

# Consumer-Based EEG Devices—Are They Mind-Wandering?

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## Introduction

Mind-wandering (MW) occurs when one's attention drifts away from the immediate task at hand. Recently, consumer-based EEG headsets have been used by professional athletes to monitor concentration during training and by schools to detect students' attention level in class. But how these one-size-fits-all devices with sparse semi-dry electrodes compare to conventional scalp EEG caps in terms of efficacy remains unclear. This study investigates whether the EMOTIV Insight device distinguishes the brain states during attention and MW.

## Materials and Methods

### EMOTIV Insight 5 Channel Mobile EEG<sup>[3]</sup>

- Sensor: Hydrophilic semi-dry polymer
- Electrode: T7, AF3, Pz, AF4, T8
- Frequency response: 0.5-43Hz
- We collected data on four brainwaves: Delta (1-4 Hz), Theta (5-7 Hz), Alpha (8-12 Hz), and Beta (13-30 Hz).
- Recent EEG studies found that MW is associated with a general *higher* Alpha wave power<sup>[3]</sup> and *higher* Theta/Beta Ratio (TBR) in frontal regions.<sup>[4]</sup>

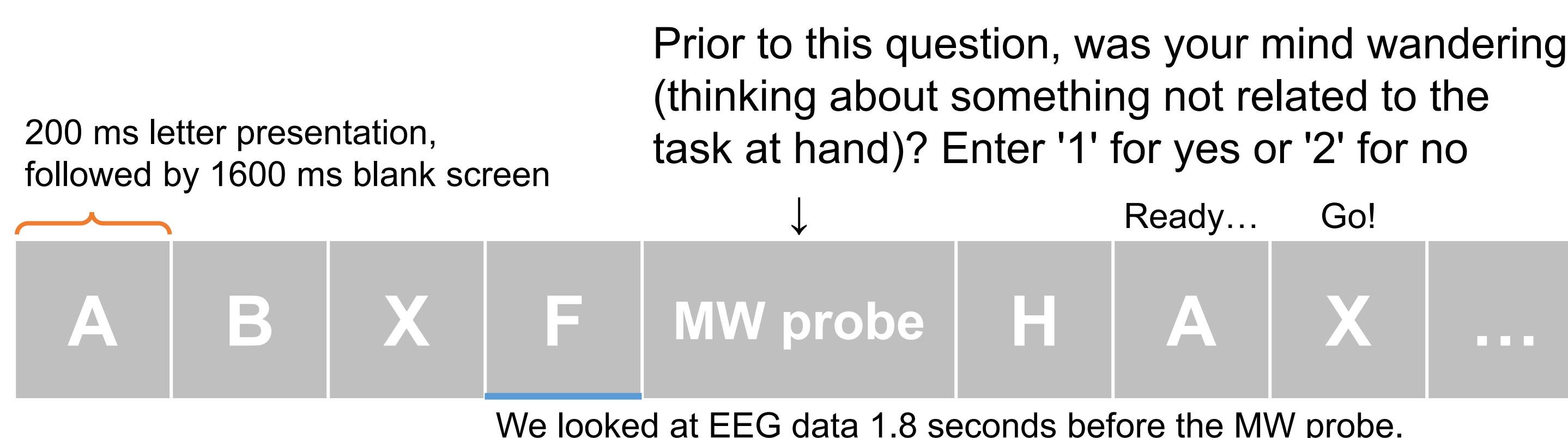


### Participants

- N = 17; M = 26.53 years, SD = 13.62; 6 female; 47% East Asian; all right-handed

### Task<sup>†</sup>

- 3 blocks of the AX-Continuous Performance Test (press the spacebar for any letter 'X' immediately preceded by an 'A')<sup>[1]</sup>
- 21 pseudo-randomly placed MW probes



## Results

- For within-subject comparison, we only included participants who reported both 'Yes' and 'No' MW Responses (MWR; see Table 1).

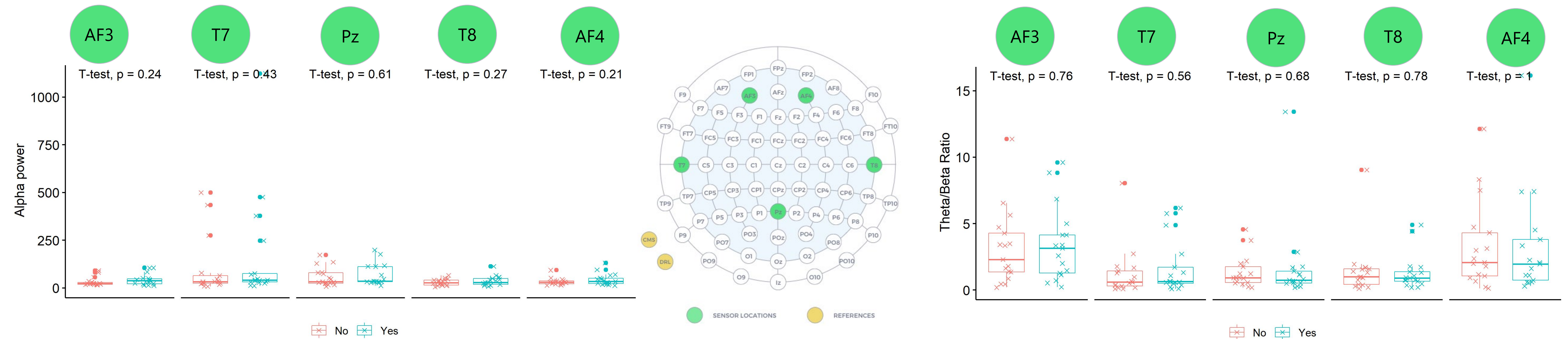
MWR	Mean (SEM)	Median	Min
Yes	9.3 (1.3)	10.5	1
No	11.7 (1.3)	10.5	4

Table 1. Descriptive statistics of participants' (N = 18) response to Mind-Wandering prompts (total = 21).



### Repeated measures ANOVA with MWR and Electrode as factors

- Alpha power: difference between 'Yes' (M = 70.38, SD = 17.35) and 'No' (M = 49.88, SD = 9.76) trials was trending toward significant,  $F(1, 16) = 4.072, p = .061$ . The interaction between MW Response and Electrode (AF3, T7, Pz, T8, AF4) was not statistically significant,  $F(4, 64) = 1.667, p = .215$ .
- TBR: no statistically significant difference between 'Yes' and 'No' trials,  $F(1, 16) = 0.145, p = .709$ . The interaction between MWR and Electrode (AF3, T7, Pz, T8, AF4) was not statistically significant,  $F(4, 64) = 0.516, p = .591$ .



## Discussion

- Based on relevant EEG studies in the literature, we chose to examine the Alpha power and frontal Theta/Beta Ratio between mind wandering and attention on task.
- We expected higher Alpha power and higher TBR during mind wandering, but the result was not significant.
- Our finding raises the questions of whether the consumer-based EMOTIV Insight EEG headset can collect the same brain activity patterns as those collected from conventional scalp EEG caps, and of whether consumer-based EMOTIV EEG data provide meaning bases for decoding people's brain states.

## Future Directions

- We are trying to replicate a more well-studied effect, the P300 wave,<sup>[5]</sup> to help us test the efficacy of EMOTIV Insight.
- In the future, we might conduct a direct comparison between consumer-based EEG and conventional scalp EEG.
- We also plan to run similar validation studies using different brands' consumer-based EEG devices.

### Disclosure

This research is not funded by any consumer-based EEG company including EMOTIV.

### Acknowledgements

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### Notes

<sup>†</sup> As part of a broader project, after the AX-CPT, we showed participants pictures from International Affective Picture System (IAPS) and asked their feelings.

### References

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