Chapter 3
What's So Special About Spatial?
A Review Study Joining Virtual Reality and Spatial Ability

Cigdem Uz Bilgin
https://orcid.org/0000-0001-6997-344X
Massachusetts Institute of Technology, USA

Melat R. Anteneh
Massachusetts Institute of Technology, USA

Meredith Thompson
Massachusetts Institute of Technology, USA

ABSTRACT

Virtual reality (VR) technology has been steadily used for research purposes over the past few decades and is now gaining attraction in educational settings. Spatial understanding of learners is one of these research topics. Although there are plenty of studies focusing on VR and spatial abilities separately, there has not been a comprehensive review of papers that focus specifically on both VR and spatial ability. To address this question, an electronic search of articles from 2015 to 2019 was conducted that found 923 articles, 26 of which met the criteria of specifically discussing 'spatial abilities' and 'VR environments'. Eleven out of 26 articles reported the reason for using VR as a spatial assessment tool. The most frequently-mentioned spatial ability that was studied was mental rotation ability. This review revealed a special link between spatial ability and VR. VR can be both diagnostic and therapeutic for spatial skills; VR is an excellent tool for examining spatial ability in individuals and also individuals can enhance their spatial abilities through using virtual reality.

DOI: 10.4018/978-1-7998-4222-4.ch003

INTRODUCTION

Virtual reality (VR) has steadily increased in popularity over the years as the technology develops and becomes more readily accessible to the general public. VR is an interactive, simulated environment that creates a sense of presence by providing regular feedback to at least one of the senses (Onyesolu & Eze, 2011; Steur, 1992; Woolgar, 2002). Spatial presence, the feeling of being in a real or artificial space, is an important component of high-quality VR experiences (Riva & Waterworth, 2014; Witmer & Singer, 1998). This sense of presence is dependent on the ability of the individual to concentrate selectively on stimuli from the simulation over that of the physical environment (Witmer & Singer, 1998). Immersion, the physical equivalent of presence, is a function of how one interacts with the virtual environment (Slater & Sanchez-Vives, 2016). Immersion is a result of the technological hardware; the more natural the user feels the hardware is to use, the greater the immersion in the VR experience (Atienza, Blonna, Saludares, Casimiro, & Fuentes, 2016; Seibert & Shafer, 2017).

Generally, VR setups involve some type of headset that provides visual, and oftentimes auditory, inputs to the user. This can be supplemented with equipment that provides additional feedback such as haptic stimulation or devices such as hand-held controllers that allow for more seamless interaction with the environment (Sherman & Craig, 2018). Although headsets can cost hundreds of dollars, cheaper alternatives like Google Cardboard, a low budget option that transforms smartphones into VR headsets, have emerged (Brown & Green, 2016). The increased portability and reduced cost have allowed VR to be applied to a wide variety of fields including medicine (Larsen et al., 2009; Laver et al., 2017), the military (McLay et al., 2011; Reger et al., 2011), education (Hwang & Hu, 2013), and cognitive psychology (de la Torre-Luque, Valero-Aguayo, & de la Rubia-Cuestas, 2017).

Spatial ability refers to the wide range of cognitive skills that one uses to interact with the environment and perceive how objects are related within that space (Yılmaz, 2017). Types of spatial abilities include mental rotation, the ability to manipulate objects in one's mind to view them from a different perspective; spatial orientation, the ability to maintain one's heading in space; object location, the ability to recall the position of an object in space; and spatial navigation, the ability to maintain and implement a mental representation of a route that can be used to travel between two points. Some of the most commonly used tests for assessing spatial ability include the Mental Rotation Test (MRT) (Jang, et al., 2017), the Boxes Room Task (Tascón et al., 2017), and the Walking Corsi Test (Wal-CT) (Parsons et al., 2004). Although the majority of spatial ability tests were administered as either paper-and-pencil or website-based assessments in the past, VR versions of several spatial measures have been developed and tested (Nori et al., 2015; Tascón et al., 2017).

Since VR assessments can provide a more valid representation of the real world than paper-and-pencil tests, researchers have begun studying spatial ability of individuals while in VR (Leó et al., 2018; Negut, et al., 2016; Meade et al., 2019). Many studies have focused on the educational aspects of this topic. High spatial ability has been found to correlate with increased learning and academic performance (Cheng & Mix, 2014; Wai et al., 2009), and research suggests that VR environments can be used to help develop spatial ability for students with a lower spatial ability (Lee & Wong, 2014; Merchant et al., 2013).

Several reviews have looked at how VR has been used to identify and treat patients with various spatial disorders, including those suffering from navigational problems (Cogné et al., 2017) and unilateral spatial neglect (Tsirlin et al.,2009). Spatial neglect, the inability to recognize, interact with, and/or orient in respect to stimuli located in a certain half of a person's visible space, results from some type of trauma to the brain such as a stroke (Tsirlin et al., 2009). Although many reviews have compiled and

Related Content