Back to Basics: Understanding Hearing Loss for Speech Language Pathologists, Part 2
Recorded March 5, 2020
Presenter: Jane Madell, PhD, CCC-A/SLP, LSLS Cert AVT
SpeechPathology.com Course #9183
- [Amy] All right, well, welcome everybody to our Back to Basics course on Audiology for Speech Language Pathologists. This is part two, which will be covering reading audiograms, and our presenter today is Dr. Jane Madell, who is a frequent presenter with us, and we're so pleased to have her back today, so without further ado, let's go ahead and let her get started. Thank you, Jane.

- [Jane] Thank you, Amy. I'm delighted to be back. For those of you who are listening, if you haven't listened to the first part, you probably wanna listen to part one first, but we'll do a little bit of a review so that we all know where we are. Speech pathologists are really critical in working with children with hearing loss, and it's important that you understand audiology so you can help plan therapy that you need to plan for your students, so let's get started. The learning outcomes for this talk, we're going to identify various possible types and degrees of hearing loss. We're gonna describe basic concepts related to audiogram interpretation, how to understand what the audiogram is about, and we're gonna explain how to use audiological information so that you can plan management for your kids with hearing loss.

So the main ideas are, we need to establish the degree and type of hearing loss, but it's not just for its own sake. We are evaluating the degree and type of hearing loss so we can figure out, does the person need technology, which is hearing aids, cochlear implants, bone-anchored systems, and remote microphone or FM systems, what are we doing about, once we get the technology, is it doing what it needs to do, and we need to use the information to plan therapy, to figure out what kind of educational environment the child should be in, and once the child is in a classroom, what it is that we have to do to help them function maximally. What do we have to do to help them be the best that they can be? And we need to advocate for the best possible audiological outcomes, and what that means is we need to be sure the children are hearing what they need to hear. We need to know that the testing we've done is valid, which means we're using the right test to find out the right information. We don’t
wanna use a speech perception test to find out degree of hearing loss, and we want to know that the information is reliable. Do we get the same information every time we do the test? Is it repeatable, can we do it over and over again? We wanna know that both of those things are true, and it's critically important that we know that in order to evaluate any test protocol we're using. We also need to recognize that the whole point of technology is to get sound or spoken language to the child’s brain. That's why we have technology. It has no other value. The point of technology is to get sound to the child's brain. So children speak what they hear. If their speech is distorted, it’s very likely that what they're hearing is distorted.

Dan Ling, who was one of the grandfathers of auditory verbal practice, used to say "What they hear is what they say." And one of the most valuable things I've learned to do as a clinician is to evaluate what a child is saying, and try to figure out what they're hearing. I am both an audiologist and a speech language pathologist and an auditory verbal therapist, and this is one of the skills that has helped me a lot in all three, with all three of my hats, and I can assure you will help you in any hat, whichever hat you have. It’s really important to be able to listen to a child and figure out what it is that they’re saying. If a child is leaving off the s at the end of words, chances are, the child's not hearing that s.

And that’s important information, because you can't, I mean, as much therapy as you can give him, you're not gonna make him hear that s if the technology and the hearing loss don't allow it to happen. So when a child is missing certain phonemes, it's important for us as clinicians to recognize that and to share that information with all the other people in the team so we can really know for sure what is happening. So let's start off with a quick review from week one so that we can understand what it is that we're looking at here. This is an audiogram, and just as a reminder, it goes from low pitch to high pitch, like on a piano, and from very soft to very loud. If a child has hearing between zero and 15 decibels, they have normal hearing. If they've got
thresholds that are between 15 and 25 decibels, that is a borderline hearing loss. If it's 25 to 40 decibels, that is a mild hearing loss. If it's 40 to 55 decibels, that's a moderate hearing loss. If it's 55 to 70 decibels, that's a moderately severe hearing loss, and if it's 70 to 90 decibels, that's a severe hearing loss. And above 90 decibels is a profound hearing loss. It's also, in addition to degree of hearing loss, we also need to remember to think about the type of hearing loss. If a child has a conductive hearing loss, that's caused by damage to the outer or middle ear, and if they have a sensory neural hearing loss, it's caused by damage to the inner ear. If it's a sensory hearing loss, that's the most common sensory neural hearing loss. That's caused by damage to the hair cells in the cochlea, and if it's a neural hearing loss, it's caused by damage to the auditory nerve. If a child has a mixed hearing loss, then they have a combination of conductive and sensory neural hearing loss.

So when we're trying to describe the degree of hearing loss, we average the hearing at 500, 1000, and 2000 Hz. 500, 1000, and 2000. And if the average is 75 decibels, then we know it's a severe hearing loss. If the average is 45 decibels, we know it's a moderate hearing loss. So by looking at the average of 500, 1000, and 2000, we're going to know the degree of hearing loss.

So we're going to describe the hearing loss across all the frequencies, for example, a child may have, we can look at the average, and that's the pure tone average and that's the basic degree of hearing loss, but it's also sometimes helpful to say, this child has a mild hearing loss in the low frequencies and a severe hearing loss in the high frequencies, because that slope will tell me some things about what sounds I expect the child to miss. But maybe most important, instead of or in addition to degree of hearing loss, is describing their speech perception abilities. We want to know exactly what a child understands. How much of conversation do they understand at normal conversation, how much do they understand at soft conversation when speech is harder to hear, and how much do they understand when there's competing noise in the
background. So all of those things are critical, because really speech perception is how they live in their daily lives, and that's what I want to know so I can figure out how they're gonna manage in a classroom, in therapy, and in daily living. So here's an audiogram. So these are the thresholds, 250, 500, 1000, 2000, and 4000. I'm gonna look at the average at 500, 1000, and 2000, and the average here is gonna be 47 decibels, so I know that this is a moderate hearing loss. In the left ear, the average is a little bit worse, 45, 55, 50, the average is 50, but it's still a moderate hearing loss. So here is that same audiogram, right, here are the air conduction thresholds, which we've gotten with earphones on, and here are the bone conduction thresholds, which we've gotten by putting a bone vibrator behind the ear and measuring how much a child is hearing. If you look here, you can see that the average is five decibels. Bone conduction is normal.

Air conduction is moderate. So this hearing loss is conductive. The damage is somewhere in the outer or middle ear. In this situation, the same air conduction thresholds, but the bone conduction thresholds are in the same place as the air conduction thresholds. So here you know that the hearing loss is sensory neural, because air conduction and bone conduction are in the same place. Here's a hearing loss in which in the right ear, red right round, in the right ear, the average hearing loss is probably around 12 decibels, and that's normal hearing. In the left ear, the average is at 70 decibels.

This is what we call a unilateral hearing loss. Normal hearing in one ear, but the other ear has a hearing loss, and it can be of any degree. If one ear is normal and the other ear is not, that is a unilateral hearing loss. So that's sort of a basic review of looking at audiograms. So let's talk about how we do testing. There are a lot of different things, ways that we test hearing. And we talked about this in more detail in part one, but I wanted to talk about behavioral testing. That's the testing in which we ask the child to cooperate in some way to tell us how they're hearing. Behavioral testing is really the
gold standard, because that is the only direct response of hearing. Impedance testing or tympanic rams test the function of the middle ear, they don’t test the whole system. Otoacoustic emissions tests the hair cell function of the cochlea, and they don’t test the whole system. ABR testing, auditory brain stem response testing, tests the functioning of the auditory brain stem, but again, it's not testing the whole system. And while all of those tests are absolutely essential parts of testing, they don’t test the entire system, and they don't require any responses from the child. So it's really important that we look at the entire child and we see where the child is performing and what a child is doing. How is the child responding to sound?

So for babies, birth to six months of age, cognitive age, we are looking at behavioral observation audiometry. And what we're doing here, you're not gonna get a three month old to raise their hand, we all know that, but we can look at how they respond to changes and sucking. When a baby hears the sound, we hear changes in sucking. If a baby, some babies respond as soon as the sound goes on, and some babies respond when the sound stops, but we're going to see responses, changes in sucking when a baby hears a sound. Now, for children who are cognitively more than six months of age, this is not the appropriate test, but we may find a child who is 10 or 11 months of age, but who's cognitively four or five months of age.

So we're looking at their cognitive age, when we're choosing a behavioral test. So if a child is cognitively birth to six months of age, BOA is the appropriate test protocol to use. In order to use BOA, however, a child has to be able to suck, so there are some children who have significant problems sucking for some reason, are on a feeding tube, whatever, those babies are not, we're not gonna get sucking responses from them, and so this isn't a test protocol we can use. Children who are six to 36 months of cognitive age, we're going to use visual reinforcement. This is a task in which we make a sound and we pair the sound with a toy, a bear banging on drums, or a light flashing, or a short cartoon. So we teach the child when they hear the sound, we show them the toy,
and they very quickly learn that when they hear a sound to look for that toy, just like Pavlovian conditioning with dogs and food. It's the same kind of reinforcer. They used a bell, we use a sound from the audiometer or a speech sound to see whether the child is responding, and it just amazes me, I've been doing this for more than 50 years, it amazes me constantly how babies learn to do this, just you make a sound, you show them two or three times, and all of a sudden, the sound goes off and they turn around and look. It's something I am absolutely, I'm in awe of every time I see a child. So we're looking for a conditioned head turn, and again, that's cognitively for children six to 36 months of age. Conditioned play is what audiologists call the listen and drop game, which we can start at around 30 months of age, and children who have hearing loss, who see the audiologist a lot, may be able to do this even younger than 30 months of age.

And what we do is we help the child hold a toy to their ear, and every time we make a sound, we help them move their hand down to put the toy into the bucket. We can use a ring stand, we can use blocks, we can use puzzles, a whole variety of things, but we want the child to do is hold the toy up to their ear and when they hear the sound, do whatever motor activity is required. In the beginning we're gonna have to help them move their hand.

As they get more familiar with the task and more comfortable in their ability to do it, they're going to be able to drop the toy in the bucket or put the ring on the ring stand as soon as they hear the sound. When children reach five or six years of age, cognitive age, then they're gonna be able to raise their hand or push the button like an adult. Sometimes even a five or six year old, although they're capable of raising their hand, or pushing the button, are gonna still have problems, we're still gonna wanna do conditioned play, because they're gonna find raising their hand boring, which it is, it's not that exciting an activity, and it is a lot of information we have to get when we do conditioned play, when we do hearing testing on children, so conditioned play may
give us more of that information. So one of the questions we have to ask ourselves, are the tests we’re selecting valid tests for measuring what we are intending to measure. We need behavioral and electrophysiological tests. We want to be sure we’ve done all the tests that we need to do for a child. Are the electrophysiological tests sufficient to be able to be used alone? In my opinion, no. Ideally we want to do electrophysiological tests and behavioral tests. Do they provide the same information? They provide complementary information. They provide information that is reliable and usable. They provide information that is helpful for us to use over time. So behavioral tests measure the entire auditory system. The outer ear, the inner ear, the auditory nerve, up to the auditory brain. Electrophysiological tests measure parts of the system, but they do not measure the entire system. However, by having both ABR and behavioral testing and impedance and otoacoustic emissions, we can get an entire picture of a child’s auditory abilities and figure out what we have to do next.

So what should we be looking for from testing? First of all, we want to know the degree of hearing loss. So was the appropriate test used? If VRA was used, is the child cognitively six to 36 months of age? Sometimes when a child is doing play, they get tired of the task and they want to stop, and I have seen audiologists who decided, well, he’s tired of doing play, he doesn’t wanna do that anymore. Instead of making him come back, I’m gonna do VRA. The problem with VRA, you may get him to turn his head a couple of times, but you’re not gonna get a threshold response, because it’s not the appropriate cognitive test for that child. For every child who we’re diagnosing hearing loss, ABR is an important and useful test. But we need to remember that ABR is testing from the auditory brain stem. It’s not going all the way up to the brain. It’s passing the auditory nerve and the brain. So we should do ABR. It’s gonna give us information, it’s gonna give us an approximation of hearing loss, it’s gonna help identify whether a child has auditory neuropathy spectrum disorder, and it’s gonna give us very critical information that we can use, along with behavioral testing, to figure out what the degree of hearing loss was. In addition, we need to do speech perception testing.
Speech perception, as I said before, is the goal. It’s where we want to know a child is. It’s going to tell us whether this child hears enough to manage in the classroom. We wanna know how they hear under earphones, because we can make it loud enough, usually, to see what they’re able to hear under sort of ideal conditions. Then we wanna test them in sound field through loud speakers without technology, and we can do that if a child has a moderate, maybe a moderately severe hearing loss, but no worse, because it’s gonna give us a sense of how a child is hearing with no assistance around them. And we’re gonna test them at normal conversation and soft conversation and in competing noise.

Now, if a child’s got a moderate hearing loss, 40 to 55 decibels, and we test them at normal conversation, which is at 50 decibels, they’re going to be hearing speech very softly, and they’re not going to be doing very well. But sometimes it’s important to do that because it helps both parents and children understand how much a child is missing. When kids get to be teenagers, and they think they don’t need hearing aids anymore. This is sometimes a very useful task to do. But always, always, always, we want to test children with technology. We want to know, what are they hearing with their technology.

Hearing aids, cochlear implants, bone anchored systems, remote microphones. Are they, how are they hearing with the right technology, with the left technology, and with both ears together? Because that’s gonna give us the information we need, first to know how to plan remediation, and secondly, how to figure out whether there’s anything we need to change in the technology. If a child’s not hearing loud enough with the right hearing aid, it tells me with my audiologist hat that I need to do something to change the technology so that they hear better. Is the child hearing well enough to manage in the classroom? If their speech perception at normal conversation is 90%, that’s great. If their speech perception for soft conversation is at 40%, that means they’re not gonna overhear the kids around them, because 40% is really lousy speech
perception. So it’s very poor. So that tells me that I need to be sure that either the teacher’s repeating what the other children are saying into her remote microphone, or that there’s a pass around mic that the children can speak into directly so that I know how the child is hearing. So I know the child’s able to follow classroom conversation. If a child has poor speech perception at normal conversational levels, I know that child’s gonna have a hard time getting auditory information in the classroom, so we need to make sure there’s a teacher of the deaf who can follow up and help the child understand what’s happening. So the speech perception information tells us so much about how a child is doing, and it gives us information that helps us plan, and that’s why it’s critical that you understand it, and you understand how to read it.

It’s important that you ask to see the test results, not just to read a report, because reading the test results, in the beginning it’s gonna be hard, I know that, but by reading the test results, you’re gonna be able to figure out what a child hears and what they don’t hear. Ask to see the test results, because we want, you need to make your own interpretation. If somebody says to me a child’s speech perception is good, I don’t know what their definition of good is. So I wanna see the test results so I can see what that means. My definition of good is 80 to 89%.

Your definition of good may be 50%. You’re not gonna learn well if you’re only understanding 50% of what happens in the classroom, so I wanna see exactly what the results are so I can make my own interpretation about how this child is performing. So let’s talk for a minute about what a child needs to hear well in the classroom. Children, 85% of children with hearing loss are educated in the mainstream. That means they need to be able to hear in a classroom. They need to be able to hear normal conversation, soft conversation, and speech in noise. If they don’t hear well, they’ll have difficulty with academic learning, with literacy, because literacy is based on language skills, and they will have difficulty with socialization, because socialization is also based on language skills. So what is normal hearing? First of all, normal hearing is
zero to 15 decibels throughout the frequency range, from low pitch to high pitch. It’s also excellent speech perception at normal conversation, you can see here, normal conversation is 50 decibels, soft conversation is 30 to 35, and they need to hear well in competing noise. Excellent means, excellent speech perception is 90 to 100%. That’s excellent. That’s the only definition of excellent. It’s not excellent for a kid with normal hearing or excellent for a kid with hearing loss. If a child is functioning in a classroom, I need to know what their hearing is like in the classroom so I know what I have to do in therapy. They also need to have a type A tympanogram, which means that there’s no middle ear disease and their eardrum is moving normally, and they need to have normal otoacoustic emissions, which means that the hair cells in their cochlea are working normally. So what do children with hearing loss need to hear? Aided thresholds from 20 to 25 decibels is what we hope that they’ll hear, because we want them to hear, they’re not gonna hear at 15, that’ll probably be providing too much distortion, but we wanna be sure they’re hearing at the top of the speech banana, and I’m gonna talk about that in a second.

From 25 to 8000 Hz, it’s not okay to have good hearing with your technology from the low pitches to the middle pitches and miss the high pitches, because an enormous amount of speech perception information is in the high frequencies. They need to have good, which is 80 to 89%, or excellent speech perception at normal conversation, at soft conversation, and in competing noise. Here’s the speech string bean. This gray area is the speech banana. It’s where all the speech sound information is here. If you hear at the bottom of the banana, you’re gonna be hearing about 10% of the information. If you hear in the middle of the banana, you’re gonna be hearing about 50% of speech information. If you hear at the top of the banana, you’re gonna be hearing 90% of speech information. So it’s really important that children hear as close to the top of the banana or in the speech string bean as they can. So what happens if hearing is not good? What are the educational implications? Well, as I said before, it’s really important that you hear in the classroom, because if you’re not hearing in the
classroom, you're going to be missing a great deal. 80 to 95% of what they learn, they learn by overhearing, by hearing conversation. Young children, preschool children, early years, 90% of what they learn, they learn by overhearing, not just face to face conversation. So we need to know that a child is getting what they need to hear. They need to be able to hear in the classroom, they need to hear the teacher, but they also need to hear classroom discussion. What other kids say, even if the mistakes are wrong, are important. They need to hear for academic development. We need to know that they are getting what they need to get. If they're not hearing all of the conversation, then they're not going to be able to learn, they're not gonna be able to use what’s happening in the classroom to learn, and their academic development is gonna be delayed.

What they hear is very critical to learning language, and that results in what their skills in literacy are gonna be. A child who has delayed language is going to have delayed literacy. So it's critical that we give them enough auditory access so they can learn language like their peers, and use that information to develop literacy skills. We also know that social skills are very clearly connected to literacy. I'm sorry, to language. Children who, when they're very young, a lot of the games, the social skills kids do, are really, there's a lot of visual stuff involved that kids need. They can manage using visual skills.

But once they get to be about middle of second grade, a lot of the games require language. They're more complicated. It’s not just chasing each other around and fooling around and throwing balls. A lot of the games are language related. Even if they don’t actually seem that way always right from the start. So children who have social skills issues are going to have problems learning language and developing language skills. And that is gonna result in social skills issues. We see kids having friends when they’re little, and then friendships start to become harder to have as they get a little older, and the result of that is the cause of problems with their language is delayed, so
their social skills become interfered with. So what are the factors that will affect speech perception? Let’s discuss that for a minute. So first degree of hearing loss, that will certainly be a factor. The more severe the hearing loss, if it is not managed with technology, The more severe the speech perception problems. How long has the child had the hearing loss, especially if it's untreated. A lot of this is changed by early identification now that we have newborn hearing screening, and fitting technology very early and making sure that kids are hearing very early. So if they’re hearing with their technology, this is not a problem. But if they're not hearing with the technology, it is a problem.

And that’s what this refers to, experience with technology. Kids who are identified at birth and fit with hearing aids in the first few weeks will have a listening age, how long they've been hearing, the same as their chronological age. If they're born, if they’re three months old and they have been hearing for three months minus a week, they’re essentially, their listening age is essentially three months. If they are five years old and they've been hearing since they were two weeks old, they’ve got a listening age of five years.

But if they’re five years old and they didn’t start listening, they didn’t get technology or good technology until they were three, then they've got a listening age of two years. So they are really behind, and that’s gonna affect social skills and language skills and academic development. So what kind of experience they've had with technology and how much they've had it is gonna be critical. Also, next thing to think about is demands on using audition. How are family and therapists and school dealing with the hearing loss? When the family talks to the child, do they talk to the child, do they expect the child to hear and to respond to them like they would expect a typical hearing child to do? Or are they, if I ask the child a question, does the parent answer? Well, that may be appropriate when the child is one, but it’s not appropriate when a child is five. So is the parent allowing the child to learn to rely on their listening skills so
that they can develop good skills and develop the ability to function. And if the answer to that is yes, then great, the child’s gonna develop the skills. We also have to worry about what’s happening in the classroom. Is the teacher expecting the child to use hearing, or is the teacher not expecting the child to understand what’s being said, not expecting the child to respond, and maybe not even calling on the child? I’ve done too many school observations in which I’ve seen the classroom teacher essentially ignoring the child with a hearing loss, which is not gonna help that child develop the skills they need to learn as they get older and more work requires academic assistance. And auditory access. So I wanna know whether the school is demanding listening and responses, and whether the family is. I also wanna know what the child’s language level is.

And I will often ask the speech pathologist to tell me what the child’s receptive language level is, because I want to choose a speech perception test that is appropriate, and there are two ways to think about this. If a child’s in third grade, I wanna use a third grade speech perception test, because I want to know how this child will manage in their classroom. If a child is in third grade and has a language level of first grade, if I test the child with a first grade speech perception test, I’m not necessarily gonna know how this child is managing in a third grade classroom, because the vocabulary in a third grade classroom is certainly different from the vocabulary in a first grade classroom.

So language level is critical, because it helps us figure out what it is we’re doing. It’s also useful to know the etiology of the hearing loss. There are certain hearing losses, like auditory neuropathy spectrum disorder, which can cause children to have increased problems with speech perception. That’s something I want to know. Conductive hearing loss, on the other hand, provides children with really better speech perception, because distortions happen in the sensory neural part of the hearing loss. So children who only have a conductive hearing loss for the most part will have better
speech perception, although maybe not as good as a child with normal hearing. We want to know next, maybe most important, how appropriate are the hearing aid settings? Is the child hearing well enough to hear soft speech, or is soft speech still going to be very soft and too hard to listen to? Are the hearing aids set appropriately, is the cochlear implant mapping strategy and rate and other settings appropriate so that the child can hear what they need to hear? And what is the experience of the audiology team or the cochlear implant team? We want to be sure that people who are working with the child are good pediatric clinicians who have the experience to do the work that needs to be done. We all have different skills. While I am certified and licensed as a speech language pathologist, you really don’t want me doing aphasia therapy, even though I’m licensed to do it, because it’s not my skill level. I have worked for more than 50 years with pediatric patients. Giving me an adult patient, could I legally do it, yeah, but you really don’t want me to do it.

And that’s the same thing. If I’m in with my audiology hat, I’ve worked with babies forever and ever and ever. I can fit hearing aids on adults, but it’s not the same skill set, so I think we need to be sure that the people who are doing the work, are doing the work we expect them to do. So we talked about this a little bit, but I want to say it again. For most part, speech perception testing is done with monosyllabic words. There are some good speech perception sentence tests, but most of the testing is monosyllabic, which means single syllable words. Normal conversation 50 decibels, right technology, left technology, both ears together. Soft speech, 35 decibels, talking soft speech, binaurally. We don’t do right and left just because of time, so we just test binaurally for soft speech, and for speech and noise, normal conversation at a plus five signal to noise ratio, which means that the speech is 5 decibels louder than the noise binaurally. So we wanna know how a child is performing in those three conditions, and then we will be able to figure out what we have to do to make life better for this kid. So when we’re describing speech perception, this is from a study I published in 2011 with some colleagues. Excellent speech perception is 90 to 100%, good is 80 to 89%, fair
is 70 to 79%, and poor is less than 70%. That's it, nothing else. So this is a test form that I use. Right ear alone, left ear alone, binaural, and binaural with the FM. Words at normal conversation, and I also score phonemes. So if I say the word bed, and the child says "bet," the child made a "t" for "d" substitution, so I will record the percent of phonemes the child got correct, as well as the percent of words, and when I score that, I also write on my test form exactly what the error is, so I can use that information to figure out how to change the settings on the hearing aids or the cochlear implant. Right ear alone, left ear alone, binaural and binaural with the FM. For soft speech, just binaural and with the FM. Words and phonemes, and then normal conversation in noise, words and phonemes, binaural and with the FM. There are some sentence tests that we do.

Sentence testing in quiet, right, left, binaural and the FM, normal conversation, and then in quiet at soft conversation and in noise. So let's talk about monitoring technology. The goal of assistive technology is first of all to reduce sensory deprivation. Whatever deprivation the hearing loss has caused, we want technology to improve it. We also want to provide auditory access which is sufficient for auditory learning. We want them to be hearing well enough so they can use technology to learn, to use audition to learn.

We want to maximize the use of residual hearing, however much residual hearing they have, they need to be able to hear with it. We want to lay the foundation for auditory academic learning, to facilitate socialization, to facilitate information access and incidental learning, because that is just critical for children with hearing loss. Everybody learns incidentally, and we want our children to learn that way also, which means they need to be able to overhear things around them. They need to be able to have good access to sound so that they are safe, so that the things around them, they can hear when a car is coming, they can hear if someone is shouting at them. We also want them to be comfortable, but you'll notice I have comfort last, because most important
is that they hear well enough to learn and to be able to be happy in the world. So the problems we need to identify with technology are, is the technology doing what we want it to do? Is the child hearing at the string bean, can they hear soft speech, and can they hear in noise? They need to be able to hear in all those conditions to do well. So how do we know if you have met those goals? You can't guess. You have to actually test. Real ear or cochlear implant mapping are essential. They are a critical first step, but then you have to go into the test booth, you have to verify how they are hearing, are they hearing softly enough, are they hearing normal in soft conversation, are they hearing in noise? And then you need to go into the classroom. Somebody needs to observe whether they are hearing in the classroom. Are they able to follow classroom conversation?

If the teacher gives an assignment, do they need to look at their partner to see what page or what math problems have to be answered now, or are they able to hear the teacher and follow the directions that way? Parent, teacher, and child questionnaires are also very helpful in helping children follow what's happening and get the questions and get a sense of what everybody thinks about how a child is functioning in the classroom. Parents may have one guess, and teachers may have a completely different view, so it's important to get all of that information. So let's look at a few cases and see what we think is happening.

First, was the appropriate behavioral test used, and we talked about this. VRA is the test for children six to 36 months of age. Conditioned play is a test for children 30 years to five or six years. Standard audiometry is for children over five or six years of age. If I'm testing a four year old, I should be using conditioned play. If I'm using visual reinforcement, the test is not going to be valid or reliable. So is the appropriate test being used? What's the appropriate speech perception test used? Did we use a test that is at the appropriate language level for that child? Are the test results valid and reliable? You may not be able to tell by looking at an audiogram whether the test was
reliable. Was it repeatable? Did the child do the same thing multiple times? But you will be able to tell if it's valid. Were they using the right test? Were the tests interpreted appropriately? If a child's got thresholds at 45 decibels, and the person says that that's a mild hearing loss, you know that's wrong. If the speech perception is 56%, and the person describes it as good speech perception, you know that's wrong. What kind of benefit is the child receiving with their technology? Are they hearing enough with their technology? Are they hearing softly enough, is their speech perception good at normal and soft conversation, and in competing noise? Is the child hearing well enough to manage in a mainstream classroom?

Critical information. Is the child hearing high frequency sounds? It's not enough to hear well through the low and middle frequencies. High frequencies carry information for about half the consonants. If you don't have normal hearing in the high frequencies or close to normal hearing in the high frequencies, you are missing a lot of consonant information, which means you're not gonna get pluralization, possession, non salient morphemes, critical language markers. Is the child hearing well enough in each ear separately?

Do they hear soft speech so they can have incidental learning and follow children's comments in the classroom? Are the ears matched? They need to be matched. Do you need to hear equally in both ears? Well, ideally you do, because by hearing in two ears, you're going to be able to follow conversation. You're going to be able to know where sound is coming from. Where do you look to see who's talking? Where do you look to see where the bus is coming from? Where do you look to see, if somebody honks a horn, where is this happening? So yes, you need two ears. Binaural hearing helps you hear in noise, and it helps with localization. So here is a five year old, a typical five year old who was tested with visual reinforcement. Is that the right test for a five year old? Not a child who's cognitively five. Visual reinforcement is six to 36 months of age. So that's not the appropriate test. So here the child was retested with conditioned play,
which is the appropriate test, and we got a test which indicates that this child has a moderately severe to severe hearing loss. Now, why did this child, excuse me, why did this child get these results. I'm sorry, we need to stop the recording for a second. I need to get a lozenge. Stop the recording. Okay, so why did this child get these results when he was tested with visual reinforcement? Well, obviously I wasn’t in the test room, but my guess is that he was just sort of alert to what's going on and was following what the person was trying to teach them to do. He heard a sound, and the tester pointed to the visual reinforcement toy, and he just started looking randomly, and the test results were misinterpreted. Choosing the appropriate test is very critical. If you do not choose the appropriate test, you’re not going to get valid results.

Okay, so here is, just for your information, here is a child who was tested using behavioral observation, which is looking for changes in sucking, when he was four months of age, and the circles are his responses at four months of age using behavioral observation, looking for changes in sucking. The triangles are his responses using visual reinforcement, using a conditioned head turn at seven months of age, and the squares are play audiometry where he, the listen and drop task, which he did at 25 months of age.

So this is an example of, if you use the appropriate test, you will get reliable, repeatable results over time. So let's look at this one. This child in the right ear has a 65 decibel hearing loss, which is a moderately severe hearing loss, and in the left ear he's got also a moderately severe hearing loss. The average is just a little under 70 decibels. The Rs are how he's hearing with his right hearing aid, and the Ls are how he's hearing with his left hearing aid. So is he hearing well enough with his hearing aids? I don’t think so. Because this means he's in the middle of the speech banana, which means he's only gonna be hearing about half of what is said. And if you look at his speech perception, you can see, okay, we’ve had a little problem with the way this is lining up on the bottom, I’m sorry about this, but let me walk you through it. With the right hearing aid,
he's hearing 72%. With the left hearing aid, he's hearing 52%, and with the two of them together he's hearing 60%. And testing with soft speech and speech in noise we could not test him, because he just didn't hear well enough. So we changed his hearing aids, and look, he's hearing right at the top of the speech banana, he's hearing at the string bean, and he's getting much more information, and it went right ear 92%, left ear 92%, binaural 100%, soft speech binaurally 92%, and speech in noise binaurally 80%. So here's a child who's got a moderately severe hearing loss, hearing well in the low frequencies, not well in the high frequencies. Here's another child who's got a severe to profound hearing loss, hearing really poorly. This child is missing most speech information. They're gonna hear normal conversation very softly, and they're not gonna hear soft speech at all. So this child definitely is not hearing loud enough, and we need to do more.

Here's a child who's got a severe to profound hearing loss, has good gain with his technology, but the speech perception is not good. And if the speech perception, in this case, we know that he's hearing well enough, he's getting enough gain with the technology, so if there's no distortion in the technology, then that means that therapy needs to work on teaching him, working on improving his speech perception abilities. Here is a child who's got, again, good gain with hearing aids, but very poor speech perception.

Now, if he's hearing well enough with his hearing aids, then something else is causing the problem with speech perception. Either no one's requiring any auditory access of him, or he's in an educational situation, for example a signing classroom, where no one is requesting listening. So here's Matthew, who's in the third grade. He was tested with a Kindergarten level test, and he did very well. The school decided that meant he didn't need services. We retested him with an age appropriate test, which indicated poor functioning, speech perception and noise, soft speech and in noise was very poor, and that enabled us to show the school what needed to happen. So here's a little tiny guy
with cochlear implants on two ears. So is it time for a cochlear implant? If a child is hearing well enough with their hearing aids, then that's good, for language learning, academic learning, or socialization. If they are not hearing well enough with their hearing aids, can we fix their hearing aids, can we get them more high frequency information? Are they FM dependent? If we can't get them more high frequency information, if we can't fix their hearing aids, then it's time to think about a cochlear implant. Here's a child who's speech perception is poor, gain with hearing aids is poor, implant that child, and we can see better improvement. We can get them to do better. This child is FM dependent, without FMs not hearing soft speech and speech in noise. But they're doing well and they will manage with hearing aids, although not perfectly. This child is not doing well. They're not getting enough gain with hearing aids, and their speech perception is clearly poor. Implant this child and they move from poor performance to fair performance, and with therapy will improve to good performance.

Here's Andrew, thresholds, hearing aid thresholds not sufficiently good enough. Here he is with a cochlear implant and speech perception, good. With hearing aids alone was good.

With hearing aids alone was good at normal conversation, with cochlear implant is good, his hearing aid alone 20%, and binaurally not good. Here's a child, Emma, good hearing in the low frequencies, poor hearing in the mid and high frequencies, could not even do speech perception on her. Implanted her and look what happens. Great hearing with the implant and speech perception outstanding. 80% with the implant, 7% with the hearing aid, because she's not hearing well enough. Here's a little guy with his cochlear implant. Another child, good hearing, mild hearing loss, good hearing with hearing aids, better with the FM, good at normal conversation, poor in the left ear. Binaurally did well. Soft speech and speech in noise a problem. The FM made all the difference. So here, is it good enough? No, it's not good enough, because you don't live your life with an FM on your head, so this is definitely not good enough performance. Not at normal conversation, soft conversation, or in noise. So the role of
the speech pathologist is critical. You need to monitor performance of the children you work with, be sure they're hearing well enough to learn. Any listening problems that you are seeing, communicate to the audiologist, the auditory verbal therapist, and the family. Work on developing auditory skills so they can learn to listen. Thank you so much for listening. Visit the Brooklyn Bridge.

- [Amy] Lovely. All right, thank you so much, Jane. It's always a pleasure to have you with us, and I think going through some of those audiograms was very helpful. It's always good to see the interpretation and see the improvement with the cochlear implant versus just hearing aids, etc., so thank you so much for sharing that.