

Introduction

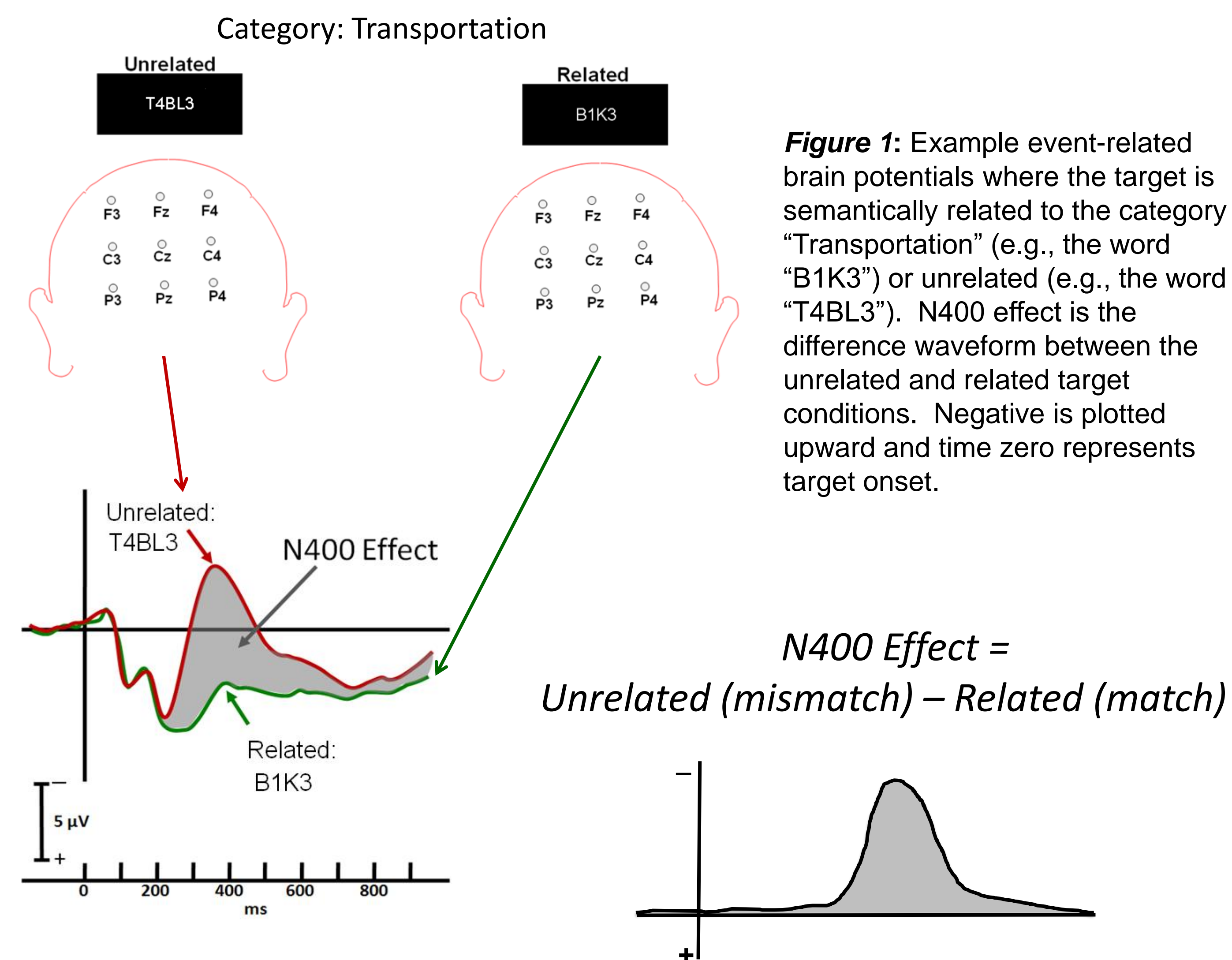
Can you read the following paragraph?

4M4ZING 7H1NG5! 1MPR3551V3 7H1NG5! 1N 7H3
B3G1NNING 17 WA5 H4RD BU7 NOW, ON 7H15 LIN3
YOUR M1ND 1S R34D1NG 4U70M471C4LLY W17H 0U7
3V3N 7H1IK1NG 4B0U7 17, B3 PROUD! ONLY C3R741N
P30PL3 C4N R3AD 7H15.

Can we derive meaning from words even if they are distorted by intermixing words with numbers? Perea, Duñabeitia, and Carreiras (2008) have suggested that digits embedded in printed words (known as LEET words; e.g., “R34D1NG” instead of “READING”) can prime the subsequent target word. That is, response times to the target word “MATERIAL” preceded by the LEET word “M4T3R14L” were similar to those when it preceded by the identical word “MATERIAL”. This finding suggests that LEET words can automatically activate lexical information. The present study was designed to replicate and extend the behavioral results of Perea et al. using electrophysiological measures (e.g., event-related brain potentials; ERPs). Instead of using the priming paradigm, we used a category task – the word was related or unrelated to a given category (Lien, Ruthruff, Logan, Goodin, & Allen, 2008).

N400 Effect

We measured the N400 effect elicited by regular words and LEET words. The N400 is an EEG component known to be elicited when a person notices that a stimulus is incongruent with the current semantic context (see Figure 1 for an example; e.g., Kutas & Hillyard, 1980). The N400 is a negative-going wave that peaks about 400ms after the onset of the incongruous stimulus and is often referred to as *mismatch negativity*. For the present purpose, the critical thing to note is that this **N400 component can be elicited only when the word is identified and processed up to semantic level**.



The Present Study

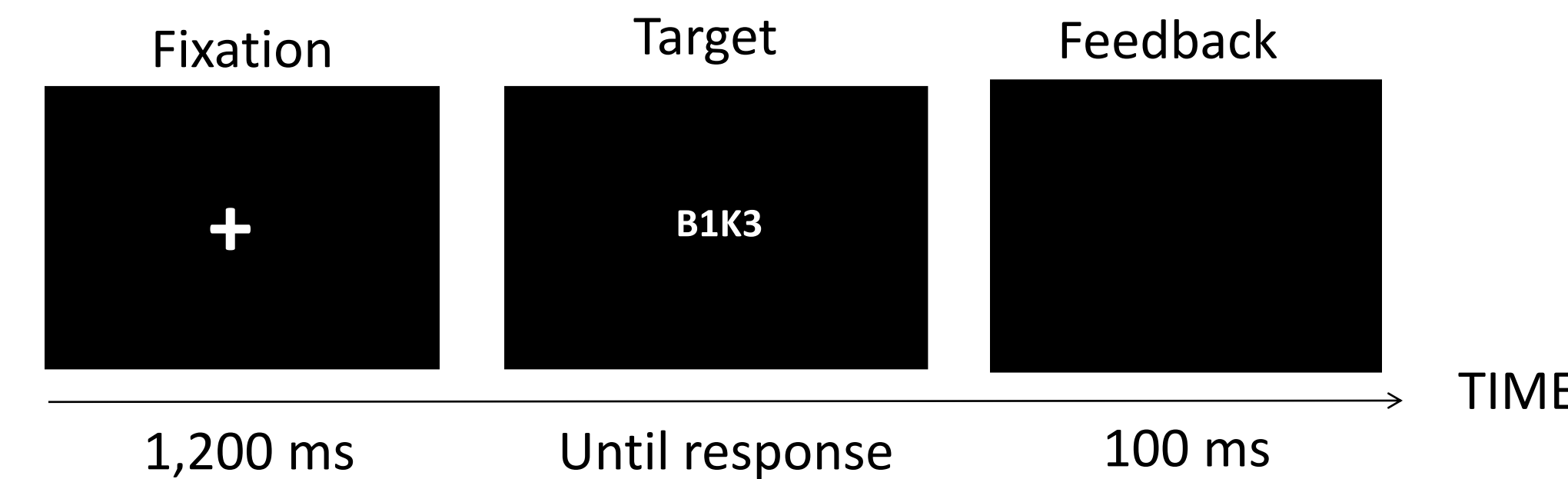
We examined whether semantic activation occurs for LEET words formed by letters and digits. We used a category task - determining if the target word was related or unrelated to a given category prior to each block.

Each participant received 21 different categories (e.g., “transportation”) in separate 36-trial blocks. Each block contained 18 related words and 18 unrelated words. Word type (regular uppercase word vs. LEET word) was varied within blocks.

Participants: 22 native English speakers (17 Females, 5 males).

Responses: Press the “1” for related and the “5” for unrelated.

Event Sequence: See below for an example based on the “transportation” category.



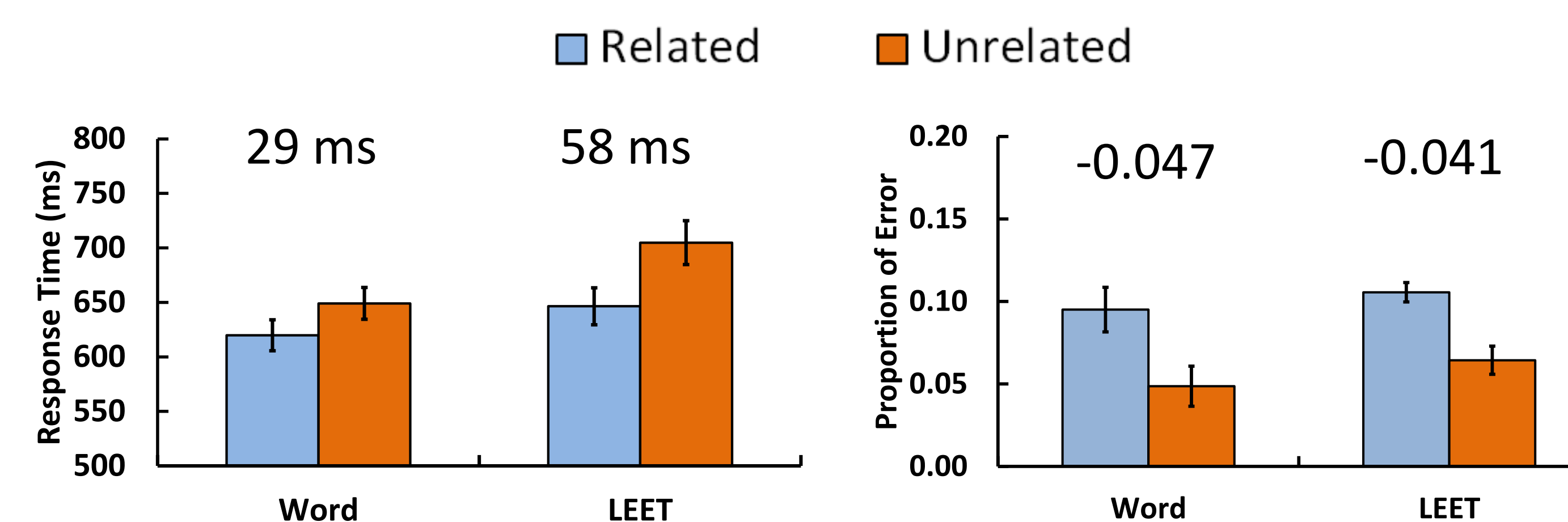
EEG Recording: EEG epochs were time-locked to target onset. The N400 effect (differences in mean amplitude between unrelated and related targets) was measured between 400-600 ms after target onset, relative to a 200-ms baseline period before target onset, separately for the frontal (F3, Fz, and F4), central (C3, Cz, and C4), and parietal (P3, Pz, and P4) electrode sites.

Predictions

If LEET words can be processed like real words (i.e., if they can be used to access word meaning), then LEET words should produce similar N400 effects as regular words. Such a result would provide converging operations with the semantic priming, behavioral results of Perea et al. (2008).

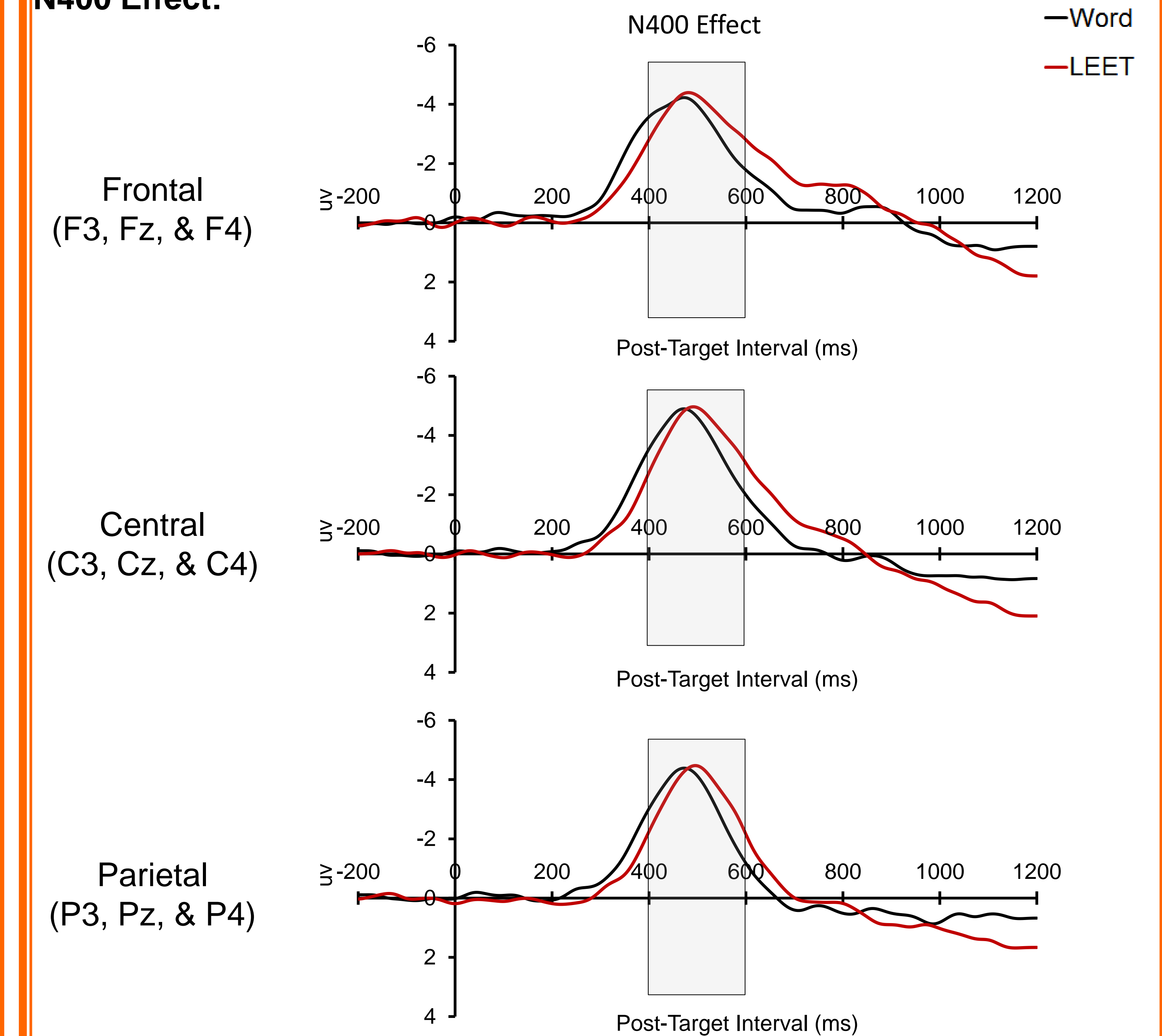
Results

Behavioral Data (response time [RT] and proportion of error [PE]):



The LEET word produced longer RT and more PE than the regular word, $F_s(1,21) \geq 28.53$, $p_s < .0001$. Unrelated targets produced longer RT but lower PE than related targets, $F_s(1,21) \geq 27.91$, $p_s < .0001$, suggesting a tendency of speed-accuracy tradeoff. The difference between unrelated and related targets was much larger for the LEET word than for the regular word on RT, $F(1,21) = 23.24$, $p < .0001$. However, the difference in PEs was similar for both word types, $F < 1.0$.

N400 Effect:



As expected, a large N400 effect was obtained for the regular words in all 3 electrode sites, $|t_s(21)| \geq 9.29$, $p_s < .0001$. The LEET words also produced large N400 effects in all electrode sites, $|t_s(21)| \geq 11.74$, $p_s < .0001$. Those N400 effects were not significantly different between regular words and LEET words, $t_s(21) \leq 1.19$, $p_s \geq .2471$, suggesting that LEET words were processed up to semantic level similar to regular words.

Conclusions

We used electrophysiological measures (i.e., the N400 effect) to determine whether LEET words allow access to word meaning. LEET stimuli showed the same N400 difference-wave amplitude (unrelated words showed a strong N400 effect than related words) as did words presented in consistent, uppercase letters. The present finding extends the Perea et al. (2008) semantic priming results to a category task and provides evidence for a more direct brain measure of semantic processing for LEET stimuli. We conclude that LEET words can be used to access meaning, just like regular non-distorted words.

References

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science*, 207, 203–205.

Lien, M.-C., Ruthruff, E., Cornett, L., Goodin, Z., & Allen, P. A. (2008). On the non-automaticity of visual word processing: Electrophysiological evidence that word processing requires central attention. *Journal of Experimental Psychology: Human Perception and Performance*, 34, 751-773.

Perea, M., Duñabeitia, J. A., & Carreiras, M. (2008). R34D1NG W0RD5 W1TH NUMB3R5. *Journal of Experimental Psychology: Human Perception and Performance*, 34, 237-241.