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THE INFLUENCE OF VISUAL AND BODY-BASED CUES ON PATH INTERGRATION IN A VIRTUAL ENVIRONMENT: A COMPARISON OF CHILDREN AND ADULTS

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Advances in virtual reality technology and the reduced size of head mounted displays (HMDs) introduces new possibilities for exploring more age ranges in virtual environments. This study was designed to examine which different types of locomotion methods are optimal for navigating a virtual environment in varying age groups. Data were collected from a group of children, aged 9 to 12 years, in a large-scale spatial task in virtual reality. This was compared with data collected from a group of young adults performing the same task.

Methods We used an HTC Vive HMD to immerse the participant in the virtual environment. This allowed for manipulation of the types of locomotion the participant used to navigate the virtual world, limiting the sensory information they received during the task. Participants completed a virtual triangular completion task (Figure 1). They were asked to remember a starting location and locomote around two sides of a triangle, and with no visual input, face back to the starting location (Figure 2). This task was completed in three different conditions. In all conditions, participants used real rotations, or body turns to locate the next target, but the method of translation, or distance traveled from point A to point B, varied. The first condition, physically Walking through the virtual environment, provided the participant with both body-based and visual cues as they completed the task. The Joystick condition provided the participant with dynamic visual cues as they pulled a trigger to translate along the path of the task. Finally, in Teleportation condition, participant pointed and clicked a controller to automatically transport themselves to the target locations, eliminating body-based and visual input. The difference between the angle that the participant turned and the correct response was calculated as a measure of accuracy for each experimental trial. We expected that participants from both age groups to be most accurate in the Walking condition, less accurate in the joystick condition, and least accurate in the teleporting condition. Our prediction was that the less sensory information the participant was exposed to, the less accurate the participant would be during the experiment.

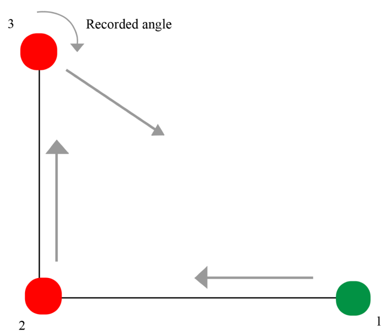
Results For young adults, the accuracy in both the Walking and Joystick conditions did not significantly differ, however, participants were more accurate in these conditions than in the Teleporting condition. Children showed a different pattern of accuracy. Children overall were significantly more accurate in the Joystick condition than the Walking condition, and more accurate in the Walking condition than the Teleportation condition. We found a relationship between age and accuracy within the experiment in all three conditions, such that error decreased with increasing age. There were significant improvements in accuracy in the child sample from age 9 to 12. There were also significant improvements in accuracy in the combined child-adult

sample from age 9 to 40. This suggests that there are significant developmental improvements in this task.

Implications The results of this experiment suggest that children rely on different types of sensory information compared to adults when keeping track of their changing position in the virtual environment. Adults appear to be more flexible in which types of information they are able to employ when learning spaces, in that in this experiment they displayed similar accuracy with the dynamic-only visual information and the visual and body-based information. Contrastingly, children were more impaired when faced with integrating body-based information and visual information. It could be the case that with their rapidly changing body size the information that children are receiving from body-based cues is unreliable; this could lead to lessened accuracy in the walking condition. These results also suggest that children are more visually dependent than adults while keeping track of their location.

These results bring into question the importance of body-based information in keeping track of where one is in a virtual environment. This could be explored further by eliminating the visual cues built into the virtual room. Eliminating visual cues could force participants to rely more on body-based information during the task. Changing the virtual environment to an open field would test whether the participant is relying on visual cues that were inadvertently provided (Figure 2). Future experiments will also test an adolescent age group to fill in the age gap between the child and young adult age groups. These future studies will provide a better picture of the development of these spatial skills across the lifespan.

Figure 1



Triangular completion task:

- Participants are asked to remember a starting location (1)
- Locomote to point A (2)
- Locomote to point B (3)
- Visual input is taken away and participants are asked to face back to the starting location
- The error in angle is recorded
- Participants were asked to take one step forward, position is recorded again

Figure 2