

Neuroelectric Markers of Lexical Ambiguity Resolution

of Visually Presented Words in Sentence Contexts: A Time Course Study

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INTRODUCTION

- An important aspect of lexical disambiguation in context (Faust & Balota, 2007; Faust & Gernsbacher, 2006) is the potential for interference from semantic activations related to the current word but unrelated to the sentence context.
- More specifically, the ability to suppress interference from contextually inappropriate senses of homographs (e.g., bank, Gernsbacher, Varner, & Faust, 1990) has been found to be related to language comprehension skill.
- The N400 event-related potential (ERP, Swaab, Brown, & Hagoort, 2003; Titone & Salisbury, 2004) may be a neuroelectric marker of lexical disambiguation processes.
- The N400 is a negative going scalp voltage that reflects semantic conflict between words and sentence contexts (e.g., he poured the cereal into the ____ would elicit a greater N400 if completed by the word HAT vs. BOWL).
- The purpose of the present study is to (a) identify neuroelectric markers of interference from contextually inappropriate word activations, and (b) their suppression over time, using the N400 as a starting point.
- We used a semantic verification task used in previous studies to assess interference effects from contextually inappropriate word activations in conjunction with EEG recording.

Task (N=18)

- Words presented visual, one at a time, at a rate of 4 words per second
- Probe word, same location, short & long delays (100, 2000 ms)
- Button press response, yes-no word related to global sentence meaning
- Stimuli are from Binzak et al. (2001) who modified stimuli of (Gernsbacher, Varner, & Faust, Experiment 4, 1990)

4 Trial Sentence Types

- **Incongruous (IN):** He dug with the *spade* **ACE**
Probe related to sentence-final **homograph**, but not to global meaning (correct response: **NO**)
- **Unrelated (UR):** He dug with the *shovel* **ACE**
Probe related to neither the sentence-final **non-homograph** or global meaning (correct response: **NO**)
- **Incongruous (IN):** He erased the *board* **CHALK**
Probe related to sentence-final word, but not to global meaning (correct response: **YES**)
- **Incongruous (IN):** He approached the *board* **CHALK**
Probe related to sentence-final word, but not to global meaning (correct response: **YES**)

EEG Method

- 40 channel cap (expanded 10-20 cap) Neuroscan NuAmps system
- Filtered (0.1, 30 Hz), artifact rejection 100 μ V peak-to-peak, epoched (-200, 800 ms)
- Electrode of Interest: Frontal Midline (Fz), Central Midline (Cz), Posterior Midline (Pz)

Questions

- N400 related to contextually inappropriate interference?
- Other markers, e.g., later positive ERPs (such as P600)?
- Neuroelectric markers associated with suppression over time?
- Context ambiguity effects on neuroelectric markers, YES trials?

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RESULTS (N=18)

Interference Effect: Slowed response to the Inappropriate (IN) condition in relation to the Unrelated (UR) condition. Interference from probe word related to the contextually inappropriate sense of the sentence final word in the IN condition.

Behavioral Interference Effect (IN – UR):

Short Delay ($p = .002$)

Mean RTs: 1168, 1090 (78 ms interference)

Long Delay ($p = .001$)

Mean RTs: 1028, 967 (61 ms interference)

Figure 1: IN & IR Conditions

N400 ($p < .001$, see Green arrows, 350-450 ms window)

IN & UR show increased negativity (N400 effect) in relation to BC ($p < .01$), but not sig. different from each other (p 's $> .05$).

Late Positivity ($p < .001$, see Orange arrows, 500-700 ms)

IN & UR show reduced late positivity (p 's $> .05$), in relation to BC, but not sig. different from each other (p 's $> .05$).

Figure 2: BC & UB Conditions

No sig. differences found for BC & UB (p 's $> .05$)

Late Positivity ($p < .001$, see Orange arrows, 500-700 ms)

BC & UB show robust late positivity that is maximal at parietal electrode site, but not sig. different from each other (p 's $> .05$).

DISCUSSION

1. Consistent with Swaab et al. (2003) a robust N400 effect was found when participants had to process a probe word that was related to the contextually inappropriate sense of a sentence-final homograph.
2. However, we failed to find a differential N400 effect for the IN and UR conditions. Swaab et al. (2003) also found this pattern for probe words related to subordinate senses of the sentence-final homograph, but did see differentiation (i.e., reduced N400) for the probe words related to the dominant meaning of the homograph.
3. We also failed to find the expected modulation of late positivity by addition of an ambiguous context condition (UB).
4. The semantic verification task may lead to strategies that affect N400 and late positivity effects, or the balanced homographs in our stimulus set (many researchers use unbalanced homographs with clear dominant and subordinate senses) may yield N400 results similar to ... subordinate probe condition.
5. Finally, Binzak et al. (2001) found inappropriate homograph sense-related fMRI activations (IN vs. UR conditions using this same stimulus set) in and around the supramarginal gyrus. We have, as of yet, been unable to detect ERP markers that might be related to this fMRI effect.

Figure 1: IN & UR N400s (Short 100ms & Long 2000 ms Delays)

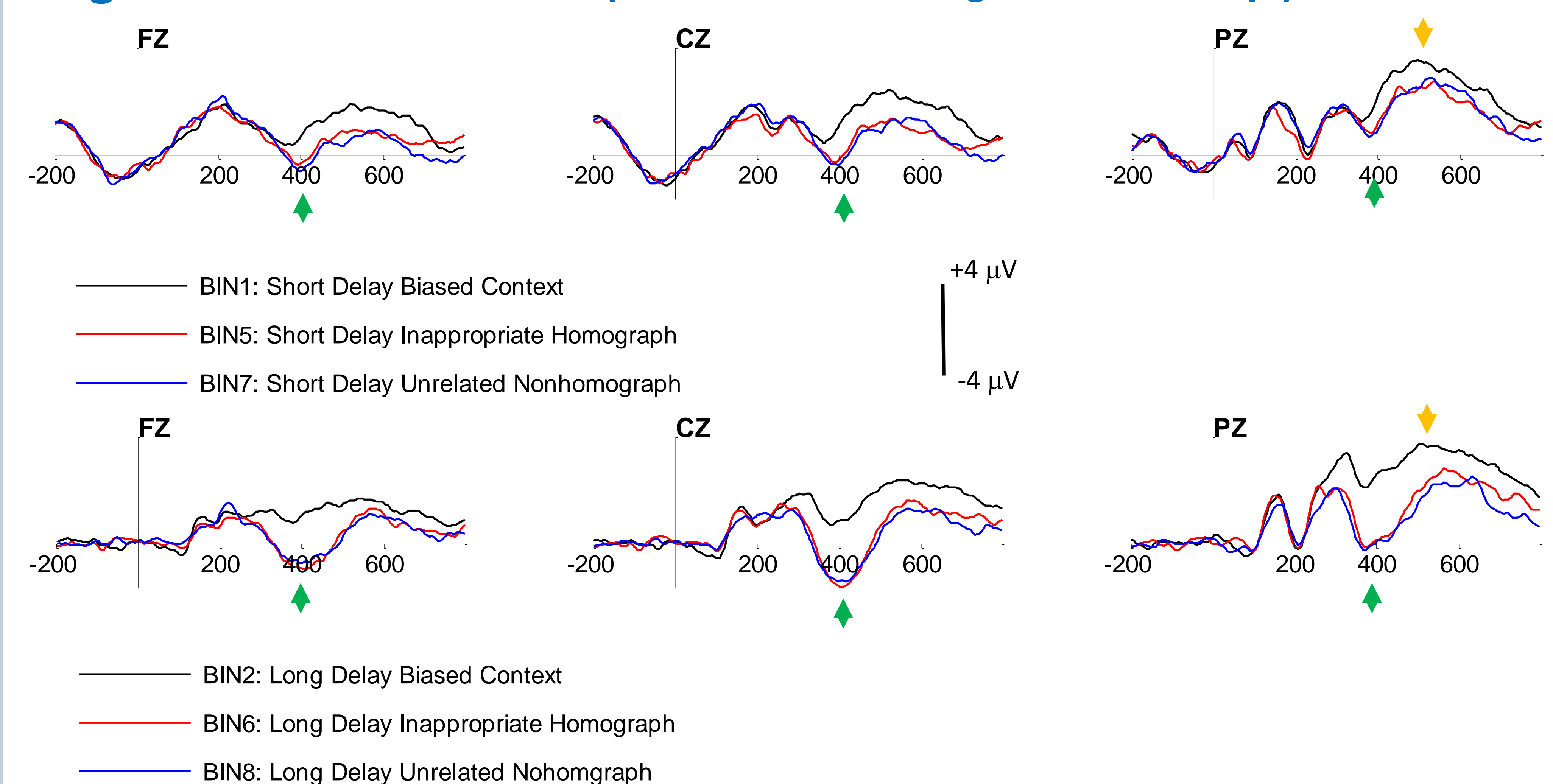
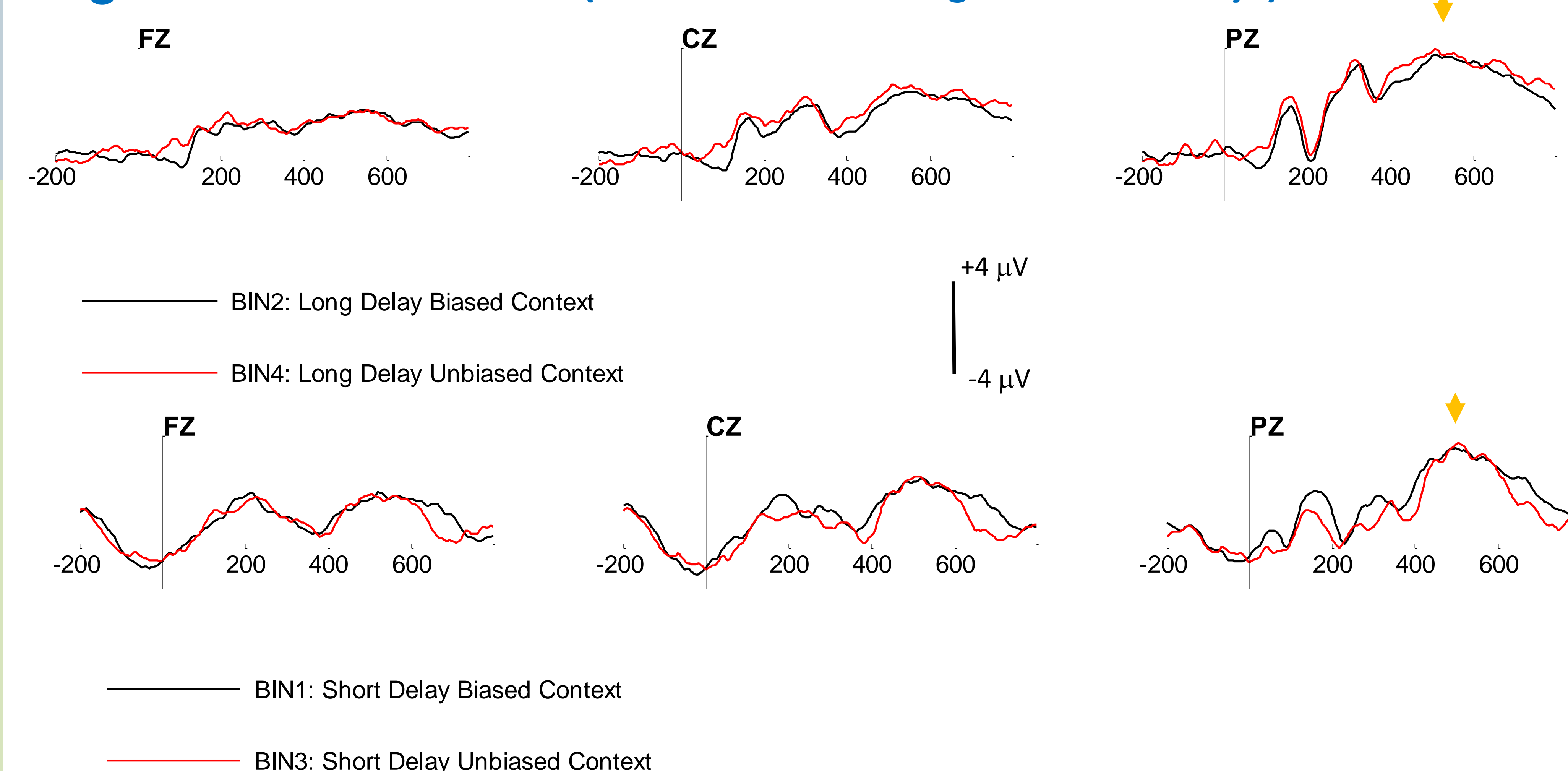


Figure 2: BS & UB ERPs (Short 100ms & Long 2000 ms Delays)



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