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How Direct Interaction in a Virtual Reality Program Aids in Developing an Internal Representation of a Complex 3-D Structure

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Introduction

Understanding how humans perform mental rotations and develop internal representations of 3-D objects began with Shepard & Metzler's seminal study in 1971. With the advancement of virtual reality programs, users are now able to interact both visually and haptically with 3-D objects in virtual space. Recent studies have begun to explore how 3-D computer visualizations can help teach medical students and residents anatomy. Although the results from these studies are inconclusive, the amount of control the user has in the program, as well as the intuitiveness of the interface, appear to be significant factors in enabling students to develop accurate internal representations of the structures. (Garg et al., 2002; Keehner & Kooshabeh, 2005). The present study examined how actively rotating a 3-D representation of an anatomical structure (the inner ear) in virtual space with an intuitive joystick facilitated the development of a mental representation of that structure.

Method & Results

Participants (N=22) first completed a standard test of three-dimensional spatial ability. After a brief training session on the Dextroscope VR machine (Volume Interactions, Singapore), participants were grouped into pairs and randomly assigned to the *interactive* or *non-interactive* group, and instructed to learn four major parts of the inner ear (Figure 1), paying special attention to how they are structured, aligned, and positioned relative to each other.

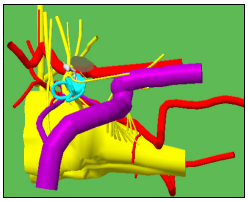


Figure 1: snapshot of the ear model in the VR program.

The *interactive* participant's session was recorded in the VR machine, and the participant in the *non-interactive* group watched the recorded movie of the *interactive* participant's session, creating a yoked-pairs design. All participants were tested on their mental representation by drawing missing parts on a snapshot of the model.

All participants who were assigned to the *interactive* condition (i.e., those who were able to use the joystick) scored higher on all three post-test measures. (Figure 2). Qualitative analysis of the strategy use indicated that those in the *interactive* group remembered multiple views of the structure and fused them. Furthermore, we found no correlation between participants' spatial ability and performance on all three post-tests. These results support the hypothesis that direct, active manipulation of a complex 3-D structure with an intuitive interface aids in developing an accurate internal representation of the structure.

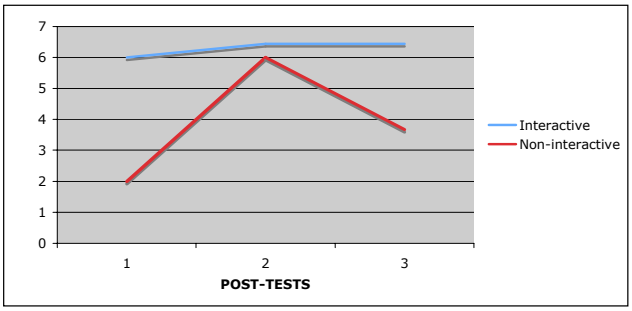


Figure 2: mean scores of correct responses for each group.

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