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Overview

- Human memory search exhibits strong influences from temporal and semantic information.
- Free recall research has characterized these effects individually, but few studies have examined how they interact to bind together, or segment, individual events into meaningful episodes.
- Manipulating the level of inter-item distraction at study, while keeping the timing consistent, disrupts the temporal and semantic organization of recall
- We analyze behavioral (*n=82*) and fMRI (*n=27*) data

Experimental Design: continual distraction category free recall

C C C L L L O O O L L L C C C O O O L L L C C C O O O

1 2 3 4 5 6… … 26 27

27 items per list (9 triplets of same-category items)

C: celebrity, L: landmark, O: object (Polyn et al., 2005)

heavy inter-item distraction

6 2 8? 3 7 11?

TRUE FALSE

heavy: mental arithmetic

light: vigilance task, button press at '?'

light inter-item distraction

6 2 8? 3 7 11?

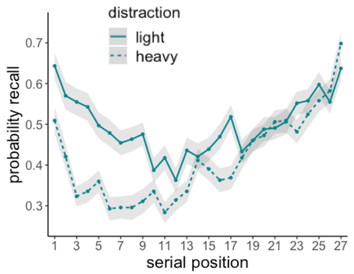
KEY PRESS KEY PRESS

stream of single digit integers

timing of ITI: 3-7s (randomly sampled, mean = 5s)

Temporal dynamics of recall

Temporal organization is disrupted



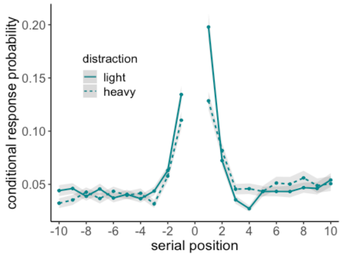
Serial position curve: the probability that an item was recalled, based on it's position in the study list

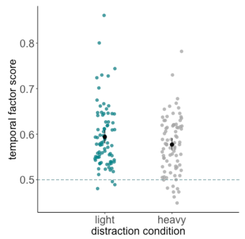
- performance decrease; fewer items were recalled when they were studied with heavy distraction
- primacy effect; the first items in a list are more likely to be recalled with minimal distraction, and are more vulnerable to drop out of recall with distraction

Contiguity

- The contiguity effect becomes weaker when items are encoded with a more demanding inter-item distraction
- Binding adjacent items creates a compound representation. Recalling one of these items increases the likelihood that the others will be recalled.
- Nearby items are less likely to be recalled together with heavy distraction, suggesting that the inter-item task interferes with temporal binding.
- Distraction disturbs a cognitive control process that utilizes the temporal structure of a list

Contiguity effect: items studied near one another are more likely to be recalled together.





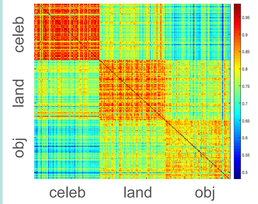
- The temporal factor score ranks the absolute value of actual : possible transitions
  scores > 0.5 indicate temporal clustering
- No group difference in temp. factor, suggests that the decrease in clustering is isolated to immediate lags

Semantic Organization

semantic vector space

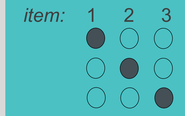
We create a stimulus space populated with unique 300-d vectors, derived from Wikipedia text, that capture the features of each item (https://github.com/prestonlab/wiki2vec)

Distance metrics can characterize the similarity of items – a pairwise cosine similarity matrix of our stimuli reveals clear category boundaries (warmer colors indicate semantic similarity)

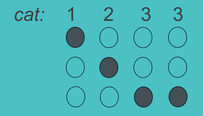


We can represent an item semantically in 3 ways

1. unique item features (unit vectors)

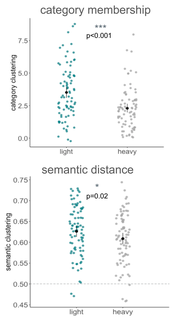


2. coarse category features



3. distributional semantic features (unique vectors)

Semantic organization is disrupted

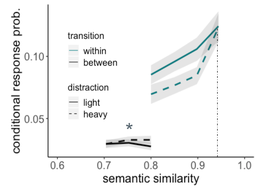


clustering scores

- [left] distraction decreases semantic clustering at the category level and, to a lesser extent, the item (distributional) level
- the interaction of category and item representations
- [right] highly related between-category transitions show a small, but statistically reliable, increase with heavy distraction
- distraction disturbs temporal binding at encoding, thereby increasing the likelihood of a between category recall

semantic CRP (within v between category)

- within-category transitions are impaired with heavy distraction
- interestingly, items that are highly semantically related are spared this impairment and are recalled together regardless of distraction



Conclusions

- Previous studies have found that inter-item distraction at study does not influence temporal organization in free recall
- We show that manipulating the level of intensity of a distraction, while keeping the timing constant, disrupts both temporal and semantic organization.

References

Polyn, S. M., Natu, V. S., Cohen, J. D., & Norman, K. A. (2005). Category-specific cortical activity precedes retrieval during memory search. *Science*, *310*(5756), 1963-1966.

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