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Fast detection of ABR- responses using neural synchronization stability and single sweep analysis

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Background:
The evaluation of auditory brainstem responses (ABRs) is accepted to be one of the most reliable methods for the objective diagnosis and quantification of hearing loss in newborns. However, in currently available devices, a large number of sweeps has to be used to obtain a meaningful signal at low stimulation levels. Due to the time consuming averaging procedure which requires the state of spontaneous sleep, sedation, or even narcosis of the newborns, the detection of ABR thresholds can only be used at the last stage of area-wide universal newborn hearing screening programs. Consequently there is a need for expensive follow up systems increasing their implementation cost significantly and thus making their realization impossible in many cases. The solution would be the detection of ABR threshold in the first screening stage by a very fast detection algorithm.

Methods:
30 normal hearing children (mean age 5;9 years) were included in the study. Brainstem evoked potentials were obtained at a stimulation level of 30 dB HL (ISI 64ms) as well as for a no stimulation condition. 250 single sweeps were obtained from right ear stimulation in each subject.

Results:
In all subjects the synchronization stability (Strauss et al. 2004, 2005) as a measure of stability of the response from sweep to sweep was larger in the stimulated condition as compared to the non stimulated condition. Also the synchronization stability was significantly (Wilcoxon test) higher in the stimulated as compared to the non stimulated condition.

Conclusion:
Even at the challenging stimulation level of 30 dB HL the synchronization stability allowed for the dicrimination of the stimulated from the non stimulated condition. Using the synchronization stability a reliable discrimination between the stimulated and the non stimulated condition can be made after 250 sweeps. Due to inter-subject variation, even better results can be obtained by combining the synchronization stability with a artificial learning algorithm such as the kernel based novelty detection.
It is concluded that the proposed method might be used for the ultra-fast detection of hearing thresholds and is thus ideally suited for universal hearing screening programs.