independent variable, training type. An interaction term between the covariate and independent variable was tested but trimmed due to insignificance. We additionally tested prior VR experience as a covariate and tested for interactions, but it was insignificant for the majority of the outcomes. Shapiro-Wilk tests were used to test the normality of the data distribution and Levene's test was used to examine the homogeneity of variance. The outcome variables of interest, including transformed data, were found to have a non-normal distribution ($p < 0.05$). Given this, we fit the data using linear mixed-effects models, which yielded the same or similar results. We report the results from the ANCOVA here and provide the output for the linear mixed effects models in Supplementary Material D for comparison. Statistical significance was evaluated at $\alpha = 0.05$. If the ANCOVA indicated differences among the three conditions, post-hoc analyses were conducted to determine the specific differences. The outcome variables were either tested by Tukey's HSD if Levene's test was $p > 0.05$, which is appropriate when performing all pairwise comparisons and is less conservative and more robust to non-normality (Lee & Lee, 2018), or the Games-Howell test if Levene's test was $p < 0.05$, given its robustness to unequal variances (Agbangba et al., 2024).

To assess the changes in participants' responses after two weeks, we conducted a standard RMANOVA. The results are presented by the grand intercept (the average response across training type and time, $\gamma_{00}$), the time-related trend (overall change in responses over time, $\gamma_{10}$), the main effect of the condition ($\gamma_{20}$), and the influence of individual differences in computer anxiety at the initial level ($\gamma_{01}$). Any interaction terms, including the interaction between the condition and the individual difference covariate, as well as the interaction between time and condition, were tested and trimmed due to insignificance.

Prior to any analyses, any outcome variables where straight-lining occurred (i.e., selecting the same scale point for all construct items) and cases that were less or greater than three standard deviations (i.e., outliers) were dropped (Müller et al., 2014). All models were fit to the data in R using the "stats" (R Core Team, 2019) and "nlme" packages (Pinheiro, 2024). Post-hoc tests were done using the "emmeans" (Lenth et al., 2024) and "rstatix" packages (Kassambara, 2023). Levene's test was employed using the "car" package (Fox et al., 2023). Figures were generated using the "ggplot2" package (Valero-Mora, 2010).

## 5. Results

### 5.1. Mastery of VR Functions

There was a main effect of training type on mastery of VR functions, $F(2,263) = 4.93$, $p = 0.00792$, $\eta_p^2 = 0.04$. Tukey's HSD post-hoc tests revealed significant differences between those in the paper and video training types, as well as those in the paper and VR training types ($ps < 0.05$), such that those who received video and VR training mastered more VR functions (Figure 4a). Additionally, there was a significant main effect of computer anxiety on the outcome variable ($F(1,263) = 14.3$, $p = 0.00020$, $\eta^2 = 0.05$), such that those who had greater computer anxiety had lower mastery of VR functions (Figure 5a).

Results from the delayed post-test showed that the prototypical participant's mastery of VR functions, $\gamma_{00} = 13.1$, $p < 0.000$ (out of 18 functions recalled), did not change significantly, $\gamma_{10} = 0.443$, $p = 0.832$. The significant effect of training type remained after several weeks, such that those who received video training mastered more VR functions, $\gamma_{20} = 0.965$, $p = 0.0463$. Individuals with greater computer anxiety had lower baseline levels of mastery of VR functions, $\gamma_{01} = -1.29$, $p < 0.000$.

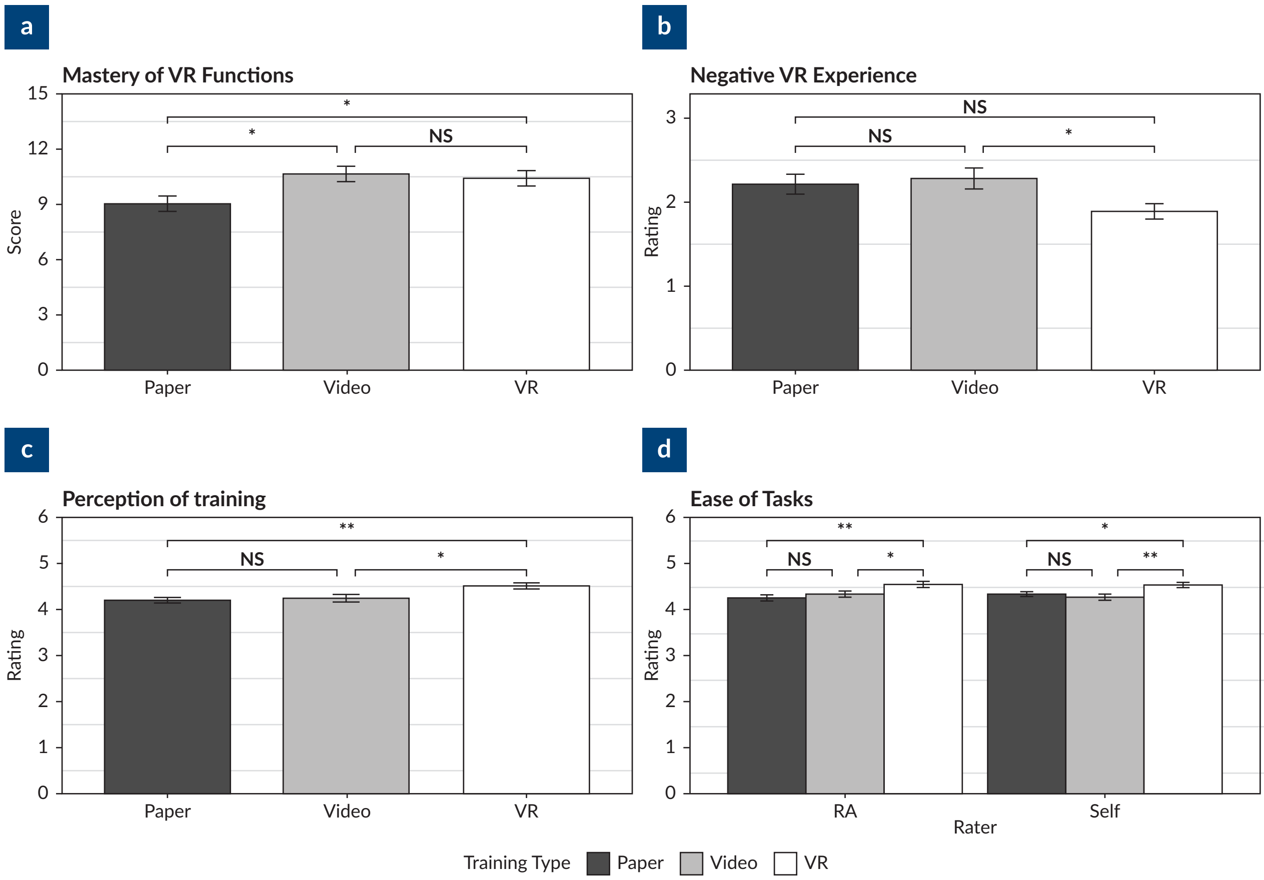


**Figure 4.** Averages and standard error bars of the outcomes by training type: (a) Average total recall of different controller and action functions in the social VR platform (out of 18), (b) average rating of how negative the VR experience was immediately after and two weeks after the experience (out of 7), (c) average rating of the perceived usefulness of the VR training (out of 5), and (d) average rating of the ease of completing various tasks within the social VR platform (out of 5). Notes: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; NS = not significant.

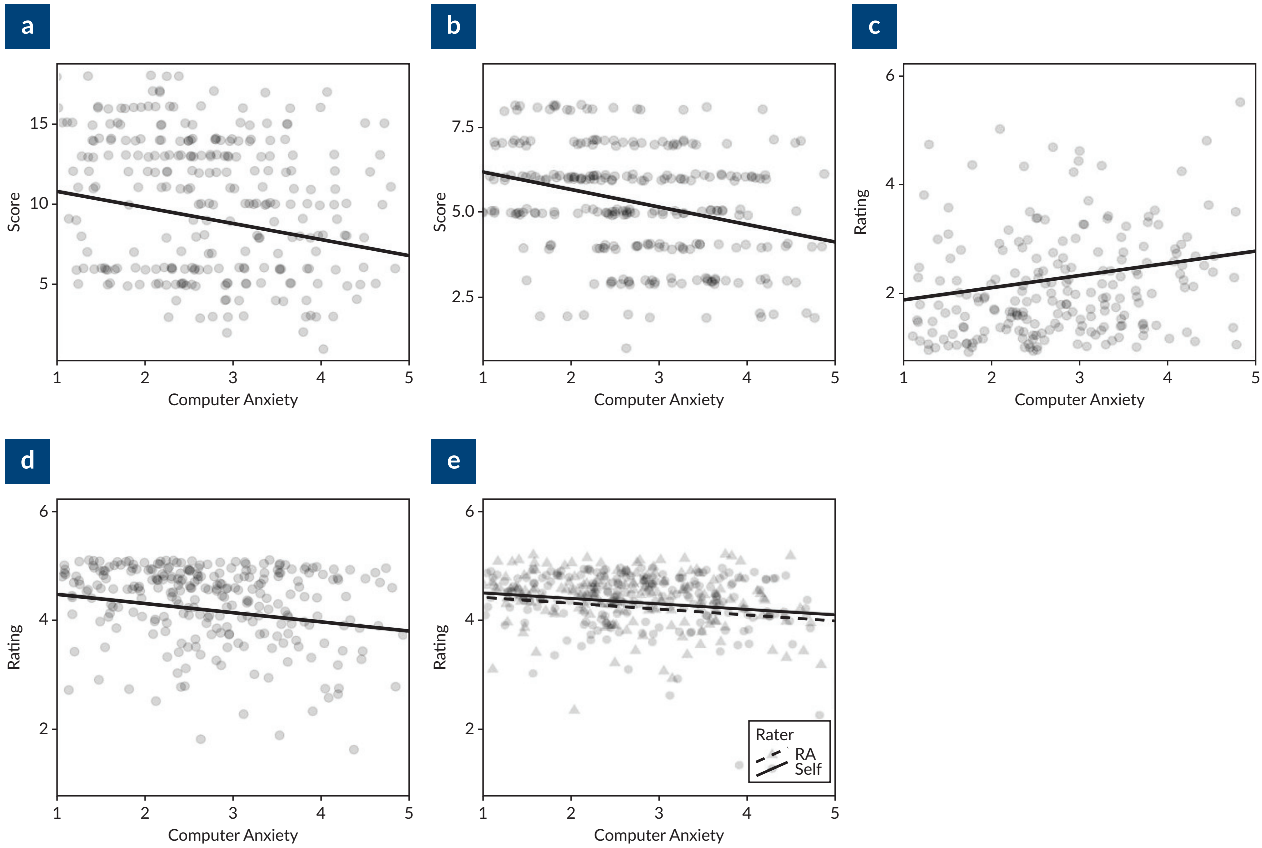


**Figure 5.** Graphs that represent the relationship between computer anxiety and each outcome variable where (a) is mastery of VR functions; (b) engagement with 360° video content, (c) negative VR experience, (d) perception of training, and (e) ease of tasks. Note: The lines represent the regression line from the ANCOVA models.

### *5.2. Engagement With 360° Video Content*

There was a main effect of training type on engagement with the 360° video content, $F(2{,}262) = 3.24$, $p = 0.04061$, $\eta_p^2 = 0.02$. However, Tukey's HSD post-hoc tests revealed that there were no significant differences when looking at pairwise comparisons (*ps* > 0.0785). There was a significant main effect of computer anxiety on the outcome variable $F(1{,}262) = 26.7$, $p < 0.001$, $\eta^2 = 0.09$, such that those who had greater computer anxiety had lower engagement with the 360° video content (Figure 5b).

Results from the delayed post-test showed that the prototypical participant's engagement with the 360° video content decreased from an initial value of $\gamma_{00} = 6.75$, $p < 0.000$ (out of nine questions recalled), at a rate of $\gamma_{10} = -1.93$, $p < 0.000$ questions. There was no significant effect of training type (*ps* > 0.3094). Individuals with greater computer anxiety had lower baseline levels of engagement with the 360° video content, $\gamma_{01} = -0.5051$, $p < 0.000$.

### *5.3. Negative VR Experience*

There was a main effect of training type on participants' report of how negative their VR experience was, $F(2{,}211) = 4.93$, $p = 0.008068$, $\eta_p^2 = 0.04$. Games-Howell post-hoc tests revealed significant differences between those in the video and VR training types ($p < 0.05$), such that those who received VR training reported having fewer negative VR experiences (Figure 4b). Additionally, there was a significant main effect of computer anxiety on the outcome variable ($F(1,211) = 10.80$, $p = 0.001190$, $\eta_p^2 = 0.05$), such that those who had greater computer anxiety during the pre-test reported having more negative experiences during their time in VR (Figure 5c).

Results from the delayed post-test showed that the prototypical participant's report of how negative their VR experience increased from an initial value of $\gamma_{00} = 1.61$, $p < 0.000$ (on a 7-point scale) at a rate of $\gamma_{10} = 0.443$, $p < 0.000$ points. The significant effect of training type remained after several weeks, such that those who received VR training reported remembering having less of a negative VR experience, $\gamma_{20} = -0.493$, $p = 0.0021$. Individuals with greater computer anxiety had higher baseline levels of negative VR experiences, $\gamma_{01} = 0.261$, $p = 0.0004$.

### *5.4. Perception of Training*

There was a main effect of training type on participants' report of how useful the training was, $F(2,262) = 6.35$, $p = 0.002036$, $\eta_p^2 = 0.05$. Games-Howell post-hoc tests revealed significant differences between those in the paper and VR training types ($p < 0.01$), as well as those in the video and VR training types ($p < 0.05$), such that those who received training in VR reported the training as being more useful (Figure 4c). Additionally, there was a significant main effect of computer anxiety on the outcome variable ($F(1,262) = 15.09$, $p = 0.000130$, $\eta^2 = 0.05$), such that those who had greater computer anxiety reported the training as being less useful regardless of received training type (Figure 5d).

Results from the delayed post-test showed that the prototypical participant's report of how useful the training was increased from an initial value of $\gamma_{00} = 3.29$, $p < 0.000$ (on a 5-point scale) at a rate of $\gamma_{10} = 1.45$, $p < 0.000$ points. The significant effect of training type remained after several weeks, such that those who received VR training reported the training as being more useful, $\gamma_{20} = 0.336$, $p = 0.0006$. Individuals with greater computer anxiety had lower baseline levels of perceived usefulness of the training, $\gamma_{01} = -0.2032$, $p < 0.000$.

### *5.5. Self-Rated Perceived Ease of Tasks*

There was a main effect of training type on participants' report of how easy the VR tasks were $F(2,214) = 6.64$, $p = 0.001601$, $\eta^2 = 0.06$. Tukey's HSD post-hoc tests revealed significant differences between those in the paper and VR training types ($p < 0.05$), as well as those in the video and VR training types ($p < 0.01$), such that those who received training in VR reported the tasks as being easier (Figure 4d). Additionally, there was a significant main effect of computer anxiety on the outcome variable ($F(1,214) = 8.68$, $p = 0.00357$, $\eta^2 = 0.04$), such that those who had greater computer anxiety reported the tasks as being more difficult (Figure 5e).

Results from the delayed post-test showed that the prototypical participant's report of how easy the VR tasks were, $\gamma_{00} = 4.51$, $p < 0.000$ (out of 5 points), did not change significantly, $\gamma_{10} = -0.05053$, $p = 0.296$. The significant effect of training type remained after several weeks, such that those who received VR training reported the tasks as being easier, $\gamma_{20} = 0.2040$, $p = 0.0025$. Individuals with greater computer anxiety had lower baseline levels of perceived ease of tasks, $\gamma_{01} = -0.080044$, $p = 0.0064$.

### 5.6. Research Assistant-Rated Perceived Ease of Tasks

There were similar results from how the research assistant evaluated the ease with which the participants completed the VR tasks, $F(2,165) = 7.055$, $p = 0.00115$, $\eta_p^2 = 0.08$. Tukey's HSD post-hoc tests revealed significant differences between those in the paper and VR training types ($p < 0.01$), as well as those in the video and VR training types ($p < 0.05$), such that those who received training in VR were evaluated as completing the VR tasks with more ease (Figure 4d). Additionally, there was a significant main effect of computer anxiety on the outcome variable ($F(1,165) = 7.46$, $p = 0.007007$, $\eta_p^2 = 0.04$), such that those who had greater computer anxiety were evaluated as completing the VR tasks with less ease (Figure 5e).

Research assistant-rated reports of perceived ease of tasks were not collected in the delayed post-test. Moreover, there was no significant difference in the self- and research assistant-reports of perceived ease of tasks ($p > 0.05$).

## 6. Discussion

As people continue to engage in VR in entertainment and educational settings, it is increasingly important to understand how to prepare them to learn and navigate virtual environments. This study examined how different types of training and computer anxiety influence people's ability to learn and engage with narratives and content within VR. Results showed that, compared to participants who received training from paper-based instructions, participants who received training in video or VR mastered more VR functions. Compared to participants who received training in video, those who trained directly in VR had less of a negative VR experience. Furthermore, participants who trained directly in VR perceived the training as being more useful and found the VR tasks to be easier compared to those who received training in paper or video. Finally, most of the outcome variables differed between conditions regardless of time and were still significant several weeks later indicating robustness.

Moreover, while computer anxiety did not interact with the type of training, results showed that those with greater computer anxiety experienced VR differently than those who had lower computer anxiety. Those who had greater computer anxiety had lower mastery of VR functions and engagement with the 360° video content, reported more negative VR experiences, the training as less useful, and the tasks as more difficult. The research assistant also evaluated those with greater computer anxiety as having more difficulty completing the VR tasks.

Evidence of the effectiveness of training in VR and learning how to directly practice the tasks was visible in the open-ended responses of the questionnaire. When asked about their thoughts on completing the various tasks inside the virtual environment, the majority of the participants talked about the ease of certain tasks and the challenges of some of the controls. There were some differences in what detail the participants focused on when describing the helpfulness of the training. Participants who underwent VR training described the training as an opportunity to practice and learn how to do the tasks, or as a walkthrough with the research assistant: "Learning how to do [the tasks] beforehand made [them] easy to do" (P63, VR training). In that vein, some participants commented that it would have been better to have undergone the training inside VR so as to make the process more interactive and more straightforward:

> The instructional video could be replaced by the [research] assistant explaining the controls in real-time, as [the material] would be much easier to take in. When given a large amount of instructional info all at once in a non-intuitive way, you're bound to forget a large amount of it. (P171, video training)

The results are largely consistent with prior literature showing that training prior to using VR could reduce the novelty effect and increase retention (Meyer et al., 2019; Miguel-Alonso et al., 2023). Given those who received training in VR recalled more VR functions and had an easier time completing the tasks, this prior training may have primed them with expectations and information that was not available to those who trained by either reading instructions on paper or watching a video. Those without the direct VR training may have been overwhelmed with the new streams of sensory information and may not have had the resources to process the information presented in VR as effectively (Meyer et al., 2019).

Furthermore, given that people's memory retrieval is better when they are in the same context in which the memory was encoded, participants who encoded the memory directly in VR may have performed the tasks with more ease as they were able to recall better from being in the same context (Godden & Baddeley, 1975; Tulving & Thomson, 1973). Meanwhile, those who received paper or video training had to recall and perform the tasks in a different medium. This difference in the medium in which memory was formed was most likely greater for those who received paper training, as the video training provided a 2D visual walkthrough similar to what one would have seen in VR. This presumably influenced how participants perceived the training. As a result of their performance, those who received VR training perceived the training as being more useful and beneficial, compared to those who received paper and video training.

This aspect of context-dependent memory during the training stage was especially relevant when participants were asked to perform and then recall the VR functions, as the tasks during the training stage were the same. In other words, the cues from the training material interacted meaningfully with the cues during the recall (i.e., mastery) of VR functions (Baddeley, 1982). Context-matching would predict that the training would help for an active, interactive task, but not for a passive watching task. Those who received VR training consequently mastered more VR functions, whereas there were no differences across training types in terms of engagement with the 360° video content.

Moreover, people who are unfamiliar with the technology may have negative experiences because of the novelty of figuring out how to use the device and interacting with the environment. Training directly in VR before performing various tasks and watching a 360° video may have mitigated the novelty and unfamiliarity of the medium (Miguel-Alonso et al., 2023). This, as a result, may have led to perceptions of having less of a negative experience. Meanwhile, those who trained in paper and video were less familiar with the VR technology prior to performing the tasks and watching the 360° video. To them, the novelty and adjustment to the medium may have led to more negative experiences.

Finally, as has been found in previous research, those with greater computer anxiety benefitted less from either type of training and had more negative outcomes. This is consistent with past research showing that computer anxiety can reduce the effectiveness of training (Torkzadeh et al., 2006), such that, despite the main effects of the condition on mastering VR functions and completing tasks with ease, computer anxiety did not interact with the condition, suggesting that no specific form of training helped those with greater computer anxiety more than other forms of training. Rather, all forms of training tested yielded similar results, and the negative outcomes persisted. This is also consistent with past research showing that those who are more apprehensive about technology may allocate more resources to processing and evaluating posed threats (Ahn et al., 2022). Those who had greater computer anxiety may have allocated more resources towards processing other features of VR, rendering them unable to focus as much on remembering and mastering the functions or fully engaging with the video content.

## 7. Conclusion

### 7.1. Limitations and Future Directions

There were several events throughout the study that posed limitations. First, several participants noted the value of having a research assistant present in person to troubleshoot challenges or explain steps that the participants could not figure out on their own. The help and presence of another figure may have alleviated potentially negative experiences, or, more broadly, may have shaped the participants' experience. We did not collect information on when (i.e., at what part of the procedure) participants received help from the research assistant. Depending on when and how much participants received help may have played a role in how well-prepared participants felt, and their perception of the training. Future studies should consider whether participants should troubleshoot and navigate technical difficulties on their own or allow research assistants to play a supporting role. Will those who fail to troubleshoot successfully and consequently have a negative VR experience attribute this to insufficient training?

In this vein, although our primary focus was to investigate training types, we had research assistants walk through the instructions and help participants during the paper and VR training types. The helpful role of the research assistant may have played a role in the training experience. Future studies should focus solely on the modalities of training and exclude external factors that could affect training, such as having an instructor or assistant help.

Third, several participants mentioned distractions from the physical world that seeped into their virtual experience. For example, one participant noted that the HMD was mounted too high and they could see the light at the bottom. Another participant, who also noticed the gap, mentioned how distracting this was when looking down. While some physical world distractions may be challenging to account for, such as noise coming from outside, or light seeping in through cracks, given it is already difficult for many to balance visual and auditory information while also navigating around the environment, future studies should aim to reduce any unnecessary distractions.

### 7.2. Implications

The current study found the beneficial effects of training directly in-headset prior to VR experiences. Results showed that, compared to those who received paper or video training, those who received training in VR had a greater recall of VR functions, reported having less of a negative VR experience, perceived the training as being more useful, and completed tasks with more ease, as rated by both themselves and the research assistant. These findings may be particularly relevant to instructors in an educational setting who want to integrate VR into their curriculum or to filmmakers or entertainers seeking to utilize VR platforms to engage users with their storylines and narratives. This also translates to those developing training and simulations for learning or entertainment purposes. Prior research has shown that learning *how to use* VR before learning *in* VR, as well as ample training, is critical (Han & Bailenson, 2024; Han et al., 2022). However, how this learning via training needed to be administered remained unclear. Our results suggest that keeping the medium the same both during training and doing is ideal. While administering training via paper and videos may reduce the amount of time inside the HMD and thus be more scalable to a larger number of students and requires fewer resources (e.g., teaching staff, finding appropriate training materials), depending on the nature of the VR experience at hand, what this training might look like and how easy it is to administer and scale may change.

Another domain in which this is relevant is storytelling and crafting experiences that are meaningful and memorable. A common issue with first-time VR users is the challenge of knowing where to pay attention to and how to attend to a variety of streams of information. Processing simultaneous streams of information in highly multisensory media like VR can affect how information is processed (Ahn et al., 2022; de Barros & Lindeman, 2013). Many participants mentioned focusing on the engaging graphics or environment and ignoring or missing information presented in the audio narrative. Integrating some form of instructions or training prior to launching a viewer to a narrative may help them understand what the expectations are and how to navigate the experience, especially if there are any interactive components.

Finally, our last implication relates to computer anxiety. Results showed that those with high levels of computer anxiety, in general regardless of training, have more negative outcomes, including less recall of VR functions, having more of a negative VR experience, perceiving the training as being less useful, and completing tasks with more difficulty. This perpetuates an unfortunate situation with negative experiences leading to further increased anxiety. These results raise the question of how those with high computer anxiety can be prepared for VR, if training type does not help them as much as it helps those with less computer anxiety. How can instructors accommodate students who are feeling anxious about using technologies? How can designers of experiences make sure those with high computer anxiety feel included and not left behind from the intended positive outcomes? While this finding demands further research and raises, rather than answers, more questions, it highlights the importance of evaluating this individual difference.

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## Conflict of Interests

The authors declare no conflict of interests.

## Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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