Bigger is Better: Large Visual Displays Improve Spatial Knowledge of a Virtual Environment

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Abstract

This study examined the effect of physical display size on spatial knowledge of a virtual environment (VE). Previous research by Tan (2004) found that performance for a path integration task in a VE was superior on a large display compared to a small one, even with visual angle held constant. This may be because large displays evoke a more egocentric frame of reference than small displays. To test whether the advantages of large displays extended to a navigation transfer task, the present studies examined the effect of display size on transferring knowledge about the spatial layout of a desktop VE to virtual reality (VR). Participants used a joystick to control their movement through a virtual city environment, finding and learning the locations of five targets separated by buildings. After 20 minutes of learning, participants' spatial knowledge was tested in a fully immersive environment by using virtual reality. Participants stood at each target location and pointed to each of the other, unseen targets. In the first study participants learned the VE on either an 18" LCD display or a 112" projected display. Visual angle was not equated. In the second study participants learned the VE on either a 25" or 72" projected display and visual angle was held constant. In both studies we found the average angular pointing error was significantly lower on the large display. Our results suggest that the advantage of a large desktop display for a virtual environment transfers to VR and is not dependent on visual angle.

Introduction

Large displays have also been shown to improve performance on cognitive tasks. Performance for egocentric tasks were found to be superior on a large display compared to a small one, even when the visual angle between the displays was identical (Tan et al., 2004). No differences between small and large displays were found for exocentric tasks (Tan, 2004). Tan has suggested the advantage for large displays may be because they bias participants into developing more egocentric strategies.

One of the egocentric tasks used by Tan was path integration. In this task participants moved through a sparse desktop virtual environment. Since the environment contained no landmarks, participants updated their spatial position using velocity and acceleration cues. After moving to specific locations in the environment, participants returned to where they believed the origin was. Distance errors relative to the starting point were lowest in the large display condition, both when participants had active control over their movement using a joystick and with passive viewing.

In our current work, we wanted to examine if the benefits of learning a VE on a large display would extend to a complex navigation task and transfer to a fully immersive test environment by using virtual reality (VR).

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Virtual Environment

Participants explored the virtual environment from an egocentric perspective.

Gazebo

School

Humvee

Tank

Helicopter

Participants learned the relative locations of five targets.

General Methods

Learning phase

Small display

or

Large display

Testing phase

Virtual reality

Participants' view in virtual reality

Participants stood at each target location and pointed at (unseen) targets

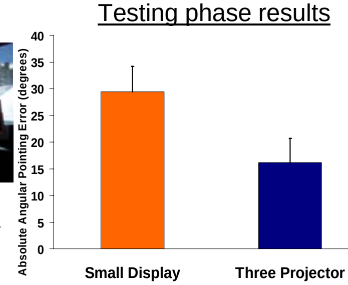
Experiment 1: Small Display or Three Projector Display with *Unequal Visual Angles*

Learning phase

Small display FOV=22.6º

Three projector display FOV=110º

Testing phase results



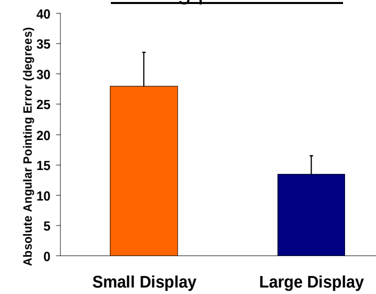
Experiment 2: Small or Large Display with *Visual Angle Equated*

Learning phase

Small display FOV=15.8º

Large display FOV=15.8º

Testing phase results



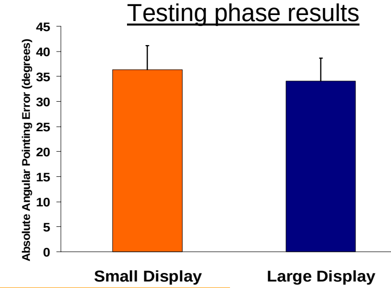
Experiment 3: Small or Large Display with *Passive Viewing and Visual Angle Equated*

Learning phase

Small display FOV=15.8º

Large display FOV=15.8º

Testing phase results



Discussion

In both experiments 1 and 2, spatial knowledge for the virtual environment was superior when it was learned on the large display. The results from experiment 2 indicate that it is the physical size of the display that matters, not field of view.

For experiment 3, participants had no active control over movement during learning. Instead, they viewed a playback of movement through the city environment. No difference between the small and large display was found.

Large displays may promote a more egocentric spatial awareness. Since participants' knowledge of the VE was assessed in VR, our findings suggest that learning a computer generated version of a real environment on a large display may transfer to the real world, leading to improved navigation performance.

References

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