

Most of us would agree that a child with a bilateral hearing loss of 40-50 dB will probably have communication problems. Most of us also would agree that a child with bilateral hearing thresholds in the range of 0-10 dB probably will not. But what about unilateral hearing losses? A high-frequency loss in the poorer ear? A flat 40-50 dB loss in the poorer ear? Little or no hearing in the poorer ear? The potential communication handicap for these children is not so easy to predict.

As recently as the 1970s, popular pediatric textbooks provided this counseling advice regarding unilateral hearing loss in a child: "Assure him that he will be able to go through school and learn just like any other child." Research from Vanderbilt University in the 1980s served as a wake-up call for all of us that this common belief just might not be true. The Vandy research team found that 35% of these children failed at least one grade, and an additional 13% needed resource assistance!

This sounds like a topic worth revisiting, and that's exactly what we're going to do this month on Page Ten. It's no coincidence that our expert guest author hails from Vanderbilt, and that her first peer-reviewed publication, a mere 24 years ago, was titled: "The young child with monaural hearing impairment."

I'm referring, of course, to **Anne Marie Tharpe**, PhD, who is a professor in the Department of Hearing and Speech Sciences at Vanderbilt. Dr. Tharpe also is the associate director of education for the National Center for Childhood Deafness and Family Communication and, in this capacity, is directing a new deaf education program at Vanderbilt. She is one of the nation's leading authorities in pediatric audiology, and you know her from her many publications, presentations, and extensive pediatric committee work. Internationally, she has held guest faculty positions in London, Singapore, and China. In addition to her teaching and administrative duties, she maintains a clinical practice and a busy research laboratory.

Anne Marie tells us that her long-standing interest in pediatric audiology stems from her high school days. In an attempt to escape study hall, she volunteered to work in the deaf education pre-school, and has been working with the pediatric population almost ever since. We're glad she has continued her volunteerism, and agreed to write this excellent article for us.

GUS MUELLER
Page Ten Editor

Unilateral hearing loss in children: A mountain or a molehill?

By Anne Marie Tharpe



Tharpe

1 No offense, but didn't I hear you talking about unilateral hearing loss in children some 20 years ago?

Yes, that's true. It was in the late 1980s that the first studies were published revealing that what we once thought about unilateral hearing loss wasn't necessarily true.¹⁻⁵ That is, before those studies came out, audiologists were telling parents just to aim their child's "good" ear toward the teacher and that would take care of any problems.

Unfortunately, that wasn't the case. Fred Bess and his colleagues found that children with unilateral hearing loss had a grade failure rate 10 times greater than that of their normal-hearing peers.¹ To make matters worse, in addition to the 35% of children with uni-

lateral loss who had failed a grade, another 13% needed academic resource assistance.

2 Wow! All that trouble just from having hearing loss in one ear?

We had the same reaction. Once we got over the surprise of finding out how wrong we had been to dismiss these losses as inconsequential, we decided to look more closely at the auditory skills of a group of children with unilateral hearing loss and compare them to a group of children with normal hearing.⁶ We weren't surprised to find that children with unilateral loss generally had more difficulty understanding speech in background noise and more trouble with localization ability than their normal-hearing peers. But, we were surprised by a couple of other findings.

First, the children with unilateral hearing loss had difficulty understanding speech in background noise even when the speech signal was directed toward their normal-hearing ear and the background noise was directed toward the impaired ear. That, of course, is the laboratory equivalent of preferential classroom seating, so it might help explain why these children were having academic difficulties.

The other surprising finding was that this speech-understanding problem was present even in quiet. That is, if speech was directed toward the impaired ear, even in a quiet environment, speech understanding was poorer than that of children with normal hearing in quiet. Prior to this study, we assumed it was only the presence of background noise that contributed to any listening difficulties for children with unilateral hearing loss.

3 Interesting. What else did you learn about these children?

Well, 20% of the children in Bess's study were reported by their teachers as having behavior problems. Other studies have also found that children with unilateral loss exhibit more behavior problems than their normal-hearing peers, including social withdrawal, inattention, distractibility, lack of cooperation, and aggression.⁷⁻⁹ We assume these behaviors result from these children having trouble hearing and paying attention in class, and, therefore, becoming frustrated or bored.

4 All this is starting to come back to me, and it is interesting from a historical perspective. But, what's the situation now?

Well, there's good news and bad news. As you know, we are identifying unilateral hearing loss in children sooner today than we did 20 years ago. The mean age of identification of the children in the Bess study was approximately 5-1/2 years, and only 23% had been identified prior to age 5; that's quite late by today's standards. Back then, most children were being identified through school hearing screenings, and now we have newborn hearing screening. We also have reason to believe that audiologists are now more alert to the potential problems associated with unilateral hearing loss and that they are intervening more than ever before.^{10,11}

Yet, despite earlier identification and intervention by audiologists, the bad news is that current studies still document similar rates of academic difficulties as those reported in the 1980s for children with unilateral hearing loss.^{12,13} So, it still appears that 30%-55% of children with unilateral hearing loss have some academic problems.

5 Does this subset of children with unilateral hearing loss differ in any way from those who don't have academic difficulty?

Good question. That's certainly something we need to figure out. After all, we want to focus our resources on the children who need them.

We initially thought that once we improved the listening conditions for children in school through the use of FM technology and other environmental modifications we would see improvement in educational outcomes. But, as I just mentioned, that didn't happen.¹³ So, more appears to be going on with these children than simply having difficulty hearing at school.

6 Any ideas what?

Well, several investigations have revealed that children with hearing loss in the right ear, as opposed to the left, are at higher risk for academic difficulty.^{3,4,6,12,14} And, although some studies have suggested that children with more severe degrees of unilateral hearing loss are at higher academic

risk than those with lesser degrees of loss,^{6,12} others have not found that.⁹ It also is certainly possible that the underlying etiology of the hearing loss contributes to the academic outcomes. In fact, Walter Nance's very interesting presentation at this year's American Academy of Audiology Convention addressed this issue.¹⁵ He reported that cytomegalovirus (CMV) is the leading cause of pre-lingual unilateral hearing loss in children in the United States. He speculated that the poor academic performance of these children may be the result of the neurological deficits associated with CMV.

7 So, what do you recommend that audiologists do when they identify unilateral hearing loss in a child?

We don't have all the answers, but until we do I recommend a multi-pronged approach to management of unilateral hearing loss in children. I like to break it out into six areas, and they go something like this:

❖ **Counseling.** Audiologists can counsel families about the importance of a good acoustic environment for communication, how to create a rich language atmosphere at home, and safety issues related to poor localization skills. Keep in mind that the effects of unilateral hearing loss may be quite subtle. Parents may not even notice that their child with unilateral loss hears any differently from other children. So, this means we have to spend time describing the types of listening problems that their child may be experiencing. In other words, less hearing loss doesn't mean we have less counseling to do. When the time comes, this counseling should be extended to classroom teachers.

❖ **Etiologic evaluation.** Medical evaluation of children found to have unilateral hearing loss should include a search for genetic and environmental causes. As mentioned, CMV is the most common causative factor of pre-lingual unilateral loss and must be identified during the first 2 to 3 weeks of life. Other causative factors associated with unilateral hearing loss include genetic causes such as Pendred syndrome, which can include cochlear malformations such as enlarged vestibular aqueduct or Mondini malformations.

❖ **Daycare/school considerations.** Despite what I said about the limitations of preferential classroom seating, certain seating arrangements may help provide children with enhanced visual and auditory cues needed for communication. A visit to the daycare or school will reveal what acoustic modifications may be needed. These can be low-tech, like placement of carpet remnants in strategic places within the room, or high-tech, like the placement of a sound field frequency-modulated (FM) system.

❖ **Speech and language monitoring.** Although most studies of the speech and language abilities of children with unilateral hearing loss have not identified specific deficits,¹⁶⁻¹⁹ at least one found that children with unilateral hearing loss who had failed a grade in school had significantly lower verbal IQ scores than children with unilateral hearing loss who were academically successful. However, both the academically successful and unsuccessful UHL groups had verbal IQs within the normal range.¹⁶ Obtaining a speech and language evaluation provides a good opportunity to document baseline functioning and allows a speech-language pathologist to talk with families about how to support a language-rich home environment.

❖ **Ongoing audiology assessment.** One may tend to think that unilateral hearing loss doesn't need to be monitored as diligently as bilateral hearing loss because its impact may be less significant. However, some very interesting data are beginning to emerge documenting the hearing status of babies who failed newborn screening in only one ear but were later found to have bilateral hearing loss.

8 That sounds interesting. Can you tell me a little more?

Sure. In fact, here's some information from a recent study. Marilyn Neault analyzed the data from 2 years of newborn hearing screening in Massachusetts.²⁰ Of the babies who did not pass the newborn screening in one ear and had confirmed hearing loss, 40% were later found to have bilateral hearing loss. Possibly these babies had bilateral loss at the time of the screening but it was missed because of screening test criteria or calibration issues. Or

the loss could have progressed from unilateral to bilateral between the screening and the diagnostic evaluation. In any case, these data certainly support the need for close audiologic monitoring of unilateral hearing loss.

9 Thanks, and please forgive the interruption. You said there are six areas in the management of unilateral hearing loss, but you mentioned only five. What's the other one?

Here's the final area to pursue:

❖ Functional auditory assessments.

Another type of assessment important in monitoring unilateral hearing loss is functional auditory assessment. Because the behavioral effects of unilateral hearing loss are often more subtle than those of bilateral hearing loss, parents, educators, and other professionals may tend to overlook them and think no problems exist.

10 Are you talking about things like clinical speech-in-noise tests?

No, not at all. The functional auditory assessments I'm referring to are designed to evaluate listening behavior in real-world settings, not in the confines of a sound-proof booth. Tools such as the Children's Home Inventory for Listening Difficulties (CHILD) for use by parents²¹ or the Screening Inventory for Targeting Educational Risk (SIFTER) for use by teachers²² can provide valuable information for assisting professionals in developing management plans for children with unilateral hearing loss.

11 What other kinds of management plans do you mean? Are you talking about hearing aids?

Yes, hearing aids and/or other assistive listening technologies such as personal or sound field FM systems ought to be considered for those children found to have listening difficulties. Functional auditory assessments can provide some indication of whether or not listening technologies are warranted.

12 Are you referring to traditional or CROS hearing aids for these children?

To some extent, that will be determined by the severity of the loss and the age of the child. But, regarding CROS-type hearing aids, we completed a study at Vanderbilt years ago that compared speech-understanding scores of children with unilateral hearing loss in three conditions: using CROS (contralateral routing of signal) hearing aids, using personal FM, and unaided.²³ The children were also tested under three simulated classroom listening conditions: monaural direct (speech signal directed toward the normal-hearing ear with noise to the impaired ear), monaural indirect (speech signal directed toward the impaired ear with noise to the normal-hearing ear), and midline signal/omnidirectional noise.

We found that the children had most trouble listening in the monaural indirect condition without amplification and did best in that condition with a CROS aid. However, the CROS aid degraded speech understanding in the monaural direct condition. The FM system was the only amplification approach that resulted in uniformly high speech-understanding scores across all listening conditions. Similarly, Updike found significantly better word-recognition ability by children with unilateral hearing loss in quiet and in noise when using a FM system as opposed to a traditional hearing aid or CROS aid.²⁴

13 But hasn't hearing aid technology changed?

It has, but the concept of CROS amplification is pretty much the same. Although today's CROS hearing aids are somewhat better than those we used in our CROS study 15 years ago, I'm not sure the outcome would be much different.

14 I've heard a lot about the use of bone-anchored hearing aids for unilateral hearing loss in adults. What do you think about their use in children?

This is something we know little about. There are reports of some success with bone-anchored hearing aids in adults with unilateral hearing loss,^{25,26} but as we have learned time and time again, children are not just little adults. Until we have more data to support their use, I'm very hesitant to recommend bone-anchored hearing aids for CROS amplification in children. At this time, the Food and Drug

Administration (FDA) restricts the use of surgically implanted bone-conduction devices to children over age 5.²⁵

15 What about putting a traditional hearing aid on the impaired ear of a child with unilateral hearing loss?

Actually, we don't have much direct evidence to support fitting traditional hearing aids on children with unilateral hearing loss, although this would naturally depend on the degree of loss. However, there are limited survey data that suggest some parental satisfaction with their children's listening and academic performance when wearing hearing aids.^{10,27} Clearly, FM is an effective approach to enhance listening in a classroom. The big questions remaining are should traditional hearing aids be used outside the classroom and, if so, are they useful for all degrees of unilateral hearing loss?

16 You didn't really answer my question. Should we fit traditional hearing aids on children with unilateral hearing loss?

I'm trying to answer you, but I'm sorry to say we don't yet have a good answer to that question. Very few studies have looked specifically at using hearing aids with unilateral hearing loss. Certainly, there are compelling data to support the benefits of binaural hearing. Audiologists are well aware of the binaural listening advantages provided by binaural summation, binaural release from masking, and localization. However, we don't know a whole lot about what happens to these binaural cues when we have asymmetric hearing.

17 Can you explain just what you mean by that?

As you probably know, in recent years we've tried to differentiate "bilateral" from "binaural" when it comes to fitting hearing aids. The point is that providing audibility in the impaired ear and thus providing "bilateral" hearing does not ensure that the patient gets the "binaural" benefits that are available from two normal-hearing ears. In fact, we could investigate if binaural listening ability suffers when the patient receives asymmetric input from the ears as compared to listening with just one ear. This phenomenon has been termed "binaural inter-

ference,”²⁸ and it’s one reason that audiologists remain concerned about amplifying children with hearing loss in one ear.

In other words, will a child be better off listening with one normal-hearing ear without amplification or with one normal ear and one ear that has less-than-optimal speech understanding? Will amplifying the impaired ear improve or degrade binaural listening? Until we can answer those questions, we will continue to see vastly different management practices among clinics and audiologists.

18 So, are there really pretty varied beliefs about the topic?

Oh, yes. For example, surveys have reported that as few as 9% and as many as 48% of children with unilateral hearing loss are fitted with hearing aids.^{13,29} Of course, it’s one thing to recommend the use of hearing aids, and quite another to get children to wear them. In the study where 48% of children with unilateral loss received hearing aids, only 50% actually wore them.²⁹

That same study showed a trend for children with greater degrees of unilateral hearing loss to be aided more often than those with less severe losses. But, there do appear to be many children with unilateral hearing loss who benefit from the use of a hearing aid on the impaired ear, at least in some environments.

19 You’ve mentioned several studies that I haven’t read yet. Is there someplace I can go to find all of this information on unilateral hearing loss?

Yes. In 2005, the Early Hearing Detec-

tion and Intervention Team of the Centers for Disease Control and Prevention joined with the Marion Downs Hearing Center to sponsor the National Workshop on Mild and Unilateral Hearing Loss. Experts and researchers from around the country gathered to discuss the latest findings in identification and management of children with mild and unilateral hearing loss. In addition, part of the meeting was dedicated to discussions of research needs in the areas of screening, diagnostic evaluation and follow up, hearing technology, and early intervention associated with mild and unilateral hearing loss in children.

The proceedings of that workshop along with summaries of the research articles discussed at that meeting are available at www.cdc.gov/ncbddd/ehdi. Good luck!

20 So finally, I have to ask you, is this whole issue a mountain or a molehill?

I think I’ll choose an analogy somewhere in between. Maybe a knoll? A prominence? Seriously, the message I hope you’ve received is that for many children, unilateral hearing loss will pose little or no difficulty. But others will be at significant academic and behavioral risk. I hope to talk with you again sometime about how we can distinguish those at-risk children from the larger population of children with unilateral hearing loss.

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