

# Cross-level predictions in language processing



## Research Question

### Predictive processing of language is well supported

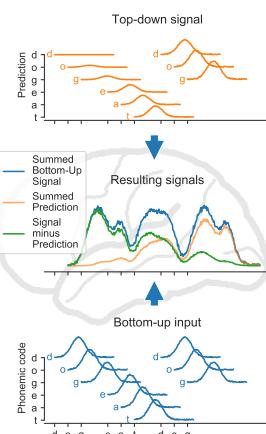
- well known neurocognitive correlates (e.g., N400; [5])
- ... typically *within* one level: i.e., from word meaning to word meaning

### Predictive Coding theory [1] suggests hierarchical predictions

- lower levels influenced by higher levels (e.g., word *forms* predicted by word *meanings*)
- levels play out on different time scales
- initial support for these questions [2] has been questioned [6]
- Hypothesis:** Predictive coding suggests lower-level (e.g., phonemic) representations should be less strong for more higher-level (e.g., semantically) predictable words

## References

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## Methods

### Potsdam Sentence Corpus

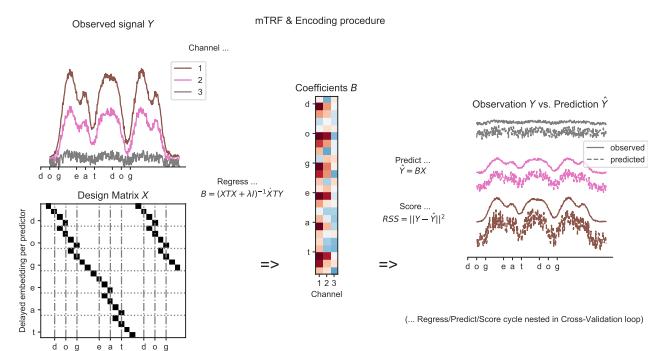
- 144 German sentences, with cloze ratings for each word [4]
- MEG (n=25) and EEG (n=35)

### Compute strength of phonemic representations

- fit continuous phoneme encoding model/mTRF [3] to MEG/EEG data
- calculate absolute (cross-validated) residuals per time point and channel (roughly: how similar is the neural activity induced by each phoneme token to the idealized template for that phoneme?)

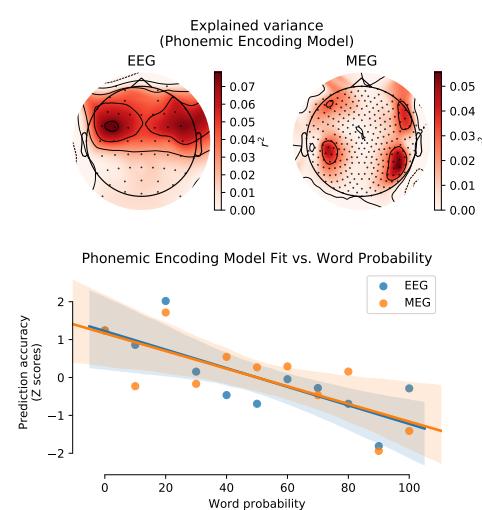
### Correlation word predictability vs. phoneme representation strength

- first approach: for each word, calculate similarity between template (first-level model coefficients) and actual neural activity, and bin by word cloze
- second approach: fit second-level *word cloze* continuous encoding model to *squared residuals* from first level ( $RSS \sim cloze$ )

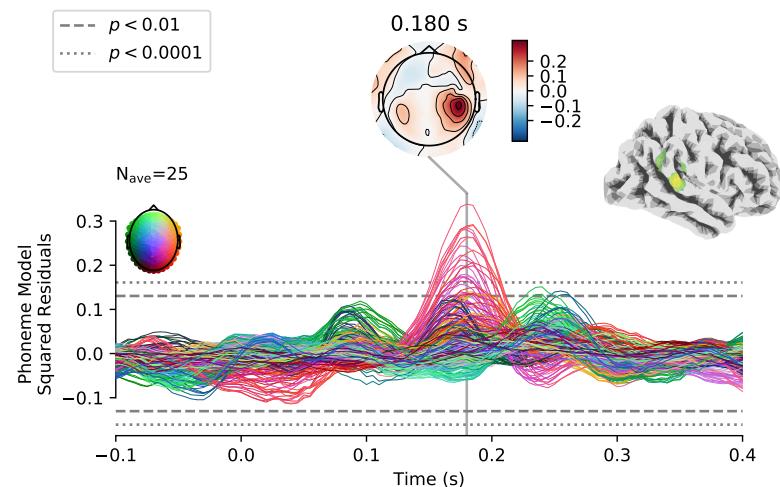


## Results

### Approach 1: Brain responses to less predictable words are more similar to the template



### Approach 2: Regression coefficients from second level (cloze on phonemic encoding residual) encoding indicate at the beginning of words ( 180ms), the phonemic model fits less well for predictable compared to unpredictable words. (MEG & EEG; only MEG shown, EEG is highly similar)



**Discussion** Results are in accordance with the hierarchical version of Predictive Coding theory: when processing continuous, congruent speech, phoneme-level representational pattern strength (in pTSG) covaries with word-level predictability - as if predicted phonemes are "predicted away".