Directly measuring reactivation of memorized content with electrophysiology

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Introduction

Rehearsal, reactivation of previously studied content during encoding or retention intervals, is thought to provide several mnemonic advantages (Ward, 2021)

Rehearsal is typically covert, making study of the relationship to overt memory behavior difficult

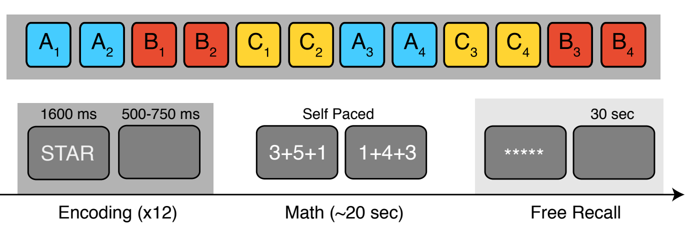
- Studying rehearsal behavioral often requires unnatural task instructions (e.g. Murray, 1968, Glanzer and Meinzer, 1967, Rundus and Atkinson, 1970)

Neural reactivation of content during sleep and awake rest intervals predicts performance in recognition, working memory and spatial cued recall (Deuker et al. 2013; Fellner et al., 2020; Jafarpour et al., 2017; Schapiro et al., 2018; Schonauer et al., 2017; Zhang et al., 2018)

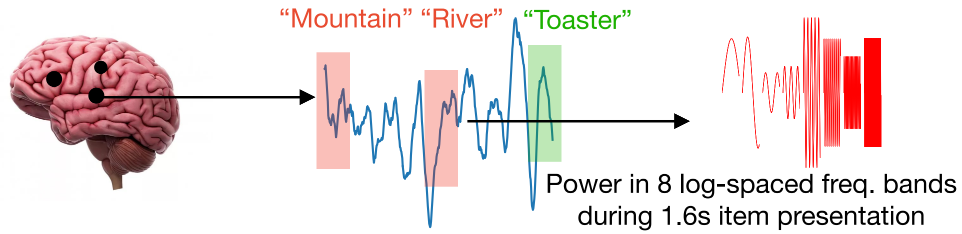
Does the content of covert reactivations during retention intervals (measured directly with neural recordings) predict the trial-level probability and organization of episodic free recall?

Data

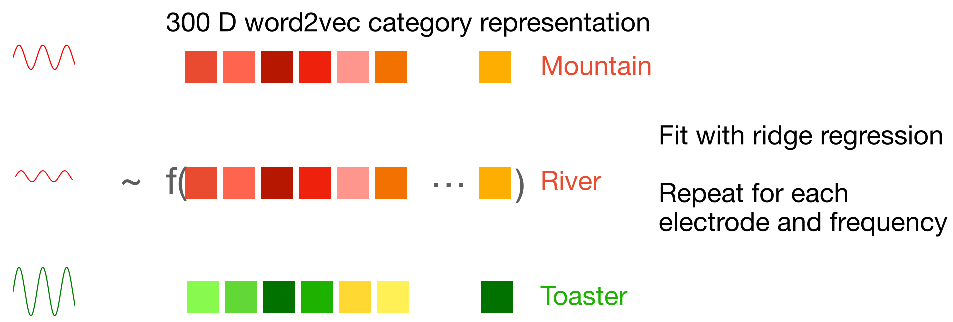
- Categorized Free Recall (catFR, Weidemann et al. 2019) performed by 82 patients with epilepsy with implanted electrodes
  - Lists of 12 words drawn from 3 semantic categories (drawn from a set of 25 categories)



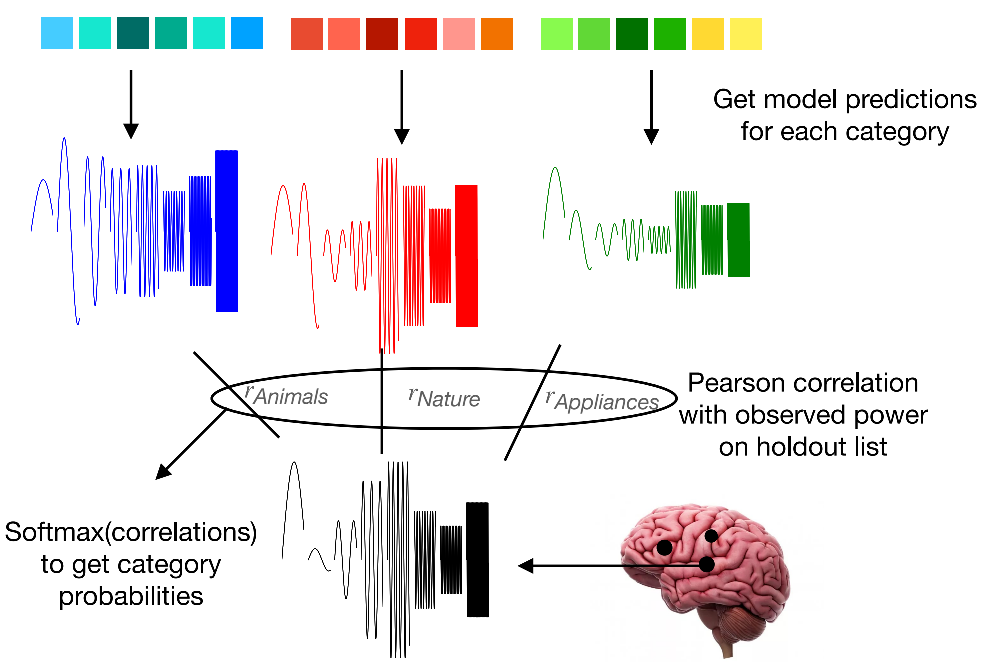
Methods



Encoding Model Training (Kragel et al., 2021)

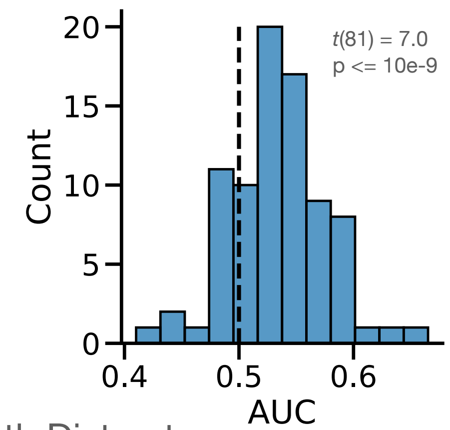


Semantic Decoding



Results

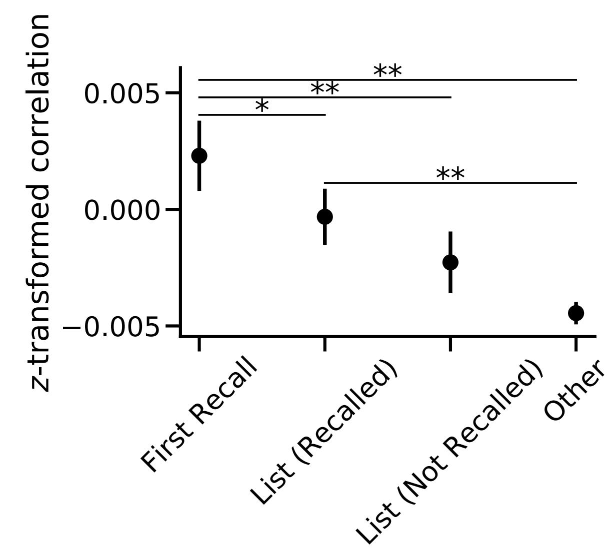
Encoding Period



All analyses conducted on heldout lists

Average one-vs-all AUCs for predicting which of 3 list categories a given word is from

Math Distractor



Correlation computed every 100 ms, averaged over entire 20s period

* = p < .05
** = p < .01
(based on permutation test)

Conclusions/Next Steps

- Semantic content of arbitrary words can be decoded from intracranial EEG during word encoding
- Reactivation during distractor predicts probability and organization of recall
- Can we decode individual items? Do the sequences of reactivations predict subsequent memory organization?

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