Clustering by Spatial Proximity During Memory Search

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Introduction

Context is an important variable in the formation of episodic memories. Events become associated with the context in which they occur, and this affects how events are stored and later recalled.

Time and location are particularly salient contextual variables.

Temporal Context—events occurring nearby in time tend to be recalled successively (Kahana, 1996).

Environmental Context—items studied in a particular environment are often better recalled when testing occurs in the same environment (Godden and Baddeley, 1975).

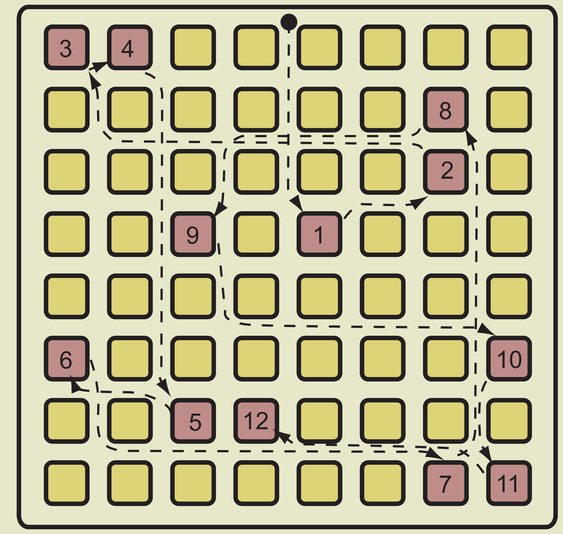
Here, we investigate whether items studied in a similar spatial context tend to be recalled successively in a free-recall paradigm.

Events occurring nearby in space should share a large number of spatial features, and thus the recall of one item may act as a contextual cue for the recall of a spatially proximate item.

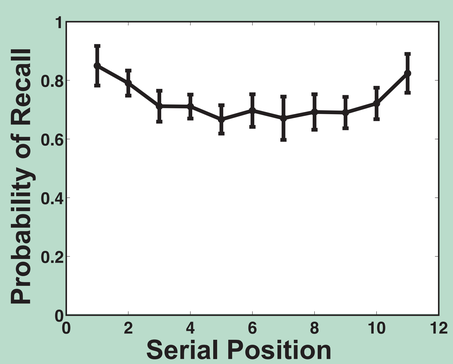
Methods

20 subjects ran in a variant of the free-recall paradigm, modified to include a spatial element.

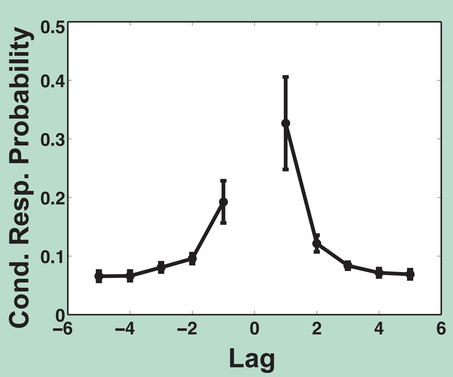
The subject plays a delivery person in a virtual town. On each trial, the subject makes a series of 11 deliveries to specific locations across the town. Upon reaching each destination, an image of the delivered object appears on the screen. After making all 11 deliveries, the subject is asked to navigate to a final location, at which point the recall period begins. Subjects are then given one minute to attempt to recall all of the items from the most recent list.



Primacy and recency effects are observed.



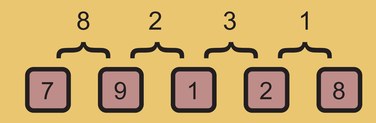
A strong temporal contiguity effect is observed.



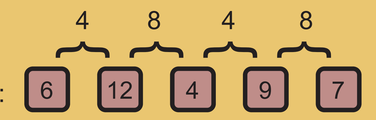
Spatial Results

A permutation analysis was performed to determine whether items cluster by spatial proximity during free recall.

1. Find mean spatial distance between recalls for a given trial's recall sequence.



2. Permute store locations, removing actual spatial data. Find mean spatial distance for each of 1000 random permutations.



3. The true mean spatial distance can be converted to a z-score by comparing it to the distribution of permuted data. A negative z-score indicates that the distance between successively recalled items is less than would be expected by chance.

4. Each trial provides one z-score, and we calculate a mean z-score for each subject.

5. A one-tailed t-test on the subject means is used to determine whether the distribution of z-scores is significantly less than zero.

Mean of z-score distribution: -0.096
t(19) = -1.854, p = 0.039

A conditional response probability analysis was developed to investigate the interaction of temporal and spatial factors.