[How to Cross the Uncanny Valley: Developing Management Laboratory Studies Using Virtual Reality]

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ABSTRACT:

Virtual reality (VR) presents an important technological advancement that can enable management researchers to improve their laboratory work and test theories previously considered untestable. VR places a participant in a virtual environment completely designed and controlled by the research team. These environments can range from anything as benign as a regular corporate board meeting or a job interview to as hostile as a CEO answering questions in front of Congress or witnessing sexual harassment in an office hallway. A key feature of experimental work using VR is drastic improvements in external and ecological validity—VR allows researchers to transition experiments from measuring how participants self-report they would react in the real-world to measuring how they actually behave when confronted with a scenario literally in front of their eyes. While alluring, the design, coding, and implementation of studies using VR adds technical complexity to projects and care must be taken to be intentional throughout the process. In this manuscript, we provide guidance to management scholars to understanding VR, its potential applications, and the considerations one must undertake when creating studies using VR. Overall, we advocate the use of VR by management researchers in their work and introduce both a roadmap and best practices to jump-start such endeavors.

KEYWORDS:

(Please supply up to 6 keywords for your Chapter)

1. Virtual reality
2. Laboratory methods
3. Validities
4. Technology
5. Laboratory design
6. Study design

Main Body:

INTRODUCTION

Laboratory methods are critical for strategy and management studies (Bitektine et al., 2020; Stevenson et al., 2020). Through experiments, we can test management theories with the goal of establishing causality. Indeed, some of the most important conclusions in the management field have come from laboratory studies which feature random assignment, manipulation of independent variables, and control over the experimental environment (Cook & Campbell, 1979; Kerlinger & Lee, 2000). Each of these factors leads to both high internal validity and statistical conclusion validity. However, as a community of scholars we should always be looking for new techniques to test theories in ways that enhance existing methods and overcome limitations.

As a methodological platform, virtual reality (VR) has the exciting potential to present new ways for management scholars to test theories (Pierce & Aguinis, 1997) and phenomena (Hubbard & Aguinis, 2023). VR is a "type of human-computer interface that allows users to become immersed in a computer-generated environment" (Hubbard & Aguinis, 2023: 1). VR users wear headsets with small computer screens close to their eyes and speakers close to their ears. The headsets are spatially tracked and the screens are updated based on the position and orientation of the head. Rather than taking a text-based Qualtrics survey or watching a video on a flat screen as one would observe the world through a window, participants can "step through the door" and be fully immersed in a virtual environment. Examples of virtual environments are innumerable: from corporate boardrooms to television sets and job interview rooms, almost any environment can be simulated. Unfortunately, VR is hard to describe to those who have not yet experienced it. Indeed, we liken describing virtual reality on paper to writing a vivid and accurate description of a color television to someone who has never seen a TV.

The purpose of this manuscript is to advocate conducting laboratory studies using VR to management researchers. And, if interested in pursuing this path, we provide the reader with a base of knowledge to start. We make design, software, and hardware suggestions and discuss best practices from both the field and our own work. In terms of scope, however, we stop short of teaching how to code VR simulations. Instead, we encourage those interested in learning more to explore the large amount of training currently available. With each passing day, this technology becomes more accessible both technically and financially. If it feels daunting today, just return to your research idea in the near future.[1]

Given these goals, we make several key contributions to the field of strategy and management research. First, we provide a clear definition and conceptualization of VR for the field to enable researchers, developers, and reviewers to have a common scope for what constitutes a promising VR study. Second, we provide a clear discussion of the benefits and drawbacks of implementing studies in VR. These benefits and limitations are categorized into factors for both internal and external validity. Most external validity points consider ecological validity, or whether the study findings will generalize to real-life settings. Third, we provide a series of development practices that can help ground researchers, developers, and reviewers to a common set of criteria to accelerate the development and assessment of VR simulations. Finally, we provide a discussion of ethical concerns and recommendations for reviewers. In total, it is our hope that this manuscript can help speed the adoption of VR into management studies to help push the field forward in a meaningful way.

[1] Compared with a few months ago, technologies such as ChatGPT are enabling developers to write code faster by providing a base code for a function of a simulation that can then be edited, refined, and optimized. While these technologies are not going to write a full simulation, they can be a great resource for learning and writing code faster.

VR DEFINED AND CONTEXTUALIZED FOR MANAGEMENT STUDIES

Researchers across disciplines such as psychology (Boydstun *et al*., 2021; Rizzo et al., 2021; Zimmer *et al*., 2019), medicine (Baghaei *et al*., 2021; Carroll *et al*., 2021; Eshuis *et al*., 2021), human-computer interaction (Dzardanova *et al*., 2021; Sterna *et al*., 2021), and education (Abich *et al*., 2021; Nesenbergs *et al*., 2020; Shorey & Ng, 2021) are already using VR in studies. VR is a computer tool wherein a person can be placed in an artificial environment through the simulation of sensory stimuli such as sight, sound, and touch. VR "creates an illusion that a person is in a different place" (Greengard, 2019) where they can participate in virtual experiences. VR experiences can be as realistic or imaginative as the researcher desires. One could as easily be placed in a corporate boardroom as a factory floor.

VR experiences can have different levels of physical interaction. For example, the headset may just rotate with the participant's head—3 degrees of freedom. The position of the head doesn't move, but the user can look around at the environment. Alternatively, the headset could also track the position of the headset in 3-dimensional space, allowing for the head to move throughout the virtual space—6 degrees of freedom. Such room-scale (6 degrees of freedom), simulations are natural for participants to interact with and match real world movements. While 3 degrees of freedom—such as simulations using 360° video—allow participants to look around, the location of their point of view is fixed in the environment. Room-scale simulations allow participants to stand up, walk around, and interact with objects in the virtual environment.

Before going into greater detail on the benefits, drawbacks, and applications of VR, we highlight a few salient points specifically for management researchers. While our community of scholars works to build and test a body of theory, the field of management is fundamentally linked to business practice—whether that is workers doing their jobs, entrepreneurs starting companies, CEOs leading companies, or stakeholders reacting to firm actions. Thus, when considering where VR can enhance laboratory studies, the options are seemingly limitless: nearly every interaction that workers, leaders, and stakeholders experience throughout their day are all opportunities to study. Table 1 provides ideas for the type of settings that can be simulated in VR. For example, strategy scholars could simulate board meetings, all-employee meetings, or media interviews. One could imagine that instead of having participants read hypothetical questions from a reporter and then type out responses, a researcher could simulate an entire television studio and have a virtual confederate play the part of a news anchor asking questions. This is one of the most straightforward benefits of using VR in studies: we can observe actual behavior, not behavioral intentions, in a highly controlled environment that better matches real-world business environments and activities.

*** Insert Table 1 about here ***

Table 1 also provides a summary of the core benefits of VR for empirical work and potential data collection opportunities.

BENEFITS AND LIMITATIONS OF EMPLOYING VR IN MANAGEMENT STUDIES

The goals of using VR in management research are twofold: (1) to test theories that would otherwise be either challenging or untestable, and (2) to improve the validity of laboratory work. As Oxley and colleagues (2022: 1) note, "virtual reality is beneficial from a research and education perspective as it allows the assessment of participants in situations that would otherwise be ethically and practically difficult or impossible to study in the real world." We specifically believe management studies conducted using VR can benefit both external, ecological, and internal validity.

VR: Improving External and Ecological Validity

External validity concerns "how strong a statement the experimenter can make about the generalizability of the results of the study" (Kerlinger & Lee, 2000: 479). Ecological validity assesses how generalizable findings are to the real world. VR has the ability for management and strategy scholars conducting laboratory work to overcome a common criticism: that laboratory studies are devoid of realism and, thus, have low external validity—regardless of empirical evidence to the contrary (e.g., Mitchell, 2012).

A Focus on Ecological Validity. VR can help improve ecological validity because it can simulate real business contexts, manipulate variables that one would experience in real life, and study business practices in a way that matches the real world. For example, instead of having participants read vignettes and rate the likelihood of their taking certain actions, they can experience a situation and choose how they behave in the moment (Aguinis & Bradley, 2014). This is the difference between reading a scenario about a company experiencing a crisis—an oil spill, product safety recall, or a workplace shooting—or experiencing the event—seeing the animals covered in oil, observing how customers could be hurt by a product, or standing in the lobby of the corporate offices surrounded by police cars and ambulances.

Psychological Realism. These crisis management examples can help scholars improve the ecological validity of their work by increasing the psychological realism of studies. Colquitt (2008: 618) notes that "a number of factors can promote psychological realism, including placing participants in real rather than hypothetical situations, using vivid and engrossing manipulations and tasks, and creating real stakes by using monetary or credit-based contingencies." There is a trade-off between mundane realism—how much an experiment is similar to everyday life situations—and experimental control. The more researchers can increase the realism and design experiments such that they mimic real life, the higher the psychological realism of their study. VR can completely reshape our existing relationship between balancing experimental control and the realism of the simulation (see Figure 1 reproduced from Blascovich and colleagues, 2002).

-- *Insert Figure 1 about here* --

Real-World Environments. Another way to achieve external validity is to put people in the most appropriate environment to test a particular theory. VR can help in this regard because participants can be placed in almost any imaginable environment including difficult-to-access as well as dangerous environments. VR can, for example, transport people to the floor of the New York Stock Exchange, the control room of a nuclear power plant, or the boardroom of a Fortune 100 company. This experience can be achieved without having to physically transport participants to the actual location. Participants can also be placed on stage in a full lecture hall without needing real people in the room. Or, if a theory is best tested in a dangerous environment, researchers can place participants in that environment without subjecting them to physical risks.[2]

VR: Improving Internal Validity

For management scholars, VR has specific benefits to improve the internal validity of their studies—or "how strongly the experimenter can state the effect of the independent variable on the dependent variable" (Kerlinger & Lee, 2000: 478). Using VR, management scholars are forced to choose almost every aspect of the participant experience: they control the virtual environments, virtual confederates, sounds, animations, haptic feedback, and more. Everything a participant sees or hears—from the time of day out the window to the color of the walls—must be chosen. With each design element available for VR, management researchers, reviewers, and

[2] Psychological risks should still be considered, see the Ethical Considerations section in the Discussion.

readers can be more confident that the relationship between the manipulation and the outcome is internally valid.

Using Virtual Confederates. Some traditional lab experiments use confederates—individuals brought in by experimenters to act as bystanders, participants, or teammates. In VR, we can use virtual confederates—avatars simulated in the software—as an alternative to humans. Real human confederates may not be needed. Instead of human confederates—who are unlikely to behave in the exact same way for every single participant (Kuhlen & Brennan, 2013)—we can program virtual confederates in VR. Because we choose exactly what they look like, what they say, and how they are animated, we know they will behave in the exact same way for each participant. If an organizational behavior scholar, for example, wanted to study supervisors dismissing employees, the employees in the study would have the exact same body language, tone of voice, and response from participant-to-participant. To provide a sense for how realistic virtual confederates can be, Figure 2 provides photos of some we have used in VR.

-- *Insert Figure 2 about here* --

Control Over the Environment. Consistent environments are important in experimentation. Studies implemented in VR can ensure that the environment is identical from participant to participant. This avoids confounds that may be present in real-world laboratories. If, for example, an experimenter uses a real-world laboratory with a window, participants will be exposed to different weather and lighting as the seasons and days progress. While such factors might be accounted for through random assignment, being able to control the environment can reduce noise in the study. In addition, a single lab room can function as many different physical spaces from boardrooms and offices to a warehouse with appropriate ambient sound that does not vary between participants (unless sound is part of the experimental manipulation). While in the past researchers have gone to great lengths to create realistic environments—such as building a casino (Blascovich et al., 1973)—VR can make varied, realistic environments much more accessible and cost-effective.

WHEN TO APPLY VR TO MANAGEMENT STUDIES

There are five broad features of studies that can especially benefit from employing VR. First, VR allows us to test theories that we either cannot or that would be difficult to test in the laboratory. Certain phenomena in the real world are difficult to recreate even in lab settings (Hubbard & Aguinis, 2023). For example, studying how people respond when they watch someone inappropriately touch or harass another person in the work environment, or when they are participating in discussions about controversial boardroom topics such as CEO dismissal, ethical lapses, or product recalls. In the case of sexual harassment, for example, a virtual confederate can inappropriately touch another virtual confederate—instead of relying on human confederates to model inappropriate behavior that could pose ethical challenges for the research team.

Second, VR allows us to test theories and phenomena that have not happened. Some researchers have done this without using VR by using laboratory experiments to understand future corporate governance changes (Krause et al., 2014). While pen-and-paper scenarios were appropriate for Krause and colleagues (2014), other upcoming phenomena might present challenges to such methods. Specifically, behavioral changes that are happening in the world can present opportunities that are ideal for VR-based methods. An example can be employees working with robots—a phenomenon that will become increasingly prevalent over time. While a researcher could study these future interactions using vignette designs—reading and reacting to a scenario about interacting with such robots—these methods have limitations (Aguinis & Bradley, 2014). In a VR world, a researcher could experimentally manipulate and vary the robots with which a participant interacts. These variations could include physical size, race, gender, attractiveness, and behavior of the robot without the need to purchase or program a single physical robot—all while presenting more realistic scenarios than pen-and-paper methods.

Third, VR allows us to safely observe the participants in dangerous scenarios. Participant safety is paramount in ethical laboratory research. VR can play an important role if testing a particular theory necessitates observing participants in situations where they feel a sense of danger or fear such as team management in search and rescue or emergency operations. VR is capable of delivering such high levels of immersion and presence that fear can be elicited (Diemer et al., 2015). For this reason, observing the management of police response in active shooter situations could be a good application for VR. VR systems can be set up as multiplayer simulations where participants can be in both the same physical and virtual environment (Christensen et al., 2018). Thus, multiple participants can participate in the same simulation.

Fourth, real-world situations that are expensive are good candidates for VR simulations. While there are upfront and ongoing expenses for VR systems, these costs can easily be balanced by the cheaper implementation of certain scenarios and their reuse in subsequent studies. Anything a management scholar can imagine, can be built in VR. VR can transport participants anywhere in the world. As illustrated in Table 1, for example, a strategy scholar could simulate an all-employee meeting taking place at a corporate retreat. Conducting a study in a real physical conference center would likely be cost prohibitive. Or, when studying corporate boardroom interactions, a strategy researcher could build a physical boardroom at a significant cost or create a virtual environment of the same fidelity at a much lower expense.

Finally, VR allows participants to experience rare situations—abusive supervision, sexual harassment, workplace accidents, or active shooter situations, among others. When a situation is uncommon, researchers can spend a great deal of time waiting to observe it in the field. And, when such a rare situation does arise, it is unlikely to be randomly assigned. Endogeneity can enter field studies where something else likely induces the rare condition a researcher hopes to study. On the other hand, VR can help management scholars by randomly assigning the occurrence of such rare events.

Limitations of Using VR in Studies

While there are numerous benefits, it is necessary that management scholars take stock of several limitations to VR. The main hurdle in implementing VR in laboratory studies is the technical knowledge required to develop the software to conduct the studies. At this point, developing custom simulations requires deep knowledge of development in real-time 3D game engines such as those used to develop video games.[3] There are special considerations—discussed below—that researchers must consider when developing VR simulation software that go beyond what is typically needed in 3D simulation development, which is yet again more complicated than simple 2D or text-based scenarios.

There are also upfront cost considerations for hardware, software, and the physical space to conduct the studies. Researchers need access to headset hardware, which can vary in cost depending on needs, discussed below. Headsets can differ in their features such as visual fidelity, refresh rates, audio quality, eye tracking, and face tracking. Each desired feature will, of course, add costs. Researchers also might need specialized software to write the simulation, design

[3] There are alternative approaches to VR simulations created using real-time 3D engines such as 360° video, which allow for easier entry, high immersion, and lower hardware requirements. Furthermore, there are off-the-shelf software that may be used such as VR conferencing solutions. The choice to use these products primarily centers around the level of presence and control a researcher requires. If a participant needs to be able to pick objects up or move around a room, real-time 3D engines are the most appropriate solutions.

digital environments, and create, rig, and animate virtual confederates. Further costs may be incurred if researchers want to collect biometric data such as electrodermal activity, heart rate, or respiratory data (Knaust *et al*., 2022). While some may view these costs as high, they must be considered in comparison to the costs of conducting studies without VR. As discussed above, it can be prohibitively costly to transport participants to specific locations or impractical to have them interact with expensive equipment.

DEVELOPMENT PRACTICES FOR VR

Developing a comprehensive, immersive VR experience may involve the creation of various digital elements such as the simulated environment, programming logic, human-like avatars, avatar animations, VR user interaction, audio (ambient or background sounds and speech), and haptic (touch) interactions. In this section, we provide management scholars a view into the different systems that makeup VR, along with best practices from other scholars and our own work in VR.

VR Development: Virtual Environments

Real-time 3D engines are available that allow for the integration of all elements of the VR experience into a distributable VR application (e.g., Unity and Unreal Engine). These platforms provide management scholars with all the functionality necessary to construct a virtual world. In addition to what is already in the engines, 3D objects and landscapes can be built using 3rd party modeling tools (e.g., 3D Studio Max, Maya, and Blender) or purchased from various 3D asset repositories. For example, a complete boardroom scene which includes a fully constructed boardroom along with a conference table, chairs, artwork, and lighting can be purchased from the Unity Asset Store. See Figure 3 below for some examples of premade virtual environments.

-- Insert Figure 3 about here --

Even if a developer of a VR environment begins with a purchased asset, once it is in the engine it can be customized. For example, there are many websites dedicated to providing free or for-pay materials, such as wood grain images that could be used to customize the look of a corporate conference table. Walls, ceilings, and floors can be customized as well with the application of other materials and textures. Research has shown that people can recognize materials and textures accurately in VR (Niu & Lo, 2022). The lighting of VR environments can be adjusted through the application of lighting types commonly found in the real world—from spotlights and emissive lighting fixtures to adjusting the "sun" to simulate the time of day. The fidelity of VR environments can be improved through the addition of small details by importing 3D models of everyday items, such as lamps, books, potted plants, and coffee mugs, among others. One way to start designing a 3D environment is to take a photo of the real environment during the scenario of interest—for example, take a picture of a conference room during a meeting. You'll be able to see what is on the table and how messy the table really is—the virtual world should be just as messy as these reference images depict.

Environments that match real-world environments with high fidelity can increase the psychological realism and give researchers more confidence that their conclusions will generalize to the working world.

VR Development: User Interactions

Once a VR environment has been constructed, there may be several ways in which both the researcher and the participant under study would need to interact with it. Within the simulation, there are many ways in which a participant could interact with the environment. Participants can directly manipulate objects in the environment: open a door, pick up a book, or turn on a light. For research purposes, text can be present on screens in view of the participant to give instructions regarding the study or provide educational content, and a laser pointer can be employed to allow participants to press buttons to advance text as well as to manipulate sliders to respond to research questions on a Likert scale. Menu and interface design is an important consideration in VR studies (Wang *et al*., 2021). These participant interactions and responses can be recorded and written out in data files for later analysis. Having precise measurements and interactions can increase internal validity and reduce noise in the study. For example, instead of a survey completed at the end of an experiment, researchers in VR can administer questionnaires in the middle of situations—essentially pausing a scenario to obtain feedback.

VR Development: Audio

Audio can be utilized in a variety of ways to enhance the feeling of immersion in VR environments (Cooper et al., 2018). Virtual confederates can give speeches or directions in virtual meetings with either voice-actor or text-to-speech generated audio clips that can be lip-synced to the confederate. Ambient sounds can be integrated to intensify the sense of being in a meeting room with subtle street noise and a slight ventilation hum.

Care should be used when planning and implementing audio design in VR (Somberg, 2021). Like other portions of development, audio is a blank slate when you start a project. It is up to the researcher to select and implement each and every sound the participant will experience. A good way to get a feel for audio implementation in VR is to close one's eyes and make notes of all the sounds heard—traffic noise outside the window, people talking outside your office, the hum of the ventilation system. One can imagine the difference between reading about angry investors in a vignette study compared to hearing angry people shouting questions at you at a shareholder meeting.

Somberg (2021) lays out three categories of sounds to consider. First, there are sounds from the world which include the environment (e.g. ambient sounds), weather (e.g. rain or wind), particle effects (e.g. fire or sparks), and physics (e.g. objects sliding against each other or collisions). Second, character sounds include the speech, movement, and interactions of all characters in the experience. Finally, the third is feedback sounds that include audio cues for feedback in menus and other sounds intended to enrich the user experience. Feedback sounds should help give confidence to the participant that they are interacting in the correct way.

Once the sound design has been planned, researchers must consider the technical choices of implementation and how those choices will influence the overall fidelity of the auditory system (Al-Jundi & Tanbour, 2022). Three factors can increase the fidelity of the auditory system in VR studies. First, is the quality of the auditory stimuli which correspond to the other cues a participant is experiencing. One such cue could include the participant's visual system: if they see a fire, they should hear a fire. It can also correspond to interactions a participant experiences: if a participant drops a cup, they should hear it hit the ground. Anytime the quality of the auditory stimuli suffers, researchers risk participants breaking immersion as their brain tries to understand why something did not happen or why it was different than they expected. The second factor is the realism of the surrounding audio. This realism reflects the degree to which the audio is an accurate reproduction of real-world sounds. The greater the correspondence between audio in the study and real-world audio, the greater the participant will accept the virtual reality as real. Finally, the third factor for audio fidelity is audio resolution, which refers to the degree of exactness with which the overall audio system reflects the real world. That is, rather than the accuracy of the individual sounds—whether a tin cup falling on the floor sounds like a tin cup—audio resolution focuses on the entire system. In real-time 3D systems, audio spatializers can be used to increase audio fidelity. These systems can control the position of the audio such that the sounds come from particular locations. There can also be room effects such as reverb (the audio bounces off surfaces in a realistic way), occlusion (objects can block sound), and decay (audio falls off as the distance between the participant and the source increase).

Such subtleties in audio design help increase immersion and presence (Al-Jundi & Tanbour, 2022). The key part of audio design, much like the other design considerations, is control. Every sound must be selected and implemented individually. And, thus, every participant will be exposed to the sounds chosen by the researcher. Detailed consideration put into strong audio design and implementation can help improve the participant experience and help melt the divide between the virtual world and the real world.

VR Development: Haptic Feedback

Haptics are physical feedback through touch sensations (Al-Jundi & Tanbour, 2022). Enabling the sense of touch in an immersive VR environment involves a broad spectrum of touch experiences from the simplicity of vibrating the VR game controller to providing realistic feelings of real-world texture through a haptic glove. Full-body haptic suits can provide physical sensation from the shoulders down to the ankles. Haptics can provide important biofeedback for participants. It can help them know that they can pick something up. It can also help confirm that participants are interacting with objects or menus. A slight vibration when a button is pushed can help the user know what to do. Haptics can also help simulate the pressure participants feel when they touch objects in VR. Through purposeful haptic design, participants can feel the rumble of machinery in a factory, the touch of a virtual confederate, or the menu with which they are interacting.

VR Development: Virtual Confederates

Virtual confederates, human or otherwise, can be present in the environment and programmed to move in realistic ways (Fysh *et al.,* 2021). These realistic movements can include body movements as well as lip-sync to match their speech. These confederates can be created with third-party software tools that allow for high levels of fidelity as well as customization. Figure 2 provides some examples of current virtual confederates used in VR. While at times the researchers should create their own avatars, online stores enable researchers to purchase human avatars of different body types, genders, and races. All aspects of the virtual confederates' appearance can be manipulated, from eye color and hairstyle to body shape and all aspects of clothing and accessories, which are also available for purchase at modest cost and customizable by modifying colors, textures, and virtual fabrics. These digital assets afford great creativity; for example, an organizational behavior scholars interested in studying discrimination based on body type could experimentally manipulate the body mass of a virtual confederate and observe participant behaviors directed towards those individuals.

VR Development: Locomotion

The choice of locomotion methods can impact the degree to which participants experience simulator or cyber sickness. The traditional recommendation for VR environments that can be "walked" include physically walking over short distances (less than a few meters) in a room-scale environment, using teleportation, or employing omnidirectional treadmills. Such treadmills enable participants to move in 360 degrees, which can also help improve simulator experience by providing a more direct mapping between physical movement and the movement experienced in the VR environment.

The choice of locomotion method depends on the requirements of the study while balancing issues such as simulator sickness. The three primary methods of locomotion—(1)

walking within the virtual space, (2) continuous locomotion such as free stick-based movements, and (3) discrete locomotion such as teleportation—all have different trade-offs. Real-world movements such as walking around are the most natural for participants (Christensen et al., 2018) and should be the goal for VR developers. If the participant can locomote on their own—either through a small virtual world or a large play area—that is the most natural and will lead to the lowest simulator sickness, highest immersion, and highest presence. However, these small-scale environments are not always feasible. If control-based locomotion is needed because the physical VR space is too small or the virtual world is too big, continuous locomotion is an option. In this case, participants use a joystick on their controller to move (virtually while standing still) or a 360 treadmill that provides a step-to-step correspondence to walking or running. The benefit to continuous movement is that there is no break in immersion, but studies have found this to have relatively higher levels of simulator sickness (Frommel *et al*., 2017). Finally, teleport locomotion "elicited least discomfort and provided the highest scores for enjoyment, presence, and affective state" (Frommel *et al*., 2017: 1). Some studies, such as participating in a board room meeting while seated at a conference room table, require no locomotion at all.

VR Development: Reducing Simulator Sickness

Simulator sickness—or VR sickness when specifically considered for VR—is "bodily discomfort associated with a series of symptoms such as disorientation, nausea, vomiting, and visual fatigue" (Chen & Weng, 2022: 817). Simulator sickness is a health and safety risk for VR studies. Simulator sickness occurs when your brain thinks you are moving, but your body is static. This disconnect causes enough confusion to make someone feel ill. Simulator sickness, however, does not have one clear cause. Chen and Weng (2022) catalog that the duration in VR, time lags, a poor field of view, display content, gender, and age may contribute to simulator sickness.

Good tracking is critically important in VR to reduce the likelihood and severity of simulator sickness (Caserman *et al*., 2021). With good tracking, the likelihood of simulator sickness is greatly decreased. Fortunately, this is an area of rapid advancement for headset manufacturers and should continue to improve over time. Poor tracking usually manifests as either the headset position doesn't match the participant's real head position or the controllers and hands don't match their physical location. Both of these situations quickly induce simulator sickness. One can imagine the discomfort of seeing their virtual hand float off into space while their real hand is stationary, or a room turn sideways while their head is still.

Researchers and developers can work to reduce simulator sickness by having a wide field of view when a participant is stationary but restricting that field of view when moving (Teixeira & Palmisano, 2021). They can also ensure that the only head movement is based on the participants' actual motions. When a participant needs to move fast—like flying through the air or going up—they should be placed within a stable reference such as a plane or elevator.

Researchers and developers should test their simulation software on the target hardware—the headsets and computers that will actually run the simulation—throughout development. By continually testing, it will become apparent when these issues arise. Normal development cycles include building up the simulation from simple models to the full simulation. Developers can more easily diagnose issues if they notice video or tracking issues throughout development as the VR simulation becomes more and more complex. When the software begins to slow down frame rates or drop frames, developers can use profiling software to locate the bottleneck. Typically, this is either the central processing unit (CPU) or graphics processing unit

(GPU). Profiling software will show how each frame is processed including what must run on both the CPU and GPU. Resolving these issues is beyond the scope of this guide but knowing that profiling exists can help researchers optimize their simulations.

VR Development: Accessibility

VR poses an exciting opportunity for management researchers to design experiments that increase the accessibility of studies to people with accessibility challenges.

VR can help participants with mobility challenges by allowing them to pick up objects at a distance, a design concept called remote grab. When designed, implemented, and enabled, remote grab allows participants to use a raycast—a laser beam from the controller or their hand—to select an object from a distance and pull it to themselves. Thus, rather than needing to walk across a room to pick up an object, participants can grab it from where they are at the moment. For participants with mobility challenges, this represents an opportunity to design the study so that they are able to participate.

Unlike the real world, researchers and programmers can also design VR interactions such that only one hand is needed potentially increasing the pool of potential participants. Sometimes objects require two hands because of the dimensions or weight. With one-handed interactions, the dimensions of an object are somewhat irrelevant. The object can be snapped or locked to a hand in any position. The weight of an object also becomes irrelevant—in VR, if a researcher wishes, participants can pick up a sledgehammer with one hand and wield it as though it were a pencil.[4]

Finally, researchers can consider using closed captioning within the virtual environment. Many times, researchers choose to exclude potential participants who have hearing impairments.

[4] Weight can also be designed into the simulation such that the physics behave in a way that requires participants to put effort into picking up and moving objects.

This might be necessary at times given some study designs require verbal prompts or verbal responses, but in general, VR may help overcome this accessibility limitation using closed captioning. Closed captioning can be used to show the text that virtual confederates are using to allow the participant to follow along without hearing the audio. Closed captioning can also be placed around objects. For example, there could be a prompt above a laser pointer that says "Pick me up" to prompt the user to grab the pointer.

VR Development: Olfactory System

Technologies to present VR environment appropriate smells are available with limited subsets of smells designed for a particular simulated situation (Serrano et al., 2016). For example, in a health and wellness meditation study, the olfactory system could deploy calming smells (forest, beach, etc.) to the participant to enhance mood. Military and first responder simulations could prepare participants for warfare and emergency situations by presenting smells of the battlefield or a fire (Lefrak, 2022). While this area of technology and research is still nascent, it is becoming more advanced and accessible.

VR Development: Important Survey Scales

There are several survey scales that can be considered in VR studies to understand the participant and simulation experience.

Simulator Sickness. First, as discussed above, simulator sickness is a phenomenon of which researchers need to be aware. Measures of simulator sickness came out of the military who needed to evaluate aviators' training protocols. The Simulator Sickness Questionnaire (SSQ) was developed in the early 1990s (Kennedy et al., 1993) and later re-examined (Balk, Bertola & Inman, 2017). Simulator sickness has three distinct symptoms: oculomotor (e.g., eyestrain, difficulty focusing, blurred vision, headache); disorientation (e.g., dizziness, vertigo), and nausea (e.g., nausea, stomach awareness, increased salivation, burping). The SSQ's list of individual symptoms is aggregated to provide the three overall symptoms.

Presence. Igroup Presence Questionnaire (IPQ) (Schubert *et al*., 2001: 266) measures the "sense of being in the virtual environment" and is operationalized by subscales measuring general presence, spatial presence, involvement, and realness (Kisker *et al.,* 2021). This scale can help researchers contextualize how well their simulation engrosses the participant by allowing them to feel present in the virtual environment.

Game Experience. The Game Experience Questionnaire (IJsselsteijn, de Kort & Poels, 2013) can help measure competence, immersion, flow, tension, challenge, negative affect, and positive affect in the VR. While this scale has been criticized (Law et al., 2018), it is still widely used.

Technology Anxiety. Technology anxiety is concerned with "the level of stress and anxiety about technological devices in general and about making mistakes when using them" (Knaust *et al*., 2022: 930). Technology anxiety can be measured using a four item subscale of the Technology Usage Inventory (Kothgassner *et al*., 2013).

It is not necessary to measure all these scales in every VR study. Instead, they can help provide context to studies and identify issues. For example, if researchers measure the SSQ in a study, they can monitor the measurement early in the study. If SSQ is higher than mean levels reported in other studies or if there is something unusual going on, the researchers can try to identify the root cause and address it.

VR Development: Unobtrusive Measurements

Beyond the survey scales just discussed, there are many other measurements that can be considered in VR studies. Researchers benefit from VR "on several fronts as data collection is covert, continuous, passive, and occurs within a controlled context" (Yaremych & Persky, 2019: 1). Two important features of unobtrusive measurement are that they are covert and continuous. Researchers and programmers must consider what unobtrusive measures they will need ahead of time, as they will typically have to develop the software in a way to record and save the data. By default, real-time 3D engines do not save any data—everything must be considered and integrated ahead of time. Table 1 provides examples of the types of measurements management scholars can choose to implement.

Measuring Eye Gaze. Tracking a participant's gaze is of vital interest to researchers (Meißner & Oll, 2019). Screen-based eye tracking is a standard and acceptable method of understanding a participant's gaze. While we can gain important insights from visual attention on a 2D plane, researchers are more and more interested in understanding visual attention in the broader world. Researchers are currently using eye tracking glasses. Analyzing the data from these devices is difficult as the researcher must match the eye gaze data with the video recorded from the front of the glasses. Eye tracking is more straightforward to handle in VR. There are two methods for eye tracking based on either headset direction or an eye tracker integrated into the headset. Using the direction of the headset assumes that the participant's gaze is straight ahead. While there is obvious error in this measurement, the simplicity of it is appealing. In either method, researchers can use a ray trace out from the head position in the direction of the eye to determine what the participant is gazing at in any particular moment. These ray casts can then be aggregated based on game objects within the software. Thus, if visual attention of a particular virtual confederate in the virtual world is of interest to researchers, they can add up the time that the ray cast hits that object during the simulation. Dedicated eye tracking hardware coupled with a VR headset is likely more precise than other head mounted solutions such as matching up video with tracking data from eye tracking glasses. Eye tracking data can give management scholars a continuous view into participant visual attention.

Measuring Movement and Position. VR headsets and controllers are continually tracked. This tracking can be augmented by trackers placed on other parts of the body such as the participants' feet. Researchers can take advantage of position tracking by recording the movement of the headset, controllers, and hands. The movement and position data can be a valuable resource for researchers. Researchers can also record when body parts are in specific volumes in the virtual world. For example, a researcher could record if a user raises their hand in a meeting or if a participant reaches for an object. These unobtrusive measures have the potential to be quite revealing of human behavior.

Measuring Facial Expressions. Facial expressions have become an important part of management and strategy research (Hellmann *et al.,* 2020). Facial expressions occur based on whether people feel a particular way, choose to express a particular emotion (even if they do not feel it), or do not express any emotion, regardless of how they may actually be feeling. Measurement of facial expressions in VR is becoming increasingly easier as technology improves. Many headset manufacturers are including facial expression cameras in their headsets to allow for avatars in social apps to accurately display their consumers' faces. Thus, when a consumer smiles in real life, their virtual avatar also smiles. This technology benefits researchers who can use the same facial expression camera to record this data throughout the study. One nuance to consider, though, is that most face trackers are used for the area around the mouth, while the eyebrows and forehead are obscured by the headset. Rather than relying on affect scales, facial expressions can provide insight into what emotions participants physically express. For example, one could determine if participants laugh at a CEO's jokes (e.g. Miron-Spektor, Baer & Eliav, 2023).

VR DESIGN LESSONS LEARNED

We now go over some unscientific lessons that we have learned while developing and running studies in VR. While there might be ongoing research on these topics, published studies corroborating our experiences are lacking. Thus, presenting these lessons serves two purposes: one is to disseminate these lessons to aid developers and the other is to propose interesting VR-specific methods research topics. We have found that focusing on making many small improvements can drastically increase immersion and presence in VR while also reducing simulator sickness. It is hard to nail down exactly which change leads to the largest improvement.

First, when designing your environment keep in mind that very little in the real world is perfectly clean, straight, and neat. Instead, there is likely some dirt on the windows, scratches on the tables, and messy papers on the table.

Second, when designing the participant flow for the study, take some time to consider the start of the VR experience. Providing acclimation time—where participants can get used to wearing the headset and their surroundings—can help participants increase immersion. We have also found it helpful to have participants learn all the mechanics they will need to use in the simulation prior to participating in the experimental simulation. Participants who will use a laser pointer to make menu selections should have time to practice and ask questions of the researchers if they are confused. If participants need to pick up objects, have a few simple 3D cubes around to try. If they need to locomote, make sure they have a practice room in which to move around. It is beneficial to have the simulation only proceed when participants have demonstrated proficiency with the game mechanics. Immersion can be broken if they need to ask a question in the middle of a simulation.

Third, watching videos in VR simulations can increase immersion. Watching a short video on a TV or computer screen is such a natural act in the real world. If you can have instructional videos or filler videos in the VR environment, these can help the participant feel grounded in the VR world.

Fourth, if virtual confederates are speaking to a participant or listening to a participant, have them look the participant in the eye. Enabling this feature poses a technical challenge that will require some programming. This challenge can be overcome since the headset position of the participant is tracked and the eyes of the virtual confederates can be animated. There is something unnatural about someone not looking a person in the eye when they are speaking or listening.

Next, when coding the simulation, ensure that the simulation is coded in a way that keeps the frame rate somewhat higher than the desired frame rate on the target platform. Thus, if the target is 90fps, try to plan for 100fps. This overhead can help ensure that if something unexpected runs in the background, the simulation will maintain a high enough frame rate and lower the likelihood of simulator sickness.

We also recommend researchers save the data to both the cloud and a local hard drive. This is good practice for data backup. Saving data to the cloud enables researchers to check on the data collection from anywhere in the world. Many labs run on multiple computers and headsets. Cloud saves can be a central repository for the different computers and headsets running the simulation at the same time.

Finally, positional audio is important. We discussed audio in the development section above, but we wanted to revisit it. Whether the noise is related to venting, traffic, or people speaking, the position of the audio can help immensely. Positional audio is especially important if there are multiple virtual confederates and they are speaking. The human brain can much easier discern who is speaking when hearing the voice as it does in the real world. For example, when a speaker is at an angle to a participant, there is a slight delay and lower volume between the closer ear and the farther ear based on the distance between them on the head. Subtle differences such as audio decay are important for the brain and can help orient the participant to the correct speaker.

STEPS TO ADOPT VR INTO RESEARCH STREAMS: HEADSETS AND LABS

In this section, we provide a general process to integrate VR into research. These recommendations are based on running VR simulations built in real-time 3D engines as opposed to other options such as 360° video. Figure 4 provides an overview and visual for how the different hardware and software come together to realize high-quality, immersive VR simulations. Table 2 provides pricing and discussion of current VR technology ranging from the highest-end headsets with integrated biometric sensors to consumer-grade headsets that can run without a dedicated computer. Finally, Table 3 provides a menu of sorts with different software that researchers can use as they design their studies, including different real-time 3D game engines, locations to get virtual assets, sounds, and avatars.

-- Insert Figure 4 and Tables 2 & 3 about here --

In general, there are four steps to implement VR in studies. Some of these steps typically happen in parallel:

1. **Identify a Developer:** The developer of the VR simulation can be the researcher or a game development professional or team. If researchers want to do it themselves, there are many resources that allow them to be self-taught through online courses or video tutorials. Developers should be familiar with real-time 3D engines and developing software specifically for VR applications.
2. **Design the Experiment:** The bulk of this manuscript can guide researchers through some

of the fundamental choices they will have to make as they develop the design of the experiment. Using each section as a guidepost for what needs to be considered can help researchers document what they will need to develop.

3. **Implementing the Experiment:** The VR simulation needs to be developed, prototyped, and tested at regular intervals to ensure that it is meeting the goals laid out in the experimental protocol. The more often the team works together to test the current state of a simulation, the greater the likelihood of success. Regular testing in headsets will ensure that the hard work being done will meet the expectations of the whole team.
4. **Setting up a VR Laboratory:** While running VR studies through online services like Prolific are becoming more accessible, many researchers will opt to conduct the studies in their own laboratories. VR labs need to be set up with the appropriate VR hardware and software to run the completed experience. Room-scale VR needs at least a 3m x 3m room. Standing/seated VR requires a few feet in front of a desk. Tables 2 and 3 provide specific hardware and software recommendations as of this writing.

While this all may seem daunting, it should be viewed as a journey—the environments and simulations you develop to run in new laboratories can serve as a foundation for an almost limitless number of studies.

ETHICAL CONCERNS FOR VR STUDIES

There are several ethical concerns researchers need to consider as they design and implement studies using VR. Remember, according to Marvel Comics, "with great power there must also come—great responsibility."

The first ethical concern stems from the excitement of possibilities. So much can be done in VR that it might be enticing for researchers to put users in inappropriate situations. Specifically, because participants cannot be physically harmed in VR, researchers could put participants in situations where they could reasonably expect to be hurt in the real world. Examples of this could include having participants observing physical fights between customers and employees or having an active shooter in an office building. Such dangerous situations are all possible in VR, but this should not be an invitation to use such simulations without a clear purpose that exceeds the risk to the participant. Participants can still fall, trip over themselves, or suffer other adverse psychological effects.

Putting participants in apparent physical danger or extremely stressful situations might also trigger unintended psychological responses—such as triggering prior traumatic events or leading to PTSD. For example, Neyret and colleagues (2020) had participants complete the Milgram Obedience experiment. Caution must be taken. Institutional human subject review boards should be aware of these possibilities and serve as guardians, but researchers must design studies appropriately and not put the burden of responsibility on an outside regulatory group.

Another area of care that must be taken is the aforementioned simulator sickness. It is imperative that researchers develop their simulation software to minimize simulator sickness. Above we discussed ways to minimize simulator sickness and fortunately have had very few cases in our own lab having run hundreds of participants. Many participants are not aware of simulator sickness as a potential adverse condition—even if it is detailed in the consent form. Thus, the onus is on researchers to ensure that they have done enough work to reduce the likelihood of participants encountering issues. It is not possible to completely remove the possibility that someone will experience simulator sickness. The only exception to this is for researchers who are investigating simulator sickness either as an independent or dependent variable. In such cases, it is important for participants to have a clear understanding of the experience which they are agreeing to undergo.

RECOMMENDATIONS FOR REVIEWERS OF VR STUDIES

At this time, many management reviewers find it challenging to properly evaluate VR studies. Specifically, reviewers may not have been exposed to VR, and so it is hard for them to conceptualize the realism and immersion of the technology. Reviewers, thus, may start from a position of aversion to VR technology. But even without having been in an immersive VR environment, there are some simple recommendations that can help reviewers effectively evaluate research using VR. The main consideration for reviewers is to increase the transparency of data and methods reported in VR studies (Lanier et al., 2019). Increasing the amount and quality of data and information about such studies is key, as it can provide the reviewer team with enough material to understand the totality of the VR simulations. A checklist for reviewers is provided in Table 4.

-- *Insert Table 4 about here* --

While one can imagine providing a printout of a Qualtrics survey experiment, it is much harder to show the merits of VR software to reviewers. It is challenging to easily provide reviewers with the experimental materials. Many reviewers do not have access to VR equipment and, when they do, VR software is often developed for the specific hardware being used in their specific laboratory. Thus, the VR simulation software might not run on a reviewer's specific headset. While this is a current limitation, many platforms are moving to consistent development environments (e.g., OpenXR), which should make it easier to run the same software on different devices. A reviewer not being able to run the software in a headset, though, is not a reasonable reason to negatively evaluate a particular study. Instead, the authors should provide screenshots and videos of the simulation. Reviewers who rely on screenshots and video though, will view them in the context of their 2D screen, which is much less immersive than being in a VR headset.

Researchers should also provide other materials used in the study including any surveys or debrief scripts used with participants. These materials can help contextualize the whole study and the experience of participants going through it. A timeline of events for participants is especially helpful so reviewers know when specific surveys were given and the order of events within the simulation. Finally, all the data and analysis files should be provided to help with transparency. The data and analysis files are also an opportunity for reviewers to answer their own questions. For example, if an author did not report a particular correlation a reviewer believes is important, the reviewer can use the data provided to run that particular correlation themselves. Including data and analysis files should speed up the review process. Public data can also allow future readers the opportunity to scrutinize the data and analyses. The data can additionally help spur future research as scholars look at other, unexamined relationships that occur in the dataset.

CONCLUSION

The field of strategy and management is at an inflection point regarding the potential adoption of VR as a legitimate method of laboratory study. On the one path, we can remain skeptical and enact barriers to prevent VR studies from publication—through the review process, doctoral training, and public skepticism. On the other path, we can be open-minded about the strengths and limitations of VR in management research. The natural reaction that VR is unrealistic, not immersive, and does not lead to participant presence in the virtual world is already outdated. The hardware and software capabilities used in VR are ultrarealistic and are now only limited by the technical capabilities of the researcher and the programmers creating the simulations. Over time, these barriers will fall as well. If researchers come together now and accept VR as a legitimate methodology, we can drastically increase the types of theories we can test and increase both the internal and external validity of our conclusions.

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INSERT ANY TABLES / FIGS / PICTURES / ILLUSTRATIONS / TABLES HERE

Figure 1. The Trade-off Between Experimental Control and Mundane Realism

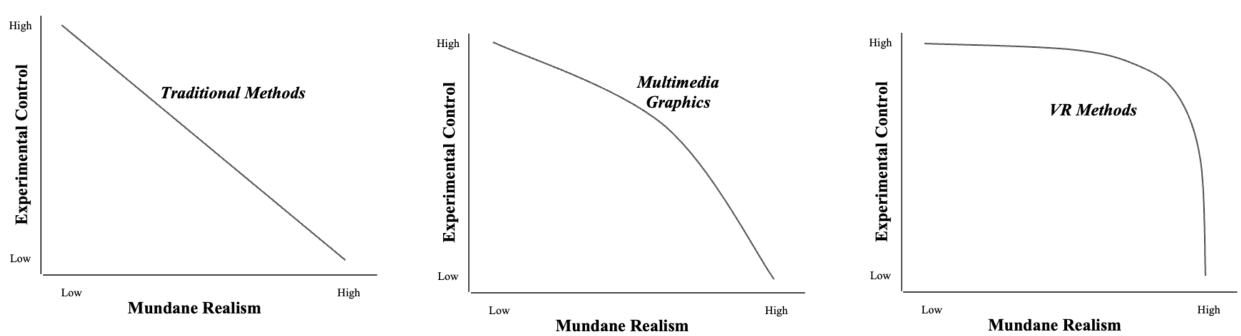


Figure 2. Examples of Virtual Confederates

Note: Created with Reallusion's Character Creator 4

Figure 3. Examples of 3D Environments

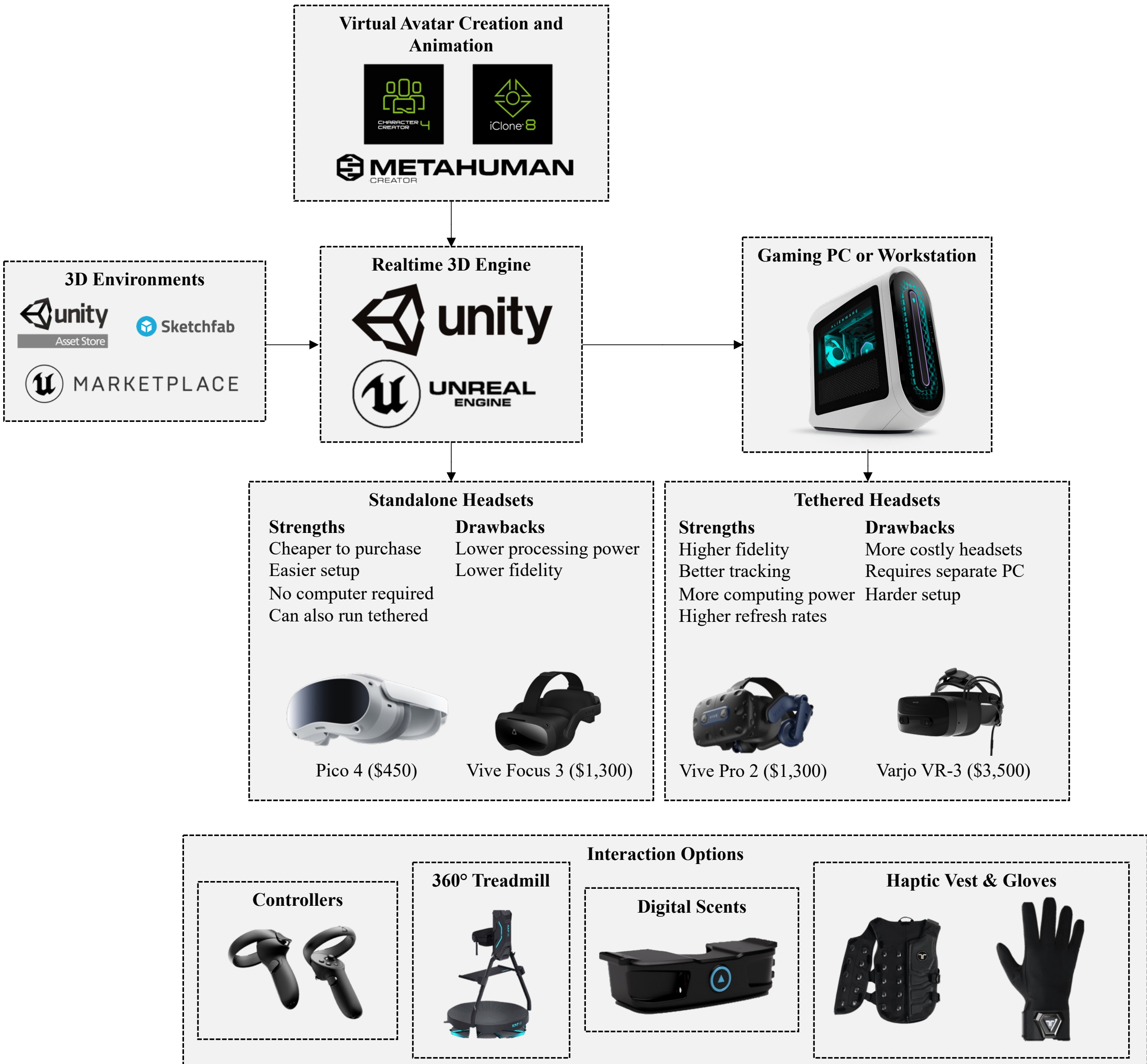
Office Interior Archviz by INIRROR on the Unity Asset Store

INIRROR OFFICE ARCHVIZ by INIRROR on the Unity Asset Store

Church 2 by Dexsoft Games on the Unity Asset Store

Modern Supermarket by AndragorInc on the Unity Asset Store

Figure 4. Examples of Virtual Reality Technology Options



Note: The arrows indicate the flow of information and assets. For example, virtual confederates are created independently and then used within real-time 3D engines. And gaming PCs or workstations run the software for tethered headsets, while stand-alone headsets do not require a PC. The prices in this figure are as of January of 2023 and we readily acknowledge they are likely to change given this evolving industry.

Table 1. Summary of Potential Research Settings, Benefits of VR, and Data Collection

Potential Management Research Settings	Core Benefits of VR	Data Collection Opportunities
Strategic Management: • All-employee meetings • Analyst meetings • Board of directors meetings • CEO media interviews in TV studios • Floor of New York Stock Exchange • Shareholder meetings • Top management team meetings **Organizational Behavior:** • Job interviews • Non-works situations • Subordinate meetings • Supervisor meetings • Team meetings • Work tasks • Workplace encounters **Entrepreneurship:** • Entrepreneurial pitches • Ideation sessions • Investor meetings • Media interviews	**Validities:** • High external and ecological validity through realistic tasks and environments • High internal validity through experimental control **Activities:** • Realistic work setting • Realistic work tasks • Can interact with objects—such as picking up a coffee cup **Environmental Control:** • Immersive environments that are purpose-designed for a particular study • Realistic virtual environment • Ability to manipulate environmental features (such as time of day) **Virtual Confederates:** • Manipulate characteristics (gender, race) • Manipulate behaviors (body language, lip sync, animation) • Perfectly consistent behaviors across participants **Audio Control:** • Consistency of speech characteristics between conditions (words, tenor, tone, pace) • Consistent audio features (sound effects)	**Participant Behaviors:** • Decisions and survey items administered in headset • Object manipulation (handling a product) • Avoidance (walking around objects) **Unobtrusive Behavioral Measures:** • Decision speed • Proximity to objects and virtual confederates • Body movement • Audio recordings and associated transcripts (content, tone, pace) **Physiological Measurement:** • Eye tracking (visual attention) • Electrodermal activity (arousal) • Electroencephalogram (EEG) • Facial expression (expressed emotions) • Respiration • Heart rate • Skin temperature

Table 2. Sample Range of VR Configurations for Headset Hardware

Headset	Computer Requirements	2023 Pricing
OpenBCI Galea ($22,500–$31,500) Varjo XR-3 or Aero headset with attached biometric sensors • Includes integrated biometric sensors (EEG, EOG, EMG, PPG, EDA and eye tracking) • Extremely high-fidelity with excellent tracking and high refresh rates • Includes automatic IPD adjustment • Requires purchase of base stations and controllers	i9 processor with Nvidia 4090 or better graphics card and 64 GB RAM (Alienware $5,000)	$27,500–$36,500 per seat
Varjo VR-3 Headset ($4,500) • Extremely high-fidelity with excellent tracking and high refresh rates • Includes eye tracking and automatic IPD adjustment • Requires purchase of base stations and controllers • Requires software subscription	i9 processor with Nvidia 3090 or better graphics card and 64 GB RAM (Alienware $3,500)	$8,000 per seat
HTC Vive Pro 2 ($1,400) • Very high-fidelity with excellent tracking and high refresh rates	Same as above	$5,000–$6,000 per seat
HTC Vive Focus 3 ($1,300) • Lower processing and graphics power when run stand-alone without a PC • Enterprise-grade, swappable batteries • Eye tracker and face tracker options	Stand-alone or tethered to gaming PC	$1,300 per seat
Pico 4 Enterprise ($1,000) • Lower processing and graphics power when run stand-alone without a PC • Enterprise-grade • Eye tracker and face tracker	Stand-alone or tethered to gaming PC	$1,000 per seat
Pico 4 ($500) • Lower processing and graphics power when run stand-alone without a PC • Consumer-grade	Stand-alone or tethered to gaming PC	$500 per seat

Note: IPD is interpupillary distance, the distance between the eyes.

Table 3. Sample Software Tools for VR Implementation

Software Tool	Purpose	Price
Unity	Realtime 3D engine	Free for research use
Unreal Engine	Realtime 3D engine	Free for research use
Unity Asset Store	Online store to acquire 3D assets	Some free assets, with many assets such as environments under $25
Unreal Marketplace	Online store to acquire 3D assets	Some free assets, with many assets such as environments under $25
Blender	3D modeling and object creation	Free
Character Creator & iClone	Human avatar editor and animator (also supports auto-lip sync)	$800 with educational discount
Adobe Mixamo	3D characters and animations	Free
GIMP	2D image manipulation for textures, such as wall styles (brick, stone, plaster, etc.)	Free
Audacity	Audio editor	Free
Replica Studios	AI-generated voice acting for Text-to-Speech	$25 for 4 hours
Freesound.org	Sound samples	Free
weloveindie	Sound samples	Free for educational uses

Table 4. A Checklist for Reviewers of VR Studies

	Consideration	Evaluation
Software Availability	Was a copy of the VR software provided for the review team?	Yes / No
	Did the researchers specify what software and hardware is needed to run the software?	Yes / No
	Were screenshots and videos of the simulation provided for reviewers who are unable to run the software?	Yes / No
Data Transparency	Did the researcher provide the other materials for the study (e.g., surveys and debrief scripts)?	Yes / No
	Were the data files provided (such as de-identified Stata files)?	Yes / No
	Were the analyses files provided (e.g. Stata .do files)?	Yes / No