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# Exploring Visuo-Haptic Illusions Using Virtual/Augmented Reality

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M. C. Moore  
Department of Computer Science  
Rhodes College, 2000 North Parkway  
Memphis, TN 38112

## Abstract

Haptic perception is a key factor in making virtual environments more immersive and useful. Our research explores the limits of visual dominance in multisensory virtual reality environments equipped with passive haptic props. In a between-subjects experiment, we will ask participants to make judgments about the lengths of surreptitiously-resized wooden blocks that they can see themselves touching under three different conditions of bodily self-representation (invisible / generic computer-modeled avatar / video-see-through self-avatar). We are seeking to test the hypothesis that with increasingly realistic self-representation, people will be more likely to believe that the size of block they are seeing is an accurate representation of the size of the block they are feeling.

## Introduction

Haptic perception and visual dominance are important elements in creating more believable virtual environments enabling users to become further immersed in the environment. This is especially important in professional and architectural settings where the

believability of the virtual environment can directly affect users' overall experience. In order for virtual environments to be convincing, the perceived scale of objects in the virtual world needs to be identical to the scale of objects in reality. It is problematic when objects in the environment appear smaller or larger than they are in

reality, when this happens the environments are not worth nearly as much as they could be otherwise.

## Objective

It is our objective to explore the limits and realm of visual dominance in multisensory virtual reality environments. We wish to explore the role of physical presence in the perception of size and scale: does the user's ability (or lack thereof) to see their own body affect how they perceive size within a virtual environment?

It is our hypothesis that, as immersiveness increases, the user will be able to more accurately guess the block's true size.

## Materials

In our study we will use two HMDs. The first is a HMD Eye Tracker and it will be used for the first two trials. The second is an sx60 and attached to it is a stereo camera used to see the see-through hands in the third trial. In addition to the HMDs we will use two wrist trackers for the second trial so that avatar hands can be tracked to the user's real hands. Finally we will have 6 blocks of varying lengths (ranging from 1 inch to 8 inches), painted black. All of our materials can be seen in Figure 1.

## Method

We are conducting a user study to examine our question. Participants will be immersed in a virtual environment in which they can see

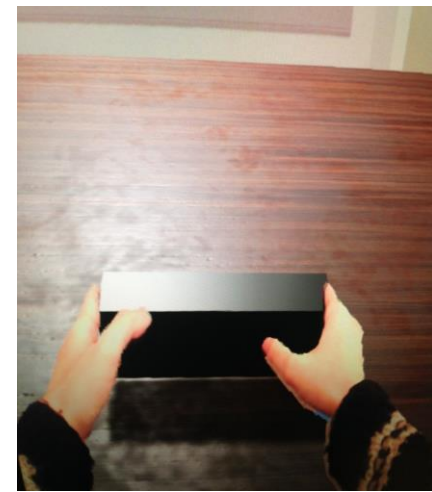
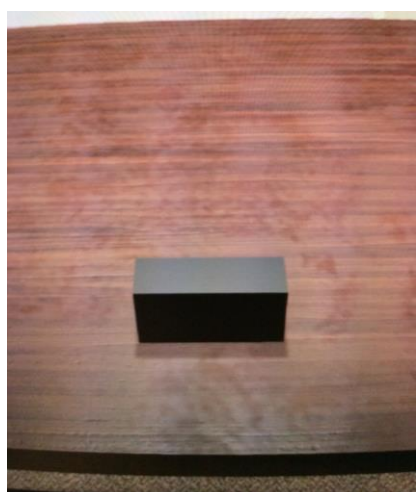
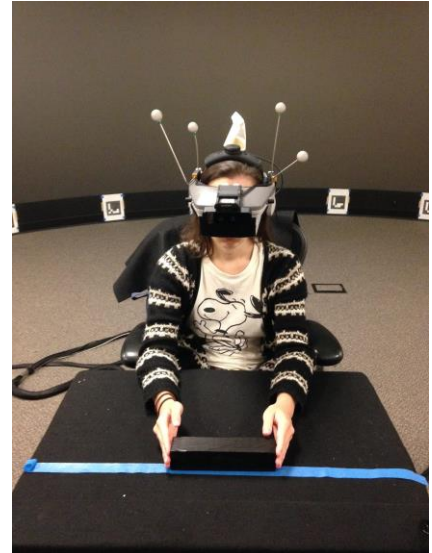


Figure 1

and feel a rectangular block. The study will involve three trials that are visualized in the figures below.

- (a) where the user has no visual indication of hand position
- (b) where the user's hand position will be relayed visually via avatar hands
- (c) where the user will see a live see-through feed of their own hands.

During each trial, the physical block will be of various lengths, and the virtual block will be larger, smaller, or true-to-size in relation to the physical block. The user will be asked to report information concerning the block and their haptic and visual experience will be recorded. This project is still in progress and will be conducted during the 2015 fall semester at the University of Minnesota.



(a)

(b)

(c)

## Future Work

In future studies we will look at the extent to which visual dominance can be exploited; however, we first need to analyze the results of this study after the trials are run in the fall.

## Acknowledgements

Many people and organizations have aided me in this journey, most notable would include: the DREU for selecting Dr. Victoria Interrante as my mentor; Dr. Victoria Interrante, Koorosh Vaziri, Peng Liu, and Helen Dougherty who were always there when I needed them this summer; the CRA-W and the University of Minnesota CS&E department for funding my summer experience; and Dr. Betsy Sanders and Haley Adams for introducing me this program and encouraging me to apply.

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