Unreliable Auditory Processing in Autism

By Nina Kraus, PhD, and Travis White-Schwoch

iStock/nambitomo

Autism spectrum disorder (ASD) is a diverse neurodevelopmental condition that typically manifests as challenges with social-pragmatic language, theory of mind, and emotional understanding. Its prevalence has increased dramatically over the past decades; it is now estimated that one in 68 children have been diagnosed with ASD (CDC, 2017). At present, audiologists are involved in initial ASD assessments to rule out hearing loss. Recent evidence, however, suggests they can play a bigger role by evaluating auditory processing in ASD.

While no two cases of ASD are identical, some commonalities are observed across the ASD population, such as difficulty processing sensory information. Understanding the neurobiological origins of these deficits is crucial to developing more accurate diagnostic tests for ASD and to identifying potential treatments. In a landmark study, Dinstein and colleagues measured brain activity in response to auditory, visual, and somatosensory stimuli (*Neuron.* 2012 Sep 20;75(6):981). They showed that ASD individuals have variable responses to sensory stimuli across those three domains. This suggests unreliable sensory processing is a bottleneck that constrains accurate understanding of incoming information–if the brain is not functioning reliably, it can be difficult to build a robust representation of incoming information.

This discovery is also provocative in light of evidence that unreliable auditory processing constrains speech and language skills. Studies using electrophysiological responses to speech have shown that variable processing is typically observed in individuals with auditory processing difficulties, such as individuals with dyslexia and the elderly (*J Neuro.* 2013;33:8; *Cereb Cortex.* 2017;27:11).

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.

NEURAL RESPONSES TO SOUND

Otto-Meyer and colleagues built on these two lines of work to study the electrophysiological responses to speech among high-functioning children with ASD (*Exp Brain Res.* 2018; doi:10.1007/s00221-017-5164-4). They measured the frequency-following responses to multiple speech sounds in 12 children with ASD, and compared these with 12 age- and sex-matched controls. They found a distinct profile in the children with ASD: Across all the stimuli, the ASD group had more variable neurophysiological responses to sound than the control group. Importantly, this effect could not be explained by the quality of the recording, such as the number of artifacts.

This finding is interesting given previous evidence that children with ASD have slower frequency-following responses to speech and that their brain responses do not accurately process pitch patterns in speech, such as those that convey prosody and emotional cues (*Clin Neurophysiol.* 2008;119:8).

An unstable base of sound processing could underlie these difficulties.

FURTHER QUESTIONS

Although this is a relatively small study, it raises some intriguing ideas and queries, including:

- Is unstable auditory processing an early marker of ASD? A major goal of ASD research is to develop objective neural markers that can predict if infants are at risk for ASD. This is crucial because early interventions lead to better long-term outcomes for language and social behavior. Because auditory-neurophysiological responses can be collected reliably in infants, they could provide an approach for early identification.
- ASD and other disorders, such as dyslexia, are characterized by variable auditory processing, but there are many ways in which they are distinct. Is variable auditory processing a bottleneck or risk factor that interacts with other genetic and environmental risk factors?
- Do treatments that improve language outcomes in ASD also improve auditory processing? And if so, can electrophysiological responses serve as a treatment outcome measure to document interventions?

While no two cases of ASD are identical, some commonalities are observed across the ASD population, such as difficulty processing sensory information. Understanding the neurobiological origins of these deficits is crucial to developing more accurate diagnostic tests for ASD and identifying potential treatments.

Research is ongoing to address these questions and provide a richer understanding of the auditory neurobiology of ASD. Nevertheless, these early results provide strong evidence that unreliable auditory processing characterizes many cases of ASD. These results also show that audiologists can play a more active role in managing ASD cases. The idea that auditory processing can be disrupted, and perhaps contribute to some of the social and language difficulties experienced by ASD individuals, suggests that a broader consideration of auditory skills can help manage cases of ASD. Audiologists have the expertise to play this active role in ASD management.