Virtual reality (VR) can be defined as the “human-computer interface that allows a user to interact with and become immersed in a computer generated environment”¹. Images can be displayed on a computer monitor, screen or through a head-mounted display which blocks out the real world. In addition to visual images, auditory and proprioceptive senses may also be incorporated to help make the immersion in the simulated environment seem more realistic. The development and applications of VR in the entertainment and computer games industry are well-known but over the past decade, interest in the potential therapeutic uses of virtual reality has increased. For example, VR has been used effectively to treat acrophobia (fear of heights)² and fear of flying³,⁴. Virtual reality offers a safe and less expensive way of providing a close-to-realistic experience in the process of desensitising a client. Glantz, Durlach, Barnett and Aviles⁵ describe the work of other researchers who have used VR to treat persons with body-image disorders, dyskinesia associated with Parkinson’s disease and social phobia. This report describes VR research on the assessment of two areas of function: driving and wayfinding.

Driving
This study began in 1997 when my colleagues and I evaluated the DriVR, a virtual reality simulator system for driving assessment. The technology was developed by Imago Systems in Vancouver for assessing driving skills in persons who have experienced a head injury. The simulator was created to provide a more realistic method of assessing driving skills compared to traditional driving simulators. A description of the hardware and software is provided in Liu, Miyazaki and Watson⁶. The DriVR allowed the driver to travel around 3D worlds, in this case a Dodge caravan. The driver used a steering wheel, a brake and an accelerator. He or she used a head-mounted display to see the road ahead and could see from side to side just by turning his head.

The DriVR simulator provided one practice and 10 testing scenarios, which appeared in a continuous sequence as the participant drove through a small town. The scenarios provided a variety of road characteristics (curved, sloped, traffic merge, lane change, etc.) and incorporated traffic signs, objects (building, lampposts, road markers, parked cars, pedestrians, etc.). As the driver “drove down the road,” the computer software tracked the driver’s progress. Did the driver cross the middle line? Did the driver react quickly enough to stop signs? Could the driver merge or avoid a car backing out of a driveway?

A total of 148 out of 162 participants completed the DriVR testing (73 men and 75 women) and formed eight age groups ranging from 13 to 76+ years. Fourteen were unable to complete the assessment due to nausea or physical discomfort. In addition to normative data, we were able to demonstrate, using a group of 15 head-injured participants, that the DriVR was able to discriminate between performance of head-injured and uninjured participants⁷. This study was also unique in that VR was used with the elderly population⁸. For all pass/fail measures, performance had no significant relationship to age group. However, many continuous measures were significantly related to age group. Most of these relationships could be attributed to the tendency of older participants to drive at slower speeds. For example, compared to younger participants aged 13-35 years, adults over 55 years took almost twice as long to complete the test. Although it was feasible to use VR with the elderly, complaints about the head-mounted display and simulator sickness increased significantly with age. However, symptoms reported by the older group were no greater than those reported by the middle-aged group. The DriVR has since undergone further validation by comparing DriVR measures to other indicators of driving ability in adults with brain injury⁹.

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Wayfinding
The second study used VR to examine a component of wayfinding ability called cognitive mapping, defined as a mental representation of a person’s environment\(^\text{10}\). Currently, cognitive mapping can be assessed by having a person draw a map or manipulate 3D objects representing elements of an environment. These approaches, however, are difficult to score, and the drawing task may be too abstract for some clients. To address these challenges, we created and used a tangible-user interface (TUI). A TUI is a physical object, such as a steering wheel or foot pedals, used as a computer interface in the virtual domain\(^\text{11}\). In this case, we used 3D model houses that, when placed on a tabletop board, would input real-time data to a computer (Figure 1). The task for the subject was to take a bus tour through a virtual scenario such as the one shown in Figure 2, and to match the scenario using the model houses. As the number of buildings increased steadily from two to eight, so did the level of difficulty.

A total of 20 healthy subjects participated in this study: 10 under 55 years of age and 10 were 55 years or older. Eight measures were taken, one of which we called “similarity,” which quantified whether a subject identified the correct building and placed it on the input board in the correct position and orientation. This assessment clearly differentiated the younger age group from the older group, and scores in both groups were correlated with level of difficulty (see Figure 3).

Implications for occupational therapy
Computer graphics are, at best, still virtual and not real. Due to a delay in response time, some users experience “simulator sickness.” However, this area of technology is developing rapidly and some computing scientists are interested in the challenge of designing programs with therapeutic and assessment applications. Occupational therapists can use their expertise in function and user requirements to advise the creators of these applications. With further research and development, VR, in combination with TUIs, may enhance occupational assessment and intervention. Currently, VR can be used by design teams to facilitate decisions about accessible and universal design of a built environment. For example, prior to or in place of a mock built environment, a client could view and “experience” physical features of a home in the design phase. Clients can also take virtual tours of potential residential care settings before taking a trip to an actual site.

References