Protocol

The Physiological Bases of Hidden Noise-Induced Hearing Loss: Protocol for a Functional Neuroimaging Study

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Abstract

Background: Rodent studies indicate that noise exposure can cause permanent damage to synapses between inner hair cells and high-threshold auditory nerve fibers, without permanently altering threshold sensitivity. These demonstrations of what is commonly known as hidden hearing loss have been confirmed in several rodent species, but the implications for human hearing are unclear.

Objective: Our Medical Research Council–funded program aims to address this unanswered question, by investigating functional consequences of the damage to the human peripheral and central auditory nervous system that results from cumulative lifetime noise exposure. Behavioral and neuroimaging techniques are being used in a series of parallel studies aimed at detecting hidden hearing loss in humans. The planned neuroimaging study aims to (1) identify central auditory biomarkers associated with hidden hearing loss; (2) investigate whether there are any additive contributions from tinnitus or diminished sound tolerance, which are often comorbid with hearing problems; and (3) explore the relation between subcortical functional magnetic resonance imaging (fMRI) measures and the auditory brainstem response (ABR).

Methods: Individuals aged 25 to 40 years with pure tone hearing thresholds ≤20 dB hearing level over the range 500 Hz to 8 kHz and no contraindications for MRI or signs of ear disease will be recruited into the study. Lifetime noise exposure will be estimated using an in-depth structured interview. Auditory responses throughout the central auditory system will be recorded using ABR and fMRI. Analyses will focus predominantly on correlations between lifetime noise exposure and auditory response characteristics.

Results: This paper reports the study protocol. The funding was awarded in July 2013. Enrollment for the study described in this protocol commenced in February 2017 and was completed in December 2017. Results are expected in 2018.

Conclusions: This challenging and comprehensive study will have the potential to impact diagnostic procedures for hidden hearing loss, enabling early identification of noise-induced auditory damage via the detection of changes in central auditory processing. Consequently, this will generate the opportunity to give personalized advice regarding provision of ear defense and monitoring of further damage, thus reducing the incidence of noise-induced hearing loss.

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KEYWORDS

functional magnetic resonance imaging; auditory pathways; auditory brain stem response

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