

Think Plausible: Parafoveal Vision and the Frontal Positivity in Sentence Reading

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Background

Reading

- While reading, people not only gather information directly from the word which they are fixating on (i.e. the fovea), but also from upcoming words through parafoveal input (1-5 visual degrees around the fovea) (Fig 1).
- From eye-tracking studies, it's been found that readers are able to extract some basic word features (i.e. phonological and orthographic) from the parafovea which allows for quicker processing and comprehension while reading.³

EEG

- Through electroencephalography (EEG) technology, we are able to pick up on brain waves that people produce while reading
- By time-locking the EEG data to stimulus onset, we receive event-related potentials (ERPs), components of neural activity that show us what brain processes are occurring while people are reading.
- By using ERP's, we're able to learn more about what happens during reading than from an eye-tracking study.
- Beyond those basic features that we are able to get parafoveally (like phonology and orthography), more complex processing is required to integrate deeper features, such as the semantic of a word.
 - This is shown by the N400, a negative-going ERP waveform between 300-500 ms at centro-parietal electrode sites when readers perceive a violation of their expectations based on the sentence context.
 - When expectation violations were presented solely in the parafovea, studies still find an N400, showing that there is parafoveal processing of semantic features.¹
- However, some later components which must be directly fixated on, require foveal input for processing.
- The late positive component (LPC) is elicited from strong semantic integration related anomalies around 500-800 ms post stimuli onset, and has been shown to require foveal presentation.⁴

Present Study

- The frontal positivity (FP) is another later ERP component. It is a positive going ERP waveform (Fig 2) present 600 - 900 ms post stimuli onset, and is elicited when readers encounter a word that they did not expect, but that does make sense in the sentence context. However it is briefly studied, and unknown what kind of presentation is required for elicitation
- The aim of this study is to see if the FP can be elicited parafoveally (like the N400) or foveally (like the LPC).

Proposed Methods

Participants

- This study will recruit participants from the University of South Florida's SONA pool.

Materials

- 3 x 3 design: crosses three sentence manipulations (expected target in a high constraint sentence, unexpected target in high constraint, or unexpected target in low constraint) by three vision manipulations (always visible, visible parafoveally only, or visible foveally only)
 - 30 stimuli in each condition, participants see 270 sentences

Procedure

- Sentences are presented in a Rapid Serial Visual Presentation (RSVP) with flankers paradigm
- EEG will be recorded with a 32 channel cap, then the data will be analyzed through MATLAB.

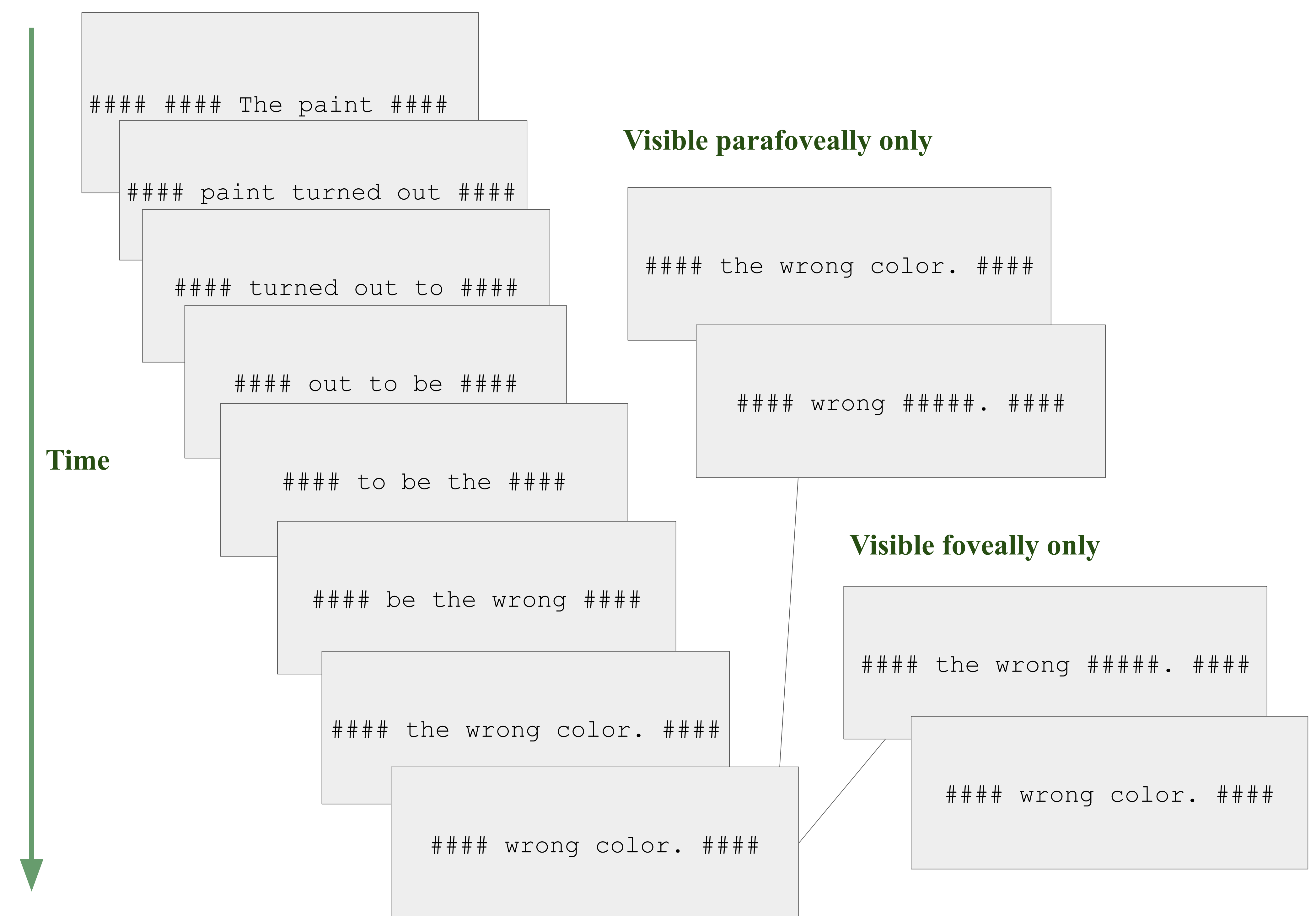


Figure 3. Diagram showing each screen a participant sees during the RSVP paradigm, dependant on the visual manipulation presented.

References

1. Payne, B. R., Stites, M. C., & Federmeier, K. D. (2019). Event-related brain potentials reveal how multiple aspects of semantic processing unfold across parafoveal and foveal vision during sentence reading. *Psychophysiology*, 56(10), e13432. <https://doi.org/10.1111/psyp.13432>
2. Kuperberg, G. R., Brothers, T., & Wlotko, E. W. (2020). A Tale of Two Positivities and the N400: Distinct Neural Signatures Are Evoked by Confirmed and Violated Predictions at Different Levels of Representation. *Journal of cognitive neuroscience*, 32(1), 12–35. https://doi.org/10.1162/jocn_a_01465
3. Schotter, E. R., Angele, B., & Rayner, K. (2012). Parafoveal processing in reading. *Attention, Perception, & Psychophysics*, 74(1), 5–35. <https://doi.org/10.3758/s13414-011-0219-2>
4. Schotter, E. R., Milligan, S., & Estevez, V. M. (2023). Event-related potentials show that parafoveal vision is insufficient for semantic integration. *Psychophysiology*, 60(7), e14246. <https://doi.org/10.1111/psyp.14246>

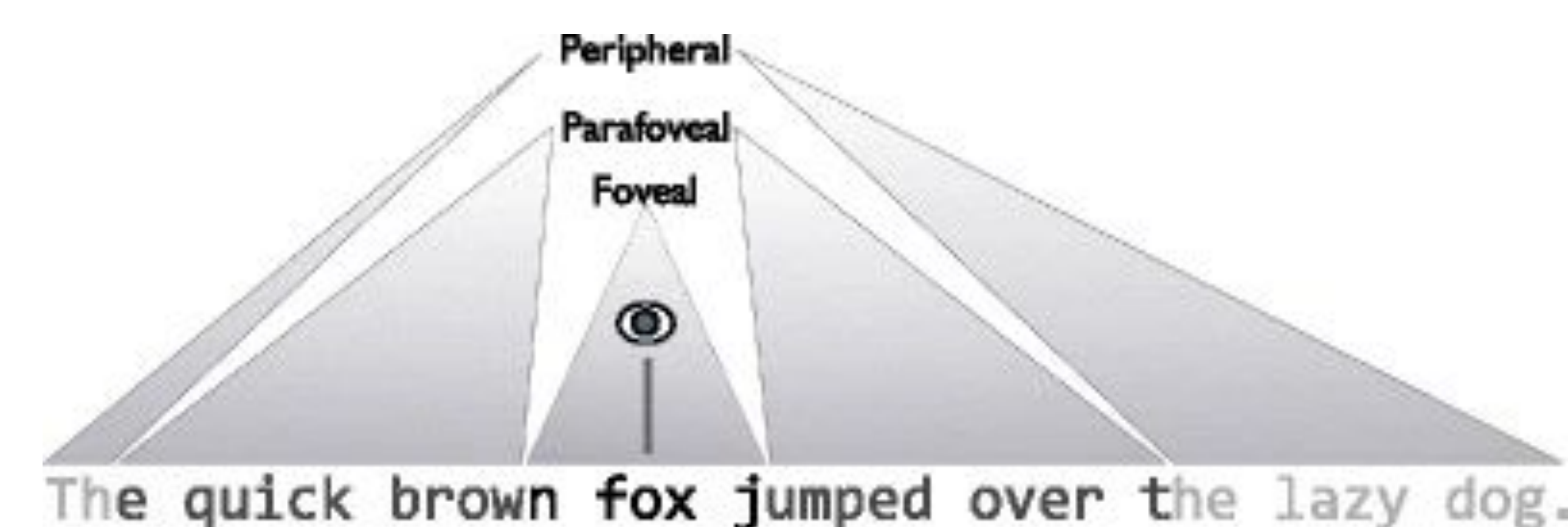


Figure 1. Diagram illustrating parafoveal and foveal vision from Schotter, Angele, & Rayner, K. (2012).

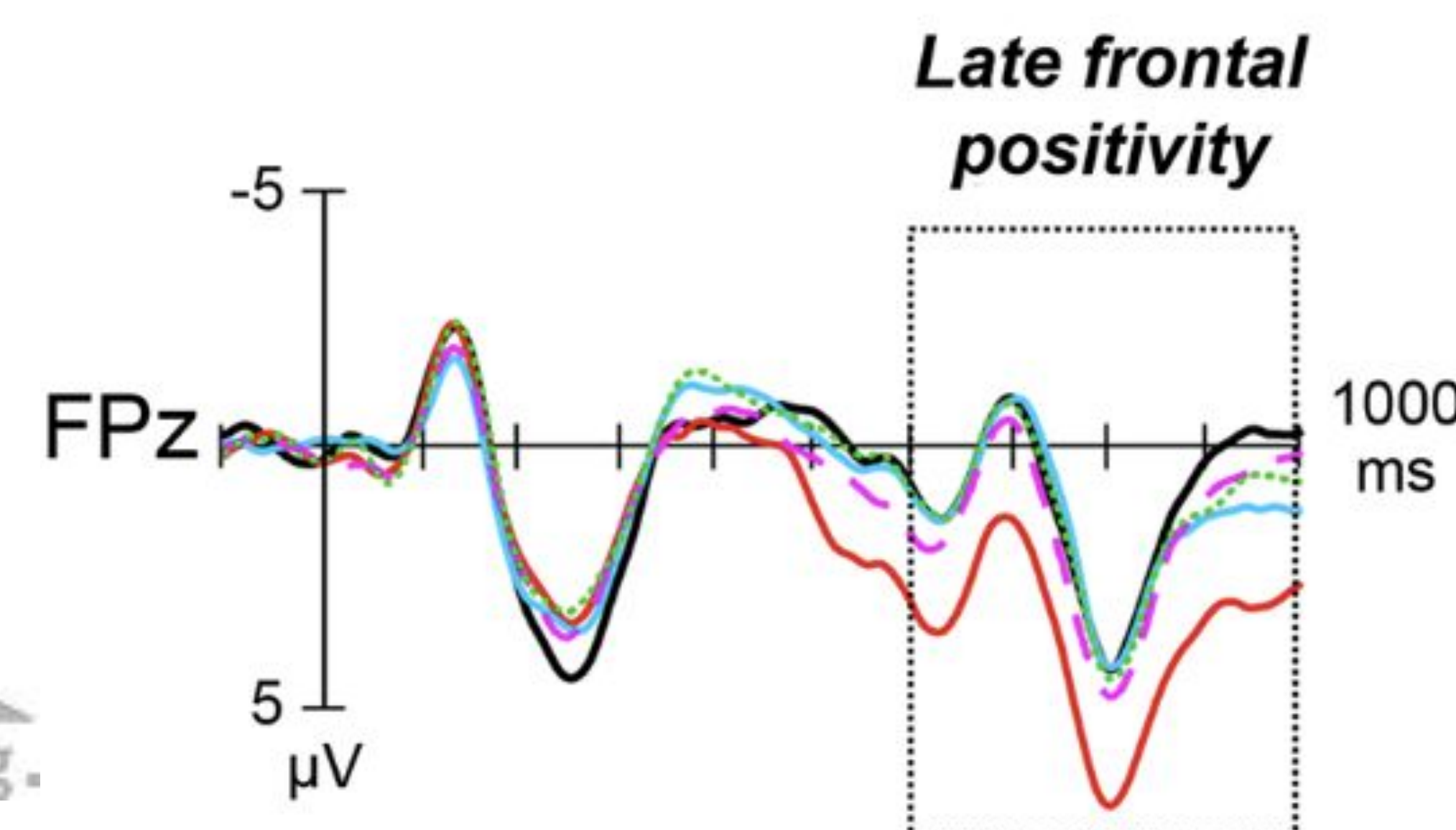


Figure 2. Grand averaged ERPs from Kuperberg et al., (2020). The red line represents the grand averaged ERP from the high constraint, unexpected plausible condition².