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Comparative Evaluation of Compact and Research-Grade EEG in BCI: P300-Based Visual/Auditory Oddball Tasks

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Introduction: One of the main challenges in the practical adoption of brain-computer interfaces (BCI) is the cumbersome nature of traditional electroencephalography (EEG) systems, requiring extensive setup and wet electrodes. Recently, compact and cost-effective portable EEG devices with dry electrodes have emerged as promising solutions to address these barriers. Devices such as Muse have shown potential in BCI applications, with studies demonstrating their ability to detect ERP components like N200 and P300 [1]. However, systematic evaluations of the signal quality and feature consistency between portable and research-grade EEG systems remain limited [2, 3]. This gap raises critical questions about the reliability of portable devices in extracting and reproducing features comparable to those of high-fidelity systems.

Material, Methods and Results: This study employed LiveAmp system (32 chs, wet type) and Muse (4 ch, dry type). Data were collected from 6 healthy adults (mean age: 24 ± 2.1 years) during P300-based visual and auditory oddball tasks. EEG signals were preprocessed with band-pass filtering (1–40 Hz), segmentation, and artifact removal. P300 response time and peak amplitude were compared for each condition. Additionally, BCI performance was assessed using classification accuracy. LiveAmp signals displayed lower amplitude, faster P300 response times, and cleaner waveforms, while Muse exhibited higher noise levels (Fig. 1). LiveAmp achieved higher averaged accuracy in both visual (0.8554) and auditory (0.8210) tasks compared to Muse (0.6848 and 0.5790, respectively), with differences more pronounced in auditory conditions.

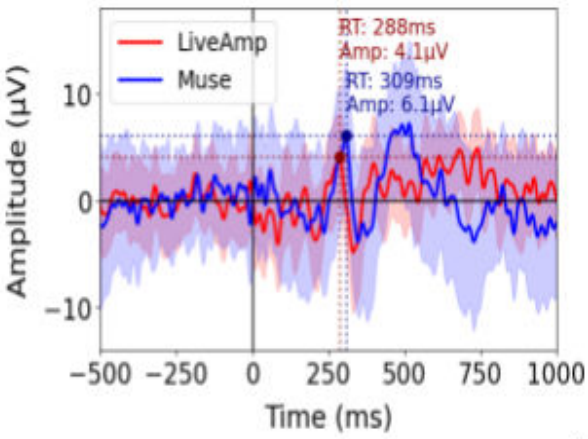

Fig. 1. Example ERP waveform comparison of target signals between LiveAmp and Muse in auditory oddball task (S04).

Conclusion: Muse offers a user-friendly and cost-effective option for basic P300-based BCI tasks but demonstrates lower accuracy, reduced signal amplitude, and delayed response time compared to LiveAmp. While promising for portable applications, improvements in dry-electrode technology are necessary for precision-demanding tasks.

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