How HIV Disrupts the Hearing Brain

By Nina Kraus, PhD, and Travis White-Schwoch

The World Health Organization[1] estimates that 38 million people worldwide are living with human immunodeficiency virus (HIV). Antiretroviral therapy offers life-saving treatment that dramatically reduces the risk of transmission and has transformed HIV into a chronic disease. However, significant health concerns remain for HIV-positive (HIV+) patients. These include hearing and cognitive difficulties as the population living with HIV ages. Since the late 1980s, inconsistent data have been reported on whether or not hearing loss is associated with HIV.

Jay C. Buckey, MD, and colleagues have provided new clarity to this question in a series of large-scale studies in Tanzania and China. In one of the largest studies of HIV and hearing to date, they compared 449 HIV+ adults with 202 HIV-negative (HIV-) controls.[2] Pure-tone audiometric thresholds and tympanograms were identical between the groups. Distortion product otoacoustic emissions in higher frequencies were slightly smaller in the HIV+ group, but the difference was probably not clinically significant. Overall, peripheral auditory function was similar between groups, suggesting that healthy patients with HIV do not have an increased risk of hearing loss. Interestingly, the HIV+ group reported more difficulty understanding speech in noisy environments than did the HIV- group, indicating potential difficulty with auditory processing.

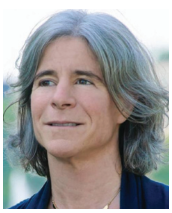
Auditory processing tasks rely not just on sound passing through the ear but also on the brain efficiently and accurately decoding that information. The best example of real-world auditory processing is recognizing speech in noisy environments such as restaurants. Cognitive abilities such as attention and working memory are crucial to our ability to hear in noise. Although HIV+ patients are generally healthy, up to 45 percent can eventually exhibit symptoms of cognitive decline, such as mental fog, forgetfulness, and difficulty maintaining attention.[3] This led Buckey and colleagues to hypothesize that the HIV+ group's reported difficulties with hearing in noise could reflect this cognitive decline. In a study of 166 HIV+ adults with normal hearing, they confirmed a strong link between cognition and auditory processing: Adults who performed better on cognitive tests could also understand speech in noise better.[4]

We partnered with Buckey and his team to dive deeper into the hypothesis that HIV disrupts the hearing brain. To test this hypothesis, we measured frequency-following responses (FFRs) to speech in 127 adults, 59 of whom were HIV+.[5] FFRs reflect the integrity of synchronized sound processing in the brain. The HIV+ group had weaker responses to fine-grained harmonic details of speech that convey a sound's phonemic identity (for example, *d* v. *g*). This effect generalized across multiple stimuli despite the groups having similar hearing and auditory brainstem responses. Interestingly, the pattern of disruptions to the FFR was distinct from that observed in other clinical populations, such as patients who had a concussion. These results support the idea that HIV disrupts central nervous system circuits responsible for auditory processing with a unique neural signature. FFR testing doesn't require input or effort from patients, making it a promising clinical tool to track the nervous system function in HIV+ patients via auditory processing.

Shutterstock/jijomathaidesigners

This research is in its early stages with many open questions. HIV is a complex disease process, and it can be challenging to disentangle the effects of the disease from the treatment. Still, there are already implications for audiology practice. First, HIV may be a risk factor for difficulty hearing in noise that cannot be explained by hearing loss. Second, adults with HIV may benefit from a careful baseline auditory processing assessment, which can provide an important benchmark to monitor their auditory-cognitive performance over time.

This work supports the notion that hearing is connected to neurological health. Consistent evidence shows that aspects of auditory function are disrupted in listeners with neurological injuries, such as concussions, dementia, or hyperbilirubinemia. To the extent these populations exhibit distinct patterns of disruption to hearing—and the evidence to date convincingly shows they do—measures of auditory function may track disease progression. Audiologists can offer a unique skill set and perspective in the management of these patients.




Dr. Kraus, left, is a professor of auditory neuroscience at Northwestern University, investigating the neurobiology underlying speech and music perception and learning-associated brain plasticity. **Mr. White-Schwoch** is a data analyst in the Auditory Neuroscience Laboratory (www.brainvolts.northwestern.edu), where he focuses on translational questions in speech, language, and hearing.

References for this article can be found at http://bit.ly/HJcurrent.