An Investigation of Hidden Hearing Loss due to Noise Exposure in Young Adults with Normal Hearing

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What is hidden hearing loss (HHL)?

“Hidden Hearing Loss” describes a change in the auditory system as a result of cochlear synaptopathy.

Cochlear synaptopathy is the loss of synapses (connections) between inner hair cells in the ear and auditory nerve fibres that carry sound information to the brain. This loss of synapses occurs as part of the natural ageing process and also due to noise exposure.

Pure-tone audiometry is the standard diagnostic test of hearing and this measures the sensitivity of the inner and outer hair cells. Cochlear synaptopathy is not detectable via pure-tone audiometry. Hence, many people may have noise damage to their hearing that is not being detected.

What is the evidence for HHL?

Primary evidence comes from experiments on rodents. Kujawa & Liberman (2009) exposed mice to 100 dB SPL noise (8-16 kHz) for 2 hours. Wave I of the electrophysiological auditory brainstem response (ABR) was used as a measure of auditory nerve function.

The measurements at 1 day post-exposure (shown in red) demonstrate a temporary threshold shift.

3-days and 8-weeks post exposure the ABR response at low sound levels returns to normal. At high sound levels there remains a reduction in the response (blue and black).

Further investigation confirmed that after 64 weeks, 50% nerve fibre loss had occurred.

Is HHL related to tinnitus?

Schaette & McAlpine (2011) measured ABR responses in a group of audiometrically matched tinnitus and non-tinnitus listeners. Figures 4 and 5 are taken from this study.

Figure 4 (right): Shows average ABR waveforms for non-tinnitus and tinnitus participants (upper and lower waveforms respectively).

The bar plots show that the growth in wave I magnitude as level increases is not as large in the tinnitus group as for the normal-hearing controls.

Figure 5 (left): Schematic of what Schaette & McAlpine believe may be occurring. In the tinnitus group, the reduction in wave I is caused by a loss of auditory nerve fibres and an increase in “central gain” results in a normal wave V, but is also the cause of the tinnitus.

Current ManCAD study

It is unclear as to whether noise induced hidden hearing loss occurs in listeners with clinically normal hearing.

If hidden hearing loss does occur in humans it is unclear the extent to which this is a problem across the population. It is also unclear what perceptual problems may result from a loss of auditory nerve function.

We are currently conducting a large scale project at the University of Manchester to address some of these issues and better understand if hidden hearing loss can be reliably measured in humans and what the consequences may be.

129 audiometrically normal listeners (mean across ears < 20 dB HL, 0.25-8 kHz) have participated in our study.

Noise exposure is assessed using a noise exposure questionnaire (Lutman et al 2008).

A number of electrophysiological and behavioural measures are collected.

References


