

Mechanisms and Impacts of Brain-Computer Interface Fatigue in Children

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Introduction: Brain-computer interfaces (BCIs) can assist children with disability with communication, environmental exploration, and game play [1]. BCI progress is rapidly accelerating but has neglected pediatric populations [1,2]. Fatigue is a key performance factor [2,3] and a common side effect reported by patients and families within our pediatric clinical BCI program. This study aims to assess the effects of BCI operation on self-reported fatigue and explore previously associated electroencephalography (EEG) fatigue biomarkers, such as alpha bandpower changes [4], in children.

Materials & Methods: Thirty-five healthy children were recruited (median age 10 yrs, range 6-16, 19 females) for this randomized prospective cross-over study. Participants played a P300 or motor imagery (MI) computer game using an EEG-BCI in two sessions and attended a third video viewing session (control). Self-reported fatigue was measured using a 10-point visual analog scale before and after each session. EEG was measured in resting state periods before and after the task and analyzed for alpha bandpower. Preliminary statistical analysis was done using mixed modelling.

Results: Procedures were generally well tolerated with no serious adverse events. Headset discomfort was common (63%) but only precluded completion for one individual. Training classification accuracy for MI and P300 respectively were 59% and 93% (n=24). The P300 control scheme was associated with greater increases in self-reported fatigue compared to the control condition. MI paradigm fatigue scores demonstrated greater variability and the mean did not differ from controls (Fig.1A). The alpha bandpower tended to increase across the video and P300 sessions but decreased across the MI session. There were no significant differences in the alpha change between session types (n=13; Fig. 1B). Further alpha band analysis will be completed along with EEG entropy quantification.

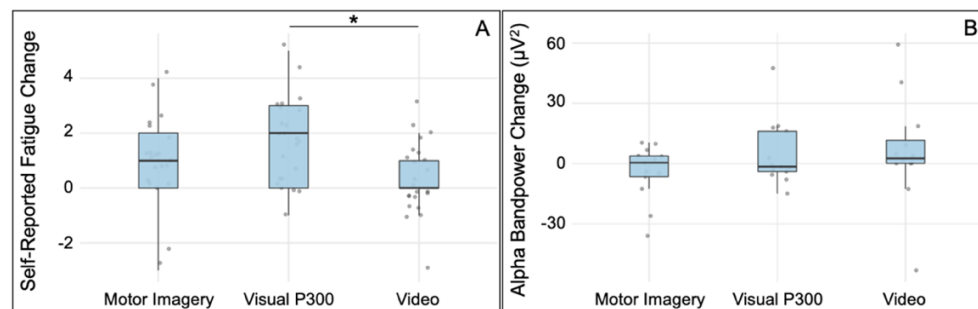


Figure 1. A. Difference (post task – pre task value) in self-reported fatigue following a 30-minute BCI or video viewing task measured on a 10pt visual analog scale. B. Alpha bandpower (8-12Hz) difference in the resting-state period before and after the 30-minute BCI or video viewing task (post task – pre task). Plots show IQR and median. * $p=0.005$.

Discussion: Fatigue is measurable in children performing common BCI paradigms. Preliminary data indicates that BCI may increase fatigue, with intensity varying across paradigms. It remains to be determined whether the alpha bandpower change will show any correlation with the self-reported fatigue values or changes in BCI performance.

Significance: This project provides a baseline understanding of BCI fatigue in children with potential to inform the design of pediatric BCI systems to meet the goals identified by children with disabilities and their families.

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References:

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