# Comparison of BCI headsets for at-home use by children with complex needs

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*Introduction*: Access to simple BCI systems at-home are increasingly showing positive impact for children with complex physical disability [1]–[3]. However, current headset design does not target children or the home and there is pressing need to evaluate BCI headsets for children capable of advanced BCI control paradigms. This work aims to compare candidate headsets across several metrics: signal quality, ergonomic design, cost, and usability to identify strengths and drawbacks that may affect at-home BCI use by children and families.

*Materials, methods and Results*: Candidate headsets were selected based on feedback from children, families, clinicians, and BCI experts in the clinical BCI4Kids program [3]. Primary inclusion properties were to be wireless, dry (or gel-free), and require limited set-up. Headsets were evaluated by BCI experts (n=5) on EEG quality, and self-reported measures of tolerance (1-10; unnoticeable to unbearable) and aesthetics (1-10; unappealing to very pleasing) EEG was recorded under 3 conditions: at-rest, intentional artifact induction (head rolling), and attending to a visual stimulus (steady-state LED flashing at 10 Hz). Resting EEG quality was evaluated using the EEG quality index (EQI) [4] compared to a gel-based standard BCI headset serving as a control A modified signal-to-noise ratio (SNR) was computed for occipital electrodes (Pz/O1/O2 as available) during the visual stimulus trials against control the headset.

EQI of resting-state EEG revealed large per-subject variance across headsets (Fig 1.A), with a trend revealing HS3 and HS5 performing lowest across channels and metrics. All headsets showed positive SNR amplitudes (Fig. 1.B) in response to the visual stimulus. However, headset 5 again had a smaller SNR compared to the rest. HS3 was unanimously the most comfortable (1.17 ± 0.41) and the most aesthetically pleasing (7.00 ± 1.55).

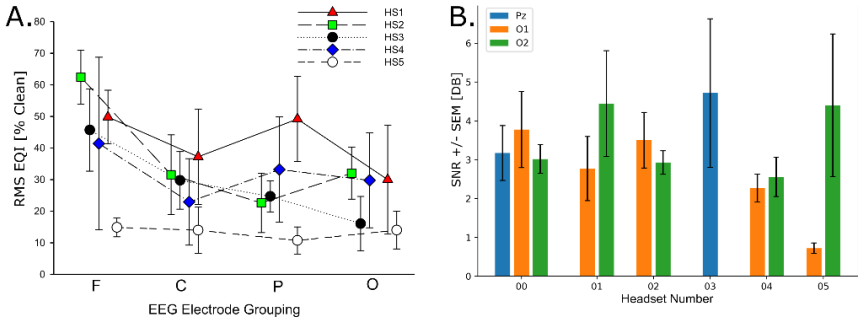


*Fig. 1. A) Root Mean Squared (RMS) EQI Metric for resting data for electrodes in similar locations: F = Frontal, C = Central, P = Parietal, O = Occipital. B) SNR of all headsets including the gel-based standard control (headset 00).*

*Discussion:* No single headset from the candidates stood out as the best option across all lines of investigation. The high variance in EEG quality across channel regions and metrics emphasizes there may not be a one-type-fits-all headset. More personalized evaluation of potential systems should be employed for at-home use by children with end-users engaged to identify the optimal systems for real-world BCI use.

*Significance:* Candidate headsets with potential for at-home use by children with physical needs have variable strengths and weaknesses in their EEG quality, comfort, and aesthetics.

*References*

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