



Frank Musiek, PhD,
Pathways Editor

In Autism Spectrum Disorders, Dichotic Listening Training Can Help

By Annette Hurley, PhD, & Inga Denman

A variety of auditory impairments are seen in autism spectrum disorders (ASD). While pure-tone thresholds are normally not affected, auditory processing often is, with difficulties including trouble understanding speech, especially in degraded acoustic environments; noise intolerance; temporal processing problems; and ear deficits on dichotic speech tasks. In children with ASD, these auditory impairments are often regarded as part of the high-order cognitive disorder, meaning the label of central auditory processing disorder (CAPD) is not appropriate ([American Speech-Language-Hearing Association Working Group on Auditory Processing Disorders](#)).

Because of their primary diagnosis of autism spectrum disorder, these patients often aren't referred to specialists for auditory training or remediation programs. However, audiologists are the professionals qualified to treat auditory deficits or weaknesses. Recently in *The Hearing Journal*, Carol Lau reported positive outcomes for children with ASD who receive auditory training, arguing for the importance of audiologists taking their rightful place on the autism team ([February 2012, p. 18](#)). In this report, we continue to advocate the audiologist's role in the treatment of ASD and describe one appropriate auditory training program that's based on neurophysiological brain differences.

THE ROLE OF NEUROBIOLOGY

Auditory processing deficits occur as part of the symptoms of autism spectrum disorders and may be partially due to organic brain differences. Auditory evoked potentials are objective measures of neuroelectric activity that reflect the integrity of the central auditory nervous system. Previous investigations have shown increased wave and interwave latencies of the auditory



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brainstem response (ABR) for children with ASD, reflecting impaired processing at the brainstem level (*J Autism Dev Disord* 1980;10[2]:215-225; *Can J Neurol Sci* 1982;9[4]:429-433; *Ear Hear* 2003;24[3]:206-214). These irregularities have been present in ABRs recorded to complex stimuli (*Clin Neurophysiol* 2008;119[8]:1720-1731). In addition, deviations have been reported in the P300 and mismatch negativity (MMN) responses, suggesting involvement of the cortical auditory regions and deficits in cognitive processing or auditory discrimination (*J Autism Dev Disord* 1983;13[1]:33-42; *J Autism Dev Disord* 2008;38[1]:52-71).



Dr. Hurley, left, is an assistant professor in the department of communication disorders at

Louisiana State University Health Sciences Center (LSUHSC). **Ms. Denman** is a speech-language pathology graduate student in the department of communication disorders at LSUHSC. **Dr. Musiek**, the clinical editor of *Pathways*, is a professor and the director of auditory research in communication sciences at the University of Connecticut in Storrs.

Structural and functional neurobiological abnormalities may contribute to the auditory processing impairments exhibited by children who have ASD, with several regions of the autistic brain showing aberrations. These abnormalities include a smaller prenatal head circumference; frontal lobe hyperplasia, or an excess of cells or tissue; abnormal cortical organization;

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atypical minicolumn structure in frontal and temporal areas; and variations in white and gray matter (*Neuroimage* 2005;24[2]:455-461). There are other reports of abnormalities in the gray matter of the brainstem and cerebellum (*J Neuropsychiatry Clin Neurosci* 1999;11[4]:470-474) and of differences in neural transmission, including synaptogenesis, or the formation of synapses, which is especially important during key periods of brain development; neural pruning, which is a neurological regulatory process that produces a more efficient synaptic configuration by reducing the number of neurons; and myelination, or the wrapping of neurons in myelin, which allows rapid transmission of neuronal signals (*Neuroimage* 2005;24[2]:455-461; *J Neuropsychiatry Clin Neurosci* 1999;11[4]:470-474; *J Child Neurol* 1996;11[2]:84-92).

Optimal and efficient processing occurs when the two hemispheres of the brain interact. Of specific importance to interhemispheric and intrahemispheric communication in children with autism spectrum disorders are differences in the corpus callosum, a body of neural fibers connecting the right and left hemispheres. The corpus callosum is anatomically divided into regions with different sensory functions, such as the posterior portion, which is specialized for auditory information. Several investigations have found reductions in the size of the corpus callosum in children with autism spectrum disorders (*J Neuropsychiatry Clin Neurosci* 1999;11[4]:470-474; *Neurology* 2000;55[7]:1033-1036; *Brain Res* 1992;598[1-2]:143-153; *Prog Brain Res* 2011;189:303-317), which may lead to fewer traversing axons. Abnormalities of cortical connectivity disrupt integrative and interhemispheric processing.

BETTER DICHOTIC SPEECH SCORES

One behavioral measure of interhemispheric function is dichotic speech tasks. Dichotic refers to the

simultaneous presentation of a different auditory signal to each ear. In normal listening situations, both ipsilateral and contralateral pathways conduct auditory information to the auditory cortex. In dichotic listening, however, the dominant contralateral pathway suppresses the ipsilateral pathway.

Most people are left-hemisphere language dominant. Thus, an auditory signal presented to the right ear goes from the contralateral right auditory pathway directly to the left hemisphere, while a signal presented to the left ear is first conducted to the right cortex and must be transferred to the left hemisphere via the corpus callosum. There usually is a slight right ear advantage for normal right-handed individuals listening to dichotic speech tasks. Our clinical experience and the work of other investigators have shown left ear deficits or unusual right ear deficits in children with ASD (*Tokai J Exp Clin Med* 1989;14[4]:339-345).

The goal of dichotic listening training is remediation of the compromised central auditory pathway—i.e., the corpus callosum. In this approach, the unimpaired pathway receives a decreased signal intensity that is slowly increased as the impaired pathway strengthens. The training targets the deficit ear, activating brain regions that transmit and receive auditory sensory input. In previous work, dichotic training has led to improvements in the central auditory nervous system, as demonstrated by behavioral and electrophysiological evidence (*J Am Acad Audiol* 2004;15[2]:117-132).

We have tested central auditory processing in “high-functioning” children with autism spectrum disorders, finding a range of impaired auditory processing abilities. Most often, a left ear deficit on dichotic speech tasks is evident. We have recommended dichotic listening training to be completed either formally at the clinic or with a dichotic listening training program for home use. Post-intervention testing

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shows improvements in dichotic speech scores, both in binaural separation and binaural integration. In addition, the participants' parents have provided subjective reports of improved listening comprehension and language processing after training.

Unfortunately, there has been limited research on auditory processing deficits in children with autism spectrum disorders and on the success or failure of auditory remedial therapies. We contend that children with ASD may benefit from deficit-specific auditory training consistent with the underlying site of auditory dysfunction. ■