



# Chunking Constrains Prediction During Language Comprehension

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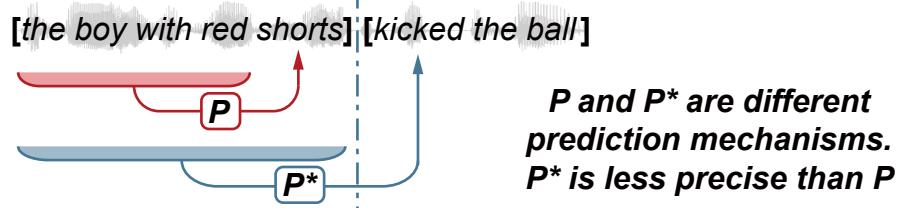
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## Introduction

Prediction and chunking are often viewed as separate or even opposing mechanisms<sup>1,2</sup>. Here, we test whether they interact and propose the **chunk-constrained prediction hypothesis: the prediction of basic units (morphemes) is modulated by chunks (linguistic constituents)**.

Chunk boundaries are typically associated with prosodic and statistical cues. We dissociate boundary effects from these cues (Exps 1&2) and test whether the boundary effect can be modulated by boundary certainty (Exps 2&3). Finally, we confirm our results using an open dataset of ECoG responses.

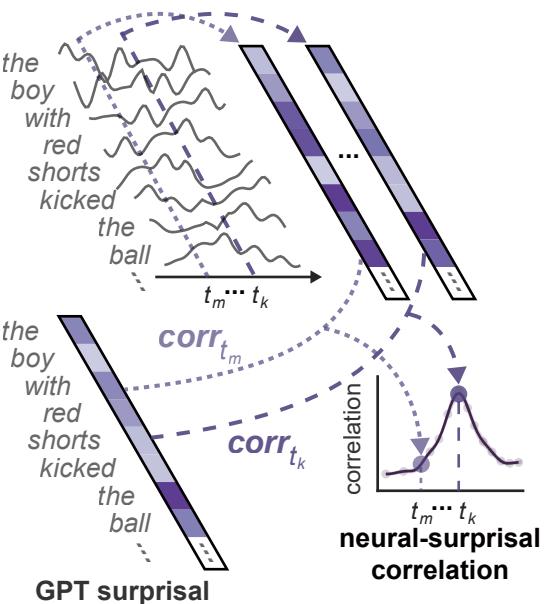
### Chunk-constrained prediction



## Analyses & Hypotheses

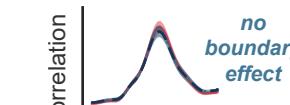
### Evaluation of prediction

#### MEG response



### Expected scenarios

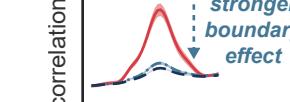
#### chunk-irrelevant prediction



#### chunk-constrained prediction

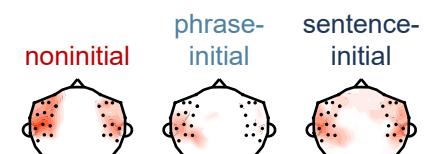
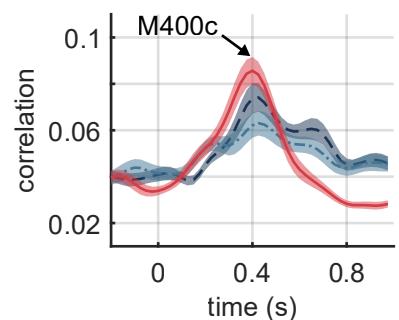


#### highly certain boundaries

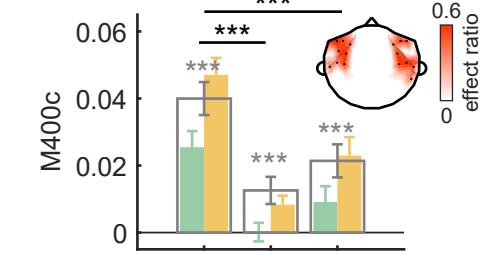


## Exp 1: Prediction and Chunk Boundary Effect

Chunk boundaries weaken neural-surprisal correlation



Chunk boundary effect is not confounded by statistical cues



statistically **typical** sentences ("many football teams aimed to win the title")  
statistically **atypical** sentences ("streams of tears flowed down the cheeks")

**The brain is less predictive when a chunk is closed**

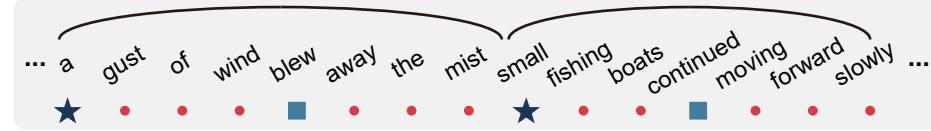
## Stimuli & Recording

**Stimuli:** Ten Chinese sentences per trial. To isolate the potential chunk boundary effect, we

- removed prosodic cues by independently synthesizing each morpheme<sup>3</sup>.
- eliminated statistical cues by including both statistically **typical** and **atypical** sentences, in which surprisal/entropy either **increased** or **decreased** after boundaries.

**Procedure:** Sentences were presented morpheme by morpheme, both auditorily and visually. Participants detected if a couple of sentences were shuffled. **MEG activity was recorded**.

### Exp 1: Sentences of variable duration



### Exp 2: Blocks of sentences of fixed duration

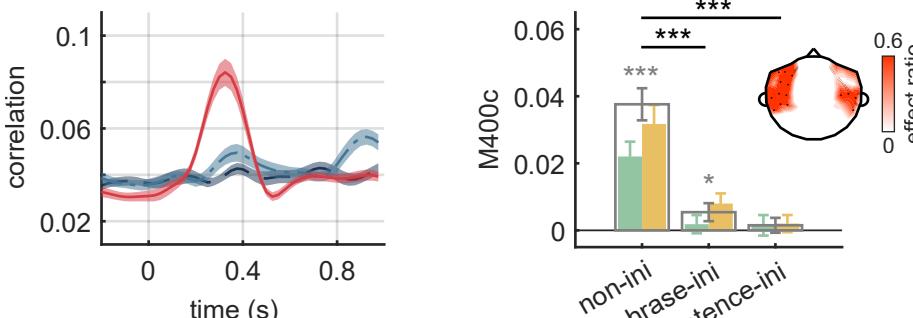


### Exp 3: Mixed trials of sentences and disconnected phrases



## Exps 2&3: Influence of Boundary Certainty

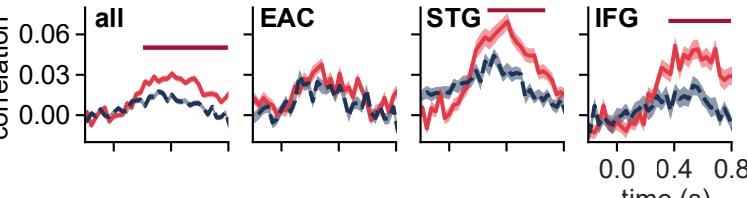
**Exp 2: When boundary is more certain due to the fixed chunk duration, the boundary effect is strengthened.**



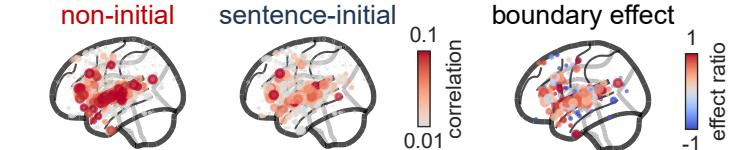
**The chunk boundary effect is stronger when chunk boundaries are more expected based on the linguistic context**

## Boundary Effect for English Narratives (ECoG)<sup>4</sup>

### Neural-surprisal correlation in ROIs



### M400c for single electrode



**The chunk boundary effect is observed in both Mandarin and English, and the effect originates from STG and IFG**

## Conclusions

**Chunking by linguistic constituents constrains neural prediction of upcoming words/morphemes.** This chunk-boundary effect is not driven by prosodic or statistical cues, is stronger at more expected boundaries, and generalizes across Mandarin and English.

## References

1. Schrimpf et al. The neural architecture of language: Integrative modeling converges on predictive processing.
2. Chomsky. Syntactic structures.
3. Ding et al. Cortical tracking of hierarchical linguistic structures in connected speech.
4. Zada, et al. The "Podcast" ECoG dataset for modeling neural activity during natural language comprehension.