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Consumer grade in-ear EEG for at home pediatric BCI

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Introduction: A primary objective for brain computer interface (BCI) research is to develop technologies that end users can use independently in their regular lives, namely at home. Key barriers for at home use identified by BCI users are headset comfort and ease of set up [1]. When comparing EEG headsets for BCI, end users have indicated preference for simple consumer grade headsets over full head research grade EEGs because of increased comfort and reduced setup time [2] (Figure 1). Furthermore, for individuals with thicker curly hair or diverse hairstyles, full head EEGs often underperform due to interference with the user's hair, thus making traditional scalp-based EEG headsets inequitable [3]. Fortunately, in-ear EEG may provide a solution. In-ear EEGs record a single channel that is comparable to a low-channel scalp EEG system [4]. Due to the low profile of these headsets (similar in size and shape to earbuds), these headsets are easy to set up, feel familiar to caregivers and users, and do not conflict with the user's hair or wheelchair headrest making them far more comfortable for prolonged wear. Thus, these headsets may be a viable solution to reduce barriers to at home BCI use. However, in-ear EEG systems still require additional validation for use in performing various BCI applications. In this study, we compare a consumer grade in-ear EEG to a research grade full head EEG to determine if in-ear EEGs may be sufficient for BCI use at home.

Materials and Methods: An in-ear, commercially available EEG system with audio playing capabilities was selected for this validation study (Headset 1). Typically developing young adult participants simultaneously wore both the in-ear headset and a gold-standard research-grade EEG headset for recordings (Headset 2). We have intentionally obscured the names of these two headsets to ensure fair validation of the systems, but can provide additional information on request. Participants were presented with commonly used BCI paradigms (auditory and visual P300, ASSR, and SSVEP) while EEG data was recorded. The resulting EEG data were then processed and classified offline with identical processing procedures. Across the two headsets, correlations between EEG data and classifier performance were compared to determine performance of the in-ear EEG compared to the gold-standard. Data collection and analysis are currently ongoing.

Figure 1: *For some children, full head EEG headsets conflict with wheelchair headrests requiring additional supports and/or braces.*

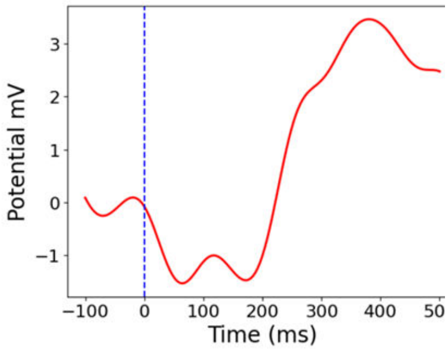

Figure 2: *An averaged auditory P300 response from one participant recorded from Headset 1*

Results and Conclusion: Initial analysis (n=3) of the EEG signal from the in-ear EEG indicates that in-ear EEG appears to be able to detect the large positive inflections indicative of the P300 response (Figure 2). Further investigations into real time classification performance are being conducted to determine if consumer in-ear EEGs may be a viable long-term solution for comfortable, equitable, and easy to use EEG for at home BCI applications for children.

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