Frequency Lowering Fitting and Verification

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- - [David] Hello, and welcome to this Audioscan webinar, entitled Frequency Lowering and Fitting Verification. I am your presenter, David Smriga, Senior Audiology Consultant for Audioscan, and it is my pleasure to share with you the latest research on frequency lowering clinical procedures and the operational capabilities of Audioscan equipment designed to implement those procedures. The learning outcomes for this course are as follows. Listeners will be able to describe clearly the different methods manufacturers use to create a frequency lowering result, identify when frequency lowering should be employed to enhance patient understanding of speech, and explain how to implement a step by step fitting procedure that programs frequency lowering for maximum patient benefit. For today's program, we'll begin with an overview of the concept of frequency lowering and when to employ it as a treatment strategy. Then we'll review the various approaches hearing instrument manufacturers have created to deliver a frequency lowering result. Next, we'll define the goals and procedures that a clinician will want to follow when fitting and verifying frequency lowering technologies, and we'll end with a discussion of the speech intelligibility index score as it relates to hearing instruments where frequency lowering has been engaged. So let's begin by overviewing the concept of frequency lowering. Frequency lowering is the process of shifting a range of input frequencies into a different and lower range of output frequencies.

Fundamentally, this is actually a technique that distorts the input signal, but for some hearing losses, particular high frequency hearing losses, this induced distortion may actual prove to be useful. For some hearing losses, the high frequency region of the audiogram may prove to be unaidable directly, yet there may be some important speech cues that fall within that unaidable region. In such circumstances, it may prove to be beneficial to shift the input energy in this unaidable frequency range to reside in a lower range of output frequencies, frequencies that are aidable. In so doing, the important high frequency speech cues would then produce an audible output result for the patient. With practice, the patient can come to recognize these altered speech

cues as representative of the original high frequency phonemes that were produced. Here is an example of a Real Ear Aided Response, or REAR, obtained within Audioscan's Speechmap verification tool. This REAR was obtained in the presence of a 65 dB average speech input signal. Notice that in the area circled in green, the aided output remains below the threshold line shown in red. This is a clear indication that for this fitting, audibility has not been restored for these frequencies when 65 dB average speech is present. If audibility cannot be restored by adding additional gain within this frequency region, perhaps because of the bandwidth of the hearing aid being used or the gain sealing of that hearing aid, or if audibility cannot be restored by selecting a different hearing aid, then this might be a situation where frequency lowering could be employed in an attempt to make important speech cues present in this frequency range, audible in a lower frequency range, where aidability is possible. There are several approaches that hearing instrument manufacturers have utilized to execute their frequency lowering function.

The first approach we'll describe is frequency transposition. In this example here, you are looking at a green line that represents the aided output across frequency. The faded area to the right of the dotted line labeled Start Frequency represents that portion of this aided output that is inaudible. We'll label this portion as the unaidable region. In frequency transposition, the algorithm is designed to cut or copy a portion of this unaidable region and paste it within a lower frequency region that is aidable. We've labeled this region here as the Target Region. As you can see in this example, once frequency transposition has been employed, there are now two components of input energy now occupying this output frequency space. One component is the transposed input energy, and the other component is the input energy that was in the target region to begin with. How might this frequency transposition effect appear in an electroacoustic measurement? Well, let's start with an input condition example. In this slide, we see the unaided, long term average speech spectrum, or LTASS, for 65 dB calibrated speech input, in this case, the carrot passage. This represents the average

input energy of normal conversational speech across frequency. Several years ago, Audioscan created four altered versions of this LTASS to be used to verify frequency lowering technologies. In this example here, we show one of those altered input signals, labeled Speech 3,150. When you compare the LTASS of this Speech 3,150 input stimulus to the conventional LTASS of the carrot passage, you can see some very distinctive differences. All of the 1/3 octave bands above 1,000 hertz have been dramatically reduced in input amplitude, with the exception of one 1/3 octave band centered at 3,150 hertz. This creates a stimulus environment that delivers a very distinctive high frequency hump in the LTASS shape. This same effect can be produced with hump center frequencies at 4,000 hertz, 5,000 hertz, and 6,300 hertz. In this example, a Speech 5,000 input stimulus at 65 dB is delivered to a hearing aid without any frequency lowering activated. The input condition is represented in gold, and the aided output condition is represented in purple. Notice how the aided version of this distinctive input hump, centered at 5,000 hertz, is reproduced as a distinctive output hump also at 5,000 hertz.

Now when this same input condition is presented to a hearing aid with frequency transposition activated, the aided high frequency hump should appear at a lower frequency. This shift in the center frequency of the aided hump is evidence that frequency transposition has taken place. More recently, another input stimulus option has been added to the arsenal of frequency lowering input stimulant. It is a fabricated version of the S phoneme of a female talker. Now we're gonna talk a little more later about how this input stimulus and its companion SH stimulus were created and why they were created, but for now, this image is what the S input stimulus looks like at 65 dB presentation level. When you deliver the S stimulus to a hearing aid employing frequency transposition, you'll once again be able to expose a very distinctive shift of this input hump to a lower frequency region. Thus several stimuli are available for you to use to verify the presence of frequency transposition. Frequency transposition technology can be found in Widex products, identified as Audibility Extender, which

utilizes a cut and paste approach, and in Oticon products, identified as Speech Rescue, which utilizes a copy and paste approach. The second approach we will describe is frequency compression. In much the same fashion as amplitude compression, decreases applied gain as input level increases above the input level knee point. Frequency compression decreases the output frequency produced by the aid as the input frequency increases above the frequency knee point. Using the same image we used before to illustrate frequency transposition, here again is a representation of output amplitude across frequency, with the faded area representing the unaidable region for this patient. The frequency compression knee point, identified here as the cutoff frequency, defines where the compression effect begins. Input frequencies below this cutoff are processed linearly and frequencies above this cutoff are compressed. The magnitude of this compression is defined by the compression ratio deployed.

In Sound Recover Two, Phonak's latest version of their frequency compression technology, they have added an adaptive element to their frequency compression procedure. In this diagram, CT One, called the lower cutoff, represents the compression knee point that I described earlier. In Sound Recover Two, there is a second cutoff frequency, labeled here as CT Two, placed within the range of frequencies targeted for compression. Now all frequencies above CT Two, above eight kilohertz, are always compressed. However, for input frequencies between CT One and CT Two, frequency compression is adaptive. In other words, frequency compression won't be activated in this region unless there are relevant speech cues identified as present within this input bandwidth. Otherwise, this bandwidth will continue to be processed linearly. When a hearing instrument with frequency compression activated is testing utilizing the S stimulus, two things should be observable in the resulting output measurement. First, as was the case with frequency transposition, the center frequency of the S stimulus should be located at a lower frequency than the center frequency of the input signal. Second, the output bandwidth of this input hump should

look narrower, reflecting the fact that frequencies are being compressed into a narrower output bandwidth. As mentioned earlier, frequency compression can be found in Phonak products, and is identified as Sound Recover. Frequency compression can also be found in Sivanto Products, identified as FC, and it can be found in Unitron products as well. The third approach we'll describe is frequency translation. To explain this approach, let's start with this illustration. Imagine that this image is a representation of a hearing aid's bandwidth with that bandwidth divided into six hearing aid channels. The higher channel numbers indicate higher frequencies. Using this illustration, one could describe frequency transposition in this fashion. In this example, the four, five, and six bands have been transposed so that the input frequencies in band four reside in the same output band space as the input frequencies in band three. Similarly, using this same graphic, frequency compression could be depicted this way, with the knee point between the three and four bands and the compressed output bands depicted above the knee point. With this as the image reference, frequency translation can be depicted in this way. In this example, an S phoneme has been identified as part of the input content residing in band six. Having identified the presence of this phoneme, if frequency translation is activated, it will create a supplemental representation of this phoneme in a lower band.

In this case, the supplemental phoneme was placed in band three. The original S input content is not removed from the output. Rather, it is supplemented with a lower frequency representation of that phoneme. If no fault speech phoneme is detected in an upper band, no frequency translation is activated. When a hearing instrument with frequency translation activated is tested using the S stimulus, the resulting output image will reflect two humps. The lower frequency hump is the S representation created by the circuitry, but the original S sound is also still present, as evidenced by the second hump aligning with the S input signal, although somewhat truncated by the bandwidth of the hearing aid's design itself. Frequency translation can be found in Starkey products and is identified as Spectral IQ. Now that we've reviewed the various

ways frequency lowering can be delivered through hearing aid technology, let's take a look at the clinical protocol that can be used to fit and verify that frequency lowering has been properly adjusted for a given patient's hearing condition. Now I want to point out two goals of frequency lowering verification, and these are the goals that have built in to the clinical procedure that we'll be describing, a procedure that was developed by Western University in Ontario. There are two main goals of this frequency lowering clinical procedure. The first goal of the procedure is to define a methodology that you can use to objectively determine whether or not a given hearing loss or fitting condition should be augmented by activating frequency lowering, in other words, to determine whether a given patient is a candidate for frequency lowering to be used. The second goal is if you do choose to use frequency lowering, the clinical procedure is designed to both confirm that the settings of the frequency lowering procedure have been correctly adjusted to restore audibility for the missing target speech cues and also so that there is minimal impact on the original audible bandwidth. Now it's worth noting that this clinical procedure is also designed to achieve these goals regardless of the frequency lowering approach that's being used. Now since we're primarily interested in restoring the audibility of high frequency speech cues, it seems to make sense that we use test stimuli with appropriate high frequency content.

There are three approaches that have been used over the years to accomplish this. One approach is for the testing clinician to simply vocalize an S or an SH through their audiometer and use that as the test stimulus. Now this approach has an advantage of using stimuli that actually represents the critical phonemes important for frequency lowering audibly restore. It also pretty easy to produce. However, the disadvantage of this approach is that the spectrum and the level of this form of stimulus production are not calibrated. Thus their content can vary. It can vary from one test to the next. It can certainly vary from one clinician to the next, and as a result, this approach could confound test, retest reliability. Now another approach that you could utilize is the filtered carrot passage 1/3 active hump stimuli that I described earlier and originally

was available within the Audioscan Verifit Speech menu and still is. Now these have the advantage of being calibrated. They're stored in all of the test systems, which means that the same stimulus condition can be present from one test to the next and from one clinician to the next. The disadvantage of this approach is that the 1/3 octave bandwidth of the stimulus options are actually narrower than the frication bandwidth of a naturally produced S or SH sound. In addition, these stimuli generate peak energy that corresponds with the LTASS level, not necessarily the peak level of an isolated phoneme, and certainly peak energy would drive audibility as well. Thus these stimuli, if utilized, may underestimate the actual audibility that's being delivered via frequency lowering for the phonemes we're targeting to make audible, and therefore may lead one to program a higher amount of frequency lowering effect than is actually necessary.

A third approach is to create and store a calibrated S and SH phoneme. Using this approach would deliver a more representative bandwidth of these fricatives. This approach would capture peak energy levels, key components that contribute to the audibility of these fricatives, and these stimuli could be stored in the test system for solid test, retest reliability. To this end, Susan Scollie and her colleagues at Western University in Ontario have worked to create two calibrated stimulus options for use when fitting frequency lowering devices. They have also designed the clinical procedure we will shortly be describing. These researchers started their new input stimulus procedure by excising the S and SH fricatives contained within the international speech test signal or ISTS, one of the calibrated speech passage choices that are available with the stimulus menu inside of your Speechmap screen, and these calibrated speech passages would be used for Speechmap fitting purposes. Since this ISTS signal was built using multi-talkers that are female, these fricatives represent how they would produce by female speakers, which generally contains more higher frequencies. Now once any of residue from adjacent vowels were extracted from these excised fricatives, the result was then compared to other clinically produced fricative

stimuli. This led to a solid definition of the frequency range and the energy levels of interest for each of these phonemes. Once those representative definitions were obtained, white noise was then shaped to fabricate these bandwidth and energy level components. Here are these two input stimuli configurations. The pink curve is the S stimulus bandwidth and level, and the blue curve is the SH stimulus bandwidth and level, both representing the energy and spectrum relative to normal conversational speech. Note that each stimulus captures overall energy level, specifically peak energy, an important component in the overall audibility of these particular phonemes. Now let's take a look at the associated clinical procedure and how these stimuli are wrapped in too. The frequency lowering clinical procedure begins first by completing a conventional Speechmap verification fitting.

Now the frequency lowering feature that may be present in the hearing aid that's being fitted needs to be turned off. Then once the fitting is completed, you would then isolate the Real Ear Aided Response result that you obtained in the presence of 65 dB calibrated speech. In this graphic example that you see here, this kind of result, obtained in the presence of a 65 dB carrot passage, is what's represented. Next you'll want to determine if frequency lowering may be appropriate for this patient. To do this, you need to first turn off any noise reduction feature that the hearing instrument may have. The reason you need to do this is because the S signal may be interpreted by that noise reduction circuit as noise, and would thus potentially cause the device to start to reduce gain, so by turning the noise reduction feature off, we eliminate the risk that that gain reduction associated with noise reduction would be activated. Then you're going to need to open another test inside your Speechmap screen separate from the test that you've just completed, which includes the previous REAR for normal conversational speech. In this example here, that test is in test one, so we need to choose a test other than test one to activate this next step. Now here's a recording of what you'll want to do here. Note that the mouse is clicking on test three. Open up the stimulus menu. Select the S stimulus, and what you now see up on the screen is the

output result in the presence of that S signal. It's in this blue line that you see here. There's no need to select an input level with this S stimulus as it's preset to be presented at 65 dB SVO, so what we've produced is an aided S response on the Speechmap screen. Now what you'll want to do is to determine if this S stimulus, amplified using the settings that are currently programed into this hearing aid, produce an audible S result. This stimulus is audible if some portion of the aided S result lands above the threshold line. In this particular example, none of the aided S result lands above the threshold line.

Therefore, this phoneme is not audible with the hearing aid operating at its current settings. If the conventional methods of addressing this issue, for example, adding more gain to the existing hearing aid settings, or if that's not possible, switching to a different hearing aid, if those aren't options for you for this particular patient, then you may need to activate frequency lowering to move the S stimulus into an aidable frequency region. This takes us to the third step in the clinical procedure. If you're going to activate frequency lowering, then you must first identify the maximum audible output frequency range, or MAOF. The MAOF stands for maximum audible output frequency. The MAOF range is the range of frequencies that can be identified using as your starting point the previously required 65 dB REAR speech banana. The low frequency end of the MAOF is defined as the point in frequency where the RTASS, oops. There we go. Grab this. Try again here. I can't get that arrow to come down. Let me try again. There it is. Okay, so the low frequency end of the MAOF range is defined at the point of frequency where the REAR, which is the thick line in the middle of the green shaded area, first crosses back under threshold, so this point right here would be the low frequency end of the MAOF. The high frequency end of the MAOF range is defined at the point where the peak percentile line, that's this top line of the green shaded area, where that line first crosses back under threshold, so the high frequency end of the MAOF is identified right here, so the range of frequencies between these two points is the MAOF range. Now rather than you being required to identify all this on

your own, with Audioscan equipment, you can choose to activate an MAOF highlighter, which will calculate and graphically highlight the MAOF range right on the Speechmap audiogram. To do this, once again you must start a test with that S stimulus. Here's another video that shows this procedure, so here you see it. We're gonna go in and click on test three. We're gonna select the S stimulus, and right below, you see this MAOF highlighter. We're gonna select test one, which is the LTASS we want to use, and if you can see it here, there is a shading right in this area on the audiogram that has identified the MAOF right there, so it's automatically highlighted in blue here as the MAOF range that we need to identify, so by using the MAOF highlighter feature of Verifit software, you can get this image to have that highlight appear right where it needs to be. Now with the MAOF now highlighted, you can begin the process of fitting the frequency lowering feature appropriately for your patient's hearing loss condition.

As in the previous step, we start by activating an S stimulus presentation at its default 65 dB level. Here is a recording of this procedure, so we'll go in. Start test three. Activate the MAOF, and then while this is still advancing on the screen, you go into your fitting software and start to activate the frequency lowering feature, and you will adjust it until you get the hump of this S sound positioned so that the upper shoulder of that S lands inside of the MAOF range. Ideally, you'll want to get this downward side or upper shoulder of this aided S hump positioned as close to the high frequency end of the MAOF as possible. Achieving this fitting target will accomplish two things. First, it will move the S into the patient's aidable listening range. As you can see here, there is now S energy above threshold, which means that the S input sounds will now be audible to the patient. Second, this restoration of S audibility has been achieved with minimal interference with the original aided bandwidth, so we're not overwhelming this area of their aidable frequency region with this transposed energy. We're just getting enough of it in here so that it's audible, but minimizing the impact that this shift will have on the audibility of the other sounds that would naturally be landing in this particular frequency region. Once the frequency lowering feature has been adjusted in

this fashion to deliver this target audibility for the S stimulus, as an option, you may then want to activate another speech path test to determine the audibility of the SH stimulus. Here is a recording of this step, so we start the fourth test. Go into the stimulus menu, and select SH, and now we will see a gold Real Ear Aided Response image appear on the screen, which is the aided result in the presence of this SH input condition. There are a couple of things that you'll want to confirm when you get this result displayed up on your screen. First, you want to confirm that the SH sound also produces audible output. In other words, there's content that is above threshold. The next thing that you'll want to confirm is that the audibility signature of this SH stimulus is distinctively different than the audibility signature of the previously recorded S stimulus.

In other words, these two sounds should sound distinctively different to the listener. This verifies that the SH is both audible and not going to be confused with the S sound. Again, it's worth noting that this fitting procedure is appropriate to use regardless of the frequency lowering technology that you may be employing. At this point, you've completed the objective procedures for fitting and verifying the frequency lowering function of the hearing instrument. Now what you might want to consider as an additional step is to do your own listening checks. Subjective listening of the sounds that are being produced by the frequency lowering procedure can give you a better indication of the magnitude of change that this frequency lowering procedure has employed. Verifit systems offer you a monitoring headset that give you the opportunity to listen to the output of the hearing instrument or instruments that you're detecting or that you're testing. Now the monitoring headset with the Verifit Two allows you to listen to two hearing aids at the same time. You can set it up so that you're listening to the left hearing aid in the left headphone and the right hearing aid in the right headphone, so if you're programming these hearing instruments in a bilateral fashion, this bilateral monitoring headset gives you the opportunity to be able to listen to both hearing aids simultaneously, so you're checking to see just how much are

these sounds changed not because you're interested in determining the quality of those necessarily, but just getting an understanding of how these sounds have been changed by the frequency lowering procedure that you just employed. So now that the frequency lowering has been programmed, you should reactivate any noise reduction feature of the hearing instrument that you had turned off in order to complete this clinical procedure, especially if you intend to have noise reduction be a feature that you want to employ when the patient is actually using these hearing instruments. Now when you get to the point where you're doing the fitting and probably even through some of the follow up visits that may be involved, it's advisable to not only pay attention to the listener's opinions and comments about the hearing aid's performance and utility to get some idea of how ready they are and how easy or difficult it may be for them to adjust to these new sounds, but you can also include output outcome measures, including age, excuse me, age and speech discrimination tests that can help to verify that the patient is understanding and utilizing these altered high frequency stimuli in a meaningful way and that it's contributing to their understanding and discrimination of speech content.

Another thing that is important to acknowledge here is if there are other caregivers or therapists that may on occasion be in a situation where they might want to, for example, perform a listening check on the hearing aids, it's probably advisable for you to inform them that these hearing instruments are gonna sound different than more conventionally fit hearing instruments because that difference might be perceived by an uneducated listener as distortion, and so, excuse me. These other potential caregivers who might be listening to these hearing aids need to understand that the distortion that they may be hearing actually is intentionally present and is there for the purposes of trying to assist in making these high frequency speech cues more available for the patient giving their hearing loss condition. Now there's one other subject area in the frequency lowering area that we feel is worth talking about as well because clinicians have asked about how the speech intelligibility index score and its

calculation interfaces with measurements made when frequency lowering is engaged, so it's worth our while here to kind of review what the SII or speech intelligibility score is and how it ends up becoming utilized or incorporated into fittings where frequency lowering is involved. Now the speech intelligibility index or SII score is a way of quantifying the likely intelligibility of speech based on the audibility of various speech cues. Probably the simplest way for us to understand how the SII score is determined is to kind of reference back to the old count the dots method that Mead Killion and Gus Mueller provided for us and updated us about back in 2010. This image here shows a speech banana, an unaided speech banana, comprised of a series of dots, and this is an HL scaled graphic here, so any of the dots that are below the threshold line, which is just identified here as the thick line or the dotted line, it's kind of diagonally going across this display of dots. Any of the dots that are below the line would be counted as audible, and the number of dots in each bandwidth represents the importance of that bandwidth in terms of intelligibility, and any of the dots that are above the line are not counted because they're not audible, so clearly the more dots that are placed into the patient's aidable listening range, the higher the speech intelligibility index score is going to be.

Now within the Speechmap display screen, the unaided and aided SII scores appear as bars for each of the tests that you may be doing, so if you look down here, for test one, test two, test three, and test four, there are a series of bars here, one for the left hearing instrument and another set of bars for the right hearing instrument, that represent the unaided, which is in gray for the input level that's being tested, and then the aided SII result as well. So in this example of test two, where the input level is 65 dB and the unaided SII is 28, the aided SII, which is represented here, or the aided speech banana, which is represented here by this pink shaded area and all of the dots that are above threshold here being counted, turns out to be an SII score of 73, and so you can very quickly and easily visualize and quantify the SII score in the aided condition when you're doing a Speechmap test that utilizes the calibrated speech input

stimulus designed for completing this test. Now when you change your input stimulus from speech standard one, the carrot passage, or speech standard two, or the ISTS signal, to an S or an SH sound, or even if you change your input stimulus to one of the four speech bananas that have been modified specifically for frequency lowering testing, that's Speech 3,150, Speech 4,000, Speech 5,000, those stimuli that I showed you before, whenever you choose any of those or an S or an SH, the bars on that test result screen will show N/A, which is telling us that there is no calculation of an SII when those stimulus are used.

So as you can see in this depiction of the Speechmap test menu screen, when an S or an SH stimulus is selected, no associated SII calculation is displayed. Now the main reason for this is because these stimuli do not produce an aided broadband speech result, which is what the SII calculation is designed to quantify. They don't produce that broad, pink shaded area that you saw on the previous slide. They produced some segment of it, but not the entire thing, and so SII's not calculated here because it's not the kind of stimulus that the SII was designed to calculate. Now these are isolated phonemes of speech, and then they additionally have been altered by the frequency lowering process that we engage to move them into an aidable area, so for those two reasons, the SII number is simply not displayed when these, other than broadband speech stimuli, are utilized or selected. Now one attempt to quantify the impact of frequency lowering and what frequency lowering may have on the SII has been pursued by the researchers at the Boys Town National Research Hospital. Led by Ryan McCreery, these researchers have developed the Situational Hearing Aid Response Profile, or SHARP, which is a tool that can be used to estimate likely SII for various listening conditions, in this case, that a child may encounter using hearing aid devices programmed in a certain way.

Now more recently, these researchers have added an SII predictor to this tool that estimates the improvement in SII that can be associated with the activation of

frequency compression. I'd like to show that to you here to give you an idea how it works. In this image here, you see a depiction of this SHARP display screen that I described before, and it's displaying the aided Speechmap result for a 65 dB speech passage. Now the portion of the aided speech banana that is audible is represented here by the blue shadedness of this aided result, and as you'll notice, there is a dot at each 1/3 octave that lands on the aided LTASS line that we see represented here. Each of these dots are assigned the value of all of the dots that are represented for that frequency range on that SII calculation screen that I showed you before, so if any of these dots are above threshold, then whatever amount of value that bandwidth plays in speech intelligibility is assigned to this fitting, so in this example here with these dots in the aided condition, there is an aided SII represented here as 77, okay? So with that said, if you look in this upper right corner here, you'll see that they've added another series of choices.

By the way, here are all of the input conditions that this SHARP tool is designed to simulate, so as you choose these different input conditions, this result can change because it's changing the estimated input condition that's present for these various different input environments, and the aided result would adjust accordingly, so you can see how the SII's impacted by these various conditions that the child may be in need of listening to, but up here you'll see a series of choices that are specific to frequency compression. There's a box here where you can turn frequency compression on, and then once it's turned on, you can identify the knee point and the compression ratio that's being used, so in this next slide here, the frequency compression tool has been turned on. The knee point is identified as 2,000 hertz, and the compression ratio is identified as 2.0. With those now being selected, what you can see represented in this result here is a squeeze of dots into the aidable range as a function of that frequency compression result, so now there are more dots inside of this aidable window than were present when frequency compression wasn't activated, and the result is a enhancement of the aided SII score from 77 to 90. Clinical comparisons between this

prediction of SII and the subsequent measurements of the aided SII score on individuals indicate that this tool is a reasonably valid predictor of the impact on SII this form of frequency lowering could provide. Now it's important to underscore that this tool is only valid for use with frequency compression technologies. Speechmap data that has been obtained with the Verifit system, once stored electronically, and there are various that you could do that, can be directly downloaded into this SHARP tool, so clinicians may find this to be a valuable tool, not only to provide clinicians with information regarding how a particular hearing aid fitting will yield speech intelligibility in various listening conditions, but this tool also gives us an opportunity for the first time to predict the impact that frequency compression in this case can have on improving or enhancing the SII score as a result.

So to summarize the information that was presented in this webinar, we have explained that frequency lowering is a hearing instrument performance feature that can be utilized to restore audibility for speech sounds that may fall outside of a patient's aidable frequency range. There are several technologies that have been developed by hearing instrument manufacturers to deliver a frequency lowering effect. These include frequency transposition, frequency compression, and frequency translation. The Audioscan's verification system can be used to objectively determine frequency lowering candidacy, to adjust frequency lowering settings, to restore audibility, for important speech cues with minimal interference with the existing aided bandwidth, to verify sound quality and distinctiveness, through the monitoring headsets, and to aid in counseling. If you're interested in exploring additional information about frequency lowering verification with Audioscan equipment, you're invited to visit the education section of the Audioscan website, which can be found at www.audioscan.com.

Also, you will find detailed operational information within the Verifit User's Manual, which is electronically embedded with the online help feature of Audioscan equipment. On behalf of all of us at Audioscan, I want to thank you for viewing this webinar. We

hope that the information it has provided will be useful to you in your ongoing efforts to effectively fit and utilize frequency lowering as a hearing loss treatment tool, and I'd like to encourage you to visit the education section of the Audioscan website as well as the Audioscan portal on Audiology Online for additional educational resources covering a variety of important verification topics. Until next time, I'm Dave Smriga, wishing you continued success in your hearing healthcare journey.