HOW ATTENDING MUSIC FESTIVALS AFFECTS NEAR AND SUPRA-THRESHOLD MARKERS OF HEARING

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ABSTRACT

Leisure activities can be a considerable source of noise exposure, and of several activities, music festivals have been reported as the loudest. Even though a number of attendees report temporary hearing loss, dullness or tinnitus after music festivals, the majority of young adults do not wear hearing protection. Recent studies have shown that temporary threshold shifts (TTS) after noise exposure might not be as benign as previously thought, and may co-occur with permanent damage to the inner-hair-cell synapses (cochlear synaptopathy) which cannot be detected via the audiogram. This study investigates how (audiometric and distortion-product otoacoustic emission) threshold measures and supra-threshold measures associated with synaptopathy (auditory evoked potentials, AEPs) change after attending music events to elucidate whether attendees had TTS and signs of permanent hearing damage. 19 normal hearing, young adults (18-25 years) attended one or two music festivals in summer 2019. One-to-two days before the event, hearing status was assessed using a test battery including questionnaires, PTA, DPOAE, AEP and speech reception threshold measurements. Auditory status was evaluated again at one, three and five days after the event.

1. INTRODUCTION

Studying how leisure activities such as music festivals affect our hearing is important for the development of effective, evidence-based hearing-loss prevention strategies. On the one hand it is important to monitor the noise-dose listeners were subject to when establishing this relationship. On the other, we need to consider hearing damage from a broader perspective than is hitherto common practice. Hearing damage associated with noise-exposure is standardly monitored using the audiogram (a measure of hearing sensitivity), whereas hearing status should include a supra-threshold hearing assessment as well. The present study focusses on exploring the second aspect by monitoring hearing status around music festivals using a hearing-test battery that includes physiological markers of supra-threshold hearing [1] to detect hidden hearing loss [2] or cochlear synaptopathy [3].

Hidden hearing loss relates to degraded performance on auditory tasks that use clearly audible (i.e., supra-threshold) stimuli, and for which performance-declines cannot be explained by the audiogram. For example, it is well-known that speech-in-noise intelligibility cannot be explained by hearing sensitivity alone [4], and that there are a number of psychoacoustic tasks on which listeners with normal audiograms perform quite differently from one another [5]. A recently discovered aspect of sensorineural hearing loss (SNHL), namely cochlear synaptopathy (CS; [3]), might be on the basis of hidden-hearing loss, as it affects supra-threshold coding of sound while leaving hearing sensitivity unaffected [1,3] and can occur due to aging [6] or noise exposure [3]. Because CS occurs before damage to the outer-hair-cells is observed (and hearing sensitivity is compromised), studies addressing the impact of noise exposure on hearing may have overlooked this SNHL-aspect. Going forward, there are two research questions that need clarification: **(i)** How do we quantify CS non-invasively in humans? And **(ii)**, even if a causal link between noise exposure and CS is established in humans, does CS have important consequences for sound perception? The answer to both questions is complicated by that a direct CS quantification is presently only possible via temporal bone histology (i.e., post-mortem). To address this issue, a number of research labs are studying how non-invasive AEP methods can be used to diagnose CS in humans. Particularly, animal research studies have reported a direct link between histologically-verified CS and auditory-brainstem-response (ABR [3]) or envelope-following-response (EFR [6]) amplitudes. These AEP-types can be recorded in humans using conventional EEG-equipment and are hence promising for future use in clinical practice. Despite their promise, human studies continue to have difficulties relating individual ABR/EFR-amplitude differences to the noise-exposure dose. This has led to a number of conflicting study outcomes and stresses the need for studies that address/minimize aspects related to methodological or translational confounds, and the quality of adopted lifetime noise-exposure questionnaires [7].

2. METHODS

This study addresses research questions (i) and (ii) by assessing near- and supra-threshold hearing of young normal-hearing adults (N=20) in the days surrounding a music festival. The study flow, as well as hearing-tests considered during each 2.5 to 3-hr session are depicted in Fig.1. To approach aspect (i), we adopted a test-battery of AEP metrics that have shown their promise in animal or auditory modeling studies of CS [3, 8, 10]. To address aspect (ii) we monitored speech-in-noise recognition using a closed-set, five-word sentence test (i.e., the Flemish

Matrix test). Speech and noise stimuli were either presented in broadband (BB) noise of 70 dB SPL, or both were low-pass (LP, 1.5 kHz) or high-pass (HP, 1.6 kHz) filtered before the speech-reception threshold was determined. The supra-threshold hearing assessment was complimented with a standard audiometric assay and questionnaires that quantified self-reported life-time noise-exposure history and experienced noise-dose during the festival. The music festivals could be different for different participants and lasted one to five days. A minimal overall sound exposure of 8-hrs was possible during all events, and listeners were free to wear personal hearing protection. When listeners wore hearing protection, 10 dB was subtracted from the $Laeq_{festival}$ calculations, and $Laeq_{festival}$ was estimated using a 40-hr-week noise-exposure calculation [9-10]. On average, listeners experienced a 76.2 dBA $Laeq_{festival}$ (standard deviation 7.82 dBA).

3. RESULTS

Of the participants, 13 wore hearing protection during the festival, seven of them for more than 50% of the time. Eight persons experienced hearing-related symptoms such as dullness, subjective hearing loss or tinnitus after the festival, and those complaints disappeared within less than 24-hrs after the event. We only observed a temporary threshold shift of 10 dB or more (OSHA, 1974) in one subject. Considering the hearing thresholds at extended high frequencies, we observed a greater-than-10-dB shift in nine subjects on day one after the event. In the presentation, we will further explore how the collected supra-threshold AEP markers varied between the above groups and across measurement sessions. We will also discuss the relationship between individual AEP markers and noise-exposure history. Lastly, we will report the relationship between the size of AEP markers and supra-threshold speech reception thresholds. Taken together, our results are important with a view on better understanding how recreational noise exposure affects supra-threshold hearing.

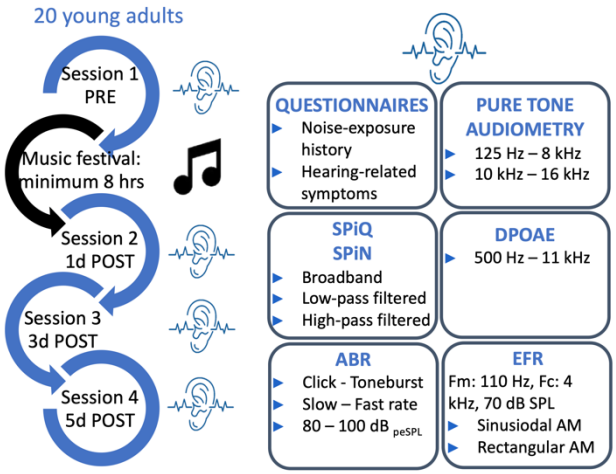

Figure 1. Left: Overview of the measurement sessions Right: Collected physiological markers during each measurement session. Supra-threshold hearing was assessed using speech audiometry in quiet. Self-reported lifetime, recent and festival noise-exposure doses were assessed using questionnaires.

4. ACKNOWLEDGEMENTS

Work supported by BOF-IOP project (UGent) EarDiMon

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