KNOWING WHAT YOUR CHILD CAN HEAR

- Welcome. Welcome. Thanks so much for joining this session a few minutes early. This is Hearing First's "Knowing What Your Child Can Hear." Our presenter today is the incomparable Dr. Carol Flexer. But before we turn things over to Carol, I'd like to turn things over to Dr. Teresa Caraway, who will do our introductions.

- [Teresa] Well, welcome, everyone. We are super excited that you are joining us today for this webinar, "Knowing What Your Child Can Hear." It's always so exciting when caring adults in a child's life are connecting to learn and grow so the children touched by hearing loss can have the same listening, spoken language, and literacy outcomes as their hearing friends. But this is the second webinar in the Living LSL series. And we have more to come. So, we invite you to register for the other webinars in this series on the Hearing First website. I guarantee you will not want to miss any of them. During this webinar, we encourage you to post your questions throughout our live session, as we have planned a question and answer at the end. So, be sure and click the Q&A on your Zoom toolbar and type your questions in this space at the bottom. We want to hear from you so that we can have that dialogue and that discussion. Dr. Terry Zwolan, Director of Audiology at Hearing First, she will be facilitating our Q&A at the end of the session. So, be sure and put those in. I am so pleased to introduce our esteemed colleague and dear friend, Dr. Carol Flexer. Dr. Carol Flexer is a renowned audiologist, a certified listening and spoken language specialist, and Professor Emeritus at the University of Akron, Ohio, and international lecture and educational audiologist. Dr. Flexer has authored over 155 publications, including 17 books, which are widely read today by professionals and the parents of children who are deaf or hard of hearing. I have no doubt that Dr. Flexer's work has profoundly influenced many of us listening and joining this webinar today. Additionally, Dr. Flexer has served as the past president for the Educational Audiology Association, the American Academy of Audiology, and the AG Bell Academy for Listening and Spoken Language. She has been supporting families and professionals for over 40 years. She must have started when she was 12. And her work has been instrumental in the amazing listening and spoken language outcomes that we get to see every day with children who are touched by hearing loss and diagnosed with hearing loss. So, please join me in welcoming Dr. Carol Flexer.

- Oh, thank you so much, Teresa. Thank you. So, and thank you to Hearing First for organizing this Family Learning Series. Thank you. This is, it's just such an honor to be working with you all today. And thank you so much for joining us for this hour. I'm coming to you from my home in Hudson, Ohio, which is near Cleveland. And I think you all are coming here from everywhere, right? So, thank you for being with us this hour. For this webinar, I'm going to provide information about the purpose and design of an audiogram, emphasizing speech and environmental information that's available to your child's brain. And after this webinar, our goal is that you'll be able to explain your child's hearing loss, their audiogram, and what sounds reach their brain. So, specifically, we're going to start with the brain. Last month's webinar was all about the brain. And I'm going to summarize that again. And how is your child's hearing tested? What is an audiogram? What does it mean? What is the impact of different degrees of hearing loss? What is that Ling Six Sound Test? A speech string

bean. What? How about music? How does that affect your baby's brain? So, what about all this information? To begin with, hearing is about the brain. We tend to think we hear with ears, but actually we hear with our brain. Your ears act as a doorway to help get sound that's auditory information to the brain. It's really vibrations. I mean, we have five amazing senses. And for example, the eyes act as a doorway to the brain for optic wavelengths. So, they get visual information to the brain. The nose gets olfactory information. But it's the brain that actually learns the meaning of the information that gets there. So, it's the brain that learns the meaning of the sound that gets in through the ears. So, we can think of your child's hearing loss as a doorway problem. The doorway can be blocked a little, causing maybe a mild hearing loss, or the doorway can be blocked more. We might call that a moderately hard of hearing. Or the doorway can be closed. And we might call that a profound hearing loss. So, the task is to reach the doorway, right? And it's modern hearing technologies like digital hearing aids, cochlear implants, bone conduction devices, and other assistive technology that are designed to break through the doorway and get clear auditory information to your child's brain. Remember, sound carries information and information becomes knowledge. The ear is the doorway to the brain for sound. Spoken language information, talking, reading, we hear, we know, we understand with the brain. The ears are the way in. Children speak what and how they hear. If their speech is distorted, if it's not clear, it's likely the brain has been receiving unclear information, deficient information. Interpreting audiologic results means that we're estimating the child's performance outside of the test situation. And then making appropriate recommendations, so your child has access to information. If you would like it, I encourage you to review or view the webinar that we had last month, which is about "Hearing is About Your Child's Brain," which has much more information about the topic. So, I love this summary because it shows that what goes into the ear, it's really vibrations from the environment. And then those vibrations are changed into neural impulses. And through exposure and practice and language, your child learns the meaning of those neural impulses. And then what comes out of your child is a function of what went in through the doorway. So, if clear auditory information and spoken language goes in, clear comes out. If garbled goes in, garbled information comes out. If English goes in, English comes out. If Spanish goes in, Spanish comes out. You don't put in Spanish and get out French, right? So, it's very important, therefore, to understand what is going in to this organic doorway that influences your child's knowledge and the output when your child speaks. That's what we're going to be talking about today. Well, how do we test your child's hearing in the first place? Many of you have already been involved with this. You have to start with a pediatric audiologist, which is an audiologist who specializes in testing and managing children. Your child will be tested in a sound-isolated room because we don't want any sounds getting to their brain, except for those which we are inserting. And your child, the sound is sent to your child's ear, their doorway through a very soft little ear-insert that's put into their ears. And then the audiologist records your child's thresholds on the audiogram at each frequency or pitch. Obtaining an audiogram, however, is only one piece of a very thorough hearing test. So, your child will receive many tests besides the actual pure tone. They'll get speech perception testing. We're going to test their middle-ear function to see if there's an ear infection. And of course, we'll take a very detailed case history to get a sense of are there any other challenges your child is working with or what historical issues or what are family issues that we need to be aware of? So, here's is this audiogram. What is it? An

audiogram is a very simple graph. It's a way we measure the quantity and quality of the doorway problem of your child's hearing loss. We chart the softest sound your child can hear. And those soft sounds are called thresholds. And we test different frequencies from 125 Hertz up to 8,000. And these are pitches, right? And then along the side is intensity in decibel, from very, very soft to very, very loud sounds. The higher the number of decibels on the audiogram means the louder the sound is, and the more hearing loss your child has, and the more blocked the doorway is. I mean, your child's doorway, auditory system, it can be blocked by ear wax or fluid, or there could be a sensorineural hearing loss, or there aren't little hair cells in the cochlea. So, there are lots of reasons why this doorway might be blocked. Now, you might wonder how could someone hear at -10 dB. That is, 10 dB, below nothing, zero. Well, the interesting thing is in decibels, decibels aren't a linear measure. They're logarithmic. Now, all that means is that it's a relationship measure. So, at zero dB is not absence of sound. Zero dB HL is the softest sound that the average normal hearing doorway can receive and transmit up to the brain. So, zero is the average best hearing that people have. Some people hear actually better than that. But this is a logarithmic scale. And then everything else is how much louder than normal, normal meaning that typical auditory access will be for a child or a person who has a doorway problem, or a hearing loss. Why are these frequencies tested? Well, these particular frequencies are used because together, these are the most important frequencies for spoken language. And specifically, English, but not only English. Think about, so here's an analogy. Think about how individual threads weave together to make a fabric or a pattern in a plot. And we're not aware of each individual thread in the pattern, are we? Just like, we're not aware of individual tones that make up a speech sound or a speech message. However, each individual tone makes a very precise and important contribution to speech detection. You even hear it. And clarity. Can we distinguish what that speech sound is? That is, can the brain distinguish what that sound is, given that auditory information has been transmitted through the auditory system? An audiogram can show three things about hearing loss. What is the type of your child's hearing loss? Is it what we would call a conductive hearing loss, meaning the problem is in the outer or middle ear, like an ear infection, or like atresia, where the outer ear is closed. Is the hearing loss sensorineural, which is in the inner ear? Often can have a genetic cause. Some people call that a nerve loss. But we're really talking about the delicate little inner ear organ called the organ of Corti that has these darling little hair cells that receive these vibrations and then change them to neural impulses that are sent to the _____ brain. And the severity of hearing loss, whether it ranges from minimal to profound, is also shown on an audiogram. And in addition, the audiogram, because we connect the thresholds with lines, show and create a configuration or a pattern, which shows how much hearing loss exists at different frequencies. See, rarely do people have a very flat hearing loss across the same hearing loss, across all of the different pitches or frequencies. The hearing loss can vary at each point along the audiogram. I'll talk more about that in a moment. And you'll see what these configurations can look like. Now, the threshold for sensitivity for each ear is displayed on an audiogram on this graph using specific symbols. What do the symbols mean? There's a zero or an O, which is the softest sound a person can hear what their right ear, when we have those insert earphones in the ear canal. And often, those circles are in the color red. X is the softest sound a person can hear with their left ear when we use those earphones. And the left ear, typically we use blue. The little carrot is the softest sound that a person can hear while they're being tested by bone conduction. S is the

softest sound a person can hear when both ears are open to sound, the child sitting in the sound room and the sounds or the speech are coming through the loud speakers in the room. All of these initial symbols are when the child is not wearing technology. They're not wearing their brain access device, right? Now, we have symbols A and C, which is when we test the child in the sound room, not with the ear-insert earphones, but with the case of A, with their hearing aid on, or C with their cochlear implant on. Because we wanna see the softer sound each side can receive and send information to the brain. And we wanna compare what your child's brain can receive when not wearing technology, and then when they are wearing technology. Because of course, the goal is the technology will breach that doorway problem and send more better, more complete information to their _____. Let me hear it their brain. Now, what about degrees of hearing loss? How much hearing loss or how much of a doorway problem can exist at different frequencies? And I'm gonna go into more detail. But just to show, we have a metric for each. So, normal hearing is when the softest sounds a person can hear across all of the frequencies is between zero and 15 dB HL, which is hearing level, which is the reference to normal hearing. Then we have borderline normal or slight hearing loss. But don't be fooled by the words minimal slight or borderline because those words sound like it's doesn't mean anything. It's just a little nothing hearing loss, or just a little nothing doorway blockage. That's not true because any blockage, anything that interferes with information getting to the brain interferes with knowledge development. Then there's a mild doorway problem. Mild hearing loss is when the softest sound a child can hear is between 25 and 40 dB HL. Moderate is between 40 and 55. Moderately severe between 55 and 70 dB. A severe hearing loss, a severe blockage is when sounds have to be very, very loud to get through, to break through that doorway and get to the brain. That means they have to be 70 to 90 dB. I mean, that's very loud. And profound is louder than 90 dB HL. So, what this audiogram shows is how much of a blockage is there in the doorway. It doesn't tell you what your child's brain can do with the information. It's just saying this information isn't getting to your child's brain until we use technology to get through that doorway. I'll talk more about the impact of each degree of hearing loss in a moment. So, now we're gonna get to the audiogram and talk about what the audiogram interpretation can mean for the development of your child's listening and spoken language. And this is what we call a familiar sounds audiogram. This is a new revised one that we just developed. And now I'm gonna talk about different features on this familiar sounds audiogram. The features are the speech banana, speech sounds, the Ling Six sounds, and the speech string bean. Let's start with the speech banana. The speech banana, as you see, 'cause it's shaped like a banana. I mean, it could be a zucchini, right? But we have just for whatever reason, for a number of years been calling this shaded area, the speech banana, which is the area that shows where speech sounds occur. In other words, what's the loudness of these speech sounds as someone is talking to you at an average conversational level, at an average conversational distance in a quiet environment. Close-by quiet. How loud are these individual speech sounds or threads? Speech information spreads throughout the speech banana. And specific speech sounds are represented at different frequencies, pitches, and intensities, loudness levels. Now, what we put within the banana are only a small sample of all of them. These are English speech sounds. Of all of the possible English speech sounds. But we use these and place them in a way to give us a general understanding of the frequency and intensity of vowels and consonants. Specific speech sounds are placed in the area of the audiogram where

they're identified with their primary energy. See, speech sounds obviously aren't pure tones. Like the sound "sh" is not a pure tone like bing. It's not like that. Obviously, speech sounds have a spread of energy across a number of pitches or frequencies. But they're represented in the banana as a function of their primary energy. And your child's brain needs to hear all of these speech sounds clearly in order to develop speech, language, and knowledge. Well, let's start now with the vowel sounds. And again, there's only a sample that we have that we have displayed in this speech banana. Vowels such as oo and ah show up mostly in the lower frequencies of the speech banana at 125. But we really rarely test 125 Hertz, but at 250 Hertz, 500, maybe 1000, this is the area in this pink or mauve circle where most of the vowel sounds that most of the primary energy of the vowel sounds occur. Now, vowels obviously are very important. They provide about 90% of the energy of speech, but only 10% of the clarity. Vowels are high-energy sounds. And in fact, the loudest sound in English is "aa". So, you can see this, it's primary energy is around a 1000 Hertz and it comes in at about 50 dB HL, just in an average conversational message. "Aah". Vowels are predominantly low frequency, high-energy sounds. So, when you speak loudly, what we're really emphasizing are vowels. Talk more in a minute because now we get to consonants. Consonants for clarity. Consonants such as s, sh, th show up mostly in the higher frequencies of the speech banana. Consonants tend to be very weak, faint sounds. In fact, they carry only about 10% of the energy or power of speech, but they deliver 90% of the clarity. I mean, how was that for unfair? Right? Consonants are critical for the clarity of speech, but they're very, very weak sounds. The voiceless th, "thhh", is the softest sound in English. "Ah", "Th", "Aah", loudest. "Th", softest. So, when one speaks loudly, what we're really emphasizing are vowels. So, if we say, "Just talk louder. Just speak up," well, really we're making vowels louder, which can ironically override, we call it upward spread of masking. It's a very delicate, fickle, weak consonant sounds. So, just speaking loudly isn't the answer. We have to make sure we emphasize and add energy through the technology to the consonant sounds because your child needs to hear all speech sounds clearly. Now, speech is made up of more than vowels and consonants, right? Speech also has a melody, a flow, and an energy. Oh, I don't know if you are listening, but there's a big storm going on outside my home. And so, if you can hear lightning... Oh, you can't really hear lightning, can you? But you can hear thunder. So, just note that - listen in and you'll hear that there's a storm. But now that you've heard it, you can forget about it because we're talking about the melody, flow, and energy. That's also called suprasegmentals. Because your child's brain analyzes the meaning of conversational speech by its melody. The suprasegmentals, in addition to speech sounds. Every language has its own melody that goes up and down. And changes in melody and flow can signal whether the utterance is a question, a statement, and can give clues about the speaker's emotional state, right? Is the person sad? Are they happy? Are they excited? Are they angry? That's all of that information. That's carried in the melody, flow, and energy, which is low-frequency information. So important for all of us to hear that information. For meaning, we need to be very aware of this melody, energy, and flow, and what that means for the intent of the speakers message. Emphasizing melody and flow with very young children is the normal way that we talk with young children. And probably one of the most important cues that babies use to know they're being spoken to. We call it infant-directed speech or child-directed speech. And we speak to children this way. That's how they know we're speaking to them. It's almost a sing-song voice. So, for example, we might say, "Susie, do you want

more juice? Oh, more juice for you? You're thirsty." We don't say, "Hey, Susie, want more juice? Thirsty? Here it is." No, we don't talk that way to children, right? So, we practically sing and wow, the brain loves that. Now, the melody, flow, and energy of spoken communication can be broken down into what we call the critical elements of loudness, pitch, and duration. These are the specific features of the suprasegmentals. The segmentals are the actual speech sounds. Those are the segmentals. Supra is above. Suprasegmentals is the overall pattern and flow and energy and intent of the message. Such critical information. Low frequencies. Loudness. Very important. Difference in loudness of the speaker's voice can help the listener identify the speaker and their mood. As I said before, are you sad? Are you happy? For example, a loud voice might be angry. A soft and quiet voice can be soothing and expressing affection. "Oh, you're mommy's baby. Mommy loves her baby. Ah, ah-ah, baby." That's all your suprasegmentals. The loudness part. The difference in loudness also emphasizes what words are important in a sentence. So, for example, if I say to you, "I drove to the store," what did I emphasize? The word I. What if I said, instead, "I drove to the store." I emphasized, made louder how I got there. I drove to the store. Where did I go? The store. So, it's very important for our children to be able to hear these low-frequency loudness cues, and to learn the meaning of these cues and how these cues alter the intent or emphasize the intent of the talker's message. The pitch of the speaker's voice varies with their age and it's a very important characteristic of a person's speech. Now, men's voices tend to be lowest in pitch. They can go down to 85 Hertz. The average of Hertz or pitch, the average pitch is maybe 118, 120 of a male voice that's average. A female voice is around 230 Hertz, 250 Hertz, 300. And a child's voice is three, four, or 500 Hertz. Obviously, you can hear the difference, and so can children. Most children with hearing loss can easily learn to discriminate pitch differences among male, female, and child voices. And when we speak with our children, we call their attention to that. We might say, "Oh, there's daddy's voice. He has a low voice. Listen to daddy, low voice. Here's mommy. Here's a 'Goldilocks.' Here's mommy with her lovely, sweet middle-average voice. And then we have baby bear. He has a high little voice. You have a high voice." So, we can really help hold the child's attention through the various pitch distinctions of the people in their family and in their world. What about duration? Durational differences are usually one of the first cues that children with hearing loss can learn to listen to and produce. I mean, for example, how often do we say to a child, "Mmmm, so good. That cookie is so good. Mmmm." And we make that loud sound. Well, it can't be loud, but long sound. This long sound. And it won't take too much time before your child is also making the same mmm long sound. And what about short sounds? Hop, hop, hop, the bunny goes hop, hop, hop. And it won't be long before your child can aa, aa, aa. So, durational differences are very important again, for meaning. I mean, think about individual speech sounds that can also be long or short. For example, at the end of the syllable wa, if we put a k there, it's walk. Very short. If we put a sh, it's wash for a longer sound. Walk, walk, washhh. Walk, washhh. You can certainly hear the difference in duration and music. The key issue in beat, the beat, the beat, beat, beat is duration. So, what about the overlap? All low and high-frequency elements of the speech signal, including melody and clarity, they all have to be made available to your child's brain. And they need to blend together. The melody and clarity overlap. And we depicted this as this bubble in the center of the speech banana, which is to display how melody and clarity interact. Both need to be present, to understand the meaning of the message. Now, the fact of the matter is all of these segments, speech sounds,

suprasegmentals, loudness, pitch duration, vowel sounds, everything blends together in the child's brain to give the specific meaning of the message to create the knowledge base in your child's brain. So, we have melody for meaning. We have vowels that carry 90% of the energy of speech, but 10% of the clarity. We have consonants. Weak sounds that carry 90% of the clarity but only 10% of the power. And then these all have to link together for the composite message. We have to make sure all of this is available to your child. So, now let's talk about the level of the doorway problem. The severity or degree of hearing loss and its impact on spoken language. How big is the doorway problem? So, now we have our entire familiar sounds audiogram showing the string bean, vowels, consonants, melody. And we have different environmental sounds displayed, is their average loudness and average pitch. We know that some dogs do "Yip, Yip, Yip, Yip, Yip," might be up here. And others are "Woof, woof, woof," right? So, this is average. And then we have, "pi, pi, pi," a little finch. But we also know that some birds are so raucous. I was at my daughter's house the other day. And there were these raucous birds. And she finally said, "Can we close the doors and windows? I can't even think with those birds." So, obviously, some birds aren't sweet little tweeters, but when people think of birds, they typically think of very soft high-pitch sounds. So, we found a little finch that actually probably sounds like that. Now, notice we have the circles for the right ear and the X's for the left ear. And these are the softest sounds that a person can hear. And this is what someone, an audiogram with someone who has normal hearing sensitivity would hear. Everything below the thresholds is audible. Above is not. But we're right at the top. So, someone with a typical doorway, with an open organic doorway can send all of the different pitches, all of the speech sounds, all of the environmental sounds to the child's brain. And through exposure and practice and language, the child learns the meaning of the information that is sent to the brain. Now, here's what a minimal borderline or slight hearing loss might look like. So, this person will have a hard time distinguishing distant or soft speech. Notice we have already we're missing some of these critical high-frequency consonant sounds. Now, what happens is the person might not respond appropriately to subtle conversational cues. Might be difficult to keep up with rapid-paced interchanges, or overhear social conversations. We need to realize that having a doorway problem interferes not only with academic or knowledge of the world, but also social encounters. Hearing people speak in a social way. Having friendship conversations. All of that has to get through that doorway. The subtle phonetic markers for grammar, for plurality, possessive, regular past tense, what happens with these in minimal hearing loss is, is over time, the child misses stuff. It's a cumulative lack of knowledge. Now, here we are to a mild hearing loss. Notice how while the thresholds are still in the speech banana, we're right at threshold. We're missing almost all of these critical voiceless consonant sounds. So, a child who experiences a 30 dB hearing loss can miss 25 to 40% of the speech around them. That's because soft speech, word endings, and unstressed words won't get to the brain. Different factors like environmental noise level, distance from the talker, and the pattern of the hearing loss will also determine how much your child will be able to hear. Now we're at the moderate hearing loss. See, moderate even sounds like it's not such a big deal. But look at this. We're at the very end of the speech banana, missing virtually all sounds. A child with a moderate unmanaged, unmanaged means no hearing aids, unmanaged hearing loss may understand face-to-face conversations from three to five feet away if it's very quiet. If you're close, if you're using a nice full voice, and if they already know the words. Which means that often,

parents may overestimate how much information is actually getting to their child's brain. When we say overestimate what their child can hear, what we mean is overestimate what's actually getting to their brain. What new information is getting there. For a child with a 40 to 50 dB unmanaged hearing loss, they miss 50 to 80% of conversational information. Then moderately severe. 100% of classroom information will be missed, if not amplified. Spoken communication must be very close and very loud, to be minimally understood. Social interactions, frustrating, if not impossible. Look at severe hearing loss. Spoken language will not develop well or at all without early use of technology and enrichment. Now, see, what only sounds below under the threshold will be available to get through this doorway. All of this information is unavailable without technology. And then profound. The brain of a baby with a profound hearing loss can't receive any speech or environmental sounds without amplification, that's typically a cochlear implant in this day and age. Now, in this day and age, degree of hearing loss doesn't determine functional outcomes when there's early use of technology like cochlear implants, in addition to family-focused LSL intervention. Remember, our job is to build a brain here. Now, I wanna go back to give you another look at what these thresholds look like. Now, these are average. Your child's audiogram might not look like this. This is showing both ears about the same. So, this is what profound thresholds might look like. This is severe. Notice how with lesser degrees of hearing loss, more information is available. This is moderately-severe. Moderate, mild, minimal, and a completely open doorway. Open doorway, minimal, mild. Again, notice how we're decreasing and missing more speech and environmental information. Moderate hearing loss, moderately-severe, severe, profound. Oh, and later after, please maybe click on the "The Flintstones" little video. It really gives an idea of what these different degrees of hearing loss might sound like. The severity of your child's hearing loss might also be described as stable, meaning it's the same over time. But here's what everyone needs to know. Studies have shown that about 50% of the time, hearing losses do get worse. That is, the doorway closes more. But don't worry. We've got a solution for that. We have technologies on a continuum. And next month, we'll talk about our continuum of technologies. Because the technology we use depends on what is going on in the doorway, right? So, if your child's hearing loss is progressive, which is likely, 50% probability, our job in the audiology world is to keep up with measuring that doorway, making sure that technology is the best technology to breach the doorway, to change programming on the technology or change technology. Because the only goal of technology is to get auditory information from the environment into your child's brain. And a fluctuating hearing loss means one that varies over time. Now, pattern of your child's hearing loss. That when we connect the threshold, a pattern is revealed. And this pattern is formed when thresholds are plotted and connected on the audiogram called the profile. And patterns are related to the speech sounds that are accessible to your child's brain. I'm gonna show you some configurations. We can talk about them as bilateral, meaning the hearing loss is present in both ears. We have a bilateral hearing loss. There's a blockage, doorway block in both ears. Or unilateral, one ear has a normal doorway and the other ear has at least a mild hearing loss. The hearing loss can be symmetrical, meaning the degree of hearing loss and the configuration is about the same in both ears. Or can be asymmetrical, meaning the degree of hearing and the configuration, there's a hearing loss in both ears, but it looks different in each ear. And that also is quite common. So, the pattern formed is called the configuration. Now, this pattern, which is quite common is called a sloping hearing loss. Now, in a

sloping hearing loss, there's a better hearing in the low frequencies. And then as the frequencies or pitches get higher, the hearing loss gets worse. So, this hearing loss is sloping, we might even say dropping from a mild to moderate hearing loss, to a severe to profound high-frequency hearing loss. So, this child might hear some melody and flow and loudness of speech in some vowels, but this child is gonna miss all of the consonants, which is 90% of the clarity of speech. This configuration is called a cookie-bite. And what this means is there's a better hearing in the low frequencies and in the high frequencies. But the worst hearing is in the mid-frequencies. And this cookie-bite can be just what we call a shallow cookie-bite. It can be a very deep cookie bite. So, that can really dip down in the mids and then come back up, right? So, again, you can see everything above the threshold is not audible, but below is. So, this hearing loss can really fool people, as it can seem like this child hears a lot and they don't. They don't hear these critical consonant sounds. And a corner audiogram is a profound hearing loss. With hearing available, this doorway is pretty well closed. Only low frequencies are available to this child's brain. Now, what about that Ling Six Sound Test that we talk about? Well, Ling is named after Dr. Daniel Ling, who is a key leader in the LSL listening and spoken language approach that we know today. Now, this test allows a quick and easy way to verify that your child detects the vowel and consonant sounds of spoken language. And these sounds were selected because they cover the entire speech range on an audiogram. So, what are the sounds? There's mm, M as in me, which corresponds to the nasal, which call it the nasal murmur. 'Cause listen, mm, mm, and mm, it's a murmur. And it occurs around 300 Hertz. But it's a spread of energy. So, it's like a narrow band of noise between 250 and 500 Hertz. Then there's aa, as in hot, which is a narrow band of noise at around 1000 Hertz. And oo, as in booth, oo, is right around 500 Hertz. Also quite a loud vowel sound. Now, ee is interesting because ee has a low-frequency component. But in order to distinguish ee from oo, oo ee, oo ee, you really need to detect a band energy at 2000 Hertz. And then sh, as in shoe is a band of energy at 2000, 3000 Hertz and up. And ss is a band of energy for 4,000 Hertz on. Mm, oo, aa, ee, sh, ss. And next month when I talk about technology and troubleshooting technology, we'll talk more about how do you deliver and administer this Ling six sound test. But you can see how critical it is to be able to detect all of these six sounds. What about the speech string bean? We can thank Dr. Jane Madell for the coming up with this whole idea. Now, because here's the thing. The goal is to make sure your child's hearing aids are programmed so they're aided thresholds fall near the top, or just above the speech banana on the audiogram. So, we want their threshold aided to be between 15 and 20 dB. Cochlear implant thresholds usually fall between 20 and 25 dB. This means that all speech sounds and even soft speech can be available to your child's brain. The target area on the audiogram for these aided responses is this green area. See this green area. Since we had a speech banana, we're calling this, Jane called it the speech string bean. This is your target area because you want your child's brain to be receiving all of these speech sounds and all of the melody and flow. Now, as wonderful as our current technologies are, they are not perfect replicas of the organic doorway. They provide amazing brain access. But we also need to wear the technology, more next month. And we really need to work with an LSL specialist because the brain needs more practice, more guided listening. The family needs to be more intentional doing the things they would typically do anyway for their child to enrich their child's brain with knowledge. So, what about singing and music? Wow. Singing music is a critical, critical part of helping your child with hearing loss, learn to listen and talk. By

music, we mean singing with your child, having a musical conversation. The frequencies of music are well within the range of most children who have hearing loss, especially when they wear their technology. Because even though speech is high-frequency dominant, those consonants that carry 90% of the meaning, music is low-frequency dominant, right? 250 Hertz on the audiogram is about middle C on the piano. And pitch intensity, duration, and rhythmic cues are all boosted in the singing voice. You see, the beat of music, the rhythm is the basis of literacy. I mean, what's literacy? Rhythm, rhyme, and repetition, rhythm, rhyme, and repetition. Singing, the beat, low frequencies, melody, flow. Singing, the brain loves that. And also when we sing, we typically slow down the words of the music and they become more audible, right? So, for example, we're singing, ♪ Row, row, row your boat ♪ ♪ Gently down the stream ♪ We don't go, row, row, row your boat, gently down the stream. We're going slower. We have a nice beat. We have a rhythm. And we're blending the low and the high-frequency components. And the low frequencies stimulate mostly, they are, I should say the rhythm, the frequencies, the melody stimulates mostly the right hemisphere of the brain. And the words, the meaning stimulate mostly the left hemisphere. And these two components, as we see, in our familiar sounds audiogram, crossover called interhemispheric transfer. So, singing every day with your child is an amazing way to get all components of sound to your child's brain in a way that the brain loves and that your child can appreciate. And that we can grow all of these elements of speech. The suprasegmentals as the basis for reading and the segmental parts, the speech sounds, the meaning of the actual words we're saying. And all of those come together in that brain for knowledge. Sing, sing, sing. Make up songs. Sing through your day. ♪ Now it's time to go to sleep ♪ ♪ Go to sleep, go to sleep ♪ Yeah, see, you don't even need to actually know how to sing, right? The child won't notice. Well, they actually will notice. When they're about five or six, they'll start noticing what you sound like. But until then, they won't. And by then, we'll be singing on tune. So, singing with your child, as I said, represents the perfect blend. The rhythm emphasizes low frequencies of loudness and pitch and duration. And then the lyrics emphasize the high-frequency sounds. And look at this overlap. The brain puts it all together. So, why is it so important for my child's brain to have such access to speech and language? Your child's brain develops by interacting with you, your family, other caregivers, social interactions, loving interactions, as well as learning new words, knowledge of the world. All of that information needs to get through the doorway into the brain. The hearing loss is a doorway problem. Technologies are a door, brain access devices designed to breach the doorway. When you talk, read and sing with your child during play and during daily routines, their brain seeks very important patterns of melody, flow, energy for developing spoken language. Their brain needs to have full access to all of the vowels, all of the consonants of speech, so they can hear conversations with clarity. When your child wears their hearing technology at least 10 hours a day or 80% of their waking hours. See, as wonderful as our current technologies are, they're not engineered for a 24-hour wear. People with typical organic doorways, they don't have earlids. Like close your earlids. Can't do it. No earlids. Eyelids, yes. Earlids, no. So, a child with a typical organic auditory doorway, their brain is available for auditory information 24/7. But when you have a doorway problem, the brain is available only when the doorway device is worn. And they're not designed, these devices, for 24-hour wear. So, if the child, for example, is only wearing their device for four hours a day, it will take their brain six years to receive the auditory exposure that a child

with an intact doorway would have received in one year. So, see, we have to identify, pediatric audiologists test the hearing, identify what's going on in the doorway? What kind of blockage do we have? What information is that child's brain receiving? What vowels? What consonants? What suprasegmentals? Are they wearing the device? Right? So, going back and looking at this familiar sounds audiogram, this audiogram is designed when we plot your child's thresholds, unaided and aided, to give you a very clear idea of what auditory information, vowels, consonants, melody, is available through this doorway to your child's brain. What environmental sounds are available? And which speech sounds? This familiar sounds audiogram can be a very valuable tool for us. So, thank you so much for listening. And right now, please jot down for yourself, if you want to, or maybe in the questions and answers, what's your plan for explaining what your child can hear to others? What would you like to do? As you're thinking about that, I'd like to introduce Dr. Terry Zwolan, who is Director of Audiology at Hearing First. And she is going to address your questions and answers as time allows. Terry.

- [Terry] Thank you, Dr. Flexer. That was just amazing. You have such a great way of simplifying all this complex information for all of us. So, thank you for that. Yes, I'm the newest member of Hearing First. And I'm so excited to be here today and be part of your webinar. And I get to address some of the questions that we've had today. So, it looks like I'll begin with it. A few participants have inquired about information from the webinar. And we'd like to point you to the Hearing First website, where you can download a copy of the "Familiar Sounds Audiogram" eBook. And this eBook was created specifically for this webinar, with all this great information. And we encourage you to download it and share it with your hearing professionals, so you can review your child's hearing test results with them together. A link for downloading the eBook is available in the chat. And additionally, a recording of today's webinar is available. So, you can go back and re-listen to some of this amazing information or send some family members or other people to the recording so that they can learn more and better understand your child's hearing loss. So, Carol, we're not letting you off the hook. We do have a few questions for you. A few parents asked specific questions about the audiogram. So, one parent said, sometimes we leave the audiology testing and there are only a few marks on the audiogram. And then similarly, another parent asked, "How many sounds should we expect to see on the audiogram? How much should be accomplished during the testing? Does this vary for children at different ages? And will we see more marks on the audiogram as my child gets older?"

- Wow, excellent questions. Excellent. Because the parents are absolutely right. For a very young child in a given setting, the child's attention might not allow us to get thresholds for both ears at every frequency. So, but on the other hand, it's very important to have a complete profile of all of the thresholds. So, it's often important to bring the child back. And some, it might take multiple appointments. Maybe scheduling, giving a child a break and bringing them back the same day. If the parent travels, maybe it's coming back the next week or in a few days. But it's very important for us to have those thresholds at all frequencies, because that allows us to be able to set the doorway devices, the technology appropriately, and to be able to track if that doorway is changing. So, it is not uncommon to obtain only a few of the thresholds that are for the session. What that means is

we need to see that child again and again and again frequently until we get a complete audiogram because we must have that whole profile.

- [Terry] Perfect. And then another great question that goes right along with that, is one parent asked, "Is there something that I can do to make my child be more successful in the audiology appointments?"

- Oh, another great question. Well, working with your, if you have a listening and spoken language specialist, they can help you. They help teach your child the various tasks that they will need to do for listening. There may be, for example, play audiometry listen and draw where your child can learn to listen to a sound, say the Ling sounds Oo, and then drop a block in a bucket. So, yes, there is definitely things you can do in terms of teaching your child to listen. And even if your child is not old enough to do the listen and drop task, having listening activities where, "Listen, I hear it, listen, I hear it," where your child is taught how to pay attention to sound, how to listen, and to look for the sound. That's very important. They can look for the sound, even if they're six or seven months or even younger of age, would definitely need to teach that. The other thing is to arrive at the appointment with your child being rested. Maybe bring snacks, so your child isn't hungry. That their diaper is changed. And you will, as the parent, you will be in the test room with your child and your child will be in a chair where they are supported physically. So, they're comfortable and feel safe and they know you're there with them. So, if they're rested and fed and dry and feeling safe and they've had practice, listen, listening, and maybe learning the task, that can be very, very important. Because getting that audiogram is critical to getting the appropriate programming and the technology and to monitoring your child's doorway issue.

- [Terry] Fabulous. That's so helpful. So, I'm gonna send it back to you, Carol. That's all the time that we have for the questions today, I would like to reference our families to the Family community, where there's always, always additional information. Back to you.

- Oh, and thank you. Thanks everyone for being here. Wonderful spending this hour with you. Please refer to the eBook and please join us for our upcoming Family Learning Series. We're gonna talk about technology, which is next month. October is remote microphones and November is "Talk, Read, Sing: Grow Your Child's Brain." All of these sessions will be taped, following their presentation. We love having you here. Please join us again. Thank you. Have a wonderful day.

- [Karen] Thanks so much, Dr. Flexer. And thank you all for being with us during this live session. Our session was recorded. The recording link will be made available as well as the transcripts. And if you'd advance ahead to the last slide, I just wanna remind folks that our family opportunities at Hearing First are available on our Facebook group and our support community. Please take a look at our website for more information. Thanks so much. We'll see you next month.