The good-enough listener: A visual world paradigm reveals the interaction between prediction and bottom-up input

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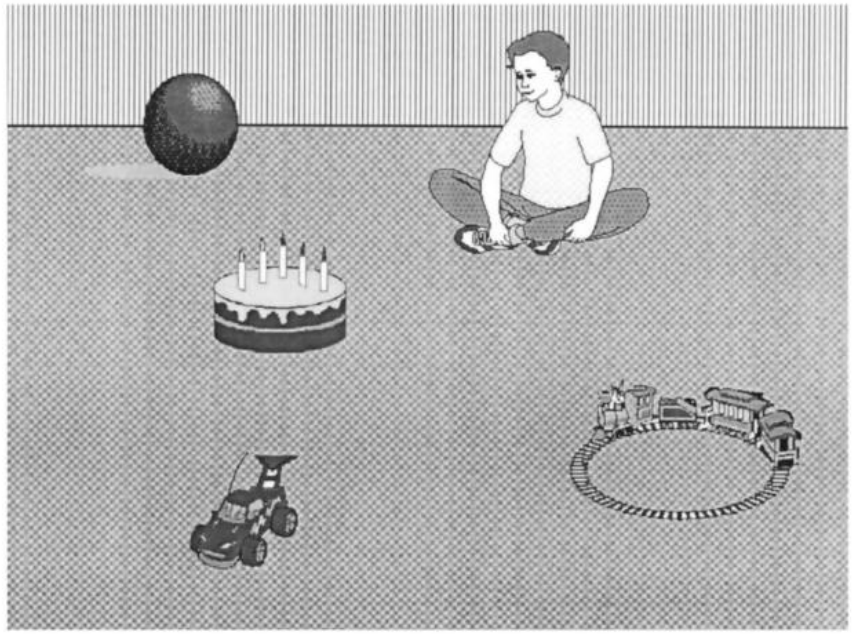
Comprehenders predict upcoming words

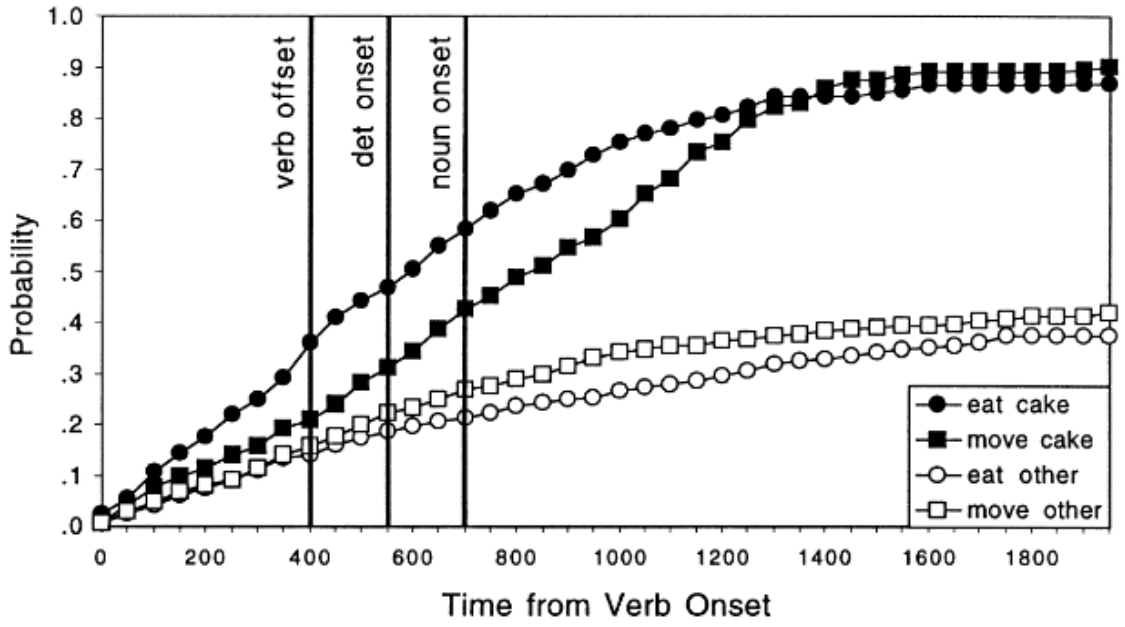
- Anticipatory eye movements (e.g., Altmann & Kamide, 1999; Kamide et al., 2003)



*The boy will **move/eat** the cake.*

The boy will eat …

Something edible

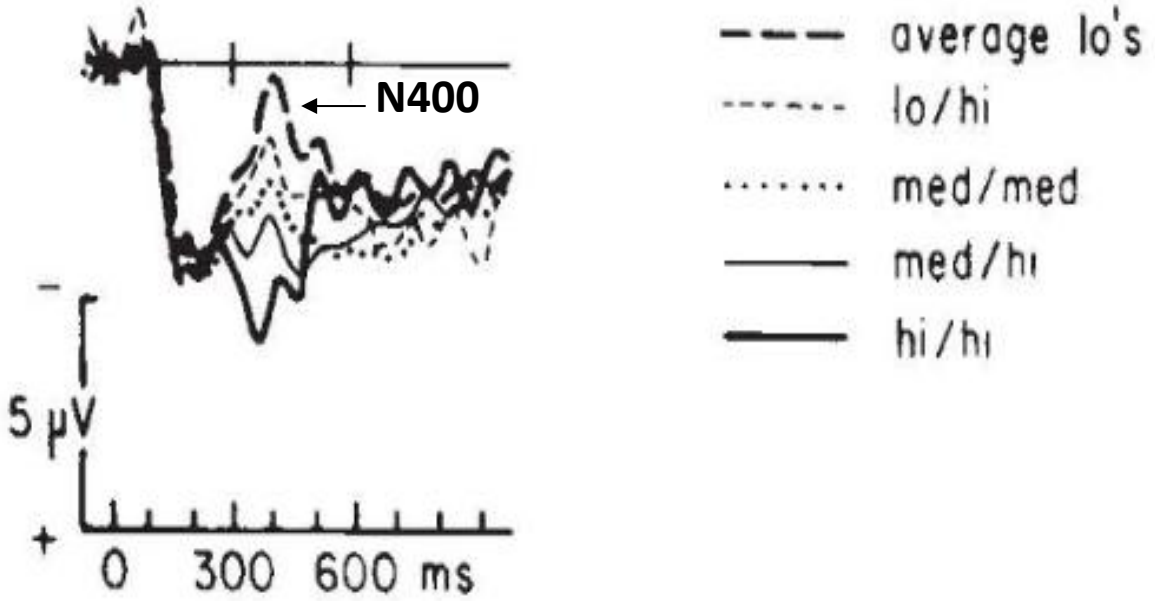


(Altmann & Kamide, 1999)

Comprehenders predict upcoming words

- N400 amplitude is inversely correlated with word predictability (e.g., Kutas & Hillyard, 1984; Wlotko & Federmeier, 2012)
- Comprehenders can detect input that mismatches their predicted noun before encountering the noun (e.g., DeLong et al., 2005; Van Berkum et al., 2005; Wicha et al., 2003)

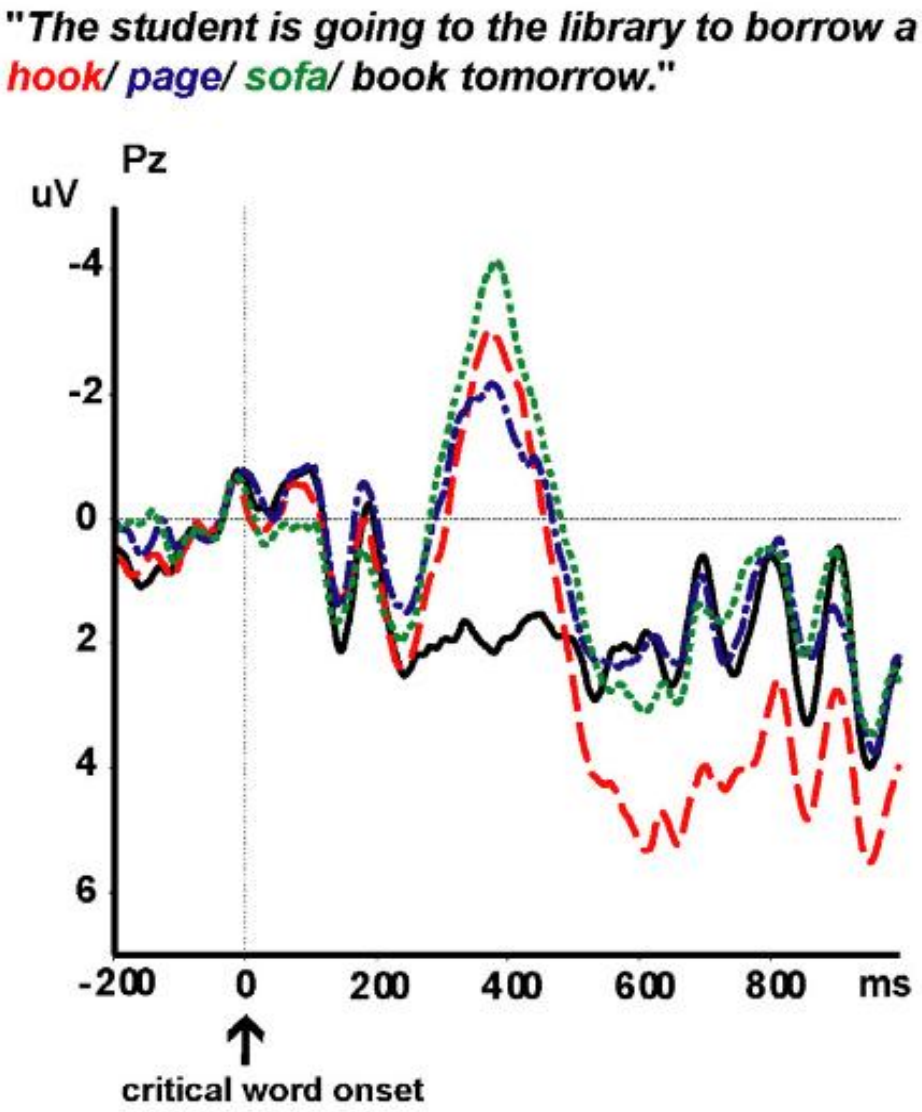
hi/hi	He mailed the letter without a stamp.
hi/lo	The bill was due at the end of the hour.
med/hi	She locked the valuables in the safe.
med/med	Too many men are out of jobs.
med/lo	The dog chased our cat up the ladder.
lo/hi	There was nothing wrong with the car.
lo/lo	He was soothed by the gentle wind.



(Kutas & Hillyard, 1984)

When prediction goes wrong

- Unexpected and anomalous words are more difficult to process (e.g., longer reading times, larger N400 and LPC).
- Semantically and phonologically related words elicit reduced N400 amplitudes relative to unrelated words (e.g., Federmeier & Kutas, 1999; Ito et al., 2016; Laszlo & Federmeier, 2009; Ryskin et al., 2021).
- This reduction has been interpreted as **facilitated lexical access** due to spreading activation from the predicted word.



(Ito et al., 2016)

When prediction goes wrong

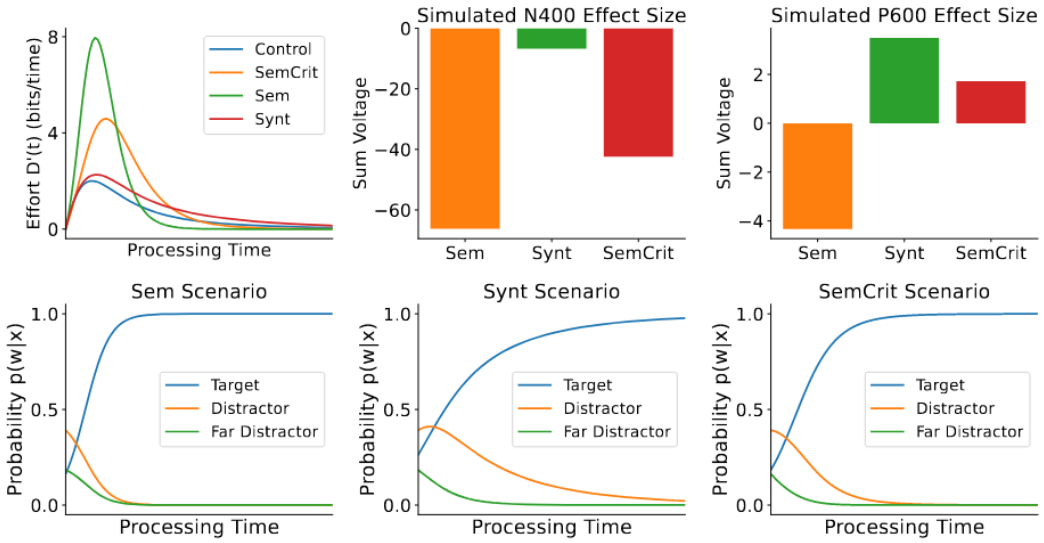
- Comprehenders often rely on heuristics and prior knowledge to construct a “good-enough” or rational representation that overrides the presented input (e.g., Ferreira & Stacey, 2000; Ferreira et al., 2002; Gibson et al., 2013; Bader & Meng, 2018; Futrell et al., 2020;Dempsey et al., 2023; Christianson et al.,2023).

An information-theoretic model (Li & Futrell, 2024)

- Li and Futrell (2024) formalises language comprehension as an optimal trade-off between accuracy and processing depth over time.
- Phonological (or semantic) overlap causes comprehenders to persist with the predicted word, delaying processing of the actual input.

An information-theoretic model (Li & Futrell, 2024)

- This model has simulated a biphasic N400-P600 effect elicited by phonologically related words (Ito et al., 2016; Ryskin et al., 2021).



(Li & Futrell, 2024)

- **Early processing** is dominated by prior predictions (*minimising effort by guessing "good enough" interpretations*).
- **Later processing** involves increased effort to extract sufficient sensory information to refine early representations and resolve conflict.

Two hypotheses:

How does prediction influence the processing of bottom-up input during early stages of processing?

Facilitation hypothesis:
Lexical access of anomalous words that are phonologically related to the predicted words is **facilitated**, as activation of the predicted word spreads to phonologically related words.

Misinterpretation hypothesis:
Early processing of the phonologically related word is **delayed**, as the high similarity between the input and the prediction allows the system to temporarily settle on a shallow, prior-based interpretation.

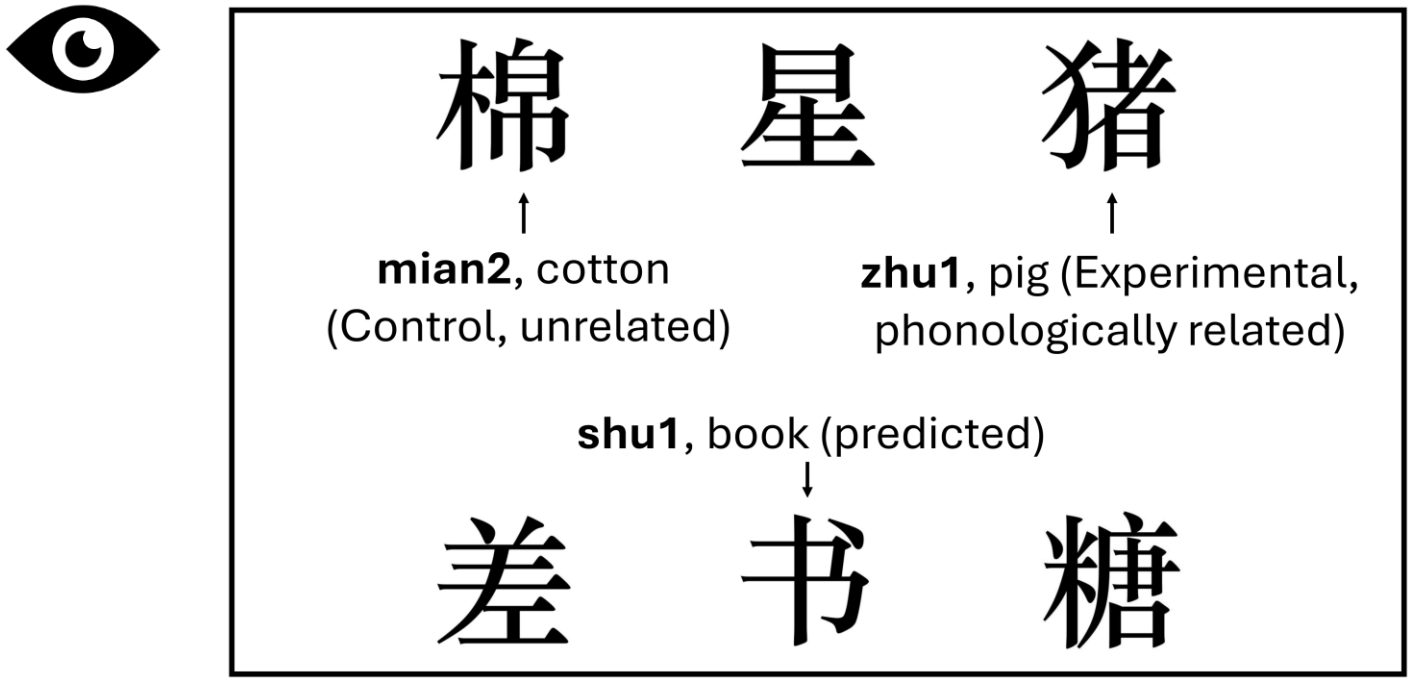
Methods

- Both hypotheses predict reduced N400 amplitude
  → insufficient to distinguish between them.

- We used a visual-world (printed-word) paradigm to address this question.

Methods

- The visual-world (printed-word) study



- 56 sets of Chinese sentences
- 44 participants
- Sentence constraint: 89.6% (range: 62.5%-100%)
- Additional 88 congruent filler sentences
- Comprehension question (57%)

阅览室的桌子上摆着一些... (predicted: book [书 shu1])

On the reading room's table are placed some ...

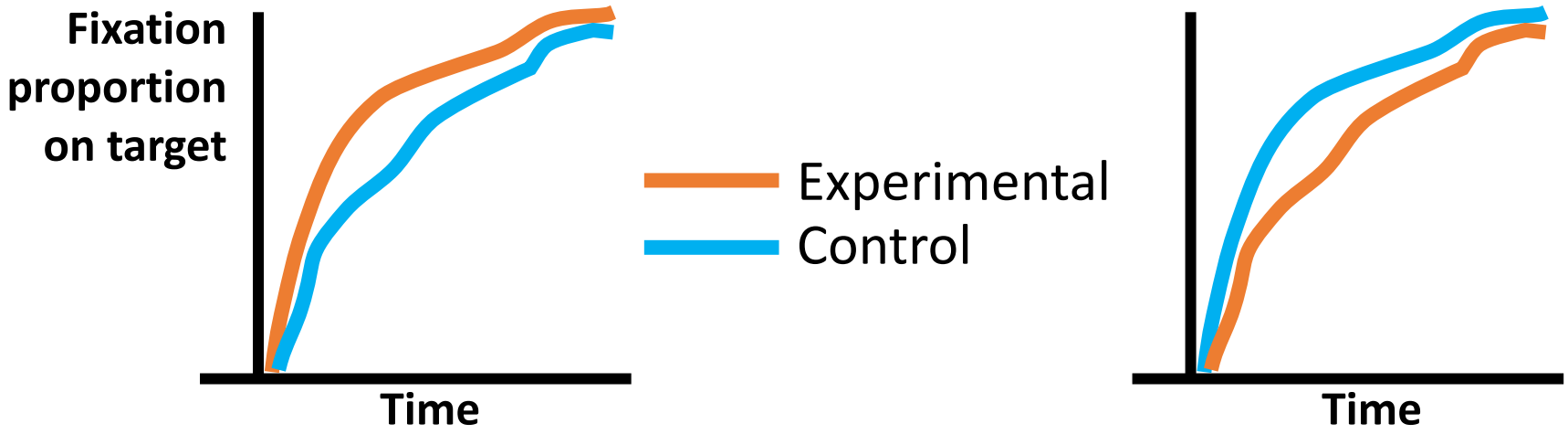
Experimental condition: pig ([猪 zhu1]; phonologically similar)

Control condition: cotton ([棉 mian2]; unrelated)

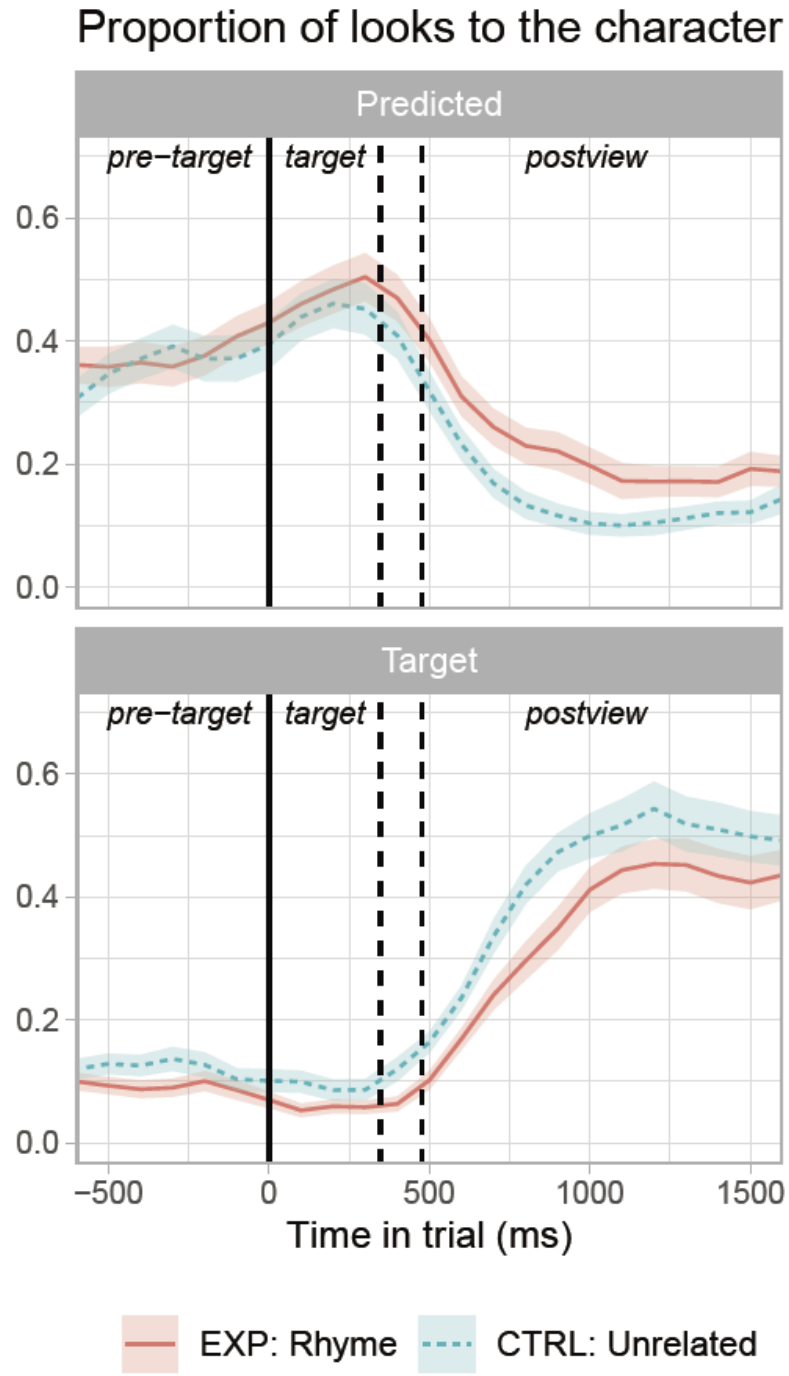
Predictions of the two hypotheses (early processing)

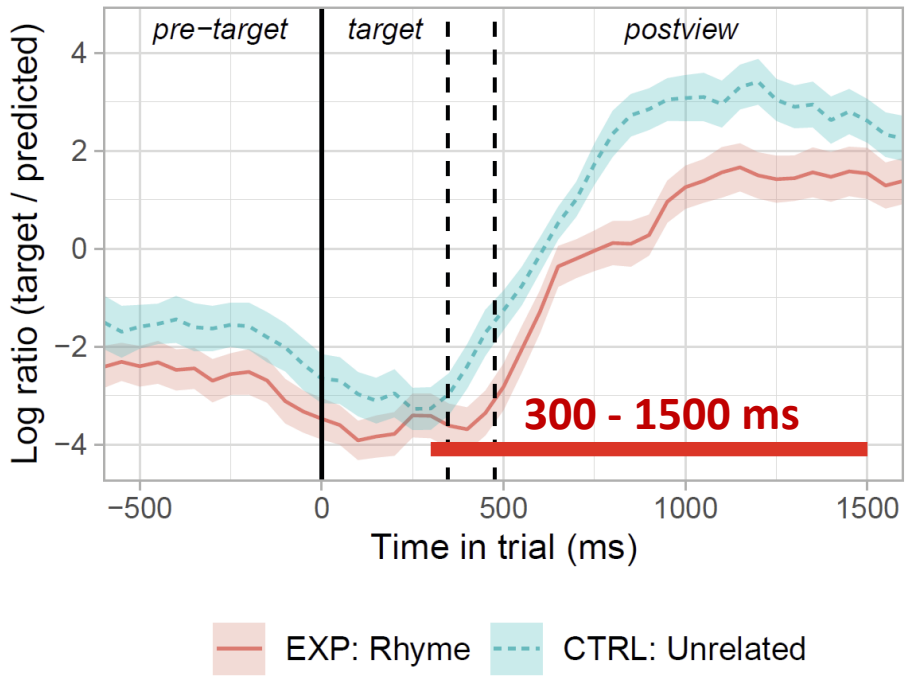
Facilitation hypothesis:
Lexical access of anomalous words that are phonologically related to the predicted words is **facilitated**, as activation of the predicted word spreads to phonologically related words.

Misinterpretation hypothesis:
Early processing of the phonologically related word is **delayed**, as the high similarity between the input and the prediction allows the system to temporarily settle on a shallow, prior-based interpretation.



Results





Cluster-based permutation test
Main effect of condition

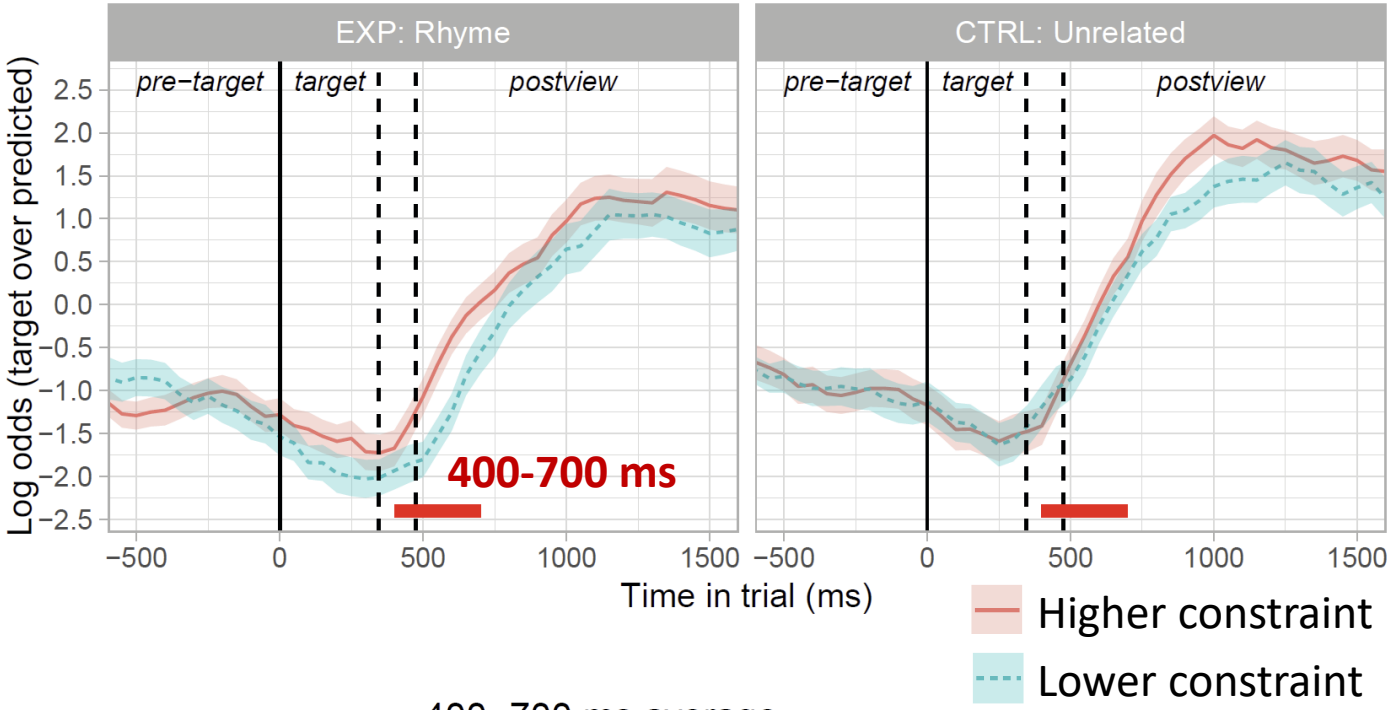
Misinterpretation hypothesis √

Results

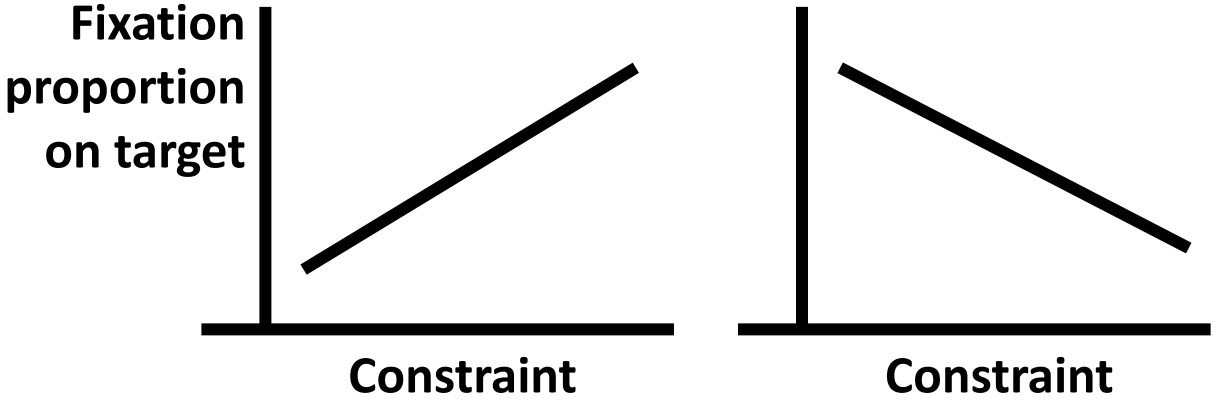
** exploratory*

Cluster-based permutation test

Interaction between constraint and condition

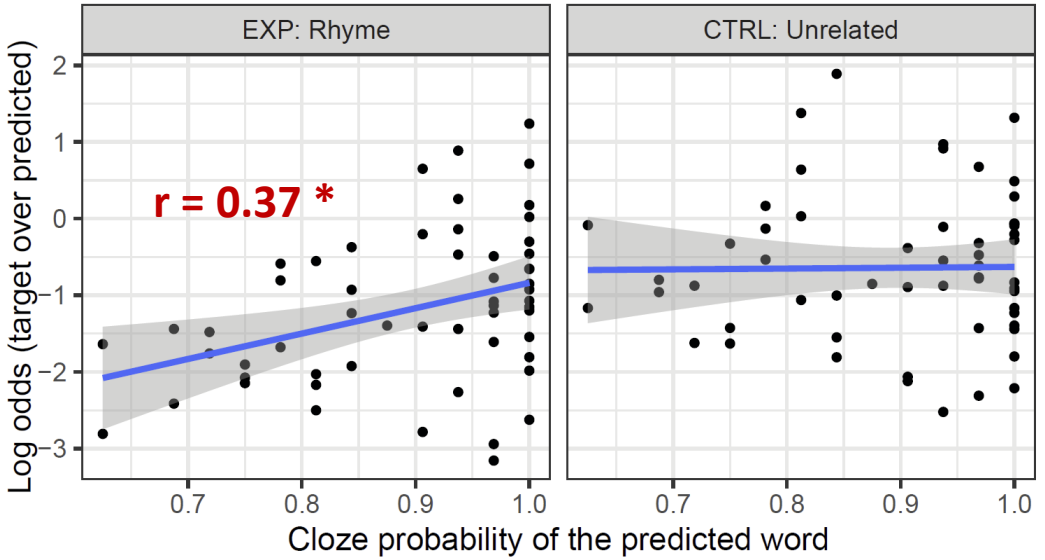


Facilitation √



Misinterpretation

400−700 ms average



Discussion

Facilitation hypothesis: (√)
Lexical access of anomalous words that are phonologically related to the predicted words is **facilitated**, as activation of the predicted word spreads to phonologically related words.

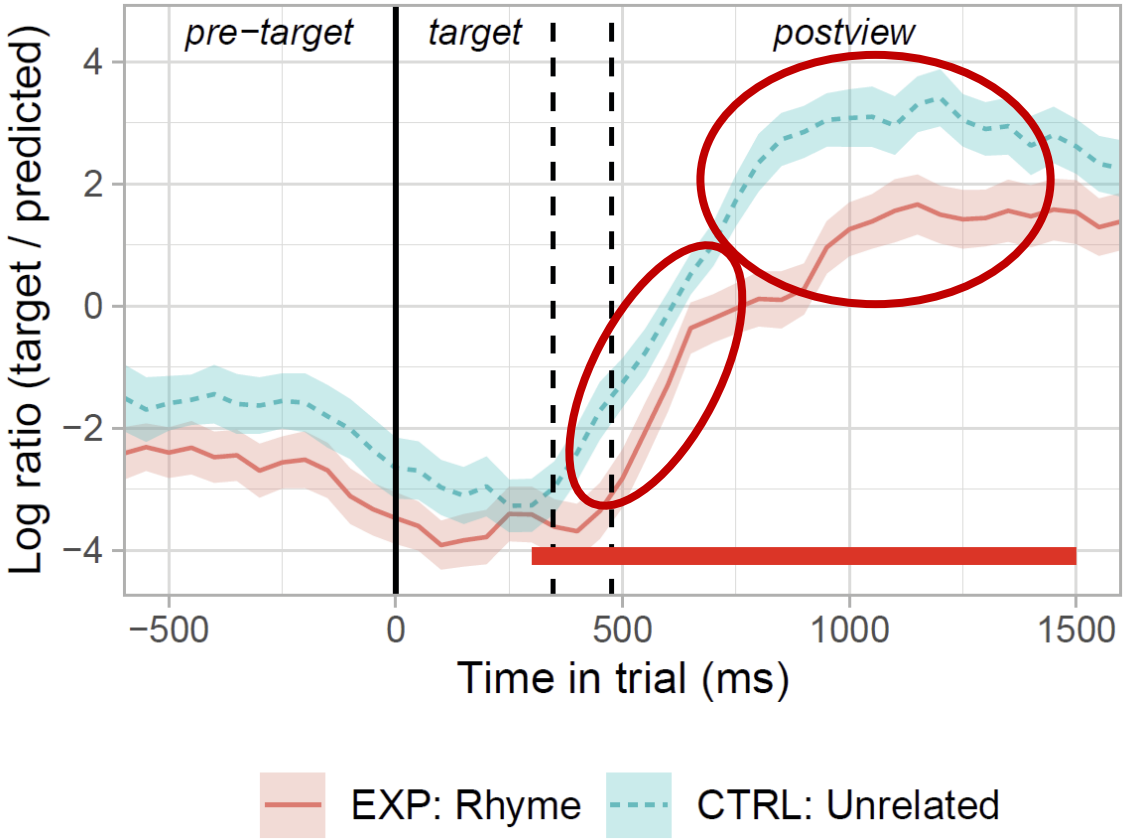
Misinterpretation hypothesis: √
Early processing of the phonologically related word is **delayed**, as the high similarity between the input and the prediction allows the system to temporarily settle on a shallow, prior-based interpretation.

Both mechanisms may be at play, albeit on different time scales.

Discussion

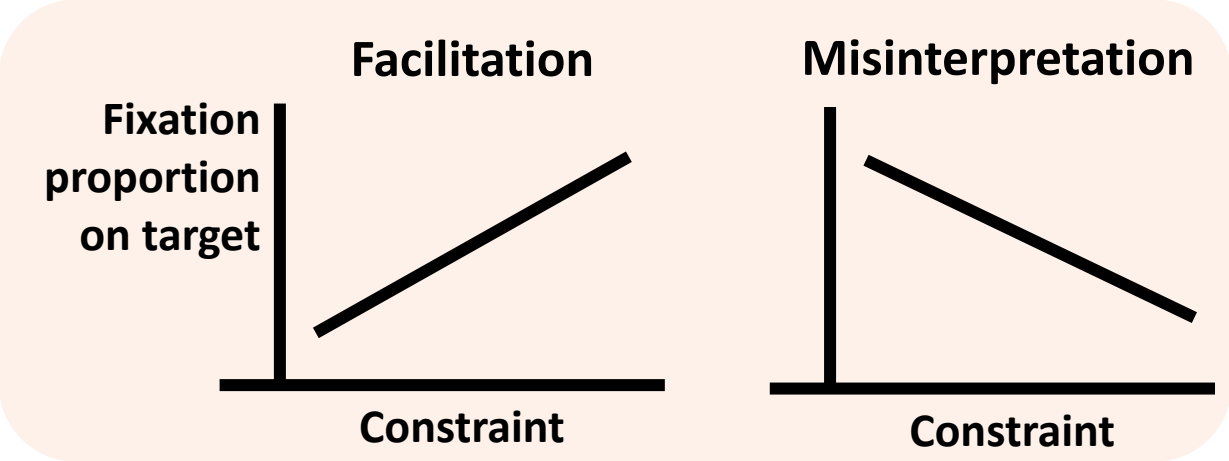
Both mechanisms may be at play, albeit on different time scales.

- Facilitation: occurs at an early processing stage (i.e., lexical access)
- Misinterpretation: exerts a sustained influence that increases over time



Limitation

- Difficult to tease apart staged models versus cascaded models of processing.
- We only conducted an exploratory analysis of the interaction between prior prediction and input.
  - A pre-registered replication study using more items and a wider range of contextual constraint should be conducted.



- Competition between the predicted word and the phonologically related word may reduce fixations to the phonologically related word, irrespective of contextual constraint.
  - A baseline for such competition effect should be established for comparison.

Thank you

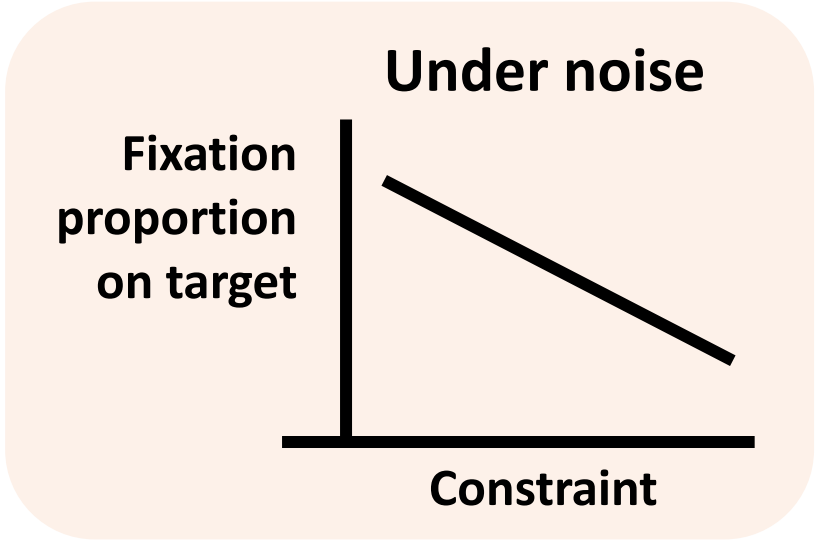
Q & A

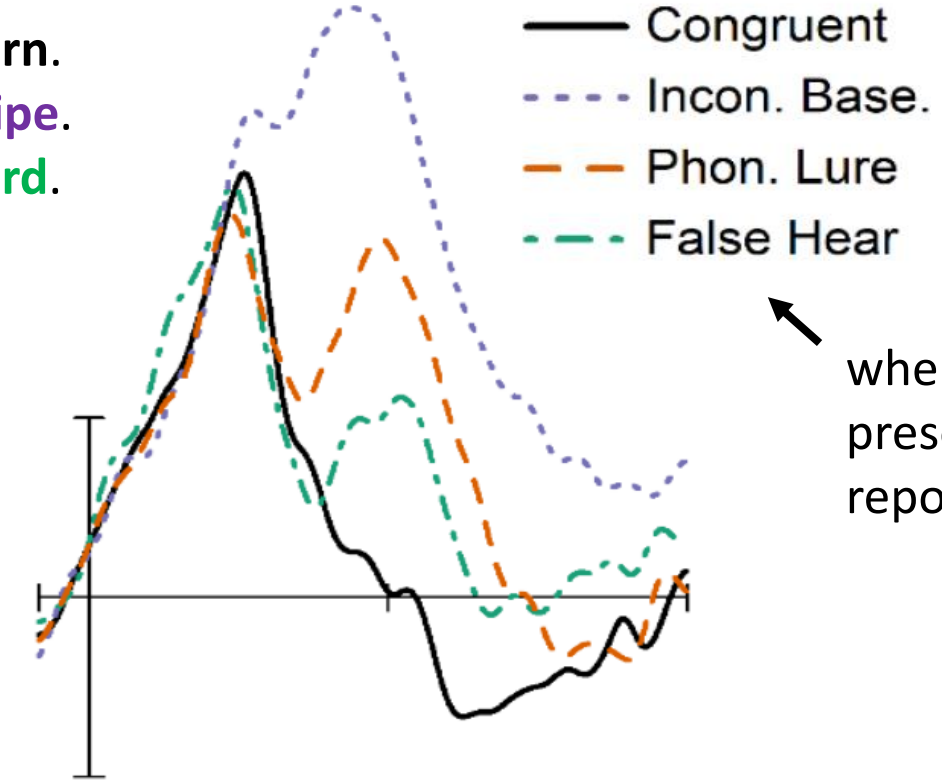
Future work

The effect of noise

- The model predicts that noise forces reliance on prior expectations, increasing the likelihood of “good-enough” rather than accurate comprehension.

The kitten played with the ball of **yarn**.
The kitten played with the ball of **wipe**.
The kitten played with the ball of **yard**.





when participants were presented with “yard” but reported hearing “yarn”

(Silcox & Payne, 2025)