Hearing in Noise: The Brain Health Connection

By Nina Kraus, PhD

It's hard to hear in noise. Listening while in restaurants, busy streets, football arenas, and other noisy settings strain our ability to make sense of sound. But what is at the root of this difficulty?

Hearing in noise relies on some of the fastest and most complex computations the brain has to do. Noisy sounds come indiscriminately through the cochlea, then the brain is tasked to tease these apart. This process relies on the integration of these distinct neural mechanisms:

- Hair cells have to amplify and digitize incoming signals that are mashed-up chunks of speech and noise.
- The auditory system has to create a crisp neural representation of the incoming signals (see our *Hearing Matters* column in this issue).
- Cognitive systems such as memory and attention need to be directed to the sound to filter and amplify incoming signals.
- The brain has to account for the fact that meaningful bits of auditory information, such as consonants in speech, are covered up by the noise—and as a consequence, the brain has to make up for gaps in the incoming signals.

I would argue that hearing in noise is one of the most difficult jobs the brain has to do on a daily basis; therefore, it stands to reason that any insult to brain health compromises the ability to effectively hear in noise. Hearing-in-noise difficulties have been documented in a lot of clinical populations, including:

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- elderly people, even with normal hearing thresholds;
- individuals who have suffered a traumatic brain injury such as a concussion;
- listeners with HIV-associated neurocognitive problems; and
- children with learning and other developmental disabilities such as dyslexia, specific language impairment, and autism spectrum disorder.

In contrast, engaging in exercises for the brain strengthens the ability to hear in noise. For example, music training and intensive computerized auditory training strengthen hearing in noise by augmenting the underlying sensorimotor and cognitive mechanisms (*Nat Rev Neurosci*. 2010;11[8]:599; Trends Cogn Sci. 2015;19[11]:642).

Accurately processing signals in noise is a crucial evolutionary ability. I often say that a bicyclist on a busy street is doing the same thing as a vulnerable zebra in the African jungle—they listen to sounds coming in that need to be tied to their meanings. If the organism can accurately make sense of these sounds, he's likely to survive. It makes sense then that such a crucial ability would rely on this nexus of neural circuits, and that there would be many avenues of disruption.

From a clinical perspective, this means that hearing-in-noise difficulties have to be addressed holistically. No one test in isolation—be it biological, an audiogram, a test of working memory, or a test of attention—will provide a complete picture of a person's hearing-in-noise skills. Instead, we need to approach it from an integrative perspective of brain health.

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