

Neuroelectric Markers of Hemispheric Differences in Ambiguity Resolution of Words in Context: A Split Visual Field ERP Study



Mark E. Faust, Elaine Hill, Jordan Pierce, & Spencer Fix
University of North Carolina at Charlotte



INTRODUCTION

- The study of lexical disambiguation in context (Faust & Balota, 2007; Faust & Gernsbacher, 2006) provides an important test case for understanding control processes associated with language comprehension skill (Gernsbacher, Varner, & Faust, 1990).
- The N400, 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) may be an important marker of lexical disambiguation processes (Swaab, Brown, & Hagoort, 2003; Titone & Salisbury, 2004).
- Recent work using trigrams (e.g., *river-bank-deposit*), where the first word acts as a single word context for the middle homograph, with split-field presentation methodology, have indicated that the N400 may provide a window on hemispheric differences in control over the contextually inappropriate senses of homographs as sentence comprehension unfolds (Meyer & Federmeier, 2007).
- The purpose of the present study is to further examine the effectiveness of the N400 in the study hemispheric differences in control over contextually inappropriate word activations.
- We used a semantic verification task used in previous studies to assess interference effects from contextually inappropriate word activations in conjunction with EEG recording. Participants viewed sequentially presented sentence contexts in the center of the computer screen, followed by brief laterally presented target words, and judged whether the target word matched the overall meaning of the sentence.

Task & Participants

- 36 right handed participants, 3 dropped due to too many artifact trials
- Visual words presented, one at a time, at a rate of 4 words per second
- Short & long delay groups (100, 1000 ms, N=17, 16)
- Probe word, right/left lateralized, 200ms duration
- Button press response, yes-no word related to global sentence meaning
- Stimuli are from Binzack et al. (2001) who modified stimuli of (Gernsbacher, Varner, & Faust, Experiment 4, 1990)

4 Trial Sentence Types

- **Incongruous (IN):** He dug with the *board* **CHALK**
Probe related to sentence-final **homograph**, but not to global meaning (correct response: **NO**)
- **Unrelated (UR):** She served on the *council* **CHALK**
Probe related to neither the sentence-final **non-homograph** or global meaning (correct response: **NO**)
- **Biased (BS):** She hated the *jam* **JELLY**
Probe related to sentence-final word, but not to global meaning (correct response: **YES**)

EEG Method

- 40 channel cap (expanded 10-20 cap) Nueroscan NuAmps system
- Filtered (0.1, 30 Hz), artifact rejection 100 μ V peak-to-peak, epoched (-200, 800 ms)
- Electrodes of Interest: Central Parietal Left (CP3) & Right (CP4)

Questions

- Will target words related to the contextually inappropriate sense of a sentence-final homograph experience reduced N400 (IN-IR comparison)?
- Will this reduction interact with visual hemifield and site hemisphere?

Acknowledgments

We would like to thank Brandon Stansley, Josh Ebner, and Josh Eyer for their help with data collection & archiving.

RESULTS

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 's > .13)
RVF & LVF Targets: 54 & 52 ms
- Long Delay** (p 's < .01)
RVF & LVF Targets: 89 & 102 ms

N400: IN – UR difference wave average amplitude in 300-500 ms time window analyzed.

Figure 1: Short Delay

- N400 IN-IR differential larger in RH site** ($p < .001$)
- N400 IN-IR differential for RVF targets & RH site** ($p < .05$, green arrow)
- Late Positivity also enhanced (P600?)**

Figure 2: Long Delay

- N400 IN-IR differential approached sig. overall** ($p = .08$)

DISCUSSION

1. Consistent with Swaab et al. (2003) a robust N400 effect (i.e., in relation to the BS condition) 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, the differential N400 effect for the IN and UR conditions was not as robust as we had hoped. A more robust N400 differential may emerge when we combine results across electrode sites.
3. Consistent with Meyer & Federmeier (2007) we found evidence of hemispheric differences in control of homograph meaning activation. Our finding of a main effect of electrode hemisphere is consistent with a generally less effective control of contextually inappropriate homograph meaning activation in the right cerebral hemisphere.
4. It is of note that the behavioral interference effect, as reflected in mean RT difference scores did not decrease with increasing probe word delay as is typically the case in this task. The statistical trend towards an N400 differential between IN and UR conditions, along with an increase in behavioral interference may reflect lapses of attention during the long delay conditions of the study.
5. While no significant P600 differences between IN and UR conditions were observed at the sites of interest, the overall pattern suggests hemispheric differences in whether a late positivity difference is likely to emerge (as the full set of electrode sites is more fully analyzed) may depend critically on target delay.

Figure 1: Short Delay (100ms) Group

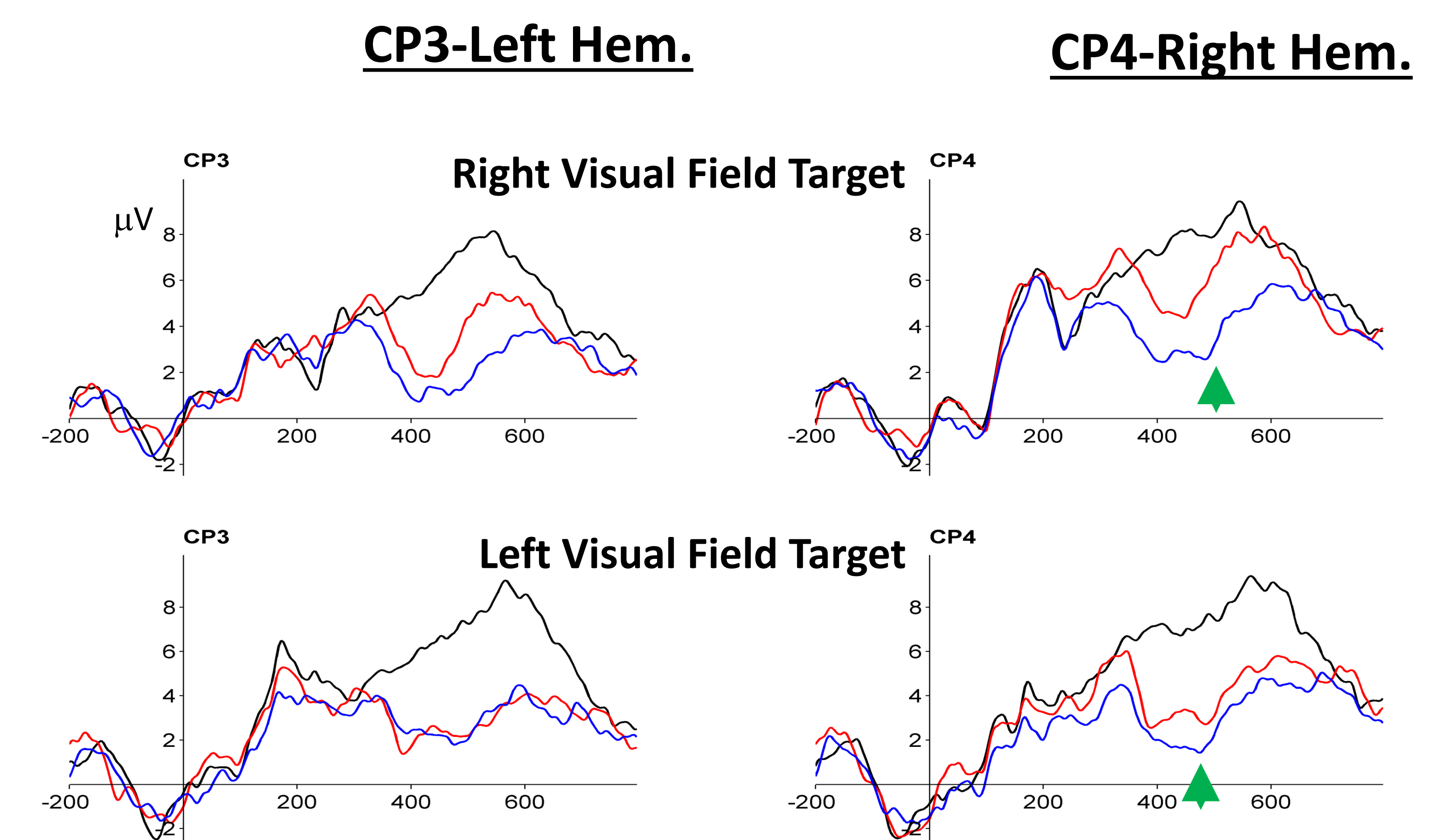
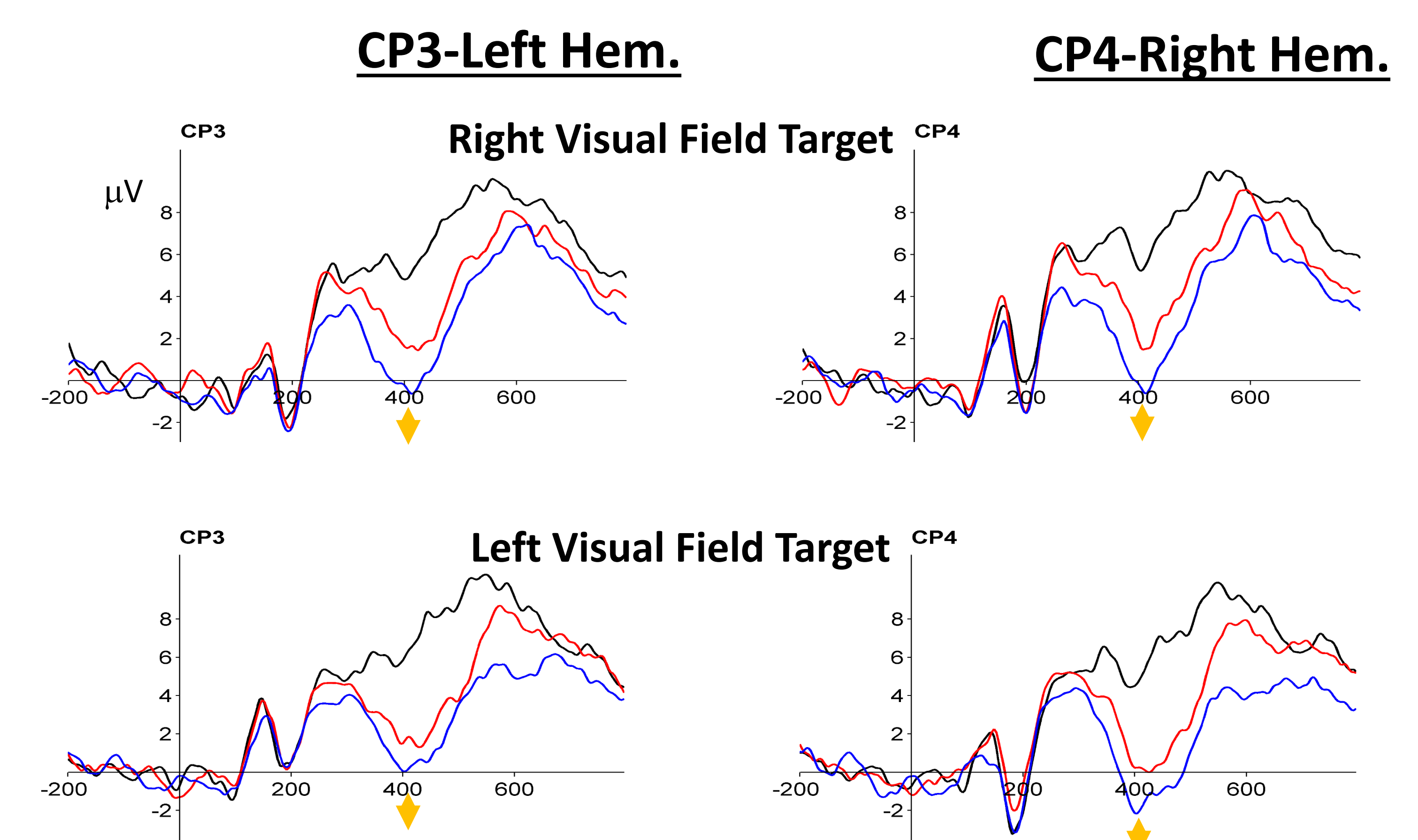


Figure 2: Long Delay (1000ms) Group



References

- Binzack, J. M., Budde, M.D., Robertson, D., Herfel, H., & Gernsbacher, M.A. (2001, March). Suppression of irrelevant meanings of homographs. Poster presented at Cognitive Neuroscience Society Conference, New York.
- Faust, M.E., & Balota, D.A. (2007). Inhibition, facilitation, and attentional control in dementia of the Alzheimer's type: The role of unifying principles in cognitive theory development. In D.S. Gorfein & C.M. MacLeod (Eds.), *Inhibition in cognition* (pp. 213-238). Washington, DC: APA.
- Faust, M. E., & Gernsbacher, M. (1996). Cerebral mechanisms for suppression of inappropriate information during sentence comprehension. *Brain And Language*, 53, 234-259. doi:10.1006/brln.1996.0046
- Gernsbacher, M. A., Varner, K. R., & Faust, M. E. (1990). Investigating differences in general comprehension skill. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, 16, 430-445. doi:10.1037/0278-7393.16.3.430
- Myer, A.M., & Federmeier, K.D. (2007). The effects of context, meaning frequency, and associative strength on semantic selection: Distinct contributions for the cerebral hemispheres. *Brain Research*, 1183, 91-108.
- Swaab, T., Brown, C., & Hagoort, P. (2003). Understanding words in sentence contexts: The time course of ambiguity resolution. *Brain And Language*, 86, 326-343. doi:10.1016/S0093-934X(02)00547-3
- Titone, D. A., & Salisbury, D. F. (2004). Contextual modulation of N400 amplitude to lexically ambiguous words. *Brain And Cognition*, 55, 470-478. doi:10.1016/j.bandc.2004.02.073

Download at: <http://clas-pages.uncc.edu/markfaust-controlleeglab/posters/>