Bridging the Gap: On the Basis of Transitive Association 3032

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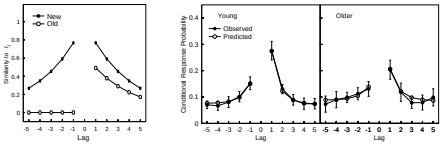
1 TCM Explains Temporal Associations in Free Recall

The Temporal Context Model (Howard & Kahana, 2002, TCM,) was developed to explain temporally-defined associations in the free recall task.

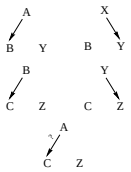


- Retrieved context supports associations.
- One component is the same across presentations.
- The other retrieves contextual states.

1.1 TCM, mediated association and the hippocampus

Howard, Fotedar, Datey, and Hasselmo (In revision) showed that disruptions to the symmetric component also predicted disruptions in mediated, or transitive, associations. Such disruptions are consistent with neuropsychological results associated with hippocampal damage.

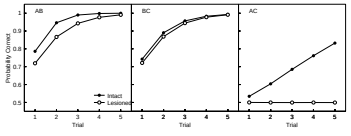
- Hippocampal rats learned $A \rightarrow B$...
- ...and B→C as well as normal rats.
- Unlike normal animals, they showed no generalization to A→C



Eichenbaum has suggested that the ability to form these mediated associations is a central property of hippocampal function. The ability to perform "transitive inferences" between arbitrary stimuli may also depend on this ability.

1.2 TCM and the dissociation between pairwise and mediated association

Howard et al. (In revision) simulated hippocampal lesion as an elimination of the symmetric component of retrieved context.



2 Experiment

2.1 Double function pairs

- Paired-associate learning: Study ABSENCE-HOLLOW, test ABSENCE-???
- *Double-function* pairs share items, e.g. ABSENCE-HOLLOW, HOLLOW-PUPIL.
- *Single-function* pairs are unrelated, e.g. POLICE-WINDOW, MONEY-FOUNTAIN.

2.1.1 Double function pairs cause a higher-order structure

RIVER -DARLING
POLICE-WINDOW
HOLLOW - PUPIL
MONEY-FOUNTAIN
PUPIL - RIVER
ABSENCE- HOLLOW
FARMER-SHIPPING

ABSENCE
HOLLOW
PUPIL
RIVER
DARLING

2.2 Prior results

Prior work has shown that double-function pairs are harder to learn than single-function pairs. Slamecka (1976) showed that double function lists cause backward and remote interference. Can we directly measure these remote associations?

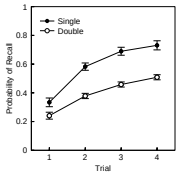
2.3 Methods

- 166 Syracuse University undergraduates participate for credit.
- Lists were composed of 35 double-function and 8 single-function pairs.
- Each list was presented for four trials—on each trial each pair was repeated three times.
- Auditory and visual presentation of items.
- Each item was on the screen for 1000 ms, 100 ms intra-pair and 1800 ms inter-pair.
- After each trial, there was a filled distractor (30 s) and then each pair was tested.
- Ss had 5s for verbal recall.
- Surprise final free recall (FFR) at end of session.

2.4 Results

2.5 Learning as a function of pair type

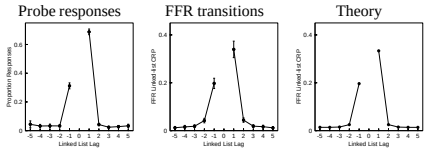
- Correct recall of double function pairs worse than single function pairs.
- Learning proceeds more slowly.
- Associative interference for double function pairs



2.6 Interference from backward associations

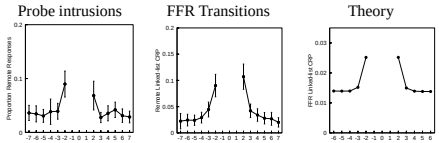
Define a variable "linked list lag"—distance between items in the linked list structure. For instance, when tested with PUPIL, the correct answer is RIVER. This response has a linked list lag of $+1$. However, the subject might also respond with HOLLOW, at a lag of -1, or DARLING with a lag of $+2$.

We can calculate the probability of a response in the probe trials as a function of list lag (Probe responses). We can also measure conditional probability of recall transitions in FFR. The rightmost panel shows simulated results using TCM.



2.7 Symmetric mediated associations, theory and data

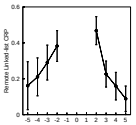
Items at linked-list lag ± 1 were presented with the item in question (e.g. B-C, C-D). Items at large |lag| were never presented with the probe item. These are true mediated associations. We repeated the above analyses considering only more remote lags.



The fact that these curves fall off with "distance" is strong evidence for mediated associations.

2.8 Are the FFR results really mediated associations?

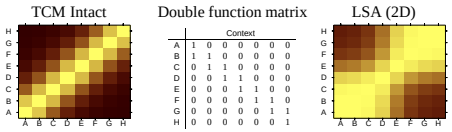
- Imagine pairwise associations in free recall.
- What if you recall *B*, and then think of *A* and *C*?
- Another experiment, analyze only first FFR transition from a list.



3 Theory

3.1 TCM builds a representation that reflects higher-order structure

Consider a double function list A-B-C-...-G-H. The context retrieved by each item at each stage of learning can be thought of as a representation of that item. The left-hand figure shows the similarity structure of this representation after learning for the unlesioned model.



- The intact TCM has "discovered" the hidden list structure
- The middle panel shows how to construct a "corpus" out of a double function list
- When taught with the double matrix, LSA (Landauer & Dumais, 1997) also forms mediated associations (right).
- LSA rates as similar words that occur together, but also words that occur in similar *contexts*.

4 Conclusions

- Mediated, or transitive associations, reflect the higher-order structure of the learning episode.
- Mediated, or transitive associations extend over several pairs in double function lists.
- This could lead to sensitive assays for α_N, which we hypothesize corresponds to MTL function.
- LSA, a model of semantic structure, also relies on mediated associations, suggesting an avenue for a theoretical connection between episodic and semantic memory.

References

Howard, M. W., Fotedar, M. S., Datey, A. V., & Hasselmo, M. E. (In revision). The Temporal Context Model in spatial navigation and relational learning: Toward a common explaination of medial temporal lobe function across domains. *http://memory.syr.edu/publications.html*.

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Acknowledgements

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