

A Bayesian Pragmatics Account of Common Ground: Behavioral and EEG/ERP Evidence



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Introduction

- Successful communication requires the integration of **common ground** information.
- A central debate concerns whether listeners incorporate a speaker's perspective **early** during comprehension¹ or initially rely on egocentric interpretations before **later** correcting them.²
- Bayesian models of pragmatics (e.g., Rational Speech Act³) formalize reference resolution as probabilistic inference under uncertainty.
- Little research links computational models with neural measures of real-time reference resolution.

Objective

Determine whether perspective-taking during reference resolution is efficient and immediate or effortful and delayed, and evaluate whether ERP components reflect model-derived uncertainty, bridging Bayesian models with neural data.

Methods

- Participants: 26 undergraduate participants aged 18-25
- Task: Director's task with 4x4 object grid⁴ wherein participants selected objects based on spoken instructions
- Conditions:

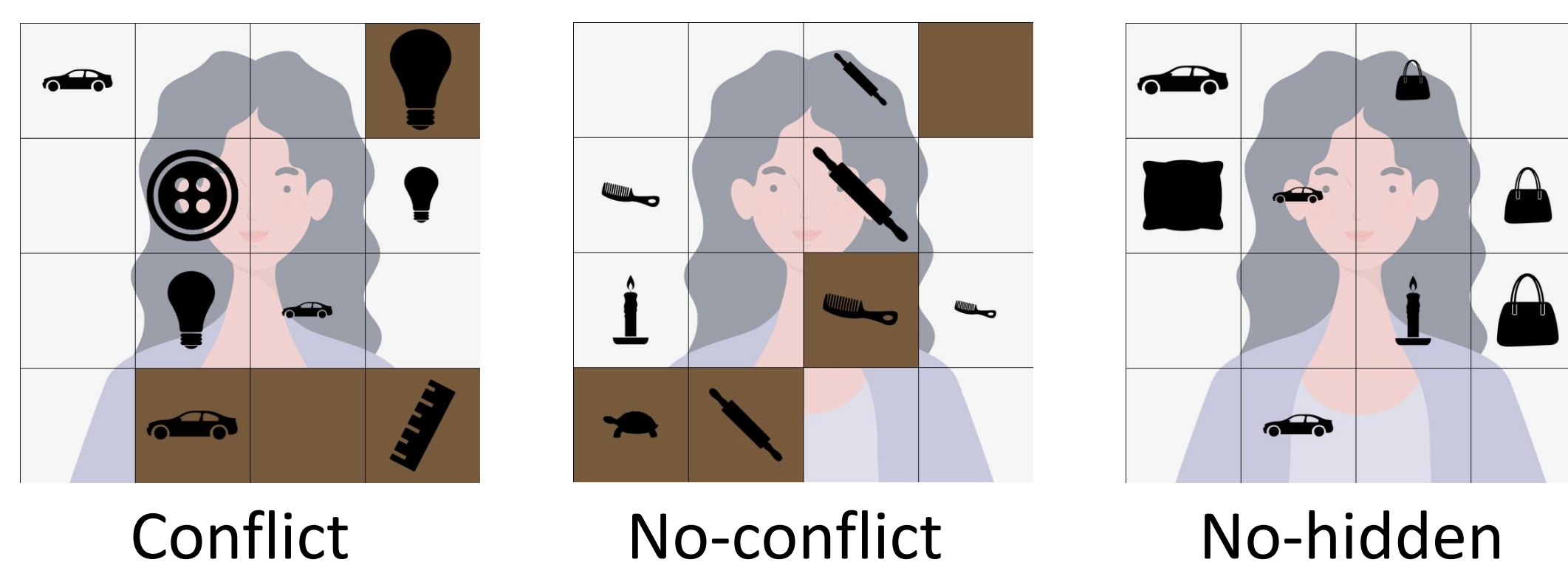


Figure 1. Example displays for experimental conditions.

- Computational Modeling: Bayesian perspective-taking model⁵ combining egocentric and common-ground domains whose outputs were then related to ERP amplitudes

$$P(obj|RE) = \alpha P(RE|obj, d = e)P(obj|d = e) + (1-\alpha)P(RE|obj, d = c)$$

Results

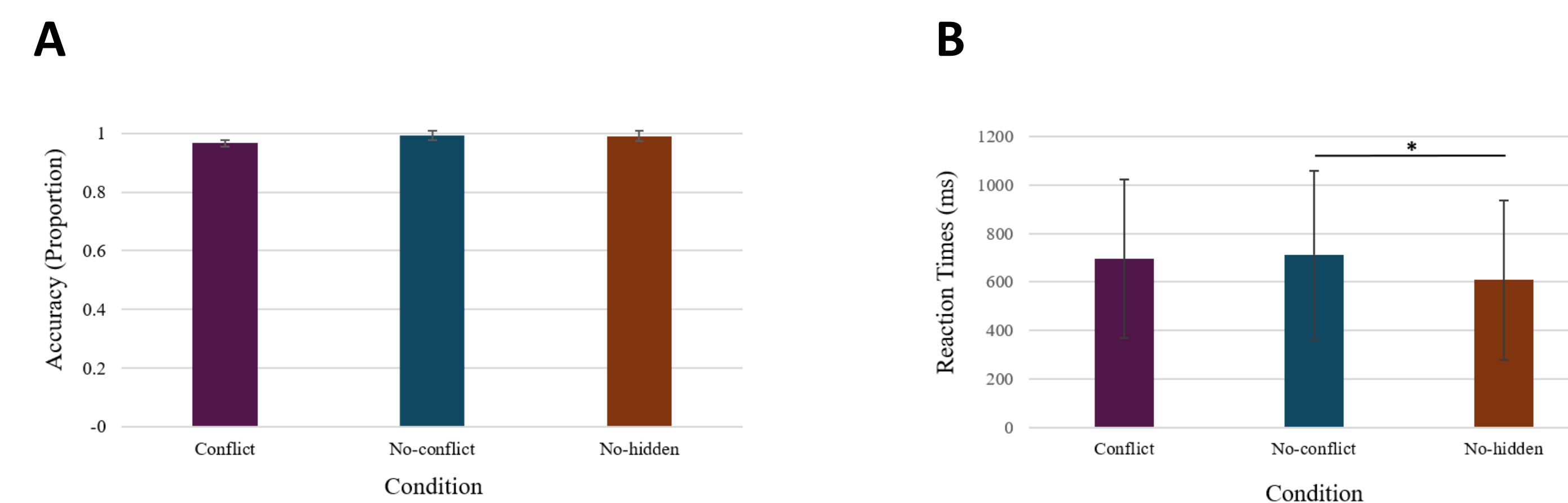


Figure 2. A) Accuracy, and B) reaction times across conditions.

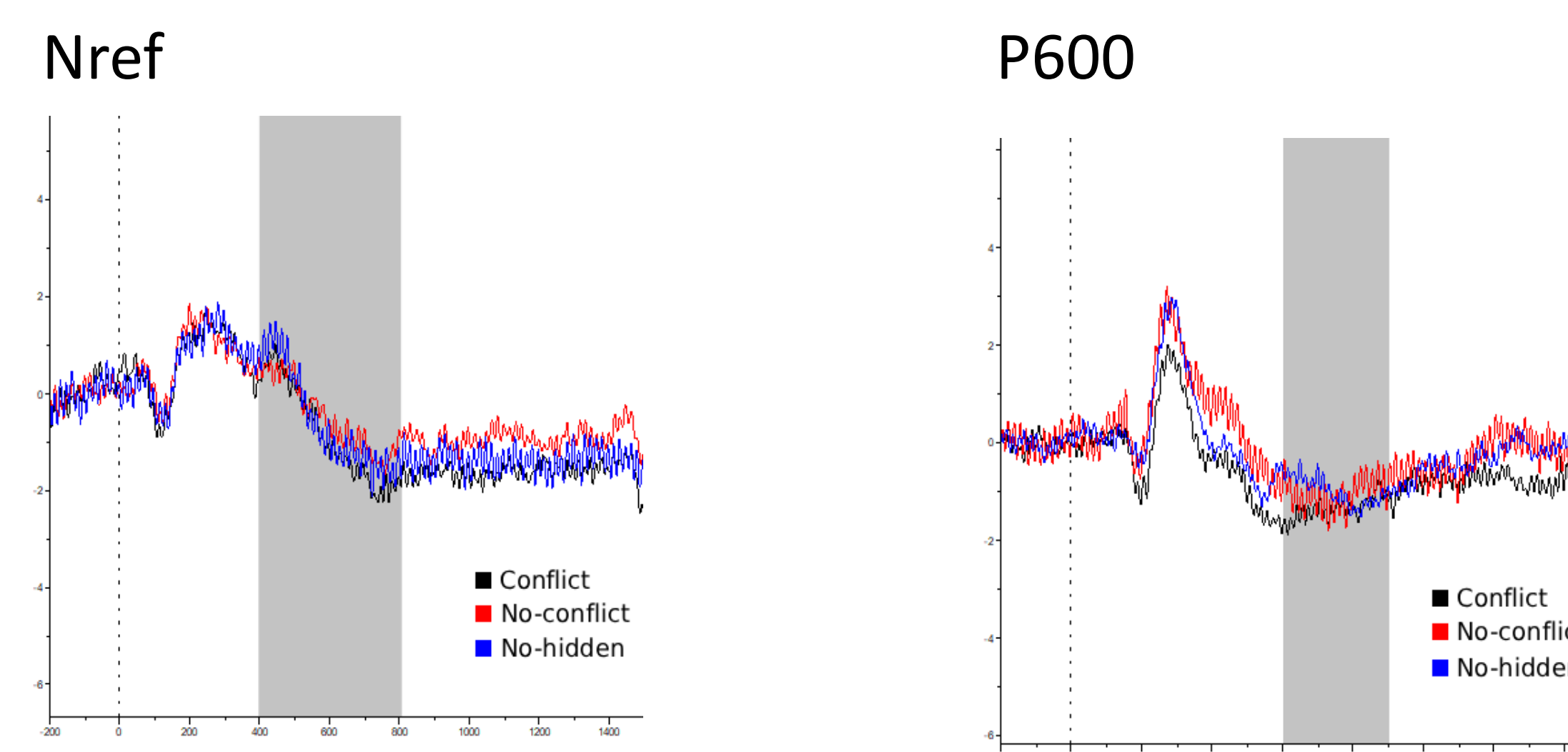


Figure 3. Nref (400–800 ms) and P600 (600–900 ms) components as a function of condition.

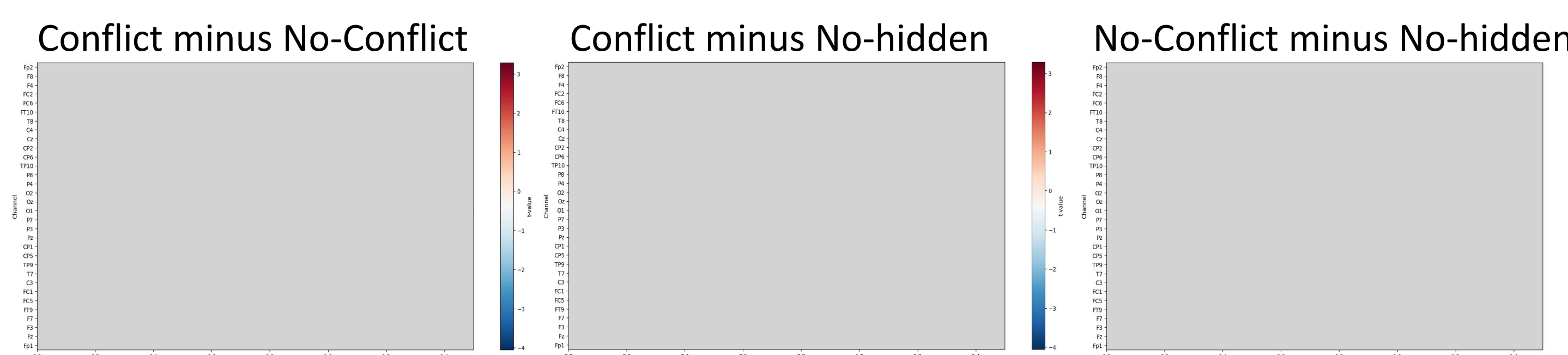


Figure 4. Raster diagrams showing results of cluster-based permutation analyses.

Predictor	Model 1	Model 2	Model 3
Intercept	-.365 (.472)	-.069 (.590)	-2.770 (2.462)
Surprisal	-1.328 (1.245)	-.843 (1.304)	-13.687 (13.544)
Entropy	1.671 (1.292)	1.171 (1.346)	10.414 (10.098)
No-conflict Condition	-	-.262 (.505)	3.590 (2.818)
No-hidden Condition	-	-.621 (.419)	1.347 (2.233)
Surprisal × No-conflict	-	-	7.398 (12.647)
Surprisal × No-hidden	-	-	19.065 (17.338)
Entropy × No-conflict	-	-	-3.365 (9.442)
Entropy × No-hidden	-	-	-15.981 (14.647)
R ²	.001	.001	.003
N	4,248	4,248	4,248

Table 1. Values are regression coefficients with cluster-robust standard errors in parentheses.

Conclusion

- Listeners showed no difference in behavioral or neural cost across conditions, consistent with **early-integration accounts** of common ground use.
- Model-derived surprisal and entropy did not reliably track ERP amplitudes, indicating a disconnect between RSA-based predictions and the neural signals measured here.

Limitations

- Low referential ambiguity may not have strongly engaged perspective-taking.
- Trial-level computational analyses were tied to electrodes and time windows from prior work despite no condition-level ERP effects in the current data.
- The model assumed a single static α per participant, which may not reflect dynamic, moment-to-moment perspective weighting.
- ERPs alone may be insufficient to capture distributed or temporally variable pragmatic computations.

Future Directions

- Increase task difficulty and ambiguity
- Use richer, more naturalistic communication settings
- Incorporate multimodal measures such as eye-tracking or fMRI to capture distributed neural and attentional dynamics
- Extend RSA models with incremental predictions and partial perspective accessibility

References

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