Chapter Seven

The Complexities of Listening and Understanding in Children with Minimal/Mild Hearing Loss

Dawna Lewis, Ph.D.
Jody Spalding, M.A.
Daniel Valente, Ph.D

Abstract

Numerous studies have shown that school-age children with minimal/mild hearing loss (MMHL) may experience difficulties in a variety of areas including speech perception in noise and reverberation, speech/language development, educational performance and social/emotional development. However, challenges experienced by this population are not always straightforward. Consequently, children with minimal and mild hearing loss may be overlooked and/or difficulties that are related to their hearing loss may be minimized, potentially influencing expectations, behaviors, and progress in a number of developmental areas. This paper will examine the impact of minimal and mild hearing loss on performance in complex listening environments and implications for real-world listening and understanding.

In 1986, Bess and colleagues published a series of studies that examined case history and performance data for 6-18 year-old children with unilateral hearing loss (UHL) who were selected from patient and educational files in middle Tennessee (Bess, 1986). The results of those studies were influential in advancing our understanding of children with UHL. Perhaps the most surprising finding from the case history data (Bess & Tharpe, 1986) was that 35% of the children with UHL had failed at least one grade and 13% required resource help. This percentage of grade failures was much higher than the district average (3.5%). While the highest percentage of grade failures for a single grade occurred in the first grade, findings indicated that children with UHL were failing grades from kindergarten through seventh grade. Similar grade-retention rates were reported by Oyler, Oyler, & Matkin (1988), who examined records for children with UHL in a large school district. They reported that 24% of the children with UHL had repeated at least one grade and 41% had received special services, compared to 2% and 8.6%, respectively, for district averages.

A little over 10 years later, Bess, Dodd-Murphy and Parker (1998) examined educational performance and functional status in a group of children in grades 3, 6 and 9 with minimal sensorineural hearing loss, which included children with UHL, bilateral hearing loss (BHL) and high-frequency hearing loss (HFHL). For this population, grade retention rates for children also were significantly higher than district averages at 29.2%, 36.4% and 47.4% for grades 3, 6 and 9, respectively. While district averages also rose across grades, none were above 10%.

Since those early studies, numerous studies have shown that school-age children with minimal and mild hearing loss (MMHL) may experience difficulties in a variety of areas that encompass communication, academics, cognition and psychosocial factors (Bess et al., 1998; Bess & Tharpe, 1986; Bess, Tharpe, & Gibler, 1986; Borton, S., Mauze, E., & Lieu, J., 2010; Crandell, 1993; Culbertson & Gilbert, 1986; English & Church, 1999; Johnson, Stein, Broadway, & Markwalter, 1997; Klee & Davis-Dansky, 1986; Lieu, Tye-Murray, Karxon, & Piccirillo, 2010; Newton, 1983; Porter, H., Sladen, D., Ampay, S., Rothpletz, A., & Bess, F., 2013; Ruscetta, Arjmand, & Pratt, 2005; Oyler et al., 1988). Many of these difficulties could be expected to influence the grade-retention results reported above. For example, MMHL, and in particular UHL may affect children's localization ability (Bess et al., 1986; Newton, 1983). Such abilities can play a role in a child's ability to follow conversations with multiple talkers and those in which not all talkers are visible. In addition, children with MMHL have shown difficulty understanding speech in adverse acoustic environments (Bess et al., 1986; Boney & Bess, 1984; Crandell, 1993).

In classrooms, where acoustic conditions can vary widely (Bradley, 1986; Knecht, Nelson, Whitelaw & Feth, 2002; Nelson, Smaldino, Erler, & Garstecki, 2008), the ability to hear and understand new information during educational activities may be compromised, impacting academic performance.

Numerous studies also have shown that children with MMHL may experience difficulties in areas such as self-esteem, stress, energy, peer relations, and social confidence (Bess et al., 1998; Culbertson & Gilbert, 1986; Keller & Bundy, 1980; Oyler et al., 1986). Psychosocial development may impact behaviors, interactions with teachers and peers and performance. In a study comparing children with MMHL and children with normal hearing (NH), Bess et al. (1998) examined the self-perceived functional status of 6th and 9th grade participants. In the 6th grade, significantly more children with MMHL demonstrated dysfunction compared to their peers with NH in the dimensions of self-esteem and energy. In the 9th grade, significantly more children with MMHL exhibited dysfunction in the dimensions of social support, stress and self-esteem. Further examination of the results also showed changes in patterns of dysfunction for the children with MMHL across the two grades. Comparatively more 9th graders exhibited high levels of dysfunction in school work, social support, stress, family and overall health. The only dimension in which dysfunction appeared to decrease across grades for children with MMHL was energy. These patterns suggest that difficulties across a variety of psychosocial areas may be greater for older children with MMHL than for younger school-age children (e.g., high-school versus elementary-school ages). Given that few of the children with MMHL were identified with hearing loss prior to the study, Bess et al. stated that the functional issues were unlikely to have been related simply to *knowledge* of the hearing loss by the children or by others (e.g., peers, educational personnel).

Although there is a large body of research showing that children with MMHL may experience greater difficulties than peers with normal hearing in a number of areas, research also has indicated similar performance in some areas (Bess et al., 1998; Borton et al., 2010; Crandell, 1993; Culbertson & Gilbert, 1986; Klee & Davis-Dansky, 1986; Lewis, Valente, & Spalding, to 2014; Lieu et al., 2010; Porter et al., 2013). Unlike children with greater degrees of hearing loss, children with MMHL often demonstrate speech recognition similar to their peers with NH when tested in quiet or in low levels of noise/reverberation (Boney & Bess, 1984; Crandell, 1993; Lewis, et al., in review). Comparable speech understanding under some acoustic conditions may lead educators to assume that these children will perform better than they actually do in classrooms where noise levels can vary significantly during the day. Despite issues with academic success for many children with MMHL, they also have been shown to perform within normal limits on numerous standardized measures of language and achievement (Blair, Peterson, & Viehweg, 1985; Keller & Bundy; 1980; Kiese-Himmel, 2002; Kiese-Himmel and Ohlwein, 2003; Wake, et al., 2006).

As the above research indicates, despite over 25 years of research examining the effects of MMHL, there is no consensus on the difficulties experienced by these children and thus no consensus on appropriate habilitative strategies. Because findings are not always straightforward, these children may be overlooked and/or the difficulties they experience may be minimized. It is important examine potential sources of differences across studies as a step in the development of measures that will lead to improved evaluation and management. For the remainder of this paper, we will discuss three areas that may impact outcomes of studies examining performance of children with MMHL: heterogeneity of hearing loss configurations within this population, perceptions regarding the impact of MMHL, and tests used to examine that impact.

Heterogeneity of Hearing Loss Configurations

The definition of MMHL can vary somewhat across studies (Bess et al., 1998; Crandell, 1993; Kiese-Himmel and Ohlwein, 2003; Lewis et al., in review; Wake, et al., 2006). Broadly defined, the degree and configuration of hearing loss in this heterogeneous population includes (1) bilateral (BHL; 3-frequency PTA between 20 and 45 dB HL), (2) unilateral (UHL; 3-frequency PTA >20 dB HL in the poorer ear and ≤15 dB HL in the better ear and (3) high-frequency (HFHL; thresholds >25 dB HL at one or more frequencies above 2 kHz in one or both ears). It is not surprising that degree and configuration of hearing loss within this population could impact outcomes. The following examples are provided to illustrate audibility issues that may impact speech understanding for two listeners with different configurations of MMHL.

Figures 1 and 2 illustrate audibility of average conversational speech for a 6 year-old child with mild-moderate UHL in the left ear. The graphs are taken from the Situational Hearing Aid Response Profile (SHARP;

Stelmachowicz, Lewis, Karasek, & Creutz, 1994; Brennan, McCreery, Lewis, Creutz, & Stelmachowicz, 2013). In each graph, the symbols represent thresholds for the right (O) or left ears (X) and the light shaded area represents the portion of the speech spectrum that is audible to the listener. Inaudible portions of the speech spectrum fall below threshold at a given frequency and are not shaded. Softer levels are toward the bottom on the y-axis. In Figure 1, the upper left panel shows audibility of average conversational speech presented in quiet at 1 meter for the right (normal hearing) ear. In this ear, the entire speech spectrum is audible to the listener. The upper right panel shows audibility for the left (hearing loss) ear for the same input. In this ear, only the low-mid frequencies are audible. Thus, if speech was presented from the left side, the child would be expected to miss a large portion of the speech signal in that left ear. However, the lower panel shows the portion of a signal presented to the left side that would be audible in the right ear (head shadow). For this child, much of the signal from the left would be audible in the right ear. The picture changes, however, when noise is added (Figure 2). In this figure, an additional shaded area has been added to each graph to provide a simplified illustration of how noise (approximately 10 dB SNR) could affect audibility of the speech signal for this child. As can be seen in the upper left graph, only the average and peaks of the speech spectrum are audible in the right ear. In addition, the lower graph shows that the signal from the left side that is being heard at the right ear is now degraded, with only limited peak information available. Together, these figures suggest that audibility of conversational speech

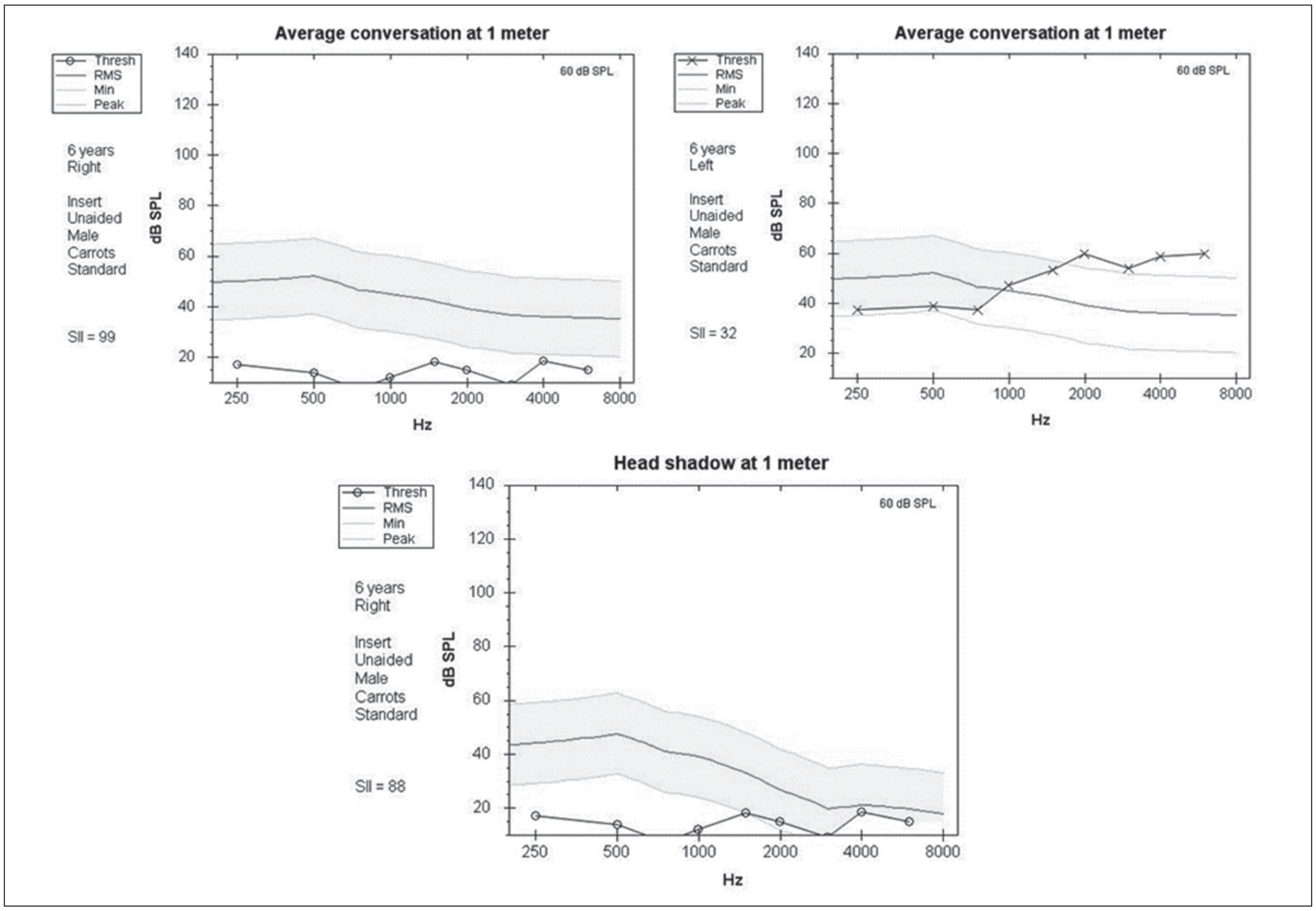

Figure 1. Audibility of speech for a child with UHL in the left ear. In each panel, the dark line represents the average speech spectrum and the lighter lines represent the minimum and peaks of that spectrum. The lightly shaded portion of the spectrum represents speech that is audible and the unshaded portion is inaudible. The upper panels show average conversational speech at one meter for the right ear (O; left panel) and left ear (X; right panel). The lower panel shows audibility of speech at the right ear based on head shadow from the left side.

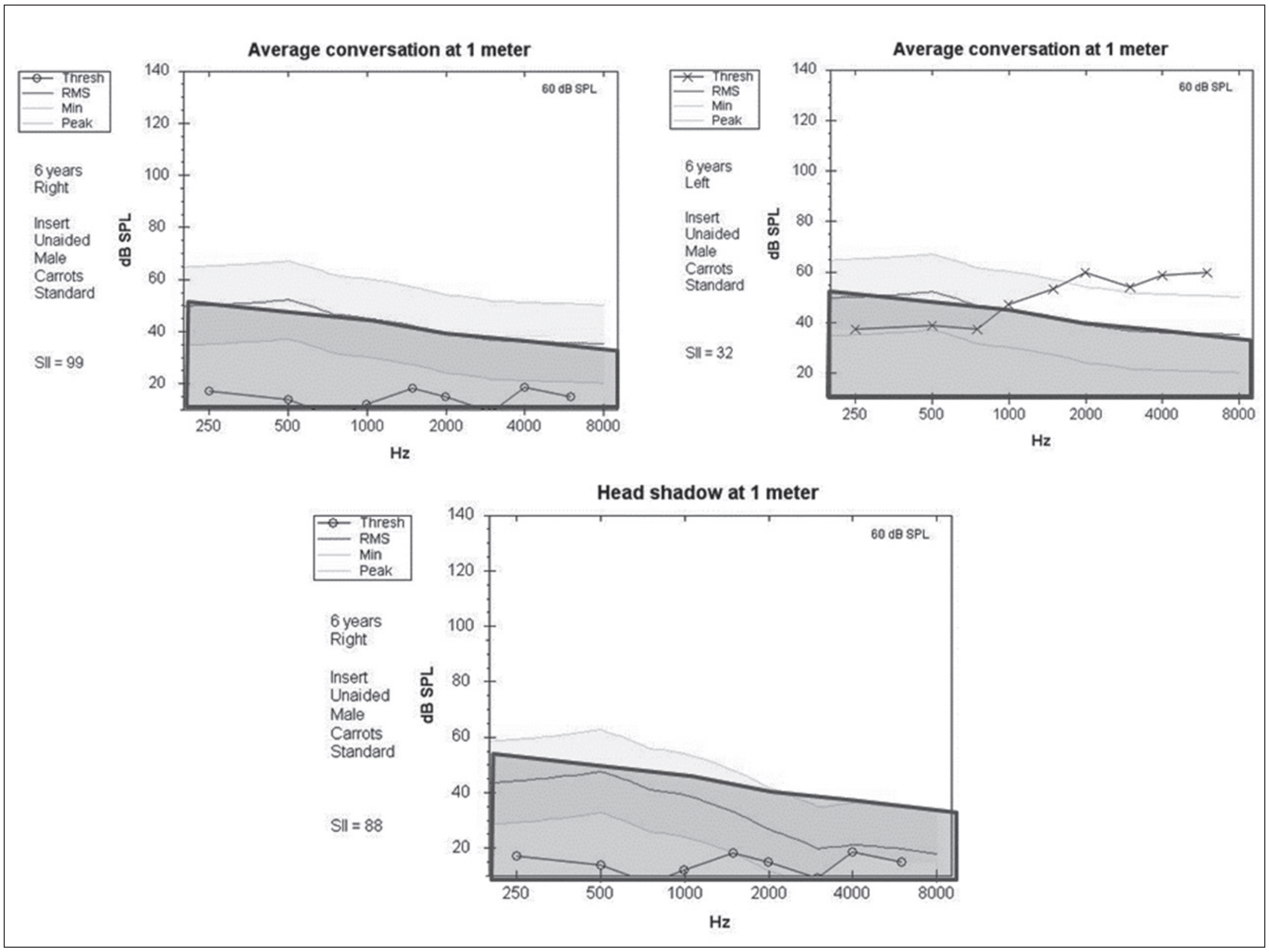

Figure 2. Same as Figure 1 with the addition of a darker shaded portion to represent the addition of noise at approximately 10 dB signal-to-noise ratio.

at 1 meter may not be an issue for this child with UHL in quiet, although speech understanding may be significantly compromised in noise.

Figures 4 and 5 illustrate audibility of average conversational speech at 1 and 4 meters (upper and lower left panels) and of a classroom teacher at the same distances (upper and lower right panels) for a 6 year-old child with bilateral hearing loss. Figure 3 shows results for the right ear in quiet (left ear values would be the same in this illustration of BHL). Notice that for this child, audibility of average conversational speech at 1 meter is compromised in the high frequencies with only peaks audible above 3000 Hz. At that same distance, the teacher's voice remains audible across most of the frequency range, with the exception of the loss of some of the softer components at 4000 Hz and above. At 4 meters the audibility of average conversational speech is much poorer across the entire frequency range. The audibility of the teacher's voice at this distance is greater and resembles that of average conversational speech at 1 meter. When noise is added (Figure 4), audibility of all speech signals is reduced. However, the teacher's voice at 1 meter remains audible across a majority of the frequency range. Together, these figures illustrate how distance, vocal effort and noise can differentially impact audibility of speech for a child with bilateral MMHL.

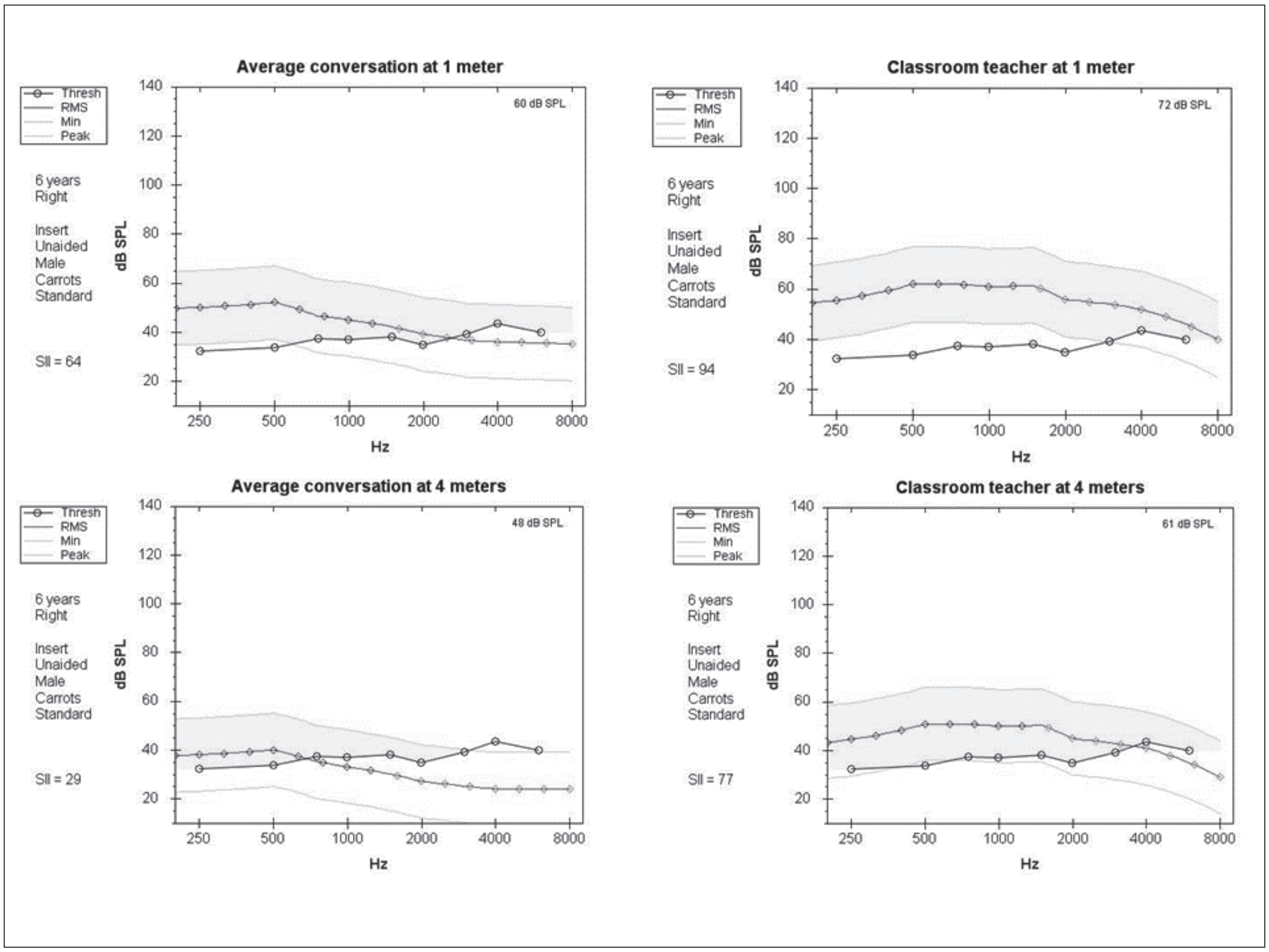

Figure 3. Audibility of speech in the right ear for a child with bilateral MMHL. In each panel, the dark line represents the average speech spectrum and the lighter lines represent the minimum and peaks of that spectrum. The lightly shaded portion of the spectrum represents speech that is audible and the unshaded portion is inaudible. The upper panels show average conversational speech at one meter (left) and a classroom teacher's voice at 1 meter (right). The lower panels show the same speech spectrums at 4 meters.

Perceptions Regarding the Impact of MMHL

Perceptions of the difficulties experienced by children with MMHL may influence expectations, behaviors, and progress in a number of developmental areas. At the same time, those perceptions may or may not accurately reflect the difficulties experienced by the child. It is possible that self-assessment by the person with MMHL will be affected by the fact that he/she does not realize what is being missed (e.g., Newton, 1983), suggesting that children may not always be the most accurate source to determine the effects of hearing loss on their auditory skills. Parents and teachers may also over/under estimate the difficulties experienced by these children (e.g., Dancer, Burl, & Waters, 1995; Oyler et al., 1988). Dancer et al. examined teacher perceptions of the effects of UHL for school-age children (5-17 yrs). The same measures were completed for one "average" student with NH from the same class as each subject with UHL. Although children with UHL scored significantly lower than their peers on most questions, there was no difference between groups in terms of teacher ratings of whether students were working to expectations. Such findings suggest that teachers may have had lower expectations for the children with UHL. Lower expectations

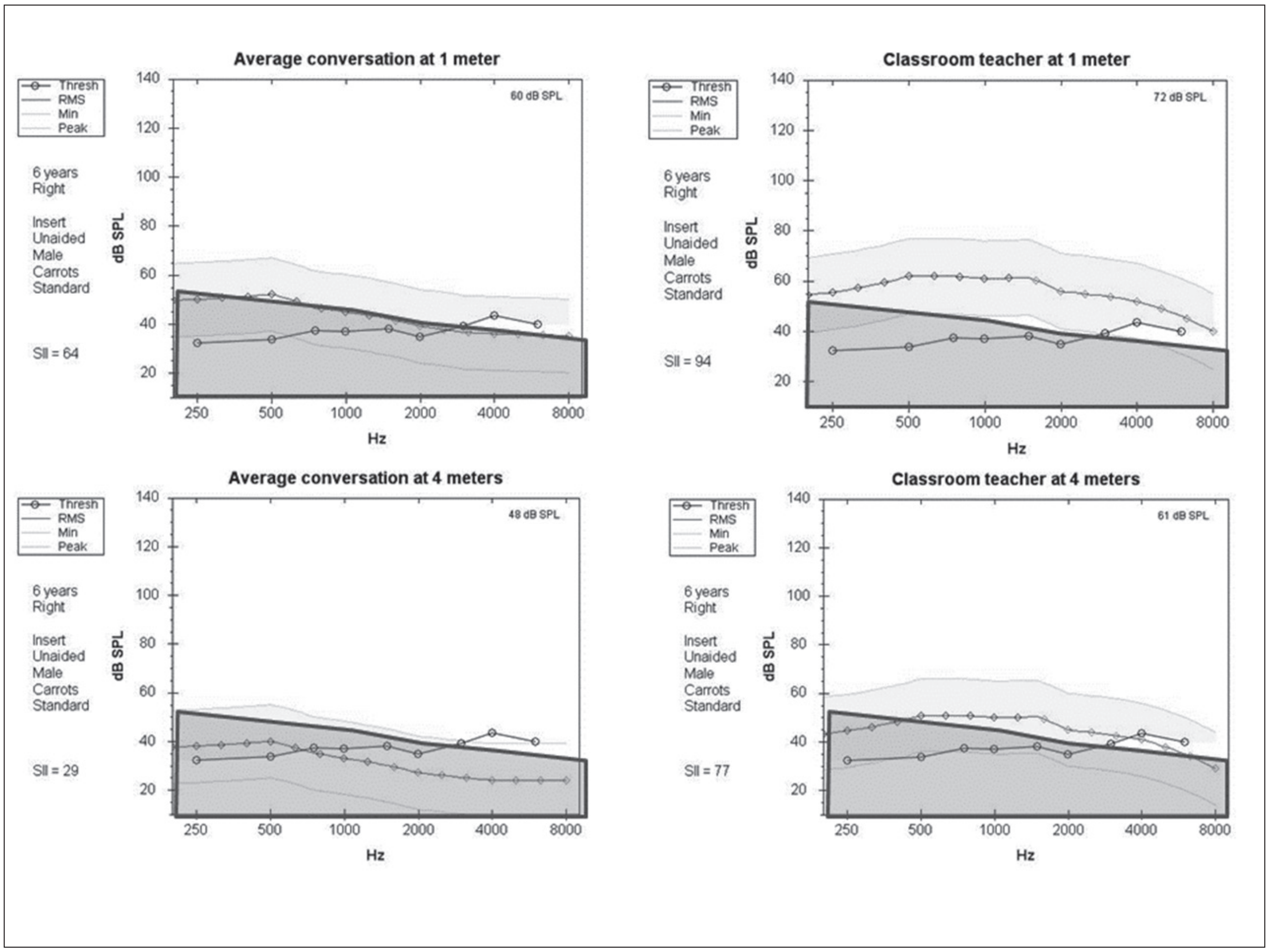

Figure 4. Same as Figure 3 with the addition of a darker shaded portion to represent the addition of noise at approximately 10 dB signal-to-noise ratio.

could affect both the teacher's willingness to challenge the student academically and the student's willingness to challenge him/herself.

Examining the child's perception of the impact of MMHL as well as those of their parents/caregivers and teachers may provide a more complete picture of potential difficulties. In the Listening and Learning Laboratory at Boys Town National Research Hospital we addressed this issue by conducting structured interviews of 20 children with MMHL, one parent/guardian of each child and, when possible, one classroom teacher for each child (responses were obtained from 9 teachers). Analysis is ongoing and only preliminary data will be discussed here (Spalding & Lewis, 2012). Data is being analyzed using both qualitative and quantitative methods.

From transcribed responses of interviewees, three broad categories of potential challenges emerged for children with MMHL. Those categories included awareness/understanding, groups/noise, and limited visual access. We first examined whether groups of interviewees were more likely to state that the child did or did not experience challenges in each of the categories. Table 1 shows the percentage of coded responses in each category for which children, parents and teachers perceived that the child was experiencing or not experiencing challenges. Note that teachers represent lower percentages than either parents or children because fewer teachers agreed to participate. The overall patterns indicate that parents and children were more likely to state that the children experienced challenges

Category	Interview Group	Coded utterances indicating challenge (%)	Coded utterances indicating no challenge (%)
Awareness/Understanding	Child	28.8	11.9
	Parent	31.5	7.3
	Teacher	15.2	5.4
Groups/Noise	Child	33.2	14.9
	Parent	27.0	8.2
	Teacher	9.2	7.6
Limited Visual Access	Child	28.6	17.4
	Parent	26.2	15.7
	Teacher	6.8	5.3
Examples of challenge statements: **Parent:** "She misunderstands things more often than she doesn't hear at all." **Child:** "I get confused when everyone is talking." **Teacher:** "She needs the visual piece. It is key for her."			

Table 1. Percent of utterances coded as either challenge or no challenge within three response categories by the child, a parent or a teacher.

in each of the coded categories. Teachers also were more likely to report challenges in awareness/understanding but their responses were more evenly distributed across challenge and no challenge in the other two categories. Examples statements from a parent, a child and a teacher regarding challenges are shown in the final row of the table. Overall, these finding suggest that the interviewees in this study perceived that the children with

Underlying Sources	Number of Occurrences Reported By		Examples
	Parents	Teachers	
Personality	10	17	Parent: "All of our family is very loud and talkative, but she is the quietest of all of our children and she talks the least."
Control	6	9	Teacher: "He wants the attention and will participate and over- run the conversation."
Behavior	8	34	Teacher: "I don't know if it's laziness because she depends on the [FM] mic or if it's the hearing loss."
Academic Challenges	8	8	Parent: "Learning often requires repetition, two or three times to understand concepts and then [he] doesn't really retain the concept."
Attention	11	10	Teacher: "When I speak and he doesn't hear, I am unsure if it's the hearing loss or that he's fidgeting with supplies or that he's not paying attention."
Same as Normal Hearing	6	5	Teacher: "His body language makes me think he can hear, because he jumps or startles when there's movement."

Table 2. Sources other than hearing loss reported by parents and teachers to explain challenges experienced by children with mild and minimal hearing loss (MMHL).

MMHL were experiencing challenges across a variety of areas. However, within those areas there also were instances that were identified as not being challenging for the child. Further examination will help us identify how these overall perceptions relate to the individual children in the study.

An unexpected finding from the interviews was the number of times parents and teachers reported that the child with MMHL was experiencing challenges but that they did not believe those challenges were related to the hearing loss. The interview questions were structured to address areas where children with MMHL could be at risk for difficulties. While it is possible that for any given child there are alternate underlying sources for reported challenges, observed responses may also indicate that parents and teachers do not fully understand the implications of MMHL on the children's performance in the challenge areas. Table 2 shows the alternative sources of difficulties and the number of times those comments occurred for parents and teachers. As an alternative to hearing loss, parents were most likely to attribute difficulties to attention followed by personality while teachers were most likely to attribute difficulties to behavior, again followed by personality.

While these findings are preliminary, they do suggest that perceptions are important. They are important as an indicator of understanding of potential implications of MMHL by families and educational personnel. Knowing how families and educators perceive MMHL and its potential impact on the child can be a useful tool for counseling and can assist in the development of habilitation strategies for that child.

Tests Used to Examine the Impact of MMHL

As the research discussed thus far suggests, outcomes may differ depending on the measures that are used to assess the abilities of children with MMHL. These differences may reflect how MMHL differentially affects skill areas (e.g., speech perception, language, memory). For example, the Bess et al. (1998) study of children with MMHL in grades 3, 6, and 9 compared children with MMHL and children with NH using measures that assessed educational performance and functional status. Results revealed significantly poorer scores for children with MMHL on some measures but not others. In addition, differences on at least one measure were significant in the 3rd grade but not in the 6th and 9th grades.

It also is possible that differences or the lack of differences between children with MMHL and those with NH in some studies relate to the measurement tools that are being used. For example, some standardized measures may not be sensitive to the difficulties experienced by this population; difficulties that may be more subtle than would be seen in children with greater degrees of hearing loss. In addition, when attempting to understand the effect of acoustics on performance, the test environment can play an important role in results. Differences in speech understanding in noise and reverberation may occur as a function of testing being conducted in a sound booth with good reproducibility but only general representation of the real world versus testing being conducted in an actual classroom with students present, which is ecologically valid, but by its nature changes frequently, limiting reproducibility.

To examine the effects of both task and environment on speech perception of children with MMHL and children with NH we created a simulated classroom whereby we could control acoustics and task. That environment is described in detail in Valente, Plevinsky, Franco, Heinrichs & Lewis (2012), which also presents results for two experiments with children and adults with NH. This paper will briefly present results from a study of 18 children with MMHL and 18 children with normal hearing from 8-12 years of age (Lewis et al., to 2014). Children completed two tasks: classroom learning, sentence recognition. For the classroom learning task, video recordings were made of a teacher and four students reading lines from a 10 minute age-appropriate play. Those recordings were presented via loudspeakers and video monitors located around the child. The child was asked to listen to the play and answer a series of factual questions at the end to assess comprehension. He/she was allowed to look around as much or as little as needed during the course of the task. Looking behavior was monitored via a head-worn gyroscope. For the sentence recognition task, sentences with three key words spoken by a single talker were presented auditory-only from the five loudspeakers and the child was asked to repeat each sentence. For both tasks, speech was presented at 60dBA at the listener's location. Neutral spectrum background noise was presented at 50dBA (10 SNR) and reverberation time was set to 600 msec.

Comprehension and sentence recognition scores are shown in Figure 5. For the sentence recognition task, scores were ≥89% for all children with the exception of two with MMHL. Thus, in acoustic conditions representative of a typical classroom, both children with MMHL and children with NH performed at or near ceiling on such a task. Although there was considerable variability in the scores for the comprehension task, statistical analysis (p<.05) revealed that children with MMHL performed more poorly than children with NH on this task. Speech recognition tasks using phonemes, words, and sentences have frequently been used to predict how children will perform under conditions of noise and reverberation. These results suggest that performance on basic speech recognition tasks may not predict performance for more complex listening tasks in the same acoustic environment.

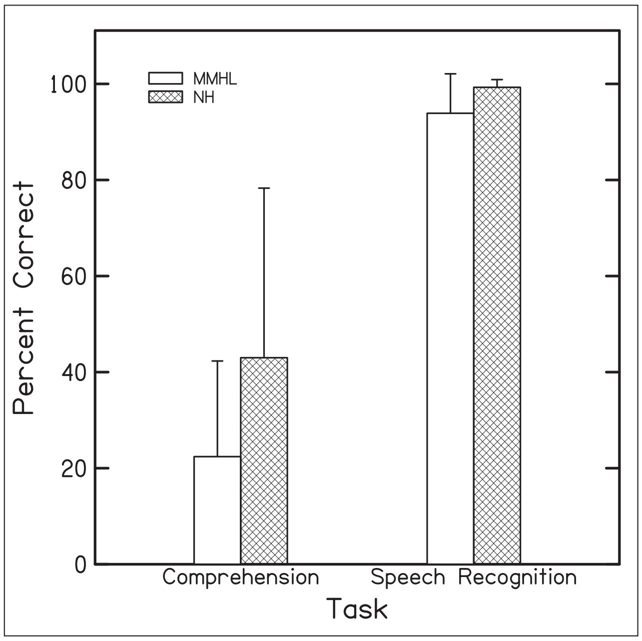

Figure 5. Mean and standard deviation of comprehension and speech recognition scores for children with NH (unshaded) and children with MMHL (shaded).

Looking behavior during the classroom learning task was analyzed in two ways. First, we examined how often listeners looked directly at the talker as he/she was speaking (proportion of events visualized; POEV). Second, we examined overall looking behavior, defined as the standard deviation (SD) of head movement from the 0º position (looking straight ahead). For this measurement, greater standard deviations represent greater attempts to look at the five talkers.

POEV results are shown in Figure 6. There were no significant differences across groups, and both groups looked at talkers, on average, less than 50% of the time. While there can be multiple reasons for this finding (e.g., choosing not to look, timing of looking relative to talkers' speaking times), these results suggest that the type of multi-talker interaction may impact whether children are looking at talkers as they speak.

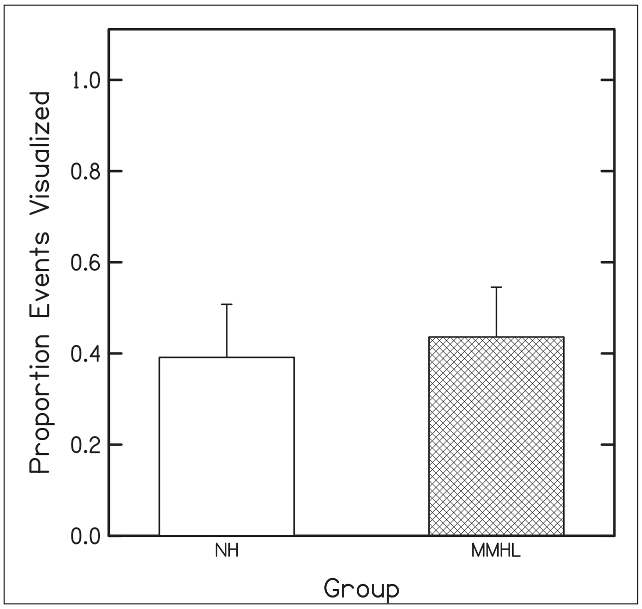

Figure 6. Proportion of events visualized (POEV) for children with NH (unshaded) and children with MMHL (shaded).

Results of overall looking behavior for individual participants are shown in Figure 7. While there were no statistically significant differences across groups, there were some interesting trends in the patterns of individual results. At younger ages (8-10 years), the majority of the children in both groups showed similar patterns of looking, with patterns that were higher than those of most of the older children (10-12 years) with normal hearing. At the older ages the two groups differed, with more of the children with MMHL showing patterns that were similar to those of the younger children in both groups.

The findings from this study suggest that, despite performing at or near ceiling on a sentence recognition task, children with MMHL perform more poorly than children with normal hearing on more complex listening tasks. Across children, individual listening behaviors vary. It is possible that these differing behaviors may impact comprehension in that attempts to visualize rapidly changing talkers may inefficiently utilize cog-

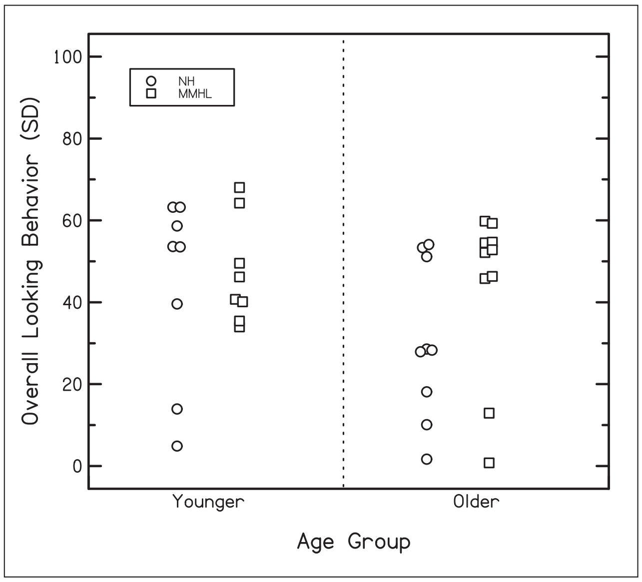

Figure 7. Individual overall looking behaviors measured in standard deviation (SD) for children with NH (circles) and children with MMHL (squares).

nitive resources that would otherwise be allocated for comprehension.

Summary

In summary, multiple factors can influence both the difficulties children with minimal and mild hearing loss will experience and how clinicians, parents and educators perceive those difficulties. Continued research is needed to more fully understand the underlying factors that influence performance for children with minimal and mild hearing loss in the real world. Such information can lead to service provision that optimizes communication access and educational achievement.

Acknowledgement

Research from the Listening and Learning Lab at BTNRH presented in this paper has been supported by NIH grants R03 DC009675, T32 DC000013, and P30 DC004662.

References

Bess, F. (Ed.). (1986). Unilateral Sensorineural Hearing Loss in Children. *Ear & Hearing,* 7(1).

Bess, F., Dodd-Murphy, J. & Parker, R. (1998). Children with minimal sensorineural hearing loss: prevalence, educational performance and functional status. *Ear & Hearing,* 19, 339-354.

Bess, F., & Tharpe, A.M. (1986). Case history data on unilaterally hearing-impaired children. *Ear & Hearing*, 7, 14-19.

Bess, F., Tharpe, A.M., & Gibler, A.M. (1986). Auditory performance of children with unilateral sensorineural hearing loss. *Ear & Hearing,* 7, 20-26.

Boney, S. & Bess., F. (1984). Noise and reverberation effects in minimal bilateral sensorineural hearing loss. Presented at the meeting of the American Speech-Language and Hearing Association, San Francisco, CA.

Blair, J., Peterson, M., & Viehweg, S. (1985). The effects of mild sensorineural hearing loss on academic performance of young school-age children. *The Volta Review, February/March,* 87-93.

Bradley, J. (1986). Predictors of speech intelligibility in rooms. *Journal of the Acoustical Society of America,* 80, 837-845.

Borton, S., Mauze, E., & Lieu, J. (2010). Quality of life in children with unilateral hearing loss: a pilot study. *American Journal of Audiology,* 19, 61-72.

Brennan, M., McCreery, R., Lewis, D., Creutz, T. J., and Stelmachowicz, P. G. (2013). The situational hearing aid response profile: An update. Poster presented at the American Auditory Society Meeting, Scottsdale, AZ.

Crandell, C. (1993). Speech recognition in noise by children with minimal degrees of sensorineural hearing loss. *Ear & Hearing,* 14, 210-216.

Culbertson, J.L. & Gilbert, L.E. (1986). Children with unilateral sensorineural hearing loss: cognitive, academic, and social development. *Ear & Hearing,* 7, 38-42.

Dancer, J., Burl, N., & Waters, S. (1995). Effects of unilateral hearing loss on teacher responses to the SIFTER. *American Annals of the Deaf,* 140, 291-294.

English, K., & Church, G. (1999). Unilateral hearing loss in children: An update for the 1990s. *Language, Speech and Hearing Services in Schools,* 30, 26-31.

Johnson, C.E., Stein, R., Broadway, A. & Markwalter, T. (1997). "Minimal" high-frequency hearing loss and school-age children: Speech recognition in a classroom *Language, Speech and Hearing Services in Schools,* 28, 77-85.

Keller, W. & Bundy, R. (1980). Effects of unilateral hearing loss upon educational achievement. *Child: Care, Health and Development,* 6, 93-100.

Kiese-Himmel, C. (2002). Unilateral sensorineural hearing impairment in childhood: analysis of 31 consecutive cases. *International Journal of Audiology,* 41, 57-63.

Kiese-Himmel., C. & Ohlwein, S. (2003). Characteristics of children with permanent mild hearing impairment. *Folia Phoniatrica et Logopaedica,* 55, 70-79.

Klee, T.M. & Davis-Dansky, E. (1986). A comparison of unilaterally hearing-impaired children and normal-hearing children on a battery of standardized language tests. *Ear & Hearing,* 7, 27-37.

Knecht, H., Nelson, P., Whitelaw, G. & Feth, L. (2002). Backround noise levels and reverberation times in unoccupied classrooms: Predictions and measurements. *American Journal of Audiology,* 11, 65-71.

Lewis, D., Valente, D.L., & Spalding, J. (to 2014). Effect of minimal/mild hearing loss on children's speech understanding in a simulated classroom. *Ear & Hearing.* Accepted for publication.

Lieu, J., Tye-Murray, N., Karxon, R. & Piccirillo, J. (2010). Unilateral hearing loss is associated with worse speech-language scores in children. *Pediatrics,* 125, 2009-2448.

Nelson, E.L., Smaldino, J., Erler, S. & Garstecki, D. (2008). Background noise levels and reverberation times in old and new elementary school classrooms. *Journal of Educational Audiology,* 14, 12-18.

Newton, V.E. (1983). Sound localization in children with a severe unilateral hearing loss. *Audiology,* 22,189-198.

Oyler, R., Oyler, A., & Matkin, N. (1988). Unilateral hearing loss: Demographics and educational impact. *Language, Speech and Hearing Services in Schools,* 19, 201-210.

Porter, H., Sladen, S., Ampah, S., Rothpletz, A., & Bess, F. (2013). Developmental outcomes in early school-age children with minimal hearing loss. *American Journal of Audiology,* 22, 263-270.

Ruscetta, M.N., Arjmand, E.M. & Pratt, R. Sr. (2005). Speech recognition abilities in noise for children with severe-to-profound unilateral hearing impairment. *International Journal of Pediatric Otorhinolaryngology,* 69, 771-779.

Spalding, J. & Lewis, D. (2012). Effects of Minimal/Mild Hearing Loss: Children's, Parents', Teachers' Perceptions. Poster presented at the American Auditory Society Meeting, Scottsdale, AZ.

Stelmachowicz, P., Lewis, D., Karasek, A. and Creutz, T. (1994). *Situational hearing aid response profile (SHARP, version 2.0) user's manual.* Omaha, NE: Boys Town National Research Hospital.

Valente, D.L., Plevinsky, H., Franco, J., Heinrichs, E., & Lewis, D. (2012), Experimental investigation of the effects of the acoustical conditions in a simulated classroom on speech recognition and learning in children. *Journal of the Acoustical Society of America,* 131(1), 232-246.

Wake, M., Tobin, S., Cone-Wesson, B., Dahl, H-H., Gillam, L., McCormick, L. et al. (2006). Slight/mild sensorineural hearing loss in children. *Pediatrics*, 118, 1842-1851.