FACULTY OF MEDICINE AND HEALTH SCIENCES

DEPARTMENT OF REHABILITATION SCIENCES

Drs. De Poortere[a], N., Drs. Vande Maele[a], T., Prof. Dr. Keppler[a,b], H., Prof. Dr. Dhooge[b,c], I., Prof. Dr. Verhulst[d], S.

[a]Dept. Of Rehabiliation Sciences, Ghent University, Belgium; [b]Dept. of Ear, Nose and Throat, Ghent University Hospital, Belgium; [c]Dept. of Head and Skin, Ghent University, Belgium; [d]Dept. Of Information Technology, Ghent University, Belgium

EEG-BIOMARKERS IN RECREATIONAL NOISE EXPOSURE

Background

Recent studies have show that temporary threshold shifts (TTS) after noise exposure may not be as benign as previously believed. TTS could co-occur with permanent damage to the inner hair cell synapses, so called synaptopathy, which cannot be detected via the audiogram. This study aimed to investigate to what extent auditory electroencephalogram (EEG) biomarkers, more specifically slow and fast auditory brainstem responses (ABR), can serve as a valid and reliable early indicator of noise-induced hearing loss (NIHL). Therefore, normal-hearing subjects were tested with these biomarkers before and after recreational noise exposure. Firstly, an interclass correlation coefficient (ICC) was determined in order to analyze the reliability of ABR-data by two independent raters who manually determined the ABR-peaks. Secondly, the recovery of these biomarkers after noise exposure was investigated and, finally, the effect of the hearing status on ABR-amplitudes and latencies after noise exposure was evaluated.

Method

19 subjects (18-25 years) attending a music festival (at least 8 hrs)

1-2 days pre event → Music event → 1 day post event → 3 days post event → 5 days post event

- Questionnaire
- Pure tone audiometry
- Speech in quiet
- Speech in noise
- Distortion product otoacoustic emissions (DPOAE)
- Envelope following responses (EFR)
- Click-evoked auditory brainstem responses (c-ABR)
  - 11 Hz 80 dBpeSPL
  - 11 Hz 100 dBpeSPL
  - 120 Hz 80 dBpeSPL
  - 120 Hz 100 dBpeSPL

  (11 Hz 80 dBpeSPL, 11 Hz 100 dBpeSPL: Slow c-ABR; 120 Hz 80 dBpeSPL, 120 Hz 100 dBpeSPL: Fast c-ABR)

1. The ICC was determined by means of an ICC(2,1) model for all sessions and conditions. **2.** The EEG-biomarkers were evaluated at four different sessions before and after the music event by means of two-way variance analyses (dependent variable: ABR-data; independent variables: the use of hearing protection devices (HPD) and session) **3.** The effect of audiometric pre-measurements on ABR-amplitudes and latencies of the first post-session was evaluated, after categorizing the pre-audiometry measurements into three groups, by means of one-way variance analyses (dependent variable: ABR-data; independent variable: hearing thresholds before noise exposure).

Results

1. The analysis of the slow c-ABR all show (very) strongly significant **ICC values** (table 1). For the analyses of the fast c-ABR, lower ICC values were found, especially for wave V (marked in red).

Table 1 : ICC for ABR peak I, III and V amplitudes and latencies measured with different stimuli.

Peak	Session	11 Hz 80 dBpeSPL		11 Hz 100 dBpeSPL		120 Hz 80 dBpeSPL		120 Hz 100 dBpeSPL	
		Amplitudes	latencies	Amplitudes	Latencies	Amplitudes	Latencies	Amplitudes	Latencies
Peak I	Pre	0,894***	0,961***	0,993***	0,802***	0,998***	0,876***	0,961***	0,780***
	Post 1	0,886***	0,987***	1,000***	0,919***	0,864***	0,279	0,494*	0,592**
	Post 2	0,9333***	0,904***	0,999***	0,987***	0,9666***	0,992***	0,986***	0,776***
	Post 3	0,589***	0,961***	1,000***	0,889***	0,997***	0,870***	0,942***	0,840***
Peak III	Pre	0,896***	0,997***	0,956***	1,000***	0,781***	0,755***	0,989***	0,305
	Post 1	0,991***	0,974***	0,990***	0,987***	0,602***	0,349	0,935***	0,639***
	Post 2	0,882***	0,557**	0,992***	0,952***	0,778***	0,988***	0,479*	0,767***
	Post 3	0,942***	0,832***	0,934***	0,488**	0,528**	-0,014	0,958***	0,837***
Peak V	Pre	1,000***	0,975***	0,929***	0,882***	0,932***	0,565**	0,141	-0,008
	Post 1	0,996***	0,997***	0,760***	0,763***	0,863***	-0,021	-0,136	0,314
	Post 2	0,881***	0,969***	1,000***	0,999***	0,986***	0,827	0,127	0,559**
	Post 3	0,998***	0,792***	1,000***	0,868***	0,999***	0,615**	0,165*	0,449*

2. The **amplitudes and latencies of the c-ABR** did not significantly differ between the four sessions before and after the event ($p > 0.05$).

3. In one condition (11 Hz 100 dBpeSPL peak I), a **significant influence of the hearing thresholds before noise exposure** on the c-ABR- amplitudes and latencies of post 1 session, was detected ($p < 0.05$) (figure 1).

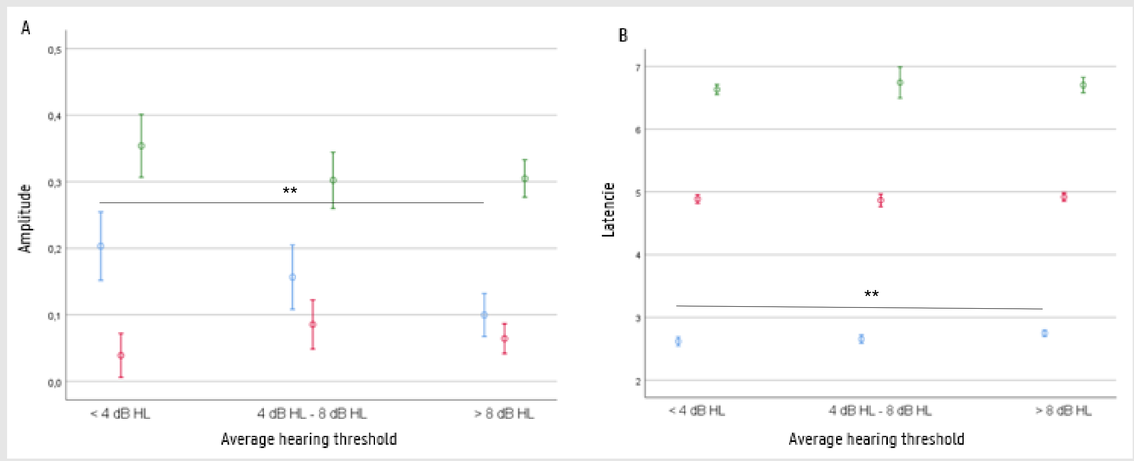

Figure 1: Amplitude- (A) and latencievalues (B) of 11 Hz 100 dBpeSPL peak I, III and V, respectively in blue, red and green for 3 groups, based on their audio-pre-measurement: average hearing threshold (AHT) of the frequencies 4-6-8 kHz < 4 dB; AHT between 4 dB and 8 dB; AHT > 8 dB.

Discussion

As expected, peak detection for fast c-ABR is less reliable compared to slow c-ABR (Prendergast et al., 2018). Furthermore, no significant changes in c-ABR-data could be detected after noise exposure. The test protocol may not be sensitive enough to detect CS in humans. The large intersubject variability (head size and geometry) may contribute to reduced statistical power for the detection of differences in human electrophysiological measurements (bramhall et al., 2019). Additionally, large variability in testresults could be clarified by the small sample size of this study. Moreover, the impact of recreational noise exposure on hearing processes can be questioned; the noise exposure at one music festival may not be enough to draw strong conclusions.

For future investigations, it is recommended to add dosimetry to the test protocol, and expand the test population, in order to analyze exact noise doses and to evaluate individual variability, respectively. This will not only improve the detection of hearing loss but also the monitoring of hearing in general, ultimately optimizing the prevention of hearing damage.

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References

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Contact

De Poortere Nele

nele.depoortere@ugent.be