Movement Strategies Used in Full Body Reaching Tasks to Target in Real-World Versus Virtual Environments

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Introduction

• Visual gaming has increased in popularity and is associated with a variety of clinical and non-clinical settings. Patients can be fully immersed in an environment by manipulating visual feedback, distraction, and varying aspects of clinical environments in order to encourage movement that is similar to real-world characteristics.

• Visual gaming:
  - Can be utilized as a potential motivating and distractive tool.
  - Can lead to significant changes in activity patterns and the potential for reducing attention to pain (Kolb et al., 2001).
  - Has demonstrated significant outcomes in the use of exposure therapy in virtual environments to treat mental health conditions, such as phobias, ADHD, and depression (Kraemer et al., 2015).
  - Has shown great potential for use in physiotherapy as a therapeutic tool as well as for the treatment of conditions such as stroke and traumatic brain injury (Kraemer et al., 2015).

• Virtual Environment (VE) vs. Real-World Environment (RWE): virtual reality is more immersive than computer games and offers greater potential for use in research and clinical settings. However, these environments are limited by the capability of software and hardware to replicate the real-world environment (e.g., sensory fidelity and display environment (FS) planning and compensatory adjustments were similar to that of the real environment) (Blum et al., 2017).

• The purpose of this study was to determine if movement kinematics of healthy individuals performing full-body reaches are different in a virtual environment compared to a real-world environment.

Methods

• Seventeen subjects (16 male, 1 female) aged 18-26 participated in the study. Each subject wore a head-mounted display and an ankle and knee sensor. The subject was instructed to reach for a virtual target and a real-world target in both environments.

• In the RWE reaches, the subject was instructed to reach for a target located in the virtual environment. The subject was instructed to reach in a similar fashion to the target located in the VE.

• In both environments, the targets were positioned such that the subject would have fully extended knees and a flexed torso (15°, 30°, and 60°) in relation to the target height in all reaches. The subject was instructed to reach with the dominant hand.

• The visual display was presented using a modified MotionMonitor, a commercially available motion-capture system. Subjects were instructed to wear a head-mounted display and ankle and knee sensors.

• The visual display was designed to replicate the real-world environment as closely as possible. The subject was instructed to perform reaches in both environments.

• All participants provided written informed consent and the protocol was approved by the Institutional Review Board of Ohio University.

Results

• There was an effect of environment on joint DOF positioning patterns (p<0.05). Subsequent analyses indicated no differences in fingertip position between 3D TV and OR, but there were significant differences between 3D TV and OR compared to RWE.

• In general, excursions of the hip and ankle were greater for reaches performed in OR versus RWE for all target heights in 3D TV and RWE.

• There was an interaction of gender and display type for ankle and knee excursions (p<0.05). In RWE, both males and females used an ankle dorsiflexion-knee extension pattern, whereas in 3D TV ankles were used in an ankle dorsiflexion-knee flexion pattern. In OR, joint excursions of the ankle and knee were greater for males compared to females (p<0.05, OR).

Conclusions

• There were significant differences in joint DOF positioning patterns across the different environments (p<0.05). Subsequent analyses indicated no differences in fingertip position between 3D TV and OR, but there were significant differences between 3D TV and OR compared to RWE (p<0.05).

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• There was no effect of environment on joint DOF positioning patterns (p>0.05).

• Subsequent analyses indicated no differences in fingertip position between 3D TV and OR, but there were significant differences between 3D TV and OR compared to RWE (p<0.05).

• In general, excursions of the hip and ankle were greater for reaches performed in OR versus RWE for all target heights in 3D TV and RWE.