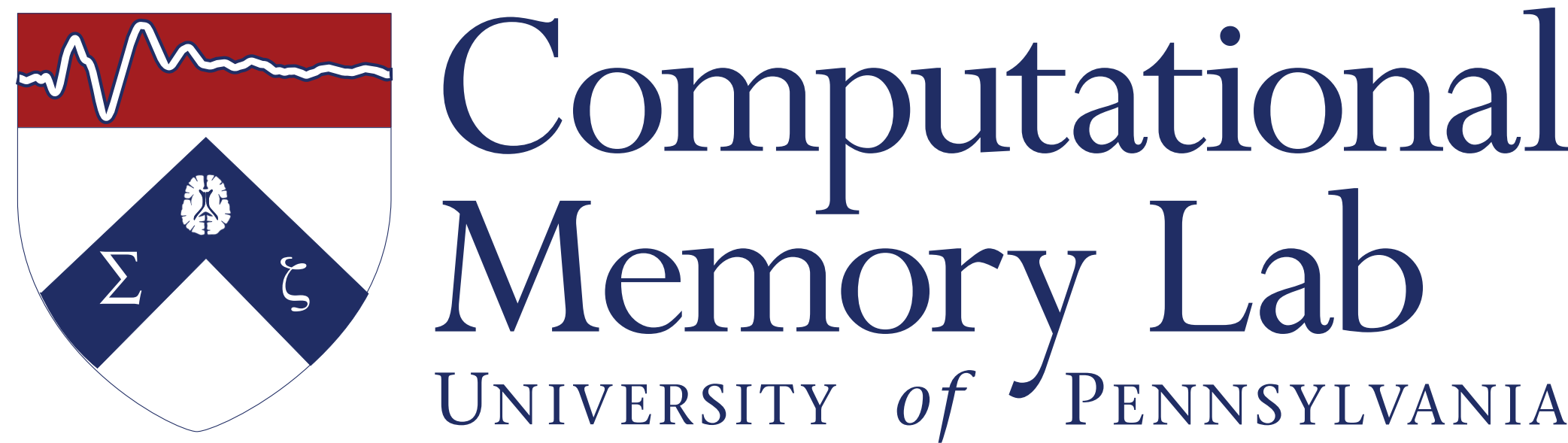


Core episodic encoding and retrieval processes revealed by dynamics of neural activity

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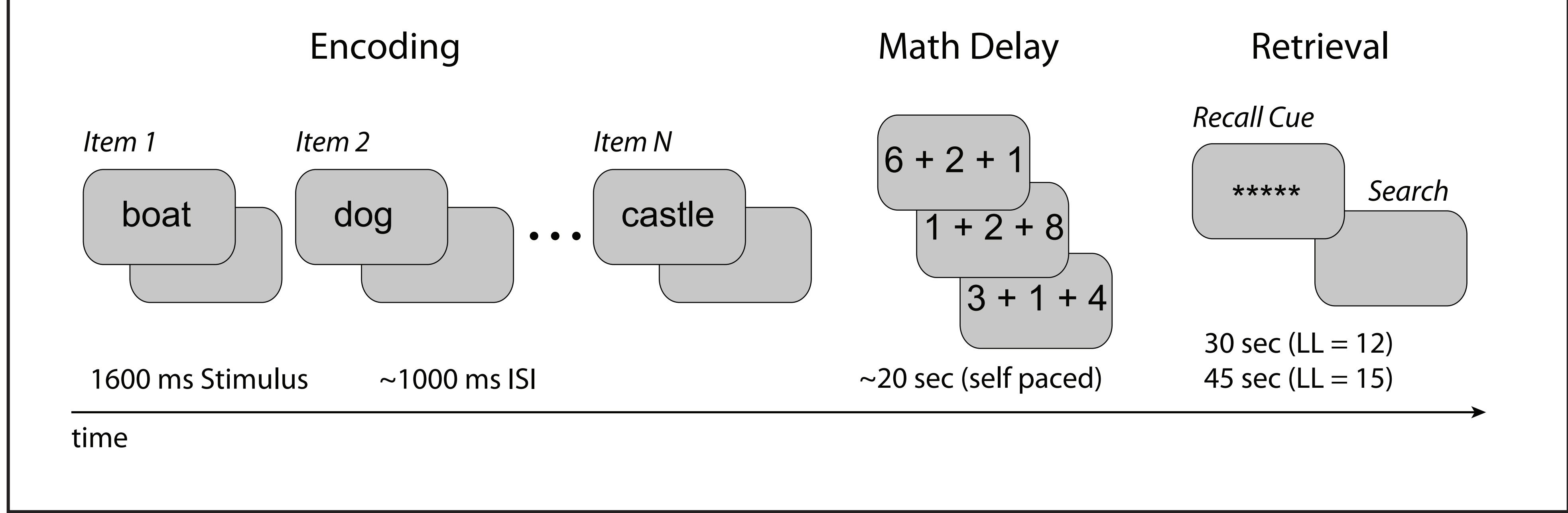


Introduction

Although distinct neural mechanisms support the encoding and retrieval of episodic information (e.g., increased activity of right lateralized prefrontal cortex during retrieval), it is unclear whether these processes are critical to determining successful memory performance.

Is successful memory performance reflected by the engagement of mechanisms that are **common** or **specific** to encoding and retrieval?

Experimental Paradigm



Delayed Free Recall | 187 subjects | 25 lists per session | 12 or 15 words per list | iEEG

Multivariate Decoding

Classifiers to identify biomarkers of good memory

- 50 log-spaced morlet wavelets from 3 to 180 Hz
- L2 penalized logistic regression
- Leave one list out cross-validation

Encoding Success

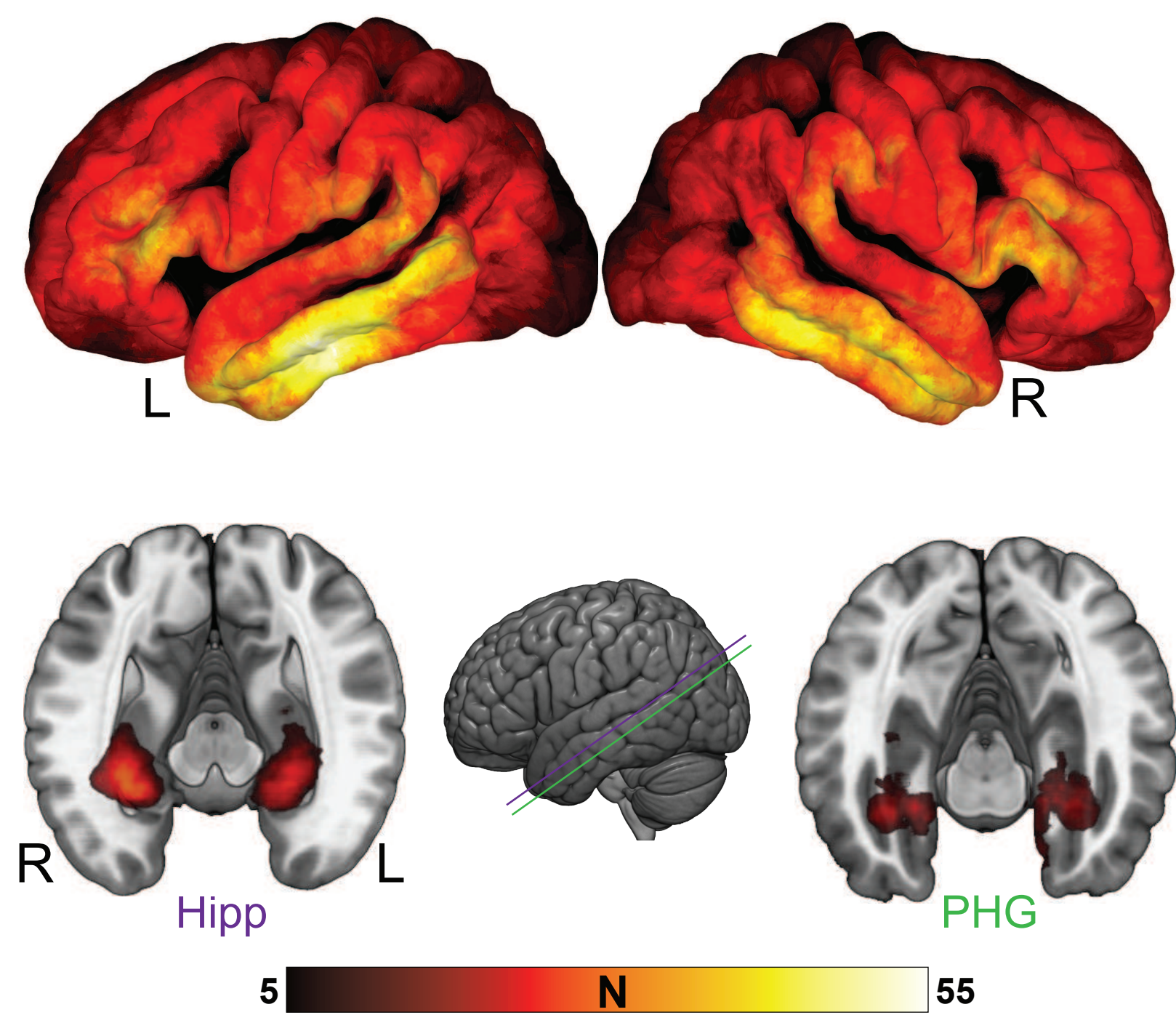
- average power during word presentation
- discriminate remembered and forgotten items

Retrieval Success

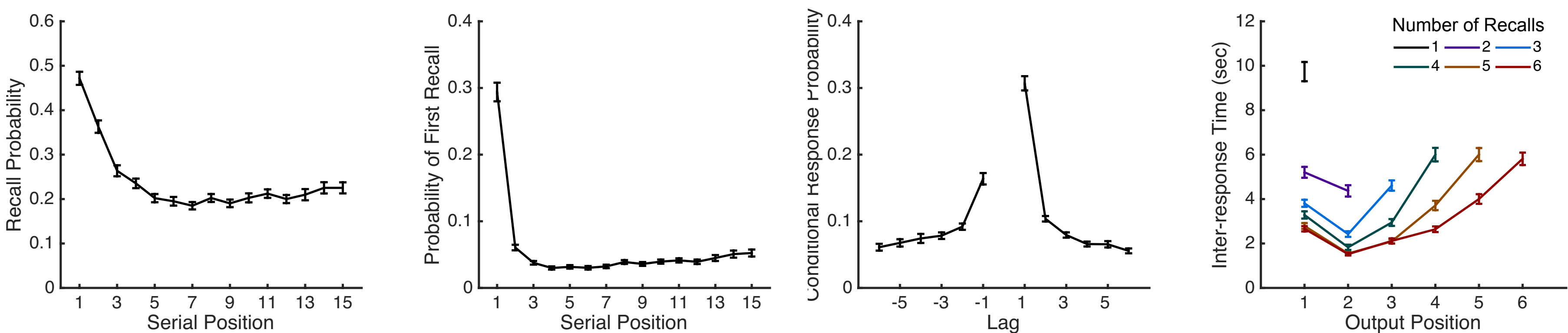
- average power 500 msec prior to recalls (exclude recall events with vocalization in 2000 msec prior)
- discriminate corrects recalls from unsuccessful search

Joint Classifier

- train on observations from both encoding and retrieval, scaling contributions of each period



Behavioral Results



• Subjects recalled 24.47 ± 0.008 (mean ± SEM) percent of items.

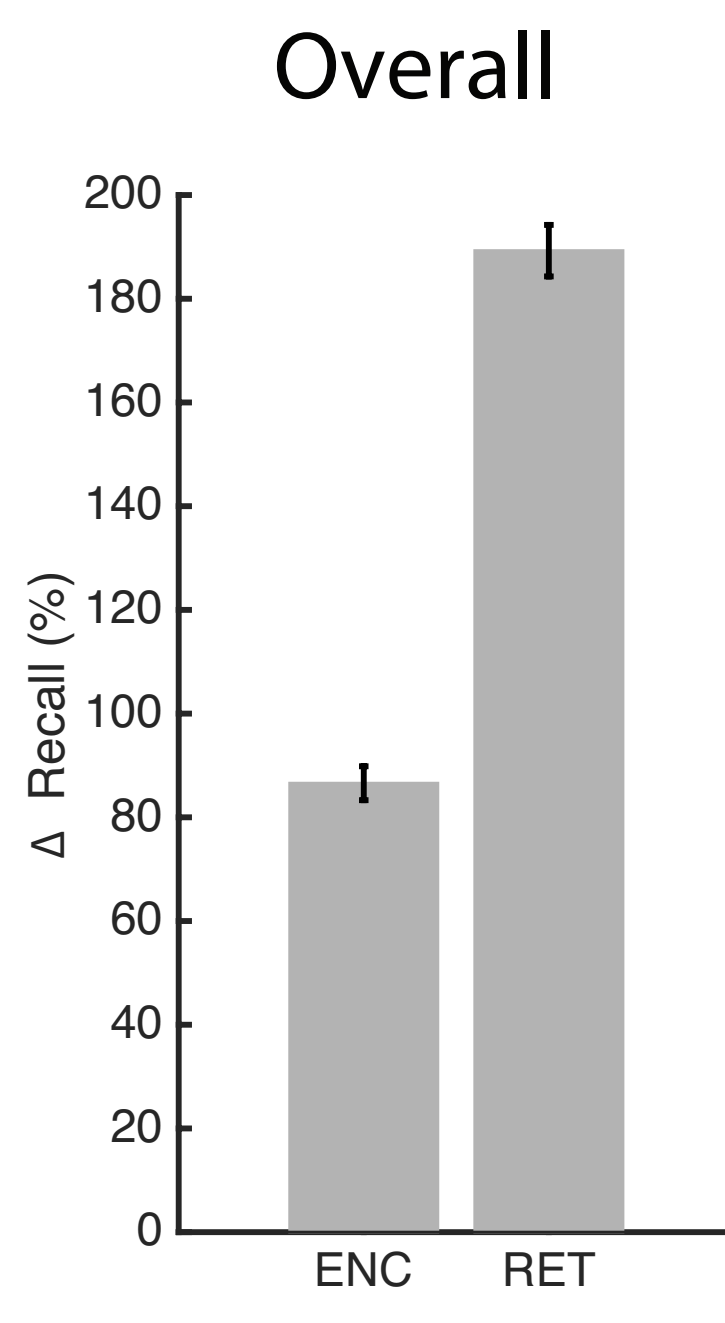
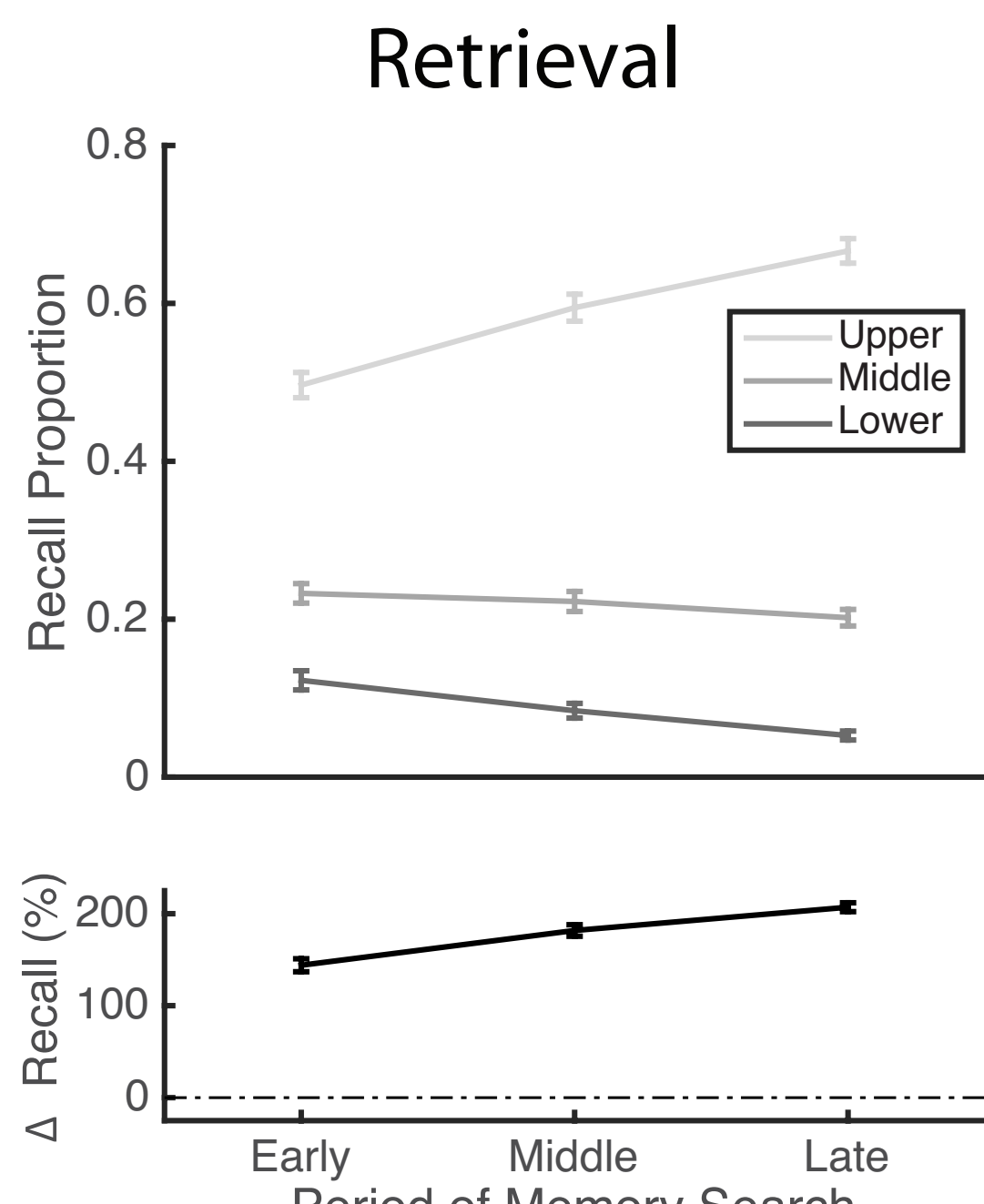
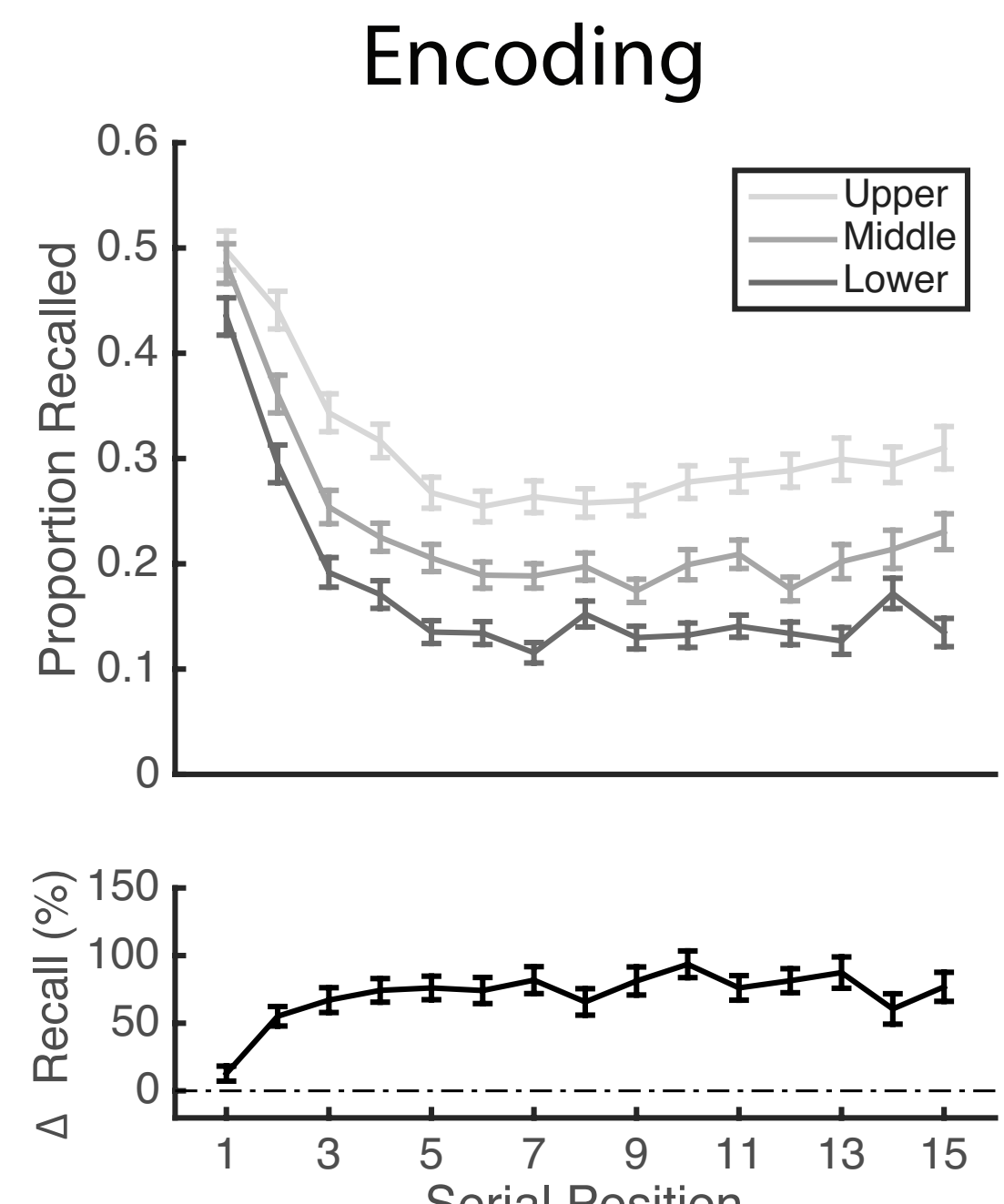
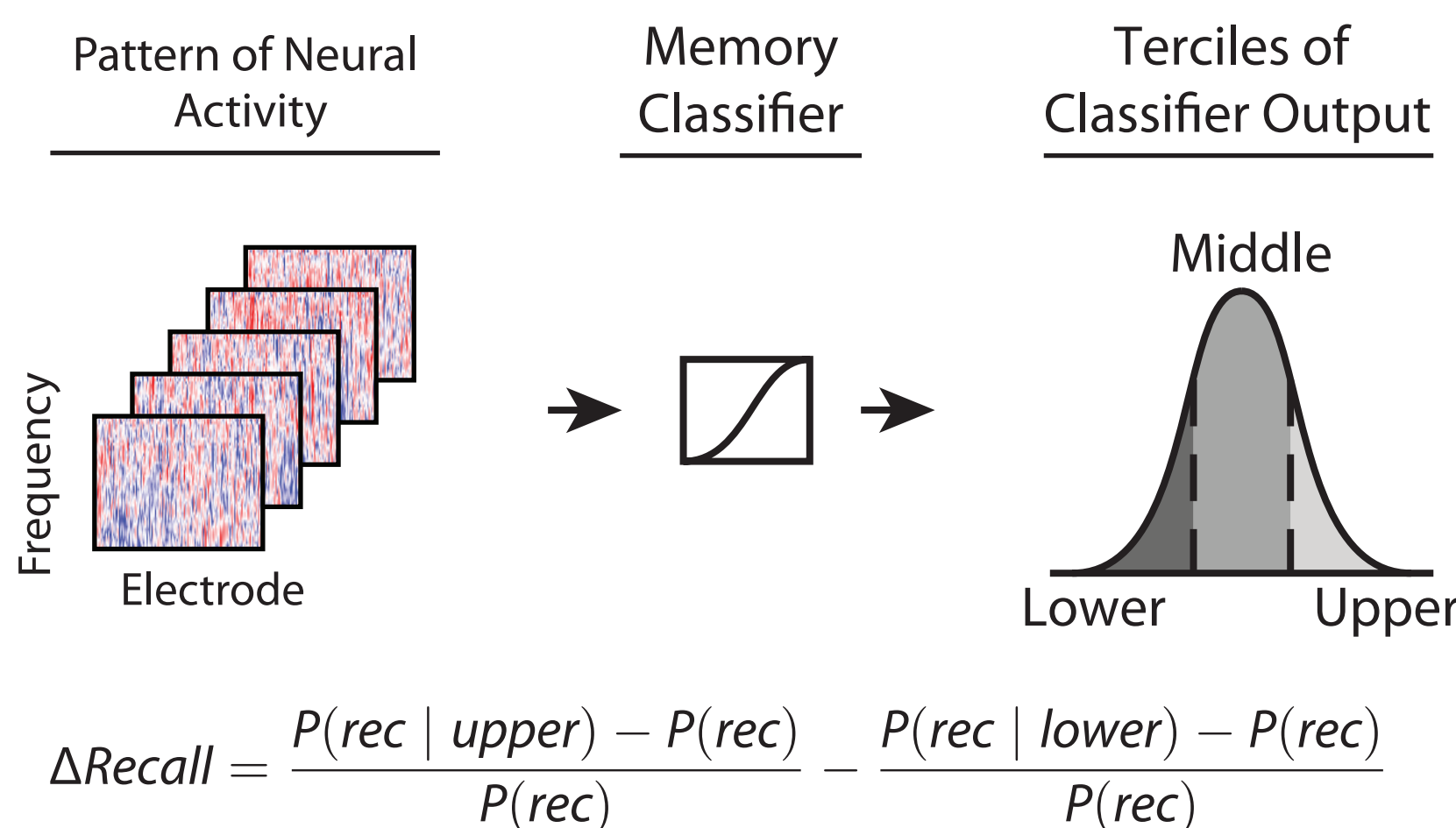
• Recall was initiated with items from the beginning of the list.

• We observed significant temporal organization, with an average temporal factor score of 0.66 ± 0.01, ($t_{191} = 22.46, p < 10^{-10}$).

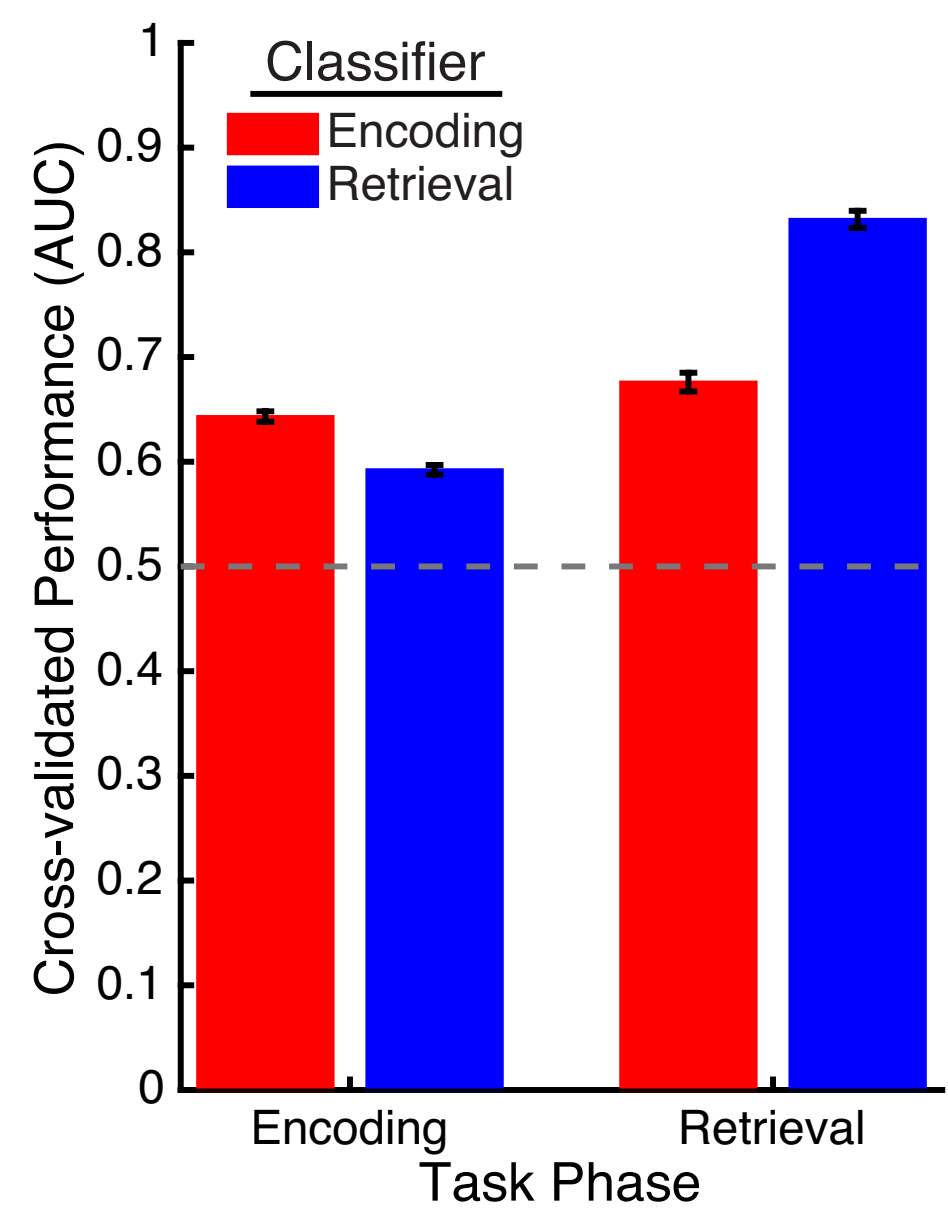
• Inter-response time increased as a function of items yet to be recalled, with the majority of recalls made early on in the search period.

Multivariate classification of successful encoding and retrieval

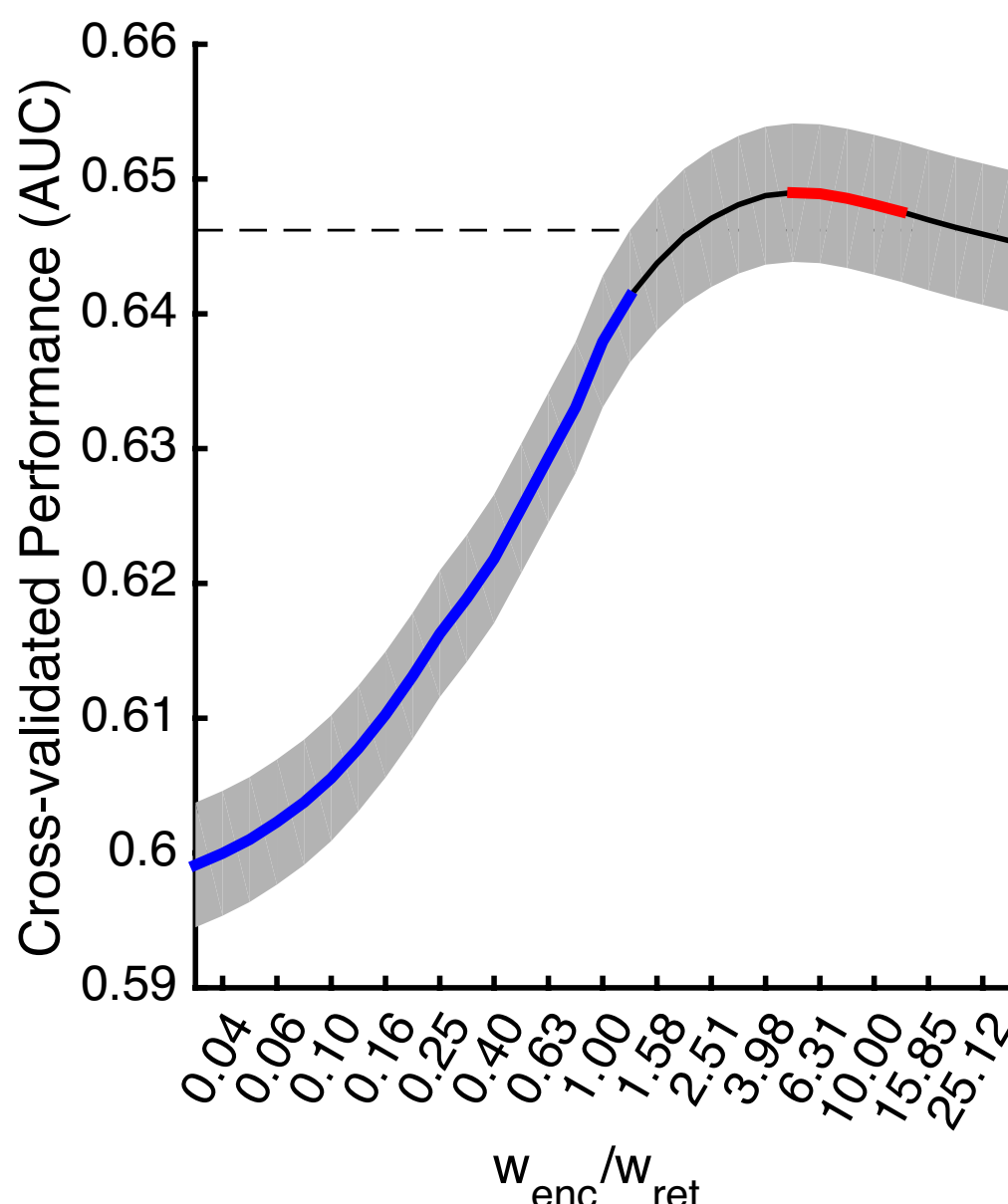
How does behavioral performance change as a function of classifier output?



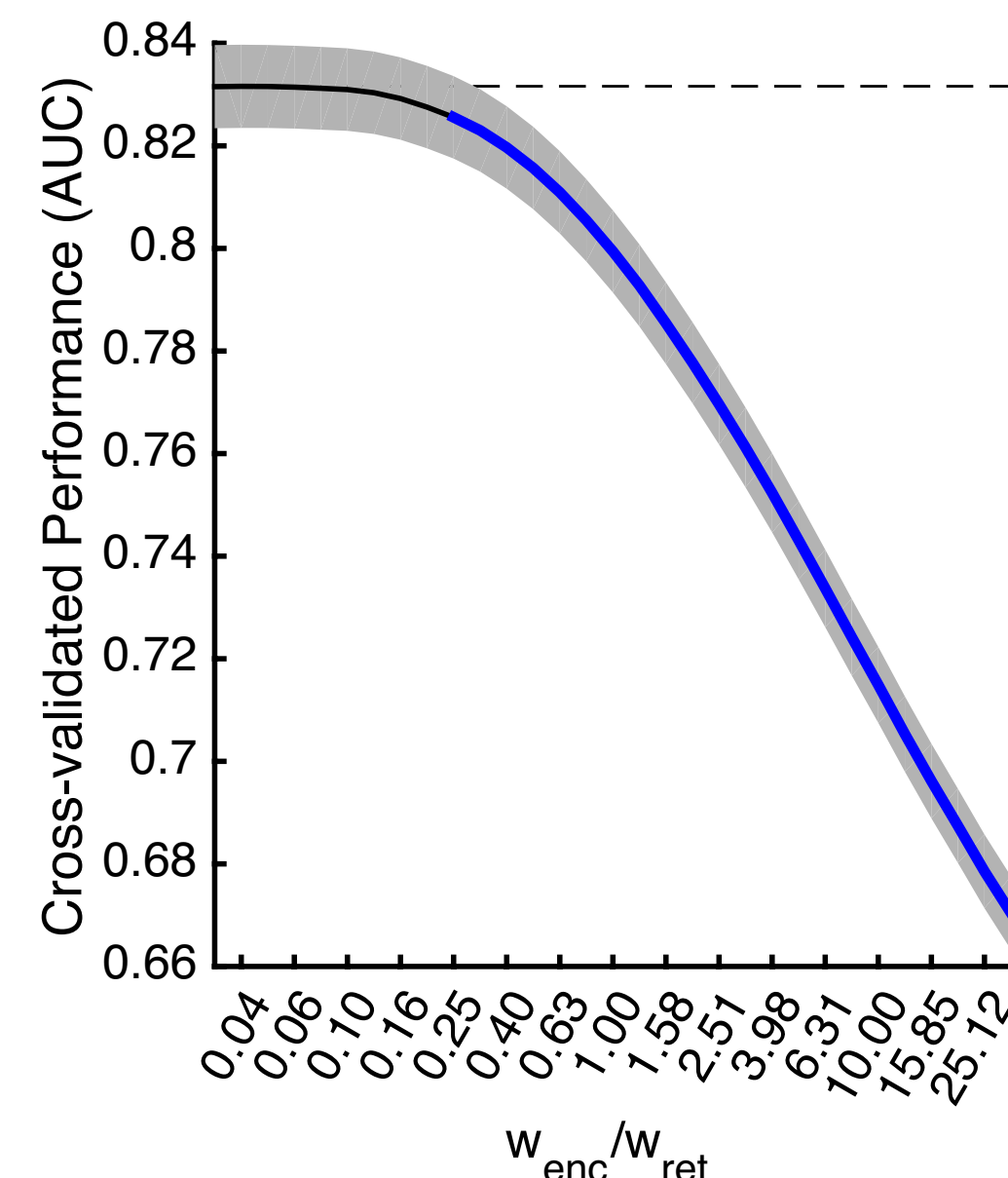
General neural mechanisms of successful memory function



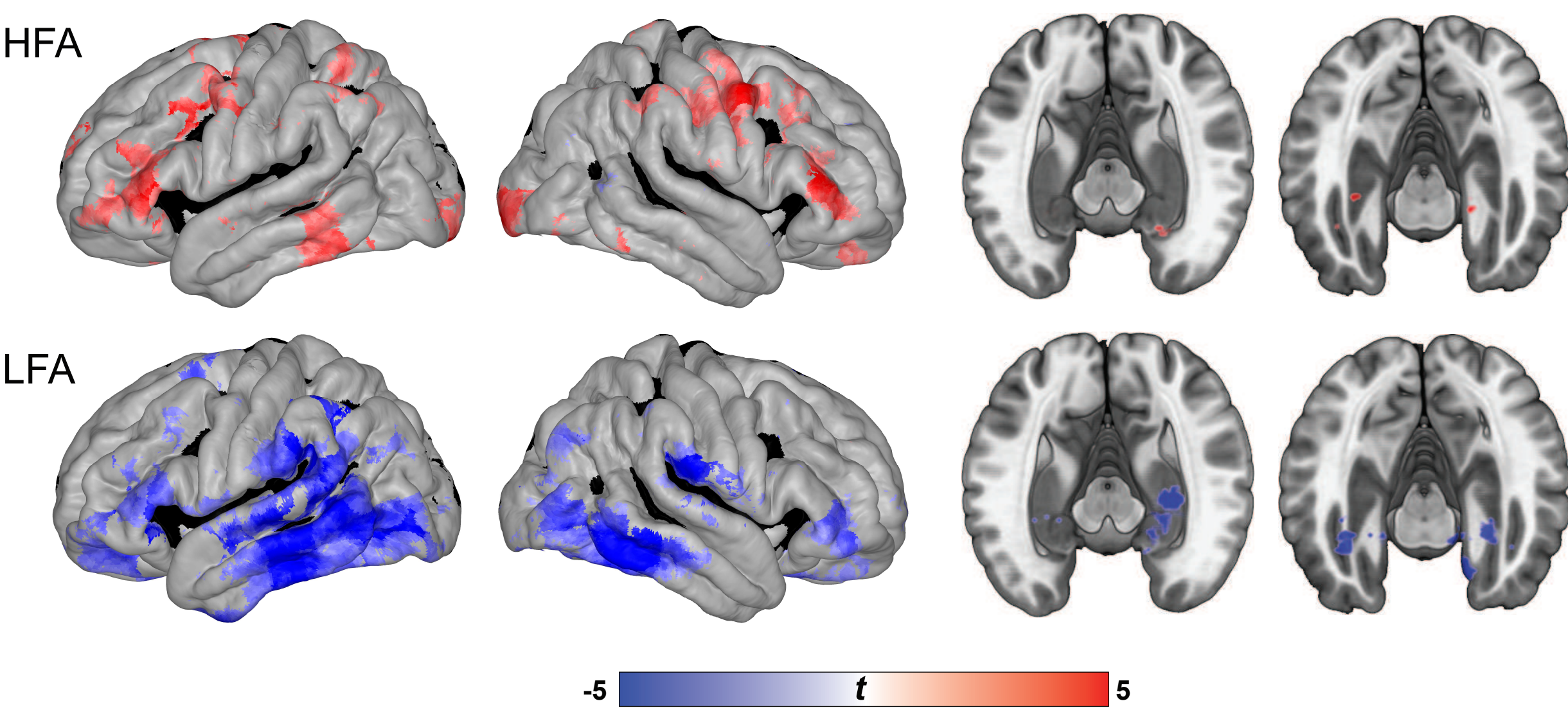
• Cross decoding reveals significant generalization across both phases of the tasks ($p_s < 0.05$).



• Incorporation of retrieval observations significantly improves classification of encoding states ($q < 0.05$, FDR corrected).

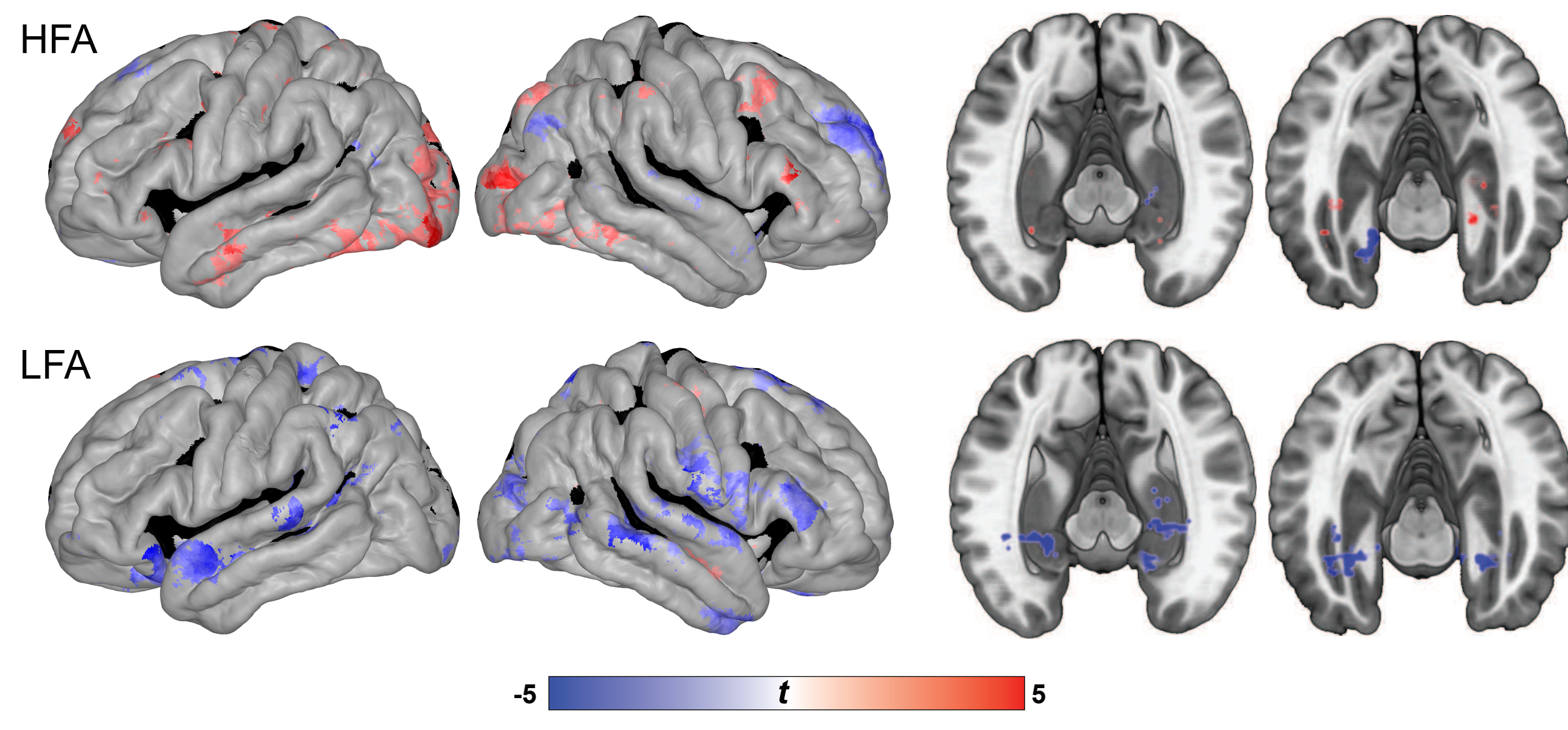


• Incorporation of encoding observations significantly impairs classification of retrieval states ($q < 0.05$, FDR corrected).

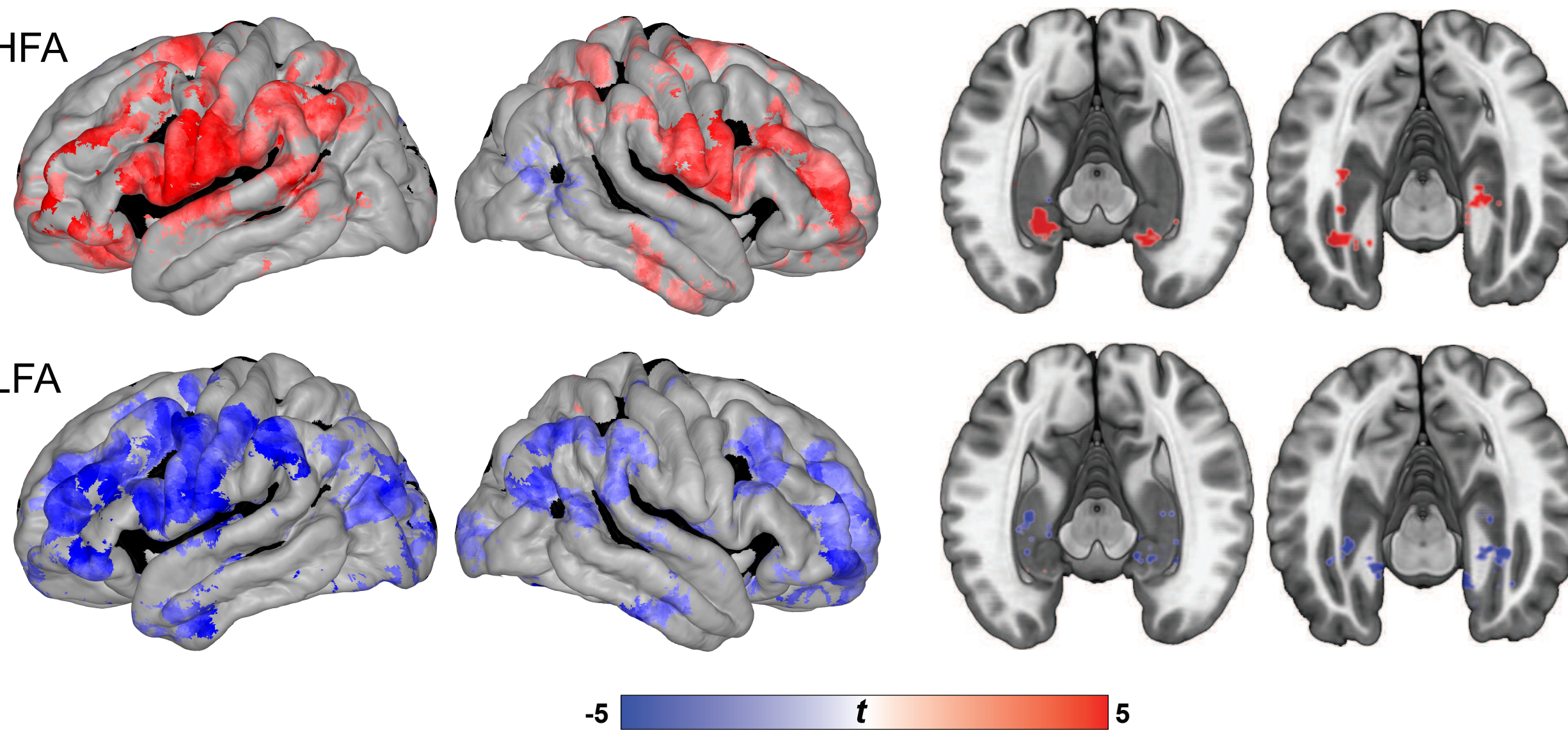


• Changes in high frequency activity (HFA, > 60 Hz) and low frequency activity (LFA, < 10 Hz) are biomarkers of memory success that are common to episodic **encoding** and **retrieval** ($q < 0.05$, FDR corrected).

Distinct neural mechanisms supporting episodic encoding and retrieval



Biomarkers of good memory specific to episodic **encoding** ($q < 0.05$, FDR corrected).



Biomarkers of good memory specific to episodic **retrieval** ($q < 0.05$, FDR corrected).

Conclusions

- Successful memory formation and retrieval are marked by increased HFA and decreased LFA within multiple prefrontal, temporal, and MTL sites, reflecting their utility as general biomarkers of successful memory performance.
- In the presence of distinct mechanisms supporting episodic encoding and retrieval, common neural activation is sufficient to predict memory performance across both phases of the task.

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