SCIENCE BRIEFS

Immersive Virtual Environment Technology as a Tool in Psychological Science

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Several years ago, I walked past the open door of my colleague Jack Loomis's visual perception laboratory and, glancing in, became intrigued. I saw a person traversing a large room deliberately, as if trying to find her way. She wore a strange looking apparatus that included a sort of backpack and a helmet that covered her eyes. A tether led from the backpack to a computer across the room. Clearly, she behaved as if in a different place than the visual perception laboratory. I watched until someone unseen closed the lab door.

Later, I asked Jack about what I had seen. He explained to me that he used computer-based immersive virtual environment technology (IVET) to conduct research on perceptual problems including visual ones, as well as on spatial cognition. (We use the term "immersive virtual environment" (IVE) to refer to synthetic or virtual environments that organize sensory information in such a way as to create a psychological state in which the individual perceives himself or herself as existing within the virtual environment.) Jack carefully explained to me that one could use IVET to manipulate and control experimental variables impossible or nearly impossible to do so using traditional technology. For example, one could control the arc of the retina subtended by two similar objects in a visual field while varying secondary cues systematically to see what effect they had on distance perception, thereby controlling for direct sensory input of the objects themselves (i.e., the size of the retinal arc subtended). He informed me that I had watched a participant finding her way through a maze.

Finally, he invited me to try out the system. I jumped at the chance, coming to his lab at the appointed hour. I donned the backpack, which I learned contained the apparatus to track my body and head movements separately as I walked around, and the head mounted display, the helmet-like device that I had seen the research participant wearing, which renders appropriate stereoscopic views of the IVE. I saw a menu in front of me, and Jack suggested I choose "The Pit" using a selector control on a belt securing the bottom of the backpack around my waist. I did and found myself in a three-dimensional virtual environment similar in size to the physical room where I stood, with the exception of a square shaped hole in the floor with a 2x6 plank across it. Jack encouraged me to walk toward and look down into the pit. I did as instructed, surprised at the fidelity of the scene, changing as it does when I walk in a physical environment. Looking down into the pit, I reflexively moved away from the edge, knowing full well that the pit did not physically exist, but still unable to overcome acute acrophobia. Walking the plank proved difficult psychologically, but I teetered across. I turned down the opportunity to return via the plank.

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With that single experience, an understanding of the potential value of IVET for researchers in the behavioral and psychological sciences (other than the perceptual sciences) came to me. When Jack asked what I thought, I responded, "Do you know what a social psychologist could do with this?" Of course, he knew, and our exciting collaboration began. We would soon begin using IVET to examine social psychological issues. Along the way, we created the multidisciplinary Research Center for Virtual Environments and Behavior (RECVEB) at the University of California, Santa Barbara (UCSB); secured external funding from the National Science Foundation; lured Andy Beall, a technology genius as well as a researcher, back to UCSB from the space lab at the Massachusetts Institute of Technology, where he had gone after earning his PhD with Jack a few years earlier; attracted postdoctoral fellows and graduate students to our project; and refined and improved our technology.

We quickly realized that IVET could begin to solve some of the major methodological problems that have dogged

experimental social psychologists and others for decades. For example, most experimental social psychologists have struggled with the tradeoff between mundane realism and control in experimental scenarios. IVET can eliminate such a tradeoff. We have also struggled with replications in the sense that exact copies of others' experimental scenarios and procedures prove nearly, if not totally, impossible. IVET can provide exact copies via e-mail. Indeed, IVET can even potentially solve our struggles with representative sampling, as Internet bandwidth increases and as head mounted displays become household computer peripherals, via a kind of "random digit dialing" based on e-mail addresses. The potential appeared astounding.

Where to start? We decided to see if we could replicate some classic social influence phenomena within IVEs. Could the presence of virtual others facilitate and/or inhibit performance, the oldest social influence process in the experimental social psychology literature? Would participants conform to norms of behavior established by virtual others? Do social comparison processes operate? Would participants respect the personal space of virtual others? Yes, yes, yes, and yes.

More interestingly, however, IVET has forced us to reexamine long-held assumptions regarding social influence. Allport defined social psychology as an attempt to understand and explain how the thought, feeling, and behavior of individuals are influenced by the actual, imagined, or implied presence of others. For the most part, nearly all experimental social psychologists have operated under the assumption that social influence occurs according to the same processes across all three types of presence.

However, IVET gives us the ability, indeed in some sense forces us, to disentangle these sources of social presence. Thus, when interacting with virtual others in an IVE, whether the virtual other represents a real person in real time or an imaginary or implied person becomes a crucial issue—it allows the determination of differences in social influence processes between people and real others versus people and imaginary or implied others. Consequently, in some of the studies alluded to above, we have varied whom the virtual other represents: sometimes a real person in real time (in our terminology, a human avatar) and sometimes not (in our terminology, a computer agent).

As it turns out, it does make a difference. Social facilitation/inhibition effects seem to occur when participants believe that the virtual others present are human avatars, but not when they believe they are computer agents. Similarly, social comparison effects seem to occur with human avatars as virtual and not computer agents. On the other hand, conformity effects occur similarly with both human avatars and computer agents as virtual others. Likewise, participants will respect the personal space of computer agents, as they would real people in the physical world. This pattern of results suggests to us that we can distinguish between higher and lower level social influence processes, an important distinction for social psychology and for the emerging discipline of social neuroscience.

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The dynamic responsiveness, or behavioral realism, of virtual others likely moderates social influence effects within IVEs. To the extent that virtual others, especially computer agents, behave realistically, more social influence will result. For example, we have found in our proxemics work that participants will maintain appropriate personal space around a computer agent when the agent behaves realistically (e.g., maintain appropriate mutual gaze), but not when the agent remains mannequin-like. Furthermore, we believe that the sensory appearance or photographic realism of virtual others is not nearly as important as dynamic responsiveness or behavioral realism, a fact that cartoonists have known for years.

Of course, understanding the dynamic responsiveness of people engaged in social interactions represents an important goal in social psychology. Unfortunately, experimental research involving actual on-going social interactions remains relatively sparse, largely, in our opinion, because of the experimental control difficulties described above and costs. IVET can help us understand the mutual dynamic responsiveness of social interactants in interesting ways. We have suggested that researchers can reverse-engineer social interaction using IVET.

To illustrate, researchers have theorized about and demonstrated many functions and meanings communicated via non-verbal facial expressions, including eye movements. However, these empirical demonstrations have largely been limited to fairly static and composite facial expressions such as those associated with basic level emotions. The subtler facial signals and cues that govern social interactions have proven very difficult to examine empirically because the control necessary to learn the additive and interactive effects of such subtle facial expressions experimentally within in vivo social interactions surpasses even the most well trained confederate's capabilities. However, controlling subtle aspects of the facial expressions of two individuals interacting on-line within an IVE via their avatars is not so difficult. For example, using IVET, one can render the gaze of an individual away from the focal point of their actual gaze, thereby sending a different signal to their interactant than the naturally occurring one and assessing its effect on the interaction. One can easily imagine controlling several facial cues simultaneously and the resulting knowledge and understanding gained.

At this point, we can imagine many other uses of IVET for scientific research in social psychology for which traditional methods are not well-suited; for example, social identity (i.e., one can vary the gender, race, body-type, etc. of a participant's human avatar with or without the participant's knowledge) and mortality salience manipulations (i.e., one's human avatar can conceivably live forever). We can also imagine many applied uses (e.g., leadership and other types of training). Science benefits from technological innovations, and IVET represents one well suited for social psychology. ■