Characterizing EEG Artifacts during Real-World Table Tennis

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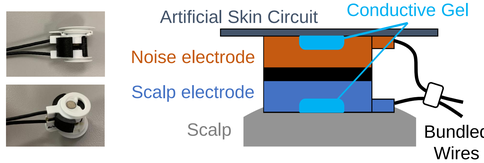
Introduction

- Prior knowledge of artifacts are useful to characterize noise in MoBI studies[1]
- Most experiments examining noise focus on locomotion[2], but gait-related artifacts may differ from discrete, multi-plane movements
- Table tennis is a responsive, goal-directed sport that uses visuomotor feedback, anticipation, strategic decision-making, and object interception

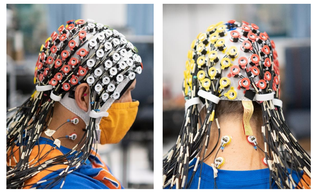
The aim of this study was to **characterize** and **identify strategies to remove artifacts** in EEG data for a whole-body task such as table tennis

Methods

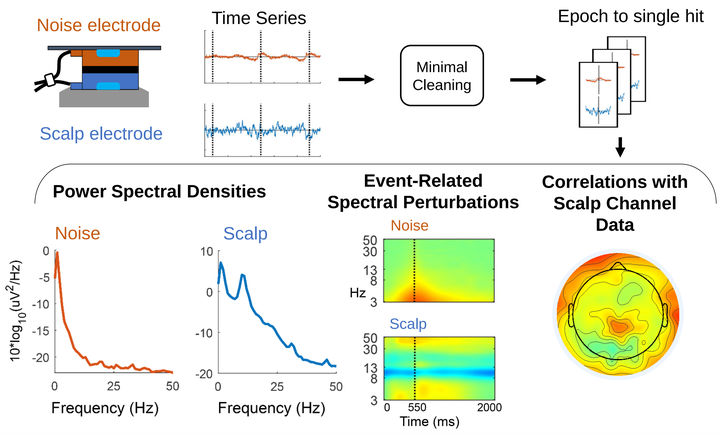
Dual-layer EEG Approach



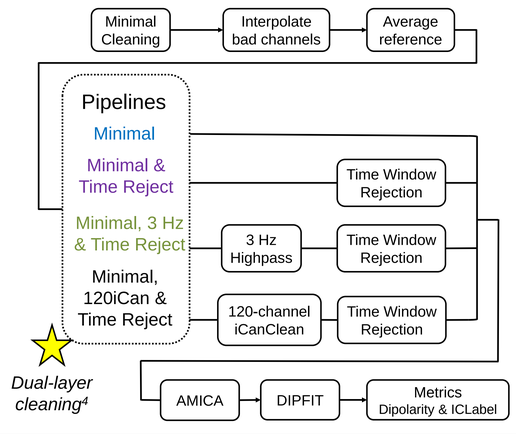
- N=20 participants
- 10 min. standing baseline
- 30 min. with a ball machine (*stationary/moving*)
- 30 min. with a human player (*cooperative/competitive*)
- 120 dual-layer EEG[3], eight neck EMG, 3-axis accelerometer on the head and body
- Accelerometers on paddles, table, net, and machine to mark events



Artifact Characterization

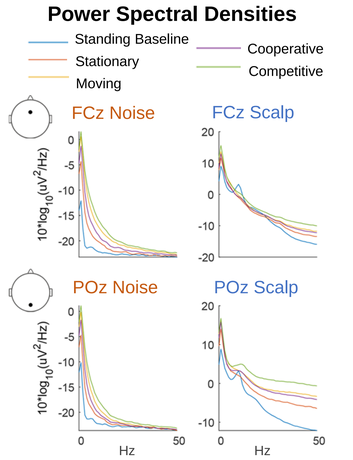


Artifact Removal

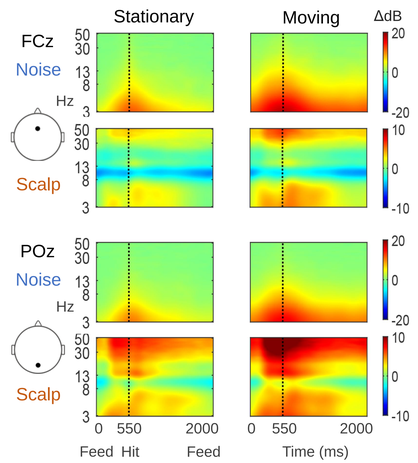


Results

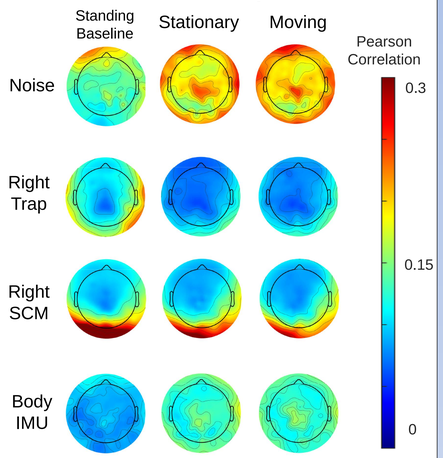
Artifact Characterization



Both layers of electrodes had higher power in low frequencies which increased for more mobile hitting conditions.

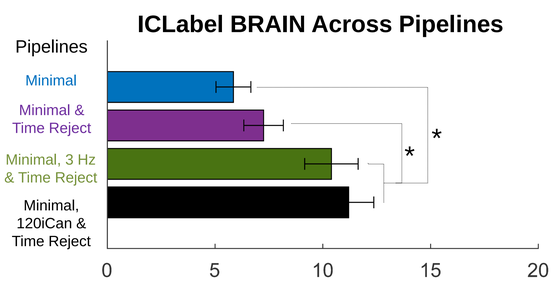


Noise electrodes' change in power were concentrated in low frequencies around the hit event (*moving > stationary*).

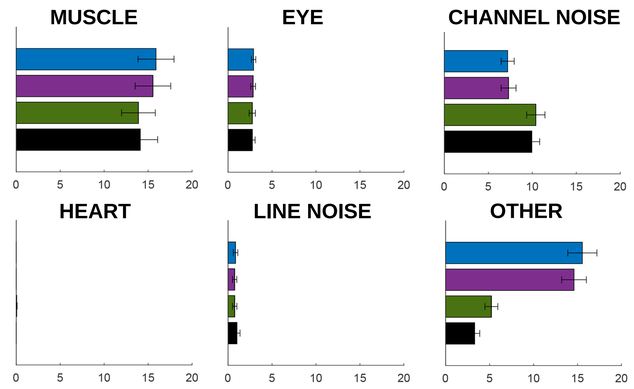


Scalp data correlated less with resultant body acceleration than noise-matched data. Neck muscle activity affected scalp channels at the back and sides of the head.

Artifact Removal



ICLabel classified more components as BRAIN and fewer as OTHER for the dual layer cleaning (black) and 3 Hz high-pass filter (green) pipelines.



The dual-layer EEG approach effectively characterized and removed low frequency motion artifacts which aided in the separation of cleaner brain components.

References: [1] J Kline et al., "Isolating gait-related movement artifacts in electroencephalography during human walking", *J. Neural Eng.*, 2015. [2] N Jacobsen et al., "A walk in the park? Characterizing gait-related artifacts in mobile EEG recordings", *Euro. J. of Neurosci.*, 2020. [3] A Nordin et al., "Dual-electrode motion artifact cancellation for mobile electroencephalography", *J. Neural Eng.*, 2018. [4] RJ Downey and DP Ferris, "The iCanClean algorithm: how to remove artifacts using reference noise recordings", *arXiv:2201.11798*, 2022.

Supported by NSF grant #1835317

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