Competition and forgetting during context-based episodic memory retrieval

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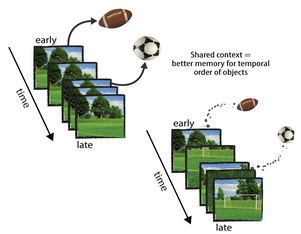
1. INTRODUCTION

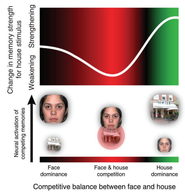
Background

Context refers to the many facets of information that characterize the situation in which an episodic memory occurs, which places our memories in space and time.

MEMORY RETRIEVAL. Recent memory models highlight the importance of contextual information for remembering episodic events. During recall, this information is used as a "spotlight" to drive memory search, which takes into account relative temporal positions and specific features associated with items (Polyn et al., 2009; Sederberg et al., 2008). Similar lines of research suggest that shifts in context influence memory for the order of events, and enhance the reactivation of items related to a context (DuBrow & Davachi, 2013).



RETRIEVAL-INDUCED FORGETTING. The retrieval of a memory can impair the recall of related memories. This is known as RIF: retrieval-induced forgetting (Anderson et al., 1994, 2000). A model has been proposed to explain this effect, in which a neural network learning rule leverages regular oscillations in feedback inhibition to weaken competing memories (Norman et al., 2007). This model predicts a nonmonotonic "U-shaped" relationship between the degree of a memory's activation and changes in its memory strength. Specifically, competing memories that activate to a *similar degree* as a target memory are more likely to be weakened and subsequently forgotten (Detre et al., 2013; Lewis-Peacock & Norman, 2014).



However, the factors governing whether and how memories will compete during retrieval are not well understood. Here, we are exploring the contributions of encoding context to memory reactivation and RIF.

QUESTION: How does the temporal distance between items in a shared encoding context influence the competitive reactivation and RIF during retrieval?

Hypothesis

We expect that changes in temporal distances between the encoding of items sharing a context will bias the competitive dynamics between those items at the time of retrieval.

Specifically, items encoded closer together in time will be more likely to compete with each other during cued retrieval.

In turn, those memories which compete (i.e., activate to a similar degree) with a target memory are more likely to be forgotten.

2. METHODS

I. Encoding
Object triplets are presented serially, separated by short (1.5 s) or medium (6 s) gaps, on a unique background image.

II. Cued Retrieval
For ~ 2/3 of triplets, one target object is cued for retrieval using the background image and a temporal position cue.

III. Recognition
Recognition confidence memory test is given for all objects seen during encoding plus novel foils.

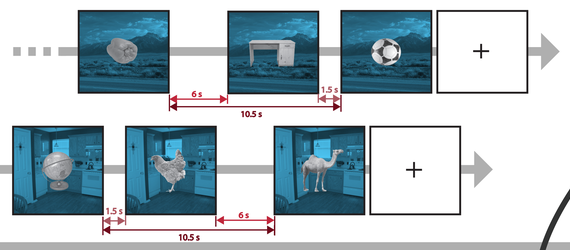
Encoding

ENCODING TRIALS

Participants are presented with a series of objects (3 s each), arranged into triplets on top of a unique background image. They are instructed to create associations between consecutive objects and the background, while performing a subcategory judgement (natural/manmade) for each object. There are 64 triplets, with 256 unique objects.

Encoding trials consist of objects presented consecutively with two contextual features:

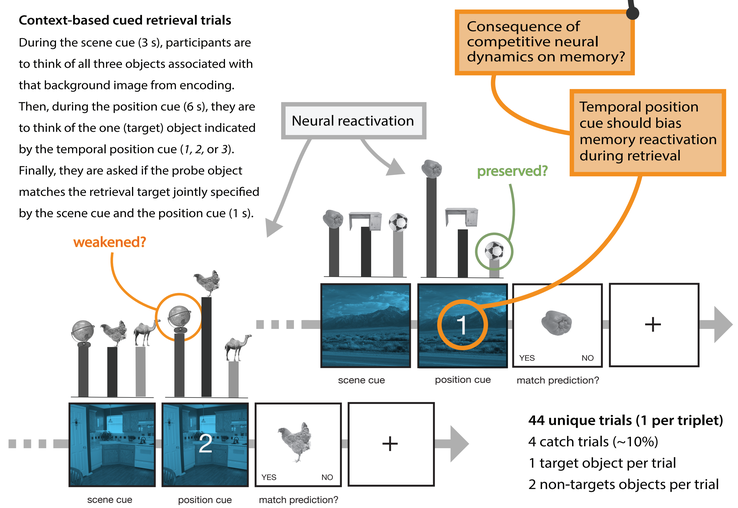
1. *background scene*
2. ***temporal context*** - the temporal distance between the presentation of two objects can be either short (1.5 s) or medium (6 s) within a triplet. This scenario allows for 3 relative encoding distances - short (1.5 s), medium (6 s), and long (10.5 s).



Cued Retrieval

Context-based cued retrieval trials

During the scene cue (3 s), participants are to think of all three objects associated with that background image from encoding. Then, during the position cue (6 s), they are to think of the one (target) object indicated by the temporal position cue (*1*, *2*, or *3*). Finally, they are asked if the probe object matches the retrieval target jointly specified by the scene cue and the position cue (1 s).

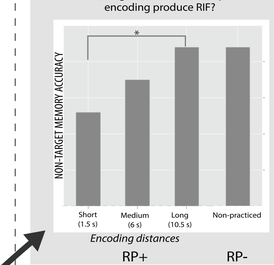


44 unique trials (1 per triplet)
4 catch trials (~10%)
1 target object per trial
2 non-targets objects per trial

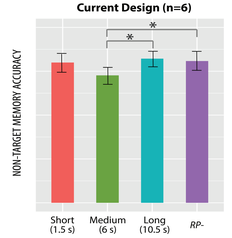
RESULTS 3.

Behavioral Results

HYPOTHESIZED RESULTS
Does high contextual overlap at encoding produce RIF?



Memory accuracy by encoding distance from target



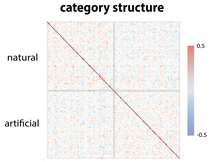
Memory accuracy for RP+ non-target objects was not systematically influenced by encoding distance *(F(3,10)=1.7, p=0.19)*, or worse than RP- non-practiced items (i.e., no RIF was observed).

***Nope!* Why is RIF not found for non-targets with short encoding distances?**

There are likely trial-by-trial differences in neural processes at retrieval, and thus variability in competitive dynamics. Thus, aggregate measures may be unable to detect relationships to memory performance. If we are able to **measure item-specific memory reactivation at retrieval, then we can link this to subsequent memory performance on an item-by-item basis.**

Neural Results

Item-level decoding category structure



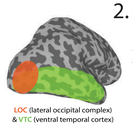
Reactivation rank of target after position cue

mean (sd), rank: 62 (34)

Neural Decoding of Memory Reactivation

Representational similarity analysis (RSA) of fMRI data is used to detect the reactivation strength of individual objects during retrieval.

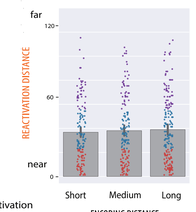
DECODING MEMORY REACTIVATION DURING RETRIEVAL



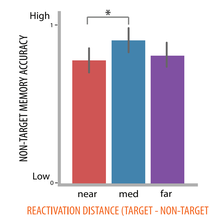
2. Representational similarity analysis of the reactivation period is accomplished with ***rank-order correlations*** of all objects during the scene cue and position cue.

3. ***Measuring reactivation distances.*** The neural activity patterns of the target and the non-target objects associated with the retrieval cues should be more highly ranked than objects from other triplets. We refer to the difference between the target rank and the non-target rank as the ***reactivation distance*** for that non-target.

Reactivation distance grouped by encoding distance

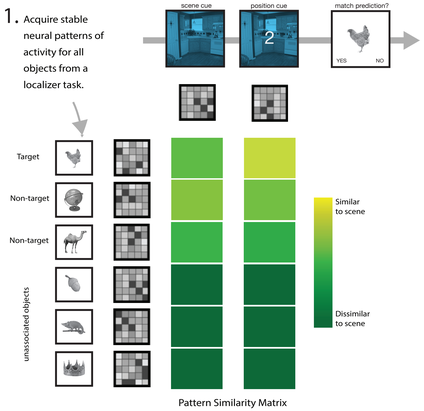


Memory accuracy grouped by reactivation distance



* p ≤ 0.05

1. Acquire stable neural patterns of activity for all objects from a localizer task.



4. We hypothesize that small reactivation distances (*reflecting more neural competition between the target and non-target objects during retrieval*), should be associated with greater forgetting (RIF) of those non-targets.

Reactivation strength for individual objects during cued retrieval are compared to memory accuracy. The difference in reactivation strength between the target and non-target objects is used as a measure of neural competition between them, where smaller differences indicate greater competition.

SUMMARY 4.

Encoding context (background image, temporal order of presentation) was used as retrieval cues to bias memory reactivation for selective retrieval-induced forgetting (RIF).

The encoding distance (1.5 s, 6 s, and 10 s) between objects in a triplet did not systematically produce RIF for non-targeted objects in these data (N=6).

Using RSA to identify item-specific neural reactivation of objects during cued retrieval suggests that non-targets which reactivate to a similar degree as the retrieval target (i.e., that are more neurally competitive with the target) show more forgetting.