A novel open-field task for the analysis of episodic-like memory and its substituents

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Introduction

- Episodic memory is often compromised in aging and dementia[1], and consists of three substituents: object recognition and discrimination (what), spatial navigation (where), and timing (when)[2].
- Research on episodic-like memory, the animal counterpart thereof, provides an avenue for studying the memory type as a whole, as well as individual differences that exist within the what, where, and when components[3].
- Since better assessment of the substituents may provide insight into the nature of episodic memory decline, this project aimed to develop a novel task for studying both episodic-like memory and its substituents in rodents.
- Through the use of scent (what), location (where), and time of day (when), this task successfully elicited the use of episodic-like memory in rats, and elucidated individual differences in the what, where, and when substituents of episodic memory – a more thorough understanding of which could provide further insight into the nature and eventual prevention of episodic memory decline.

Methods

Procedure:

Eight male Sprague Dawley rats were sequentially trained via four phases for episodic-like memory integration in the fifth phase.

Each individual had to obtain a criterion of 75% correct for two days prior to advancing to the next phase.

Following task completion, rats were retested in one of two conditions:

1. Sequential retest – rats completed the same task just as during baseline
2. Random retest – rats ran one pseudo-randomly selected phase each day for 10 days

Phases:

"What" – Scent discrimination (Figure 3a)
"Where" – Spatial location (Figure 3b)
"What-when" – Scent discrimination and temporal integration (Figure 3c)
"Where-when" – Location discrimination and temporal integration (Figure 3d)
"What-where-when" – Episodic-like scent, spatial, and temporal integration (Figure 3e)

Analysis:

Daily percentages of correct choices were converted to a d' sensitivity measure (Signal Detection Theory) using a table for 16-choice measures[5].

General linear modeling and the AIC criterion were used for all analyses.

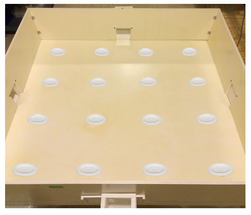

Figure 1. The table apparatus including four start boxes and sixteen holes (6cm in diameter and 24cm apart) that were filled with plastic cups. These cups contained a 2oz plastic cup that served as a food receptacle and were covered with plastic lids scented via the Branch, Galizio and Bruce 2014 technique[4].

Figure 2. Representation of the cups that were placed within the holes of the matrix. They contained a second smaller cup that acted as a food receptacle.

Results

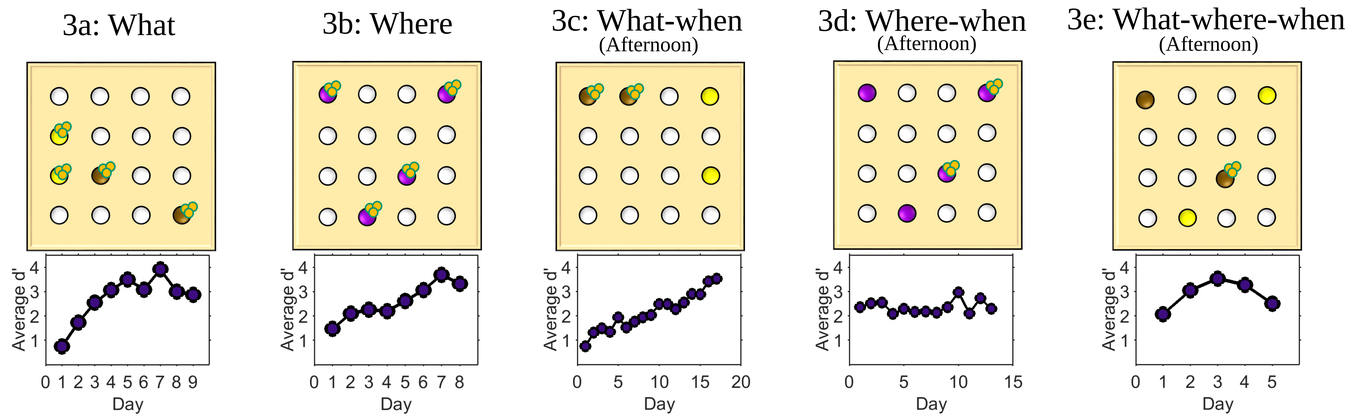

Figure 3. Top Row. The correct outcomes in each phase. Beet-scented lids are marked in brown, ginger lids in yellow, and fixed locations in purple. Correct choices are indicated by food pellets (small light brown circles). **Bottom Row**. There were significantly different rates of learning across tasks, with the fastest learning rats occurring in the what, where, and what-where-when tasks. The rapid learning in the final what-where-when task indicates significant transfer of training from the previous tasks.

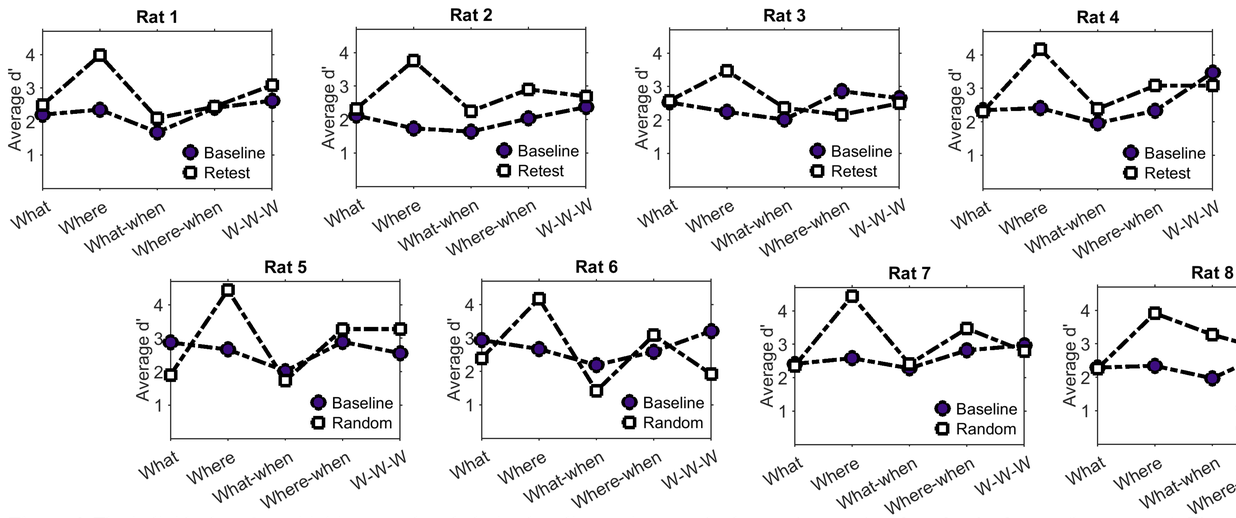

Figure 4. The individual rats' sensitivities to each task during baseline testing, standard retest (top row) and randomized retest (bottom row). Figures highlight that individual rats had unique strengths and weakness across tasks, most of which were robust across the first and second rounds of testing. Both the sequential retest and randomized retest rats performed significantly better during their retest than baseline testing. Randomized rats also had a greater change in performance across phases during their retest, further indicating the robustness of the individual differences in task performance. Lastly, the "where" phase, which relied solely on spatial information, resulted in the best performance during both re-test types in all rats, suggesting strong use of spatial cues in the tasks.

Discussion

- This novel task elicited episodic-like memory in rats, as seen in the what-where-when phase.
- Rats showed individual strengths and weaknesses in rates of learning and overall performance across the phases, but all rats relied heavily on spatial information during the retests.
- Individual differences were exacerbated when the rats had to solely utilize the what, where, or when information in random testing, as opposed to when tested in a sequential fashion.
- Future work aims to parse out these differences and determine if supporting the underlying constructs can support episodic-like memory as a whole.

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