Efficacy of Consumer-Based EEG Devices for Conducting Future Research

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Introduction

Attention is selective concentration on a particular task or piece of information, and has a large effect on performance. Mind-wandering occurs when attention veers away from the task at hand. High grade EEG devices have been used to investigate attention, mind-wandering, and emotion. With consumer-based EEG devices now more accessible, this study aims to determine if the these devices (specifically the EMOTIV Insight device) are able to distinguish between varying brain states.

Materials & Methods

Participants

•For mind-wandering and emotion detection we had 17 participants (M_{AGE} = 26.53, SD_{AGE} = 13.62; 35% female; 47% East Asian; All right-handed)

Study Protocol

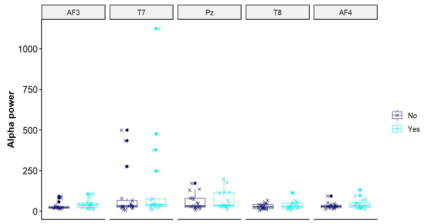
•Participants were fitted with the EMOTIV Insight Mobile EEG device with T7, AF3, AF4, T8, & Pz hydrophilic semi-dry polymer electrodes, with a frequency response of 0.5 - 43Hz.

•Participants completed the Continuous Performance Test (CPT; not presented in this poster)[1] to assess attention, with Pulse-Caught self-report mind-wandering throughout to measure external/internal attention.

•Participants then randomly viewed three different sets of images from the International Affective Picture System (IAPS) chosen to elicit different emotions (positive, negative, neutral), and after each set they were given questions to self-report current emotional states (valence, arousal, dominance) through the Self-Assessment Manikin (SAM).

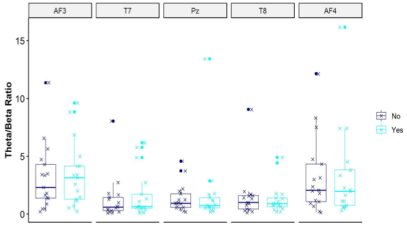
•We recorded data on 4 brainwaves: Delta (1-4 Hz), Theta (5-7 Hz), Alpha (8-12 Hz), & Beta (13-30 Hz).

Results



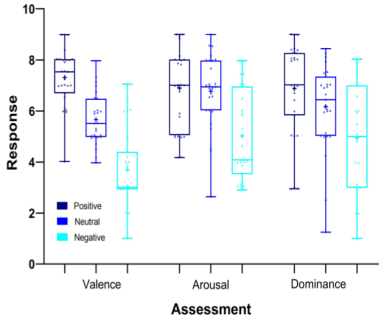
Mind-Wandering: Alpha Power

Difference between 'Yes' (M = 70.38, SD = 17.35) & 'No' (M = 49.88, SD = 9.76) trials was trending towards significant, F(1, 16) = 4.072, p = .061. The interaction between MW Response & Electrode (AF3, T7, Pz, T8, AF4) was not statistically significant, F(4, 64) = 1.667, p = .215.



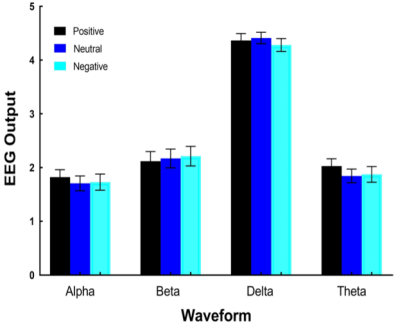
Mind-Wandering: Theta/Beta Ratio

No statistically significant difference between 'Yes' and 'No' trials, F(1, 16) = 0.145, p = .709. The interaction between MW and Electrode (AF3, T7, Pz, T8, AF4) was not statistically significant, F(4, 64) = 0.516, p = .591.



Emotional Behavioral Reactions

Repeated measures ANOVA between the Emotional stimuli (Positive, Negative, & Neutral) and Assessment (Valence, Arousal, & Dominance) was statistically significant, $F(4, 234) = 2.999$, $p = 0.019$. Positive stimuli had significantly higher ratings of Valence compared to both Neutral & Negative stimuli (all $p \leq .001$). Both Positive & Neutral stimuli had significantly higher ratings in Arousal & Dominance compared to Negative stimuli ($p < .001$ & $p \leq .016$ respectively).



Emotional Brain Activity:

The difference in average activity across all 5 electrodes was not statistically significant for any waveforms of interest.

Discussion

•The results from our experiment at this time are mixed as we have some results going towards trending, and others were non significant.

•Our findings bring up the discussion about the validity of the consumer-based EMOTIV headsets in collecting the same data as the conventional scalp EEG caps. Our findings raise questions about whether these devices can accurately decode brain states.

Acknowledgements

Graph & images: Shenyang Huang, Claire Simmons.

[1] Barch D et al. Dissociating working memory from task difficulty in human prefrontal cortex. Neuropsychologia. 1997 Oct 1;35(10):1373–80.

[2] Compton R et al. The wandering mind oscillates: EEG alpha power is enhanced during moments of mind-wandering. Cogn Affect Behav Neurosci. 2019 Oct 1;19(5):1184–91.

[3] van Son D et al. Frontal EEG theta/beta ratio during mind wandering episodes. Biol Psychol. 2019 Jan 1;140:19–27.