Decoding mental walkthroughs of spatial memories in an immersive virtual reality environment

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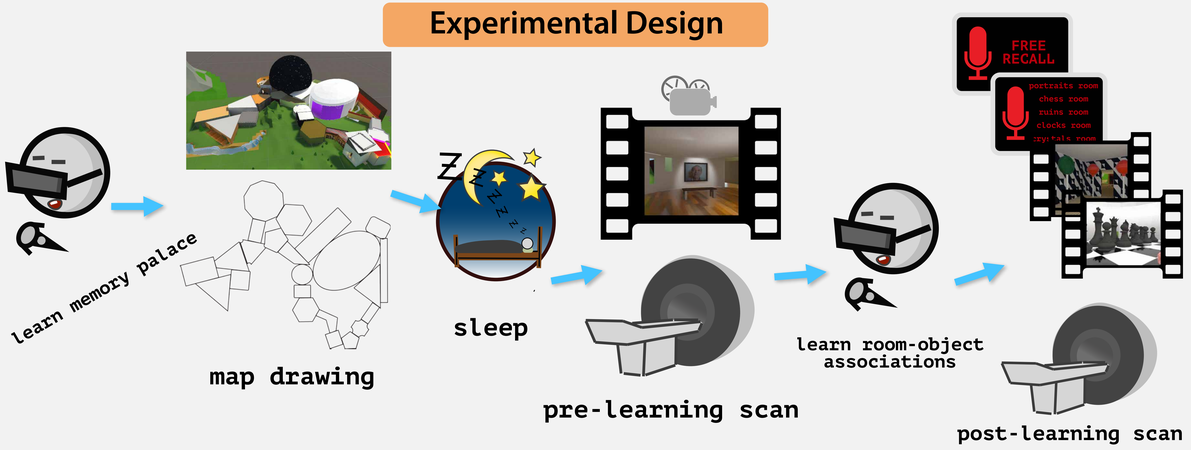
Key Questions

- How do we use spatial context (e.g. rooms of a memory palace) to scaffold episodic memory details (e.g. objects in a memory palace)?
- Where in the brain is spatial context represented?
- Where in the brain are objects represented?
- Can we track people's mental walks through a memory palace?

Background

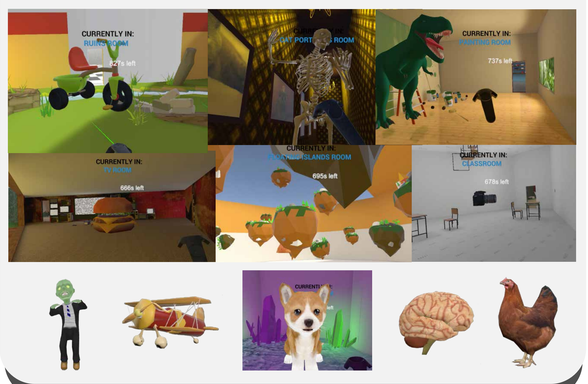
- Memories need to be accessible and stable over time
- Context is one of the most powerful memory cues
- Spatial context contributes to the representation of events
- Method of loci / memory palace is a memory technique that uses spatial contexts to cue memories
- Anterior Temporal (AT) Network : objects
- Posterior Medial (PM) Network : context
- Hidden Markov Model (HMM) can be used to track mental walkthroughs

Experimental Design

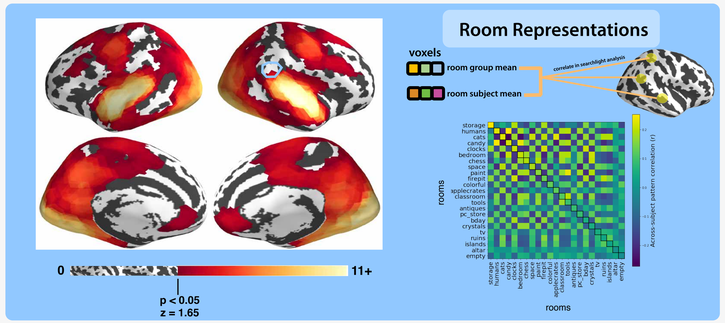


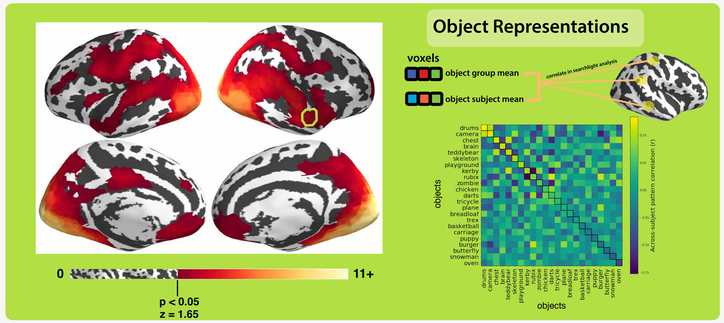
Stimuli

23 rooms | 23 objects | 1.3s TRs | 11 subjects

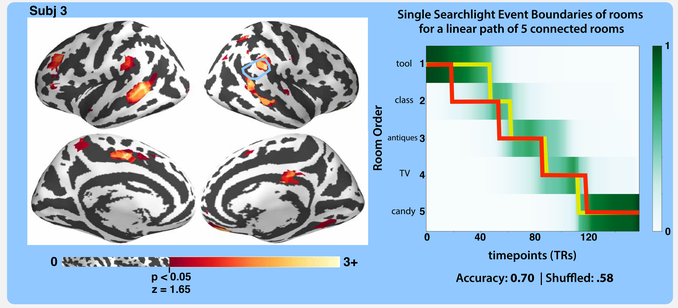


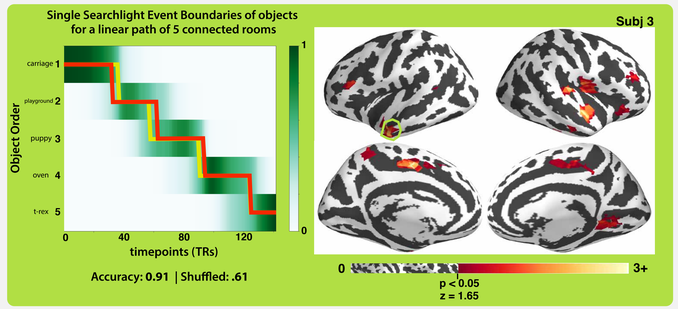
PRELIMINARY RESULTS (n = 11): Room + Object Representations





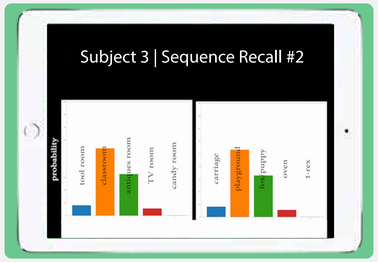
PRELIMINARY RESULTS: Segmenting Mental Walkthroughs of Rooms





By comparing brain activity to a pattern template for each room (left) or object (right), the HMM estimates when the subject transitions between recalling room-object pairs. Accuracy for a searchlight was measured as the mean boundary overlap of 'predicted' vs 'actual' (relative to a shuffled null) across multiple runs of the 5-room sequence recall task. : real boundaries : predicted boundaries

Mental Tracking



Summary

- Room-specific patterns in sensory and Posterior Medial Network regions
- Object specific patterns in sensory and some Anterior Temporal Network regions
- Room-patterns / object-patterns are good predictors for event boundaries

Current Directions

- How do the PM and AT network regions work together with the hippocampus to retrieve objects from spatial context cues?
- What are the neural correlates of a well-functioning (vs. poorly-functioning) memory palace?

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