CROS/BiCROS Fitting and Verification

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-- [Dave] Hello everyone and welcome to this audio scan webinar entitled Real-Ear Verification of CROS and BiCROS Fittings. I'm your presenter Dave Smriga Senior audiology consultant for audio scan, and it's my pleasure to share with you a review of the current clinical procedures recommended for verifying the performance of CROS and BiCROS hearing aids. For today's presentation, we'll be using as our measurement device, the audio scan verified two which is a comprehensive real-ear and test box hearing instrument measurement system that boasts both binaural as well as broadBand measurement capabilities. Our learners outcomes are as follows we're going to explain how to use real-ear measurement to objectively measure head shadow effect on any patient. We're going to explain it To use real-ear measurements to objectively measure the effectiveness of a CROS or BiCROS instrument in overcoming those head shadow effects, and we're gonna describe a CROS/BiCROS system verification protocol, using either an insertion gauge template with pink noise as the input or a speech maps template using speech as the input. We'll begin today's presentation with a brief overview of the CROS and BiCROS hearing instrument design and treatment concept, followed by an overview of several methods for objectively verifying the aided performance of these systems.

Specifically, we will explore CROS verification strategies from two measurement templates. First, the insertion gain template approach, and then the speech map template approach. And we're gonna describe the advantages and disadvantages of these approaches. We'll then describe how these strategies can be altered if a BiCROS system is employed. So let's begin with an overview of the CROS and BiCROS concept. Nature has given us two of the various senses we use to secure an awareness of our external environment, two eyes, two ears, even two nostrils, binaural listening has its advantages. For example, when sounds originate from a location other than dead center, the time it takes for that sound to reach the nearer ear, as opposed to the farther ear, the arrival time difference or interaural time difference gives the brain important information. Add to this the difference in intensity level or the interaural level

difference that reaches each ear due to head shadow the brain now has a data set that can be used to determine sound source location. When listening with two ears, whose hearing sensitivity is essentially the same, this localization ability is fully optimized. For patients with single sided deafness or SSD, or one ear that is unaidable interaural latency cues are no longer available, severely impacting localization. In addition, as a unilateral listener, head shadow now becomes a disadvantage. When sounds originate on the unaidable ear side, the head shadow effect reduces the intensity level of these sounds reaching the better ear, the only listening ear. Minimally this means that the sounds may be more difficult to hear the intensity loss of head shadow may be as much as seven to eight dB and the lower frequencies and as much as 15 dB and the higher frequencies. Compensating for this loss of intensity by placing amplification in the better ear is not the answer. And the reason is because there are also sounds that come from the better ear side that are not attenuated by head shadow. So, if these sounds are also amplified the head shadow disadvantage remains unchanged. Head shadow and single sided deafness is particularly disabling when speech coming from the unaidable ear side must compete with noise coming from the better ear side. What this suggests is that head shadow must not just be compensated for, but rather its effects must be overcome.

And that's the purpose of a CROS hearing instrument. CROS stands for Contralateral Routing of Signal, a microphone is placed on the unaidable ear side. This signal picked up by that microphone is then routed electronically to the better ear side, where it can be heard without head shadow interference. It is this approach that overcomes the effects of head shadow. However, it must be acknowledged that the patient is still a single sided listener. So although the CROS system provides improved awareness of sounds originating nearer to the unaidable ear, localization still remains compromised, as the listener is unable to use binaural cues to compare arrival time and level differences between the two ears. CROS systems are used when normal hearing is present in the better ear. The better ear remains on occluded to receive sounds that

normally reach that ear. But through the CROS system sounds that normally reach the unaidable ear are heard as well in that better ear. This is a single microphone system. BiCROS systems are used when there is evidence of some hearing loss in the better ear that requires amplification. In addition to routing signals from the unaidable ear to that ear, those two microphones are used one to collect signals reaching the better ear and then send them to the hearing aid processor and the other to collect signals from the unaidable ear and send them to the same hearing aid processor on the better ear side. There are several types of CROS and bi CROS systems available. In addition to other approaches to addressing single sided deafness. The most common type of CROS and BiCROS systems available are air conduction systems. These can come in two forms, wired and wireless. Wired systems make the electrical connection between the microphone on the unaidable ear and the receiver on the better ear through a wire. This wire can either wrap around the back of the head as seen here, or can be embedded into the frame of a pair of eyeglasses.

Today, wired systems have been supplanted by wireless technology. In earlier analog hearing devices. This wireless transmission from one ear to the other was accomplished using near field magnetic induction. The electromagnetic signal was placed on AM carrier frequency to isolate it from stray magnetic field interference. In digital hearing aids, the wireless transmission is accomplished by utilizing the Bluetooth or other ear to ear communications infrastructure built into the paired hearing aid systems functionally common in digital hearing aids today. Thus CROS has now become a programming option with a paired system design rather than a unique and dedicated hearing aid design. Another approach to send auditory signals from an unaidable ear to a better ear is through transcranial bone conduction. A bone anchored hearing device placed on the mastoid of the unaidable ear will send bone conducted energy to the entire skull, thus this bone conducted signal can be heard by the cochlea on the better rear side, accomplishing much the same effect in overcoming head shadow as an air conduction CROS system would do. Another approach identified as

transcranial CROS is based on the notion that if you place an air conduction hearing aid on the unaidable ear side, and send enough amplified energy into that ear canal, you can cause the cartilage and surrounding bone to be stimulated, thus sending a bone conducted signal to the better ear cochlea. This approach has as its advantage the need to wear only one hearing aid rather than the two required for conventional air conduction CROS systems. It should be pointed out that cochlear implants can and indeed have been used to overcome listening issues, With is associated with single sided deafness as well. But to be clear, our focus for today's discussion regarding clinical verification of CROS and BiCROS systems will be on the clinical verification procedures that can be employed to verify the function of conventional air conduction CROS systems. As was pointed out earlier in today's care digital hearing aid environment. contralateral routing of signal is accomplished by using the same ear to ear pairing infrastructure used to execute any paired function feature. Thus CROS becomes a programming option in the fitting software of such paired instrument technologies. And these devices are pretty much ubiquitous across the various brands of digital hearing technologies available today.

So now that we have a common Understanding of CROS and BiCROS systems and when they may be employed. Let's get into the methods available for verifying their performance. Since the purpose of a CROS system is to overcome the effects of head shadow the verification process must be designed to effectively measure whether or not this purpose has been achieved. Fundamentally this is done by measuring in the better ear canal, the sounds coming from the transmitter side and comparing this measurement to the measurement of the better ears unoccluded response. Ideally, these two measurements should match thus verifying CROS system transparency. From a real-ear verification prospective there are several key considerations that must be attended to prior to conducting a CROS verification procedure. The first key consideration is probe tube placement. In all instances where either a CROS or a BiCROS hearing instrument fitting is being verified, the measurement probe tube

should always be placed in the better ear canal. The ear that is being tested if you will, is always the better ear. In this example, the left ear is the better ear and so, the left probe module of the Verifit two identified in this picture by the blue probe module lanyard should be used for all subsequent measurements. Another key consideration and hearing instrument coupling, is if the patient is being fit with a CROS instrument, the patient will need to wear a transmitter device on the unaidable ear and a receiver device on the better ear. In the case of a REIT, or a BTE style hearing instrument, these devices will need to be secured to the ear with some form of a concha or canal insert. It is important in CROS fittings that this coupling appliance does not occlude the better ear canal. So that sounds originating on the better ear or normal hearing side can travel to the eardrum unimpeded by the device and be heard naturally. Simply affixing this receiver unit to the ear with an open dome of an appliance does not necessarily guarantee that the ear canal is unoccluded. One way to know for sure to conduct a quick REUR, REOR in other words real or unaided response or real-ear unaided gain versus real-ear open response, or real air open gain. In this example, we're using the speech map screen to conduct this test.

The green result that you see here was obtained by completing a 65 dB speech map test with only the probe tube in the patient's better ear canal. The pink result that you see here was obtained using the same input condition. But with the addition of the receiver unit and its coupler now in or on that ear. The hearing instrument is off or muted at this point, just physically present on the ear. If the pink result looks like the green result, this is a clear indication that the physical presence of the receiver unit and its associated coupling component has done nothing to alter the acoustic properties present in that ear canal when nothing was in it other than the probe tube this test confirms the absence of any occlusion the condition needed in a correct CROS fitting. If differences between the green and pink results are measured, this would be an indication that a different form of coupling may be an order prior to completing your CROS verification procedure. Now final key consideration prior to conducting a CROS

verification is your probe microphone systems capabilities. Fundamentally, you need to use a probe microphone system that allows you to separate the reference mic that is being used to control the input signal from the probe mic that is being used in the measurement. Now in the case of the Verifit two, as well as the Verifit one max manufactured by audio scan, there are two probe assemblies available for testing. When selecting the CROS choice in the instrument pull-down menu associated with the test you are conducting the system will use the reference mic of the probe assembly located at the non test ear to control the input signal being used for the test being conducted. We'll show this feature in greater detail as we describe the verification procedure a bit further. Now, the first approach that we're going to describe in CROS verification is the insertion gain template approach. Unlike the speech map screen which displays output measurements, the insertion gain screen displays both output measurements and difference measurements. For example, if you measure the REUR an output measure with no amplification present, and an REAR an output measure with amplification present. The difference between these two output measures is the REIG or real-ear insertion gain. This difference curve is calculated and then displayed on an insertion gain screen.

So when you're verifying a CROS aid, we can use this feature to quantify a few things. We can use this feature to document the head shadow effect a CROS frequency on that patient's particular head. We can use this feature to confirm that when a CROS system is present, it overcomes this head shadow effect and we will use this ability of measuring these systems to see if we can match the open air response of the better when a sound is just being presented to the better ear. Now will typically utilize a comfortable listening level, which in the case of the insertion gains screen would probably be a setting of either 55 or 65 dB, and the stimulus is going to be a pink noise. And since it is a pink noise we need to make sure to disable any noise reduction features that may be present in the hearing instrument. before conducting the test, we don't want those capabilities to be changing the result we're looking for while we're

doing the test, so disabling noise reduction is advisable. Now to accept to, excuse me to access the insertion green screen you would want to open up the main test selections menu on your system, this is typically accomplished by simply executing a right mouse click. And then you'll select insertion gain on your menu that you see on the left side of this main test selection screen. To set up the screen for CROS testing, you'll need to do the following. First make sure that you're in single view. The presentation item here toggles between single view and dual view, select single view. Select the better ear or the ear in which the probe tube is being inserted as your test ear. Click on the audiometry bar, which will open up the audiometry poster that you see here in the upper middle of the screen. And then make sure that you you've selected "Measure" as your choice for the REUR is the pull down, you just click on it and select "Measure" as your choice. Now once you click the green check mark below that measure button, it will ask you to enter audiogram data. We don't need any audiogram data at this point. So just enter a threshold at some frequency, I usually enter zero at 250 hertz. And then finally, in the rules menu that you see here, you have to open it up and select, "None" as the rule. Here's a video showing you these steps in sequence.

So here we're in dual view, we're gonna go over and click on the dual View button to change the screen to a single view. Then we're going to use our main test selections menu select right or left ear as the tester, we've selected right, let me click on the audiometry button, which opens up the audiometry poster. And we make sure that the REUR is set to measure. When you click on the green check, it's going to ask you to enter a threshold data. Just enter zero and 250 for example, click the green check, it closes that out. And then go over to your rules menu and select from the rules list, "Not." To prepare the patient for testing, position both the right and left probe manuals on the patient's head. Insert the probe tube into the patient's better ear using the audio strand probe guide to correctly position the probe tube, then position the patient in front of the sound field speaker of your verified system, so that the better ear is the one

closest to that speaker. The patient should be positioned at either a 45 or 90 degree angle relative to that speaker. In this video, you'll see how the probe guide of the verified system is designed to work, you click on this button right here. which then allows you to select the ear you wish to test and as you insert the probe tube into the patient's ear, you'll see this little white ball moving down the ear canal. And when you get the tip of the probe tube to within five millimeters of the eardrum, a green check will appear. And then you'll also hear a ding, so that tells us You've now positioned the probe tube in the correct location. So you can use this pro guide to position the probe tube prior to conducting any CROS tests as well. The first step in the process of verifying across fitting using the insertion gain template is to measure the REUR. This is accomplished by first selecting BTE as the instrument choice in the instrument pull-down menu.

This activates the test ears, probe mic and reference microphones. You should replace the receiver unit on the patient's ear without activating it. This will also give you the opportunity if you want to check for it to check whether any occlusion exists with that receiver unit placed into the patient's ear. Now remember, the patient is seated with the better ear closest to the sound field speaker. With this arrangement click and the REUR or test in your insertion gains screen. Here is a video of this procedure. Here's our screen, we're clicking the REUR, we're getting a measurement in the presence of the pink noise and when it's stable you can go ahead and click on the green check to save it. Now what you see here is relatively flat line with a hump in the higher frequency areas. That's probably this patient's ear canal resonance characteristics. And this would not be an uncommon sort of measurement to obtain when you do this REUR measurement. You have the REUR measured the second step in the process is to measure head shadow. Select the CROS instrument choice in the instrument pull-down menu to activate the reference microphone on the unaidable side while maintaining the measurement microphone on the better ear side. Then rotate the patient 180 degrees so that the unaidable or poor ear is now the one closest to the

sound field speaker again at an orientation of 45 to 90 degrees. The transmitter of the CROS instrument is either not on the unable ear or on, but the CROS system is not activated or muted. Click and run REAR/REIG 1 with the same input level and signal that you used for the REUR, here's this procedure in action. We change it to the CROS setting in the instrument pull-down menu, we click on our REUR/RIG 1 and you get a second measurement. The green line that you see up above is the output measurement. And the green line that you see below is the difference measurement. So the difference between the Gold Line and the green line that you see above, is displayed as the green line that you see below. The green line that you see below is reference to the zero dotted line. If the two curves are identical, then the difference measure would be zero. Where the two curves are different, the difference measure deviates from that zero line. This is in fact your measurement across frequency of this patient's head shadow effect. Now that we've quantified the head shadow effect, the next step is to confirm if the CROS system can effectively overcome this effect.

To accomplish this, we must now activate the CROS system keeping the patient in the center same location relative to the sound field speaker that we used previously, the instrument choice remains CROS. The only difference between this test and the previous test is that the CROS system is now in play. Click and run ar Rear/ REIG 2 using the same input stimulus and level used in the two previous tests. Here's a demonstration of this procedure. We click on REIG 2 get a third curve up here. It's now displayed as the pink line. We have the pink line on top which is the output for this measurement. If you'll notice you also have a pink line on the bottom, which is the difference between the Gold Line and the pink line up here. So there's the difference measure down here. And if that difference measure hovers around the zero line. What it is telling you is that the presence of the CROS instrument has effectively overcome the head shadow effect that we measured previously. So the goal of this procedure is to determine whether or not this second REIG measurement that you've obtained looks like the REUR measurement you originally made. If these two curves the first test and

the third test overlap with this line hovers around zero, then you have effectively verified that the CROS system is doing what it's supposed to do, in other words overcoming the head shadow effect. The advantages of using the insertion game template to verify CROS fittings is that the insertion gains screen clearly displays both the head shadow effect a CROS frequency and the CROS systems effectiveness in overcoming this effect within the insertion gains section of the display screen by hovering around the zero line, also, by using pink noise as the input signal, this allows you to get a very quick snapshot of the test result, you don't have to wait long for the probe to stabilize and have a clear indication of the result that you're trying to obtain. The disadvantage is that because the stimulus is noise, precautions need to be taken to ensure that automatic features within the hearing aid that are intended to react in noise conditions have been disengaged prior to running the necessary verification test. So as a result, the verification process is being conducted in a context that may not be present during actual hearing aid use.

So, now that we've described the CROS verification approach from the insertion gain template perspective, let's take a look at how you can alternatively use the speech map verification template to do CROS verifications as well. Now speech map utilizes a calibrated speech energy as the input stimulus, and is designed to measure the unaided response for REUR and aided response REAR conditions. As such, this format can be used to both quantify head shadow effects aCROS frequency as well as to confirm a CROS systems ability to overcome these effects by matching that response to the better ear REUR. as with the insertion gain template. This speech map test approach used for CROS validation is also conducted at a fairly comfortable level, in this case a level of 65 dB input. Because calibrated speech is the input stimulus there's no need to disengage noise reduction features within the hearing aid. In fact, the hearing aid both can and should be configured in the fashion it ultimately is intended to be used. Finally, as mentioned earlier speech map results are displayed as realer aided response or output results. To access the speech map screen, you would once again

go to the main test selections menu screen, right mouse click and click on the purple on-ear button left of the word speech map in your test menu. This will open up the speech map screen, as was the case with the insertion gains screen. some preliminary setup configuration is required. First it is necessary to change your screen from dual view to single view. Next, select the test ear which is the ear that you have the probe to been or the better ear. Click on the audiometry button and select, "None" as the target rule. Then you'll be prompted again to enter audiogram information. And you would simply enter one thresholds worth of data is in our example, entering zero dB at 250 hertz to proceed to the test. Here is a video of this setup procedure. Here we are in dual view, we're going to change it to single view by clicking on the dual view toggle button. Then we're gonna go up and select as our test here, the right ear, and we'll click on the audiometry button. Make sure that our target choice is none. Click on the green check and enter a single threshold at 250 hertz zero here.

Click the green check and you're ready to proceed. Patient positioning prior to testing is the same as was described in the insertion gain template approach. Specifically, you'll place both probe modules on the patient's head and insert the probe tube into the better ear side of the patient. The patient is oriented relative to the sound field speaker so that the better ear is facing the speaker at a 45 to 90 degree angle. Select BTE from the instrument menu to activate the probe and reference microphone of the probe module. You can place the inactive or muted receiver unit of the CROS instruct on the better ear side, and check for occlusion. Once you've confirmed that the receiver unit and its coupling or not including the ear canal, you can then click and run test one using a calibrated Speech Input like speech standard F and a presentation level of 65 dB. Here's a video of this procedure. We're going in and selecting BTE in the instrument menu clicking the play button for test one. And then once the measurement starts, click the Record button to secure the long term average. So what you're seeing here is the speech banana being measured by the probe tube in the better ear, and this is the real-ear unaided response to that better ear side. The solid

line in the middle is the long term average speed spectrum and we'll use that line as our reference point for doing these tests. Now that we have measured the REUR, the next step in the process is to measure head shadow. To do this, change your instrument choice from BTE to CROS, rotate the patient 180 degrees so that the poor ear is now the one closest to the sound field speaker. Again at this 45 to 90 degree angle. Make sure that the CROS instrument is not on, it's muted and run test two using the same input stimulus type speech standard F, and level speech standard one. Here is this procedure, we changed our instrument choice from BTE to CROS. We've rotated the patient to 180 degrees so that their poor is now the one closest to the speaker. And we click the play button for test two, and the record button to get our long term average. The averaging process takes about 12 seconds to complete. There, now what's important to note here is the difference between the green line which is the long term average speed spectrum for test one our REUR, and the purple line, which is the measurement we've done with the patient 180 degrees in the opposite direction.

The difference that you see here is head shadow. So even though we don't have a difference curve displayed as we did in the insertion gain screen, we can still clearly identify the head shadow effect by looking for and identifying the difference between the green line and the thick purple line that you see here. The final step in is to measure the CROS instruments ability to overcome this head shadow effect. The patient remains in the same location relative to the sound field speaker. But now the CROS instrument has been activated and we run the test in test three with the CROS system now in play. Here's a video of this. So now we're gonna click on the test three play button. And we're going to record that result. Now remember the difference between test two, and test three is the presence of the CROS instrument, the CROS instrument is now active. And rather than trying to make interpretations with a fairly busy screen, as you see here, we can use our hide show tools to just say show the LTAs of test one and test three on the screen. And as you can see here, those two measurements look pretty much identical which is verification that the system is doing what it is intended

to do to overcome the head shadow effect. So clearly the advantages of verifying CROS functions with speech map is that speech map is the stimulus speech is the stimulus is being used for verification. Thus, all of the hearing aids, dynamic gain functions are being dynamically engaged as they would be in the real world. There is no need to turn off any of the interactive features programmed into the hearing instrument for the patient's use, including any noise, sensitive interactive features they can be on during this test when speech is the input stimulus that's being used. Now unlike REIG approach, the speech map display just shows our EAR or output data, not difference data. However if the results the test results of test one and test three are essentially the same, this indicates effective CROS transparency or benefit. And is just about as easy to identify as a curve hovering around a zero dB insertion gain line that the REIG approach provided. Now, if you want you can even overcome this disadvantage with speech map because pink noise is a stimulus option in your speech map stimulus menu. So if you choose you can do this with pink noise and overcome that limitation. So now that we've explained and demonstrated the procedures available for verifying CROS hearing instrument function and performance.

We can now discuss how incorporate this same verification process when a BiCROS hearing aid is being utilized. As mentioned previously, the difference between fitting a patient with a BiCROS instrument instead of a CROS instrument is the presence of an audible hearing loss in the better ear. So instead of just having a receiver on the barrier, you'll be fitting a hearing aid on the better ear that is also equipped to receive the transmitted signal from the unaidable side of the head. This requires that the better ear hearing aid must first be programmed to appropriately fit the patient's hearing loss in that better ear. To do this it is recommend that you utilize the speech map verification fitting strategies available with your verified system. This fitting strategy is both outlined in the user manual of your verified system, as well as presented in detail via articles and webinars. That can be accessed from audio scans website library, or audio scans audiology online web channel. When verifying the CROS aspect of a BiCROS fitting,

instead of using the realer on aided response, as the reference point for determining head shadow and CROS benefit, you will now use the better ear's realize their ad aided response as the reference. This means that the First step in the process is to acquire that better real-ear aided response for normal conversational speech using 65 dB input with the patient's better ear closest to the sound field speaker at a 45 to 90 degree angle, and with the instrument choice set to BTE with the patient's setup in this fashion, click and run test one and you will probably get a result that looks something like this. Now, since the aid has already been programmed to the target, this step should do result that looks like an aided response on target. There is no need to measure or be concerned about occlusion in this ear. This ear has been fit with the hearing aid and the appropriate coupling system but was needed to address the hearing loss in this better ear. And it is this aided condition that the CROS microphone will be driving as well.

You would then rotate the patient 180 degrees so that the poor ear is now the one closest to the sound field speaker at a 45 to 90 degree angle and change your instrument choice to CROS. Make sure the CROS microphone is muted for this test, and then run test two using the same stimulus and level that you used in test one. This would likely yield a result that looks like this. The difference between the green line and the purple line is this patient's head shadow. Again, we're using as our reference, the realer aided response on the better rear side rotating the patient under 180 degrees sending the speech signal to the poor ear using that reference mic to control it. And then measuring the aided result of the better ear side exposes this patient's head shadow effect. Now that we've measured that, we would leave the system set up in the CROS position, keep the patient in the same position activate the CROS transmitter on the patient's ear, and run test three. Now seeing whether the CROS system can effectively overcome this head shadow difference. In this picture here, we've produced another line a blue line. If the blue line emulates the original green line which was the realer unaided or excuse me the real-ear aided response of the better, then we've now

verified that the CROS feature of this BiCROS fitting is effectively overcoming the head shadow effect. If this blue line doesn't emulate the original green line, it may be necessary to go into the programming software and use the controls available in that software to adjust the transmission characteristics, so that it more closely matches this green line target. Now keep in mind and BiCROS fitting, the dynamic range compression features of that hearing instrument, the output settings of that hearing instrument have all previously been verified as part of the better fitting procedure that you implemented earlier and before you started to check the CROS capabilities but those settings dictate the hearing aids performance whether or not the input information that's being amplified is coming from the better ear microphone, or that that information is coming from the transmitter or unaidable ear microphone. And since both of those input conditions are being sent to the same compression dynamic range amplification system, one would expect that you would be just as capable of hitting targets for any input level or MPO level when you're sending the signal to the transmitter microphone, as you did when you were sending the signal to the aided ear microphone.

So it is possible for you to test that yourself. If you leave your patient positioned for the CROS measurement with their better or excuse me there, the unaidable ear facing the speaker leave the CROS choice in the instrument menu at the CROS setting see if I can get that here, right here, right there. So we've got a set aCROS, you can run 55 dB inputs, 65 dB input, 75 dB input and even MPO sweeps, stimulating the CROS microphone. And you can compare those results to your targets. And if transparency exists, then all of those results even though we're stimulating the CROS microphone should look very similar to the results that you obtained when you fit during instrument on the better ear side. So this is an option that you could consider as well in terms of CROS verification checking different levels and MPO once you've programmed the hearing instrument for that purpose. So in summary what we've been able to show you today is that when you fit a CROS or BiCROS instrument you can verify its functions

using the verified system. You can use the verified system to verify that the CROS system effectively compensates for or overcomes the patient's head shadow effect you can measure on a frequency specific basis, what that head shadow effect is that measure whether the CROS system has been effective in overcoming it. And you can do this procedure either in an insertion gain template approach where you have in addition to output curves, an insertion gain graph to look at, and comparing that to zero. On that gain insertion game screen, you can verify transparency or you can do this in the speech map screen environment which now means you don't have to worry about the noise stimulus, impacting the hearing aids functions with the noise reduction features that it might have other words having to turn them off. To do this test you can leave those on speech will be dynamic enough not to cause those noise reduction features to be engaged. But you now will compare the re you are measurement and the REAR measurement that you obtained to see whether or not transparency exists in that environment. I wanna thank you for this opportunity to share this useful verification information with you. And I'd like to encourage you to visit the audio scan portal within audiology online regularly. For other useful webinar and article information describing other verified procedures and applications that can help you get the most out of your verified system. And it can help you to deliver the very best possible hearing care experience for the patients under your care. Thank you and I look forward to our next opportunity to get together.