Decoding episodic retrieval processes: Frontoparietal and medial temporal lobe contributions to free recall

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Introduction

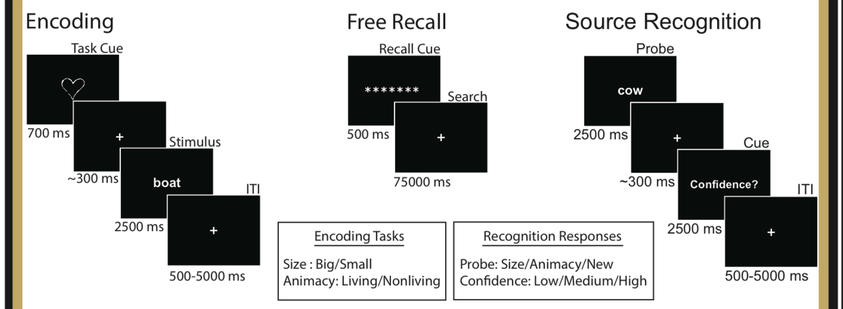
Question: Neuroimaging investigations of recognition memory have identified distinct neural systems associated with processing **item familiarity** and **episodic recollection** during recognition memory tasks - are these processes both recruited during free recall?

Hypotheses

H1. Anatomical regions that support recollection,[1-2] including hippocampus, posterior parietal cortex, and medial prefrontal cortex mediate retrieval not only during recognition but also during free recall of items. This prediction is consistent with long-standing models of free recall.[3-4]

H2. The neural substrates that mediate processing of item familiarity,[5] including the anterior medial temporal lobe (MTL), dorsal parietal cortex, and lateral prefrontal cortex, additionally support free recall.

Methods



We used univariate conjunction analysis and multivariate pattern analysis of fMRI data collected while 20 subjects performed free-recall and source recognition tasks. Similar neural engagement provides evidence for common cognitive operations mediating retrieval across tasks.

Contrasts and Classifiers

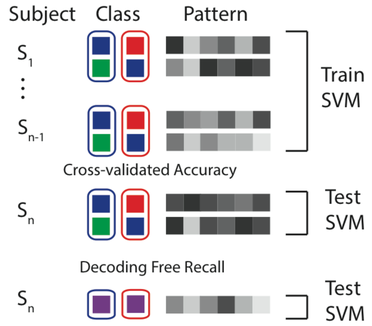
Source Recollection ■ vs. ■ | **Item Familiarity** ■ vs. ■ | **Recall Success** ■

Convergence Analyses

Source Recollection and Recall (■ > ■) ∩ ■

Item Familiarity and Recall (■ > ■) ∩ ■

Support Vector Machine Classification



■ Source Hit ■ No Source Hit ■ Correct Rejection ■ Recall Success

Conclusions

Successful retrieval of an item during free recall engaged posterior MTL regions that were also implicated in source recollection processes (*H1*), as well as posterior parietal and lateral prefrontal regions that were also implicated in item familiarity processes (*H2*).

In contrast to these univariate findings, multivariate decoding analyses suggest that familiarity-related processes, but not source recollective processes, were engaged during free recall (*H2*).

Processes supporting the determination of item familiarity involve determining whether the item was seen in the temporal context of the most recent list. These contextual processes may be similarly engaged during retrieval in free recall.

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3. Polyn, S. M., Norman, K. A. & Kahana, M. J. Psychol Rev 116, 129–156 (2009).
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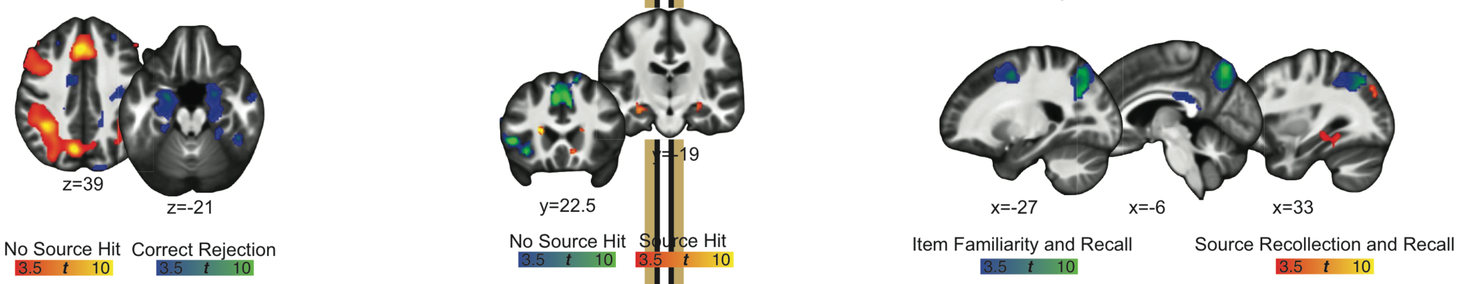
Results

Univariate convergence analysis identifies common correlates of recognition and recall



$p < 0.001$, uncorrected; k > 50 (cluster α = 0.05)

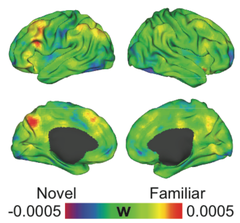
Decoding reveals common patterns of activity during processing of item familiarity and free recall

Item Familiarity Classification

Step 1: Train classifier to identify item familiarity processes

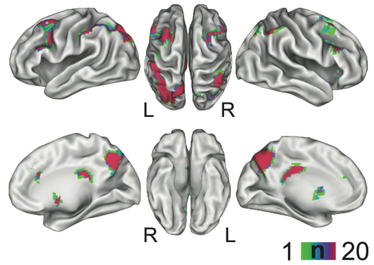
Whole Brain:

Average Classifier Weights



Functional Network:

Frequency map of features (n=folds)



Cross-validated Performance

accuracy = 0.93 (0.88–0.96), $p < 0.0001$
sensitivity$_{familiar}$ = 0.95 (.87–0.99), $p < 0.0001$
sensitivity$_{novel}$ = 0.90 (.81–0.95), $p < 0.0001$

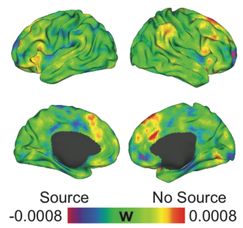
accuracy = 0.85 (0.70–0.94), $p < 0.0001$

Source Recollection Classification

Step 1: Train classifier to identify source recollection processes

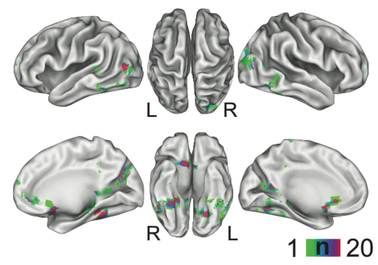
Whole Brain:

Average Classifier Weights



Functional Network:

Frequency map of features (n=folds)



Cross-validated Performance

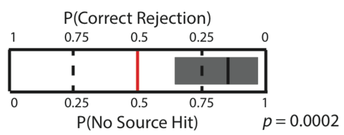
accuracy = 0.80 (0.74–0.85), $p < 0.0001$
sensitivity$_{source}$ = 0.90 (.81–0.95), $p < 0.0001$
sensitivity$_{no\ source}$ = 0.70 (.60–0.78), $p = 0.021$

accuracy = 0.60 (0.43–0.75), $p = 0.077$

Decoding Item Familiarity during Free Recall

Step 2: Decode retrieval during free recall using item familiarity classifier

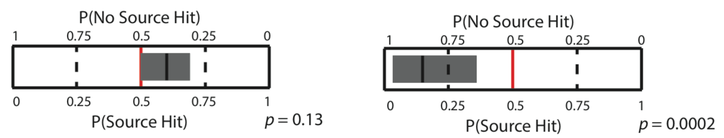
Whole Brain: ■ → ■ Functional Network: ■ → ■



Decoding Source Recollection during Free Recall

Step 2: Decode retrieval during free recall using source recollection classifier

Whole Brain: ■ → ■ Functional Network: ■ → ■



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