CARL

Lesson Plan – Fitting Hearing Aids with CARL using Real Ear Probe Tube Measures

Lesson Overview

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

This lesson can be completed with one clinician and CARL.

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

CARL allows for trainees to become experienced at otoscopy, placing probe tubes, RECD measures, inserting hearing aids and fine-tuning hearing aids without the risk to human participants.

Practicing with CARL allows the trainee to become more comfortable and experienced in Real Ear Measurements which in turn may translate into more consistent use of verification clinically

- This activity allows trainees to practice hearing aid fittings using CARL.

- Trainees will be able to practice otoscopy, receiver-in-the-canal sizing, probe tube placement, real ear to coupler (RECD) measures, insertion of the hearing aid into the ear hearing aid fine tuning and probe tube real ear measurements (REM).

- Trainees will be able to practice real ear hearing aid fittings for a variety of power levels that could not completed using human participants.

- This lesson is appropriate for audiology and hearing instrument specialist students.

- This is an introductory lab lesson for REM hearing aid fitting with CARL and a basis for future lessons on hearing aid fittings.

- This lab lesson may run over several sessions depending on allotted time.

Lesson Prep

- Obtain pairs of hearing aids for this lesson. The example for this lesson uses a receiver-in-the-canal/ear (RIC or RITE).

- 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.

- Print out Bisgaard standard audiograms[1]

- 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 and one foam insert on hand.

- There are a lot of concepts in this lesson. The trainees should complete the recommended readings in advance (See Resource slide)

First Steps

Receiver-in-the-canal

Fitting Example

Trainees must:

- Choose a hearing loss to fit.

- Choose a receiver-in-the-canal (RIC) hearing aid to fit to the hearing loss.

- Use the hearing aid company's measurement tool to determine the proper RIC length for CARL using the same technique as you would with a patient.

- Based on the audiogram being used, choose the appropriate receiver strength and dome for the RIC and couple it to the hearing aid.

Next Steps

Receiver-in-the-canal

Fitting Example

- Trainees must:

- Enter the audiogram into Noah and connect the aids to the manufacturer's software, entering the appropriate acoustic information such as dome type.

- Choose the prescriptive method (NAL-NL2 or DSL v5.0 adult)

- Use the software to "first fit/quick fit" the hearing aids.

Many clinicians fail to continue to the next step of verifying that the software adjusted the aids properly and therefore do not fine-tune the aids accordingly, resulting in poorly fit hearing aids.[2]

We are going to use CARL to show how we complete this next step with a patient.
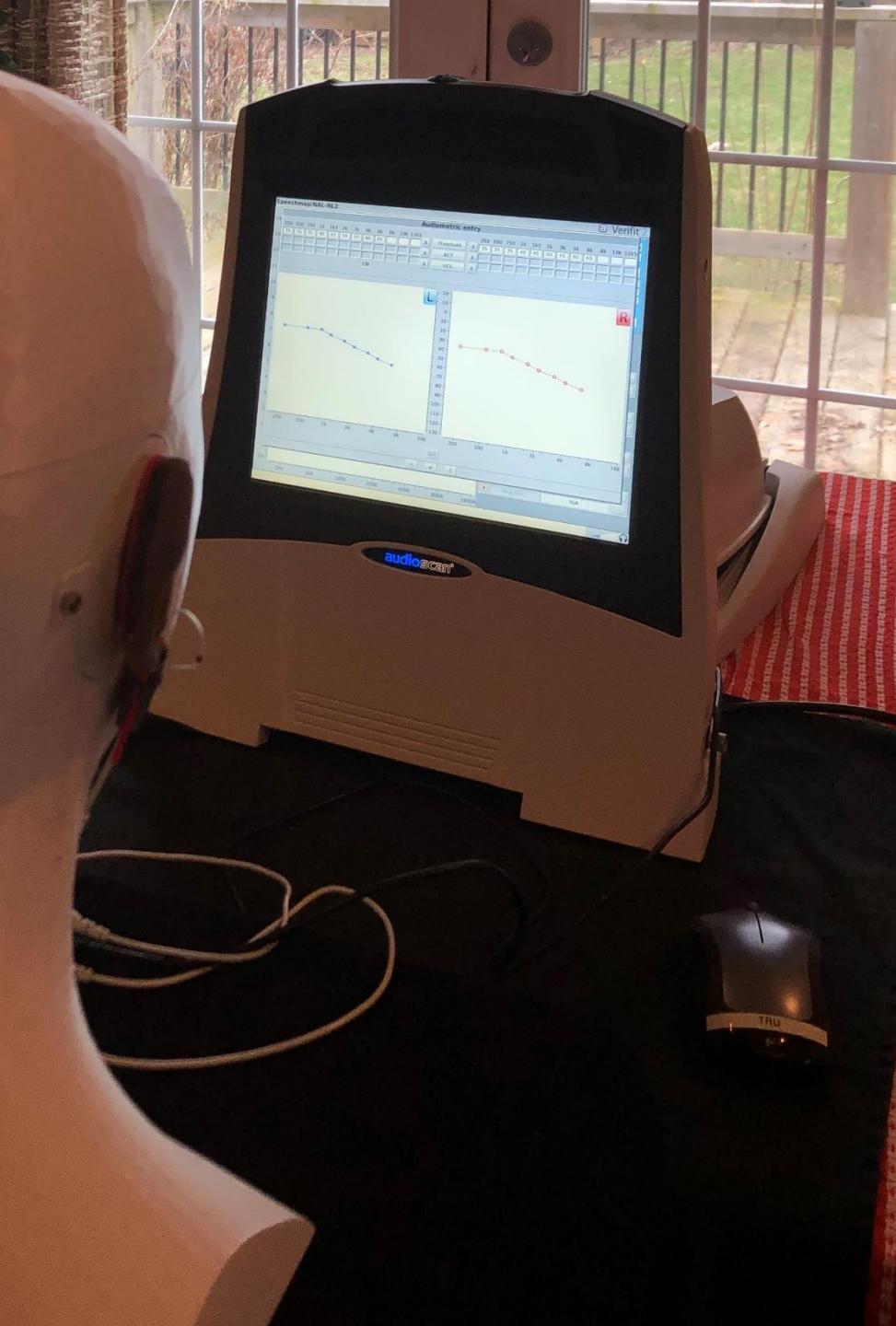
# Setting Up CARL for REM Verification of the Hearing Aid Fitting

- Place CARL in front of the real ear equipment.

(For this example, we are using an Audioscan Verifit 2)

- Enter the audiogram information and choose the hearing aid type, coupling type, monaural/binaural fitting and prescriptive method in the real ear equipment as you would for a fitting with a patient.

Probe Placement With CARL

Set-up the probe tubes the same as would be done with a patient. Set the probe tube marker at a standard depth of 30mm. Place the probes into CARL's ears so the marker is at the inter-tragal notch.
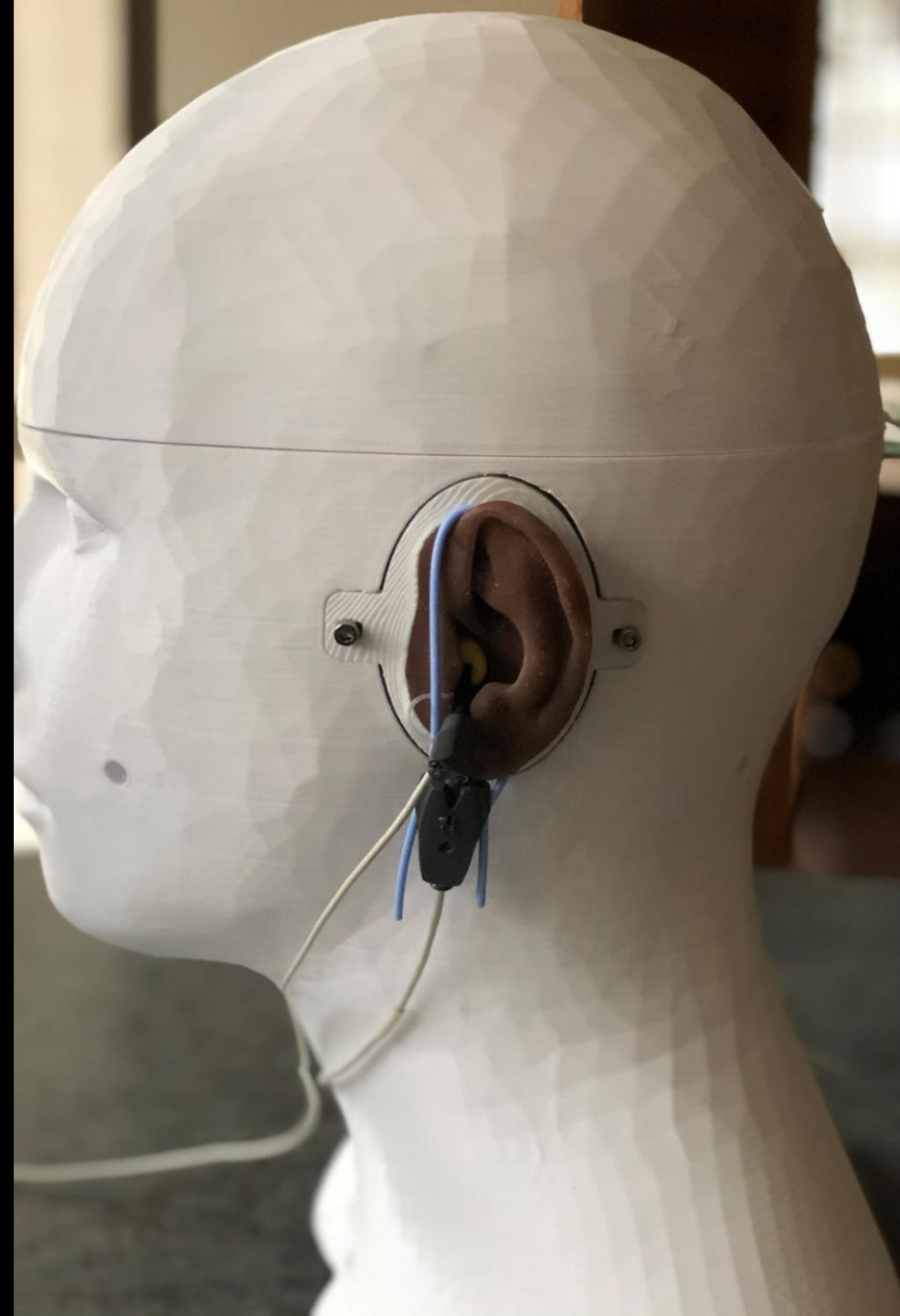
Trainees should also try placing the probe within 5 mm of the tympanic membrane using otoscopy.

Users of Camera CARL can access the software assisted probe placement tool.
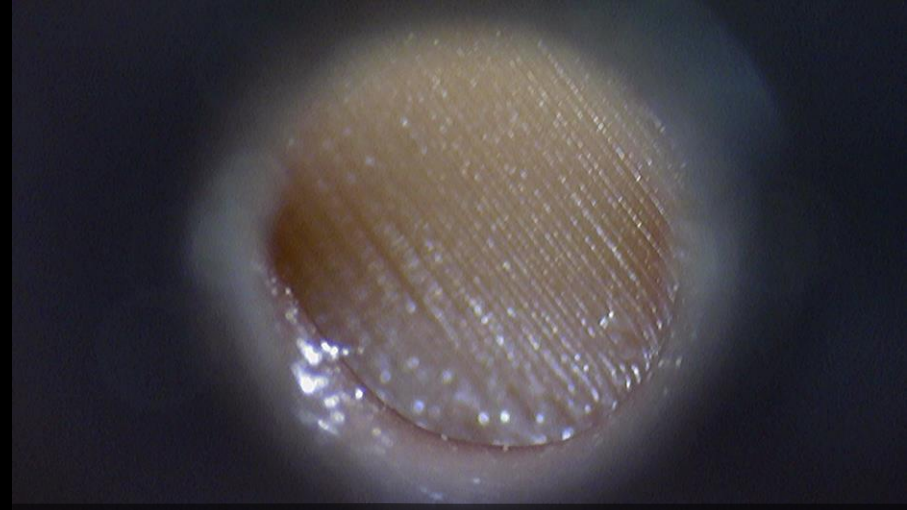
A view of Carl's tympanic membrane through the video otoscope
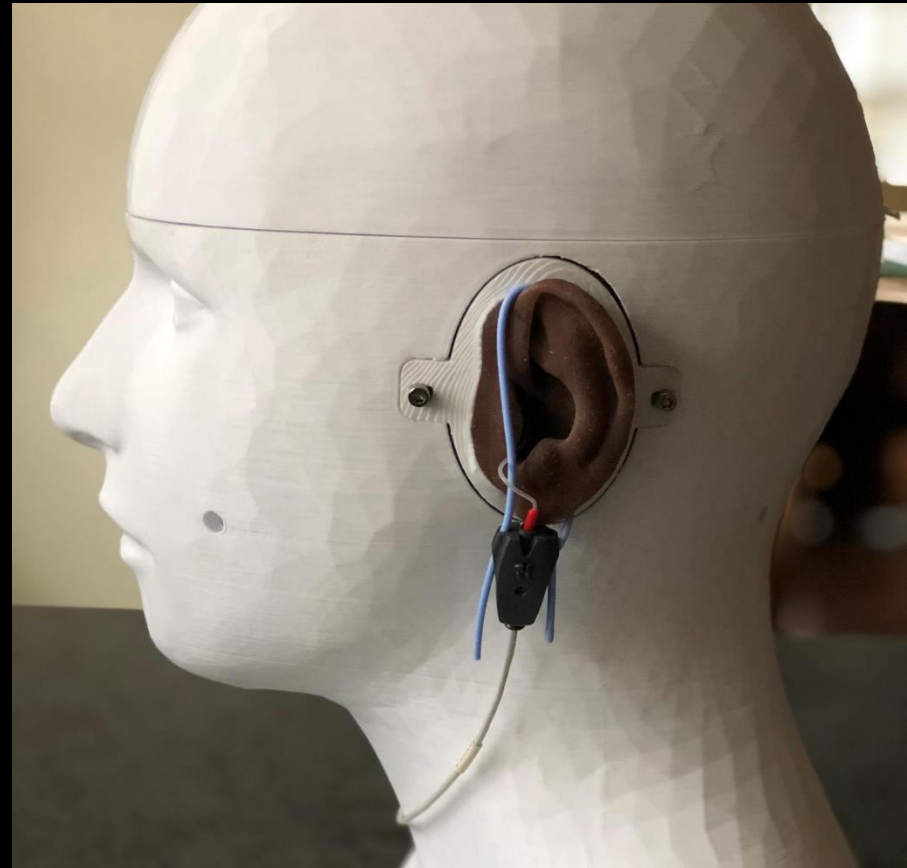
Real Ear To Coupler Difference (RECD)

A measured real ear to coupler difference (RECD) can be completed with CARL and used in the hearing aid fitting.

In the picture to the left, a foam RECD of the left ear is being measured.

If measuring an RECD, have the trainees practice until they are proficient at placing the foam without moving the probe tube.

With a patient, probe movement further into the canal could cause an uncomfortable tympanic membrane bump or if the probe moves out of the ear, the measurement could be incorrect.

Trainees should also practice inserting the foam plug so that it is deep enough so there are no leaks when measuring the RECD.

Note: An average adult RECD can also be entered into the VF2 if RECD's are not measured.
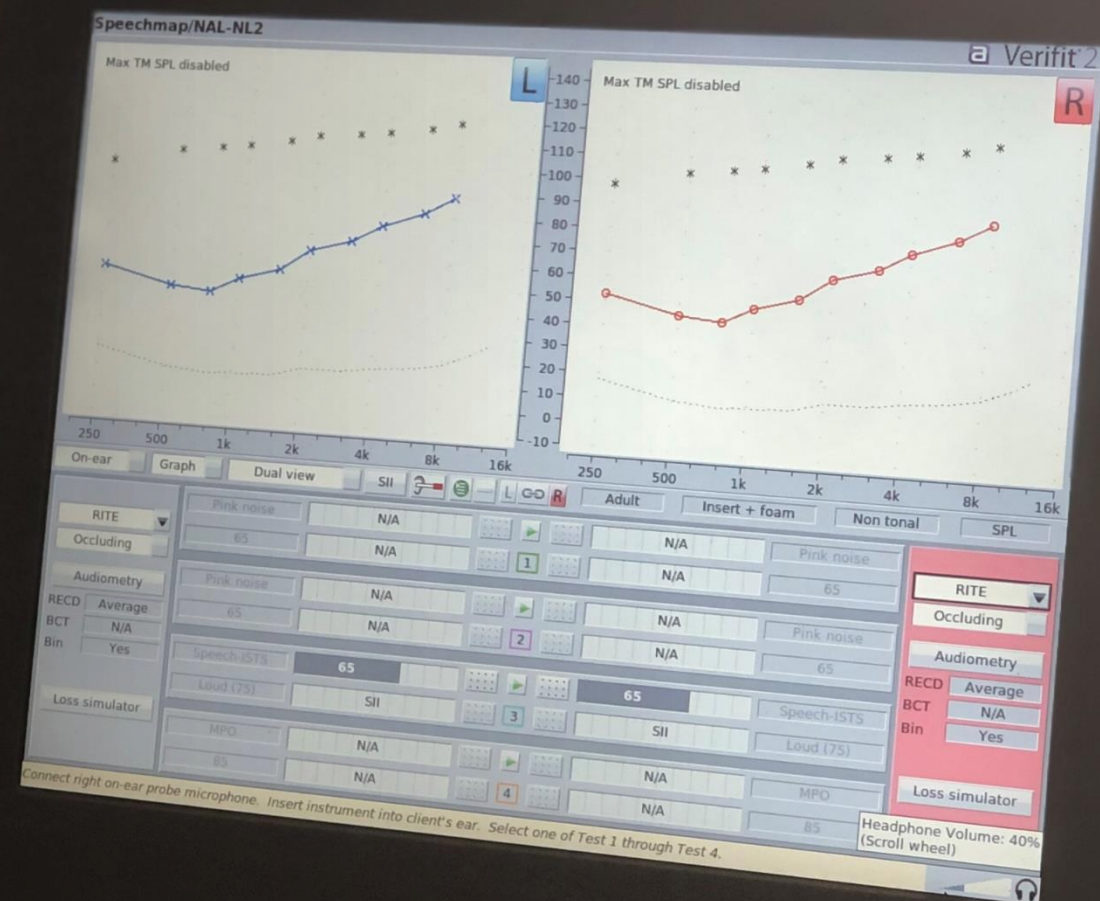
Next Step

Inserting the Hearing Aids

- Mute the hearing aids (as you would with a patient) and place them into CARL's ears without moving the probe tubes. The placement of the marker at the intertragal notch should remain in the same place. If it has moved, reposition the probe.

- Trainees should practice inserting the hearing aids into the ears until they are proficient at having the hearing aids in the correct place without moving the probe.

- As with a patient, make sure that the hearing aids are properly in the ears prior to starting the real ear measures.

Completed CARL Set-up for probe tube REM

Probe tubes and RICs are in CARL's ears

The audiogram is entered into the Audioscan VF2 and the prescriptive method (NAL-NL2 for this example) have been chosen along with an average RECD

The proper hearing aid type and coupling have been chosen and a binaural fitting was selected
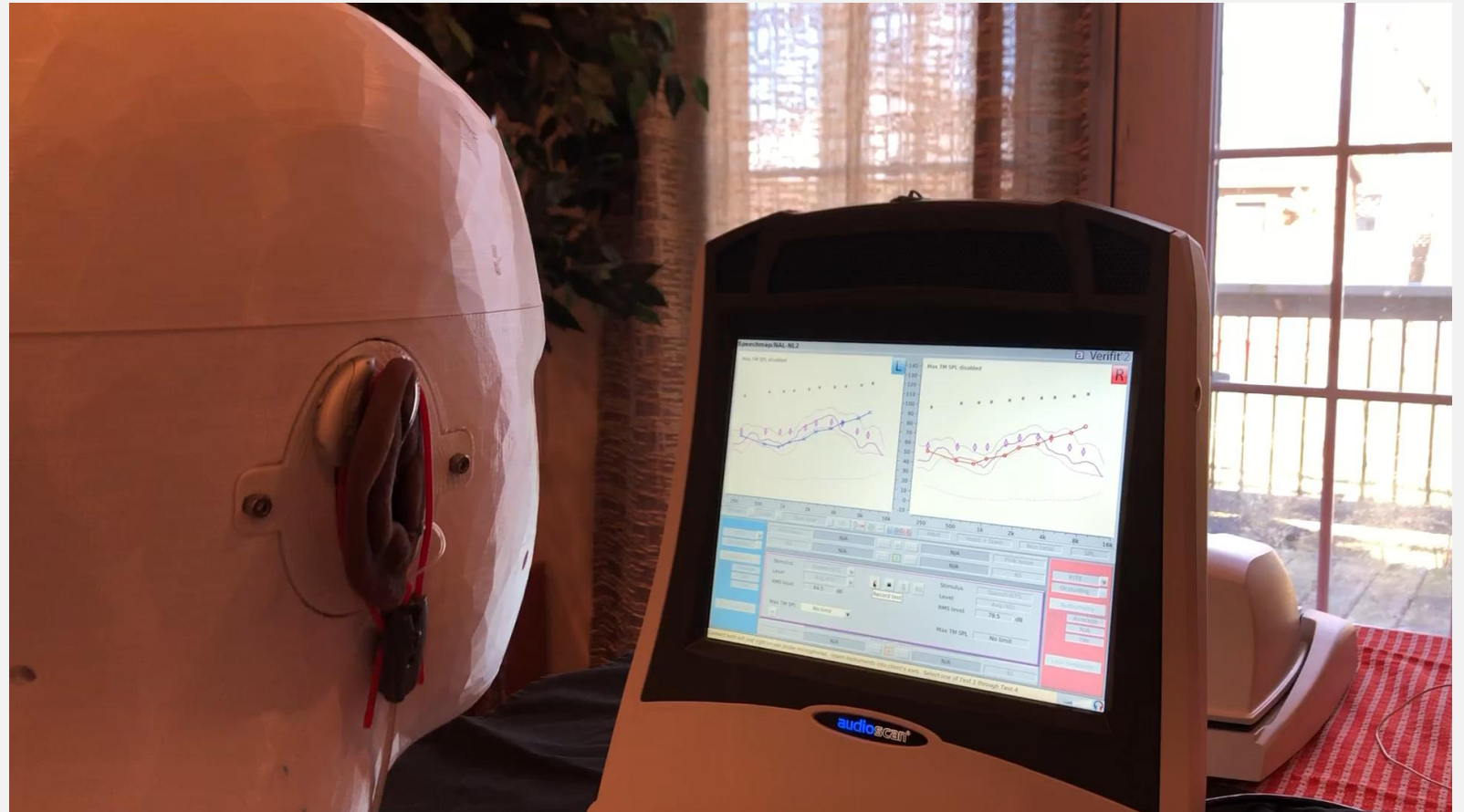
Next Steps:

Run a 65 dB SPL curve on the manufacturer's fit to NAL-NL2 using a speech signal.

Then use the manufacturer's software to fine-tune the frequency response closer to target.

Notes:
In this video, we used the ISTS signal, but the trusty Carrot Passage works just as well.

The manufacturer's software derived NAL-NL2 fitting can be seen at time 0 seconds of the video. Have trainees print this screen to compare this fitting with the final fine-tuned fitting

Next Steps:

Once the frequency response of the hearing aid matches the 65 dB SPL curve well, repeat the same procedure for a 55 dB SPL, 75 dB SPL and MPO signal.

If changes are made when running other curves, ensure that trainees rerun the 65 dB SPL curve to make sure it is still on target.

Review what the results on the screen mean including the fit-to-target, RMSE, SII.

Examples of Possible Lab Exercises

1. Have the trainees "print screen" the 65 response to the manufacturer's first fit before starting the fine tuning. Once the aids are fine tuned, compare and discuss differences in the fit-to- target, RMS error and SII obtained.

2. Choose a set of hearing aids with a VerifitLink option. Have the trainees fit the aids using the protocol just reviewed and time themselves (Make sure to check what test curve levels the VerifitLink runs and adjust the trainee fitting accordingly). "Print screen" the fitting. With the hearing aids and probes still in CARL's ears, put the fitting back to the manufacturer's first fit then use the VerifitLink option to fit the hearing aids. Time the fitting and compare the REM results and time taken.

3. Have the trainees first fit the hearing aids to the manufacturer's own fitting method and run the curves for 55, 65, 75 dB SPL and MPO. Compare and discuss the output across frequencies of this fitting to the fitting that was fine-tuned to the prescriptive target.

4. Trainees can measure and compare the manufacturer's proprietary fittings without fine-tuning of several brands of hearing aids.

Lesson Note

- This lesson is the starting point for other hearing aid fitting lessons. The proper fitting of the hearing aids to a validated prescriptive method is the first step before other features can be examined.

- Trainees should practice hearing aid fittings with a variety of hearing aid brands, styles, power levels, and venting options.

- If possible, trainees should practice hearing aid fittings using a variety of real ear fitting equipment to prepare them for placements and employment.

Evaluating Competencies

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

- Place a probe tube into CARL's ear at the proper depth
- Set-up CARL to have real ear probe tube measures completed
- Complete a real ear to coupler difference measure with CARL
- Complete a RIC hearing aid fitting with CARL choosing the appropriate receiver length, acoustic coupling for the audiogram chosen
- Be able to identify and discuss the components of the Speechmap fitting screen including threshold in SPL, targets, range of amplified speech, amplified long term average speech spectrum, loudness discomfort levels (see Figure 7.11 p. 300 in Modern Hearing Aids).
- Be able to discuss the results of the fitting with respect to frequency response, fit-to-targets, SII with a high degree of knowledge.

Resources

Referenced:

[1]Bisgaard, N., Vlaming, M. & Dahlquist, M., (2010). Standard Audiograms for IEC 60118-15 measurement procedure. Trends Amplif. 14(2); 113-120.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4111352/

Referenced and Recommended Reading

[2]Beck DL.(2017). Speech mapping and probe microphone measurements: An interview with Gus Mueller, PhD. *Hearing Review* 24(8):38-39.:
https://www.hearingreview.com/hearing-products/testing-equipment/speech-mapping-probe-microphone-measurements-interview-gus-mueller-phd

Recommended Reading

Modern Hearing Aids: Verification, Outcome Measures, and Follow-up. Editors: R. Bentler, H.G. Mueller, T.A. Ricketts, 2016.

- Chapter 4 sections on prescription method and programmer being used
- Chapter 6 sections on background and procedure for REAR and setup
- Chapter 7 : pp: 298-304.

Recommended Reading if completing VerifitLink exercise

Folkeard, P., Pumford, J., Abbasalipour, P., Willis, N., Scollie, S., (2018). A comparison of automated real-ear and traditional hearing aid fitting methods. Hearing Review 25(22):28-32

https://www.hearingreview.com/hearing-loss/patient-care/hearing-fittings/comparison-automated-real-ear-traditional-hearing-aid-fitting-methods

Modern Hearing Aids: Page 284

Resources

REM Equipment

For review of the Real Ear Measurement Equipment used in this example visit

Audioscan:

https://www.audiologyonline.com/partners/audioscan/

https://www.audioscan.com/en/

Other Real Ear Measurement System information can be found at:

Interacoustics: https://www.interacoustics.com/hearing-aid-fitting

Natus: https://hearing-balance.natus.com/en-ca/products-services/aurical-freefit

https://www.audiologyonline.com/audiology-ceus/course/verification-counseling-digital-hearing-instruments-24674

MedRx http://www.medrx-usa.com/remlsm-3-fitting-systems/