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QUANTITATIVE STUDY

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Pre-training interventions to counteract seductive details in virtual reality training programs

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Abstract

We propose that (a) certain aspects of virtual reality (VR) training programs are seductive details, (b) these seductive details prompt trainee distraction and/or cognitive overload, and (c) pre-training interventions can benefit learning from VR training programs by targeting these mechanisms. In Study 1, we apply a meta-cognitive strategy pre-training intervention, which targets distraction, and a habituation pre-training intervention, which targets cognitive overload. Habituation had no effect, whereas meta-cognitive strategies worsened learning. Qualitative results indicated the meta-cognitive strategy intervention prompted trainees to become more cognitively engaged in the distracting seductive details of the VR training program. In Study 2, we tested an alternative pre-training intervention, attentional advice, to reduce distraction and increase learning. The attentional advice pre-training intervention was successful, as trainees demonstrated greater learning when provided attentional advice. Together, all proposals were supported. VR can contain seductive details that cause distraction, and attentional advice can improve learning by reducing distraction.

KEYWORDS

pre-intervention, pre-training, seductive details, training, virtual reality training

1 | INTRODUCTION

The popularity of virtual reality (VR), the computer-generated simulation of a three-dimensional environment with interactive capabilities, for organizational training purposes has greatly expanded with the advent of powerful computing technology. VR enables learning in a safe and controlled digital environment, and the technology can be implemented in an array of training contexts—the most popular and presently being used in healthcare and military applications (Aïm, Lonjon, Hannouche, & Nizard, 2016; Alaker, Wynn, & Arulampalam, 2016; Mirghani et al., 2018). Despite widespread use, notable concerns exist with the application of VR for training purposes. While trainees report favorable reactions, several studies have shown that VR training programs can be less effective than traditional alternatives (Bertram, Moskaliuk, & Cress, 2015; Howard, 2019; Våpenstad et al., 2017). The causes of these lackluster findings are unclear, and few justifications have been provided for such results (Johnson, Guediri, Kilkenny, & Clough, 2011; Moskaliuk, Bertram, & Cress, 2013). We address this dilemma by testing seductive details and pre-training interventions in conjunction with VR training programs.

Certain aspects of VR may be seductive details: details that are interesting but irrelevant to the instructional objective (Park, Flowerday, & Brünken, 2015; Rey, 2012; Towler et al., 2008). Seductive details are most commonly studied in educational research, and they have been shown to reduce learning via distraction and/or cognitive overload (Mayer, 2014, 2017; Rey, 2012). While immersive VR environments are exciting for trainees, VR may also distract and/or overload working memory. In turn, these distractions and cognitive overloads can worsen the outcomes of VR programs (Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012; Howard, 2017b). For instance, a trainee may participate in a VR training program to learn proper safety procedures for operating a heat press machine; however, the seductive details of VR may cause the trainee to become distracted from the training material, and they may instead focus on exploring the digital workshop and testing the boundaries of their novel immersive environment.

To counteract this possible detriment of VR training programs, we test the impact of certain pre-training interventions. Pre-training interventions are activities performed before or during a training program to improve learning outcomes, which is achieved by counteracting specific negative aspects of the training program (Mesmer-Magnus & Viswesvaran, 2010). For example, advance organizers involve the provision and explanation of resources (e.g., outlines, diagrams, and text) to aid the trainees' integration of new training material with prior knowledge, whereas goal orientation interventions encourage trainees to set goals (whether performance- or learning-oriented) to influence their cognitive, effective, and motivational processes. In the current article, we apply pre-training interventions that target the cited mechanisms of seductive details' detriments to learning, distraction and cognitive overload (Mayer, 2014, 2017; Park et al., 2015; Peshkam, Mensink, Putnam, & Rapp, 2011). In Study 1, meta-cognitive strategy and habituation pre-training interventions are applied to mitigate distraction and cognitive overload, respectively, resulting from the VR environment. In Study 2, an attentional advice pre-training intervention is applied to mitigate distraction resulting from the same VR environment. These studies not only identify useful pre-training interventions for VR training purposes, but they also shed light on the mechanisms by which seductive details disrupt trainees' learning in the VR environment. That is, a pre-training intervention should have a significant effect only if the targeted mechanism (distraction or cognitive overload) is present in the VR training program.

We provide several implications from these efforts. First, many authors have noted that computer-based training (CBT) research, especially VR training, is often atheoretical (Moskaliuk et al., 2013; Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012; Werner, 2014). We introduce a new perspective, seductive details, to better understand VR training programs, which can serve as a starting-point for integrating novel theory into the broader study of CBT research. Second, we illustrate a possible underlying source that may harm the effectiveness of VR training programs (distraction or cognitive overload), which can prompt further research regarding the exact causes of these mechanisms. Third, authors have called for investigations into the context-specific effects of pre-training interventions (Cannon-Bowers, Rhodenizer, Salas, & Bowers, 1998; Mesmer-Magnus & Viswesvaran, 2010), and we reveal the impact of three pre-training interventions on an emergent and popular training method, VR. Future research can use the current studies as a model and conduct further investigations into the efficacy of pre-training interventions for other VR training programs. Fourth, while we study VR training programs, the inferences derived in the current article may apply to learning scenarios more broadly. That is, a pre-training intervention shown to successfully improve learning from a distracting VR training program may improve learning in other potentially distracting programs (e.g., lecture) with other populations (e.g., students). Fifth, the current results provide notable practical implications to organizations, and therefore, the current article may have an immediate impact on current human resource development efforts—particularly those involving CBT and VR training programs.

2 | LITERATURE REVIEW

2.1 | VR training programs

A VR training program is a CBT in which instructional material is presented in a digital environment that permits user interaction and replicates a real or imagined space (Aïm et al., 2016; Gavish et al., 2015; Mirghani et al., 2018). Trainees navigate this space using an avatar in either a first- or third-person perspective, wherein an avatar is a digital representation of the user—often taking the visual form of a human in VR training applications. The environment also allows varying levels of interaction. For example, users may be limited to only changing their point of view in a fixed position, or they may be able to manipulate objects and communicate with others. When applied in organizational settings, trainees typically have specific objectives to achieve (e.g., welding a fuel tank), but they may also be allowed to freely explore the possibilities of their virtual world (e.g., test an array of tools and explore new environment).

These VR training programs are often administered via a head-mounted display (HMD), such as the Oculus Rift or the Samsung Gear, but HMDs are not required for VR. VR can also be administered via a traditional computer monitor. Likewise, many VR programs interpret user input via motion sensors, but the traditional keyboard and mouse are also commonly used. Together, VR is a broad term that encapsulates many different programs, but the medium always presents a three-dimensional virtual environment with interactive capabilities (Howard, 2017a).

VR training programs are often applied due to assumptions about their beneficial impact on learning, and such assumptions likely arise for three reasons (Johnson et al., 2011; Moskaliuk et al., 2013). First, the application of VR training programs follows previous notions in CBT research—technological improvements prompt learning improvements (Salas et al., 2012). Authors often assume that sophisticated technologies address the limitations of previous training programs, and this optimism is partially reflected in the growing number of boutique human resource firms that market cutting-edge solutions for employee development. Second, trainees regularly report positive reactions to VR training programs, which are likely due to the novelty and interactive capabilities of VR (Bedwell & Salas, 2010; Cannon-Bowers & Bowers, 2009). These positive reactions often lead to further VR training applications, as employees become more committed to their organization if they have positive perceptions regarding developmental programs (Werner, 2014). Third, organizations often adopt sophisticated technologies for signaling purposes (Giones & Miralles, 2015). That is, employees, customers, and shareholders may perceive the organization as forward-thinking if such technologies are utilized, resulting in more favorable perceptions from all the three (and thereby better organizational performance).

Despite such a positive outlook toward the application of VR training programs, absent from this list is the actual effectiveness of VR for learning and transfer. Indeed, extant research supports that VR training programs can be less effective than alternatives, prompting a call for research on lackluster VR training results and the integration of relevant theory (Howard, 2017b; Howard, 2019; Johnson et al., 2011; Våpenstad et al., 2017). We propose that the inconclusive benefits of VR training programs may be due to the presence of seductive details that hinder trainees' learning. To support this claim, we review prior research on seductive details.

2.2 | Seductive details

Seductive details were first investigated in the field of education to identify approaches to improve instructional effectiveness, and they are interesting details that are irrelevant to learning objectives (Langer, 1997; Park & Lim, 2007; Peshkam et al., 2011). Most textbooks contain seductive details, such as entertaining pictures or stories, to capture learner attention with hopes of improving comprehension, and lectures often include seductive details, such as funny jokes or videos, to increase listener engagement. Researchers, however, have repeatedly supported that seductive details reduce learning by showing that instructional materials without seductive details (e.g., textbooks without pictures; lectures without jokes) produce better learning outcomes than instructional materials with seductive details. Recurrent empirical support for this discovery prompted researchers to coin the seductive detail effect—the phenomenon that leaning outcomes increase when irrelevant information is excluded from learning material (Lehman, Schraw, McCrudden, & Hartley, 2007; Park et al., 2015; Towler et al., 2008).

Two mechanisms (among others) have been repeatedly proposed to explain the negative outcomes resulting from seductive details: distraction and cognitive load (Mayer, 2014; Park et al., 2015; Rey, 2012). Seductive details may reduce learning by distracting attention away from instructional material and realigning focus on irrelevant information (Mayer, 2014, 2017; Mayer, Griffith, Jurkowitz, & Rothman, 2008). In testing this hypothesis, researchers have empirically supported that individuals with poor attention control are more susceptible to seductive details and suffer decreased learning outcomes (Park et al., 2015; Rey, 2012), suggesting that distraction is a probable cause of seductive details' negative impact on learning. Alternatively, the cognitive theory of multimedia learning and cognitive load theory assert that working memory is limited and can be overloaded by excessive stimuli (Mayer, 2014, 2017; Mayer et al., 2008). When seductive details are presented with instructional materials, trainees may be unable to process relevant information due to cognitive overload. In testing this hypothesis, researchers found that those with limited working memory are more susceptible to the detrimental effects of seductive details on learning outcomes (Park et al., 2015; Peshkam et al., 2011; Rey, 2012), suggesting that cognitive overload is a probable cause of the seductive details' negative impact on learning.

Rey (2012) suggests that researchers should identify situations in which particular seductive detail mechanisms are present, as seductive details may cause distraction, cognitive overload, or both. We investigate this suggestion by testing pre-training interventions designed to target these specific mechanisms in a VR training program. If an intervention designed to counteract the negative effects of distraction or cognitive overload is shown to improve learning outcomes, then it can be inferred that distraction or cognitive overload was the mechanism that produced the negative outcomes of the VR training program's seductive details.

Furthermore, the results can identify pre-training interventions that counteract the negative effects of specific seductive details, which may be particularly important for the application of VR training programs. Some seductive details in VR cannot be removed due to cost or administrative reasons, and others provide benefits in addition to detriments. For instance, a primary allure of VR training programs is the capability to provide a high-fidelity training that mimics the circumstances of applying trained skills and abilities in transfer environments, and the aspects that produce high fidelity (e.g., interaction and graphical quality) may be seductive details themselves. It may be desirable to retain these seductive details in a VR training program, and identifying useful pre-training interventions may allow practitioners to “keep the best of both worlds”—to utilize the benefits of fidelity while avoiding the detriments of seductive details. Therefore, the current results contribute to theory by identifying the mechanisms by which seductive details in VR training environments can impair the trainees' learning outcome. These results also provide information to managers and training intervention designers on the detrimental effects of seductive details and how to mitigate such influence by implementing additional pre-training interventions to maximize the effectiveness of the VR training programs.

2.3 | Pre-training interventions

Prior research on seductive details has often investigated their effects by removing certain elements of the media, such as comparing post-test knowledge scores between participants provided learning material with pictures and others provided learning material without pictures (Lehman et al., 2007; Rey, 2012; Towler et al., 2008); however, removing seductive details in VR training programs is difficult due to multiple reasons (for both research and practice). First, VR programs are costly to alter, as they often require experienced computer programmers to modify training material (Lawson, Salanitri, & Waterfield, 2016; Zyda, 2005). Second, some seductive details are unable to be removed, because they are integral to VR. For instance, trainees are presented a virtual environment in a VR training program. The environment itself and any interactive features may be seductive details, but they cannot be removed entirely. Thus, we take an alternative approach to understand the seductive details in VR training programs.

Authors have long proposed that pre-training interventions can improve training outcomes, including learning and transfer, by aligning learning processes to the training program (Mayer, 2014; Pauli, May, & Gilson, 2003; Phye, 1991; Phye & Sanders, 1994). Pre-training interventions do not replace any aspect of the training. Instead, they provide relatively simple but influential assistance before or during the training process. The current literature classifies pre-training interventions into five categories: attentional advice, meta-cognitive strategies, advance organizers, goal orientation, and preparatory information (Cannon-Bowers et al., 1998; Mesmer-Magnus & Viswesvaran, 2010). Each category is meant to familiarize trainees with the nature of the training and/or provide learning strategies to aid information encoding. Mesmer-Magnus and Viswesvaran (2010) meta-analytically demonstrated that each category can improve trainee outcomes; however, they also note that "pre-training interventions likely vary in their effectiveness for different learning outcomes, and that certain moderators like intervention format, training context, and training method may interact to yield varying results" (p. 261). In other words, certain pre-training interventions may be more effective in particular contexts.

For a VR training context, the most effective pre-training interventions may be those that address distraction and cognitive overload. We thereby investigate the effects of two pre-training interventions, meta-cognitive strategies and habituation, that have been suggested to help trainees overcome these two specific detriments (further detailed in the following), whereas other pre-training interventions have less prior support that they can overcome distraction and cognitive overload (Cannon-Bowers et al., 1998; Mesmer-Magnus & Viswesvaran, 2010). Meta-cognitive strategy interventions provide instructions that encourage trainees to engage in their cognitive, self-regulatory processes to improve learning, whereas habituation interventions allow users to experience and interact with their training environment before the training formally begins.

2.4 | Meta-cognitive strategies

Meta-cognitive strategies are self-regulatory tactics to direct and maintain efforts toward goals, prompting trainees to identify learning difficulties and modify behavior accordingly (Mesmer-Magnus & Viswesvaran, 2010). Meta-cognitive strategies redirect trainee attention toward learning material (Cannon-Bowers et al., 1998; Ford, Smith, Weissbein, Gully, & Salas, 1998; Phye, 1991; Phye & Sanders, 1994), and previous studies have shown that meta-cognitive strategies improve learning through reducing distraction (Ford et al., 1998; Kraiger, 2017).

Two types of meta-cognitive strategies exist (Mesmer-Magnus & Viswesvaran, 2010; Pauli et al., 2003). First, "why-based" meta-cognitive strategies require trainees to periodically ask themselves why they are performing a task or behavior. The purpose of this strategy is to prompt trainees to remain goal-directed and encode learning information. Second, "think aloud" meta-cognitive strategies require trainees to speak their thoughts aloud. This strategy makes trainees aware of their thought processes and allocation of cognitive resources.

For current VR training programs, "think aloud" meta-cognitive strategies may be more effective than "why-based" strategies. "Why-based" meta-cognitive strategies are effective for longer training programs, whereas "think aloud" meta-cognitive strategies are effective for shorter training programs (Mesmer-Magnus & Viswesvaran, 2010). Some VR training programs require trainees to participate over extended periods of time (e.g., multiple hours), but current research and practices primarily focuses on shorter VR training programs that are applied to train a specific task (e.g., less than an hour; Ahlberg et al., 2007; Aïm et al., 2016; Alaker et al., 2016; Gavish et al., 2015; Johnson et al., 2011; Park & Lim, 2007). Due to the popularity of short VR training programs, we investigate the impact of "think aloud" meta-cognitive strategies.

Hypothesis 1 *"Think aloud" meta-cognitive strategy pre-training interventions result in greater learning from a VR training program.*

Hypothesis 2 *Seductive details in VR training programs prompt distraction*.

2.5 | Habituation

During a VR training, trainees are transported to a digital environment. While some trainees quickly acclimate to the novel environment, others may be cognitively overloaded by new and possibly excessive stimuli (Howard, 2017b; Moskaliuk et al., 2013; Zyda, 2005). These latter trainees may be unable to process the large amount of information, which may result in decreased learning. In such occasions, a habituation pre-training intervention may be useful to combat cognitive overload (Balkenius, 2000; Gardner & Gardner, 2013).

Habituation likely falls under the pre-training intervention category of preparatory information (Cannon-Bowers et al., 1998; Mesmer-Magnus & Viswesvaran, 2010). Habituation is the diminishing of a psychological or emotional response to a stimulus through repeated exposure. This habitation process allows trainees to become acclimated with their surroundings and objectives in the VR environment. Subsequently, trainees can direct more attention to following instructions, as they are familiar with the VR environment. The effects of habituation would also incur particular implications for cognitive overload (Balkenius, 2000; Gardner & Gardner, 2013). When trainees are more familiar with the VR environment, they can interact with their surroundings without devoting as many cognitive resources to their actions. This may allow training programs within complex environments, such as VR, to become manageable.

Hypothesis 3 *Habituation pre-training interventions result in greater learning from a VR training*.

Hypothesis 4 *Seductive details in VR training programs prompt cognitive overload*.

3 | STUDY 1

3.1 | Method

3.1.1 | Participants

Participants (N = 80, M_{age} = 18.68, SD_{age} = 0.97, 81% female, and 72% Caucasian) were recruited from a large Northeastern University of the United States of America and compensated with course credit. Participants were randomly assigned to one-of-four conditions, with approximately 20 in each condition.

3.1.2 | Procedure

All procedures were performed in a lab setting, in which one participant completed at a time. Participants provided their informed consent and answered a demographic questionnaire. Next, they were directed into a private room that contained the VR system. The following procedures were dependent on the condition, and each participant was assigned to one condition.

1. The control condition did not include a pre-training intervention, and the participant immediately began the training program.
2. In the metacognitive strategy pre-training condition, participants read the following script before the training: "Today, you are going to use a virtual reality program to explore space. This will last about twenty minutes. While

using the program, make sure you speak aloud everything you see and think. Although it may sound silly, it is very important that you speak aloud everything you see and think. For example, if you see a person, you might say 'It is a person. He has red hair and a blue shirt. I wonder if I can talk to him.' I will close the door, so no one can hear what you say. I will only be able to hear faint noises. So, if you stop talking throughout the program, I will have to remind you to speak aloud everything you see and think. Do you have any questions?"

The training program occurred with the researcher in an adjacent room, and participants were reminded to speak aloud if they stopped.

3. In the habituation pre-training condition, the VR hardware applied during the actual training was used to present a program entitled VR player. VR player presents 360° pictures and videos, allowing participants to become accustomed to the immersive environment before the actual training. Participants read the following script: "First, you are going to use this initial program to get used to virtual reality. Just look around and get used to your surroundings for three minutes. I will tell you when your time is up. Then, I will start another program."

Then, participants viewed a 360° picture of a metropolitan street corner for three minutes. After the time elapsed, the participants began the training program.

4. The interaction condition included both pre-training interventions. Participants underwent the procedures described in the habituation condition, followed by the procedures described in the metacognitive strategy condition. Then, they began the training program.

After the assigned condition, participants began the VR training program. The hardware was the Oculus Rift Development Kit 1. This HMD uses two lenses that form a 1,280 × 800 pixel display with an high-definition multimedia interface video connection. The training VR software, Titans of Space, provides a virtual walkthrough of the solar system. Participants take a first-person perspective within a futuristic spaceship that effortlessly maneuvers around the planets. Participants can move their first-person point of view and zoom-in on the planets' surface, and a digital display reads facts about the celestial objects. A visual presentation of Titans of Space is presented in Figure 1.

Upon completing the VR training program, participants were administered a second questionnaire that included a qualitative item. The qualitative item asked whether and why the VR training was effective. Finally, participants completed a post-test that gauged learning.

Before continuing, it should be discussed why we chose Titans of Space to study VR training programs. The present concern of VR training programs is their inclusion of seductive details. Trainees are expected to comprehend and encode relevant information when undergoing a VR training program, and thereby adequate comprehension is an integral aspect of learning in VR training programs. Titans of Space presents ample detailed information that must be comprehended and encoded despite the presence of possible seductive details associated with VR training programs. Titans of Space therefore possesses operational similarities to VR training programs regarding the nature of comprehending and encoding instructional material, which allows the current lab results to generalize VR training programs in modern organizations.

Also, student participants may be unmotivated to complete VR training programs currently administered in organizations, as these programs are typically boring to those not working in the relevant position. Student participants using these VR training programs may provide results that do not correspond to actual trainees due to poor motivation. In contrast, students reported favorable reactions to the Titans of Space program in a prior study (Howard, 2017b), suggesting that they were presently engaged and motivated. Therefore, we believe that choosing a VR training program that can motivate student participants to be engaged in learning better reflects the organizational

FIGURE 1 Visual presentation of VR training within Studies 1 and 2

contexts of a VR training in which trainees have a certain level of motivation to learn, ultimately improving the external validity of the current study.

3.1.3 | Measures

Post-test: Thirty questions on material presented by the Titans of Space program were used to gauge learning. An example item is "Which planet has the most moons?" with the correct answer being "Jupiter." Each item was in a multiple-choice format with four possible responses. Participants' post-test scores were created by calculating their percentage of correct responses, as would be done to calculate a students' or employees' grade on a test. The Cronbach's alpha of the 30 items was .71.

3.2 | Results

Outliers were removed by calculating *z*-scores for post-test scores separated by condition. Those with extremely low or high post-test scores may have had insufficient motivation or significant prior knowledge of the subject material, and the removal of these participants is necessary. Z-scores below negative two or above two were considered outliers and removed ($N = 4$), resulting in 20 participants within the control, 18 in the habituation-only, 19 in the metacognitive strategy-only, and 19 in the habituation and the metacognitive strategy conditions.

To test the effect of pre-training interventions, a univariate ANOVA was performed (Table 1). Habituation did not have a significant impact upon post-test performance ($F[1, 72] = 1.50$, $p > .05$), whereas metacognitive strategies demonstrated a significant relationship with post-test performance ($F[1, 72] = 10.28$, $p < .01$). Their interaction was not significant ($F[1, 72] = .04$, $p > .05$). Table 2 shows the means and *SD*s of each experimental group. Regarding the only significant effect, those within conditions that included the metacognitive strategy pre-training intervention performed worse on the post-test (*Mean* = .45) than those within conditions that did not (Mean = .54). Individuals in

TABLE 1 Univariate ANOVA results of habituation and meta-cognitive strategy pre-training intervention on virtual reality (VR) training post-test scores

	Sum of squares	*df*	Mean square	*F*	η^2
Corrected model	0.17	3	0.06	3.87*	0.14
Intercept	18.88	1	18.88	1,298.65**	0.95
Habituation	0.02	1	0.02	1.50	0.02
Metacognitive strategy	0.15	1	0.15	10.28**	0.13
Interaction	0.00	1	0.00	0.04	0.00
Error	1.05	72	0.02		
Total	20.08	76			

*$p < .05$; **$p < .01$.

TABLE 2 Means and *SDs* of Study 1 conditions

	No habituation	Habituation	Total
No meta-cognitive strategies	0.52 (0.13)	0.56 (0.13)	0.54 (0.13)
Meta-cognitive strategies	0.44 (0.11)	0.47 (0.11)	0.45 (0.11)
Total	0.48 (0.13)	0.51 (0.13)	0.50 (0.13)

Note: These values represent the percentage of correct answers on the post-test. For example, a mean value of 0.52 indicates that participants in that condition correctly identified 52% of the answers, on average. *SD*s are listed in parentheses.

the habituation alone condition performed best on the post-test (*Mean* = .56), whereas those within the meta-cognitive strategy alone condition performed worst (*Mean* = .44). Thus, the results of the current study do not support any of the proposed hypothesis.

3.3 | Discussion

We proposed that meta-cognitive strategy and habituation pre-training interventions, which, respectively, address distraction and cognitive overload, improve learning from VR training programs. Contrary to expectations, the habituation intervention did not significantly improve post-test scores, and the metacognitive strategy significantly reduced post-test scores.

These results are not only surprising, but they provide an unclear view of the relationship between VR training programs, seductive details, and pre-training interventions. Fortunately, the qualitative data provide inferences. Across all conditions, participants noted the exciting nature of the VR training program. One participant stated, "felt like I was in space" (Participant 27), and another claimed, "[it] felt like I was actually traveling through space, eliminating all outside world visual stimulation, and allowed me to really express myself in the program" (Participant 56). Participants also noted that these aspects detracted their attention. One participant directly stated, "The novelty of the headset distracted from the content" (Participant 18). Another claimed, "The material was not as interesting as the images and HMD" (Participant 46). Finally, a participant in the meta-cognitive strategy condition noted, "I was so focused on watching the planets that I didn't notice the dialogue box at the bottom of the screen presenting information until the very end of the program. Had I been aware that information was being presented the whole time, I would have learned a lot more" (Participant 62). No participant mentioned that too much information was present, supporting the null findings for cognitive overload.

We believe that the meta-cognitive strategy intervention caused trainees to become more cognitively engaged, but it did not direct attention toward the pertinent training material. Instead, trainees became cognitively engaged in the seductive details of the VR program, causing them to ignore large portions of the relevant material. These inferences are supported by the quantitative results, in which participants in the meta-cognitive strategy condition had the lowest post-test scores. Nevertheless, these results do not provide firm evidence for the existence of seductive details in VR training programs or their associated mechanisms. Therefore, a second study investigates the effect of an alternative pre-training intervention, attentional advice.

3.4 | Attentional advice

Attentional advice pre-training interventions “direct attention toward specific aspects of the training or practice curriculum” (Mesmer-Magnus & Viswesvaran, 2010, p. 262) and can set appropriate expectancies, guide learning objectives, and direct attention (Cannon-Bowers et al., 1998). Attentional advice pre-training interventions are effective across a variety of contexts (Phye, 1991; Phye & Sanders, 1994), and they can be differentiated into two separate types: specific advice and general advice. Specific advice directs attention toward particular aspects of a training program. For example, a trainee may be instructed to solely focus on highlighted portions of an instructional passage. Alternatively, general advice also directs attention toward specific aspects of training programs, but the advice is vague and can apply more broadly. For example, a trainee may be instructed to focus on the educational aspects of instructional passages rather than the exciting aspects. By doing so, trainees are more alerted to the instructional materials more generally, compared with only the highlighted portions of an instructional passage.

Mesmer-Magnus and Viswesvaran (2010) meta-analytically showed that general advice is more effective than specific advice for learning. They propose that the effectiveness of general advice is due to two reasons. First, trainees can easily integrate general advice into their learning strategies, and general advice allows the trainee to take control of their encoding of information. Second, general advice allows the trainee to be more active in deciphering and integrating advice during the training program, whereas specific advice may discourage trainees from participating in an active learning role. Accordingly, we expect that an attentional advice pre-training intervention improves learning outcomes from a VR training by directing trainee attention toward the instructional material and reducing distractions.

Hypothesis 5 *A general attentional advice pre-training intervention results in greater learning from a VR training*.

Hypothesis 2 *(repeated): Seductive details in VR training programs prompt distraction*.

4 | STUDY 2

4.1 | Method

4.1.1 | Participants

Participants (N = 101; M_{age} = 18.86, SD_{age} = 1.54, 85% female, and 73% Caucasian) were recruited from a large Northeastern University of the United States of America and compensated with course credit. Participants were randomly assigned to one-of-two conditions, with approximately 50 in each condition.

4.1.2 | Procedure

All procedures were completed in a lab, in which one participant completed at a time. Participants answered demographic questions and were directed to a private room for the VR training program. Each participant then followed one of the following assigned conditions.

1. The control condition did not include a pre-training intervention, and the participant immediately began the training program.
2. In the general attentional advice pre-training intervention condition, the researcher read the following script to participants before initiating the training:

   "This is meant to be an educational opportunity. The program is fun, but some users forget the purpose. So, do your best to learn the information while exploring space, and try to commit all the material that you see to memory."

All other procedures, including the VR hardware and software, were identical to Study 1.

4.1.3 | Measures

Post-test: The same 30-item post-test from Study 1 was used. The Cronbach's alpha was .71.

4.2 | Results

Z-scores were calculated for each participants' post-test score separated by condition, and z-scores below negative two or above two were considered outliers and removed (N = 2), resulting in 50 participants in the control and 49 participants in the attentional advice conditions.

To test the effect of the pre-training intervention on learning, an independent samples t-test was performed. Levene's test for the equality of variances was not significant, indicating that equal variances could be assumed. A significant difference exists between the two conditions (t[96] = −2.90, $p < .01$, *95% C.I.*[−.15, −.03]). Individuals in the attentional advice pre-training intervention condition performed better on the post-test (*Mean* = .60) than those within the control condition (*Mean* = .52). These results support Hypotheses 2 and 5.

4.3 | Discussion

The goal of Study 2 was to determine whether an attentional advice intervention significantly improved VR training outcomes, which would indicate the presence of seductive details cause distraction. Attentional advice significantly improved post-test scores, and the seductive details in the VR training program are thereby assumed to cause distraction. In the current study, the seductive details may have included the visual imagery of planets or the ability for users to look around themselves in all 360° using the HMD—both of which may have pulled participants' attention away from the descriptive information provided in the program.

5 | GENERAL DISCUSSION

We predicted that VR training programs may include seductive details that cause trainee distraction and/or cognitive overload, such as the immersive digital environment itself. Two pre-training interventions, meta-cognitive strategies and habituation, were applied in Study 1 to test this notion, which, respectively, targeted distraction and cognitive overload. The meta-cognitive strategy pre-training intervention produced lower post-test scores of knowledge retention from the VR training program, and qualitative responses indicated that this intervention caused trainees to become more cognitively engaged in the seductive details of the VR training program. Study 2 tested the effects of an attentional advice pre-training intervention to direct trainees' attention to the instructional material. The attentional advice pre-training produced greater post-test scores, suggesting that the attentional advice helped keep participants' attention to the instructional materials despite any seductive details. These results have several implications.

First, we argue that seductive details may be present in VR training programs more broadly. That is, seductive details may be present in VR programs beyond the program currently studied, as certain essential aspects of VR may be seductive details (e.g., immersion and digital environment). Authors often assume that the natural allure of VR improves learning (Aïm et al., 2016; Alaker et al., 2016; Howard, 2019), but this notion is counter to research on seductive details (Lehman et al., 2007; Rey, 2012; Towler et al., 2008). Future research should continue integrating seductive detail research with the CBT and VR training literature. As others have noted, researchers often approach CBT and VR training programs with modest theoretical rationale (Johnson et al., 2011; Moskaliuk et al., 2013; Salas et al., 2012), but the application of novel perspectives may prompt a deeper understanding of cutting-edge training methods.

Second, as Rey (2012) noted, the mechanisms that cause seductive details to negatively impact learning may differ between training programs, and it is important to determine the effects of seductive details in various instructional methods. We achieved this goal for the tested VR training program, supporting that distraction but not cognitive overload was a negative influence. This discovery provides a theoretical approach to improve learning in VR training programs, and practitioners can strive toward creating new VR training programs with minimal distractive elements. Relatedly, the current article also links distraction scholarship with VR training research. Several authors have investigated the causes and detriments of distraction, particularly within the field of education (e.g., Langer, 1997). These studies should be considered in a VR context to determine methods to understand and improve VR training programs.

Third, Mesmer-Magnus and Viswesvaran (2010) suggested that researchers should discover the contexts in which pre-training interventions are most effective. The results show that attentional advice can be an effective pre-training intervention for VR training programs, and researchers may develop further attentional advice interventions to prompt greater learning. Conversely, the results also demonstrate that meta-cognitive strategies may worsen outcomes. The negative effects of pre-training interventions are rarely discussed, but other contexts should be considered in which pre-training interventions negatively impact training programs. Identifying these other situations could uncover current instances in practice that organizations are hampering their employee training and development efforts, as further discussed in the following.

Fourth, while the effectiveness of pre-training interventions depends on the context, we believe that practitioners should broadly apply attentional advice interventions before most VR training programs—and perhaps most learning contexts more broadly. This intervention is brief, and it can strongly improve associated outcomes. Researchers should likewise investigate these real-world applications and test whether attentional advice interventions improve the primary outcomes of both VR and more typical training programs, such as transfer in CBT programs.

5.1 | Limitations

The results of the current article are confined to a specific VR program, and not all VR programs are identical. Our VR program presented instructional material about space, which is irrelevant to most workplaces. Nevertheless, both studies can still provide inferences regarding VR training programs. Regardless of the topic, trainees in a VR training program encode information to memory, and the dynamics of instruction are expected to be similar across topics. Relatedly, most participants underwent the entire training in a relatively short period of time, approximately 20 minutes, which restricts the application of findings to longer VR training programs; however, extant VR training programs are typically short (Ahlberg et al., 2007; Aïm et al., 2016; Gavish et al., 2015). Studying a short VR training program allows the studies to generalize to more applied contexts, but the results may not apply to all VR training programs.

Both studies were performed in a lab setting. Although tests of training effectiveness would be better investigated by a field study, lab studies allow for the control of certain variables that are often unable to be altered in workplaces. As VR training is a budding area of research, with potential undiscovered confounds, controlling extraneous variables is important to understand VR. Once VR training programs are understood within these controlled settings, future research should analyze the dynamics of VR training programs in naturalistic settings.

Participants were not given direct learning goals in the current studies, as doing so may inadvertently function as an attentional advice pre-training intervention in the non-attentional-advice conditions, but participants should have been aware that the purpose of the study was to investigate learning. They signed up for the study via an online platform for the subject pool, and the name of the study was listed as, "Investigating the Effectiveness of Online Teaching and Training." Participants also signed an informed consent sheet with the same title written on top in bold at the beginning of the experiment. Thus, participants should have been aware that the purpose of their participation was to learn new knowledge, which was achieved without providing attentional advice in the unintended conditions; however, it is not guaranteed that each participant had equal understanding of the study's purpose or expected a learning experience.

In the same vein, the current studies utilized a post-test only experimental design to gauge learning outcomes, which prevents an assessment of whether participants' prior knowledge influenced results; however, we chose not to administer a pretest in order to reduce testing effects (Christensen, Johnson, Turner, & Christensen, 2011; Gravetter & Forzano, 2018). A pretest could cause participants to cue onto the specific moments of the learning experience that provide answers to the pretest questions, serving as a type of pre-training intervention within itself. Such attentional direction may not occur in a classroom or training environment, and thereby a pretest could contaminate the lab experiments and prevent a normal learning experience. Also, random assignment created an equal likelihood that participants with prior knowledge would be assigned to different experimental conditions, and prior research has shown that random assignment tends to result in an equal distribution of participant characteristics across experimental conditions, such as prior knowledge (Christensen et al., 2011; Gravetter & Forzano, 2018). Likewise, we removed outliers from analyses, providing further assurances that any participant with ample prior knowledge did not skew the results. Therefore, we believe that these countermeasures reduced the influence of any participant characteristics, including prior knowledge, and avoiding testing effects outweighed any detriments of not including a pretest.

Finally, we did not include manipulation checks in our studies, and we did not test for mediating effects. We assumed that the observed effects were due to the proposed theoretical mechanisms, such as attentional advice narrowing the trainees' attention to relevant material. It is possible, however, that other explanatory mechanisms are the actual causes for these effects, and these explanatory mechanisms should be studied to better identify (a) which pre-training interventions may be effective with VR and (b) how to improve effective pre-training interventions for VR (e.g., attentional advice). That is, once a mediating effect has been identified, researchers could then identify other pre-training interventions that produce the same effect as well as determine how to heighten those effects in effective pre-training interventions. While these limitations of the current studies are recognized, they are also highlighted as a potential avenue for future research—an avenue that is further discussed in the following.

5.2 | Future directions

The current study has several implications for research and practice. First, researchers should test multiple VR training programs to determine the source of seductive details. Certain VR features, such as immersive environments or user control, may cause distraction, and developers of VR training programs should minimize these seductive details. Because certain VR features cannot be removed from VR training programs, it may also be important to analyze features that compensate for seductive details, such as providing attentional advice throughout the VR training program. We recommend that authors should apply Bedwell et al.'s (2012) typology to identify VR elements to investigate in conjunction with seductive details.

Second, the investigation of the specific seductive details may also illustrate the causes of differential VR training effectiveness. Research has shown that the effectiveness of VR for training purposes greatly varies, and ineffective VR training programs may possess more seductive details (Alaker et al., 2016; Howard, 2019; Mayer, 2014, 2017; Mayer et al., 2008). Future research should integrate prior scholarship upon seductive details and distraction, thereby creating several new perspectives for these future studies. Through this effort, authors' call for more theoretically sophisticated investigations into CBTs, particularly VR training programs could be satisfied (Bedwell & Salas, 2010; Salas et al., 2012).

Third, researchers should investigate seductive details in other training technologies. For example, great interest is evident for serious games and the gamification of the workplace (Armstrong & Landers, 2018; Bedwell et al., 2012; Bedwell & Salas, 2010; Landers, 2014; Salas et al., 2012). Authors have considered serious games to be forms of play in which the primary goal is education rather than enjoyment (Bedwell et al., 2012; Landers, 2014), whereas gamification is defined as "game design elements in non-game contexts" (i.e., training programs; Armstrong & Landers, 2018, p. 1). These authors have proposed that the excitement of game elements may prompt greater learning and productivity; however, these additional elements may function as seductive details, as it was the case for similar aspects in VR training programs. Likewise, scholars have investigated the relevance of multi-user VR environments to the workplace (Armstrong & Landers, 2018; Landers, 2014). These multi-user environments may add unnecessary details to tasks, thereby impairing organizational outcomes. Future research should investigate whether these lauded technologies are seductive details.

Fourth, authors should analyze the effect of pre-training interventions across a variety of VR training programs that vary on their graphical sophistication, user control, and other factors. Each attribute may cause pre-training interventions to have differing effects. For example, trainees undergoing VR training programs with high graphical qualities may be most distracted by their VR environments, and pre-training interventions may have the greatest impact in such contexts. While it is expected that the current results replicate across other VR training programs, the strength of these effects may vary with the program's technological sophistication.

Fifth, authors should test the effects of pre-training interventions not discussed in the current article. In addition to the five primary categories of pre-training interventions, each category further divides into subcategories (Mesmer-Magnus & Viswesvaran, 2010). Future research should determine the circumstances in which these pre-training interventions are most effective, and the application of other pre-training interventions may uncover additional seductive detail mechanisms. For instance, several authors have noted that CBT programs require the trainee to be self-motivated and self-organized (Armstrong & Landers, 2018; Bedwell & Salas, 2010; Salas et al., 2012). Goal orientation pre-training interventions may prove to be useful in directing trainees' motivation in otherwise difficult VR training programs.

Sixth, future research should heed Mesmer-Magnus and Viswesvaran's (2010), call, and investigate the impact of contexts on pre-training interventions. While pre-training interventions are often assumed to be beneficial, we show that certain pre-training interventions may worsen learning in a VR context. Authors should also investigate the mediating mechanisms of pre-training interventions and learning, which would provide direct insights into causes and impacts of their benefits and detriments. Specifically, researchers should test whether habituation improves other learning experiences that may cause distraction. These may include other CBT programs, but they also may include learning experiences that do not incorporate technology, such as a lecture. Pairing pre-training interventions with specific seductive detail mechanisms may be an effective avenue to understand the ideal applications of these interventions.

Seventh, several possible moderating effects should be considered for the effects of pre-training interventions on VR training program effectiveness, with perhaps being the most relevant aspects of the trainee and the context. Regarding the trainee, prior research has shown that those with worse attention control and/or working memory are more affected by seductive details (Mayer, 2014, 2017; Rey, 2012), and these individuals may experience reduced outcomes from VR training programs with seductive details. A relevant pre-training intervention, however, may be more so effective for these trainees, as these trainees would have more to gain from realigning their attention. Regarding the context, some organizations may have a poor training climate (Kraiger, 2017; Salas et al., 2012). In such cases, a training program may be considered as a break from work by supervisors and coworkers, and transferring learning experience to the actual work settings be discouraged by the peers; trainees may feel that the training programs are not taken seriously and consider a VR training program as entertainment rather than education. A pre-training intervention that emphasizes the importance of the VR training (e.g., goal orientation intervention) may be effective when the organization has a poor training climate, as trainees may begin to recognize the importance of the program. Because such interventions may not be effective when the training climate is good, the training climate may be a moderator of the relationship between the pre-training intervention and VR training program effectiveness.

Eighth, the researchers should consider the current results in the wider context of human resource development. As detailed by Werner (2014), employee training has historically been considered the core of this field, but recent trends have increasingly recognized that human resource development includes broader organizational dynamics, such as change management and strategy. Future research should consider how VR training programs and pre-training interventions align with this wider context. As mentioned, VR training programs could signal to employees, customers and shareholders that the organization is forward-thinking, which could benefit strategic objectives. Similarly, pre-training interventions could stress to employees that their development is important to the organization, again producing positive signals and eliciting employee commitment (Werner, 2014). At the same time, certain pre-training interventions, such as advance organizers, could emphasize that any learned behaviors are intended to be transferable to new settings and even positions, thereby improving the career development of employees and the capability of the organization to handle market changes.

Finally, the current results may be able to provide immediate implications for practice. Some organizations already apply VR training programs, and it may be useful to apply an attentional advice intervention in conjunction with such programs. Doing so could capitalize on the fidelity of the program, while negating the detrimental effects of distraction. Likewise, other types of trainings, including CBT programs, may likewise include distracting elements, and organizations applying such programs may too benefit from an attentional advice intervention. At the same time, the current results that emphasize the importance of ensuring pre-training interventions are effective. Some organizations may be applying meta-cognitive strategy interventions, for example, and their trainees may be suffering reduced learning outcomes. Thus, practitioners should reflect on whether their interventions are causing undue harm.

6 | CONCLUSION

We proposed that certain aspects of VR training programs may be seductive details, and pre-training interventions can counteract the mechanisms of these seductive details. Study 1 demonstrated that habituation had no effect on learning and meta-cognitive strategies worsened learning from a VR training program. Study 2 showed that an attentional advice intervention was beneficial to learning. These results suggest that the seductive details present in the tested VR training program cause distraction, which provides a link for future research between VR training programs, seductive details and pre-training interventions.

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