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Abstract	
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Comparison of artifact suppression methods for the measurement of electrically evoked auditory steady-state responses

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Electrically evoked auditory steady-state responses (EASSRs) are currently being investigated for objective cochlear implant (CI) fitting, the development of stimulation strategies, and studying auditory maturation and plasticity in CI subjects. EASSRs can be detected in the electro-encephalogram (EEG) in response to periodic (modulated) pulse trains presented through the CI. However, the EEG is obscured by electrical artifacts, that may also be present at the response frequency and that are caused by (1) the implant's radiofrequency link, and (2) the electrical stimulation pulses. Their characteristics are subject and stimulus dependent, and vary depending on the stimulation mode.

A number of CI artifact suppression methods have been developed in our lab, with the aim of suppressing CI artifacts in all recording channels for clinically used high-rate stimulation in monopolar mode. The first method is based on a linear interpolation over the CI artifact duration. The underlying assumption is that the CI artifact is short enough such that for each stimulation pulse two samples free of CI artifact can be found. The second method is based on independent component analysis. It is assumed that CI artifacts and EASSRs are statistically independent, such that they can be separated by minimizing the mutual information. The third method is based on template subtraction: templates are constructed for each subject in every recording channel, based on a response-free measurement. The constructed templates are subsequently subtracted from the recording of interest. This single-channel method has the potential of suppressing CI artifacts in EASSR measurements, without imposing

many assumptions on the CI artifact morphology, and only assuming that CI artifacts are stationary within one recording session.

The three CI artifact suppression methods have been applied to the same dataset, consisting of EASSRs with high-rate stimulation in monopolar mode at comfort level for various modulation frequencies in the 30-50 Hz range. The performance of each method and trade-offs will be discussed. As expected, the linear interpolation method cannot sufficiently suppress CI artifacts in ipsilateral recording channels for high-rate stimulation. The second method, based on independent component analysis, can reliably suppress CI artifacts in ipsi- and contralateral channels in case the contralateral hemisphere is response dominated. However, a multichannel EEG acquisition system is needed. The third method, based on template subtraction, reliably suppresses CI artifacts in ipsi- and contralateral channels for high-rate stimulation at comfort level in monopolar mode.

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