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System-wide electrophysiological assessment of hearing

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Western BrainsCAN Transforming brain research.

Project **Summary**

KNOWLEDGE MOBILIZATION & IMPACT

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Background

Hearing loss affects about one in two Canadians aged 60 and older and puts them at risk for a reduced quality of life and poor health outcomes. These poor health outcomes can include depression and cognitive decline.

Standard hearing tests measure how loud a sound has to be to *just* hear it (the minimum sound level that is just distinguishable from silence). Most of the sounds we hear are not that quiet, and it turns out that the brain has different pathways for processing moderate and louder sounds, compared to those for the quiet sounds that are tested clinically. It should be no surprise, then, that these standard hearing tests are not very sensitive to some difficulties that older people experience in the real world, such as understanding a conversation in a restaurant, or finding sounds to be unpleasantly loud, or highly distracting. These difficulties probably arise due to damage to auditory brain structures to which current clinical tests are not sensitive.

Recent work suggests that much of the effect of age on hearing deficits with typical, every-day sounds (i.e. not the very quiet sounds, but conversations, a television, vehicles and so on) may be the result of accumulated noise damage to the link between the inner hair cells and the auditory nerve (AN), with long-term consequences for cortical function.

The Problem

This accumulated noise damage, building up over time, has a selective element - it doesn't impact our hearing uniformly. The synapses within the AN that respond to louder sounds - like a dog barking or listening to the television - are greatly impacted, while those that respond to quiet (or threshold) sounds are much less affected.

Our auditory system includes dense, extensive feedback connections from the cortex (the auditory information processing region of the brain and what we might consider the highest level of the auditory system) all the way back down to the cochlea in the inner ear where sounds are first received. The function of these feedback fibers is largely unknown, although there is some speculation (such as they might be involved in attentional tuning, for example). If there is damage to the auditory system's peripheral stages such as this accumulated noise damage accruing as we age, it ought to modify the higher regions in the brain related to hearing which in turn will modify these feedback fibers as well. Since this has never been studied, it is the focus of our research.

The Project

The current work proposes to develop and evaluate an electrophysiological recording setup capable of assessing neural function at all levels of the auditory neural pathway, including hair cells, auditory nerve fibers, brainstem and cortex. We will then test the neural responses across those levels of the auditory pathway in younger and older people.

A non-invasive technique has already shown early promise in identifying accumulated noise damage in the auditory neural pathway from hair cells to auditory cortex. We hope that it can also be used to explore the feedback connections that reach back to the cochlea and hair cells.

This project will establish a flexible technique to provide simultaneous recording of the cochlea, AN, brainstem and cortex in humans. With that in place, we hope to validate it as a method to detect damage to AN fibers and then to correlate the neural signals between the different stages of the auditory neural pathway.

Funding Program

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Western Faculty, Group or Institution

Department of Psychology, Faculty of Social Science
School of Communication Sciences & Disorders, Faculty of Health Sciences

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