

Spatiotemporal Dissociations Associated with Fulfilling and Violating Predictions at Multiple Levels of Representation: A Multimodal Approach

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Introduction

- During language comprehension, we use linguistic context to predict at multiple levels of representation. [1]
- In this study, we asked whether & when distinct neuroanatomical networks are engaged to inputs that fulfill or violate strong contextual predictions of specific events and/or broader event structures.
- Multimodal neuroimaging approach: EEG, MEG & fMRI

Methods

- 32 subjects participated in EEG, MEG and fMRI sessions
- Task: read & judge whether scenarios make sense
- Stimuli counterbalanced within & across conditions and within & across sessions

High Constraining context:

The lifeguards received a report of sharks right near the beach. Their immediate concern was to prevent any incidents in the sea. Hence, they cautioned the...

... Swimmers (HC_pred)

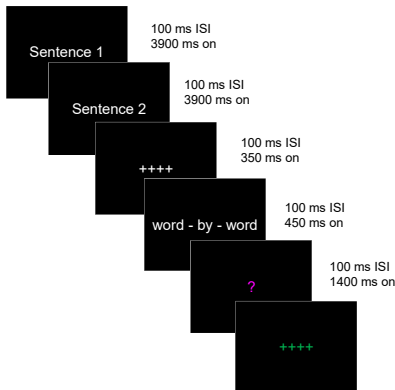
... Trainees (HC_lexviol)

... Drawer (HC_SRviol)

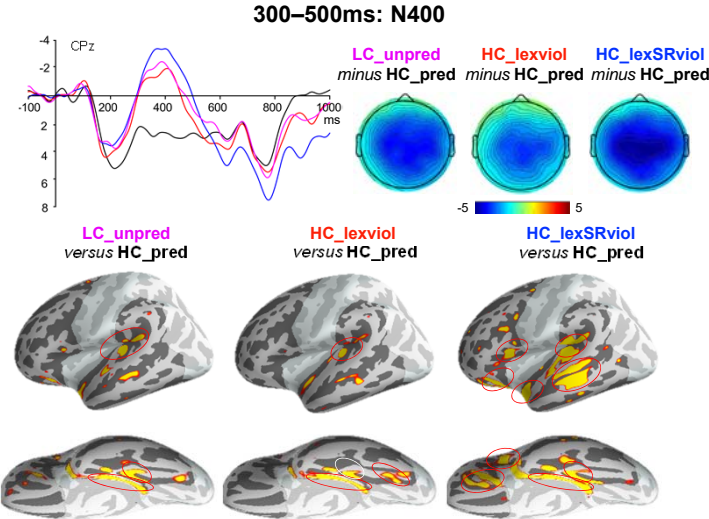
Low Constraining context:

Eric and Grant received the news late in the day. They mulled over the information, and decided it was better to act sooner rather than later. Hence, they cautioned the...

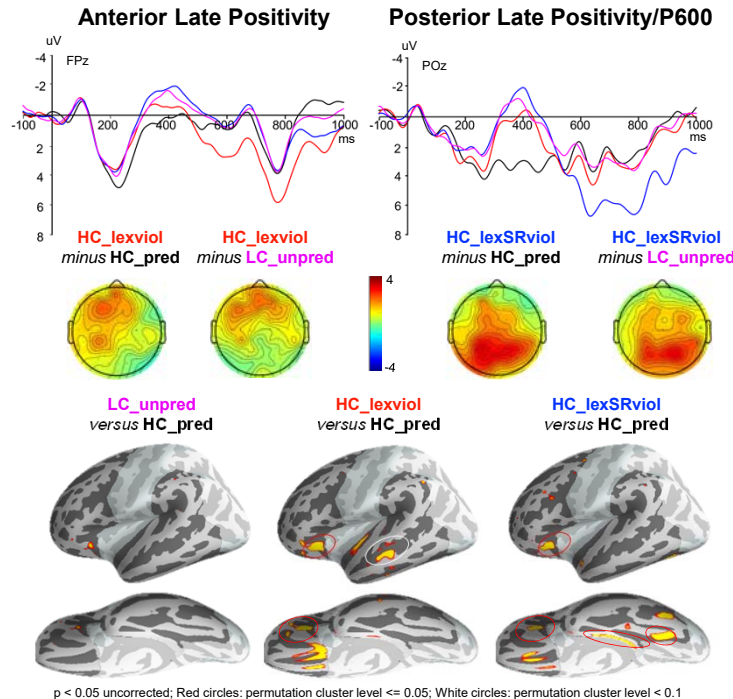
... Trainees (LC_Unpred)



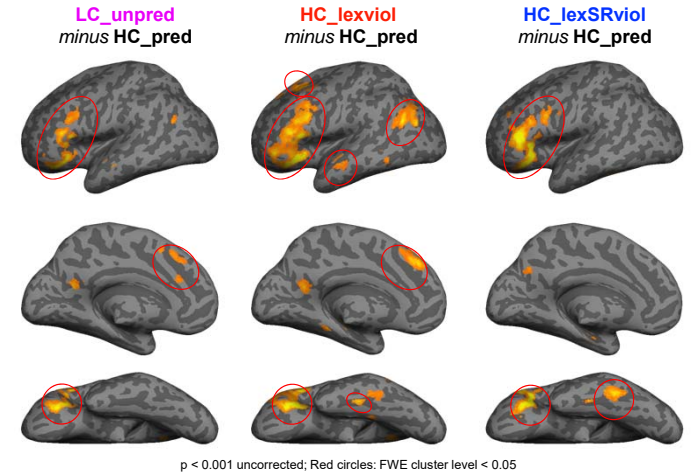
Results: ERP and MEG



600–1000ms: Late Positivity Components



Results: fMRI



Conclusions

- Inputs that fulfill versus violate strong predictions at different levels of representation engage partially distinct networks in time and space.
- **Fulfilling strong semantic predictions: 300-500ms**
 - Reduced activity within the left lateral temporal and fusiform cortex to predicted (versus unpredicted) words: facilitated access to pre-activated semantic features [2]
 - Dipoles to predicted and unpredicted words within the left medial temporal cortex were of opposite polarity: distinct roles of the medial temporal cortex in retrieving unpredicted information from memory and recognizing fulfilled predictions
- **Violating strong predictions of events and event structures: 600-1000ms**
 - Increased activity within the left anterior inferior frontal cortex: prolonged process of inferring the specific event or event structure dictated by the bottom-up input.
- **Violating a specific event prediction:**
 - Increased activity within the left lateral temporal cortex: prolonged analysis of semantic features of the incoming word (selecting these features over those associated with the erroneously predicted word)
- **Violating a whole event structure prediction:**
 - Increased activity within the left fusiform cortex: prolonged analysis of the orthographic features of the incoming word
- The fMRI findings were most consistent with MEG activity in the later, rather than earlier N400 time window. They additionally revealed activity that was not seen in either MEG time window. This illustrates how different imaging modalities can be sensitive to different neurocognitive processes occurring at different time scales.

References

- [1] Kuperberg & Jaeger (2016). Language Cognition and Neuroscience. 31(1): 32-59
 [2] Lau, et al., (2016). Cerebral Cortex. 26 (4): 1377-1387.