Children with Minimal Hearing Loss: Interventions in the Classroom

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Children with minimal hearing loss are often not identified, and the educational implications of their hearing disability are unrealized. Because children with special learning problems have been shown to have a higher incidence of hearing loss than typical learners (Flexer, Millin, & Brown, 1990), special educators should be particularly aware of this significant issue. The purpose of this article is to clarify what is meant by minimal hearing loss (MHL), to summarize issues associated with MHL, and to describe instructional modifications for children with MHL.

Children with moderate-to-severe levels of hearing loss are generally identified at an early age and provided with instructional modifications. However, children with slight or minimal hearing loss are often not identified, and the educational implications of their hearing disability are unrealized. This occurs in spite of the fact that on any given day, one fourth to one third of normally achieving kindergarten and first-grade children are not hearing clearly enough to perceive the word–sound discriminations necessary for academic success (Flexer, Richards, Buie, & Brandy, 1994). Because children with special learning problems have been shown to have a higher incidence of hearing loss than typical learners (Flexer et al., 1990), special educators should be particularly aware of this significant issue. Children with learning disabilities are further at risk because they have been shown to have a higher incidence of attention problems, an aspect of auditory perception, than

typical learners (Blake, Field, Foster, Platt, & Wertz, 1991). Auditory attention is a prerequisite for learning. Auditory attention problems, coupled with a decrease in hearing, significantly reduce a student's learning capacity. The purpose of this article is to clarify what is meant by minimal hearing loss (MHL), to summarize issues associated with MHL, and to describe instructional modifications for children with MHL.

Significance and Causes of Minimal Hearing Loss

Minimal hearing loss is roughly defined as a level of hearing loss between 15 and 25 decibels (dB). Figure 1 shows the relationship of speech sounds and some of the important cues that might be missed with an MHL. Minimal hearing loss may not be problematic for a linguistically sophisticated person who has disciplined attending skills. However, an MHL can sabotage the overall development of an infant or child who is in the process of learning language and acquiring knowledge (Downs, 1988; Flexer, 1994). There is considerable evidence that the academic implications can be devastating for a child who is unable to hear or discriminate speech at levels softer than 25 dB (Bess, 1999; Ross, 1991; Flexer et al., 1990). For example, in a study conducted by Bess (1999), third-grade children with MHL performed significantly below their normally hearing peers on a test of basic skills. The largest discrepancy between the two groups was on subtests focusing on language comprehension, vocabulary word-usage skills, and storytelling abilities—all-important skills for academic success. Bess concluded that the children he studied were 4.3 times more likely to experience trouble in the area of communication as well as academic difficulties as compared to children with normal hearing.

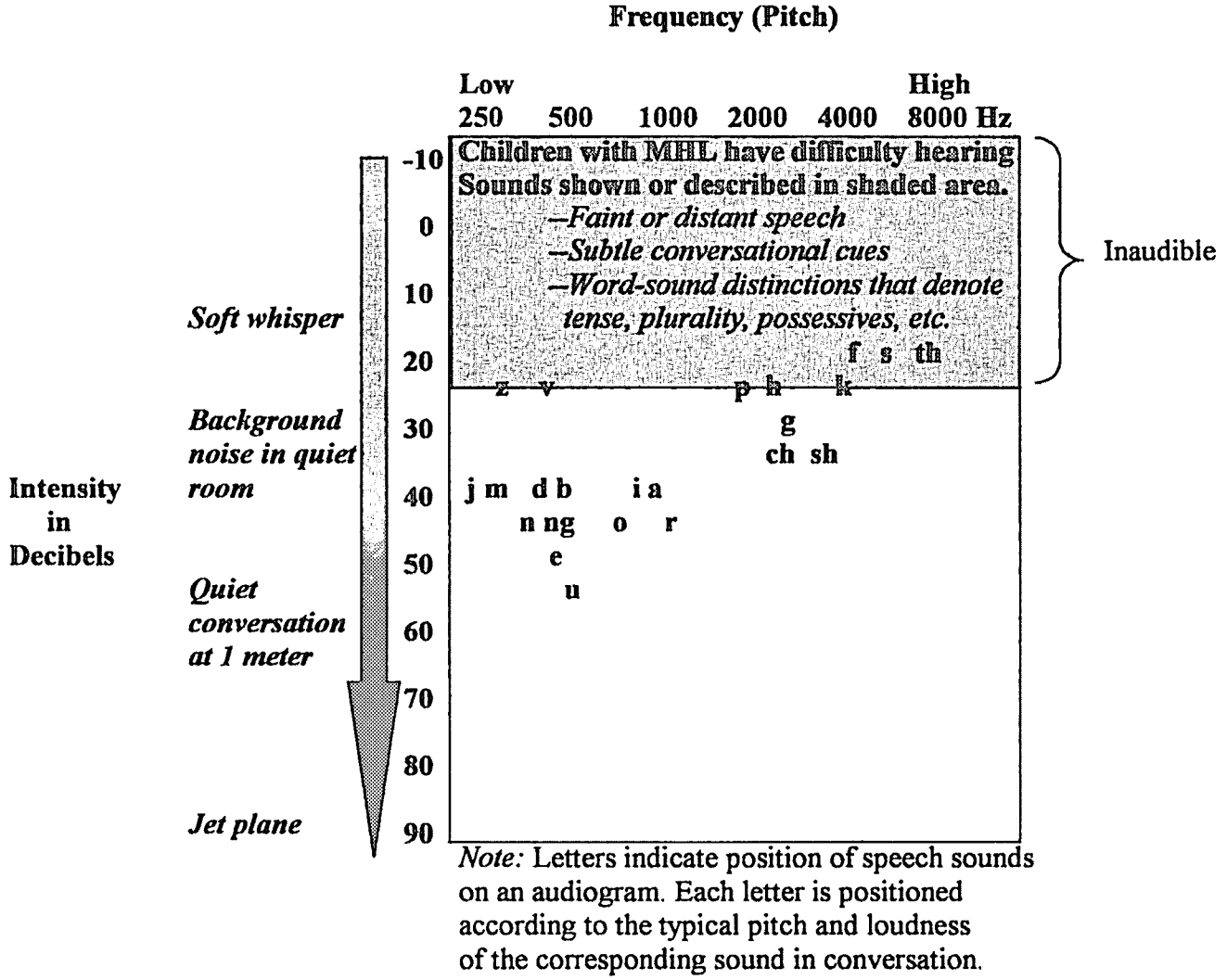

Figure 1. Typical loudness and pitch values of common speech sounds, including those sounds that may be inaudible when an MHL exists (Flexer, 1994; Northern & Downs, 1991).

Children's inability to respond to sounds at levels at or below 25 dB can be caused by a number of factors. Minimal hearing loss can be related to problems in the outer ear (e.g., ear canal) or middle ear function that result in a *conductive hearing loss.* Damage or malformation of the inner ear (which houses the cochlea or sensory mechanism) or less commonly of the auditory nerve are termed *sensorineural hearing loss.* Otitis media with effusion (fluid in the middle ear) can cause a conductive hearing loss on average of 15 to 30 dB HL in one or both ears. Left untreated, a perforated eardrum, scarring, or other damage may further impair hearing. Sensorinueural loss may be unilateral (ranging an average of 15 dB or greater in the impaired ear), bilateral (average of 15 to 25 dB HL in both ears), or sloping, with an average of 15 to 25 dB loss in the presence of hearing thresholds at some frequencies greatly exceeding the minimal loss range. The causes of sensorineural loss may include congenital problems, noise exposure, and disease. Sensorineural hearing loss is typically a permanent loss that may remain the same or progress. Conductive loss is often a fluctuating loss because the degree of hearing loss will vary with the middle ear status. Children can be significantly challenged in the classroom, even if MHL occurs in only one ear (Flexer, 1994).

Less than 1% of children with hearing loss are being served in schools (Berg, 1986). Reasons children with MHL are not identified are that hearing screenings generally let children "pass" when they can respond to tones at levels of 20 dB, and sporadic administration of screenings may not identify children with progressive or fluctuating hearing loss. The limited identification of MHL can have serious implications in that children with MHL have been found to more frequently appear immature, become more easily fatigued in the classroom (due to the extra effort needed to listen), have more behavior problems, and demonstrate reduced peer interactions. These behavioral problems can occur in addition to the academic problems noted above (Bess, 1999; Flexer, 1994). When teachers and parents notice a child's attention, behavioral, or academic problems, often hearing loss is not considered as a source of the child's problem.

Academic Implications and Interventions for the Classroom

Listening in Noise: Problems

Students with MHL often cannot access the critical acoustic cues from the teacher's voice during instruction and may struggle to communicate with peers. This situation is even more critical for younger children because in order to understand a message, children require speech to be louder (in relation to the background noise level) than do adults (Anderson, 1999).

Currently, there are no required standards for classroom acoustics in the United States. Common acoustical problems are caused by background noise, including voices from classmates, noise from adjacent classrooms and hallways, outside traffic noise, and ventilation systems. Noise intensity values in typical schools range from 45 dBA in small special classrooms to 60 dBA in traditional classrooms, to up to 70 to 90 dBA in open plan classrooms, gymnasiums, cafeterias, and computer rooms (Berg, 1987). The high background noise problem is further compounded by hard surfaces (walls, tiled floors, windows without treatment) that create sound reverberation. *Reverberation* (repeated reflection causing prolongation of sound) alone has been shown to substantially decrease speech recognition in normal hearing students.

To understand the effects of varying noise levels and reverberation conditions on student learning, Finitzo-Hieber (1981) compared the speech recognition of students hearing normally with the abilities of students with various levels of hearing loss (average hearing level was 45 dB HL, which is considered a moderate loss). Scores for students with normal hearing ranged from 30% in the worst-case scenario to 83% under the best test listening condition. Students with MHL scored much lower; they obtained only 60% word recognition in the best test condition and an average of 11% in the most difficult listening condition. Finitzo-Hieber (1981) concluded that children with MHL require better listening conditions than their hearing counterparts, but all children's word recognition decreased in noise and reverberation.

In the typical classroom, background noise levels (noise + reverberation) tend to be consistent throughout the room, but the teacher's speech level at the student's ear gets weaker as the distance between the student and teacher increases. In some locations, the signal-to-noise ratio (SNR) may be so poor that listening is difficult even for children with normal hearing (Leavitt & Flexer, 1991). The relationship between distance and teacher's voice intensity is shown in Figure 2.

Despite the urge to talk "over the noise," increasing the teacher's voice intensity is not an appropriate solution. An acoustic analysis of speech shows that when someone speaks loudly, vowel energy is increased, but consonant energy is not increased in the same degree (Berg, 1993; Ling, 1989). Thus, ironically, if a teacher uses loud speech or yelling, the listener may be more likely to know that the teacher is talking but less able to understand what the teacher is saying because intelligibility is decreased (Berg, 1993; Ling, 1989).

Listening in Noise: Interventions

Fortunately, there are several approaches that teachers can take to improve the signal-to-noise ratio. Table 1 provides an overview of the classroom applications. Generally, those changes can be divided into two categories:

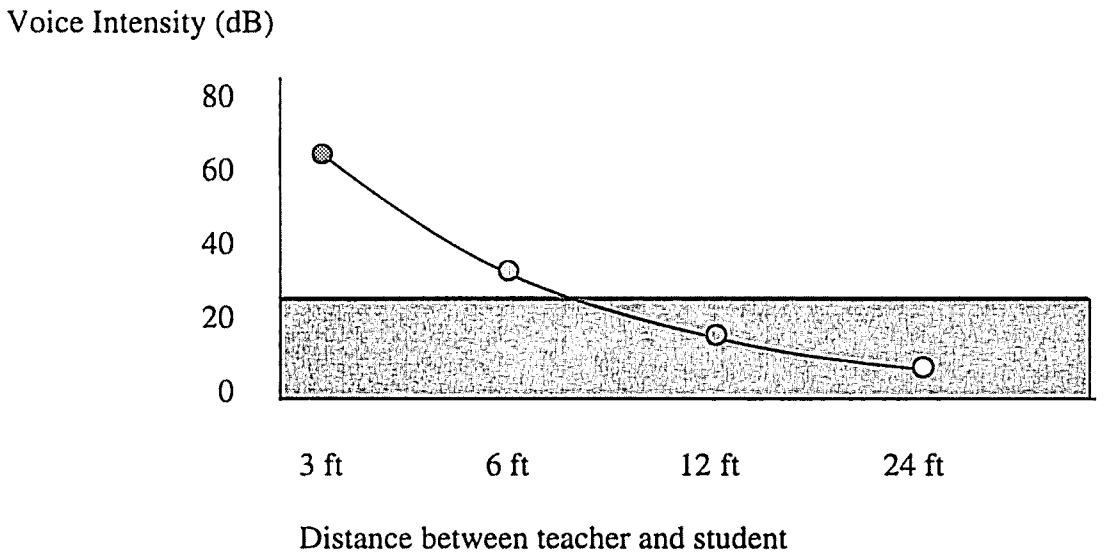

Figure 2. Demonstration of how a teacher's voice intensity diminishes as distance between the teacher and the student increases.

Note. Gray area represents dB level considered to be a minimal hearing loss (MHL). When the teacher's voice falls within the gray area, it will be inaudible to the children with MHL. A student with MHL needs to sit within 6 feet of the teacher at all times to hear speech at a typical volume under ideal listening conditions (i.e., minimal background noise).

environmental modifications and *instructional modifications.* Environmental modifications include reducing or eliminating background noise, adding acoustical treatments to reduce reverberation, and using SNR-enhancing devices such as a sound field or FM system. Instructional techniques may include modifications in speaking to individuals with MHL as well as teaching strategies that may benefit the entire class.

ENVIRONMENTAL MODIFICATIONS. In most situations, several classroom noise sources can be identified and modified. For example, ventilation system service may reveal loose or vibrating pipes/ducts, and music may be turned down or off during free time. While most new classrooms have acoustic ceiling tile, there are other inexpensive ways to reduce reverberation and noise. Some possible noise-reduction strategies include

- adding carpeting to the floor or covering the bottom of chair legs with rubber caps to reduce sound reverberation;
- installing small fiberglass panels at various wall locations to break up sound reflections (empty egg cartons can serve as a substitute);
- adding (or closing) window shades or curtains to reduce reverberation because windows are highly noise reflective.

SIGNAL-TO-NOISE ENHANCING TECHNOLOGY. To ensure proper access to classroom instruction, the optimal signal-to-noise ratio in the classroom is +20 dB (teacher's voice is 20 dB louder than the background noise) for normal hearing children and +30 dB for hard-of-hearing children (Berg, 1987). Typical classroom signal-to-noise ratios range from −20 dB (background noise is 20 dB louder than the teacher's voice) to +5 dB. Because it is not practical to completely eliminate classroom background noise and reverberation, the signal (teacher's voice) must be increased. While many teachers attempt to accomplish this by raising their voices, the speech sound intensity cannot be adequately increased and may lead to voice strain (Crandell, Sapienza, & Curtis, 1996). In addition, the louder voice actually causes distortion of the speech sounds because it is easy to increase vowel intensity but not necessarily the overall loudness of consonants. (Try it

Table 1. Overview of Classroom Applications to Improve Listening in Noise

Problem	Modification
Environment	• Obtain speech-enhancing devices and use consistently and appropriately. • Eliminate background noise as much as possible • Decrease reverberation by adding acoustical treatments.
Instruction	• Gain student's attention when speaking directly to that student or covering material relevant to that student. • Provide materials in writing when possible, particularly for prestudying new information. • Provide a closed set, moving from the known to the unknown.

for yourself: Say the word *stop* in a soft voice and listen to the consonant–vowel relationship. You will easily hear the higher pitched consonants. Now, say *STOP* in a very loud voice. The "O" sound overpowers the softer consonants.)

A more appropriate and effective way to improve the signal-to-noise ratio is with the use of signal-to-noise enhancing devices. The most common devices used for children with MHL and learning disabilities are personal FM systems and sound field amplification systems (see Table 2). Each system picks up speech via an FM wireless microphone located near the speaker's mouth. The devices effectively decrease speaker–listener distance and minimize the detrimental effects of reverberation and noise (Crandell, 1998). A personal FM system is used by an individual student who receives the FM signal through earphones, personal hearing aids (not typically used by children with MHL), or similar devices. Sound field amplification is a wireless, public address system that is self-contained in a classroom. The amplified voice is delivered to the entire classroom via strategically placed loudspeakers. Both systems have proven effective in improving attending behaviors of children with learning disabilities when no hearing loss exists (Blake et al., 1991; Ray, Sarff, & Glassford, 1984, as cited in Flexer et al., 1990). However, all children, including those with regular hearing, benefit from this technology (American Speech-Language-Hearing Association, 1991; Berg, 1987; Crandell et al., 1996). Unfortunately, the cost of installing sound field systems in all classrooms within a school district is often staggering. Subsequently, many districts are seeking community assistance for the purchases or are limiting the number of classrooms that are amplified.

Instructional Techniques. Students with MHL or fluctuating hearing loss will perform better in the classroom if they can anticipate potential vocabulary and conversational content before the interaction takes place. Teachers can provide this information if "pre-study" materials are provided in advance or by enhancing visual cues. Whenever possible, teachers should be sure to have the light in front versus directly behind them (as when standing in front of a window) and move closer to the student to encourage speech reading (Tye-Murray, 1998).

Another important strategy requires teachers to change the delivery of the message. When sensing that a child does not understand the message, narrow the question to help the student understand what his or her response should be. For example, instead of asking, "Did you do your homework?" you can ask, "Did you practice your spelling word list last night?" This will improve the child's comprehension and successful response. This technique can also help the student anticipate potential vocabulary that may occur as the conversation continues. These strategies, as well as some additional approaches for teachers, are summarized in Figure 3.

Handling Communication Breakdowns: Problems

Children, especially adolescents, are reluctant to admit to a hearing loss. Admitting hearing loss is embarrassing and can have negative social consequences with other students (Blood, Blood, & Danhauer, 1978; Hetu, Riverin, Getty, Lalande, & St. Cyr, 1990). Students do not want to be perceived as being "hard to talk to" or deserving of

Table 2. A Comparison of Personal FM Systems and Sound Field FM Systems

	Personal FM	Sound field
Equipment		
Teacher	• Wears a microphone (lapel, neck strap, headset, & transmitter)	• Wears a microphone (lapel, neck strap, or headset)
Student	• Wears headphones or earmolds and receivers	
Classroom	• No modifications	• Appropriately placed loud speakers and a transmitter
Benefits	• Student can individually control volume level	• Clear and consistent signal for all students in the classroom
	• Improved signal for students using FM	• 10 to 15 dB improvments in S/N ratio (Hawkins, 1984)
		• May be used by same students across classes/years
		• +20 to +30 dB S/N ratio is possible (Berg, 1986)
Disadvantages	• Student may not adjust appropriately	• If not installed and used properly, signal may not be consistent or clear
	• Only FM users benefit	• Device is not usually portable
Approximate cost	• $300–$1,000 per student	• $600–$1,000 per classroom

pity. It is natural to want conversations to go smoothly; if the student with MHL interrupts or asks for clarification, communication may feel unpleasant and troublesome (Tye-Murray, 1998).

Students often develop nonproductive strategies to minimize their difficulties. These negative strategies include pretending to understand; socially withdrawing to avoid communication difficulties; dominating conversations to maintain an understood topic; giving in to feelings of anger, hostility, or self-pity; and feeling anxious and tense before, during, and after conversations. Clearly these are reactions that must be minimized, as they can leave a person feeling depressed and isolated from the world (Kirkwood, 1999).

Many students with MHL may also have poor language skills or poor articulation abilities. Sometimes it may be difficult for the listener to comprehend the spoken message of a child with hearing loss due to associated expressive speech and language deficits. These difficulties result in fewer attempted conversational interactions (Tye-Murray, 1998). Again, these characteristics add to a student's negative self-esteem and unproductive interpersonal relationships.

Children with hearing loss may feel anxious or stressed when called upon to listen in a learning environment. They tend to worry about what they might miss or what their communication partner might think of them (Tye-Murray, 1998). Bluffs of nodding or smiling as if the message was heard can have negative consequences. The student may appear to be insensitive, uninterested, dull, or inattentive. Teachers assume the student with MHL understands the classroom discussion when in actuality he or she has not comprehended the message. Students may feel like a failure or be angry with themselves because they cannot manage communication difficulties (Tye-Murray, 1998).

Example of common speaking style:

"Afttaya eat lunch, weregunna make-a diarama so putyur books inyur desk angityur money tabuy lunch."

Difficulties in discriminating common speaking style for children with MHL:

- There are no clear word boundaries.
- Several ideas (lunch time, money for lunch, put your books away, what we're doing after lunch) are all introduced in one long expression.
- Because some sounds will be inaudible, student may only understand segments of the request.
- An unfamiliar word (diorama) is introduced without explanation or reference.

Solutions to improve intelligibility in teacher speaking style:

- Talk distinctly, not louder.
- Use a slightly slower rate of speech and pause between ideas.
- Face the students. Be careful not to speak when facing the blackboard.
- Be animate: Use gestures and facial expressions.
- Be lively: Emphasize important points; use inflections.
- Keep sentences short and relate back to the main idea.
- Provide as many visual supports as possible (written outline, pictures, etc.)
- Rephrase rather than repeat.

Figure 3. Common problems and solutions for teacher speaking style.

- Encourage students to inform classmates about hearing loss and related problems.
- Provide a comfortable atmosphere to encourage students to provide feedback on communication breakdowns to facilitate hearing.
- Assist students in locating a seat that allows maximum cues (visual, auditory, etc.) and decreases the chances of "hiding" or distraction.
- Encourage students to request necessary tools or employ strategies (writing, visual cues, etc.).

Figure 4. Helping students handle communication breakdowns.

Handling Communication Breakdowns: Interventions

As they mature, students with fluctuating hearing or MHL should learn to self-manage their environments and interactions to improve spoken language comprehension. Examples of these techniques are shown in Figure 4. First, students should take responsibility for their own communication needs. It is helpful if a student explains his or her hearing loss and listening needs to teachers and peers. Students should also be allowed to find the best seating position in the classroom to maximize listening. Factors may include distance from the teacher, lighting, and other environmental factors or distractions. If a student uses a personal FM system, he or she should be responsible for using it appropriately.

When a student does not comprehend important auditory information, he or she must also learn not to bluff. If a student is comfortable employing repair strategies, he or she will be a more effective listener. Students who anticipate a negative reaction when a communication breakdown occurs are more likely to exhibit problems.

To improve spoken language comprehension, students should practice strategies to verify unclear information.

For example, if a student asks the teacher, "Could you say that again?" an uninformed teacher is likely to repeat a lengthy message, including information that the student already understood. Instead, if the student learns to request repetition of only the missed information (e.g., "Which pages are we to read?"), communication is more efficient and effective.

Interventions developed to improve the spoken speech and language skills of students with MHL may be carried out in conjunction with a speech–language pathologist. However, in general, the student should be aware of the need to monitor the listener's comprehension. Misunderstood productions should be rephrased with more exaggerated articulation, reformulated into shorter sentences, or enhanced with written notes or hand gestures. Students should be taught to recognize these conversational breakdowns so that they can modify their spoken communication.

- Pulling or pressing on ears (usually when middle ear problems are present)
- Frequent colds or sinus-related problems (may be related to middle ear problems)
- Difficulty following fast-paced discussions
- Trouble distinguishing morphological makers that denote plurality, tense, possessives, and so forth (Flexer, 1994)
- Fatigues easily (particularly on days with many listening activities)
- Daydreams, misbehaves, in is inattentive during oral instruction or other highly auditory activities, particularly when background noise is high
- Inconsistent (or poor) academic performance

Figure 5. Signs of and risk factors for minimal hearing loss.

Assessing the Effectiveness of Intervention Strategies

There are several tools that teachers can employ to assess or monitor a student's listening effectiveness. *The Screening Instrument for Targeting Educational Risk* (SIFTER) is a rating scale designed to identify students who are educationally at risk due to a potential hearing problem (Anderson, 1998). The *Listening Inventory for Education* (LIFE) is an efficacy tool designed for teachers to ascertain listening difficulty in the classroom and monitor changes with hearing technology (Anderson & Smaldino, 1998). Both tools are one-page check-off sheets that are quick and easy to administer.

Challenges to Identifying and Helping Children with MHL

Identifying children with MHL can be challenging. Learning is highly episodic, multifaceted, and influenced by diverse contextual factors. These factors may be environmental as well as child-related. A child's MHL interacts with other developmental and environmental factors such as his or her auditory perceptual abilities, language decoding skills, intellectual potential, individual temperament, and social/cultural support systems. Often, because of these interrelationships, hearing loss is not suspected when a child is struggling in the classroom. Instead, behavioral, attention, or related problems are often blamed for the child's difficulties.

A hearing screening alone may not provide useful information about the presence of MHL. School hearing screenings are completed at only a few test frequencies and at a decibel level that may not be sensitive to MHL. Furthermore, screenings are often performed in less than ideal testing environments; frequently, screenings occur in the presence of background noise and visual distractions. Signs of MHL are illustrated in Figure 5. When indications of an MHL are present, teachers may consider administering a classroom-based screening such as the SIFTER or LIFE or request a full hearing evaluation from an audiologist.

It may be difficult to obtain services for a student identified with MHL. Two main federal laws mandate special educational services for children with hearing problems. The first is the Educational for All Handicapped Children Act of 1975 (PL 94-142). Later, this law was amended and its name changed to the Individuals with Disabilities Education Act (IDEA, 1997). A second law is the Rehabilitation Act of 1973, Section 504, amended in 1992.

Children with MHL are typically not eligible for services under IDEA; this legislation is designed for children with more severe hearing loss or those who have already failed a grade because of their hearing loss. Fortunately, Section 504 of the Rehabilitation Act of 1973 does protect children with MHL; interpretation of this legislation has determined that all children have to right to "acoustic accessibility" in the classroom. Consequently, signal-to-noise enhancing technology can be obtained for children with MHL. As advocates for children with MHL, we can advocate proactively, stating that a child's hearing problem interferes with his or her ability to access spoken instruction in the classroom preventing an "appropriate education" (Flexer, 1994). While documenting a hearing problem at school may be difficult, teachers have tools that can help determine which children warrant a full audiological evaluation. In many districts, an educational audiologist is available to complete this evaluation. If the school does not have an educational audiologist (or contract with one) or the educational audiologist does not

have access to the appropriate audiological testing facilities, a referral to a community audiologist may be necessary.

Conclusion

It is highly likely that at any one time a teacher has at least one unidentified child with MHL in the classroom. A few specific strategies, however, can dramatically increase the academic and communication success of children with MHL. Use of these strategies not only improves the educational opportunities for children with MHL but also benefits all children with learning challenges. As such, teachers should be encouraged to incorporate these techniques into their teaching approach.

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