

CARL

Lesson Plan

Fitting and Verification of CROS/BICROS with CARL and the
Audioscan Verifit VF2

Lesson Overview

This is an advanced hearing aid fitting lesson. Using CARL allows for hands-on training in a controlled environment with simulated head.

Using CARL for this lesson reduces costs of replacement probe tubes, receivers, and domes.

This lesson can be completed with one trainee and CARL.

This lesson can be completed using a range of amplification strengths that could not be used with human participants.

This lesson can be adapted for various hearing aid and/or hearing aid analyzer brands.

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- This activity allows trainees to work with CROS and BiCROS fittings. These fittings are less commonly seen in clinic and have unique steps with respect to patient positioning and reference microphone activation compared to a bilateral air conduction hearing aid fitting.
 - Having a simulated fitting with CARL is an opportunity to become comfortable and proficient.
 - Prior to starting this lesson, trainees should be able to place probe tubes, insert hearing aids into CARL's ears and complete a hearing aid fitting using real ear measurements.
 - This lesson is appropriate for audiology, hearing instrument specialist students and clinicians unfamiliar with CROS and BiCROS verification.

Lesson Prep

- Obtain pairs of CROS hearing aids for this lesson. The example for this lesson uses a receiver-in-the-canal/ear (RIC or RITE). Some hearing aids with binaural streaming telephone programs can be set as CROS aids. This is a useful option for teaching if you don't have CROS/BiCROS hearing aids on hand. For a protocol on how to do this, see Unitron, 2017.
- Ensure there are appropriate receiver lengths and strengths and a variety of domes for the aids chosen.
- Ensure the manufacturer's software in NOAH is installed and up-to-date.
- Check that the aids are communicating with the programmer and troubleshoot in advance of the lesson if necessary.
- Take impressions of CARL's ears in advance and make earmolds to test behind-the-ear style hearing aids.
- Ensure the instructor is familiar with all aspects of the real ear equipment being used in this lesson.
- Calibrate the real ear measurement system and ensure there are two available probe tubes.



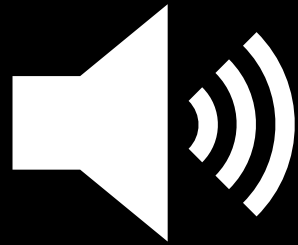
This is an advanced hearing aid fitting lesson.

Review “Fitting Hearing Aids with CARL using Real Ear Probe Tube Measures” prior to completing this lesson.

Head-Shadow Effect

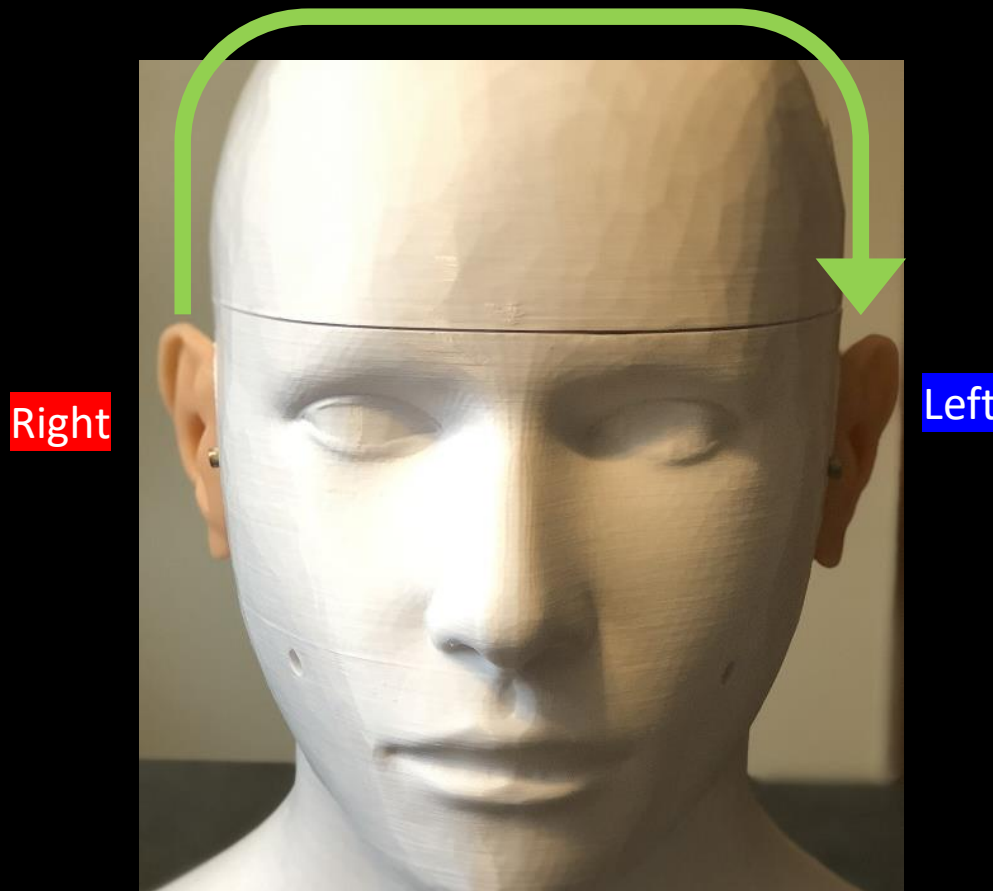
The head acts as an acoustic barrier, blocking sounds that come from one side, reducing the amplitude of the sounds as they travel to the other side.

The primary goal of a CROS fitting is to eliminate the head-shadow effect.



CROS (Contralateral Routing of Signal) and BiCROS fittings are used when one ear cannot be fitted with a hearing aid due to the degree of hearing loss or poor clarity of sound. Typically, beneficial hearing aid fitting in that ear is not possible.

In the examples for this lesson, CARL's right ear is too severe to benefit from a hearing aid fitting. CROS/BiCROS devices transfer the sound coming from his right side and send it over to his better left ear.



CROS is used when the better ear has normal hearing.

BiCROS is used when the better ear also has a hearing loss but can be fitted with a hearing aid.

To start, we will measure CARL's real ear unaided response (REUR) and measure the head-shadow effect without hearing aids.

In these examples we are using the Audioscan Verifit 2.

Set CARL up with the probe module with the reference microphone on the right ear and the probe module with the reference microphone and a probe-tube in the left ear.

Left

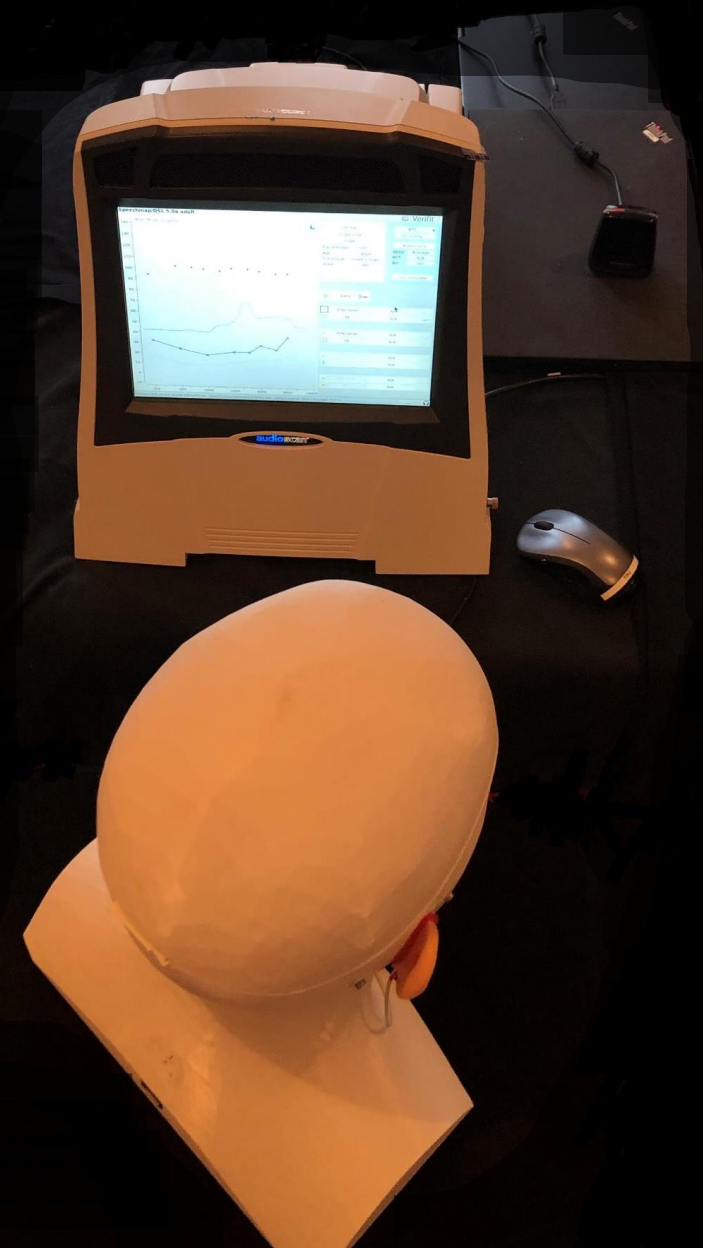
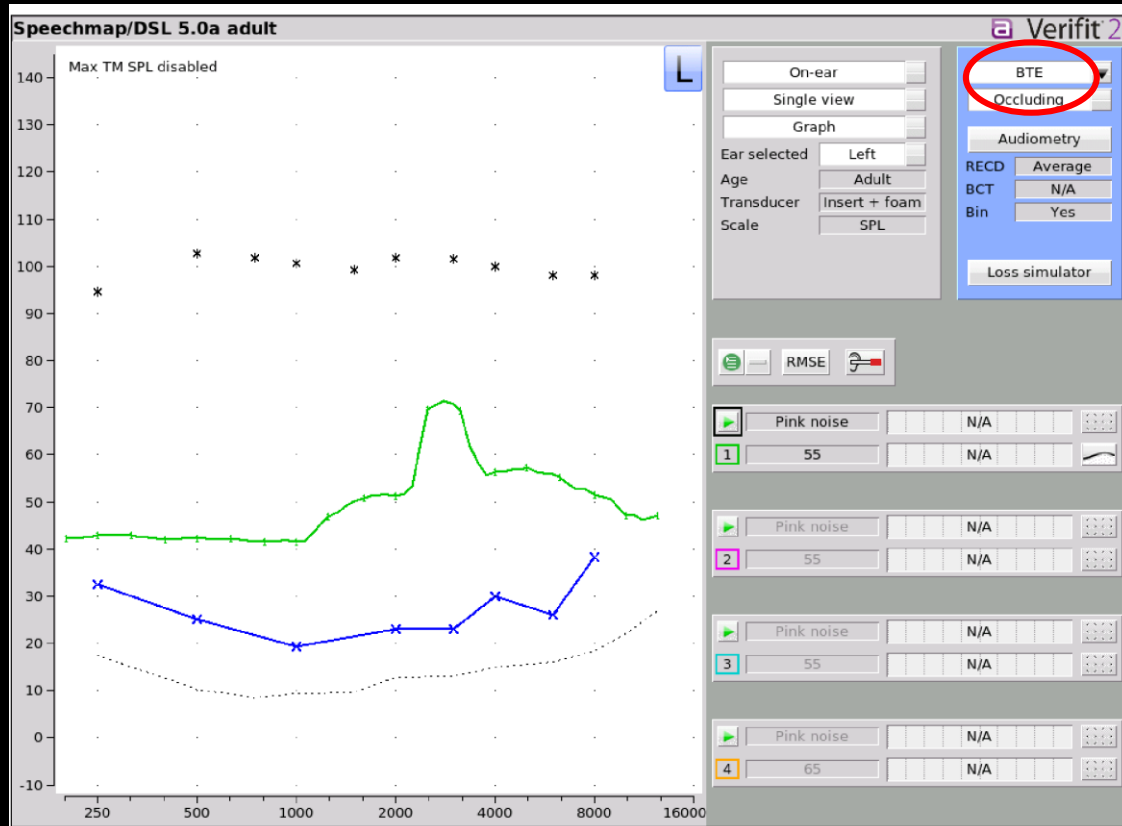


Right



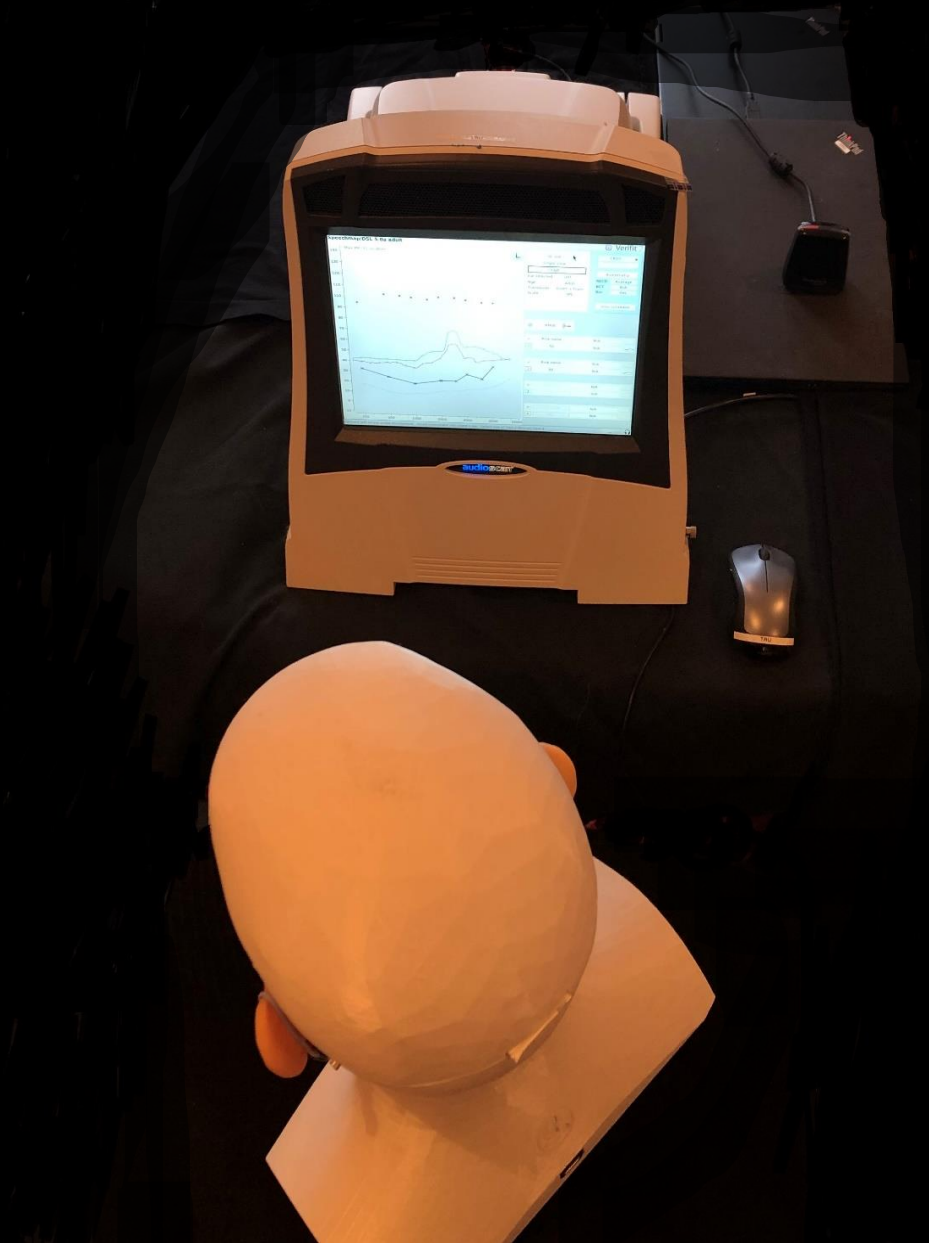
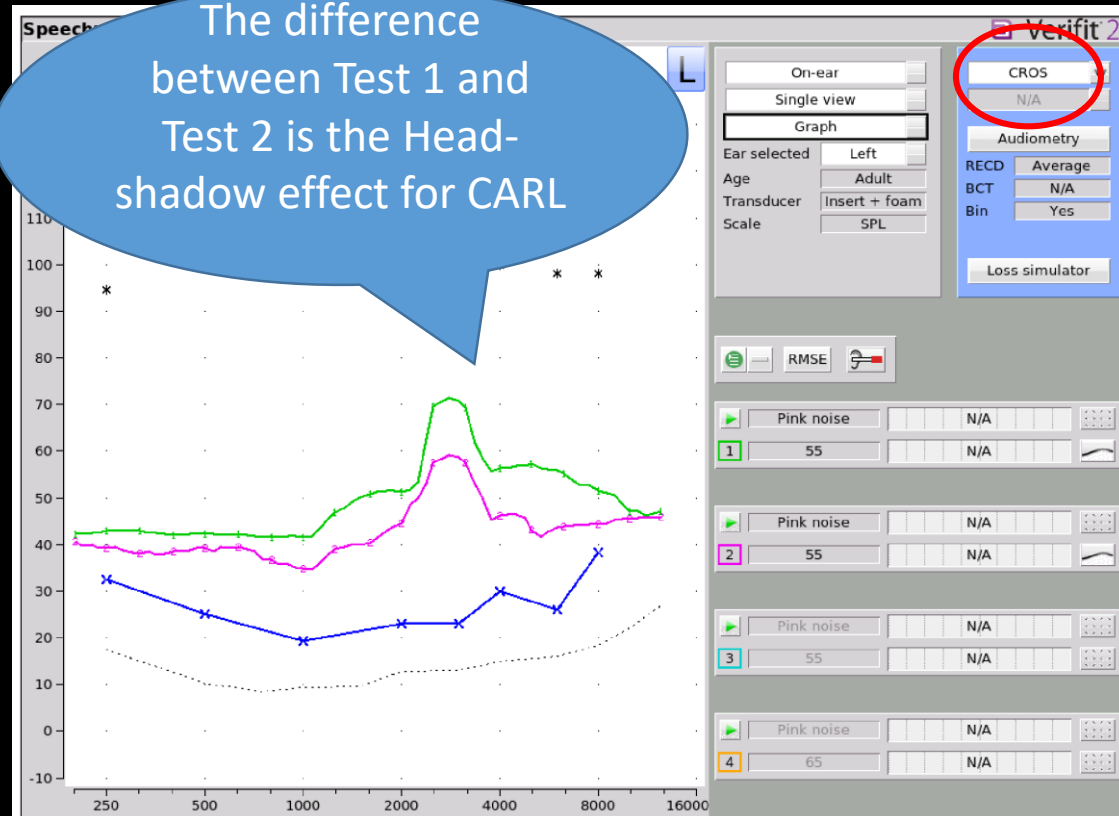
Step 1: Turn CARL 45° so that his left ear is toward the speaker.

Step 2: In Test 1 of Speechmap, run a curve using Pink Noise at 55 dB with BTE as the instrument choice.



Step 3: Turn CARL 45° so that his left ear is away from the speaker.

Sept 4: In Test 2, run a curve using Pink Noise at 55 dB using CROS as the instrument choice.

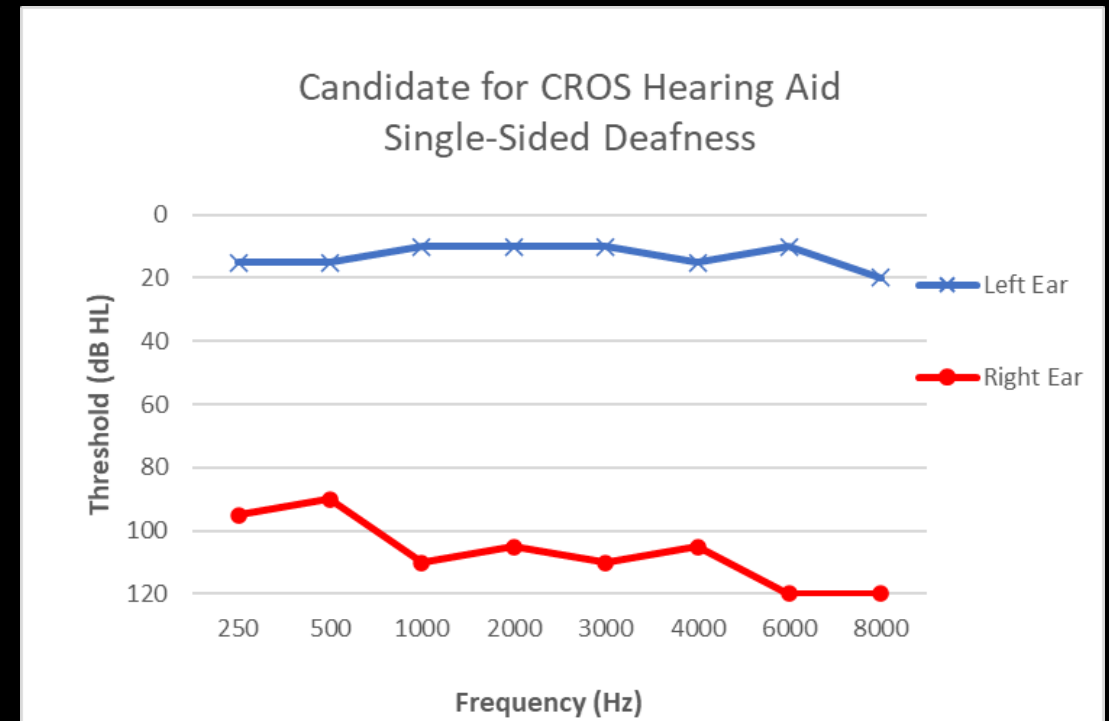


CROS Hearing Aid Fitting

A CROS hearing aid is fitted for those who have normal hearing in the better ear and an unaidable hearing loss in the other ear. Often this is called single-sided deafness.

In our example, CARL's right ear has a profound hearing loss, but his left ear has normal hearing. If someone is speaking on his right side, sounds (particularly high frequency sounds) are attenuated by the time they get to his better left ear.

In a CROS hearing aid fitting, CARL wears hearing aids in both ears. The hearing aid worn on CARL's right ear does not send sound into his right ear. Instead, it sends sound to the hearing aid in his normal hearing left ear.

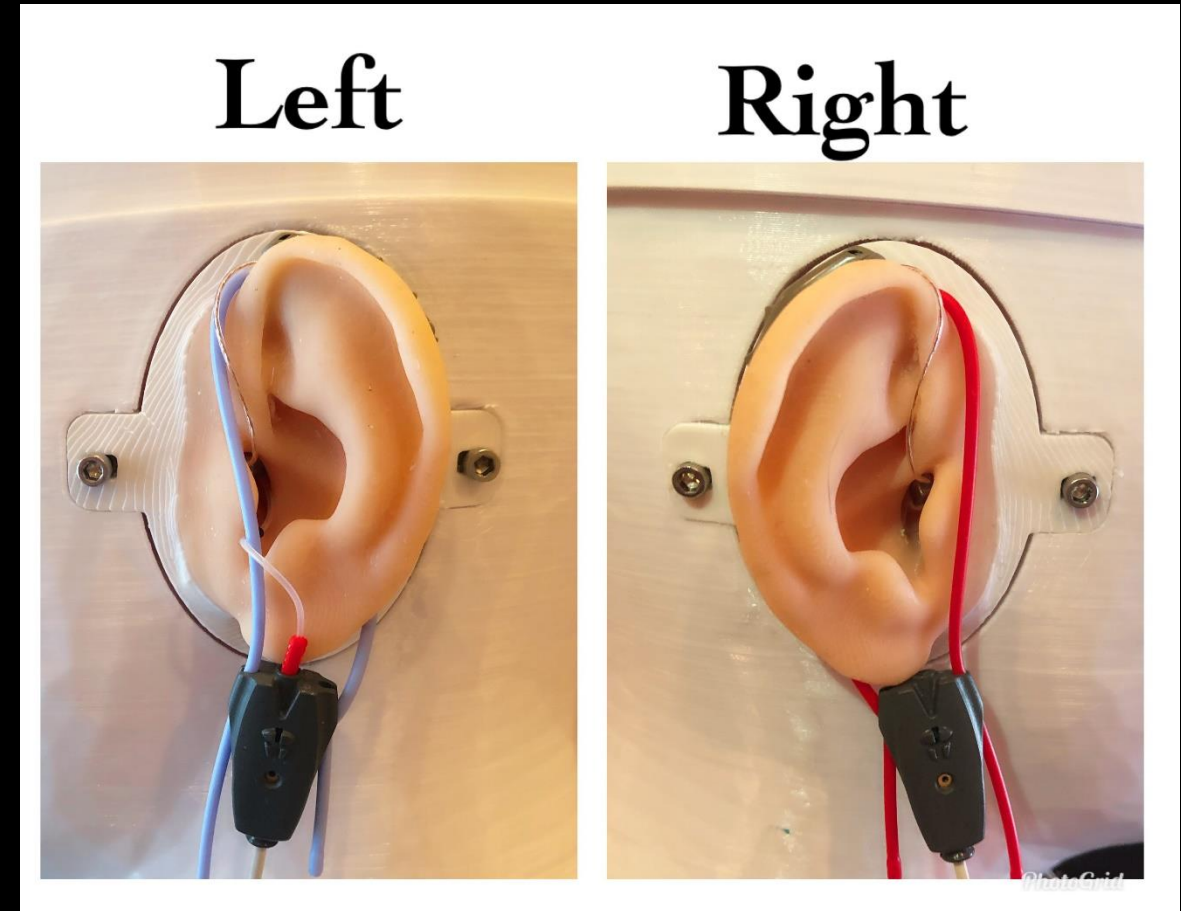


We will want to use open couplings to allow for natural sound to enter the left ear from the left side.

We can use CARL, a verification protocol outlined in Pumford, 2005 and the Verifit Users Guide to ensure the best fitting for this type of device, even though there is no amplification being provided. Use of this protocol lets the clinician confirm that the head shadow has been overcome by the CROS system.

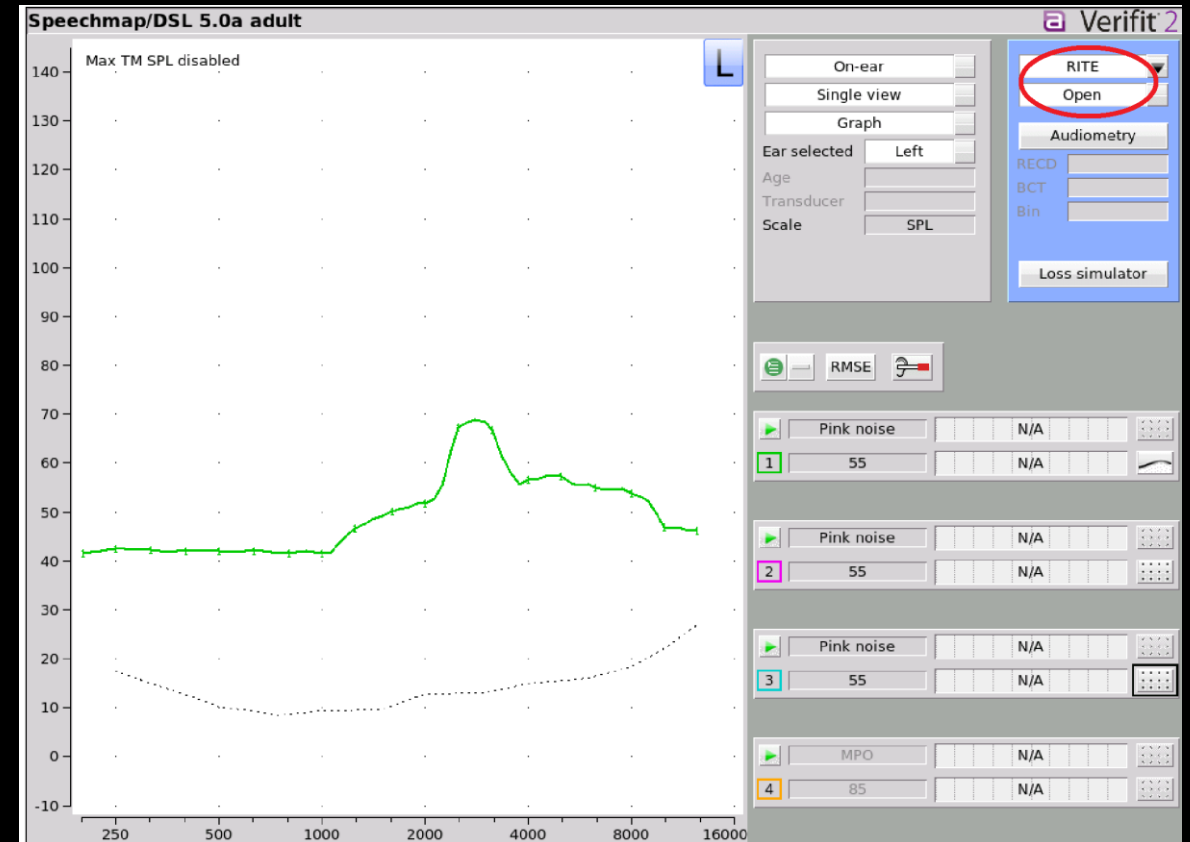
In this example we are using the Audioscan Verifit 2. Set CARL up with the probe module with the reference microphone on the right ear and the probe module with the reference microphone and probe-tube in the left ear.

Program a set of CROS hearing aids for CARL and put the hearing aids into CARL's ears. Turn them on so that the CROS is functioning.



Steps:

- With the hearing aids on and set to CROS, navigate to SpeechMap on the Verifit2
- In this example, we are using receiver-in-the-canal style hearing aids, so choose RITE open.
- Turn CARL so that his left ear is at a 45° angle toward the speaker (see slide 8).
- Equalize the sound field when prompted by muting the hearing aid and clicking Equalize.
- Start Test 1 using a Pink noise at 55 dB SPL. This measures the REOR.



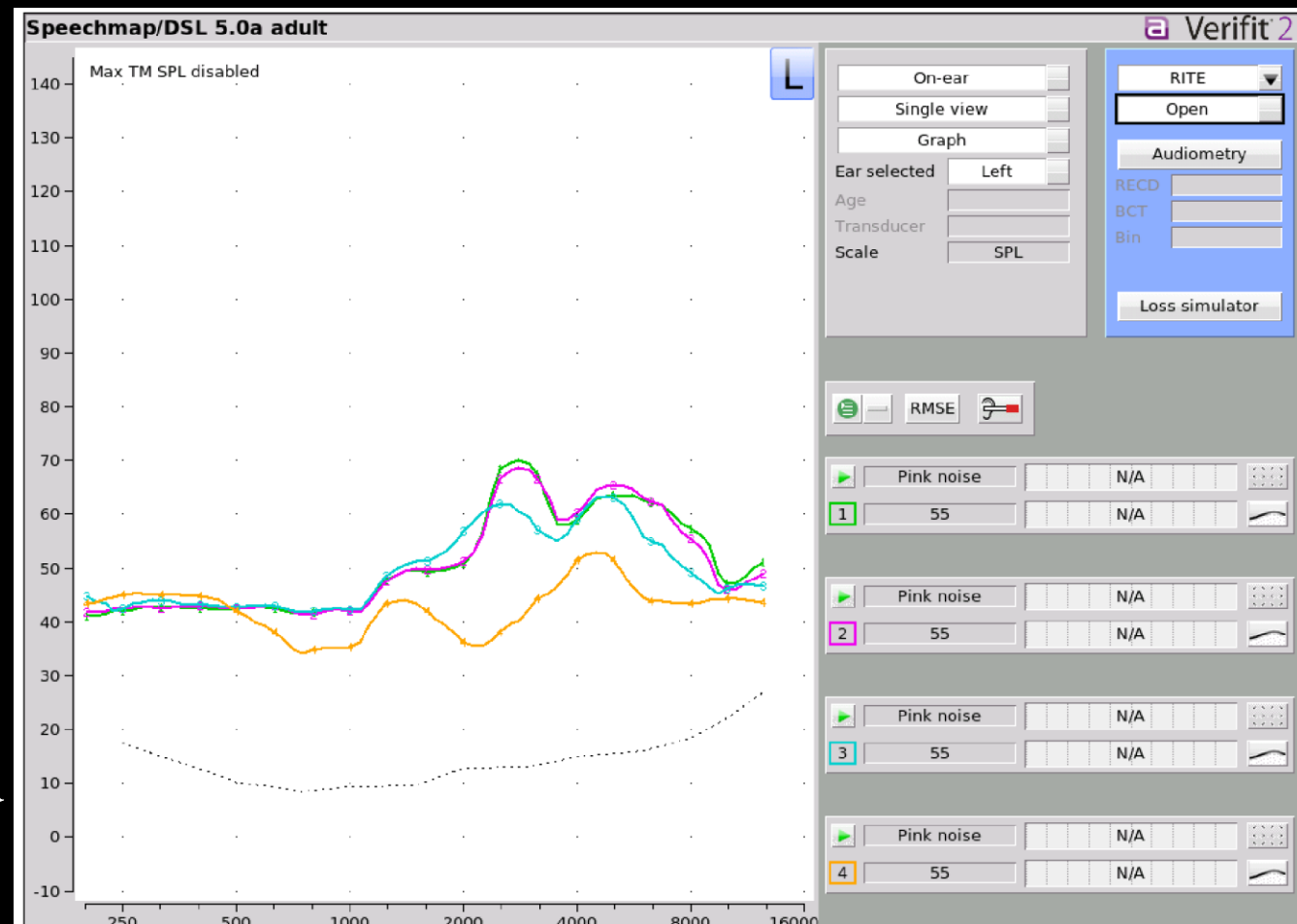
Interpretation:

A good result:

- The REOR should match CARL's REUR as closely as possible as they do in Test 1 (REUR) and Test 2 (REOR with open dome).

A bad result:

- The REOR is below CARL's REUR as they are in Test 3 (REOR with closed dome) and Test 4 (REOR with power dome).
- Remember, a CROS is fitted to an ear with normal or near-normal hearing. We don't want to block sound from entering this ear.



Troubleshooting: If the response curve doesn't look like the REUR, try making the fitting more open by changing domes.

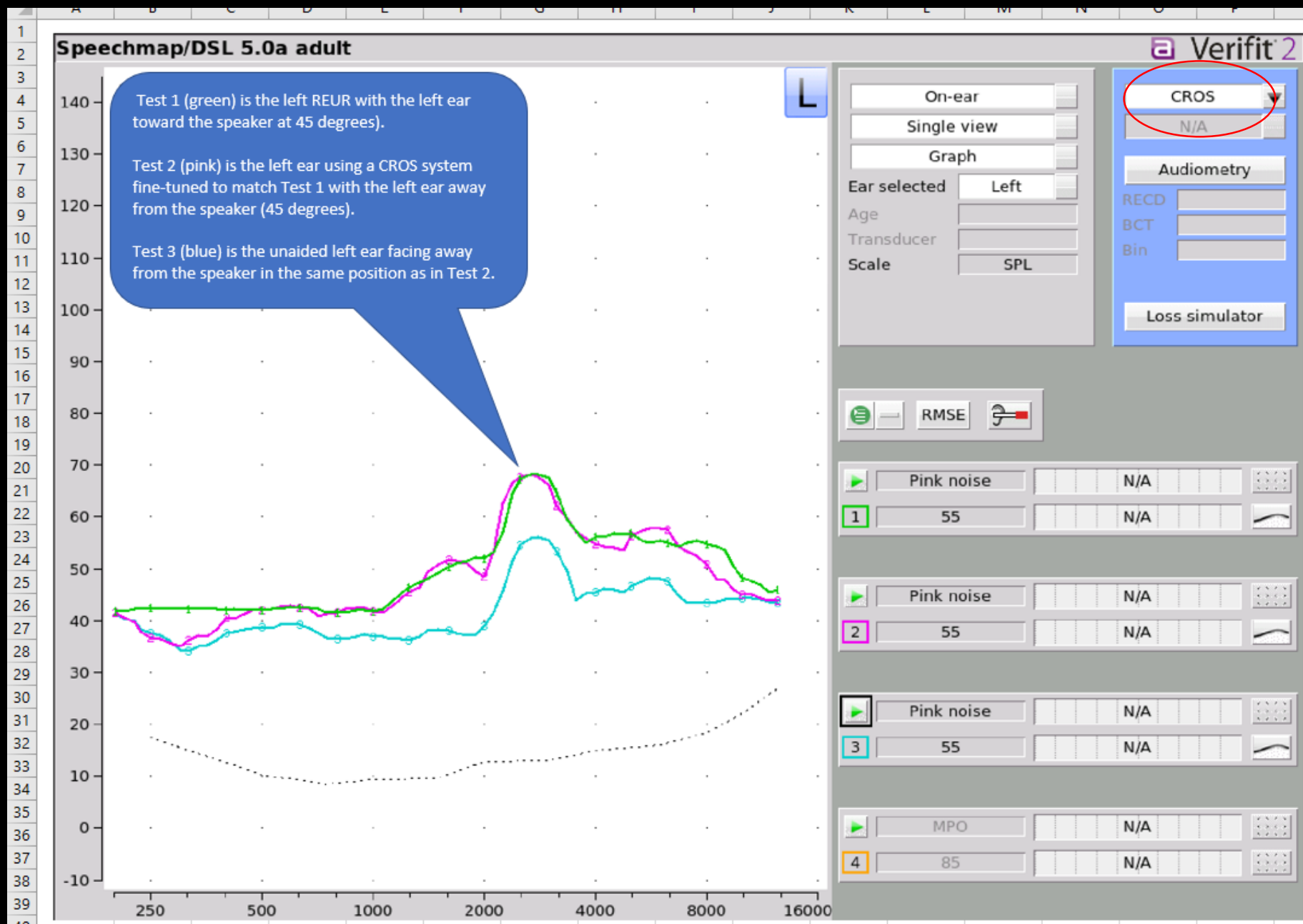
Steps:

Turn CARL so that his left ear is at a 45° angle away from the speaker (See slide 9).

Change Instrument Type on the Verifit to CROS.

Run a 55 dB SPL Pink Noise in Test 2.

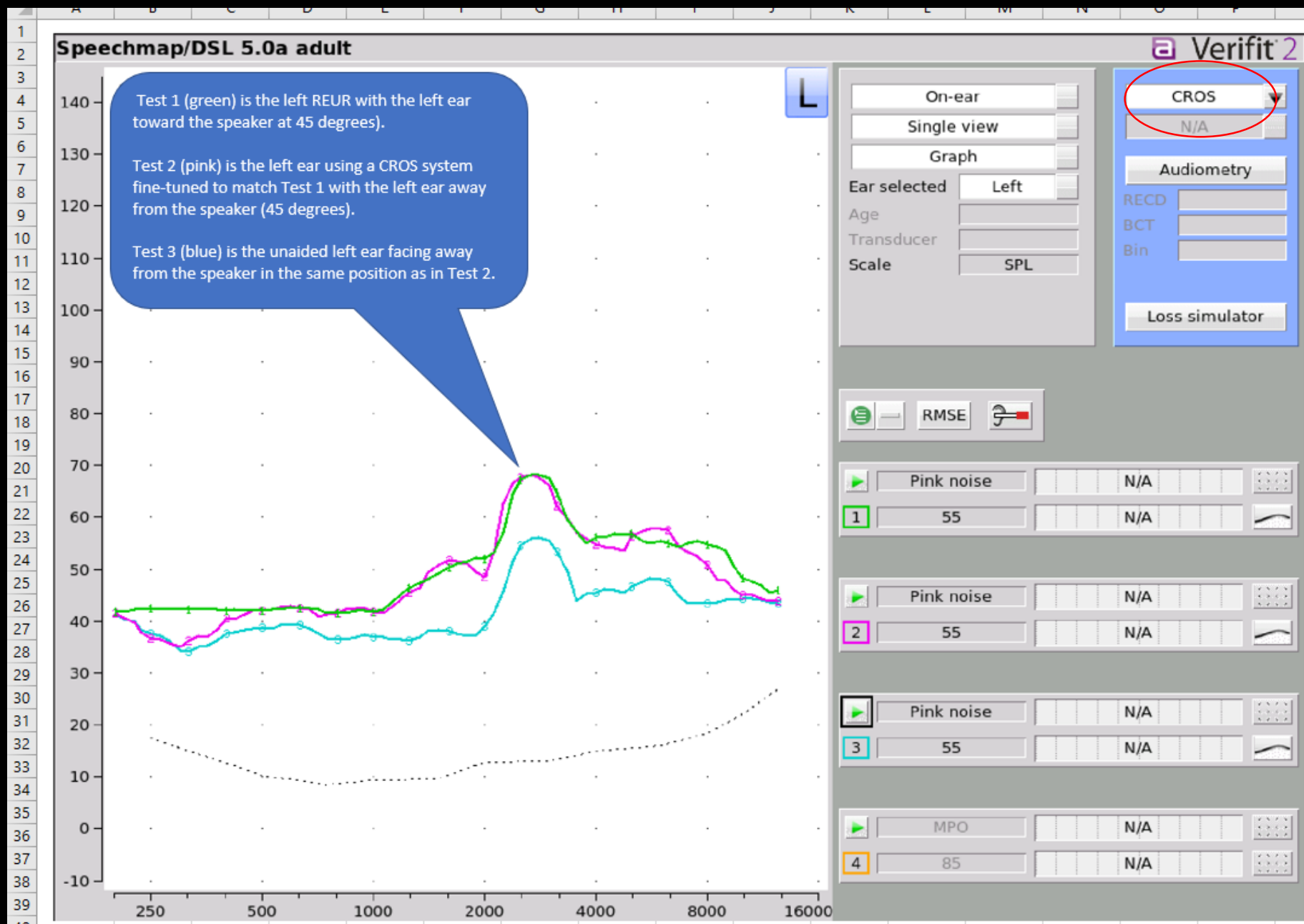
You may need to reconnect to the programming software to adjust the aid if necessary, to match the curve from Test 1.



Interpretation:

1. Can you see head shadow? This is what you are trying to "fix". Look for sound being attenuated when presented from the unaidable side.

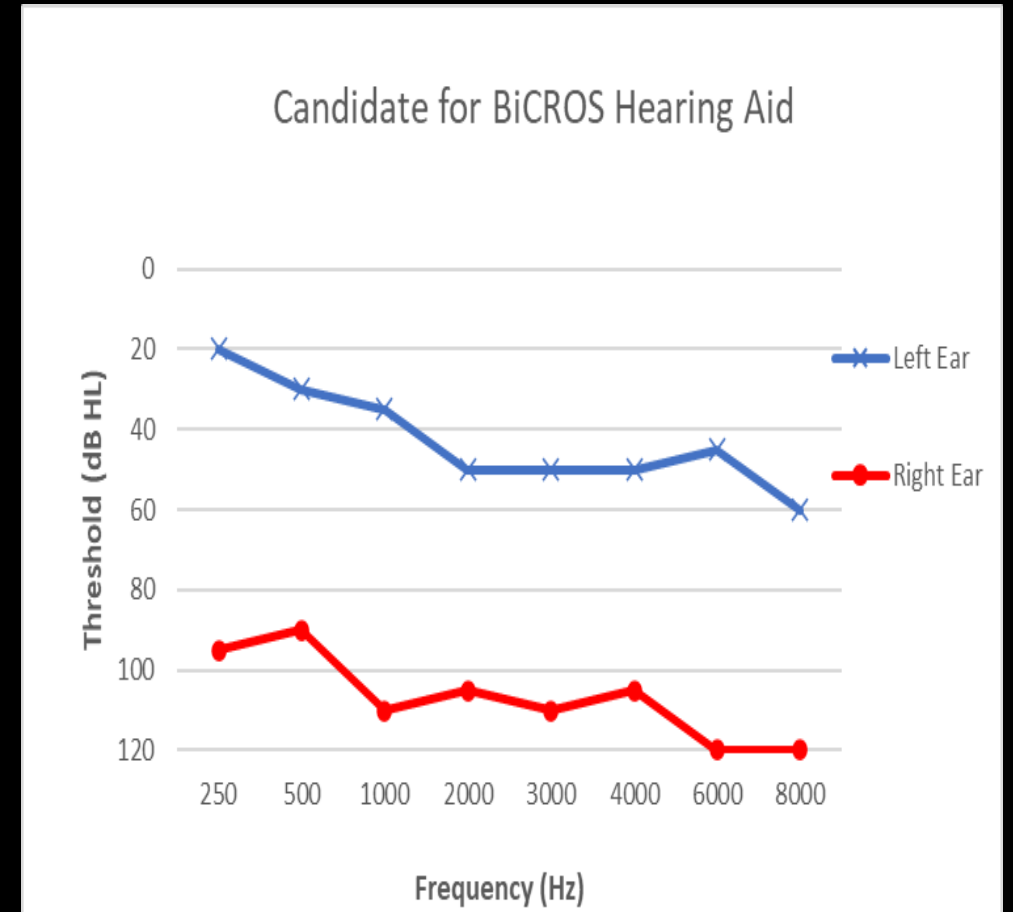
2. Is the CROS overcoming head shadow? If so it should match closely with the REUR from the good side, even though sound is arriving from the unaidable side.



BiCROS Hearing Aid Fitting

A BiCROS hearing aid is fitted for those with a hearing loss that can benefit from a hearing aid on the better ear.

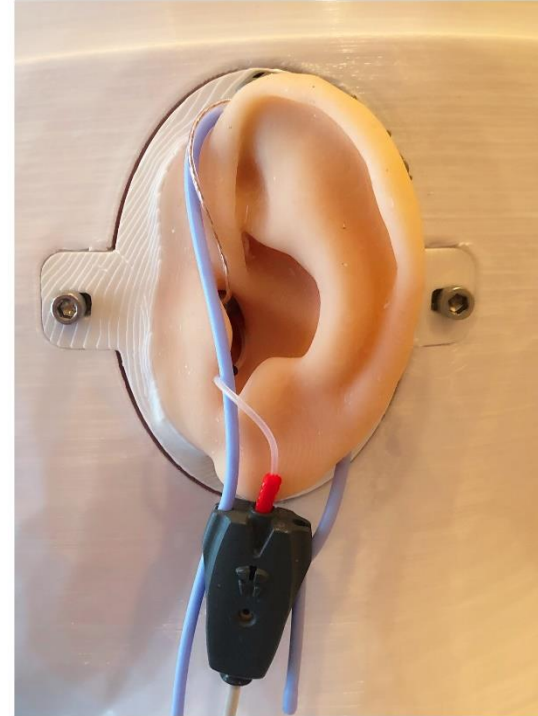
In our example, CARL's right ear has a profound hearing loss, and his left ear has a mild to moderate sensorineural hearing loss. He still needs the sound transmitted from the right side to combat the head-shadow effect, but also needs amplification for his left ear.



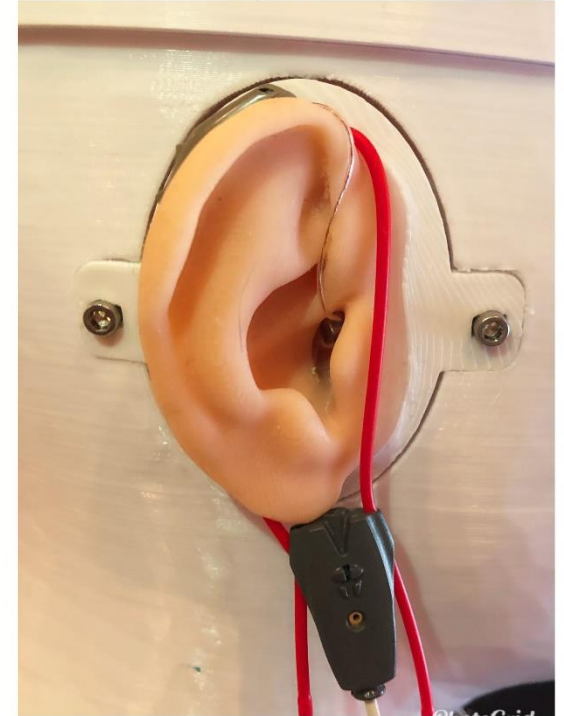
In this example we are using the Audioscan Verifit 2.

Set CARL up with the probe module with the reference microphone on the right ear and the probe module with the reference microphone and probe-tube in the left ear.

Left



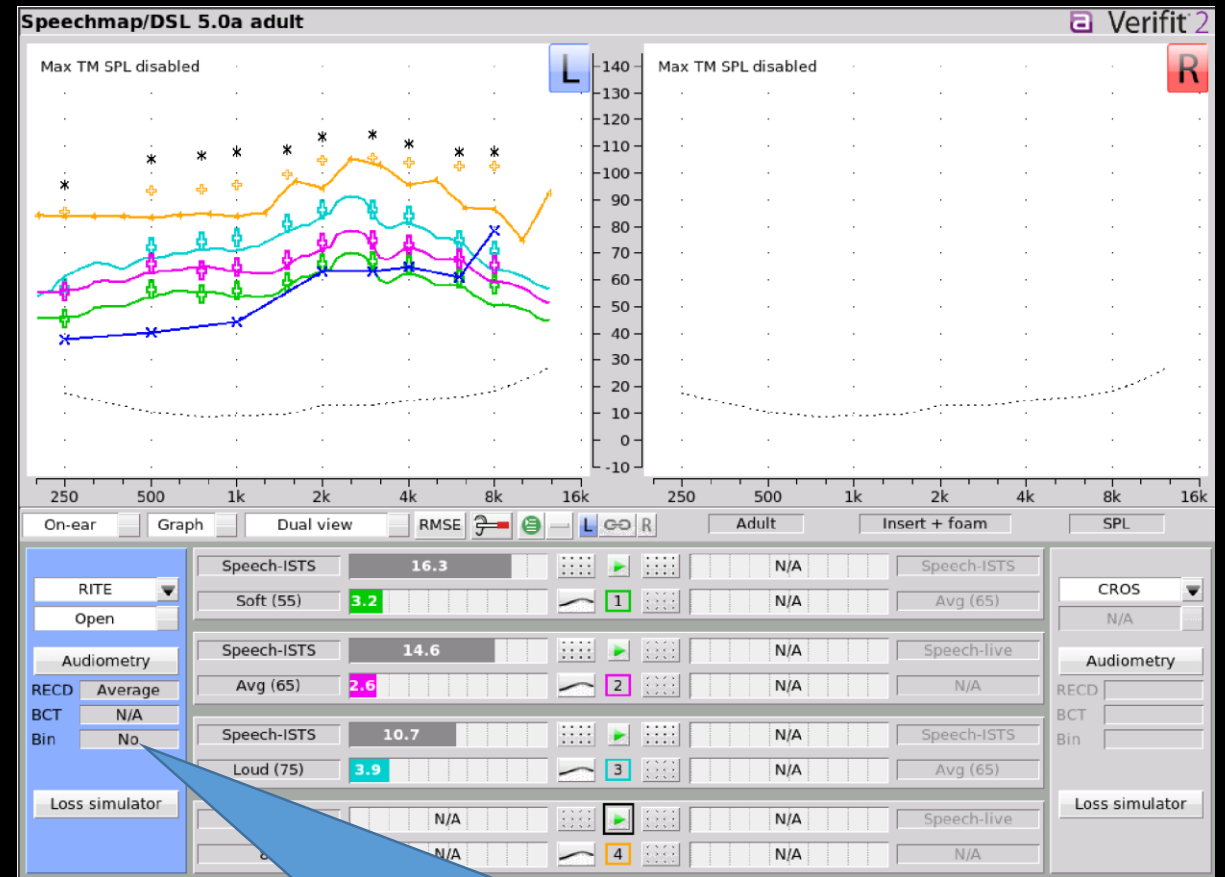
Right



In a BiCROS hearing aid fitting, CARL wears hearing aids on both sides. The hearing aid worn on CARL's right ear does not send sound into his right ear. Instead, it transmits to the hearing aid he wears in his left ear. This left hearing aid also provides amplification to the left side.

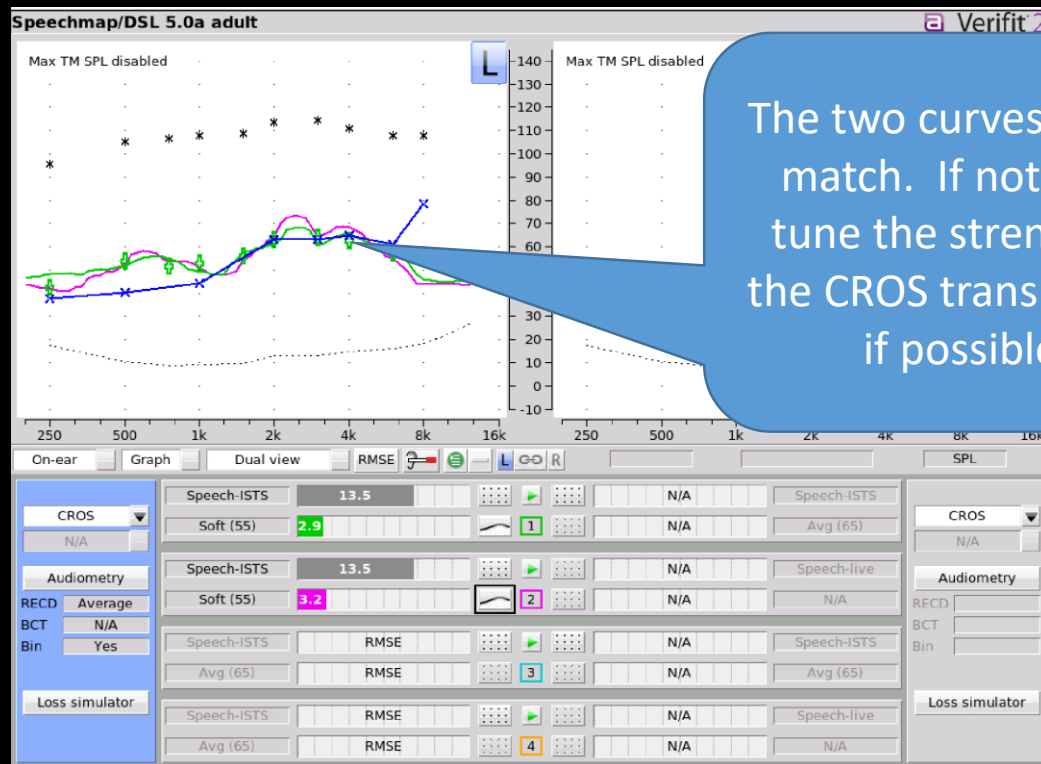
The hearing aid on his left is fitted using the same protocol outlined in “Fitting Hearing Aids with CARL using Real Ear Probe Tube Measures”.

Have CARL face the Verifit as you would have a patient seated during a hearing aid fitting: at zero degrees azimuth. Fit the left hearing aid to a validated prescriptive target. In this example we are using DSLv5-adult targets.

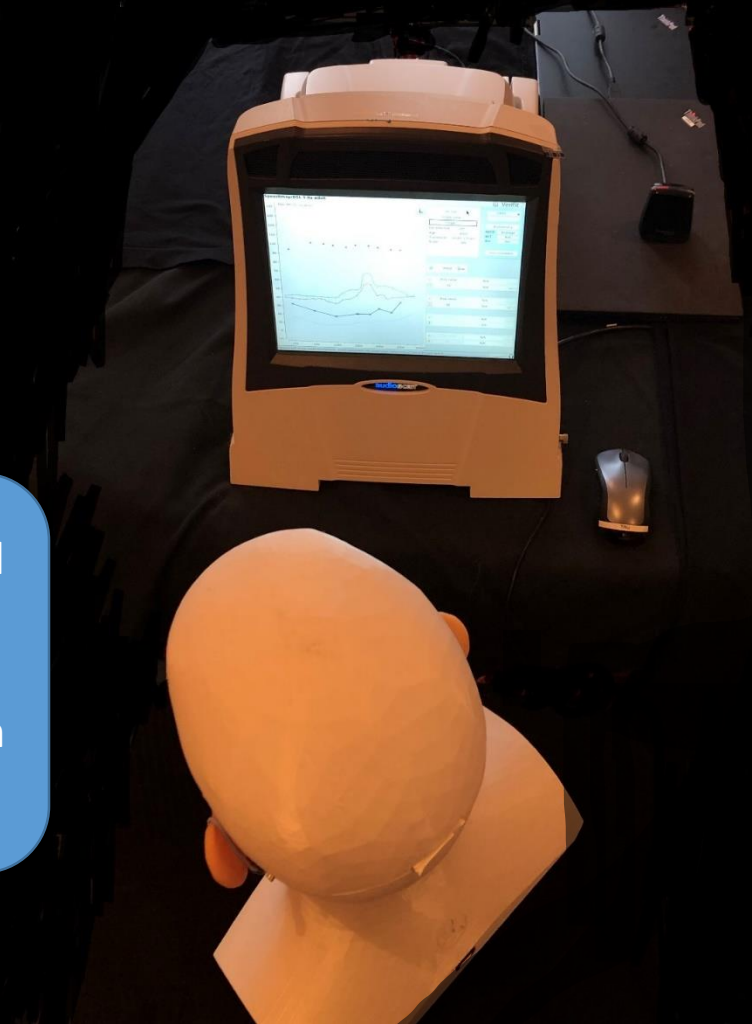


Remember – even though there are hearing aids in both ears, the sound is only going to the left ear and therefore should be considered a monaural fit without binaural corrections.

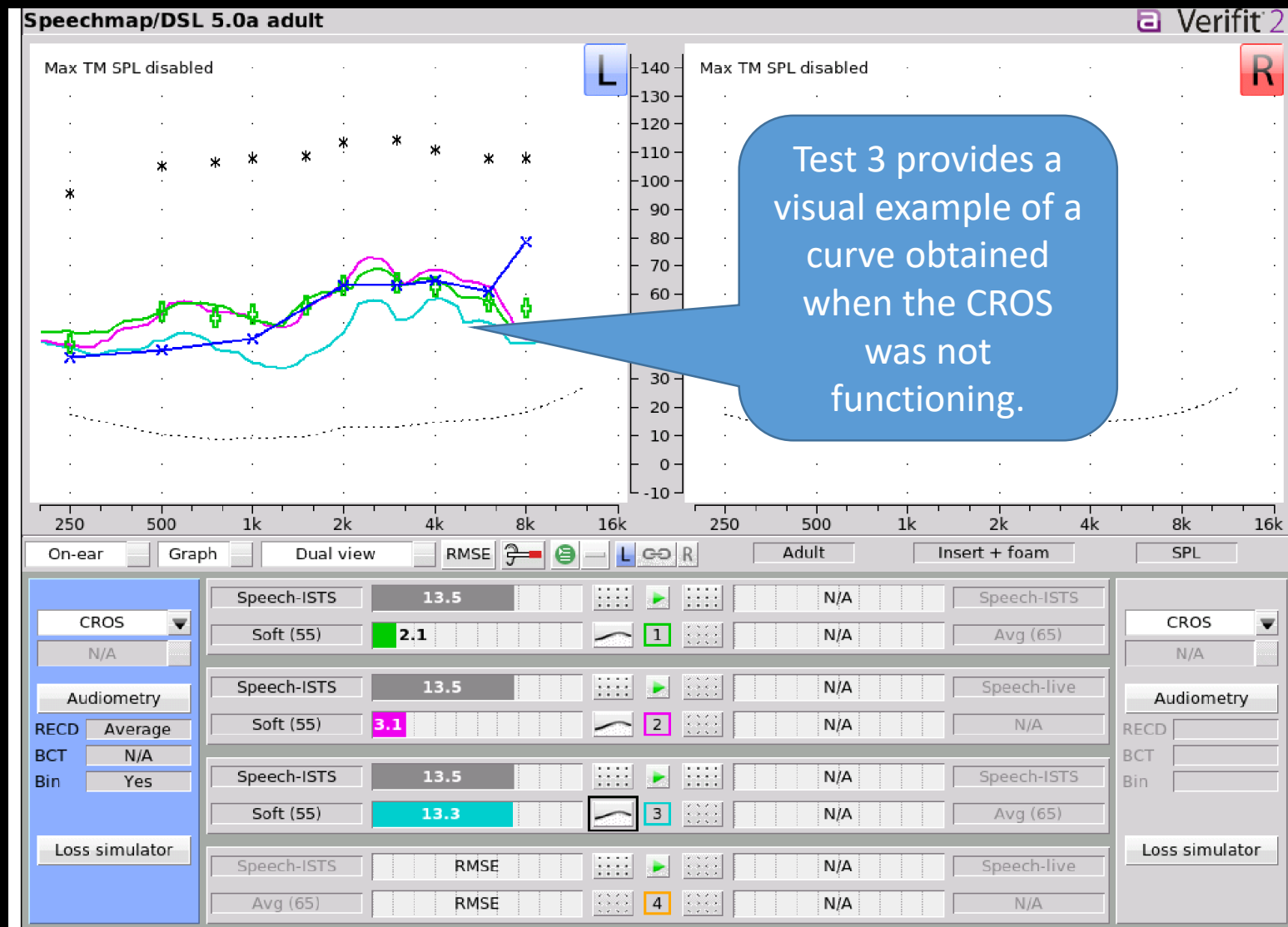
Once the aid is fitted, turn CARL 45° so that his left ear is away from the speaker. Change the instrument choice on the Verifit to CROS. At this point, you may need to disconnect hearing aids from the fitting software to engage the BiCROS. Leave the 55 dB curve from the fitting on screen. Run the same speech signal used for the fitting in Test 2. (ISTS in this example).



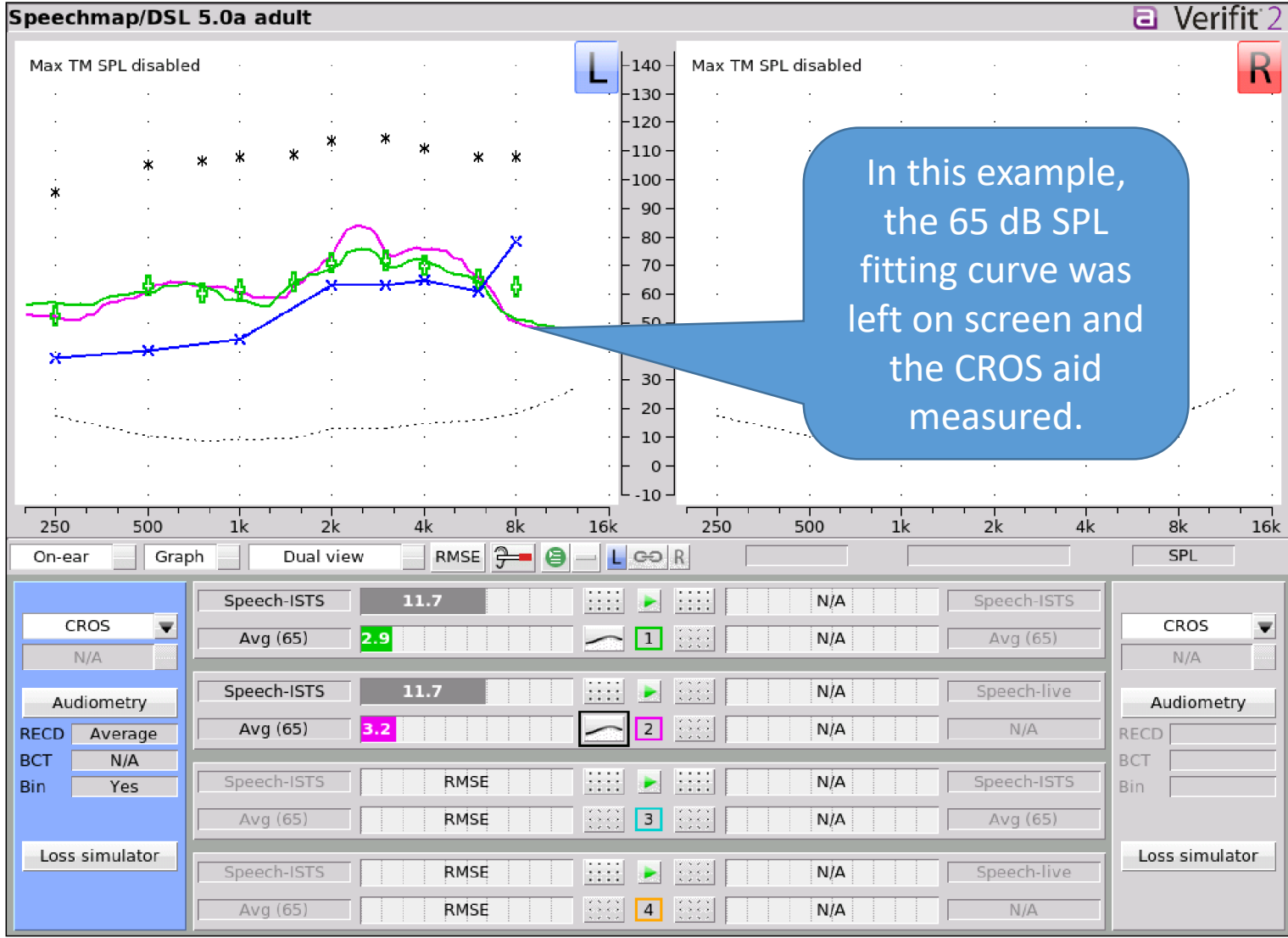
The two curves should match. If not, fine-tune the strength of the CROS transmission if possible.




Interpretation: Is the BiCROS system working?



This protocol can be completed at different test levels





Using CARL to
keep up with
advancements
in technology

Technology Advancements and How CARL Can Help

Hearing aid technology continues to evolve rapidly. For example, at least one manufacturer offers devices that have simultaneous external audio streaming via 2.4 GHz Bluetooth and CROS transmission using NFMI.*

Use CARL to verify that both are set and functioning in advance of a complicated fitting. This will also ensure the clinician is familiar with the programming of the system and how to troubleshoot issues in advance.

*(Bagatto & Moodie, 2020).

Pediatric Considerations for Fitting CROS and BICROS

For a comprehensive discussion on unilateral hearing loss and CROS/BICROS fittings for children, see the AudiologyOnline Course: Oticon Symposium in Pediatric Audiology (2020) with Marlene Bagatto and Sheila Moodie.

Exercises

- Measurements should be completed using different brands of CROS/BICROS hearing aids.
- Examine the effects that different coupling styles have on the REUR of the better ear by changing domes, vent sizes.

Evaluating Competencies

At the end of this lesson trainees should be able to:

- Complete all competencies outlines in Fitting Hearing Aids Lessons
- Explain the head-shadow effect.
- Define the candidacy for CROS and BiCROS fittings.
- Fit a CROS hearing aid using REUR matching.
- Fit a BiCROS hearing aid using target matching.

Resources

Audioscan (2019). Verifit User's Guide Version 4.20, page 73. [\[click here\]](#)

Bagatto, M. and Moodie, S. (2020) CROS & BICROS Fittings in Children: Considerations for Clinicians. Oticon Symposium in Pediatric Audiology. Audiologyonline Course 35173

Pumford, J., (2005). Benefits of probe-mic measures with CROS/Bi-CROS fittings. The Hearing Journal, Vol., 58(10): pp.34-40. [\[click here\]](#)

Unitron (2017). Programming a CROS or BICROS using wireless streaming. [\[click here\]](#)