

A full-body avatar improves distance judgments in virtual environments

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1 Introduction

Distance judgments are compressed in HMD-based virtual environments (e.g., [Loomis and Knapp 2003]). A user's own body is almost never rendered in HMD-based VEs, and we hypothesize that this may contribute to perceptual distortions in such systems. In the real world, a view of one's body is not necessary in order to make accurate spatial judgments, at least about egocentric distance [Creem-Regehr et al. 2005]. However, there are several reasons why the visibility of a user's body may affect the perceptual fidelity of virtual environments, where other sensory information supporting space perception is less compelling. First, the visual and/or proprioceptive feedback associated with an awareness of one's body could provide a metric for scaling of absolute dimensions of space. Second the presence of the body in the VE could serve to ground or situate the user in the VE, acting as a frame of reference.

Draper [1995] explored whether rendering parts of a user's body in an HMD affected space perception, with equivocal results. Beyond this work, the influence of the body on space perception within the context of virtual environments has been largely unexplored. The experiment described here investigated this issue using more realistic avatars, more complete and accurate tracking of body movements, and the same response measure used in the majority of other VE distance perception research.

2 Experiment

The study was done in a fully tracked free-walking space, 6×7 meters in size. Users' full-body position and orientations were tracked using an optical tracking system (12 Vicon MX13 cameras) through the monitoring of reflective markers (26-60ms latency). In addition to updating the visual environment as a function of users' head movements, the tracking system also allowed for the capturing of the position and orientation of the neck, shoulders, elbows, hands, torso, hips, knees and feet, which was used to animate an avatar linked to the user's own motions.

Twelve paid volunteers participated in this experiment (balanced for gender). The participants were divided evenly into two groups, each presented with a different exploration condition before giving distance estimations. After an initial setup phase, participants actively explored the space within the virtual environment, with or without the visual first-person avatar. The only difference between the instructions for both conditions involved the presence/absence of the avatar. Participants were not permitted to move out of their standing location and instead were instructed to look down and explore the space where their body was located. If they were in the no avatar condition they saw only a 0.5 meter long line on the ground which marked their location in the room. If they could see their avatar they could then see their legs, arms, feet and hands freely moving in the space, tracked to reflect their actual body motions. No line was placed on the floor in this condition. After the exploration phase, participants were asked to immediately perform a



Figure 1: From left: viewer's hands (1) and feet (2) in virtual world, line marking viewer's location in virtual world in the "without avatar" condition (3) and virtual world where the target and hallway were viewed before blind-walking (4).

direct-blind walking task. This was done in a different virtual world than was used for the exploration phase and without the view of the avatar (see Figure 1).

3 Results and Conclusions

An independent t-test confirmed a significant difference between the percent distance walked in the two conditions, with exploration without avatar (mean = 76.9%) showing overall more compression than exploration with the avatar (mean = 89.3%), $t = 4.261, p < 0.01$ (see Figure 2). Our results provide evidence that if participants are able to explore a fully-articulated avatar of themselves within the immersive VE they will make less errors in their subsequent egocentric distance judgments.



Figure 2: Direct blind-walking results averaged across subjects (6 per condition) for 15 trials. Error bars represent one standard error.

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References

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