Temporal Dynamics of List-level Encoding State

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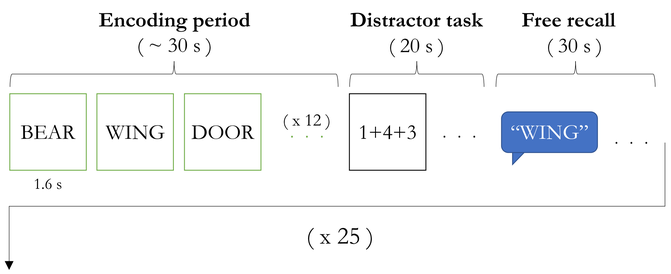
Background

- Fluctuations in encoding state are subjectively apparent, but how can we measure them objectively, and at which time scales can we measure them?
- We hypothesized that slowly-varying neural activity can accurately predict recall, and that classifiers trained to predict recall can reveal underlying dynamics of encoding state
- **Specifically, we use a classifier approach to characterize list-level subsequent memory effects (SMEs) and their temporal dynamics, in comparison to item-level SMEs**

Methods

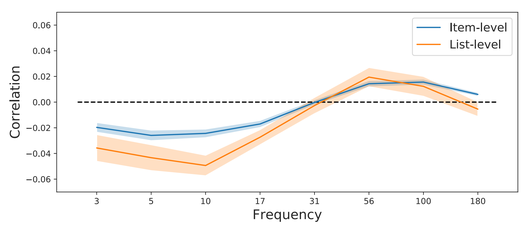
- We used a free recall task performed by patients with epilepsy (N=62) with intracranial electrodes
- Words were presented in lists of 12 items each, for 1.6s at a time, with random ISI of 750-1000ms, followed by a distractor task and free recall.



- Up to 25 lists completed per session, up to 10 sessions
- Spectral power calculated using Morlet wavelets at 8 frequencies (3, 5, 10, 17, 31, 56, 100, 180Hz).
- We trained classifiers using leave-one-list-out cross-validation to predict recall for each patient; features consisted of power in each electrode for each frequency.
- **Item-level classifier:** Logistic regression classifier, using power averaged over 300-1600ms epoch following word presentation
- **List-level classifier:** Ridge regression classifier, using average of 300-1600ms epochs over whole list, or average power over whole list

Results

Univariate correlation between power and performance



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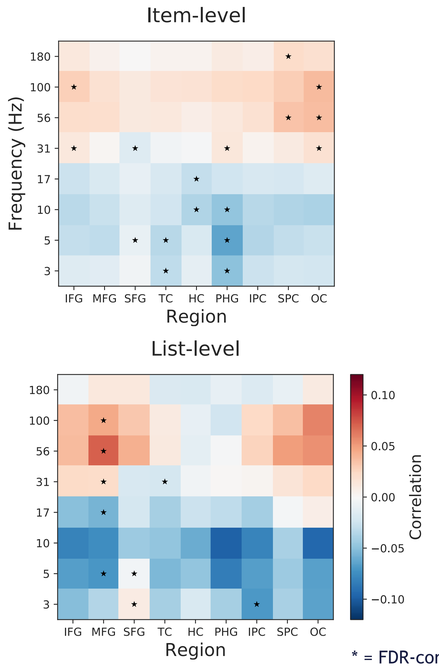
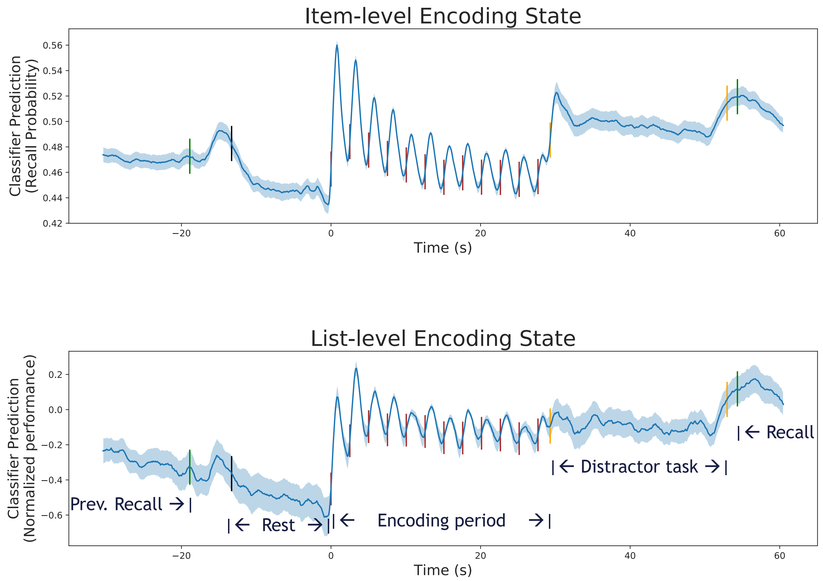
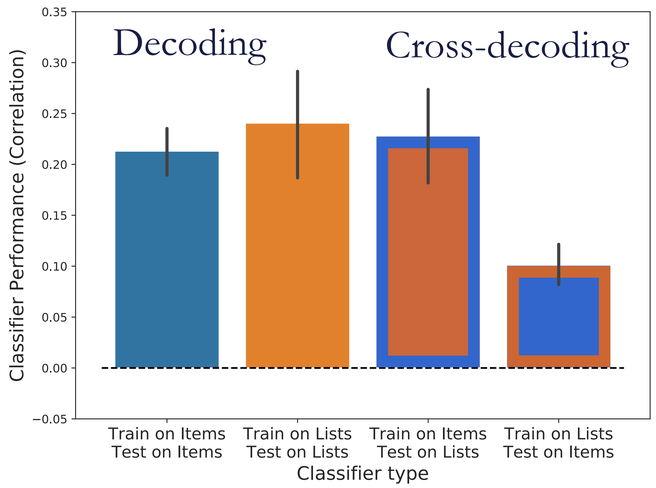


Results: Time Courses of Classifier-Derived Encoding State



- List-level and item-level encoding states fluctuate with item presentation
- Only item-level encoding state exhibits large primacy effect
- List-level encoding state remains elevated through distractor and recall periods, then subsides until next list presentation

Results: List-level and Item-level Classification



In cross-classifiers, classifiers are either trained on individual item recall and tested on left-out list, or trained on list performance and tested on left-out items.

Conclusions

- Both list-level and item-level classifiers robustly predict recall at both list-level and item-levels.
- Despite training list-level classifier on average list-level activity, it also exhibits item-level temporal fluctuations, suggesting close relationship between neural processes underlying fast-varying and slowly-varying encoding states.

References

Weidemann CT, Kahana MJ. Neural measures of subsequent memory reflect endogenous variability in cognitive function. *J Exp Psychol Learn Mem Cogn.* 2021;47(4):641-651.