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Spatial Memories of Virtual Environments

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Spatial Memories of Virtual Environments

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Introduction

The organization of long-term spatial memory for real-world scenes depends heavily upon a combination of egocentric experience and environmental structure. Environmental features such as lakes, buildings, roads, and walls impose salient reference frames used to structure spatial memories (McNamara, Rump & Werner, 2003). Shelton and McNamara (2001) found that, when learning an environment from multiple views, experienced views aligned with the dominant environmental reference frame are represented in memory, whereas views misaligned with this reference frame are not. When no such dominant reference frame exists, egocentric views (corresponding to the experienced views) are used to select multiple reference directions, demonstrating the interaction between egocentric experience and environmental structure.

In order for virtual reality to be an effective research tool for studying spatial cognition, virtual environmental structure should impact spatial memory in much the same way as real environmental structure does. Therefore, we investigated the roles of egocentric experience and environmental reference frames in a virtual environment.

Method

Twenty-four participants (12 males) studied a virtual environment from two perspectives, separated by 135°. The environment (Figure 1) contained seven objects arranged in a columnar structure, and the square walls of the environment were either congruent or incongruent (Figure 1) with this intrinsic object structure. Participants never saw the physical walls of the surrounding lab. After first studying the 135° view, participants were led without vision to the 0° view. All participants received the same viewing sequence.

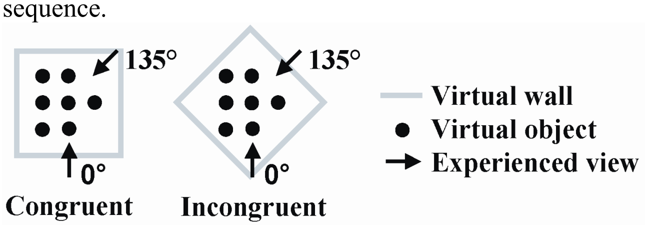

Figure 1. Plan view of the virtual environments.

After learning, participants moved to a different location and made judgments of relative direction, in which they were asked to imagine standing at one object, facing a second object, and point to a third object. Imagined heading varied from 0° to 315°, in 45° increments, and correct pointing direction was equated across imagined heading. Reference frame congruency, between the virtual walls and the intrinsic object structure, was manipulated between participants, and imagined heading was manipulated within participants.

Results and Discussion

Figure 2 displays mean absolute pointing errors for the 8 imagined headings. Congruency between the reference frames of the virtual walls and the virtual object array influenced spatial memories of the objects, evidenced by the two-way interaction [$F(7,154)=2.10$, $p<0.05$]. Performance was best along the 0°-180° and 90°-270° axes when the reference frames were congruent [$t(11)=4.96$, $p<0.001$], but not when they were incongruent [$t(11)=0.91$, $p=0.39$].

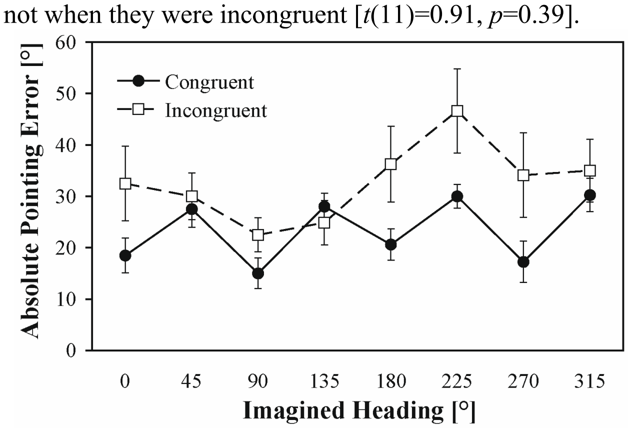

Figure 2. Pointing error as a function of imagined heading.

These results corroborate those of Shelton and McNamara (2001), and endorse the use of virtual environments for studying spatial memory.

Acknowledgments

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