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Several studies (e.g. Kerr, 1987; 1993; Diwadkar, Carpenter & Just, 2000) have asked participants to report the final location of a point after imaginary moves through 2D and 3D arrays. The results suggest that visualizing 3D space is inherently more difficult than 2D visualization, and may even use different brain mechanisms. However, 2D and 3D trials were presented in separate blocks, so participants could have developed different strategies for 2D and 3D cases. Here we reduce this risk by presenting randomly intermixed 2D and 3D trials. To further enforce the use of spatial memory, we use a new technique (path visualization, PV, Lyon, Gunzelmann, & Gluck, 2004) that taps information about the whole path.

Method

Twelve paid participants were each given ten 30-trial PV sessions. On each trial, a sequence of 15 text phrases was presented on a monitor (2 sec. per phrase). Each phrase described the direction and distance (e.g. 'Left 1') of a segment of a path (in this study, all distances were 1). As each phrase was presented, the participant decided whether the endpoint of the new path segment intersected with any previously presented part of the path, then pressed one of two keys to indicate 'yes' or 'no'. Half of the paths were constrained to one of three 2D planes (coronal, sagittal, and horizontal) passing through the center of the space. The other half were 3D paths.
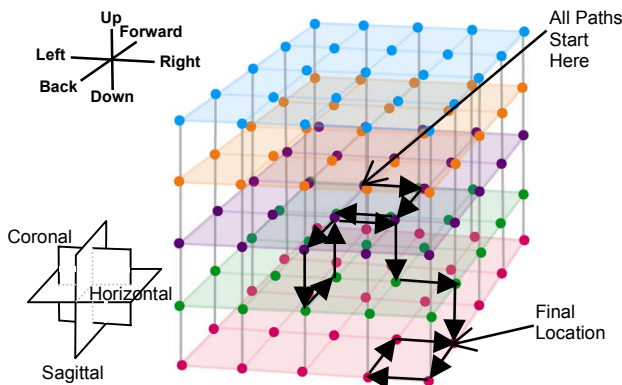

Figure 1: Depiction of a 3D path in an imaginary space.

Results and Conclusion

Performance was equally good for 2D and 3D paths. There was no effect of dimension on either accuracy or response time (Accuracy: $F(1,23)<1$, n.s.; RT: $F(1,23)<1$, n.s.). Within the 2D condition, there was no effect of the plane of the path (coronal, sagittal or horizontal; Accuracy (Fig. 2): $F(2,35)<1$, n.s.; RT: $F(2,35)<1$, n.s.).
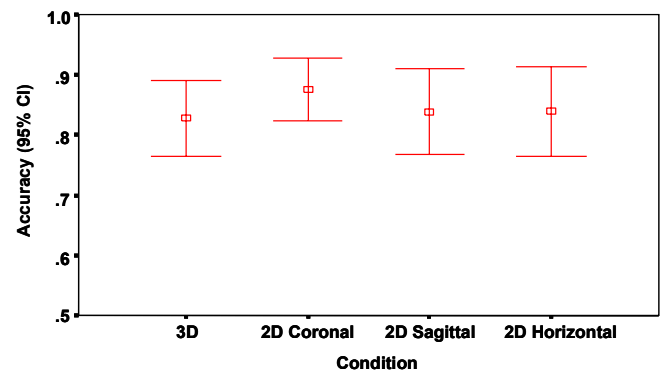

Figure 2. Visualization accuracy for 3D vs. 2D paths

These results suggest that, given randomly intermixed trials and a task that forces participants to rely heavily on spatial memory, 2D and 3D visualization are equally difficult, and may not require inherently different cognitive processes.

Acknowledgments

References

Diwadkar, V. A., Carpenter, P. A., & Just, M. A. (2000). Collaborative activity between parietal and dorso-lateral prefrontal cortex in dynamic spatial working memory revealed by fMRI. *NeuroImage, 12*, 85-99.

Kerr, N. H. (1987). Locational representation in imagery: The third dimension. *Memory and Cognition, 15*, 521-530.

Kerr, N. H. (1993). Rate of imagery processing in two versus three dimensions. *Memory and Cognition, 21*, 467-476.

Lyon, D. R., Gunzelmann, G., & Gluck, K. A. (2004). Emulating a Visuospatial Memory Field Using ACT-R. In M. Lovett, C. Schunn, C. Lebiere, and P. Munro, *Proceedings of the Sixth International Conference on Cognitive Modeling* (pp. 368-369). Mahwah, NJ: Lawrence Erlbaum Associates.