Introduction: Selective Failures in the Processing of Agreement Errors

- Any theory of sentence processing requires a theory of structure-building, which in turn requires dependency formation.
- Agreement provides a window into a large class of dependencies, incl. verb-argument linking and clausal structural dependencies.
- Agreement errors are easy to spot: the key word on the table.
- Neural signatures of regular agreement errors: LAN (sometimes) + P600 (always).
- However, some contexts greatly reduce the ability to spot such errors.
  1. The key to the cabinets is on the table. (Kutas & Hillyard, 1984)
  2. Known as agreement attribution errors, these occur when a nonsubject NP intervenes (structurally, linearly) on the “correct” subject-verb dependency.
- Because these errors are selective, they can be leveraged to indirectly examine the structure-building underlying agreement dependencies.
- Occur in both production and comprehension (Wagers, et al. 2009).
- Behavioral data well-understood, but neural data only recently emerging (Koan, 2002; Tanner, et al. 2012, 2014).
- Questions: How are these errors neurally represented, how do they compare to non-error contexts, and what are their neural generators?
- Present Study: A concurrent EEG and MEG investigation of agreement attraction configurations.

Materials & Participants

- All drawn from the preambles in the agreement literature.
- Systematic manipulation of number of NP1, NP2, and Verb – all measurements at Verb.
- NP1 equally distributed across wave, i.e., has/have, and lexical verbs (4–8 dying).
- (2) The door (to) the offset (of) gradually (closely) if not propped open.

Results — Behavioral & EEG

- Waveforms on the left show RMS amplitude by sensor quadrant.
- Ungram elicits less activation than Gram in 500–900 ms time window.
- Localized to posterior sites (lower right plot).
- Topoplots show this is driven by slightly posterior activation.
- Mild (no significant) effect of attraction: more activation elicited in attraction error configurations.
- Consistent with the notion that attraction is an illusion of acceptability when ungrammaticality is present.
- Appears that early LAN impacted by attraction configurations (NP2 considered as controller).

Results — MEG Sensor Space

- Source modeling with MNE using free orientation.
- Preliminary ANOVA using spatiotemporal cluster permutation test.
- LSTG Activation in Gram - Ungram, 700–800 ms.
- Waveforms on the left show RMS amplitude by sensor quadrant.
- Localized to posterior sites (lower right plot).
- Topoplots show this is driven by slightly posterior activation.
- Mild (no significant) effect of attraction: more activation elicited in attraction contexts.
- Consistent with the notion that attraction is an illusion of acceptability when ungrammaticality is present.
- Appears that early LAN impacted by attraction configurations (NP2 considered as controller).

Results — MEG Source Space

- Source modeling with MNI using free orientation.
- Preliminary ANOVA using spatiotemporal cluster permutation test.
- LSTG Activation in Gram - Ungram, 700–800 ms.
- Waveforms on the left show RMS amplitude by sensor quadrant.
- Localized to posterior sites (lower right plot).
- Topoplots show this is driven by slightly posterior activation.
- Mild (no significant) effect of attraction: more activation elicited in attraction contexts.
- Consistent with the notion that attraction is an illusion of acceptability when ungrammaticality is present.
- Appears that early LAN impacted by attraction configurations (NP2 considered as controller).

Discussion

- Behavioral results show attraction is occurring.
- More errors in NP condition relative to others.
- EEG results show an LSTG and P600 to ungrammatical sentences.
- LAN dependent upon attraction configurations.
- P600 smaller with attraction (Tanner, et al., 2014).
- Possibly a result of some subjects simply not noticing errors.
- Greater MEG response to grammatical utterances relative to ungrammatical ones.
- Interpretation: structure-building is reflected in increased MEG activation.
- Corollary: P600 effect is a consequence of a negative deflection for grammatical utterances.
- Activation seen in two sites: LSTG and right lateral occipital sites.
- More careful work needed to see which structures in the STG are driving the effect.
- Occipital sources surely triggered by next word, but why they are distinct by condition remains unclear at present.

Future Directions:
- Cluster permutation tests for sensor-space data.
- Correlational analysis between EEG and MEG.
- Analysis of brain responses conditioned on correct/incorrect behavioral responses.
- Spectral analyses of both EEG and MEG data.
- Closer examination of different orthographic verb forms (waveshapes).•
- Do all grammatical - ungrammatical comparisons result in increased MEG activation?

Acknowledgments & References

Acknowledgments — Thanks to Eric Blance and Laura Cuffaro for assistance with experimental procedure. Thanks to Christian Brocchi for invaluable assistance with analysis. Finally thanks to Alice Maranie, Luiza Pylkkänen, Jon Sprouse, and Shravan Vasishth for comments on previous iterations.