Using Virtual Reality Environments to Assess Context Boundary Effects and Temporal Memory Performance via Spatiotemporal Exploration

Horecka, K., Dulas, M. R., Cohen, N.J.
Beckman Institute of Advanced Science and Technology, University of Illinois at Urbana-Champaign

Virtual Reality (VR) has been identified as a useful tool in neuropsychological evaluation thanks to its increased control and measurement capabilities over other methods (Schultheis et al, 2002). More recently, evidence shows that along many measures, VR provides similar ecological validity to real environments (Kuliga et al, 2014). One area of research which is particularly amenable to VR paradigms is learning and memory. Previous work has suggested that context-boundaries impact the binding of sequential information, resulting in within-context information being remembered as closer together than across-context information, even when equidistant, i.e. the segmentation effect (DuBrow & Davachi, 2013). Previous work by our group has shown that segmentation effects can be found in the spatial reconstruction of item locations within and across contexts, with within-context items being placed closer together and across-context items being placed further apart. The present study explored segmentation effects in temporal memory; a VR spatiotemporal navigation task with four contexts (colored time periods) and 2 objects per context (one that appears and one that disappears) was constructed to evaluate how memory for item pair temporal locations within a context differ from pairs which cross contexts. During study, participants were instructed to explore the VR environment and learn the spatiotemporal locations of all items. Importantly, participants were given the ability to explore not only space, but also time, via a button press that changed the direction of the flow of time. Measurements of participant position, orientation, and subsequent memory for item spatiotemporal locations were assessed across four repeated trials. Results showed significant increases in performance (speed, efficiency of movement/orientation, and memory accuracy) across successive training/test trials. Across all trials, participants showed a significant event segmentation effect, with across-context pairs being remembered as further apart in time and within-context pairs closer together, despite these pairs being equidistant. These segmentation effects remained stable despite improvements in overall accuracy suggesting they are tied to the organization of memory, and not simply a type of error. Lastly, temporal exploration during the first study phase correlated with the size of the segmentation effect, suggesting early exploration behavior may influence the organization of memory relative to context. These results show that temporal segmentation effects are present even when participants can freely navigate the axis of time.