Neural Pre-Activation During Language Comprehension Predicts Future False Memory

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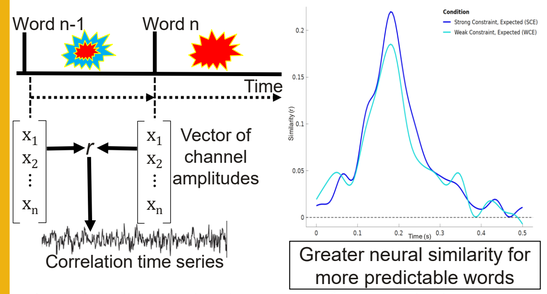
Introduction

• Individuals can predict features of upcoming words during language comprehension to facilitate processing (Federmeier, 2022; Kuperberg & Jaeger, 2016)

- Representational similarity analysis (RSA) of EEG data during reading gives evidence of rapid neural pre-activation of upcoming features (Hubbard & Federmeier, 2021)



Greater neural similarity for more predictable words

• Predictability impacts later memory for words that were read (Hubbard et al., 2019; Hubbard & Federmeier, 2024)

- Participants will falsely recognize words that were predicted, but never actually read
- Word features that are pre-activated during reading might be encoded into memory, but no direct evidence of this

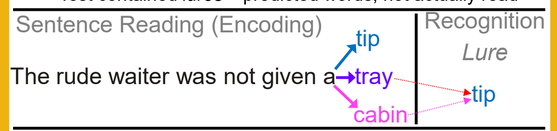
The Present Study

We used the RSA method to test the hypothesis that predictive pre-activation of word features during reading engenders false recognition of predicted but unseen words. We performed a "subsequent memory" RSA, in which neural patterns during test were related to patterns during reading. We also conducted additional control analyses to test alternative explanations.

Methods

Re-analysis of Hubbard & Federmeier (2024); N = 40

- Subjects read sentences that were strongly constraining (cloze > 67%) or weakly constraining (cloze < 42%)
- Sentence endings were Expected (highest cloze response), Unexpected (near zero cloze but plausible), or Anomalous (zero cloze and did not make sense with the context)
- Afterwards, recognition memory test on sentence ending words presented during the encoding period
- Test contained *lures* – predicted words, not actually read

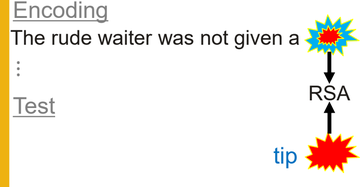


EEG Analysis

- Bandpass filtered, 0.2-40 Hz
- Ocular artifacts corrected with AMICA (Palmer et al., 2015)
- Stitched z-score baseline (Ciuparu & Muresan, 2020)
- RSA: Pearson correlations of channel activity vectors
- Statistical comparison of mean similarities in time window of interest

Primary Analysis

Is Pre-Activation During Reading Greater for Falsely Remembered Lures?

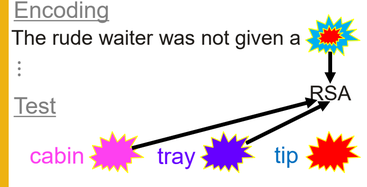


Compare EEG activity following predictable lure during test to EEG activity following *pre-final* word during sentence reading

Greater neural similarity for later false alarms to predictable lures compared to correct rejections

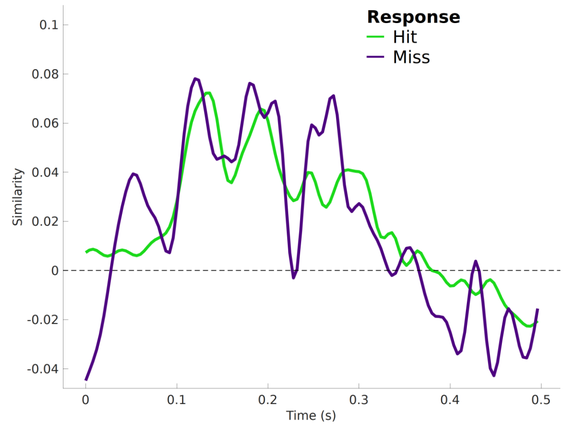
Control Analysis 2

Is Increased Similarity Due to Memory Search, Rather than Prediction?



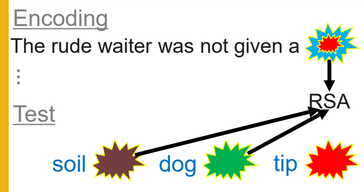
Compare EEG activity following unexpected endings during test to EEG activity following *pre-final* word during reading

No evidence of increased neural similarity to predictable lures due to memory search during test



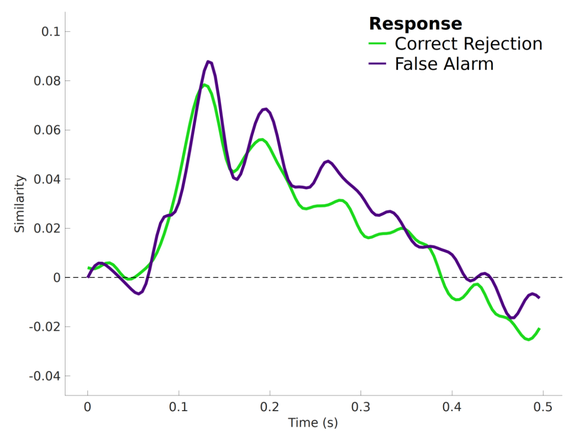
Control Analysis 1

Is Increased Similarity Due to Test Response, Rather than Prediction?



Compare EEG activity following every other predictable lure during test to EEG activity following *pre-final* word during reading

No evidence of increased neural similarity to predictable lures based on different response to lures at test



Control Analysis 3

Is Increased Similarity Due to Other Factors, Such as Frequency?

Extract *trial-level* neural similarity by averaging similarity in time window of interest, and enter these as a predictor in a mixed-effect logistic regression predicting later memory decision

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Accuracy ~ RSA + WordFreq + WordLength + ClozeProb +
(1+RSA+WordFreq|Participant) + (1|Word)
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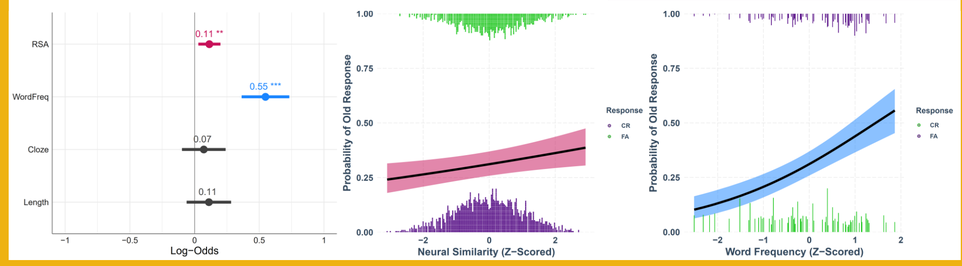
Increased neural similarity to predictable lures is evident, even when other factors are considered and analyzed, and similarity is predictive of later memory response



Conclusions

- RSA was used to measure similarity between neural activity following a predictable word that wasn't presented during sentence reading, but presented during the recognition test, and the neural activity *prior* to the final word of the sentence that was predictive of the lure
- Similarity was greater when participants falsely recognized the predictable word, suggesting predictive pre-activation during reading influenced later memory
- Control analyses did not find significant evidence that these similarity differences were due to differences in response during the recognition test, or to differences in memory search at the time of test rather than prediction at the time of reading
- Regression analysis showed that that while predictive pre-activation impacts memory, the effect is fairly small compared to other factors such as word frequency, suggesting prediction doesn't tell the whole story and other factors are still at play