Situational Processing: Differential ERP Effects From Deep and Shallow Comprehension

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Background

Anomaly Detection vs Disconfirmed Predictions

Prediction: Proficient readers *can* anticipate upcoming words/concepts in high-constraint texts [1, 2]. While some factors (e.g., lexical association [3]) are known contributors to prediction, any kind of constraint *may* contribute.

Disconfirmed Prediction: When a prediction is made but a different word is read, that prediction is **disconfirmed**.

Evidence from iEEG, ERPs, and MEG [2, 4, 5] suggests a multi-step process associated with co-occurring **N400** and Late Frontal Positivity (**LFP**) effects:

1. Predicted & observed semantic information are *both* held open in the left ventromedial temporal lobe
2. If they conflict, *observed* information is passed to higher-level processes (the discourse model)
3. New predictions are formed for upcoming text

Error Detection: Detection of an anomaly in a text can happen in the absence of prediction. Error detection is often associated in ERP research with the Late Posterior Positivity (**LPP**) effect [2], though this interpretation is debated.

Research Question

Does event knowledge contribute to online next-word prediction?

Hypothesis: Critical nouns that are lexically associated with the prior text but *incongruous with the event structure* should cause disconfirmed predictions.

Methods

ERP studies with short narrative texts with or without a situation-level violation

Shared Design: Two-sentence stories presented in RSVP (ISI = 600ms) followed by a true/false comprehension question

Norming Design: Texts are shown either up to and including or up to and *not* including critical word; participants were asked to rate S2 sentence fragment on 7 point scale from "Very Unnatural/Unreasonable" to "Very Natural/Reasonable." Participants did not participate in EEG experiments

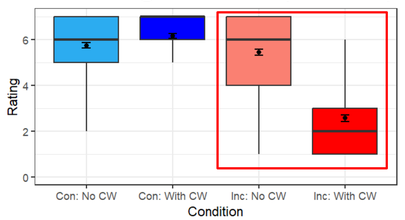
Experiment 1 (*N* = 31): Event structure is disrupted with minimal changes to the text (Agent either enters/exits a location or starts/finishes a task)

Stimuli

Congruent: Isabella walked *into* the spa.
Incongruent: Isabella walked *out of* the spa.

Sentence 2: After a while, the **massage** brought relief to her back.
T/F Question: Isabella got a massage.

Norming Results (*N* = 39)



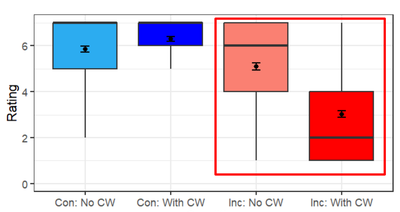
Experiment 2 (*N* = 28): Event structure is disrupted with larger changes to the text, but lexical association kept high by use of a related prime word

Stimuli

Congruent: Ed was at the nearby spa, hoping to blow off some steam from the week.
Incongruent: Ed was staking out the nearby spa, thinking it might be a criminal organization.

Sentence 2: After a while, the **massage** brought relief to his back.
T/F Question: Ed got a massage.

Norming Results (*N* = 38)



Anticipated Results (Both Experiments):

If event information is used during online prediction, we will observe an N400/LFP effect pattern, evidence of a **disconfirmed prediction**

If event information is *not* used during online prediction, we will observe *only* an LFP effect, evidence of **error detection** without a disconfirmed prediction.

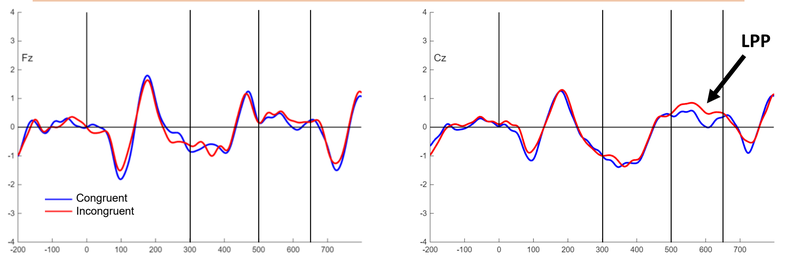
Key Results

ERP waveforms comparing congruent/incongruent critical words

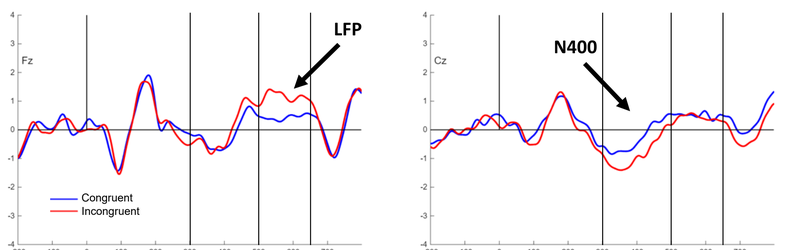
Investigated Components:

N400: 300–500ms post-stimulus over centro-parietal sites (Cz, C4, Pz, P4)
LFP: 500–650ms post-stimulus over frontal sites (F3, Fz, F4)
LPP: 500–650ms post-stimulus over centro-parietal sites (Cz, C4, Pz, P4)

Experiment 1: LPP effect (p = .002) but no N400 effect (p = .957)



Experiment 2: Co-occurring N400 (p < .001) and LFP (p = .010) effects



Main Takeaway

Experiment 2 found evidence of disconfirmed predictions, but Experiment 1 did not. This suggests that use of event knowledge in prediction is variable. Future work should examine why similar manipulations caused very different responses from readers.

References

[1] Ryskin, R. & Nieuwland M. S. (2023). Prediction during language comprehension: what is next? *Trends in Cognitive Science, 27*(11), 1032–1052.
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[4] Wang, L., Wang, B., Jensen, O., & Kuperberg, G. (2023, October 24). *Intracranial EEG reveals simultaneous encoding of pre-activated and currently processed information during language comprehension*. Talk presented at the 15th Annual Meeting of the Society for the Neurobiology of Language, Marseille, France.
[5] Hansen, T. A., Yacovone, A., Nour Eddine, S., & Kuperberg, G. R. (2025, September 14). *Bottom-up and Top-Down Propagation of Residual Information Across the Left Fronto-temporal Cortex during Sentence Comprehension: Converging Evidence from M/EEG and Predictive Coding Simulations* [Conference Poster]. 17th annual meeting of the Society for the Neurobiology of Language, Washington DC, USA.