UDK 616.895-053.2:159.937
534.78-053.2:616.8
376.4-053.2
Izvorni znanstveni rad

Dana Boatman
The Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

SPEECH SOUND PERCEPTION IN A CHILD WITH HIGH-FUNCTIONING AUTISM

SUMMARY

Children with autism often have increased verbal communication difficulties in noisy environments. Although these difficulties have been attributed to impaired attention abilities, recent studies suggest a possible perceptual basis. However, previous efforts to evaluate speech perception abilities, even in relatively high functioning autism, have been impeded by methodological limitations arising from the dependence of standardized tests on verbal responses. Because many high functioning autistic children have a history of articulation difficulties, it is difficult to rule-out potentially confounding articulation effects on response accuracy. Here we describe results of comprehensive auditory function testing in a high functioning autistic boy, with a history of mild articulation difficulties. Results showed impaired speech sound perception across multiple response modalities (verbal, motor). Tests of attention, auditory comprehension, and auditory working memory were normal. Our patient's perceptual deficits were relatively subtle, emerging only when the speech signal was acoustically degraded. Degradation of acoustic cues occurs in high levels of background noise (e.g., < 5 dB S/N), thereby accounting for his increased communication difficulties in noisy environments. These results illustrate the utility of performing comprehensive auditory function testing, using multiple response modalities, in high functioning children with autism.

Key words: *autism, speech perception, phoneme perception, auditory impairments*

attention that requires the listener to shift attention from one ear to the other under dichotic listening conditions. The second, the Conners Continuous Performance (CPT) Test (Conners, 2000), a screening test of attention that involves monitoring a sequence of visually presented letters by pressing a computer key in response to all letters with the exception of one letter (X).

Receptive language. The Token Test for Children (DiSimoni, 1978) was administered to assess auditory language comprehension. The patient was asked to implement one-step and two-step verbal directions, of increasing complexity, by manipulating tokens of different colors and shapes (e.g. touch the small red square).

RESULTS

Test results indicated normal peripheral hearing bilaterally. Specifically, pure tone thresholds were $\leq$ 20 dB HL at all frequencies tested, tympanograms were Type A, acoustic reflexes were present at expected levels, and word recognition in quiet was excellent (96% bilaterally).

On tests of central auditory function, the patient performed within normal limits on all measures of auditory processing, except speech sound perception (Table 1). His scores were in the normal range on tests of word recognition in background noise (scaled score 8; age norms 10 ± 2), auditory sequencing (96%; age norms = 92 – 100%), and auditory working memory (scaled score 9; age norms 10 ± 3). Similarly, his dichotic word scores (scaled score 7; norms 10 ± 3) and age-appropriate right-ear advantage for speech suggested no neuromaturational delays.

In contrast, his performance was impaired on all three tests of speech sound perception. He performed 3 standard deviations below the mean on the Filtered Word Test (scaled score = 2; age norms = 10 ± 2). Similarly, he identified only 11 of the 25 phoneme strings presented on the Phoneme Synthesis Test, well below the lower limit of normal (23). His errors on both tests consisted largely of phonological substitutions (e.g. coat > cat, ship > sit). On the auditory word discrimination test, his score (96% correct) was within the normal range for the non-filtered word condition. Conversely, his score (72%) on the non-filtered word condition was significantly below the normal range ($p < 0.004$, Fisher Exact test).

Additional testing revealed age-appropriate receptive language abilities (Token Test overall scaled score = 501; age norms 500 ± 5), and no evidence of auditory selective attention (Competing Sentences Test scaled score 9; age norms 10 ± 3) or other attention difficulties (CPT index = 6.16, normal index scores < 8).

CONCLUSIONS

Comprehensive auditory function testing revealed impaired speech sound perception in a high-functioning child with autism. Other auditory functions were normal. The perceptual deficiencies identified were relatively subtle in nature, emerging only when the speech signal was acoustically degraded. The patient's poor performance on tests of filtered word perception suggests difficulty compensating for loss of high frequency (> 1000 Hz) acoustic information from the speech signal. This is consistent with the patient's history of reading difficulties and has been observed in other pediatric populations with reading disorders (Bradley & Bryant 1983, Tallal et al. 1985). The patient performed poorly on tests of speech sound perception regardless of response modality (verbal, motor). These results corroborate recent reports of speech sound perception difficulties in high functioning children with autism or Asperger syndrome (Boatman, 2003). In light of our patient's history of articulation difficulties and recent reports documenting articulation disorders in this population, the inclusion of perceptual measures that did not depend on verbal responses was important for ruling-out potentially confounding effects of articulation difficulties on his response accuracy.

The patient's relatively normal speech-in-noise scores were somewhat puzzling given his history of difficulty following verbal directions in noisy classrooms. Moreover, our testing showed no evidence of attention, auditory memory, or receptive language difficulties that may have contributed to his perceptual difficulties in the classroom. One possible explanation for his relatively good speech-in-noise performance is that the level of background noise used for testing (+8 dB S/N) was not as high as that of a noisy classroom (typically < 5 dB S/N). If the patient's perceptual difficulties were not due simply to the presence of background noise, in which case they would have been evident regardless of the noise level, but rather to the effects of high levels of background noise that can mask (filter) acoustic cues, as suggested by his poor filtered word scores, then the speech-in-noise test would have failed to identify such difficulties. Additional testing with different levels of background noise would be useful for clarifying this issue.

Based on the patient's test results, a number of recommendations were made including preferential classroom seating, a classroom trial with an assistive listening device (FM system) that transmits the teacher's voice directly to the child, and inclusion of acoustic-phonetic awareness training in the child's existing speech-language therapy program. Subsequent parental and teacher report confirmed improved academic performance following implementation of these recommendations.

ACKNOWLEGEMENTS

This research was supported by the National Alliance for Autism Research and NIH-NIDCD grant R01-DC005645. Special thanks to Dr. Diana Miglioretti for the statistical analyses.

REFERENCES

American Speech, Language, Hearing Association (ASHA). (1996). Central auditory processing: current status of research and implications for clinical practice. *American Journal of Audiology* **5**, 41-54.

American Psychiatric Assocation. (1994). *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.). Washington, DC: American Psychiatric Association.

Bellis, T. (2003). *Assessment and Management of Central Auditory Processing Disorders in the Educational Setting: From Science to Practice.* Clifton Park, NY: Thomson-Delmar Learning, 213-215.

Boatman, D., Gordon, B., Hart, J., Selnes, O., Miglioretti, D., Lenz, F. (2000). Transcortical sensory aphasia: revisited and revised. *Brain* **123**, 1634-1642.

Boatman D. (2003). Impaired speech sound perception in children with Asperger syndrome. *Journal of Developmental and Learning Disorders* **7**, 27-36.

Bradley, L., Bryant. P. (1983). Categorizing sounds and learning to read – a causal connection. *Nature* **301**, 419-421.

Conners CK. (2000). *Conners' Continuous Performance Test II.* Multi-Health Systems Inc: Toronto.

DiSimoni, F. (1978). *The Token Test for Children.* Austin, TX: Pro-Ed.

Howlin, P. (2003). Outcome in high-functioning adults with autism with and without early language delays. *Journal of Autism and Developmental Disorders* **33**, 1, 3-31.

Katz, J. (1986). *SSW Test and User's Manual.* Vancouver, WA: Precision Acoustics.

Keith, R. (1994). *SCAN-A: A Test of Central Auditory Function for Adolescents and Adults.* San Antonio, TX: Psychological Corporation.

Koning, C., Magill-Evans, J. (2001). Social and language skills in adolescent boys with Asperger syndrome. *Autism* **5**, 1, 23-36.

Landa, R. (2000). Social language use in Asperger syndrome and high-functioning autism. In A. Klin, F. Volkmar, S. Sparrow (eds.), *Asperger Syndrome*, 125-155. New York, NY: The Guillford Press.

Pinheiro, M., Ptacek, P. (1971). Reversals in the perception of noise and tone patterns. *Journal of the Acoustical Society of America* **49**, 1778-1782.

Schatz, A., Weimer, A., Trauner, D. (2002). Brief Report: Attention differences in Asperger syndrome. *Journal of Autism and Developmental Disorders* **15**, 359-360.

Shriberg, L., Paul, R., McSweeny, J., Klin, A., Cohen, D., Volkmar, R. (2001). Speech and prosody characteristics of adolescents and adults with high-functioning autism and Asperger syndrome. *Journal of Speech, Language, and Hearing Research* **44**, 1097-1115.

SoundForge, version 6.0. (2002). Madison, WI: Sonic Foundry, Inc.

Tallal, P., Stark, R., Mellits, D. (1985). The relationship between auditory temporal analysis and receptive language development: evidence from studies of developmental language disorder. *Neuropsychologia* **23**, 4, 527-534.

Weschsler, D. (1991). *WISC-III R Manual.* San Antonio, TX: Psychological Corporation (Harcourt).

Dana Boatman
Medicinski fakultet Johns Hopkins, Sveučilište u Baltimoreu,
Maryland, SAD

PERCEPCIJA GLASNIKA DJETETA S VISOKOFUNKCIONALNIM AUTIZMOM

SAŽETAK

Djeca s autizmom često imaju pojačane poteškoće u verbalnom komuniciranju u bučnom okruženju. Iako su ove poteškoće bile pripisivane otežanoj pažnji, novija istraživanja ukazuju na moguće poteškoće u percepciji. Ipak, dosadašnji pokušaji procjene govorne percepcije, čak i u slučajevima prilično visokofunkcionalnog autizma, bili su ograničeni činjenicom da standardizirani testovi zahtijevaju verbalne odgovore. Budući da mnoga djeca s visokofunkcionalnim autizmom imaju i artikulacijske poteškoće, nije moguće u potpunosti isključiti utjecaj nejasne artikulacije na točnost odgovora. U ovom članku iznose se rezultati sveobuhvatnog testiranja slušanja dječaka s visokofunkcionalnim autizmom te s blagim artikulacijskim poteškoćama. Rezultati su pokazali poremećenu percepciju glasnika u višestrukim modalitetima odgovora (verbalnim, motoričkim). Testovi pažnje, slušnog razumijevanja i slušne radne memorije bili su normalni. Poteškoće u percepciji kod našeg ispitanika bile su blage. Do izražaja su došle tek kada je govorni signal bio akustički narušen. Narušenost akustičkih ključeva javlja se pri visokim razinama pozadinske buke (npr. < 5dB S/N), čime se opravdavaju izražene komunikacijske poteškoće u uvjetima pojačane buke. Rezultati pokazuju korist sveobuhvatnog testiranja slušanja s višestrukim modalitetima odgovora u slučaju visokofunkcionalnog autizma.

Ključne riječi: *autizam, percepcija govora, percepcija fonema, slušni poremećaji*