

Understanding Sound Sensitivity in Individuals with Autism Spectrum Disorders

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Abstract

Literature on sound sensitivity in individuals with and without autism spectrum disorders (ASD) is reviewed in this article. Empirical evidence is examined, and physiologic and psychoemotional-behavioral perspectives are described. There is virtually no evidence of true physiological differences in auditory systems of individuals with ASD. It is evident, however, that many people with ASD (a) feel fearful and anxious about sound, and (b) may experience unpleasant physiological sensations because of autonomic and/or behavioral responses to nonpreferred sounds, but (c) can learn to react in less stigmatizing, more effectively self-regulating ways. Current assessment and intervention practices are discussed, and a case is presented. Heightened understanding of this issue among caregivers and interventionists may ultimately improve life participation for individuals with ASD.

Keywords

autism spectrum disorders (ASD), sound sensitivity, hyperacusis, auditory, [one phrase] hyperreactivity

Hypersensitivity to sound has been discussed for decades as an exceptionally problematic issue within the autism spectrum disorder (ASD) community. Between 1964 and 1994, the Autism Research Institute collected histories on more than 17,000 children with autism in numerous countries, and more than 40% contained parent reports of sound sensitivity (Rimland & Edelson, 1995). Many poignant personal accounts written by individuals with autism and their parents provide powerful documentation of their difficulties tolerating sounds. Educators and researchers have debated many angles of the issue, from the definition itself to characteristics, causes, and possible treatments. Additionally, the report of the Quality Standards Subcommittee of the American Academy of Neurology and the Child Neurology Society (Filipek et al., 2000) contained an explicit request for investigations that would shed light on atypical auditory characteristics and behaviors of individuals with ASD.

Hyperacusis is broadly defined as an unusual intolerance of ordinary environmental sounds (American Speech-Language-Hearing Association, 2008; Andersson, Lindvall, Hursti, & Carlbring, 2002). Because there is no specific reference to the etiology of the intolerance, the term can encompass any number of causes. In the ASD literature, both physiologic and psychoemotional-behavioral perspectives have been investigated. Researchers have suggested that individuals with ASD may react to stimuli more intensely and less conventionally than typical peers

(Prizant & Meyer, 1993). Therefore, the terms “hyperacusis” and “hyperreactivity” are used to discuss sound tolerance difficulties in the ASD population.

For many individuals with ASD, hyperacusis and the associated hyperreactivity result in activity limitations and participation restrictions as defined in the *International Classification of Functioning, Disability and Health* (World Health Organization, 2001). This article is based on beliefs that: (a) The auditory channel is the primary pathway for language-based learning; (b) hyperacusis/ hyperreactivity may result in habitual sound avoidance and isolation from typical peers; (c) certain sound avoidance behaviors may render an individual less able to manage everyday manual tasks; and (d) ear protection and sound avoidance do not provide an effective long-term solution, and may lead to lifelong difficulties tolerating sound. It is therefore critical that professionals and family members involved with children with ASD be aware of the issues surrounding hyperacusis/hyperreactivity. Early intervention may result in more positive educational, social, and vocational outcomes. When a child is diagnosed with, or considered at

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risk for ASD, hearing testing should routinely address the ability to tolerate sound in a variety of environments. If there is evidence of hyperacusis, recommendations should be made, and interventionists should address the issue using appropriate evidence-based practices. The problem should not be expected to remit with maturation. The purposes of this article are to (a) review literature on hyperacusis/hyperreactivity, (b) offer suggestions relative to appropriate assessment and intervention procedures for individuals with ASD who present with hyperacusis/hyperreactivity, and (c) present a clinical case example.

Hyperacusis in Individuals With ASD

Hyperacusis is one of the most commonly reported auditory issues in ASD (Rimland & Edelson, 1995; Rogers, Hepburn, & Wehner, 2003). In numerous compelling personal accounts, parents' narratives, and clinical experience narratives, authors have described behaviors exhibited by individuals with ASD in response to sound stimuli (e.g., Grandin, 1995; Grinker, 2007; Hughes, 2003; Jackson & King, 1982; Park, 2001). Depending on the observer's perspective, the behaviors may be viewed as challenging behaviors, self-treatment strategies, autonomic fear responses, or emotional regulatory strategies. Such behaviors include covering ears, crying, and/or tantruming in response to certain sounds, fleeing the area where the sound is occurring, humming/vocalizing in the presence of sound, trembling, increased muscle tone, hyperventilation, pupil dilation and even self-injury in the form of blows to the ears. Temple Grandin, a high functioning person with autism, wrote about her own hyperacusis in *Thinking in Pictures* (1995, p. 67):

When I was little, loud noises were also a problem, often feeling like a dentist's drill hitting a nerve. They actually caused pain. I was scared to death of balloons popping, because the sound was like an explosion in my ear. Minor noises that most people can tune out drove me to distraction. When I was in college, my roommate's hair dryer sounded like a jet plane taking off.

In their attempts to spare themselves the anticipated sensations associated with hyperacusis, individuals with ASD may adopt habitual, lifelong compensatory strategies. As one example, Robert Hughes (2003), in his memoir *Running With Walker*, described his son with ASD as a person who routinely protected his ears; in fact, the photograph on the book's cover is an image of Hughes and adolescent son, Walker, with an index finger in each ear. Similarly, David Monahan (2002), a teenager with ASD, told a National Public Radio (NPR) interviewer:

Sirens and sudden like, sudden like hammers or something like that . . . I gotta get my plugs in my ears, or I'm outta there. Fire alarms! The fire alarms, oh boy, whoo! Yes, sir, I carry my plugs around, basically as often as I can, or I'll use my trusty indexes.

Hyperacusis in ASD: Physiologic Perspective

Researchers have earnestly attempted to discover some measurable physiologic difference that could lead to hyperacusis in individuals with ASD. Results have not indicated that such a physiologic difference exists. Within the various studies, operational definitions of hypersensitivity to sound have differed. In the most recent studies, investigators used hearing thresholds equal to or less than 0 dB as an operational definition for auditory hypersensitivity (Gravel, Dunn, Lee, & Ellis, 2006; Tharpe et al., 2006). That is, rather than seeking indications of discomfort or difficulties tolerating sound, these researchers sought evidence of extrasensitive hearing—auditory thresholds significantly better than those found among typical peers. Upon testing 37 higher functioning children with ASD and matched control subjects, Gravel et al. (2006) found the ASD group did not demonstrate better threshold sensitivity than their peers, even though six of the children with ASD had been identified previously as sensitive to sound according to parent report. Additionally, the children with ASD did not require the examining audiologist to discontinue the stimulus for acoustic reflex testing any more often than did their typical peers. The authors did not speculate on possible reasons why some of the subjects were considered hypersensitive by their parents. Tharpe et al. (2006) supported the findings of Gravel et al. Although their study did not focus directly on the issue of hyperacusis, the authors found that when children with ASD were tested using physiological measures, they did not exhibit better auditory thresholds, or extrasensitivity, in comparison to typical peers. It is important to note, however, that when parents of the 22 subjects with ASD (average age, 5 years 7 months) were asked, "Does your child seem to regard certain sounds as painful or distressing?," 17 of 22 responded "yes" in comparison to only 6 of 22 "yes" responses from parents of typically developing peers.

Earlier investigators defined hyperacusis as a difficulty tolerating sound at normal intensities. Researchers in one study noted that a statistically significant number of subjects with ASD and normal hearing demonstrated hyperacusis in comparison to 0% of the typical controls (Rosenhall, Nordin, Sandstrom, Ahlsen, & Gillberg, 1999). This interpretation was based on behavioral protests that were observed during the administration of an auditory test. The possibility that subjects' protests may have been associated with anxiety or fear of unfamiliar stimuli was not considered. In another investigation, pure tones were

presented monaurally through headphones to 11 youngsters with ASD and a control group (Khalfa et al., 2004). All subjects with ASD demonstrated hypersensitivity to sound, defined as “an increased perception of loudness.” Subjects rated the stimuli as “low,” “medium,” “loud,” or “too loud.” Loudness discomfort levels (LDLs) were lower than 80 dB HL in 63% of subjects with ASD and 27% of typical controls, a statistically significant difference. The authors concluded that subjects with ASD demonstrated an increased loudness perception of pure tone intensity, but cautioned that their tendency to label stimuli as “too loud” could indicate a “psychological bias” rather than an auditory abnormality. Additionally, Gomes, Rotta, Pedroso, Sleifer, and Danesi (2004), working in Brazil, examined 46 individuals with ASD ranging in age from 5 to 20 years. Although 11 individuals were clinically diagnosed as “oversensitive to sound” using reports from caregivers and school personnel, only two subjects demonstrated discomfort when stimulated with a 90 dB warble tone presented through speakers in sound field. Gomes et al. suggested that adverse reactions to sound in individuals with ASD may not reflect a physiological difference in the auditory system, but rather a psychoemotional-behavioral difference: A fear of sound stimuli, accompanied by hyperreactive avoidance behaviors.

In summarizing the studies described above, it can be stated that (a) definitions of hyperacusis varied in the ASD literature, (b) there was a considerable subgroup of individuals with ASD in each subject sample that presented behavioral responses indicating hyperacusis, and (c) there was no evidence of a physiologic difference in people with ASD that would lead to hyperacusis. Although both Rosenhall et al. (1999) and Khalfa et al. (2004) concluded that hyperacusis was a commonly occurring characteristic of ASD, the latter group considered the possibility that the problem might be a psychoemotional-behavioral one, rather than a physiological one. Gravel et al. (2006) and Tharpe et al. (2006) used a somewhat different definition of hypersensitivity to sound, and both groups strongly doubted the existence of any causal physiological differences, at least in the peripheral auditory systems of children with ASD.

Hyperacusis in ASD: Psychoemotional-Behavioral Perspective

According to empirical data and personal accounts, sound stimuli need not be especially loud or high pitched to elicit strong avoidance responses (Jastreboff & Jastreboff, 2000). Anthropologist Roy Grinker (2007, p. 299) wrote about his teenage daughter Isabel's hyperacusis as follows:

. . . she still hates certain sounds, like a baby crying, the car alarm that tells you your seatbelt isn't fastened,

or the sound of a bathtub draining. When she hears them she gets agitated, holds her hands over her ears, and vocalizes to block out the sound. She has the same reaction when she hears me clear my throat, or when someone says words associated with bathing, such as 'bath,' 'shower' or 'shampoo.'

Prizant, Wetherby, and Rydell (2000) discussed emotional regulation (ER) as one of the core developmental processes to be addressed in assessment and intervention planning for individuals with ASD. ER is a person's ability to use various strategies to manage his or her level of emotional arousal and associated reactions (Prizant & Meyer, 1993). It is possible that neurophysiologic differences in ASD contribute to hyperreactivity in some individuals, resulting in the emotional dysregulation associated with hyperacusis (Prizant, Wetherby, Rubin, & Laurent, 2003). These authors contend that when people are dysregulated, they are less available for educational and social opportunities.

Terms used in the literature to describe psychoemotional-behavioral conditions resulting in hyperacusis/hyperreactivity to sound are *phonophobia*, a fear of sounds, and *misophonia*, a learned, emotional reaction to sound (Henry, Zaugg, & Schechter, 2005; Jastreboff & Jastreboff, 2000; Khalfa et al., 2004; Koegel, Openden, & Koegel, 2004). Both terms have been applied to otherwise-typical individuals who exhibit difficulty tolerating ordinary sounds as well as to individuals with ASD.

Phonophobia. Phonophobia is defined as “abnormally strong reactions of the autonomic and limbic systems (without abnormally high activation of the auditory system by sound), resulting from enhanced connections between the auditory and limbic systems” (Jastreboff & Jastreboff, 2000, p. 163). Individuals who exhibit phonophobia in the absence of any measurable auditory pathology have the following in common: (a) They believe that sound can be harmful; (b) they attempt to overprotect their ears; (c) their reactions to sound are context-dependent; and (d) they may react strongly to specific sounds, yet demonstrate no reaction to louder sounds. Such reactions are associated with extreme anxiety and decreased quality of life.

In typically developing children, fear of sound is anything but rare. Parenting publications routinely include “loud and unexpected noises” on lists of the most common childhood fears (Iowa State University Extension, 2003; University of New Hampshire Cooperative Extension, 2002). The category that included “noise, events associated with noise and noise plus motion” was the most commonly reported group of fears in a classic, large-scale study (Jersild & Holmes, 1935). Moreover, Brown (1991) specifically cited childhood fears of loud noises as a constant across all peoples and cultures.

In most cases, sound-related fears are relatively mild and transient, diminishing as children reach preschool age. For some, however, the fear persists and even intensifies, resulting in activity limitations and participation restrictions for the individual and his/her family (King, Muris, Ollendick, & Gullone, 2005). According to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR, American Psychiatric Association, 2000), such a disruptive and chronic fear would be classifiable as “specific phobia—miscellaneous other type.” There are multiple examples of otherwise-typical children who reacted to noises with avoidance behaviors similar to those seen in individuals with ASD (Mendez & Garcia, 1996; Stableford, 1979). For some individuals with ASD, true phonophobia may lead to emotional dysregulation and sound avoidance behaviors.

Misophonia. Recall that hyperacusis is defined as “an unusual intolerance of ordinary environmental sounds.” Surely, any typical individual can list sounds that do not cause real fear, but are nonetheless considered extremely annoying (e.g., loud chewing or sniffing, fingernails on a chalkboard). Perhaps some individuals with ASD feel annoyed by a greater quantity of sounds, and their emotional reactions are less conventional and seem more dramatic to observers. In such cases, what is essentially misophonia and associated regulatory behavior might be misinterpreted as a problem within the auditory pathway.

One possibility to consider is that individuals with ASD often do, as many have expressed, feel real physical discomfort in the presence of sound stimuli, but the problem does not stem from the auditory pathway itself. Gawande (2008, p. 63) described human perception of sensation, in general, as “the brain’s best guess about what is happening in the outside world.” He used the metaphor of a car’s electronic dashboard sensor blinking a constant warning message. Imagine that there is nothing mechanically or electronically wrong with the car, yet the sensor continues to blink its warning. It may be possible to apply this perspective to hyperacusis/hyperreactivity in individuals with ASD. Just as the car’s owner might finally ask, “Is the problem in the car or in the sensor?,” interventionists might ask, “Is the problem somewhere in the auditory system itself, or is the individual receiving incorrect information from some other ‘sensor’?” What if, instead of originating in the auditory pathway, the problem stemmed from centrally stored information about negative past auditory experiences? This phenomenon, termed “phantom perception,” has been studied in other realms (Ramachandran & Hirstein, 1998). The discomfort experienced is real, but approaches for intervention (to be discussed later) would need to address the reaction to the problem as much as the problem itself. If a person with ASD has a “sensor” that is incorrectly interpreting the world, then interventions would need to help reset it or calm it down by providing some new information.

Interventions that would help an individual with ASD to realize that sounds are not harmful or threatening might put a stop to the sensor’s warning messages (Gawande, 2008, Jastreboff & Jastreboff, 2000).

Assessment of Hyperacusis

Assessment of hyperacusis currently is not part of routine hearing examinations administered by audiologists to individuals with ASD (or young children at risk for ASD), but it easily could be incorporated without adding excessive time or cost. Indeed, it is routinely covered by funding agencies (e.g., Medicare, Medicaid, health insurance providers). One simple addition would be an expanded case history. Individuals could be asked to provide a detailed description of the problem, including the types of noises and length of exposure that cause discomfort, whether or not the sensation is bilateral, and whether or not the sensation occurs consistently whenever the offending sounds are present. Individuals also would be questioned about medical history, including invisible concerns such as headaches, tinnitus, and depression. If the individual with ASD could not provide such a detailed oral self-report, the information could be obtained via observation and/or caregiver interview. There are a variety of questionnaires that might be adapted for this purpose (Anari, Axelsson, Eliasson, & Magnusson, 1999; Dauman & Bouscau-Faure, 2005; Jastreboff & Jastreboff, 2000; Johnson, 1999; Valente, Goebel, Duddy, Sinks, & Peterein, 2000). This process may assist audiologists in categorizing the hyperacusis as physiologic or psychoemotional-behavioral in nature (or both). In addition, the information gleaned could help determine targets to address in intervention, and ultimately could lead to significant improvements in life participation.

The audiologic exam for hyperacusis includes pure tone audiometry, speech audiometry, and tympanometry, which are routinely administered in a normal audiological assessment battery. A useful addition would be the assessment of LDLs (Katzenall & Segal, 2001). The purpose is to determine whether or not the hyperacusis is due to identifiable physiologic causes, and if so, to establish if the physiologic site of the hypersensitivity is in the ear itself or in the nervous system (Henry et al., 2005; Jastreboff & Jastreboff, 2000). The procedure involves presenting pure tone and/or speech stimuli while gradually increasing loudness. The LDL is recorded as the decibel level at which the individual indicates the stimulus is uncomfortably loud. Establishing LDLs helps identify a key element: whether loudness alone is aversive to the individual. If loudness alone does not turn out to be aversive, the audiologist could recommend a positive, individualized behavioral treatment.

Certain individuals with ASD may have difficulty fully cooperating with all aspects of this type of evaluation, and

some caregivers may be reluctant to subject individuals (particularly children) to the distress associated with unfamiliar people, places and procedures. Davis and Stiegler (2005) suggested ways to facilitate hearing evaluations for individuals with ASD. One recommendation was for audiologists to be persistent in their testing attempts and not adopt a "let's try again next year" stance. It is desirable to allow individuals time, perhaps in short sessions across several days, to become familiar with the audiologist, the environment, and the procedures. Second, close collaboration with caregivers and other professionals may contribute to successful assessment, because they may be able to provide the audiologist with advance knowledge about an individual's unique sensory preferences and strategies for emotional regulation (Prizant et al., 2000). Finally, a very thorough preparation of the individual during the weeks prior to the assessment is recommended. Ideally, a representation of the visit with the audiologist would be included on the child's calendar or visual schedule to help create awareness of the upcoming event (Hodgdon, 1995). An individualized Social Story™ or Power Card might be developed and reviewed frequently in advance (Gray, 1995; Keeling, Myles, Gagnon, & Simpson, 2003). In addition, one or more videorecordings of the audiologist, the testing environment, and various procedures could be prepared to meet specific individual needs, then reviewed and discussed prior to the assessment (Charlop-Christy, Le, & Freeman, 2000).

Interventions for Hyperacusis/Hyperreactivity

The literature on interventions designed specifically to address hyperacusis in individuals with ASD is sparse, but hopeful (Buckley & Newchok, 2006; Grinker, 2007; Jackson & King, 1982; Koegel et al., 2004; McCord, Iwata, Galensky, Ellingson, & Thomson, 2001). In some cases, surprisingly simple interventions have been effective. Most have focused on helping individuals habituate to auditory signals that the individual finds aversive. Habituation is possible in any sensory modality, as long as the input is not considered threatening or negative (Jastreboff & Jastreboff, 2000). In otherwise-typical individuals diagnosed with hyperacusis, gradual and systematic desensitization is a commonly recommended treatment.

One of the key aspects of sound-desensitization protocols for typical individuals is to discontinue overprotection of the ears (i.e., earplugs, earmuffs, covering the ears manually). Overuse of ear protection can lead to increased hypersensitivity to sound, and an even greater degree of phonophobia (Jastreboff & Jastreboff, 2000; Mraz & Folmer, 2003). Additionally, the recommended protocol includes exposure to an enhanced auditory environment. For non-ASD individuals, bilateral sound-generating devices, worn like

behind-the-ear hearing aids, are often an integral part of the desensitization process. These instruments provide a consistent sound source that should not interfere significantly with the perception of environmental sounds and can be easily controlled by clinicians and users (Jastreboff & Jastreboff, 2000; Mraz & Folmer, 2003). There are no reports of sound generators being tested in individuals with ASD. Instead, individuals with ASD have been exposed gradually to everyday activities that have a necessary sound component.

In one study, investigators assumed that the responses of a 4-year-old boy with ASD to toilet flushing were due to a phobia (Jackson & King, 1982). He would become tense, tremble, scream, hyperventilate, and run away, but only when an actual toilet was present. Audiotapes of flushing sounds paired with photographs of toilets evoked no notable reaction, no matter how often or how loudly the tapes were played. No other sounds caused the negative reaction. Additionally, the boy could always be prompted to use various toilets for urination and defecation, as long as he believed flushing would not occur until he was out of range. The investigators devised an in vivo systematic desensitization program using tickle-induced laughter, which the boy reportedly loved, as an anxiety inhibitor. As the child began his toileting routine he was tickled and would typically laugh throughout toileting. After toileting, the toilet was flushed many times over a 2-min to 3-min period, with more tickling if necessary. If the boy did not show fearful responses, he was reinforced with an edible and verbal praise. Over a course of 15 days, the procedure was repeated numerous times on nine different toilets at school, home and several other environments. The phobia was eliminated, and at 3-month and 6-month follow-ups, the child showed no anxiety in response to toilet flushing.

Koegel et al. (2004) also used systematic desensitization to treat hyperacusis in three very young children (mean age = 34 months) diagnosed with autism. Each child displayed ear-covering, screaming, and other aversive reactions, not only to sound stimuli, but to the mere sight and/or mention of certain noise-producing toys (e.g., a Mattel See-and-Say) and household appliances (e.g., mixers, blenders, vacuum cleaners, toilets flushing). A detailed, individualized sound desensitization hierarchy was developed for each child and implemented across various time spans. Each child was exposed to his/her problem sounds gradually, but persistently. For example, with one boy who reacted negatively to toys that produced animal sounds, the sounds were first presented 20 feet away from a room where the child played with his mother, with the door completely closed. Over relatively brief increments of time, the sounds were presented at increasingly closer proximities to the closed door, until the toy was finally held against the closed door. Next, the sounds were played with the playroom door slightly ajar, one quarter open and one half open, before the

toys were activated inside the room. At the end, the child spontaneously requested activation of the toy. This entire sequence was accomplished in one long session, after which the clinician maintained phone and email contact with the child's mother to be sure he was playing comfortably with sound toys at home. Postintervention and follow-up measures showed no aversive reactions in the presence of sounds and objects that were previously judged to be intolerable.

Grinker (2007) anecdotally described another intervention. He expressed how difficult it was for him to see his daughter suffering, and admitted that her hyperacusis/hyperreactivity to common environmental sounds posed major obstacles on family outings, as well as difficulties for Isabel's teacher and classmates at school. The family visited a psychiatrist to ask for medication that might help, but the physician suggested a challenge in which Isabel would receive one point each time she tolerated one of her problem sounds without the customary reaction. Grinker wrote:

So we explained the game to Isabel and told her that when she got 100 points she could visit the new baby panda bear at the National Zoo. Within just a few hours she was begging me to clear my throat and to say "bath" and "shower." She got her prize, and the game's over. Isabel still hates those sounds, but she no longer reacts defensively. It was a simple example of how effective it can be to use a reward system, but it felt like a miracle. (p. 299)

Auditory integration training (AIT) and other sound "therapies" that involve a period of listening to electronically altered auditory stimuli through headphones have been offered as treatments for hyperacusis in individuals with ASD. Randomized clinical trials have shown that AIT is ineffective (Mudford et al., 2000; Zollweg, Vance, & Palm, 1997). There are clear statements from the American Academy of Audiology, the American Speech-Language-Hearing Association (ASHA), the American Academy of Pediatrics, and the Educational Audiology Association, all categorizing AIT and other sound therapies as investigational, nonevidence-based practices (ASHA, 2004; Tharpe, 1999). The instruments used to administer AIT are not approved by the United States Food and Drug Administration. Furthermore, some professional licensing boards place strict limitations on the use of AIT, even as an experimental treatment, and require clinicians to obtain caregivers' informed consent prior to use (Louisiana Board of Examiners for Speech-Language Pathology and Audiology, 1994).

Prizant et al. (2000) provided goals and interventions for ER in general, as applied to the ASD population. These ideas are appropriate for the more specific issues of hyperacusis/hyperreactivity, and targets should reflect each person's

needs and the priorities of families. Depending on the individual, ER may be accomplished independently (self-regulation) or collaboratively (mutual regulation). Additionally, the strategies used may be presymbolic or symbolic (linguistic) in nature. For example, behaviors such as placing hands over ears and running away from sound are considered to be presymbolic, sensorimotor ER strategies that some individuals with ASD adopt in attempts to help themselves cope and stay focused. For a person at a presymbolic level, more socially acceptable self-regulation strategies may include holding a favorite object or engaging in rhythmic movement. Caregivers/interventionists can provide support by being sensitive to behavioral indicators of hyperacusis/hyperreactivity and reducing or changing (but not completely eliminating) environmental sound stimulation. Nonspeaking individuals can learn more conventional ways (e.g., gestures, visuals) to communicate about sound and how it affects their emotional state (Prizant et al., 2003). For more able individuals, self-regulation may include using language in the form of self-talk (e.g., "That's the vacuum cleaner. It's a safe sound.")

Caregivers/interventionists can teach useful vocabulary for self-talk, and promote the ability to request help or a break. Even for individuals who are able to use language, visual supports may be extremely useful during moments of dysregulation (Prizant et al., 2003). The notion of mutual regulation is particularly relevant in the hyperacusis/hyperreactivity discussion, because sound tolerance difficulties occur so often in social contexts. Mutual regulation is a social phenomenon that involves one individual's ability to accept assistance in maintaining a calm, alert state, as well as a partner's ability to interpret and respond to signals of dysregulation (Prizant et al., 2003). Thus, the beliefs, interpretations, and reactions of social/communication partners are critical variables. If a classroom teacher believes (based on behavioral observations, or based on ideas about ASD) that her student with ASD is physiologically and permanently hypersensitive to sound, she unfortunately may curtail that student's exposure to certain worthwhile academic and social events.

Case Example

GM, a 6-year-old boy with a diagnosis of autism, was receiving speech and language intervention at a university clinic. Careful audiologic evaluation by a certified audiologist indicated normal hearing, yet his mother commented that sensitivity to noise was "the part of [GM's] autism that disrupts family life the most." She provided numerous examples of family activities (e.g., haircuts, eating in restaurants, attending ballgames, going to church) that were rendered unpleasant or otherwise limited because of GM's hyperacusis/hyperreactivity. GM's mother expressed strong

interest in any intervention that would improve his ability to tolerate sounds, and requested haircuts as the first targeted activity. Her routine was to cut his hair herself using electric clippers, and GM typically reacted with numerous behaviors associated with hyperacusis/hyperreactivity.

The first author and the mother collaborated to create a Social Story™ using Power Point software. A Social Story intervention (Adams, Gouvousis, VanLue, & Waldron, 2004; Crozier & Tincani, 2005; Gray, 1995; Sansosti, Powell-Smith, & Kincaid, 2004) was considered an appropriate treatment because (a) it offered a form of positive behavioral support, (b) it was a language-literacy based intervention that could be incorporated easily into a language treatment session, and (c) it was preferred by the parent. The idea was to communicate clear, descriptive information about the haircut process and offer options for how GM might comfort himself during and after the haircut. The story's text was enhanced by color photographs of GM, his mother, her actual hair clippers shown from two different angles, a four-part sequence depicting a peer having a haircut, and close-up shots of an ear and a thumbs-up gesture. Various familiar icons and symbols were included to facilitate comprehension. Additionally, a digital recording of electric hair clippers was embedded as a sound file and played wherever the clippers appeared in the story. The resulting Social Story was approved by Carol Gray as being appropriately individualized and constructed according to prescribed guidelines (C. Gray, personal communication, October 20, 2008).

An undergraduate practicum student presented the Social Story twice a week for 2 weeks in four regular language intervention sessions. During each session, the Social Story was read and discussed for 5 to 10 min. Whenever the story referenced the clippers, the clinician would access the sound file and gradually increase the speaker volume. The mother was given digital and paper copies of the Social Story and asked to read it frequently to GM over the time leading up to the next haircut, and especially just before the event. GM reportedly loved using the computer to look at the Power Point version, and carried the hard copy version around the house and brought it along on car trips. His younger sister memorized it and "read" it often to GM.

GM's mother submitted a 24 min and 55 s videorecording of the next haircut. The recording was transcribed by the first author, and checked for accuracy by a graduate student in communication disorders. Analysis revealed that while GM verbally and/or vocally protested 54 times during the haircut, none of the protests referred to auditory stimuli. GM did not cover his ears or try to flee during the haircut. He willingly held the clippers, and turned them on and off without prompting. Although there are no pre-intervention data other than parent report, it might be hypothesized that repeated exposure to the Social Story and sound file helped

desensitize GM to the sound of the clippers, and helped him better understand and predict what was happening. He may not have enjoyed the experience, but he was able to tolerate it.

Although GM's mother and the investigators had been convinced that he reacted negatively to haircuts because of the noisy clippers, examination of the video file and transcript raised numerous other possibilities. GM may have remembered previous negative experiences with haircuts, because he began to protest from the outset, before the clippers were activated. Perhaps the length of the process, its open-endedness, and the fact that it was not part of this daily routine, were disconcerting to GM. About halfway through the haircut, the mother began to make time-related statements (e.g., "I'll stop in a minute," "I'm almost done") with the intention of comforting GM. These utterances may have contributed inadvertently to GM's anxiety by giving him false hope that the event would end quickly. The somatosensory issues of feeling the clippers against his scalp, having his face held, feeling bits of hair on his skin, and having the hair brushed off may have added to his discomfort. It is doubtful that auditory aspects played more than a minor role in the event.

Conclusions

Although sound sensitivity issues are commonly discussed in the context of ASD, individuals with ASD are likely to differ in terms of their reactions to auditory stimuli. There may be varying etiologies among those who exhibit or complain of some level of hyperacusis. Constellations of offending sounds are apt to be individual-specific, and these sounds may be part of complex social events rather than isolated auditory stimuli. Interventions will need to be tailored to the cognitive, linguistic, emotional, and auditory needs of each individual with ASD.

It is clear that this issue should be discussed as early as possible in a person's assessment/intervention process. Assessments should include a question about hypersensitivity to sound in case histories and/or parent interviews; if problems are reported, follow-up education should be provided. Families should seek the most accurate and thorough auditory assessment possible. Professionals should consider adopting the assessment and intervention protocols that are used routinely with sound-sensitive individuals without developmental disabilities. As part of intervention, caregivers should be educated on relevant issues, including the differences between physiologic and emotional etiologies, as well as strategies for addressing hyperacusis/hyperreactivity. Overprotection of the ears should be discouraged, as that may lead to long-term difficulties with hyperacusis.

ASD are clearly complex and multifaceted conditions. Early awareness, better assessment, and practical intervention

regarding hyperacusis/hyperreactivity may enhance individuals' ability to benefit from educational resources, participate in life events, and attain greater functional independence in adulthood.

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