

# Cue-related alpha modulation during a semantic judgement task

Lisa Payne<sup>1</sup>, Many Jiwjinda<sup>2</sup> & Chad Dubé<sup>3</sup>

<sup>1</sup>Rutgers University, Camden NJ; <sup>2</sup>Swarthmore College, Swarthmore PA; <sup>3</sup>University of South Florida

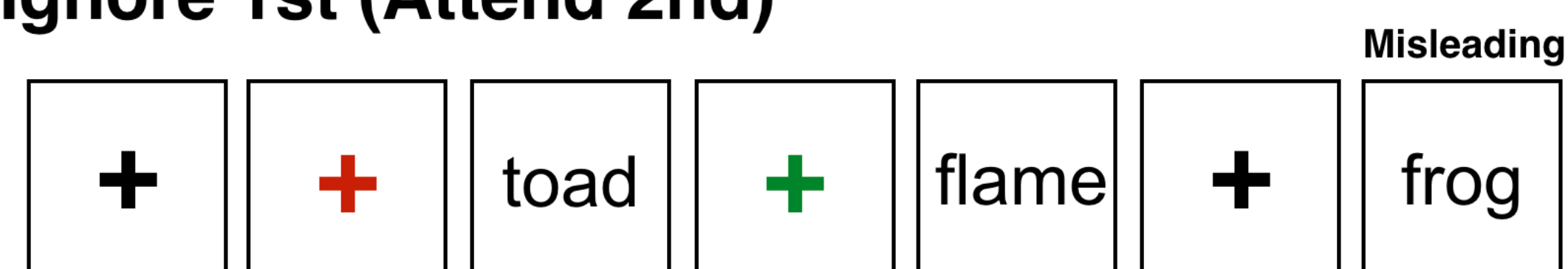
## Introduction

- EEG alpha band oscillations (8 – 14 Hz) have been used as a marker of attentional control for sensory stimuli.
  - Increase in alpha oscillations over visual, auditory and somatosensory brain regions is believed to represent suppression of task irrelevant sensory information<sup>1</sup>.
- In addition to sensory characteristics, evidence suggests that the meaning of a stimuli, such as auditory intelligibility<sup>2</sup>, threat<sup>3</sup>, and language characteristics<sup>4</sup>, may be a factor in the modulation of alpha activity.
- We combined a cued-attention design shown to reliably induce alpha modulation with a relatedness semantic judgement task to investigate the role of alpha beyond sensation, in higher order cognitive functions such as semantic processing.

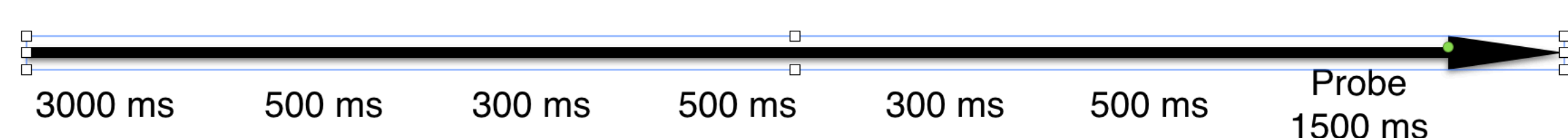
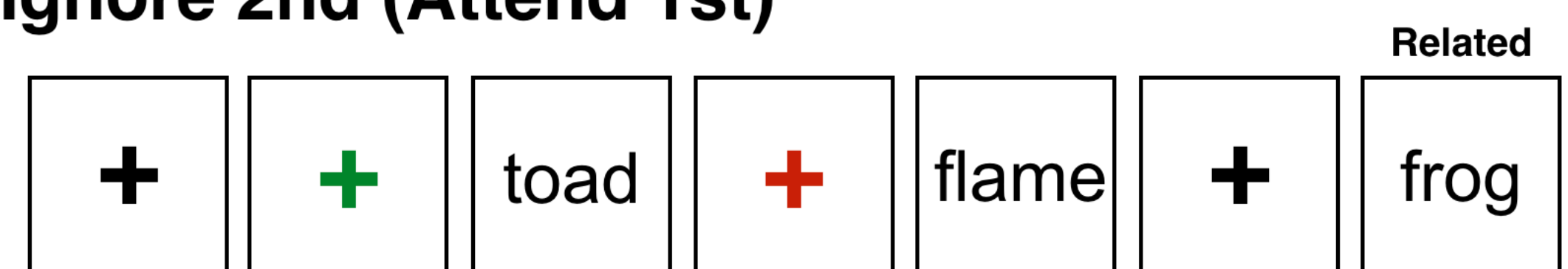
## Method

- 15 participants performed a semantic judgement task while EEG was recorded.
- Stimuli – Four to five letter monosyllabic shown only once.
  - Words were considered semantically related if they had a frequency association score (FAS<sup>5</sup>)  $\geq 5\%$
- Trial sequence (120 experimental trials) –
  - A green or red fixation cross before the stimulus signaled whether that stimulus was to be remembered or ignored.
- Probe –three types of probe words.
  - Related probe** – related to to-be-remembered
  - Misleading probe** – related to to-be-ignored
  - Unrelated probe** – unrelated to either word
- Participants indicated with a button press whether or not the probe word was related to the to-be-remembered word.
  - Feedback during 16 practice trials indicated correct, incorrect or too slow.

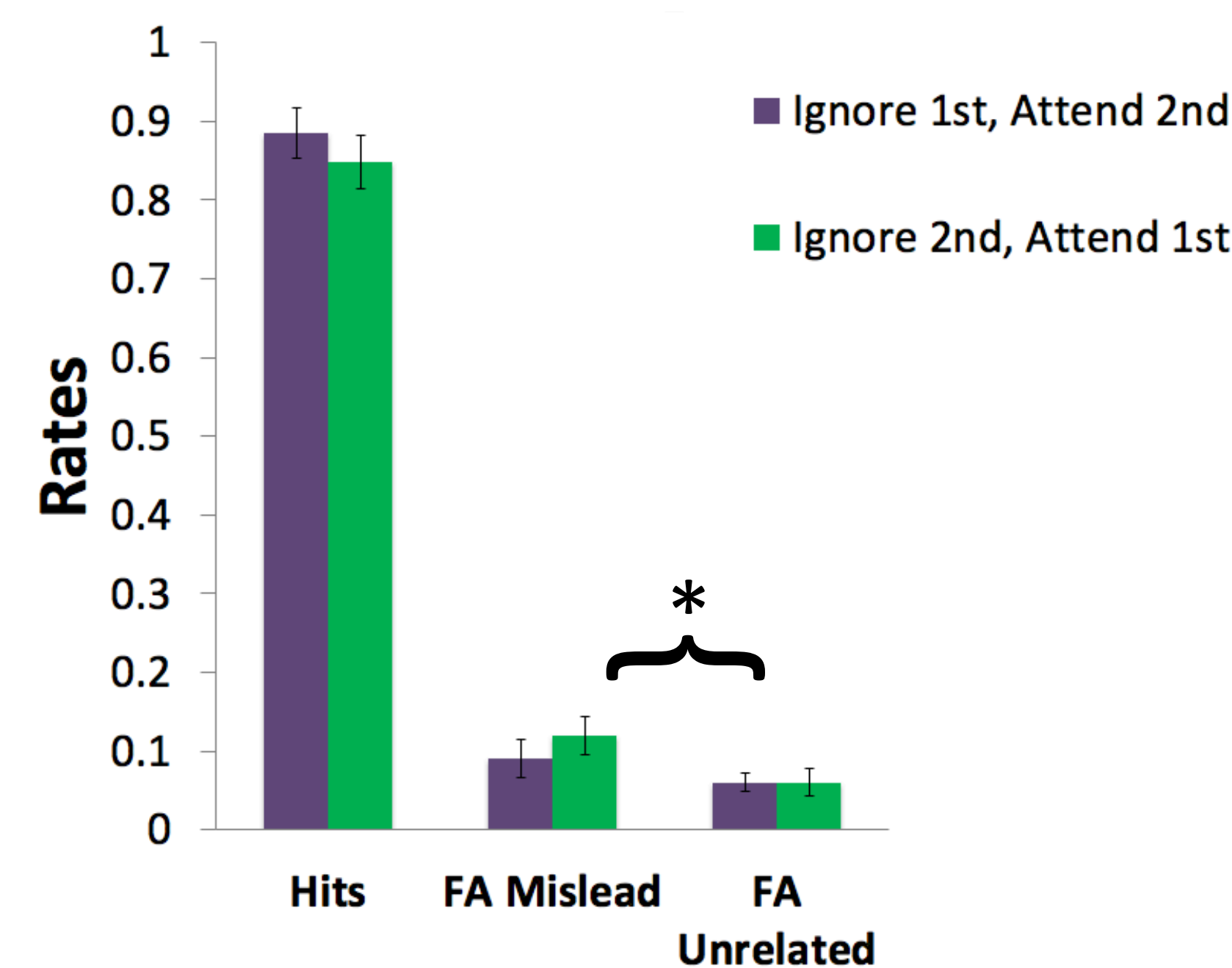
### Ignore 1st (Attend 2nd)



### Ignore 2nd (Attend 1st)



## Irrelevant Speech during subvocal rehearsal disrupts recall



Accuracy and False Alarm (FA) rates for the two types of trial orders. There was a significant difference in the proportion of times that participants gave an incorrect semantic judgment, between trials with misleading versus unrelated probe words ( $p = .008$ ). Regardless of the order that participants were told to attend and ignore, trials with misleading probes elicited significantly more incorrect responses relative to the unrelated probes. No significant differences were found in the accuracy rates of the two trial types but there was a trend toward better accuracy in Ignore 1<sup>st</sup>, Attend 2<sup>nd</sup> trials ( $p = .06$ ). Error bars indicated  $\pm 1$  SEM.

## Alpha oscillations extending beyond sensory cortices reflect preparation to ignore a visually presented word

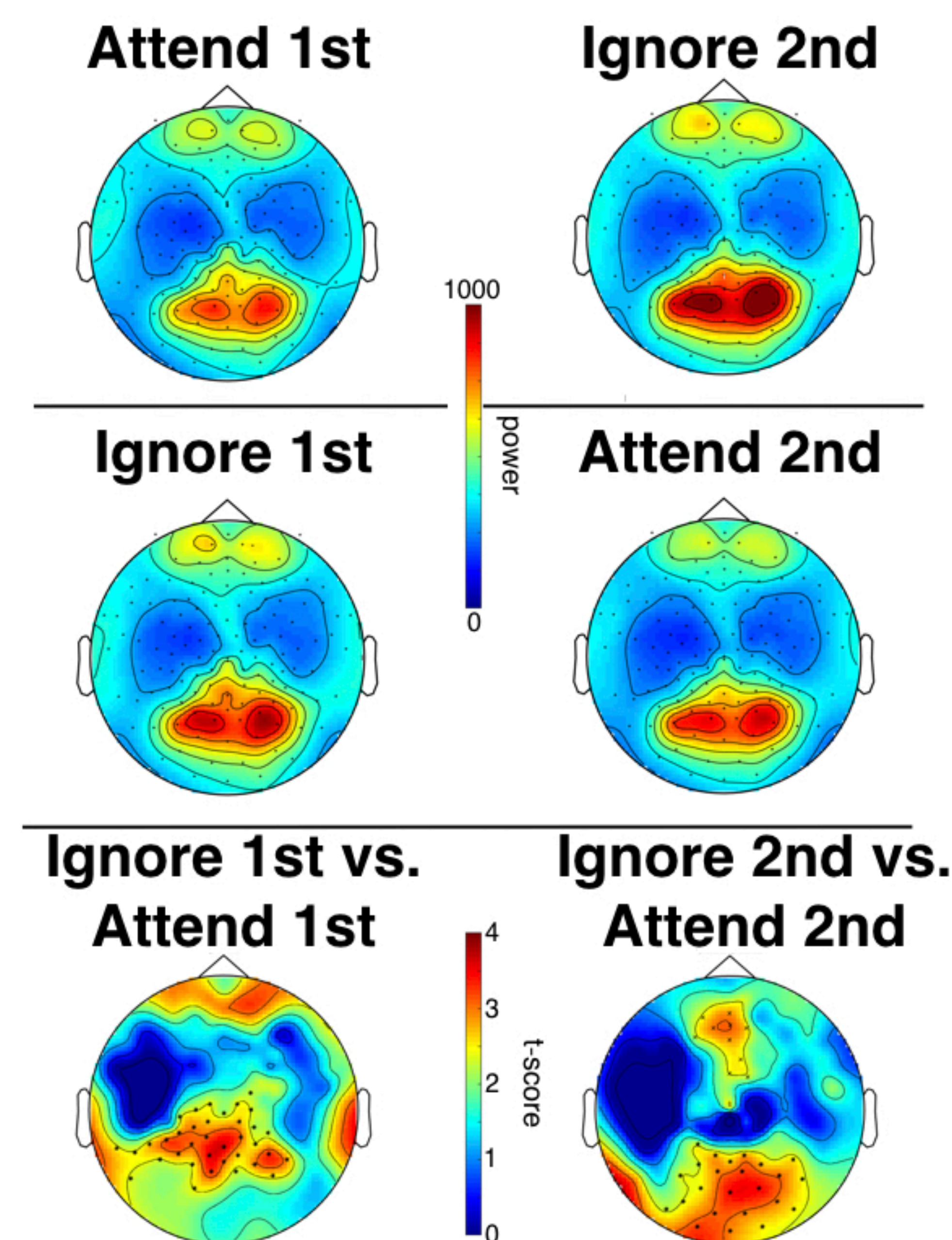


Figure 2. Topographical EEG maps displaying pre-stimulus alpha power. Top row: Attend 1<sup>st</sup>, Ignore 2<sup>nd</sup> trial type. Bottom row: Ignore 1<sup>st</sup>, Attend 2<sup>nd</sup> trial type. Bottom row: Ignore versus attend for each trial type. In the Ignore 1<sup>st</sup> vs Attend 1<sup>st</sup> contrast, ignore-related alpha power can be seen in a 33-electrode cluster located over midline parietal and left-lateralized parietal cortex (bottom row, left figure,  $p < .01$ ). For the Ignore 2<sup>nd</sup> versus Attend 2<sup>nd</sup> comparison, ignore-related alpha power can be seen primarily in an 25-electrode cluster located over occipital and parietal cortex (bottom row, right figure,  $p < .01$ ).

## Conclusions

- Alpha activity when ignoring the first word, thus with no to-be-remembered word being encoded and retained, involved left-lateralized parietal-temporal cortex and parietal cortex. Functions in these regions include:
  - Verbal recognition
    - Wernicke's
    - Visual Word Form Area (VWFA)
  - Spatial visual attention
- Alpha activity when ignoring the second word, thus with a to-be-remembered word already being encoded and retained, involved frontal and parietal cortices. Functions in these regions include:
  - Working Memory
  - Spatial visual attention
- Misleading probe words, that were related to the to-be-ignore word on that trial, led to more errors than probe words that were unrelated to either word in the trial.
- Our results indicate that ignoring an irrelevant word in the absence of simultaneously retaining a target word, involves suppressing the semantic meaning of a word.

## References

- Payne, L., & Sekuler, R. (2014). The importance of ignoring: alpha oscillations protect selectivity. *Current Directions in Psychological Science*, 23(3), 171-177.
- Wöstmann, M., Lim, S. J., & Obleser, J. (2017). The human neural alpha response to speech is a proxy of attentional control. *Cerebral Cortex*, 27(6), 3307-3317.
- Kuo, Bo-Cheng, et al. "Top-down modulation of alpha power and pattern similarity for threatening representations in visual short-term memory." *Neuropsychologia* 106 (2017): 21-30.
- Dubé, C., Payne, L., Sekuler, R., & Rotello, C. M. (2013). Paying attention to attention in recognition memory. *Psychological Science*, 24(12), 2398-2408.
- Kiss, G.R., Armstrong, C., Milroy, R., & Piper, J. (1973) An associative thesaurus of English and its computer analysis. In Aitken, A.J., Bailey, R.W. and Hamilton-Smith, N. (Eds.), *The Computer and Literary Studies*. Edinburgh: University Press.

Contact: [lisa.payne@rutgers.edu](mailto:lisa.payne@rutgers.edu)

