

Hearing Industry Research Consortium (IRC): Lay Person Description of Project

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Project Title: What does “hidden hearing loss” sound like? Linking subjective experiences with objective measures

Primary Project Goal: The aim was to investigate how exposure to noise from work or leisure activities affects our ability to hear and communicate, particularly in noisy situations. Many people find it difficult to hear in noisy places, but often these people do not have a measurable hearing loss. This is thought to be the result of noise damage leading to loss of connections between the cochlea and auditory nerve fibres. This condition is known as ‘hidden hearing loss’ (HHL), and the aim of the study was to gain a better understanding of the nature of HHL, its impacts on communication, and how it affects our ability to listen in background noise.

Knowledge Translation: The information obtained in this study will help us:

- better understand what HHL is, the early signs of HHL, and what sort of help people would most benefit from;
- understand how an individual’s noise exposure is related to the level of difficulty they have in noisy situations, and use this information to provide effective health promotion messages for noise-exposed workers and the general public; and
- develop questions and listening tasks that could be used to identify those with HHL.

Results: Participants’ performance on a range of listening-in-noise tasks was not negatively affected by lifetime noise exposure. Rather, the perception of speech in background noise was related to other factors such as working memory, attention, the ability to predict sentence endings, and hearing sensitivity in the extended high-frequency range.

In contrast, we found evidence that participants’ noise exposure was associated with brainstem (but not cortical) responses to auditory stimuli. Those with more noise exposure produced smaller wave I ABR amplitudes than those with less noise exposure. While this provides some evidence for the existence of noise-induced HHL, the fact that no adverse effects were observed for perception of speech in noise suggests that other factors play a more significant role when we listen in challenging conditions.

We interviewed people who reported difficulty understanding speech in noise, and found that:

- The most troublesome listening environments were cafes, bars, restaurants and parties with background noise resulting from people talking.
- For most people, their speech-in-noise difficulties had a minimal impact on social participation. Most participants did not take into account the level of background noise when deciding whether or not to attend an event, and only a handful had sought advice from a professional.
- Participants nominated attention and concentration as important factors when listening to speech in noisy situations. Participants’ self-rated ability to ignore background noise was significantly correlated with the scores on a behavioural attention task.
- Participants’ preferred option for a service, product or training program that might improve listening in noise was some form of communication training delivered either online or face-to-face, rather than hearing aids or other assistive devices.

Methods: A total of 134 normal-hearing participants in their mid-adult years with a wide range of noise exposures participated in the study. We assessed noise exposure over the lifetime to obtain a cumulative noise metric for each individual. After undergoing a full audiometric test battery, each participant completed two speech-in-noise tests: a) the high-cue condition of the LiSN-S, in which sentences are heard in spatially separated babble noise; and b) the NAL Dynamic Conversations Test, in which short monologues are heard in competing conversational noise while participants complete a written 'on-the-go' comprehension task. They also completed several cognitive tests, including selective attention, attention-switching, and working memory, and the text reception threshold test, which measures a person's ability to predict sentence endings.

A subset of participants (n=74) were tested on a range of electrophysiological measures, which assessed sound processing at the brainstem and at higher (cortical) levels of the auditory system.

A subgroup of participants (n=50) with self-reported listening difficulties completed an online survey. In the first section, participants were asked to identify and rank situations where their hearing difficulties occur and provide reasons for avoiding situations. The second section asked about the degree of social limitation and/or emotional distress experienced by participants and the level of effort and concentration required when listening. In the third section, participants were asked about their help-seeking behaviours; strategies they use in difficult situations, and their willingness to use technological aids to improve their listening.

Background information about your research group: The National Acoustic Laboratories (www.nal.gov.au) is the research division of Australian Hearing. Since 1947, NAL has conducted a wide-ranging research program in the areas of hearing assessment, hearing loss prevention and hearing rehabilitation. Our mission is to lead the world in hearing research and evidence-based innovation that improves hearing health and transforms the lives of people with hearing difficulties.

References

Beach EF, (2018) Hidden hearing loss in humans: cochlear synaptopathy is superseded by cognitive effects when listening to speech in noise. *ENT & Audiology News*, 27(1):84-85

Pang J, Beach EF, Gilliver M, Yeend I (under review) Adults who report difficulty hearing speech in noise: Experiences, impacts and coping strategies. *International Journal of Audiology*.

Valderrama JT, Beach EF, Yeend I, Sharma M, Van Dun B, Dillon H (under review) Effects of lifetime noise exposure on the middle-age human auditory brainstem response, tinnitus and speech-in-noise intelligibility. *Hearing Research*.

Yeend I, Beach EF, Sharma M and Dillon, H (2017) The effects of noise exposure and musical training on suprathreshold auditory processing and speech perception in noise. *Hearing Research*, 353, 224-236.

Yeend I, Beach EF, Sharma M (under review) Working memory and extended high-frequency hearing in adults: diagnostic predictors of speech-in-noise perception. *Ear and Hearing*.

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