Recording Electrically-evoked Auditory Brainstem Responses (EABR) in Human Cochlear Implant Subjects

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Abstract – Auditory Brainstem Responses (ABR) and Electrically-evoked Auditory Brainstem Responses (EABR) are two closely related exogenous auditory evoked potentials (AEP) elicited from EEG measurements [1]. ABR is used as a hearing screening tool for newborns [2] and general hearing loss [3], while EABR is used in cochlear implant (CI) intraoperative monitoring [4] and speech processor tuning [5]. Here, a battery operated handheld audiometry device, Sentiero (Path Medical Gmbh), is tested for its suitability as an EABR device in addition to ABR. Due to the similarity in techniques, research conducted in one AEP is often beneficial to the other.
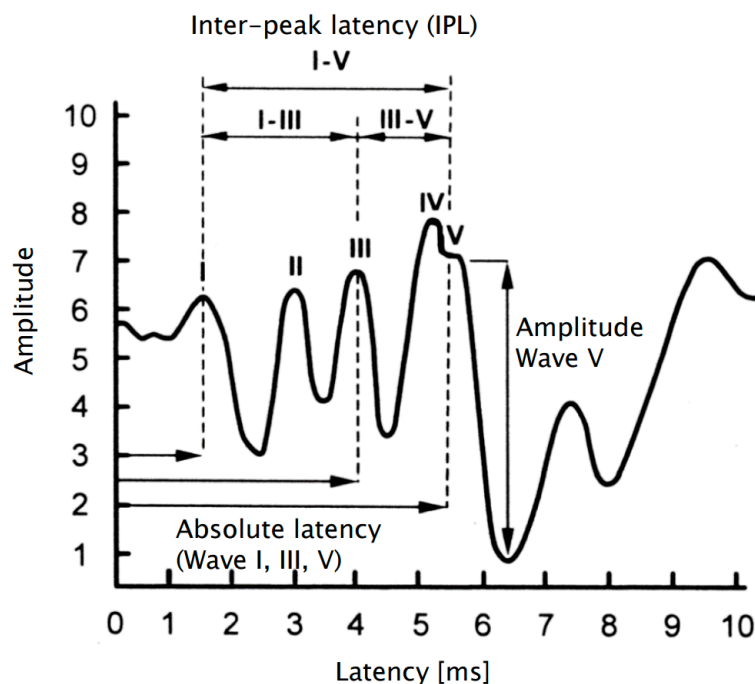
Fig. 1 Classical example of the Jewett Waves obtained during an ideal ABR. The absolute latency of Wave V as well as the inter-peak latencies are considered most important for diagnostics.

Currently, an investigation into ABR functionality is complete. Using ABR data obtained from the author at varying decibel levels and stimulation rates, suggestions carried out by earlier research are tested. The Sentiero audiometry device from Path Medical is used in conjunction with Matlab to record the EEG data from ABR measurements.
Digital filtration is performed and varied about recommended levels. Rejection of epochs contaminated by muscle artifacts by thresholding absolute values versus variance is examined, as

well as existing algorithms for optimal rejection rates. Methods of testing for statistical significance found in various papers are compared. Signal to Noise (SNR) calculations are tested and their interactions with previously mentioned factors established.

A band-pass filter between 0.15 and 2 kHz appears the most effective at elucidating the waves. Removal of epochs outside of a normal distribution's +/- 3 sigma significance level is deemed more time efficient than other algorithms. The Single Point Sign Test as well as an adapted Wilcoxon Test appear able to locate regions of high interest, although showing strong variability with differing filter levels. A previously used SNR calculation method, weighted non-stationary fixed multiple-point estimation, is deemed more suitable than previous methods, although it shows poor correlation with thresholding.

Clinical trials with EABR are awaited in the next month. Research continues in clinical trials of the Sentiero device and its suitability as an EABR device aside from existing ABR functionality. Data will be obtained from post-lingually deafened adult CI users who are native German speakers in a method similar to Bahmer et al [6].

The use of wavelets as a post-processing feature will also be examined. While wavelets have been used extensively in attempts to recover EEG features [7, 8], a proposed method from EMG artifact elimination [9] will be used to trigger data from stimulation artifacts in EABR and eliminate them as well.

References

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