Deep Learning Models to Attenuate Cochlear Implant Artifacts in Pediatric Cortical Auditory Evoked Potentials

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Background

- Cortical auditory evoked potentials (CAEPs) are essential for determining auditory cortex function in individuals with normal hearing and those with hearing impairment
- Electroencephalographic (EEG) recordings of cochlear implant (CI) users are contaminated by electrical artifacts from CI devices that temporally coincide with CAEPs, thus contaminating the true waveforms (Figure 1)
- This contamination makes the systematic use of CAEPs as an investigational and clinical tool in CI users difficult, if not impossible[1]
- A common approach to attenuate CI artifact in EEG CAEPs involves independent component analysis (ICA)[2], however this approach has analyzer subjectivity and is not statistically robust enough to remove much of the CI artifact

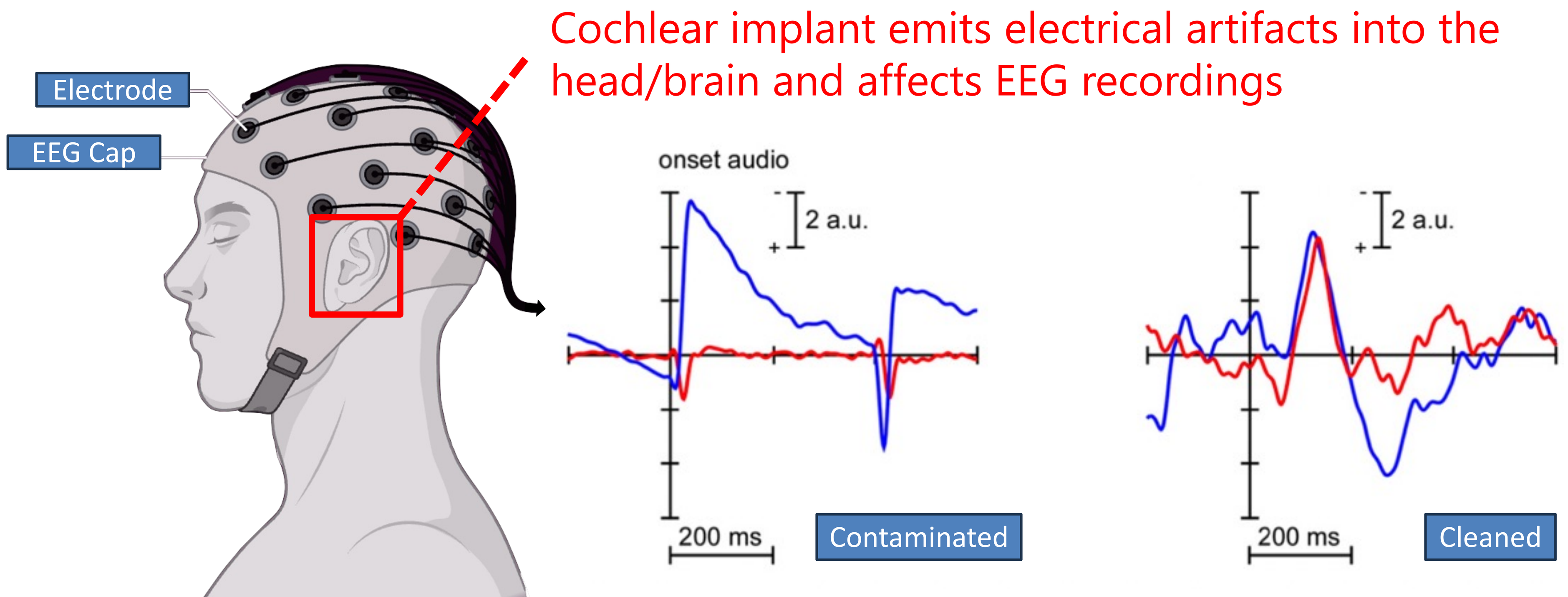


Figure 1. Brain signals (CAEPs) contaminated with electrical artifact from a cochlear implant (Left Panel). Non-contaminated CAEPs in response to an auditory stimulus (Right Panel). Figure adapted from Viola et. al, 2012[3].

Purpose

- To develop a deep machine learning model that attenuates CI artifacts from EEG CAEPs. These CAEPs will more faithfully represent auditory cortex signals as compared with current denoising methodologies.

Methods

- 56 children (28 with normal hearing (NH), 28 with CIs) participated in a passive audio-visual EEG task described by Corina et al., 2022
- Children viewed silent cartoons displayed on a screen while they saw peripherally flashing checkerboards and heard short auditorily presented sentences optimized for eliciting CAEPs (Figure 2)

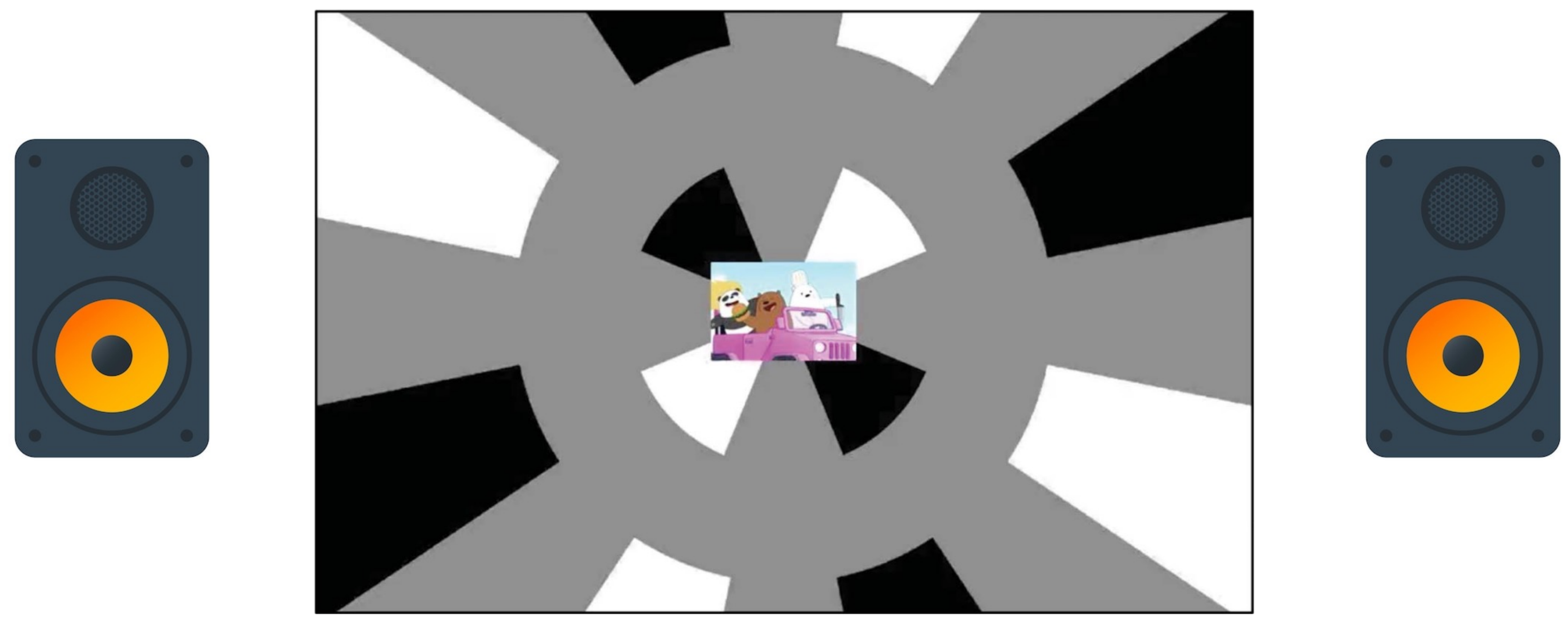


Figure 2. Central cartoon surrounded by an inner ring of eight flashing components and an outer ring of 16 flashing components. Sentences were presented by air-field in auditory and audio-visual trials. Figure adapted from Corina et al., 2022[4].

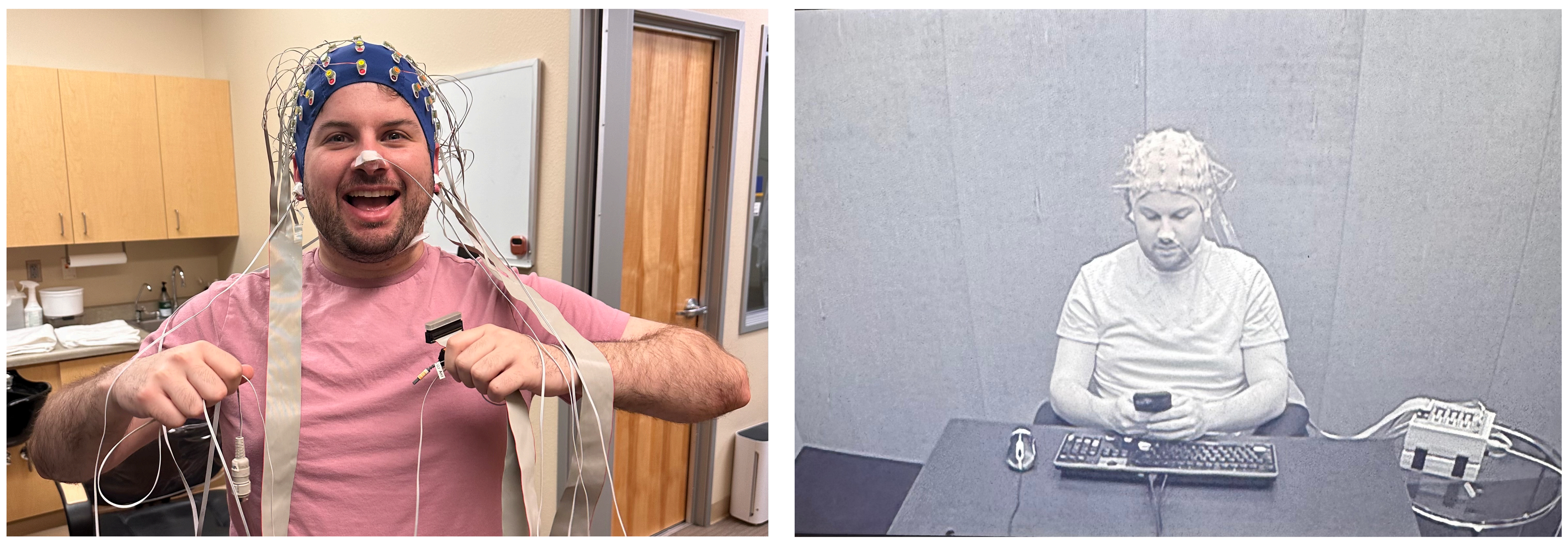
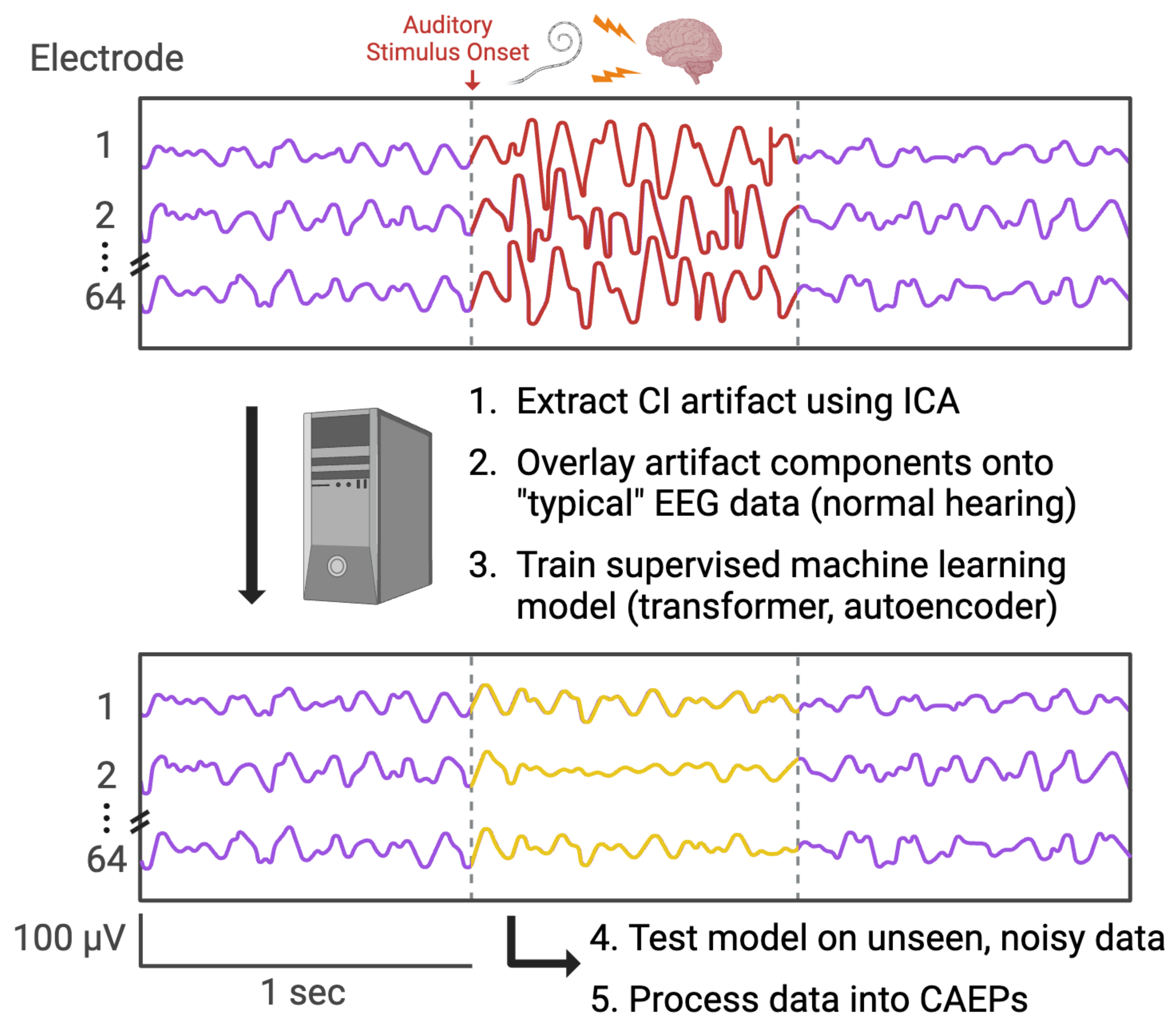


Figure 3. An example of recording EEG auditory and visually-evoked potentials using 64 scalp electrodes and multiple external reference electrodes. These signals are recorded by an acquisition system which tightly links stimulus presentation with evoked potential responses.

Progress

- Understanding EEG: I have learned to set-up, run participants, and process EEG waveforms from start to finish using our BioSemi data acquisition system
- Processing Pipeline: We finished processing our CI EEG data using MATLAB/EEGLAB and ICA algorithms, and are currently in the process of stitching together artifact components onto NH data



Future Directions

- After stitching together artifact components with EEG data from NH kids, we will implement machine learning architectures (e.g., transformer, complex-valued denoising autoencoder) using array-based or spectrogram-based approaches
- We will compare the efficacy of our models to different denoising methods and validate accuracy with known biomarkers of auditory cortex development

References

For a list of references, please scan the QR code or visit: *https://bit.ly/ucdsom_msrf24_CIdenoising*

Acknowledgements

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