

# Limitations in the link of frontal positivity and metacognitive confidence in lecture learning

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## Introduction

Perceptual confidence has been linked to a frontal-positivity (FP) event-related potential (Lim et al. 2020), but whether this marker generalizes to metacognitive confidence during learning remains unclear. This study attempts to conduct a preliminary evaluation of the transferability of FP correlates to the more learning pertinent, metacognitive confidence that accompanies appraisal. Using EEG in this manner and establishing a link between areas of perceptual confidence and areas of metacognitive confidence has already had success (Vugt et al. 2019, Polychroni et al. 2021).

## Key Findings

At the outset, the goal was to see if areas of perceptual confidence could be applied to metacognitive confidence. Ultimately, the attempt to establish a link between more metacognitive confidence and frontal positivity proved ineffective.

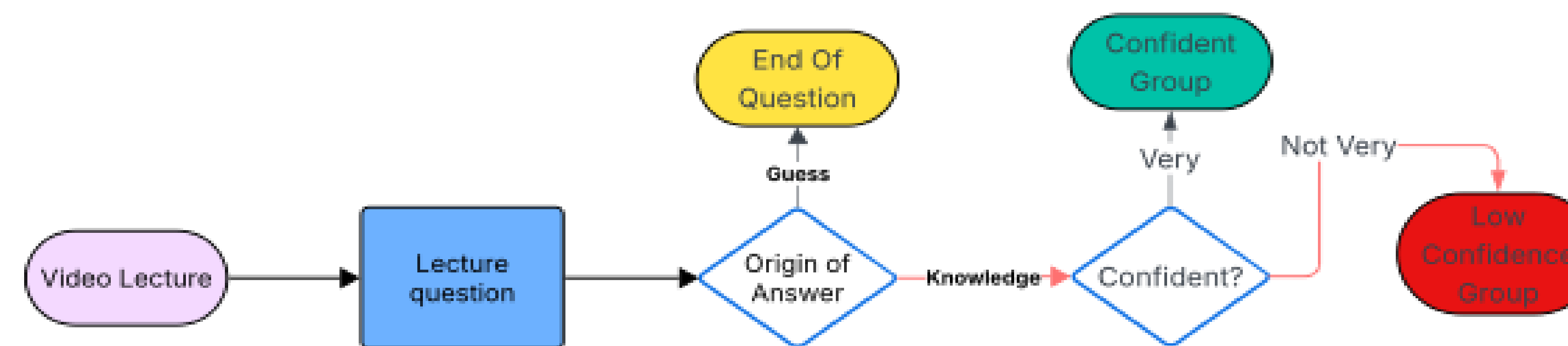
## Methods



To answer such questions so 10 participants were selected from a broader study about attention to undergo analyses. The broader study had participants placed in and EEG headband (as seen above) and then watched one hour of video lecture. Three of these participants had to later be excluded due to faulty EEG readings resulting in N=7. From these participants EEG measurements were collected using a as they answered questions about an approximately one-hour lecture and Confidence level was appraised using retrospective confidence ratings (either very confident or not confident) following the questions about lecture content. The peak level of activation in the both frontal channels (AF7, AF8) was found for the -1000 to 0ms window preceding response concurrent with previous studies on perceptual attention on FP

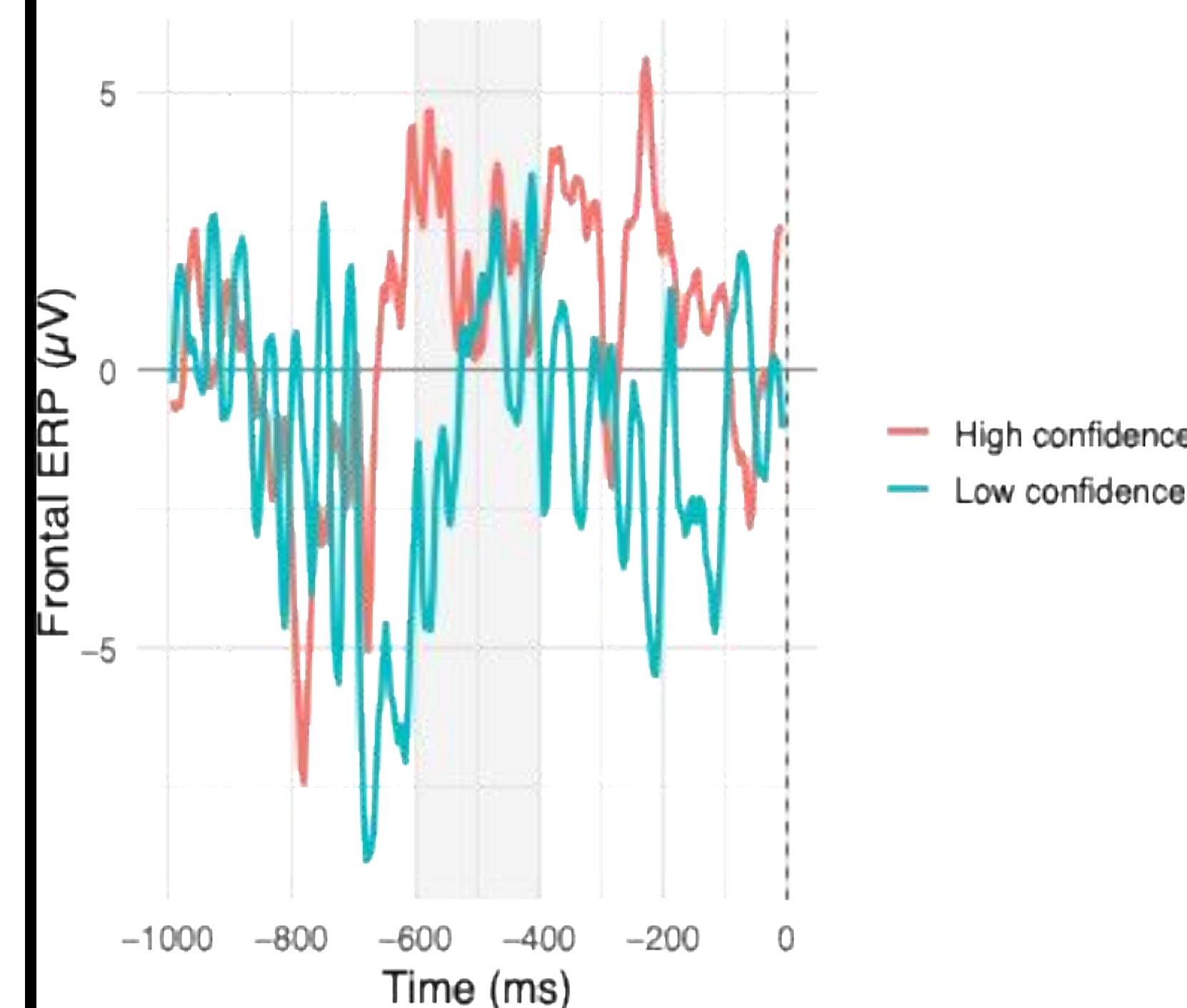
## Analyses

To narrow the scope, participants that most consistently input high confidence responses were placed into the high confidence group, and vice versa for the low confidence group. The EEG data preceding the low confidence responses of the “High Confidence” participants was then excluded, and the EEG data preceding the high confidence responses of “Low Confidence” participants was excluded. While the region for the second preceding response was saved, only the time from -600ms to -400ms was analyzed for peaks as that is when FP is most active preceding decision (Lim et al. 2020). A T-test and a Wilcoxon test were then ran between both the respective groups.



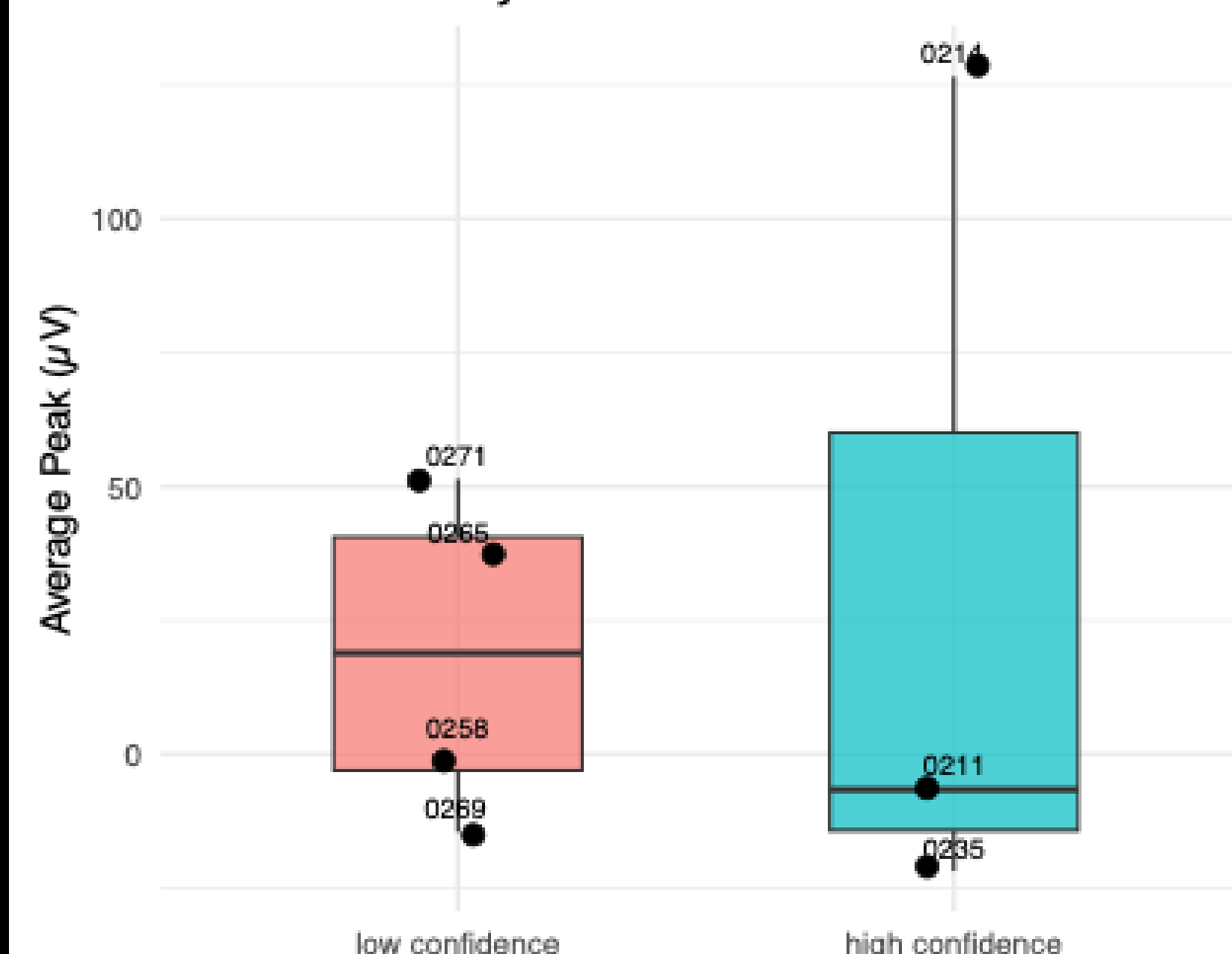
## Results

By Confidence (-1000-0 ms pre-response)



	Mean
Low C	32.7
High C	18.6

Frontal Positivity within 600ms-400ms



	P-value
T-test	0.799
Wilcoxon	0.860

## Conclusions

### Interpretation

- The FP of the higher confidence participants and lower confidence participants exhibited no statistical difference prior to response with a  $p = 0.799$  and Hedge's  $g = 0.208$  just in the opposite direction of prediction.

### Limitations

- Limitations include small sample size, limited number channels, and only two bins of confidence.

### Future Areas of Study

- Such a result highlights the need for further research into feasible ways of measuring real-time confidence to incorporate broader scalp analyses and trial-level modeling, and test additional neural markers and task designs. Clarifying whether these potential shared substrates can be easily measured within context will inform the design of EEG based indicators of students' self knowledge.

### Takeaways

- Presented opportunity to develop coding and data analysis skills
- Drove me to focus more on mechanistic side of neuroscience

## References

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