Frequency following responses in cochlear implant users

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For acoustic stimulation, auditory processing at brain stem level can be investigated through frequency following responses (FFRs). FFRs are auditory evoked electroencephalogram (EEG) potentials, generated by the brain stem, that literally follow the frequency of the evoking stimulus. Measuring FFRs for cochlear implant (CI) users is challenging, as the electrical stimulation of the CI causes large artifacts in the registered EEG signal. These artifacts obscure the neural response and moreover, can be mistaken for a response. Previously, our lab has developed a method to reliably measure cortically dominated auditory evoked potentials in CI users, i.e., electrically evoked auditory steady-state responses (EASSRs). There, the same problem was solved through a number of artifact reduction techniques (a.o. based on blanking and interpolation ([1], [2])). We investigate (adaptations of) these techniques to allow the measurement of electrically evoked frequency following responses (EFFRs) as well.

A first attempt to measure EFFRs was part of a previous study in our lab, which investigated the effect of modulation frequency (1-100 Hz) on auditory evoked EEG potentials [3]. Cortical areas of the auditory system do not phase-lock to modulation frequencies as high as 80-100 Hz. As a result, auditory responses to these fast modulations are strongly dominated by activity at brain stem level. In this study very few significant responses were found for modulation frequencies between 80 and 100 Hz, but measuring EFFRs was not the focus of the research.

The goal of the current study was to verify the feasibility of measuring EFFRs with high-rate amplitude modulated pulse trains (modulation frequencies equal to 80 and 100 Hz) and unmodulated low-rate pulse trains (pulse rate equal to 80 pps and 100 pps). In contrast with the previous study, results show that significant EFFRs can be measured in response to both the amplitude modulated and low-rate electrical pulse trains for stimulus frequencies of 80 Hz and 100 Hz (and even up to 500 Hz in pilot studies). Moreover, low-rate pulse trains seem to cause responses with higher amplitudes and signal-to-noise-ratios than amplitude modulated pulse trains, confirming expectations based on pilot studies in normal hearing subjects. Final results and conclusions will be presented at the conference.

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<u>References</u>

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