CIAP 2021 - Abstract

Title: Neural tracking of the speech envelope in cochlear implant users

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Abstract:

Electrophysiological measures in response to auditory stimuli have great potential for objectively assessing auditory functioning in cochlear implant users and fitting implant settings accordingly. However, current clinical applications are limited to using short, transient stimuli which target the periphery of the auditory system, such as the auditory nerve (ECAPs) or responses from the brainstem (EABRs). Responses to continuous stimulation at clinical rates, for instance, modulated tones (EASSRs) reflect frequency-specific higher-level processing in the auditory pathway. However, none of these techniques make use of ecologically valid stimuli such as natural running speech.

The temporal envelope of a speech signal, one of the most important cues for speech intelligibility, is tracked by the listener's brain. Studies with normal hearing participants have shown that this neural representation of the envelope can be decoded from electroencephalographic (EEG) recordings, and that the outcome of this decoding analysis relates to speech intelligibility. This forms the basis for a newly developed objective measure of speech intelligibility which can also be applied to cochlear implant users. Furthermore, this method enables assessment of speech envelope encoding in the auditory pathway, which is appealing to apply to cochlear implant users as current stimulation strategies mainly rely on encoding envelope information.

The major challenge in applying EEG-based neural envelope tracking methods in cochlear implant users is the presence of electrical stimulation artifacts originating from the cochlear implant itself. When presenting a speech stimulus at clinical rates, these artifacts are temporally overlapping. Furthermore, the stimulus artifacts contain the same modulated envelopes as the stimulus and are thus highly correlated with the targeted neural responses, making their interpretation challenging due to false positives.

In this contribution, we will present an overview of our work to translate neural envelope tracking methods to cochlear implant users. Using new techniques to reduce or avoid the effects of electrical stimulation artifacts, we demonstrated that envelope tracking can be measured in cochlear implant users, and that the obtained measures reflect the intelligibility of the speech stimulus. Efficacy of artifact removal is evaluated in multiple ways, for instance making use of subthreshold stimulation. Furthermore, interpretations of the envelope tracking models reveal interesting information about the temporal and spatial dynamics of how the electrically stimulated brain responds to speech.

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