15_113

T13: THE MODULATION FREQUENCY TRANSFER FUNCTION OF ELECTRICALLY EVOKED AUDITORY STEADY-STATE RESPONSES

Robin Gransier[1], Hanne Deprez[1,2], Michael Hofmann[1], Tom Francart[1], Marc Moonen[2], Astrid van Wieringen[1], Jan Wouters[1]

[1]ExpORL, Dept. of Neurosciences, KU Leuven, Leuven, BEL

[2]STADIUS, Dept. of Electrical Engineering, KU Leuven, Leuven, BEL

Minimum (T-level) and maximum (C-level) electrical stimulation levels vary across stimulation electrodes and cochlear implant (CI) recipients. The determination of these subject and electrode dependent stimulation levels can be challenging and time-consuming, especially in recipients who cannot give reliable behavioral feedback. An objective method to determine the electrical stimulation levels would be of great value. Because T-levels are pulse rate dependent it is a prerequisite for an objective method to use the same pulse rates as are used in clinical devices [500-1200 pulses-per-second (pps)]. Electrically evoked auditory steady-state responses (EASSRs) could potentially be applied to objectively determine the high-pulse rate T-levels of CI recipients. EASSRs are periodic neural responses that can be elicited by modulated high-rate pulse trains. In order to make EASSRs clinically applicable, insight needs to be gained in which modulation frequencies evoke the highest responses.

We measured the modulation frequency transfer function (MFTF) in five awake adult CI recipients. All subjects had a Nucleus® device. Monopolar stimulation was used with both the external ball electrode and the casing of the stimulator as ground electrodes. Intracochlear electrode 11 was used as the active electrode. A 500 pps pulse train was modulated with 43 different modulation frequencies to measure the MFTF from 1 to 100 Hz. This range was chosen to compare our results with the ASSR MFTF of normal hearing adults, which has clear peak in the 40-50 Hz range. EASSRs were measured with a 64-channel EEG setup. The blanking method [Hofmann and Wouters, 2012, JARO, 13(4), 573-589] was used to remove the stimulation artifacts, resulting from the electrical stimulation pulses, from the EEG recordings. Hotelling's T-squared test was used to test if the response at the modulation frequency differed significantly from the background activity. For Nuclues® devices EASSRs can be measured free from stimulation artifacts in bipolar mode (stimulation between two intracochlear electrodes). In monopolar mode, however, stimulation artifacts are larger in amplitude and longer in duration, and are difficult to remove from the EEG recording. The phase delay was used to assess the presence of stimulation artifacts after blanking. The absolute phase delay of the EASSR increases with increasing modulation frequency whereas the phase delay of the stimulation artifact remains constant.

Results show that EASSRs can be measured free from stimulation artifacts by recording electrodes located in the hemisphere contralateral to the implant. For these contralateral electrodes, the absolute phase delay of the significant EASSRs increased with increasing modulation frequency. Recording electrodes positioned in the ipsilateral hemisphere showed significant responses for all modulation frequencies. These responses had a constant phase delay, indicating an artifact-dominated response. Modulation frequencies which evoked the highest responses were within the 30-50 Hz range. This range is line with the MFTF obtained from normal hearing adults reported in literature.

Acknowledgements: Research was funded by the Research Foundation Flanders (G.0662.13) and a Ph.D. grant to the first author by the Agency for Innovation by Science and Technology (IWT, 141243).