Chapter 6
Thin Screen:
The Creation of Depth Perception in Desktop Virtual Reality in Alignment with Human Visual Perception

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ABSTRACT

Human depth perception involves complex visual and brain functions. Depth perception in desktop virtual reality has become more important given the uses of such spaces for learning, training, collaboration, simulations, showcasing work, and conducting research on human behaviors. This chapter involves a meta-analysis of the extant research on human depth perception in virtual worlds. It posits some early design concepts for both the creation and evolution of such spaces but also their deployment for educational purposes.

INTRODUCTION

Desktop virtual reality is a critical part of electronic gaming, online learning, human socializing, entertainment, and simulation learning. While this type of 3D space is created through illusory design and phi phenomenon of illusory motion on a 2D screen, the experience of dimensionality and depth perception is an important part of this immersive virtual experience. The perception of depth in these synthetic spaces is important for image fidelity and imagistic realism; effective collaboration with other human-embodied avatars co-building 3D objects; and proper interfacing with other devices (including haptic ones). More accurate depth perception may enhance the uses of virtual environments for the study of real-world human behavior—such as research about children's road-

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crossing behaviors or adult collision-avoidance behavior. Improved depth perception design may result in more effective virtual walk-throughs of designed spaces that may be equivalents of physical spaces and may increase utility (Kuhl, Thompson, & Creem-Regehr, 2006). Virtual depth tasks, such as tele-surgery, 3D co-design, and avatar interactivity, require accurate human depth perception.

Proper depth perception may enhance the user's experiences in immersive spaces. Proper calibration may help them avoid simulator sickness (Bigoin, Porte, Kartiko, & Kavakli, 2004), learned mal-adaptability to real spaces, and "ocular stress" (Alexander, Conradi, Winkelholz, 2003, n.p.) or eye discomfort. Having proper calibration of the virtual reality medium may avoid negative and incorrect adaptations to depth sensations (Kuhl, Thompson, & Creem-Regehr, 2009, p. 19:2) in real spaces. These corrections may also enhance the human ability to immerse longer in desktop virtual reality spaces.

This chapter will provide a brief overview of human visual perception in real environments. Then, it will show the differences of visual perception—particularly depth perception—in desktop virtual reality environments. This will summarize the challenges of creating depth perception in online spaces and look at current strategies. This will also explore some potential future areas of development to enhance human depth perception in virtual spaces.

A REVIEW OF THE LITERATURE

Human Depth Perception in the Real

The nature of human perception in the real has been the subject of various theoretical debates. The two main conceptualizations involve direct (ecological) or indirect (constructivist) perspectives on perception. The direct perception school of thought suggests that an animal adapts to its environment by interacting with it based on its sensory mechanisms, and the richness of the environment offers direct information to help that animal survive, make decisions, and take actions. This approach suggests that there is no need for the augmentation of sensory stimuli with memory or experience because of the genetic and evolutionary "pre-attunement" and imprinting to particular environmental signals helps the animal survive in its niche (Michaels & Carello, 1981, pp. 78-79). According to direct perception, sensing is continuous over time for the duration of the experience, for cumulative sensations. By contrast, indirect perception suggests that human perceptions are fleeting and incomplete; people then need to augment their perceptions to make meaning, based on their prior experiences and memories, and the experiential context (Gregory, 1980, p. 183). The constructivist approach also suggests that people use their sensory information for problem-solving and practical applications—in context; they bring deeper meanings to the senses.

Naïve realism suggests that what is perceived is exactly what the world is, and in actuality, human perception has been found to be non-veridical and not directly matched to the intensity of the stimuli in the environment. Solipsism or mentalism suggests that reality is only what is perceived and captured in the human mind. The computational approach integrates both direct perception and constructivist concepts with the sense that while the environment has rich sensory information, people do also engage the environment in cognitive ways to augment the sensory feedback.

Anatomical, physiological, psychophysical, and human perception research have enhanced understandings of human perception. The human brain fuses information from multiple sensory streams—sight, smell, taste, touch, and hearing—for a unified experience. The brain fills in gaps in perceptual information, often without people's conscious awareness. The research is done both *in vivo* (in the world) and *in vitro* (in laboratories).