Shifting Forms of Memory in Spatial Navigation

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Background

- Both episodic memory and semantic memory, which is the schematic memory of patterns extracted over time, can be used to guide spatial navigation behavior (Graves, 2020).
- Previous theoretical work has shown that depending on the environment, it can be advantageous to rely on either episodic or semantic memory.
- As over short time periods, the environment is less likely to change, relying on episodic memory makes sense. The environment is more likely to change over longer time, making semantic memory more advantageous (Santoro, 2016).

Primary Question: Given the likelihood of change in the environment, do people alter between relying on episodic memory vs. semantic memory to optimize their spatial navigation behaviors?

Methods

Main Hypothesis:

Participants will use semantic memory to guide navigation when the environment is more likely to change and episodic memory when the environment is more stable.

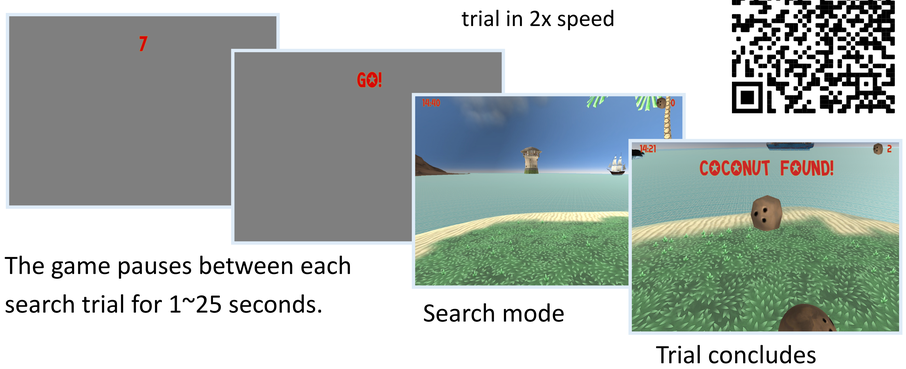
Experimental Design:

31 participants played a computer game where they navigated a small virtual island and searched for coconuts.

- Coconuts were most likely to appear on a particular part of the island.
- Coconuts constantly changed location; they could either shift incrementally to a nearby location or go through a sudden and complete shift in location.

Example Trial:

Scan to watch an example trial in 2x speed



The game pauses between each search trial for 1~25 seconds.

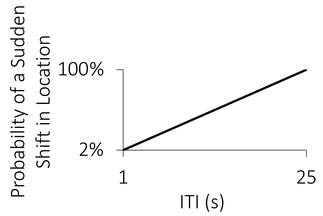
Search mode

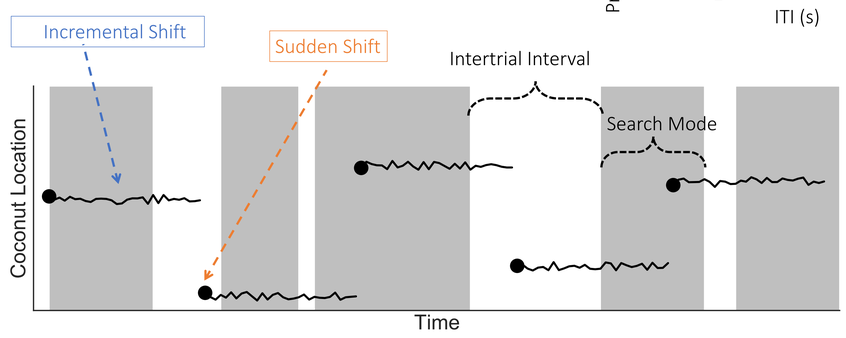
Trial concludes

Methods cont.

Main Experimental Manipulation:

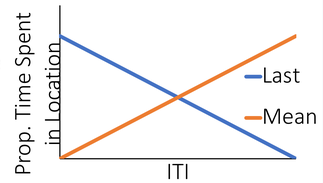
Intertrial intervals (ITI) varied between 1 to 25 seconds. The longer the ITI, the higher the probability that a sudden shift in the coconut's location has occurred.





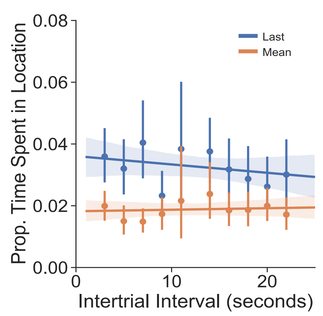
Prediction:

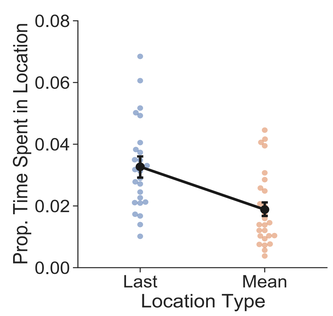
As ITI increases, participants will spend more time proportionally in the mean location (where coconuts are most likely to appear), and less time in the last location (where they've most recently found a coconut).



Results

Data show that participants did not alter their navigation behavior as a function of ITI. Overall, participants spent more time proportionally in the last than mean location.





Main effect of Location Type ($\beta = 0.007$, 95% CI = [0.005, 0.009], $t = 6.771$, $p < 0.0001$);
No main effect of ITI ($\beta = -0.001$, 95% CI = [-0.003, 0.001], $t = -0.759$, $p = 0.448$);
No interaction effect of Location Type: ITI ($\beta = -0.001$, 95% CI = [-0.003, 0.001], $t = -1.101$, $p = 0.271$).

Discussion

Current data yielded no conclusive evidence for our main hypothesis. We speculate that some limitations for our study may include:

- Individual differences in experience with the control of a computer game might impact participant's navigation abilities;
- Not enough incentive for completing the task as efficiently as possible.

Future Directions:

- Potential design changes to address the limitations above;
- Further analysis to see whether the individual's performance correlate to prop. time spent in mean location.

References

Graves, K. N., Antony, J. W., & Turk-Browne, N. B. (2020). Finding the Pattern: On-Line Extraction of Spatial Structure During Virtual Navigation. *Psychological Science*, *31*(9), 1183–1190. https://doi.org/10.1177/0956797620948828

Santoro, A., Frankland, P. W., & Richards, B. A. (2016). Memory Transformation Enhances Reinforcement Learning in Dynamic Environments. *The Journal of Neuroscience*, *36*(48), 12228. https://doi.org/10.1523/JNEUROSCI.0763-16.2016

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