

Contextual constraint and the frontal post-N400 positivity: A large-sample, pre-registered ERP study

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1. Do readers predict long-distance particles in verb-particle constructions?

- In the sentence **He took the trash...**, the particle **out** is highly certain and may therefore be lexically predicted:
⇒ Encountering an unexpected particle should be very surprising and incur a large reanalysis cost.
- In a less constraining context, the identity of the particle would be less certain, and lexical prediction discouraged:
⇒ Encountering an unexpected particle should be less surprising and incur a smaller reanalysis cost.
- To measure reanalysis cost, we used the anterior post-N400 positivity (PNP); which has been shown to be larger to unexpected words in high- vs. low-constraint contexts. [2-4]
- In a previous experiment, we observed a larger PNP at unexpected, *implausible* particles when constraint was strong. [1]
- This was surprising, because amplitude of the PNP should only be affected by constraint if the unexpected word is still *plausible*. [2-4]
- We attempted to replicate our surprising result in a large study.

2. Design

German particle verb sentences were divided into two constraint conditions:

- Condition (a):** Context strongly constrained for only 1 plausible particle, implausible particle presented.
- Condition (b):** Context moderately constrained for at least 2 competing plausible particles, implausible particle presented.
- ERPs were analysed at *implausible* particles (a vs. b).
- Control sentences with plausible particles were compared with the implausible conditions as a sanity check that the expected N400/P600 were elicited. [1]
- The experiment was pre-registered on OSF. [5]

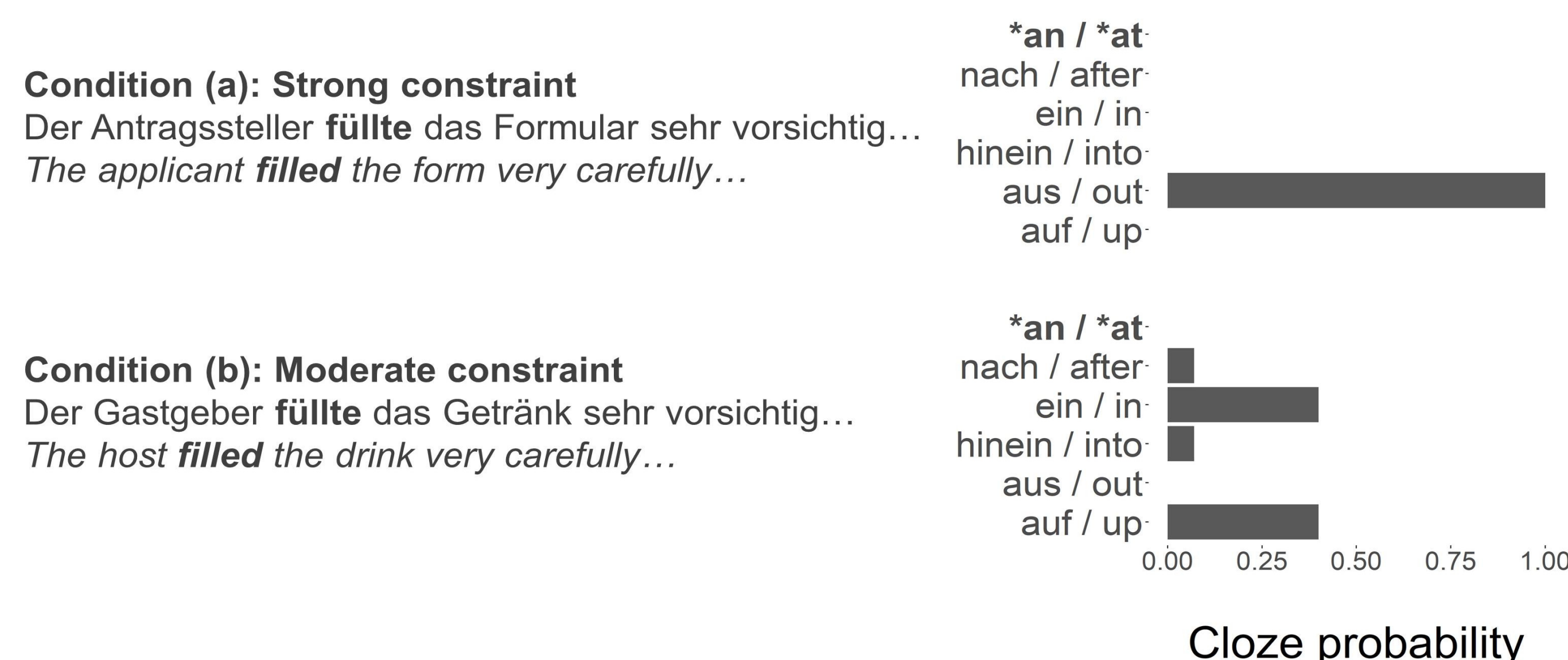


Figure 1. Example item and cloze test results. The bolded particle “an” (English translation: **at**) is the implausible particle that was presented.

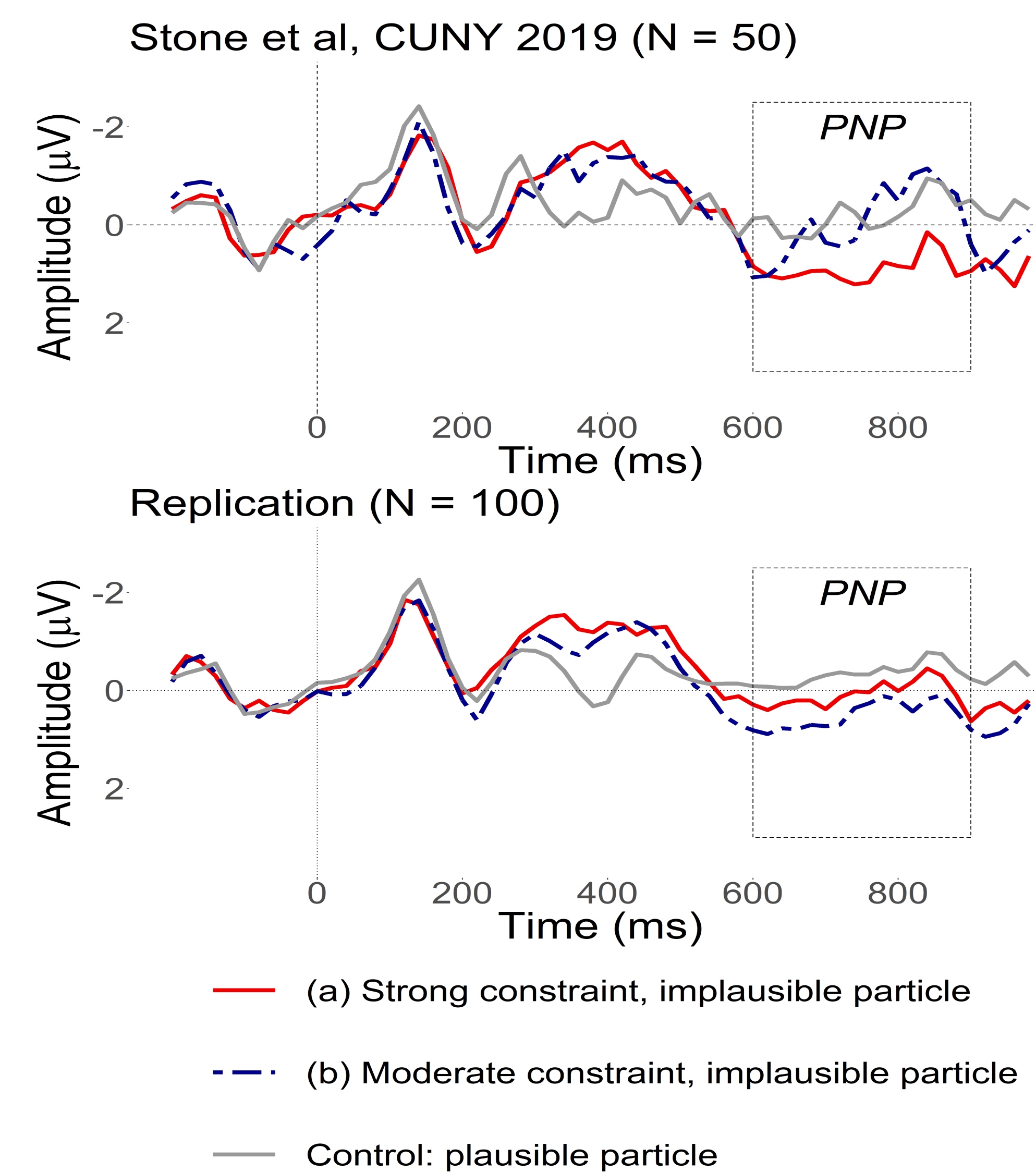


Figure 2. Target analysis, anterior region (FC1-Fz-FC2): PNPs elicited by implausible particles (coloured), original and replication experiments. ERPs for plausible particles (grey) are displayed for reference.

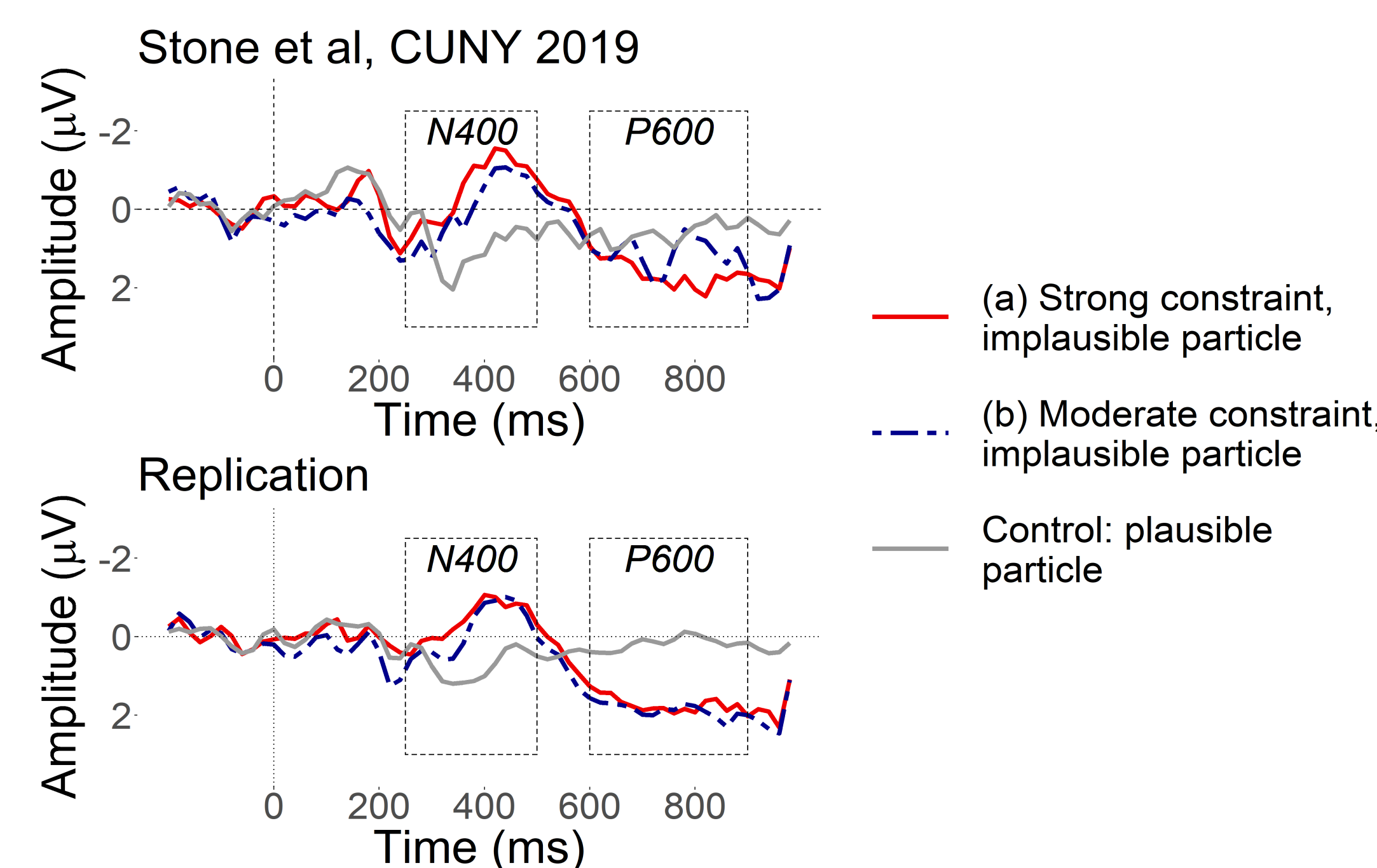


Figure 3. Sanity check, posterior region (Cz, CP1, CP2, Pz): Implausible particles elicited the expected N400 and P600 relative to plausible particles in both the original and replication experiments.

3. Methods

- 32-channel EEG
- 100 participants
- 25 target items per condition
- 54 length-matched, plausible particle verb control sentences
- 108 fillers
- RSVP 190 ms/word + 20 ms/letter; target particle 700 ms; 300 ms ISI
- Comprehension questions after each sentence
- Bayesian LMM with maximal random effects structure modelled by-trial mean amplitude 600-900 ms in the violation conditions averaged over electrodes FC1-Fz-FC2 (PNP).

4. Results & Conclusions

Although the direction of the PNP effect appeared to have reversed (Fig. 2), the Bayes factor was 7:1 in favour of the null hypothesis that there was no difference in amplitude associated with the constraint manipulation, $\hat{\beta} = -0.42\mu V$, 95%CrI = $[-0.97, 0.12]\mu V$.

What did we learn?

- We did not replicate our CUNY 2019 result, but provide a large-sample, conceptual replication of findings that constraint does not influence PNP amplitude at implausible words. [2-4]
- Since the PNP was not sensitive to our constraint manipulation with implausible particles, we cannot tell whether readers predicted the particle in condition (a) vs. (b).

5. Exploratory analysis

- Previous research suggests that the PNP is not affected by constraint at implausible words, but also that it is not elicited by implausible words *at all*. [2-4]
- In contrast, there was a reliable difference in waveforms elicited by plausible and implausible particles in our replication experiment, $\hat{\beta} = 0.57\mu V$, 95%CrI = $[0.22, 0.92]\mu V$.
- This may suggest that our region of interest was too posterior, as this finding is more consistent with a posterior P600. [4]
- We therefore combined data from both experiments and compared ERPs at plausible and implausible particles in a more anterior region: [4]

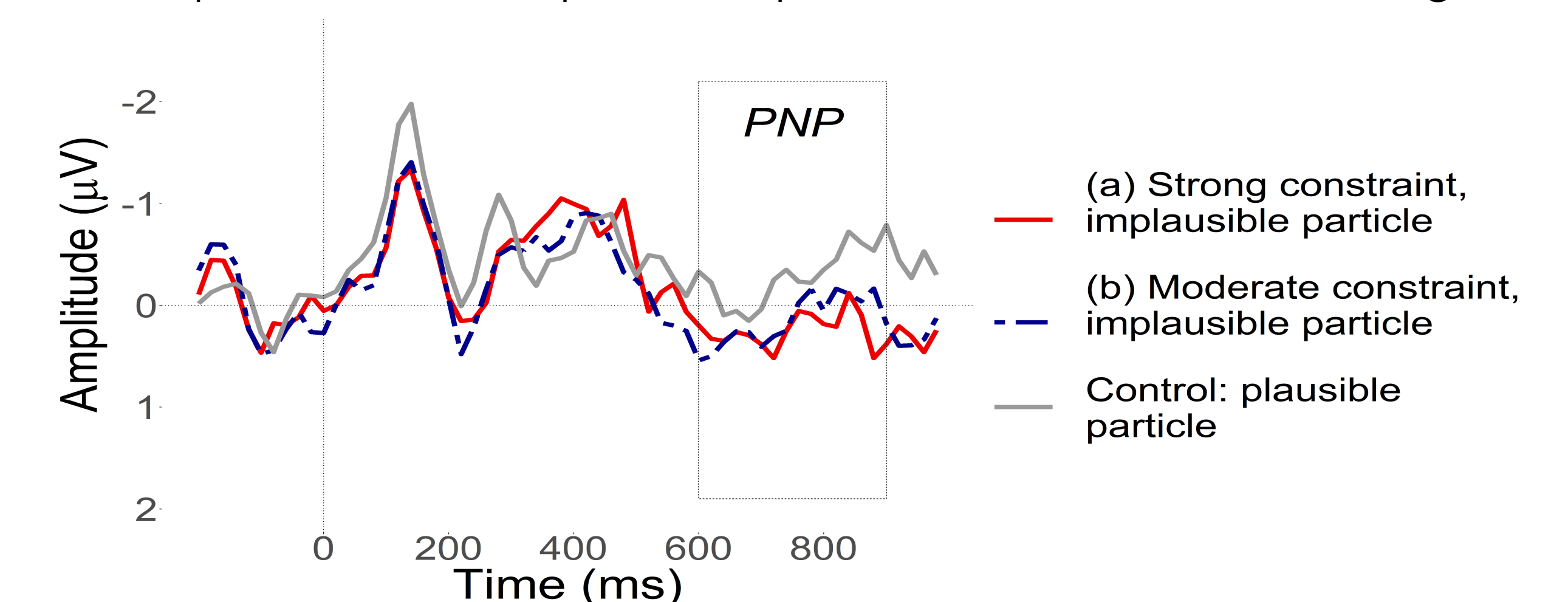


Figure 4. ERP from a more anterior region, Fp1-Fpz-Fp2.

- There was a trend in the expected direction, but the result was inconclusive, $\hat{\beta} = 0.26\mu V$, 95%CrI = $[-0.11, 0.62]\mu V$.
- The inconclusive plausible/implausible difference may reflect more variable cloze probability among plausible particles, or that implausible verb particles are not as implausible as the anomalous nouns used in previous research. [2-4] A more controlled experiment is needed.

Bibliography and links

[1] Stone et al. (2019) *CUNY* [2] Federmeier et al. (2007) *Brain Research* [3] De Long et al. (2014) *Neuropsychologia* [4] Kuperberg et al. (2019) *J Cog Neurosci* [5] OSF preregistration: <https://osf.io/y6k2d>

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