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On a Mac

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Real-Ear Measures

A Deep Dive

AMANDA WOLFE, Au.D. EDUCATION AND TRAINING AUDIOLOGIST

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Hear better. Live better.

Learning Outcomes

1. Participants will be able to explain the benefits of utilizing real-ear measurements in their practice
2. Describe how to prepare for real-ear measurements
3. Describe the real-ear measurement process

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Best Practice

Contributes to higher overall satisfaction with hearing aids and their hearing care professional, as well as an improved patient experience[1].

Includes individual ear information for a **more precise, personalized hearing aid fitting**.

The best way to verify the performance of a hearing aid[2] according to best practices.

1. Amlani AM, Pumford J, Gessling E. Improving patient perception of clinical services through real-ear measurements. *Hearing Review.* 2016;23(12):12-21.
2. Valente M, Abrams H, Benson D, et al. Guidelines for the Audiological Management of Adult Hearing Impairment. *Audiology Today.* 2006;Vol 18.

Goals of REM

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Goals

Verify Audibility

Verify Output

Ensure Patient Benefit

Troubleshoot Complaints

Soft speech and environmental sounds are audible

Average speech is comfortable

Loud sounds are not uncomfortable

Independent Fitting formulas

NAL-NL1 *(Byrne et al, 2001)*

- Maximizes speech intelligibility
- Keeps overall loudness at a level no greater than that perceived by a normal-hearing person

NAL-NL2 *(Keidser et al, 2011)*

- Revised version of NAL-NL1, but provides a different gain-frequency response shape
- Slightly higher compression ratios for mild/moderate hearing loss

DSL v5 *(Beck et al, 2007)*

- Provide maximum audibility
- Maintain comfortable loudness

NAL-R *(Byrne & Dillon, 1986)*

- Intended for linear hearing aids
- Amplifies speech so that all frequency bands contribute equally to its loudness

Integrating REM into your Clinical Practice

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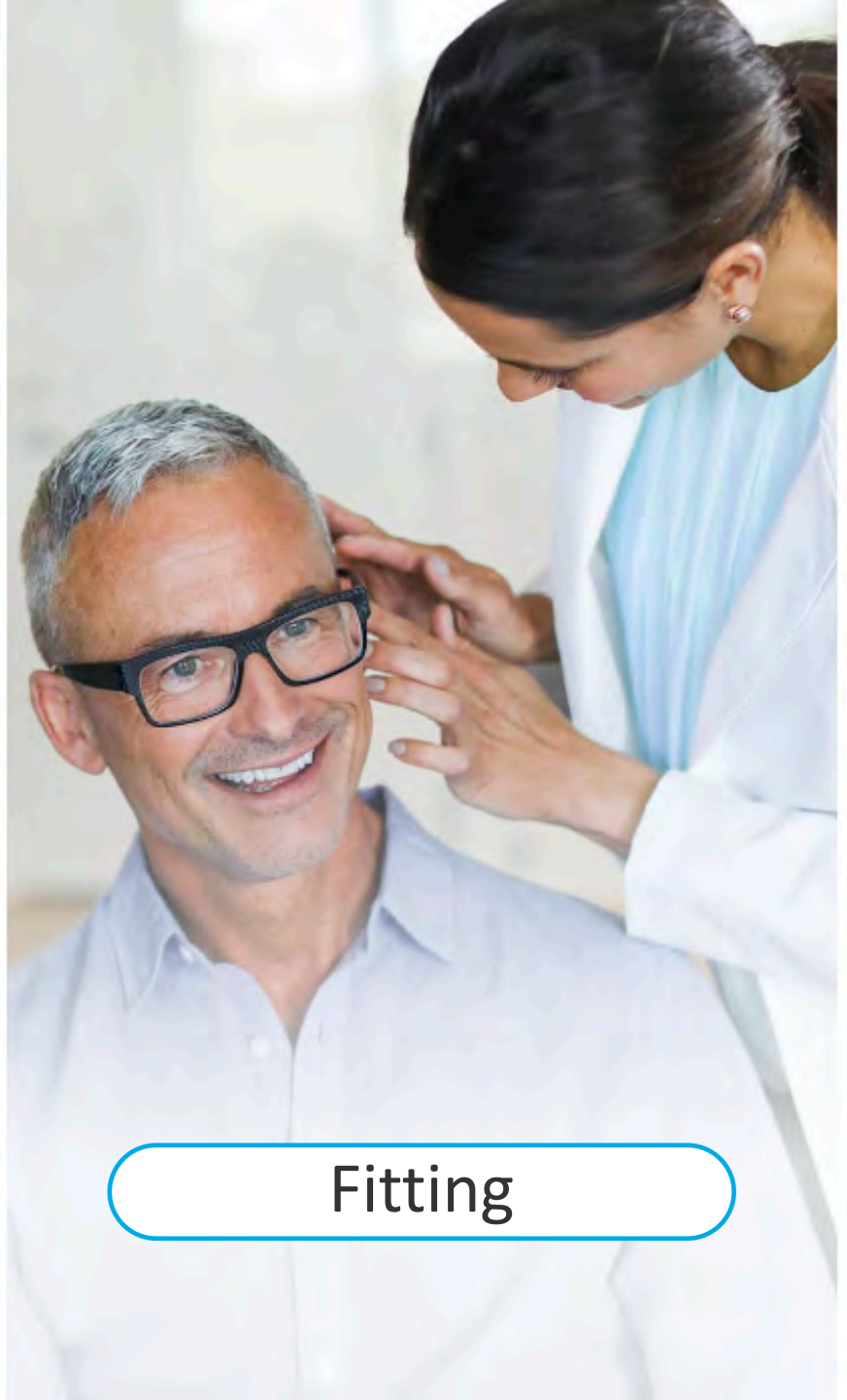
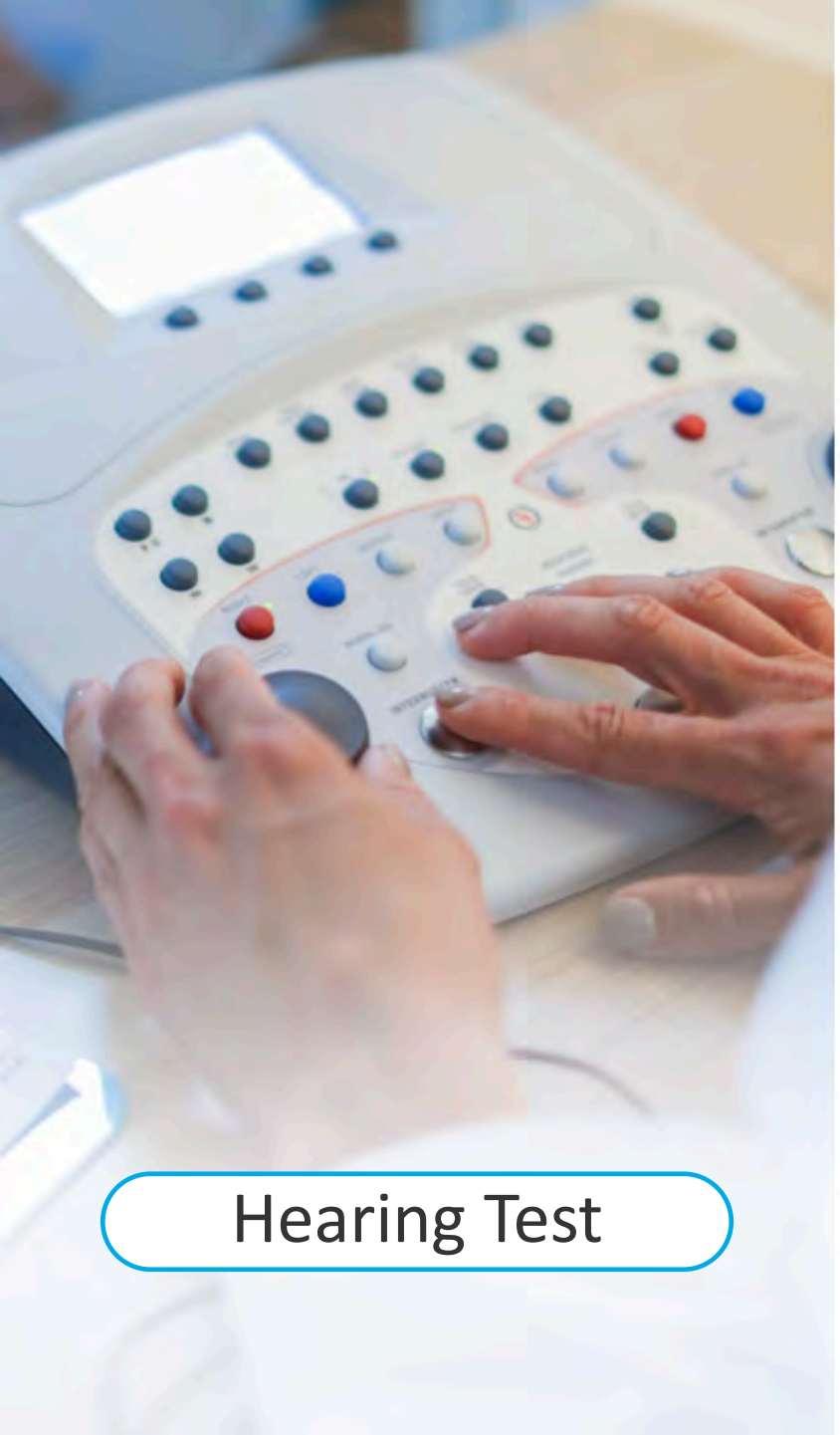
Hearing Test

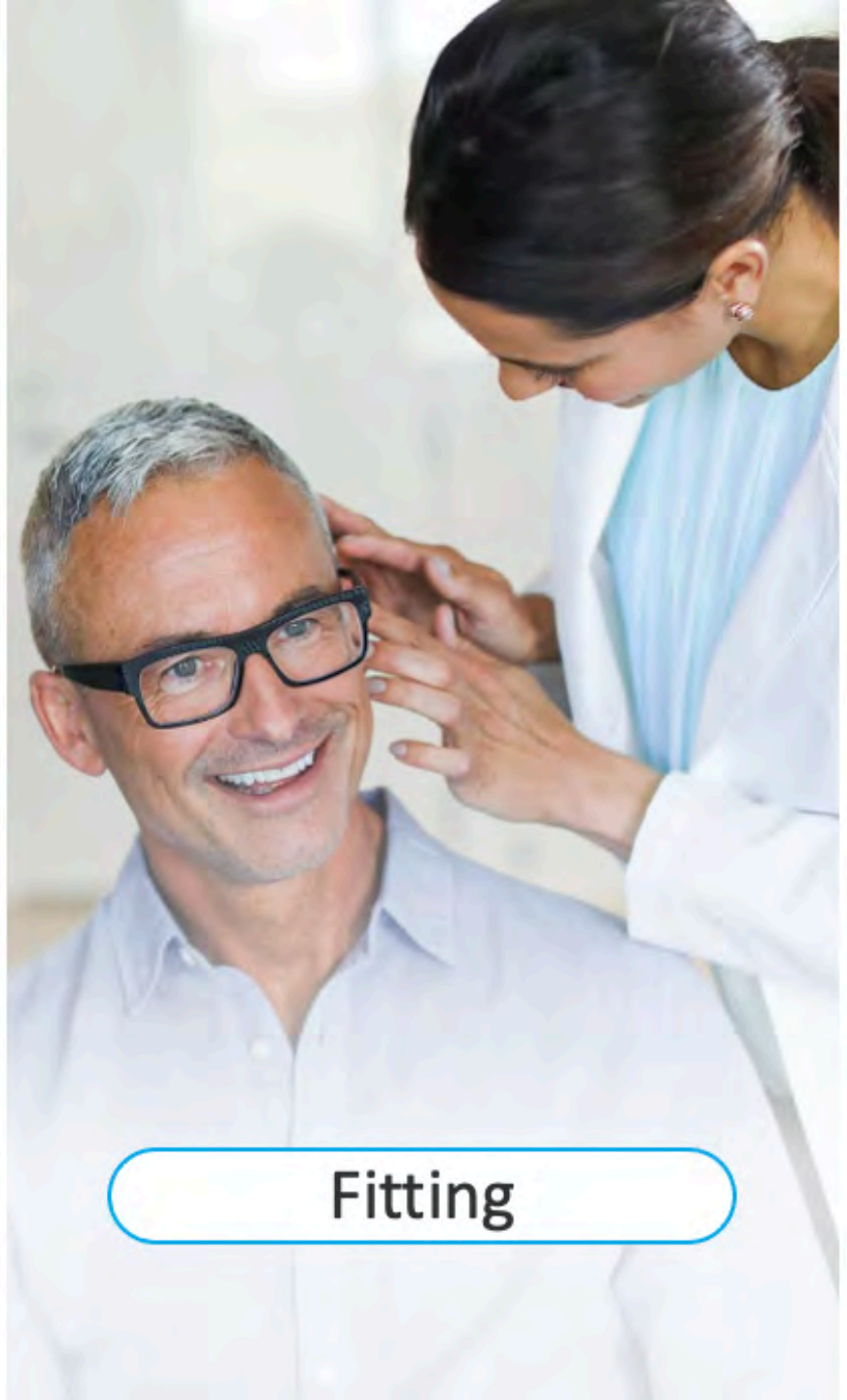


Fitting

Follow-up



Hearing Test



Fitting

Follow-up

REM Terminology

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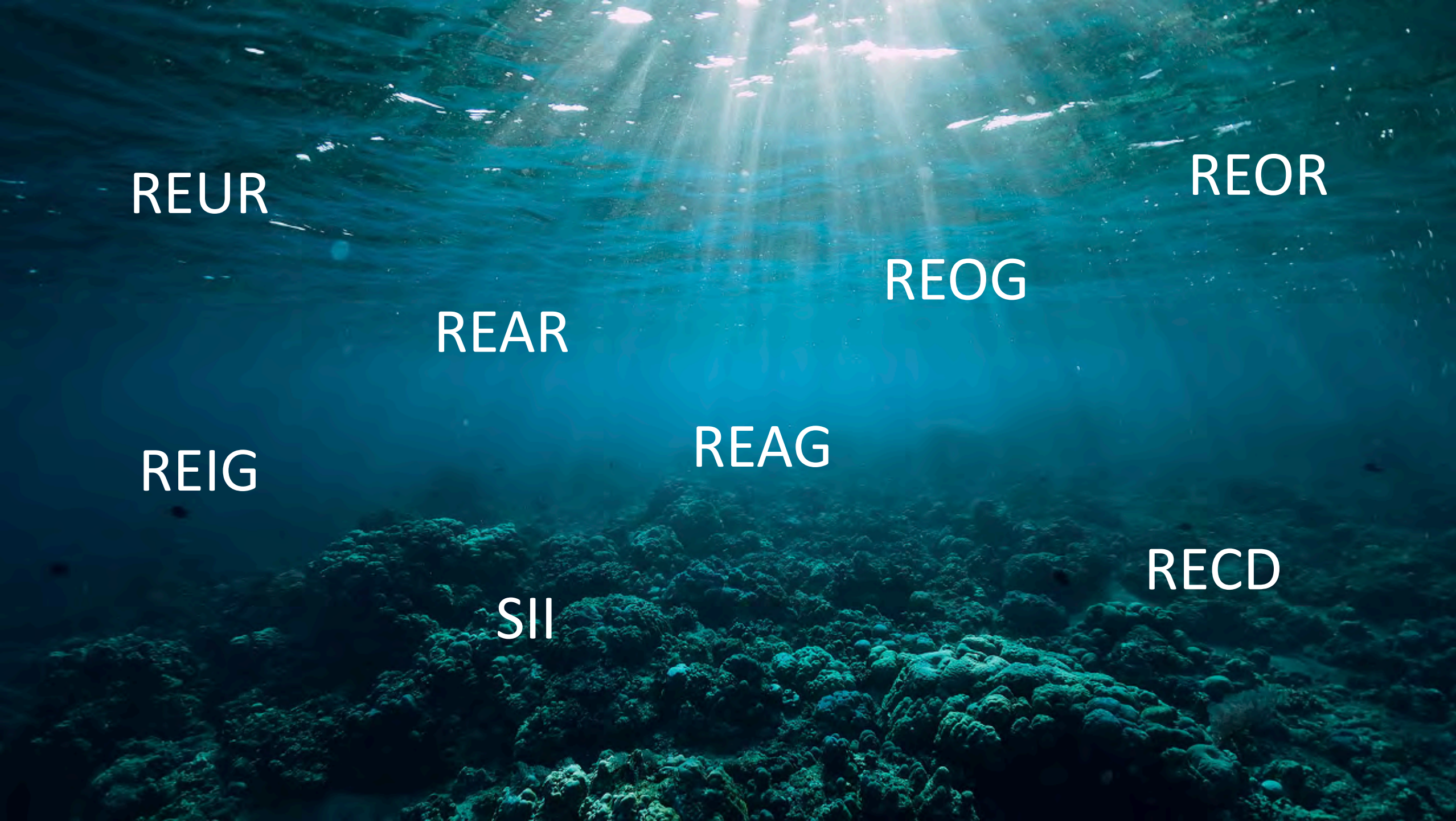
REUR
REOR
REOG
REAR
REAG
REIG
RECD
SII

Response

An *absolute* measure of SPL

Input + Gain = Response/Output

Gain

A response that is expressed *relative* to a specified input or reference response

---

Output – Input = Gain

REAR Real-Ear Aided Response

(ANSI S3.46-1997)
The SPL, as a function of frequency, at a specified measurement point in the ear canal for a specified sound field, with the hearing aid (and its acoustic coupling) in place and turned on.

The frequency response of a hearing aid that is turned on, measured in the ear canal, for a particular input.

REAG Real-Ear Aided Gain

(ANSI S3.46-1997)
Difference in decibels, as a function of frequency, between the SPL at a specified measurement point in the ear canal and the SPL at the field reference point, for a specified sound field, with the hearing aid (and its acoustic coupling) in place and turned on.

The gain of the hearing instrument across frequencies, measured in the ear canal. Subtract the input signal level from the REAR across frequencies to obtain the REAG.

REAR – INPUT = REAG

SII Speech Intelligibility Index

The SII score is a way of quantifying the likely intelligibility of speech based on the proportion of speech cues that are audible to the listener.

It is a measure ranging between 0.0 and 1.0 “that is highly correlated with the intelligibility of speech.” (ANSI, S3.5, 1997, p. 1).

On-Ear Measures Setup

Audioscan Verifit 2

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Audioscan Verifit

Speechmap

Set-up Steps

1. Calibration
2. Enter audiogram
3. Select fitting formula
4. Select device type/coupling
5. Select stimulus
6. Patient placement
7. On-ear probe tube placement
8. Hearing aid set-up
9. Patient preparation

SETUP

Calibration

Compares frequency response of probe tube to flat frequency response of the external reference mic, and compensates for this difference in all subsequent measurements

STEP 1

Calibration

Fold the probe tube over and place the probe tube opening on top of the reference microphone.

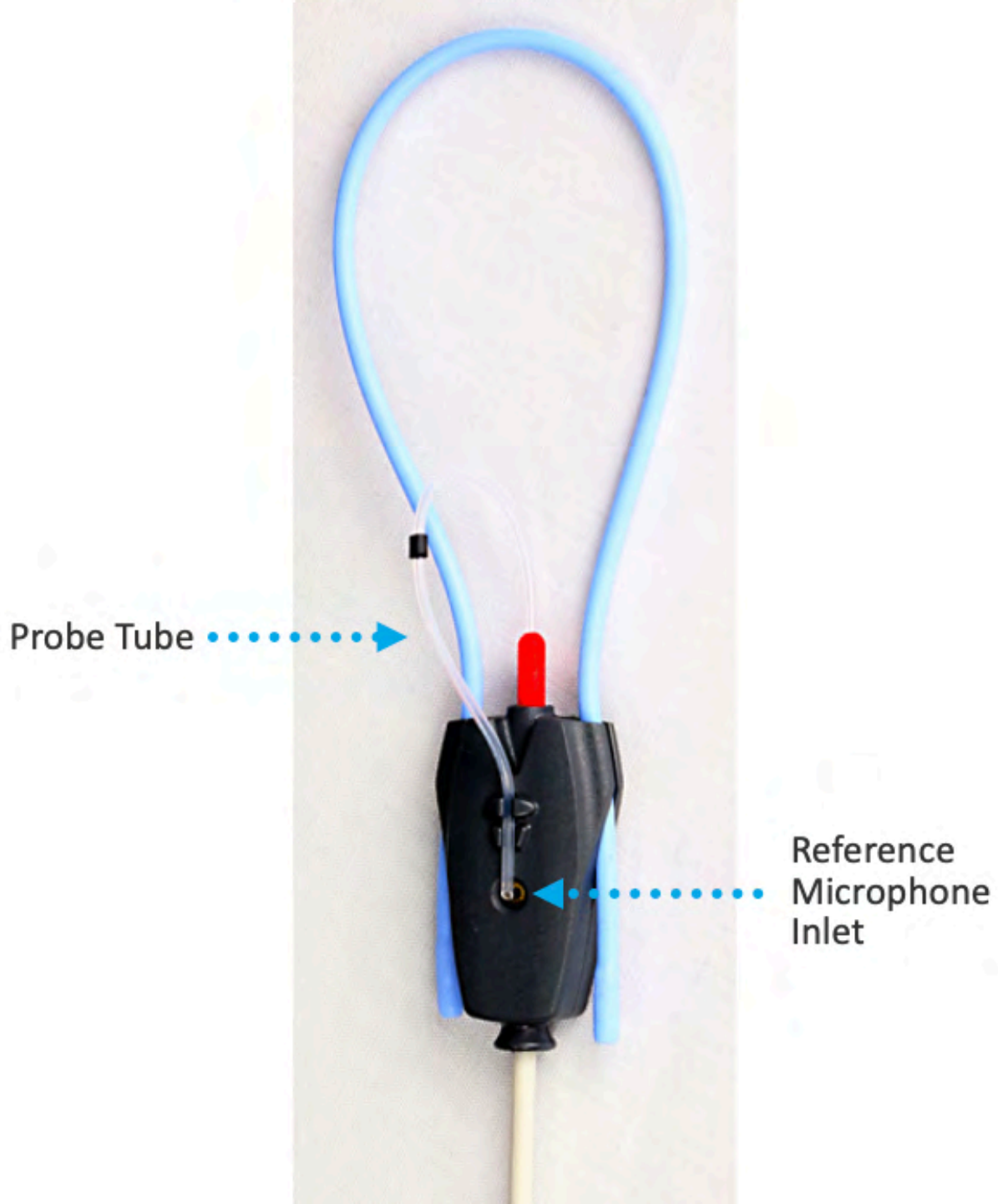


Image take from the Audioscan Verifit User Guide

STEP 1

Calibration

To Calibrate

- Hold the probe dock 6-36 inches from the speaker
- Select Calibrate

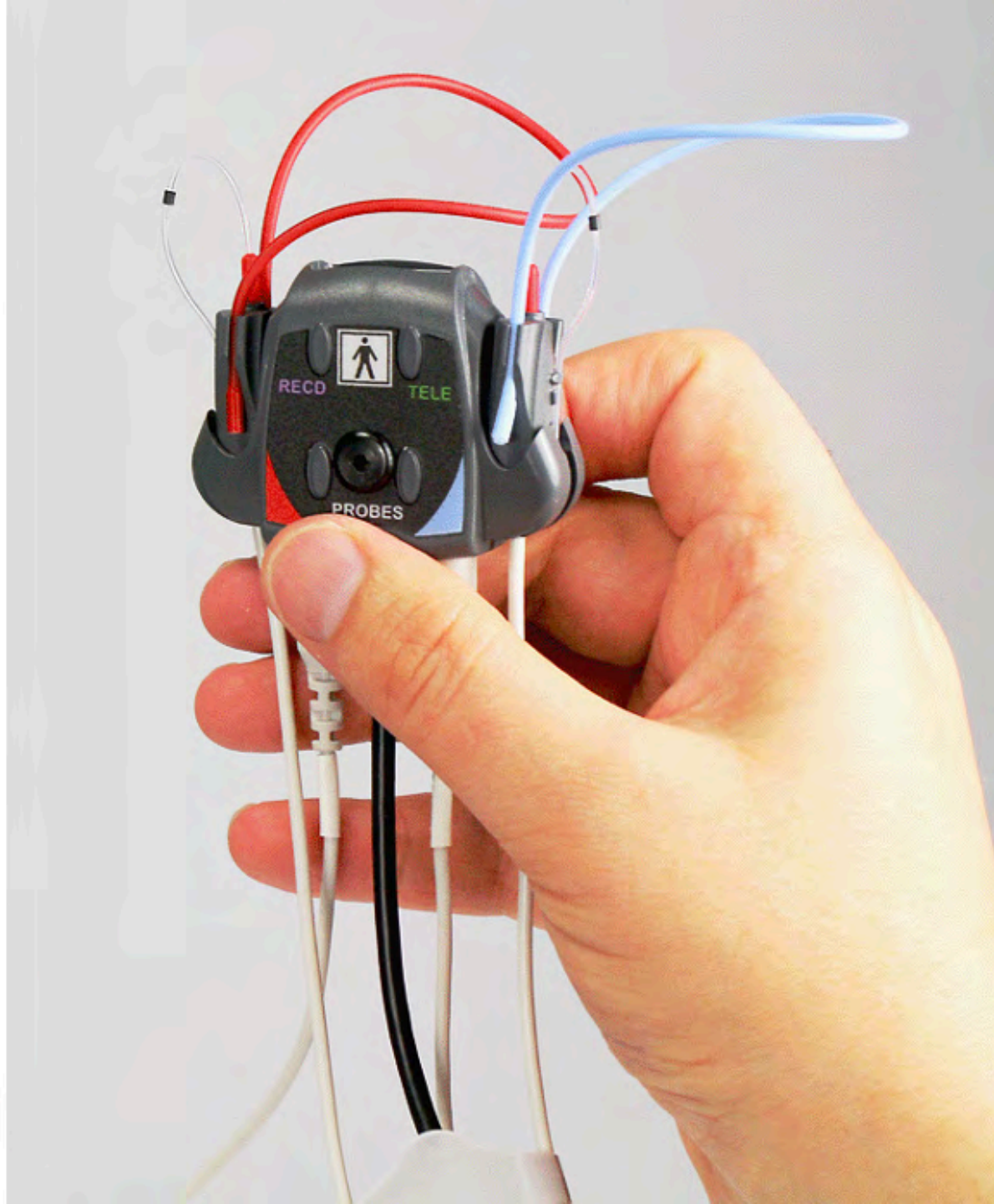


Image taken from the Audioscan Verifit User Guide

STEP 1

Calibration

To Calibrate

- View calibration curve
- Repeat for other probe dock

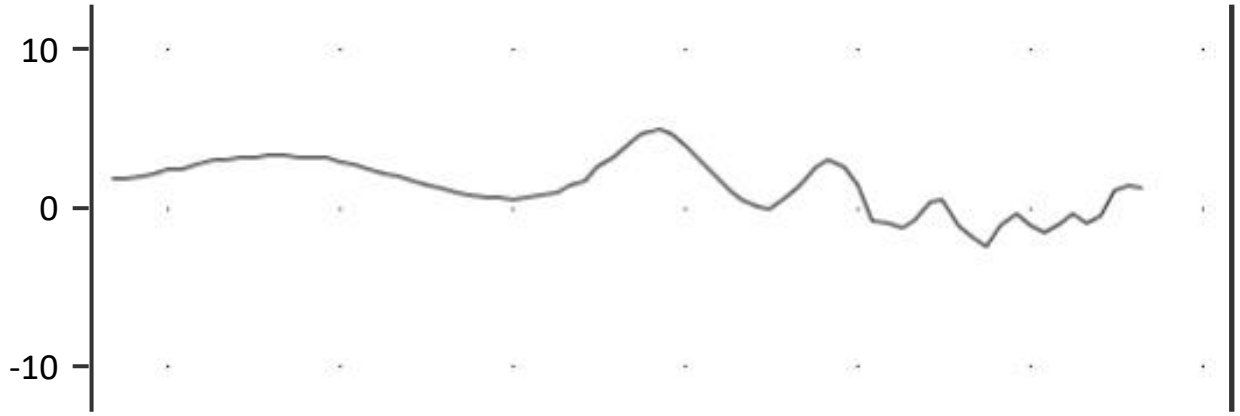
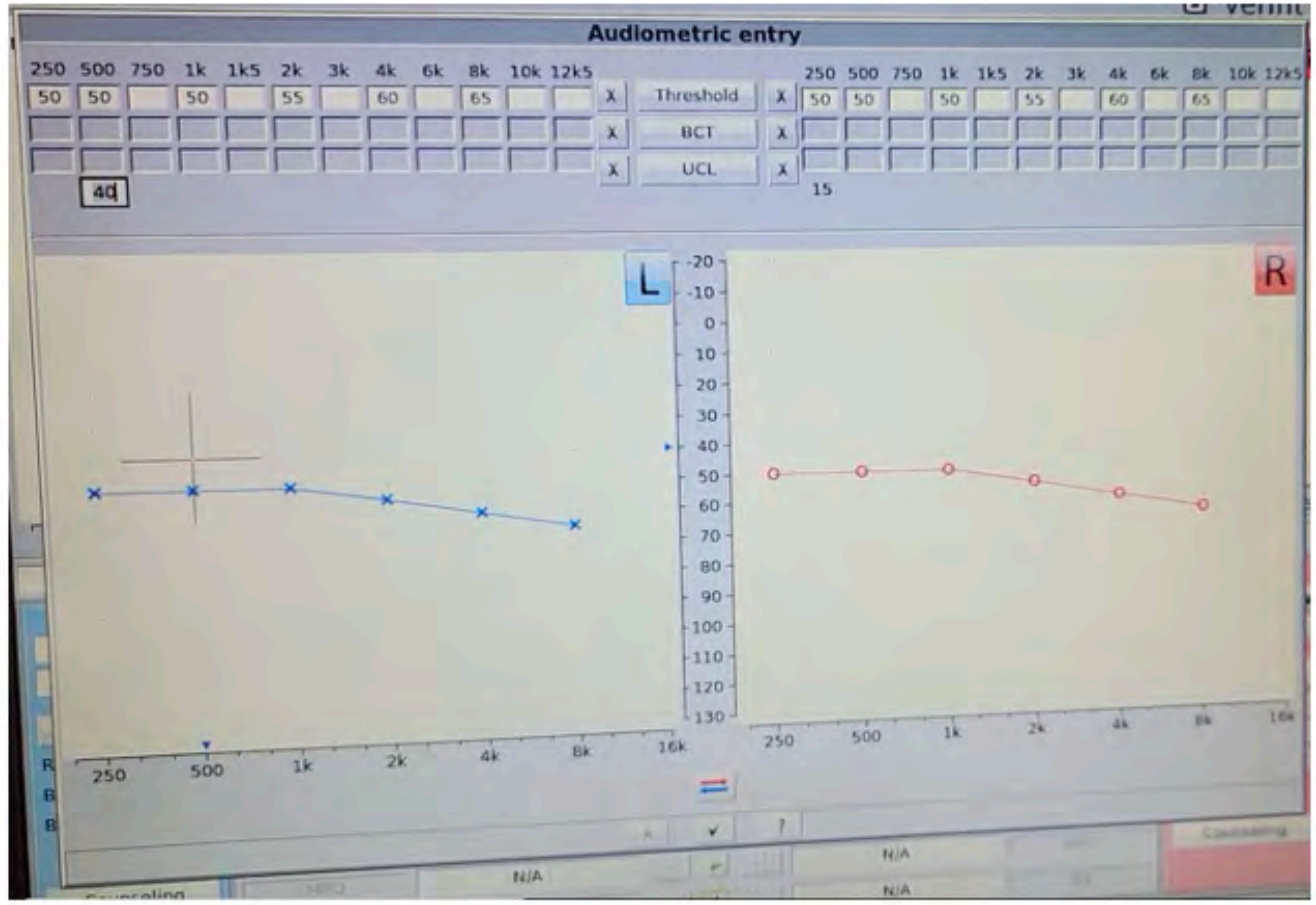


Image take from the Audioscan Verifit User Guide

STEP 2

Enter Audiogram

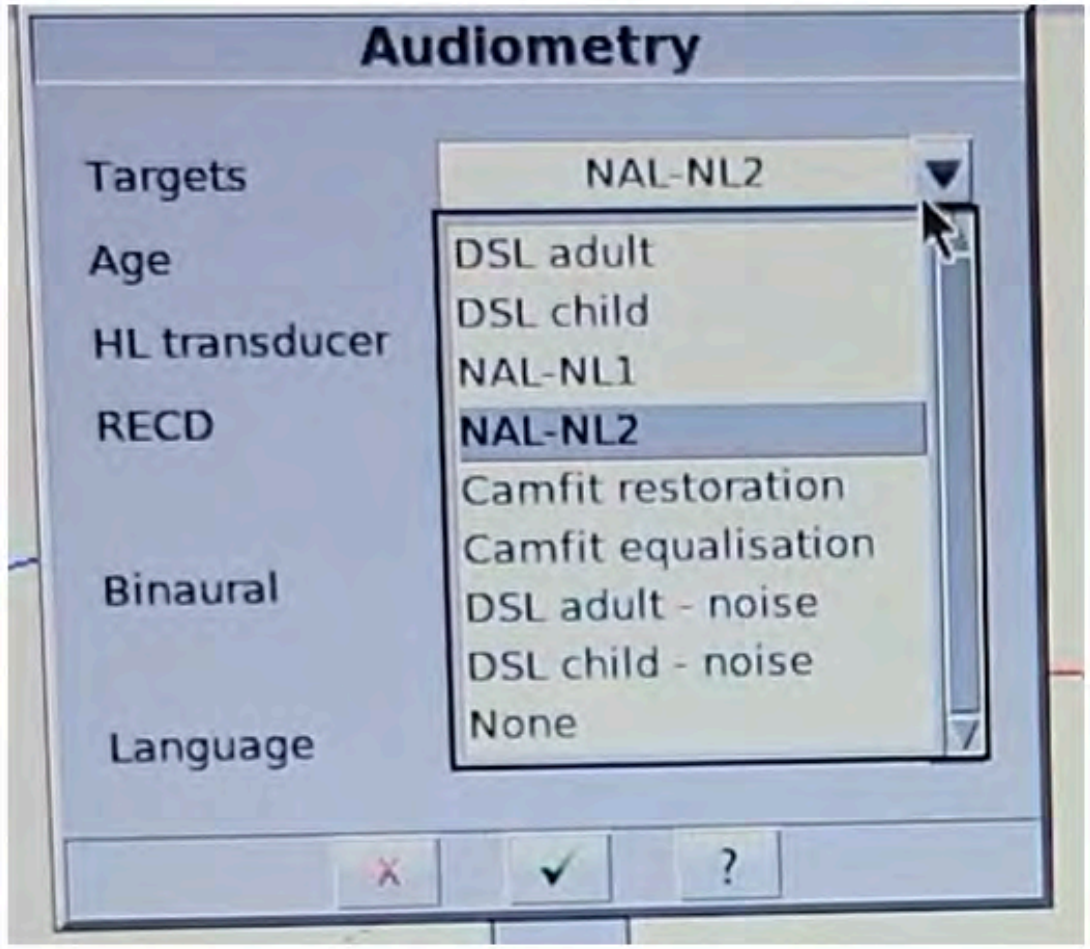
- Required to generate targets
- Manual entry or Transfer from database



STEP 3

Select Fitting Formula

- Determines fitting targets based on fitting formula philosophy
- Match fitting formula selected in the fitting software
- Approximate fitting formula based on manufacturer proprietary formula*

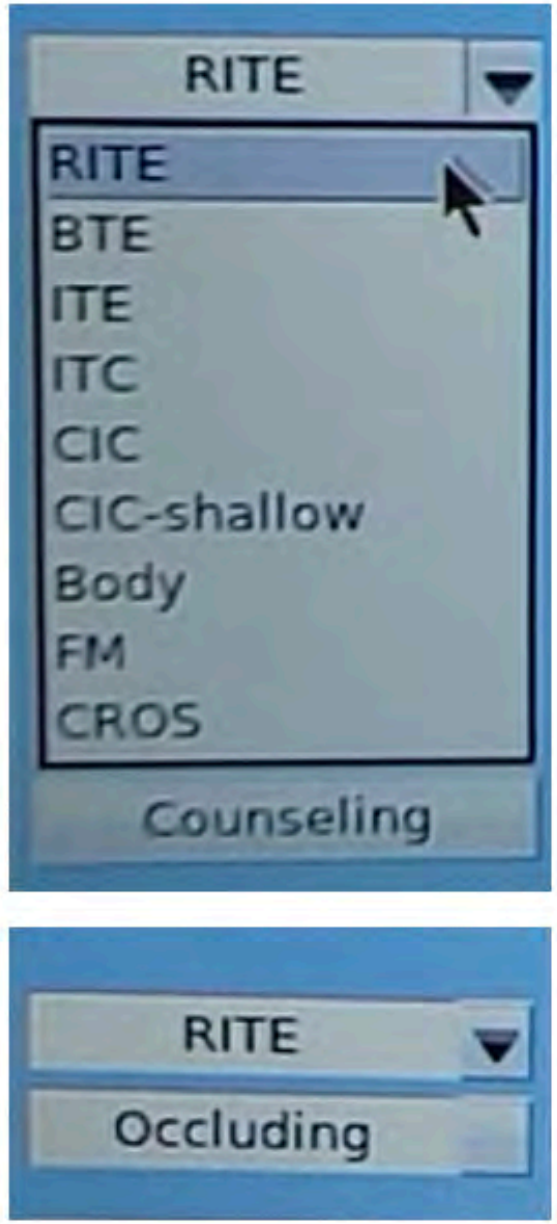


*Contact manufacturer for guidance

STEP 4

Select Device Type and Coupling/Vent

- Ensures appropriate target generation
- Determines need for sound field equalization



Sound Field Equalization

Concurrent

- For occluded fittings
- Reference microphone is on during measurements
- If the patient moves during the measurement, the system will adjust the signal level as needed.
- May result in an underestimation of hearing aid gain if used with open fit.

Stored

- For open fittings
- Reference microphone is off during measurements
- Patient must remain still during the measurement or equalization should be repeated if patient moves.
- Will prevent underestimation of hearing aid gain due to leakage.

STEP 5

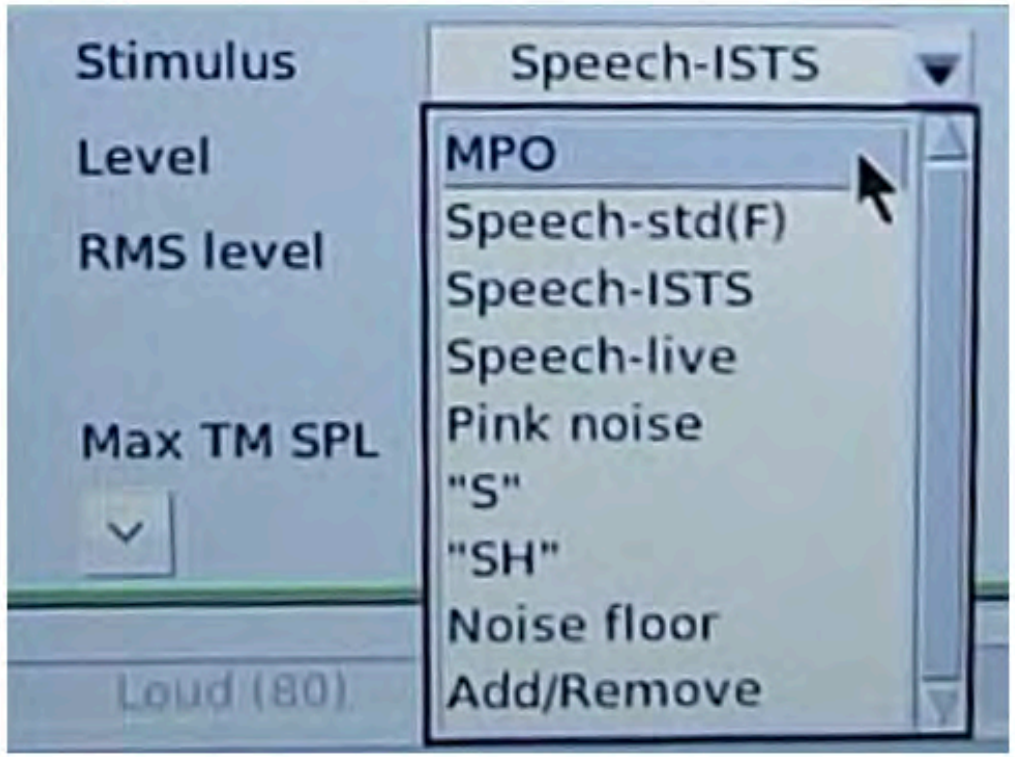
Select Stimulus

ISTS

- Female talker
- Segments of 6 languages sliced together to match the average speech spectrum

Speech-std

- Carrot passage
- Filtered to provide the long-term average speech spectrum (LTASS)

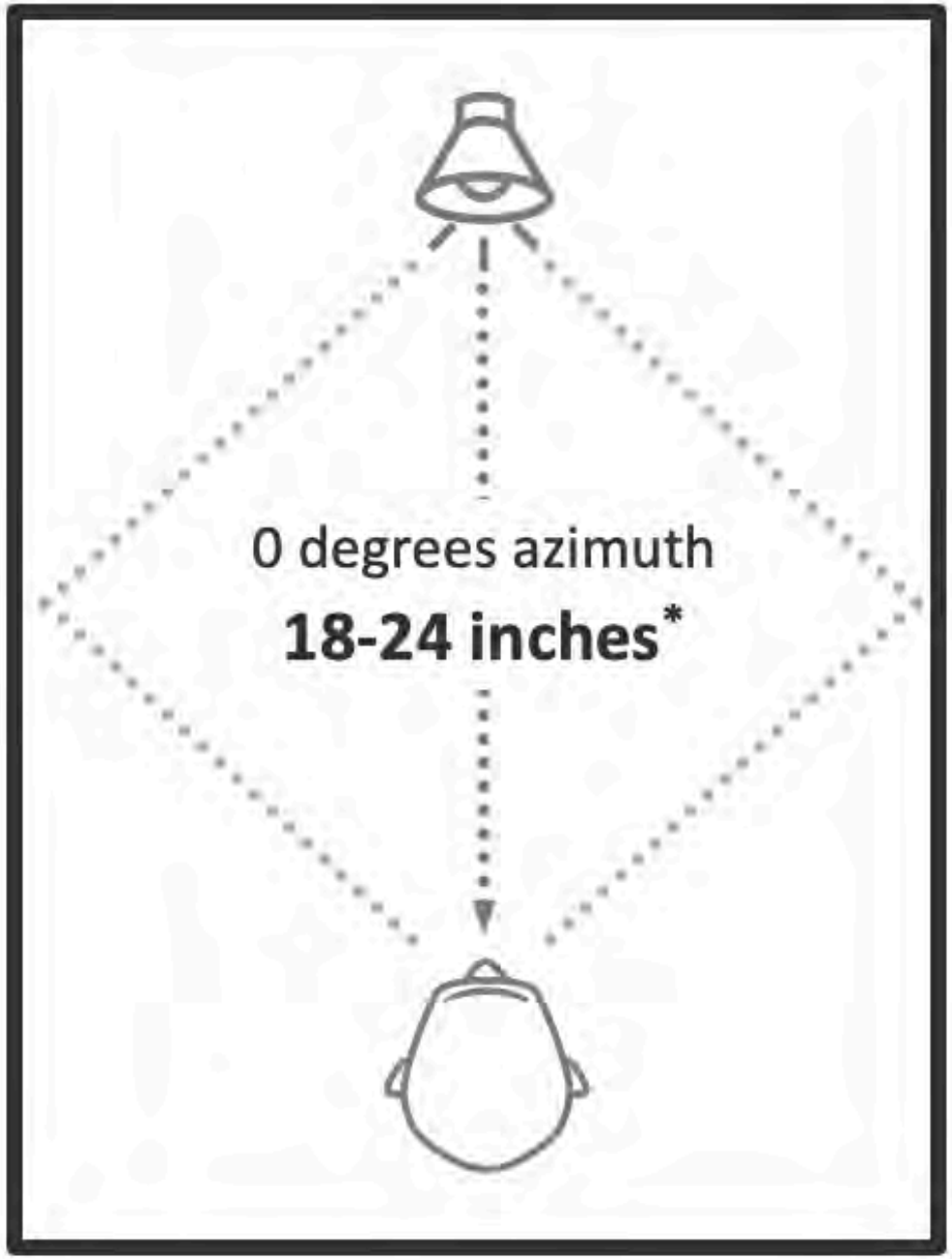


STEP 6

Patient Placement

To Position

- Choose a quiet location
- Position patient 18-24 inches in front of the speaker



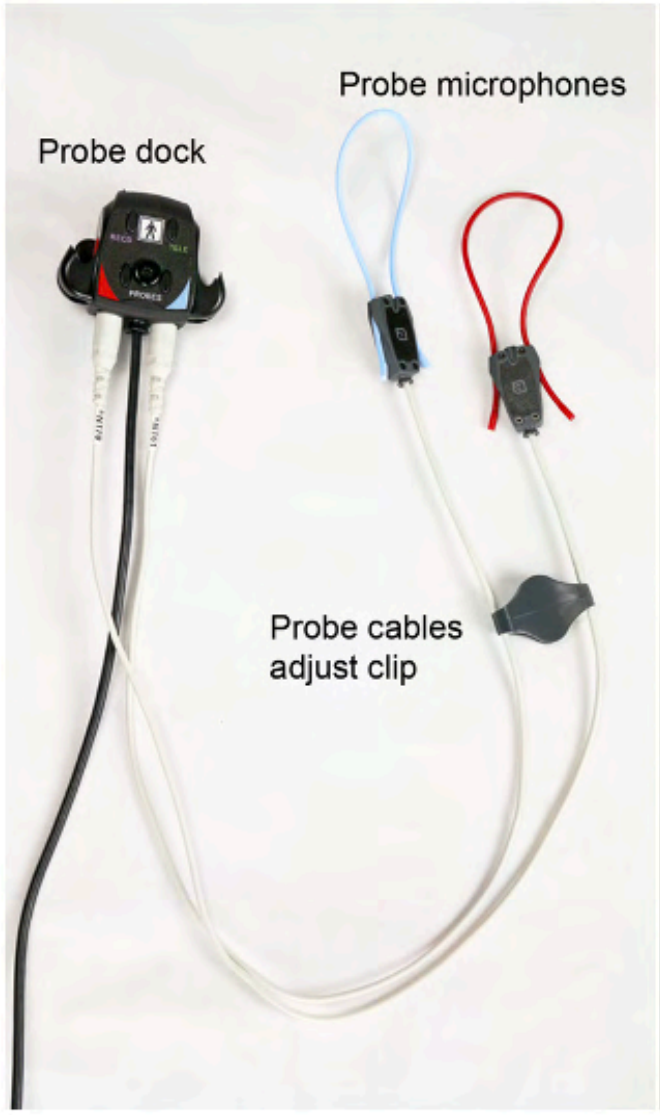
*Follow instructions from real-ear system manufacturer

STEP 7

On-Ear Probe Tube Placement

To Position

- Clip probe dock to patient’s shirt
- Hang ear loops over pinna and adjust to fit near the head and away from acoustic influence of pinna or hearing aid



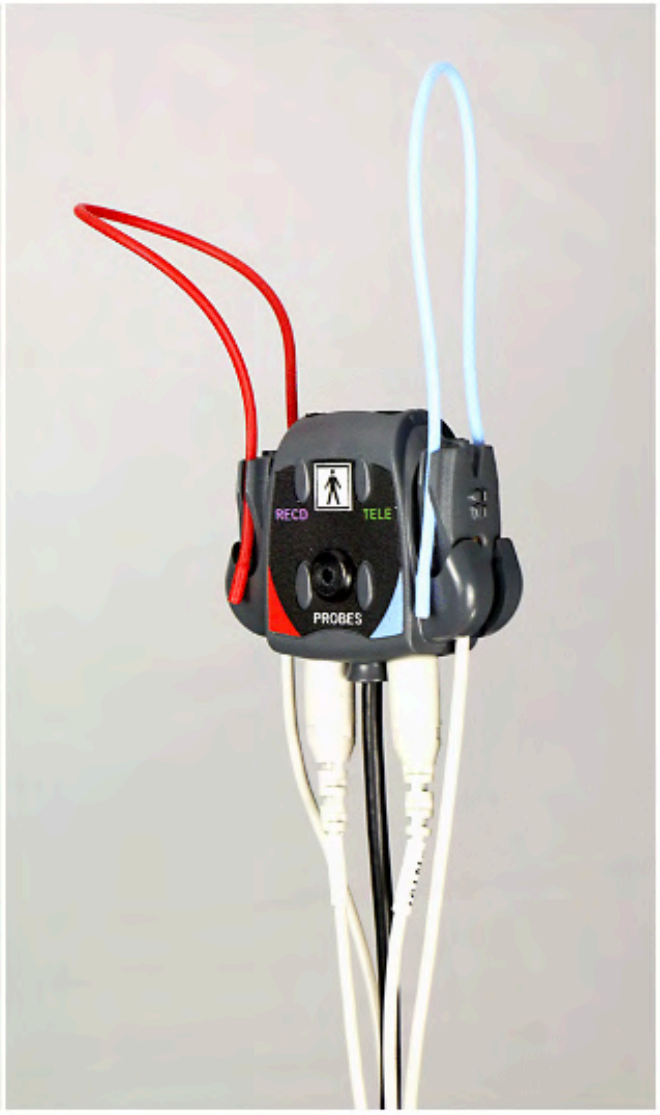


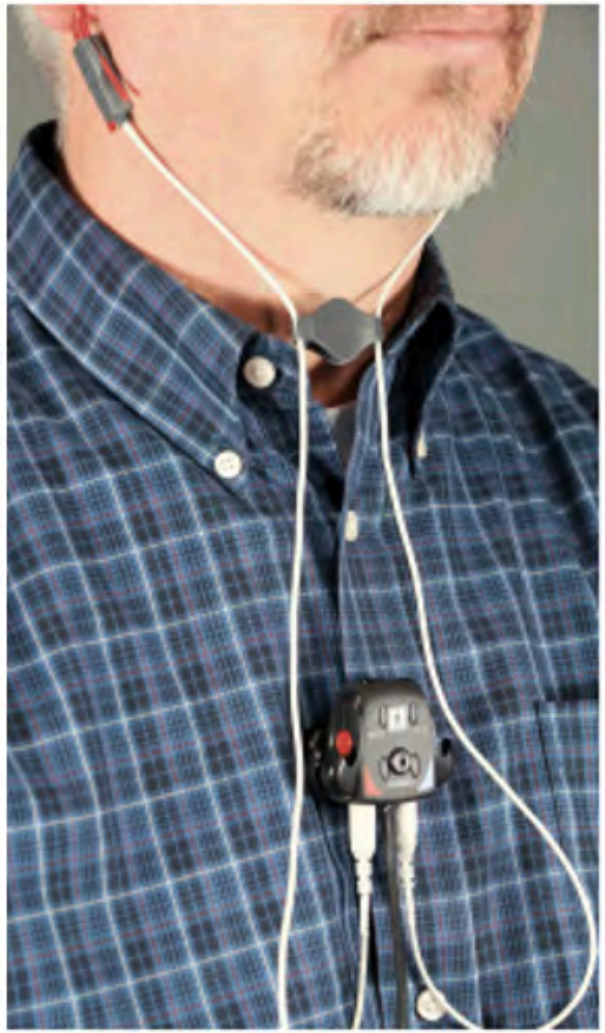
Image taken from the Audioscan Verifit User Guide

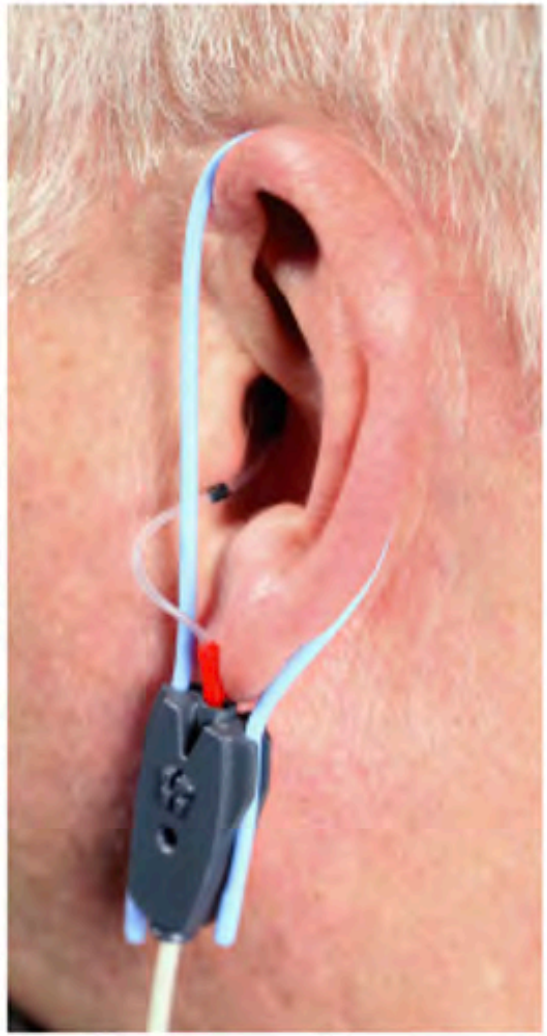
STEP 7

On-Ear Probe Tube Placement

To Position

- Positioning the probe tube
  - **Goal**: Within 2-5mm of eardrum
    - Adult males: ~30mm
    - Adult females: ~28mm
    - Children: ~20-25mm



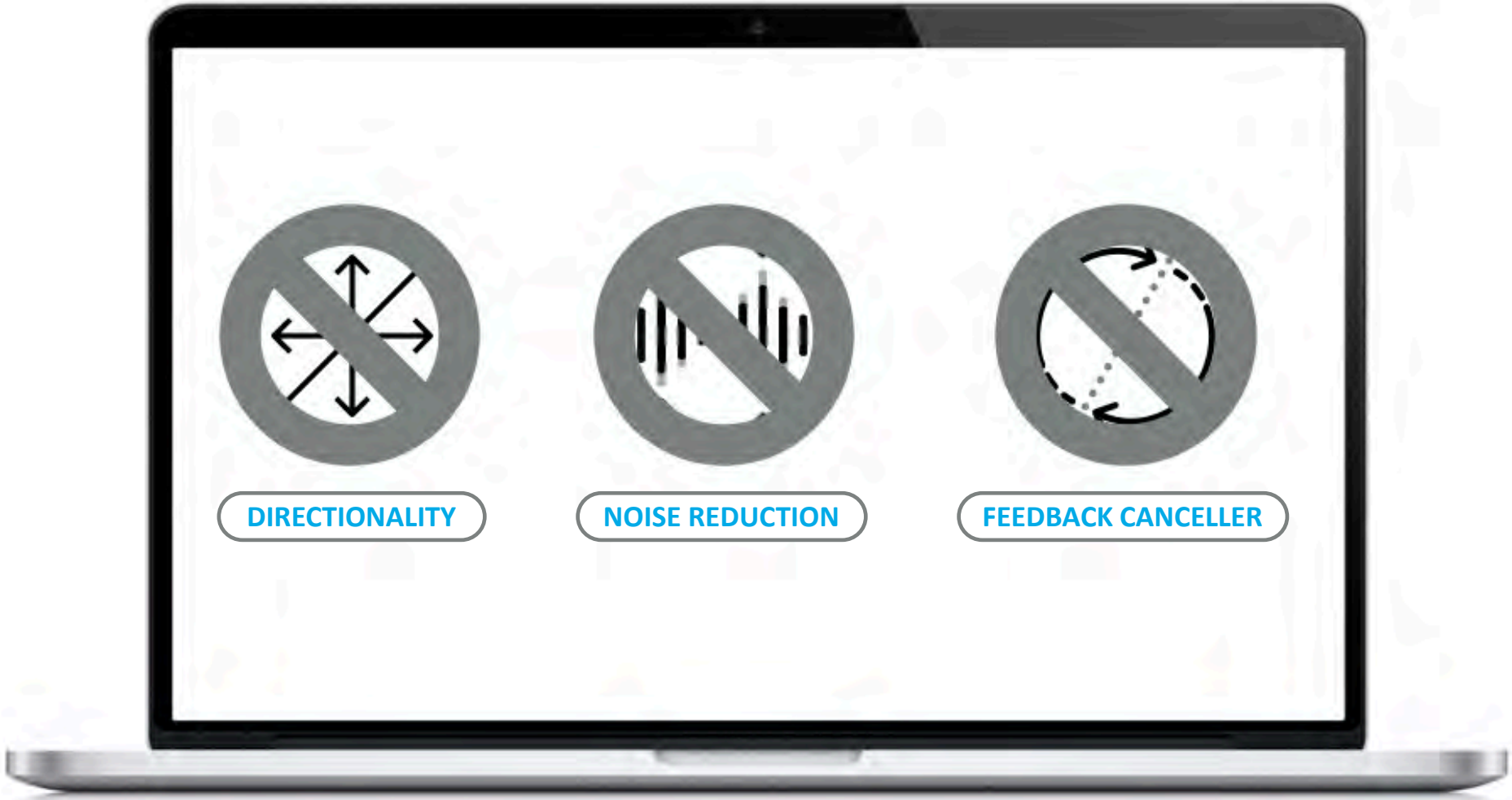


⚠ **CAUTION**: Do not poke the eardrum with the probe tube

Image taken from the Audioscan Verifit User Guide

STEP 8

Hearing Aid Setup

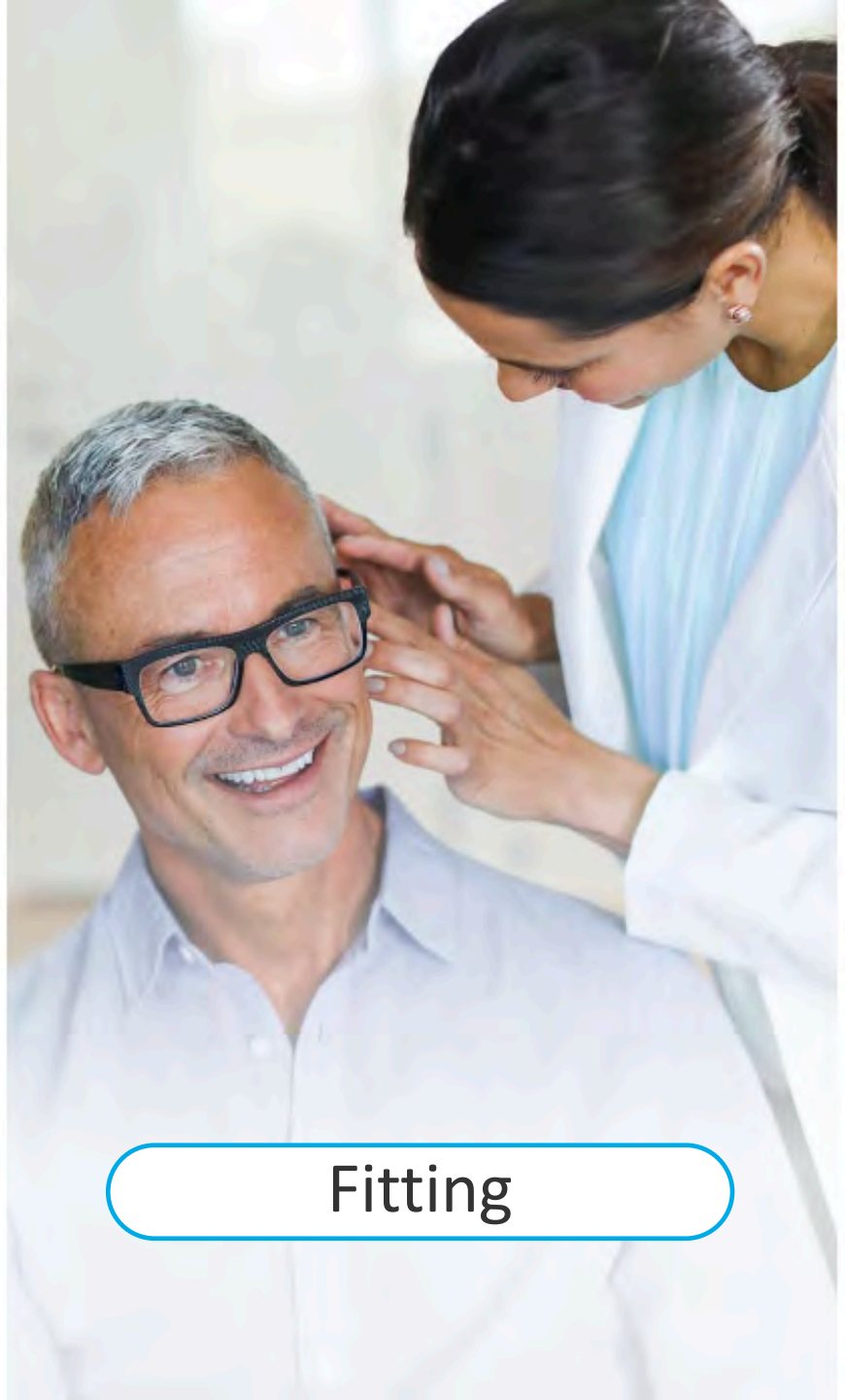


STEP 9

Patient Preparation

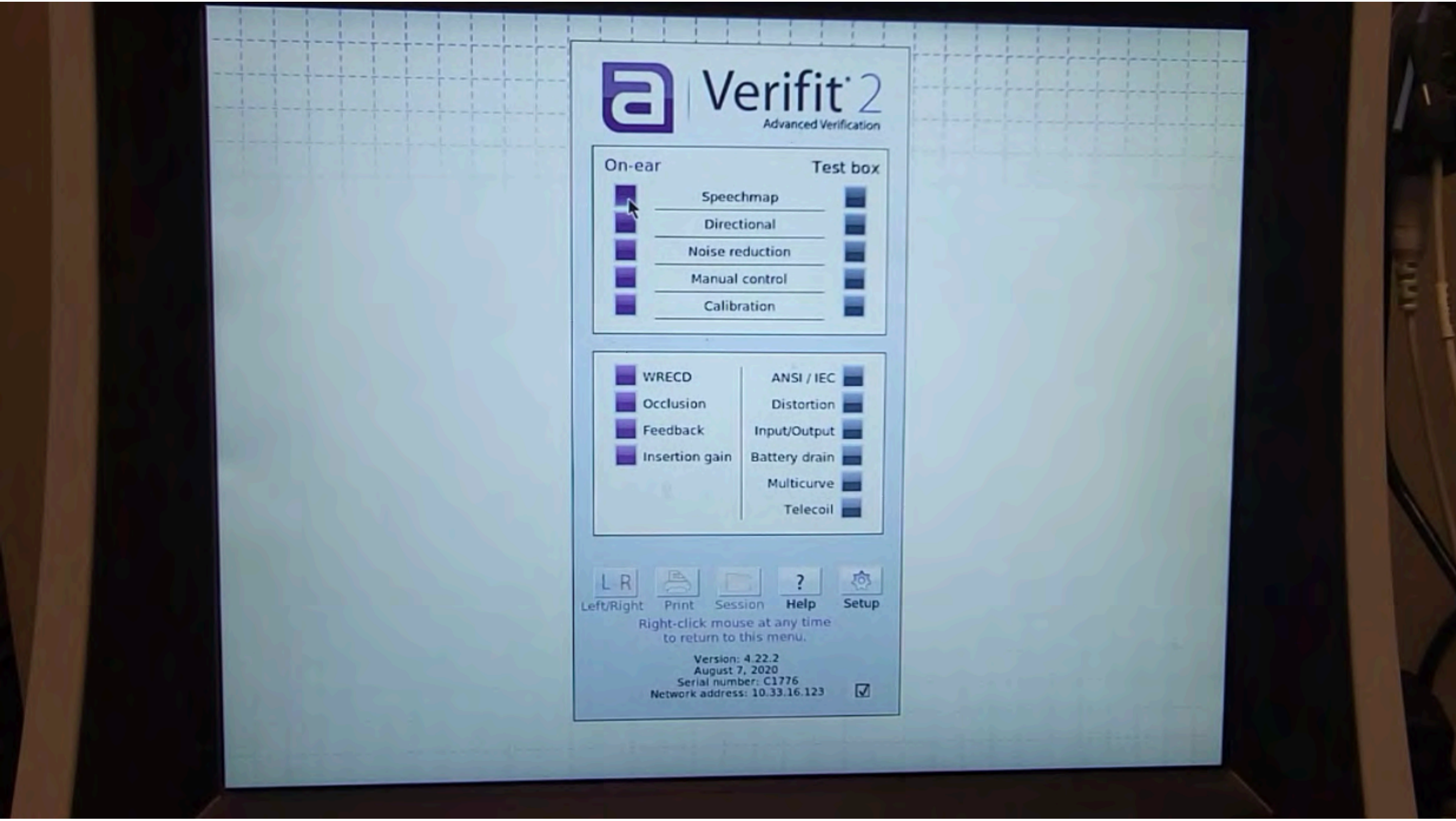
- Remain quiet and still
- Will be listening to speech at different volume levels
- Do not need to repeat back or even understand stimulus
- If signal gets uncomfortable loud, raise hand

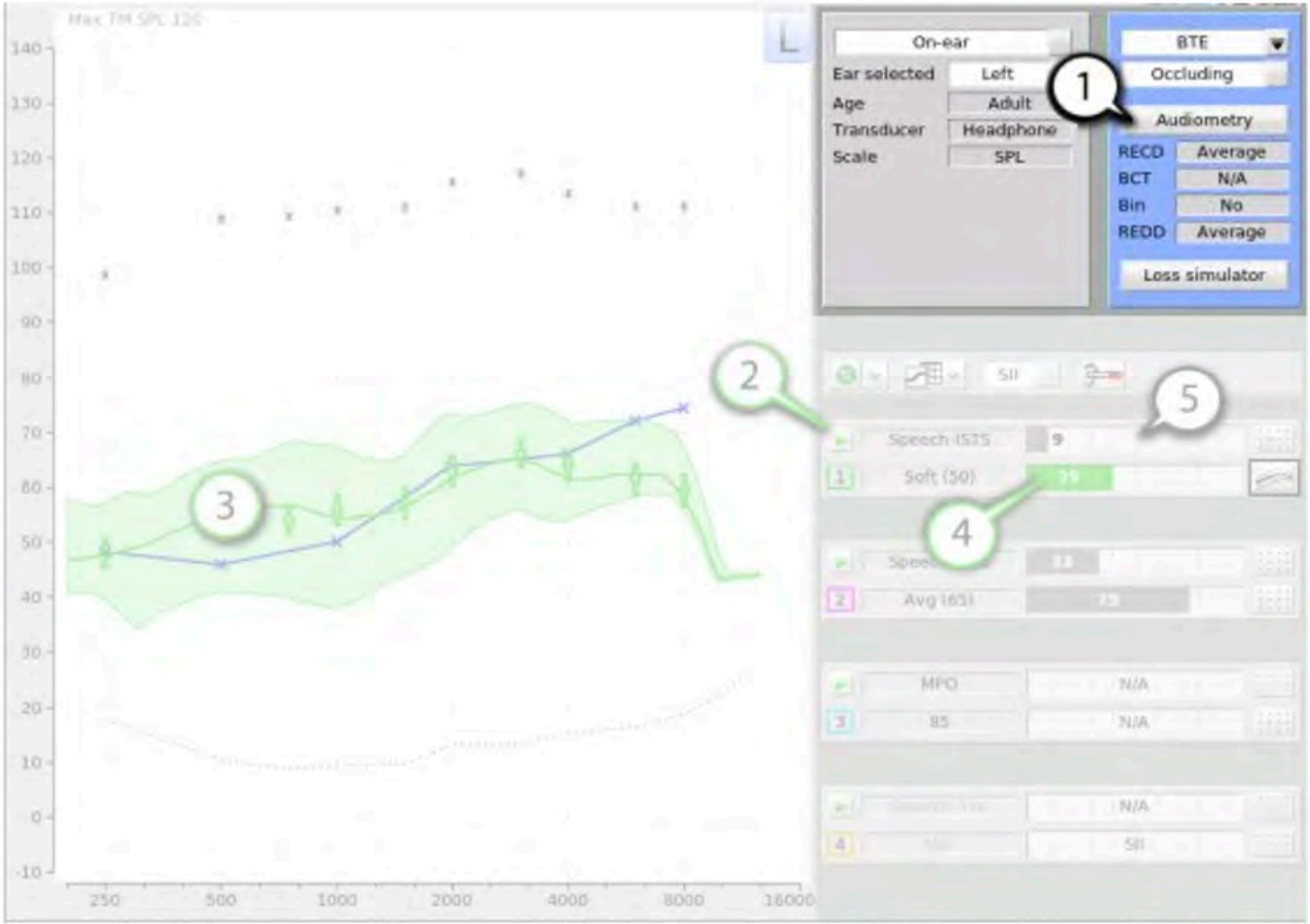
Hearing Test



Fitting

Follow-up

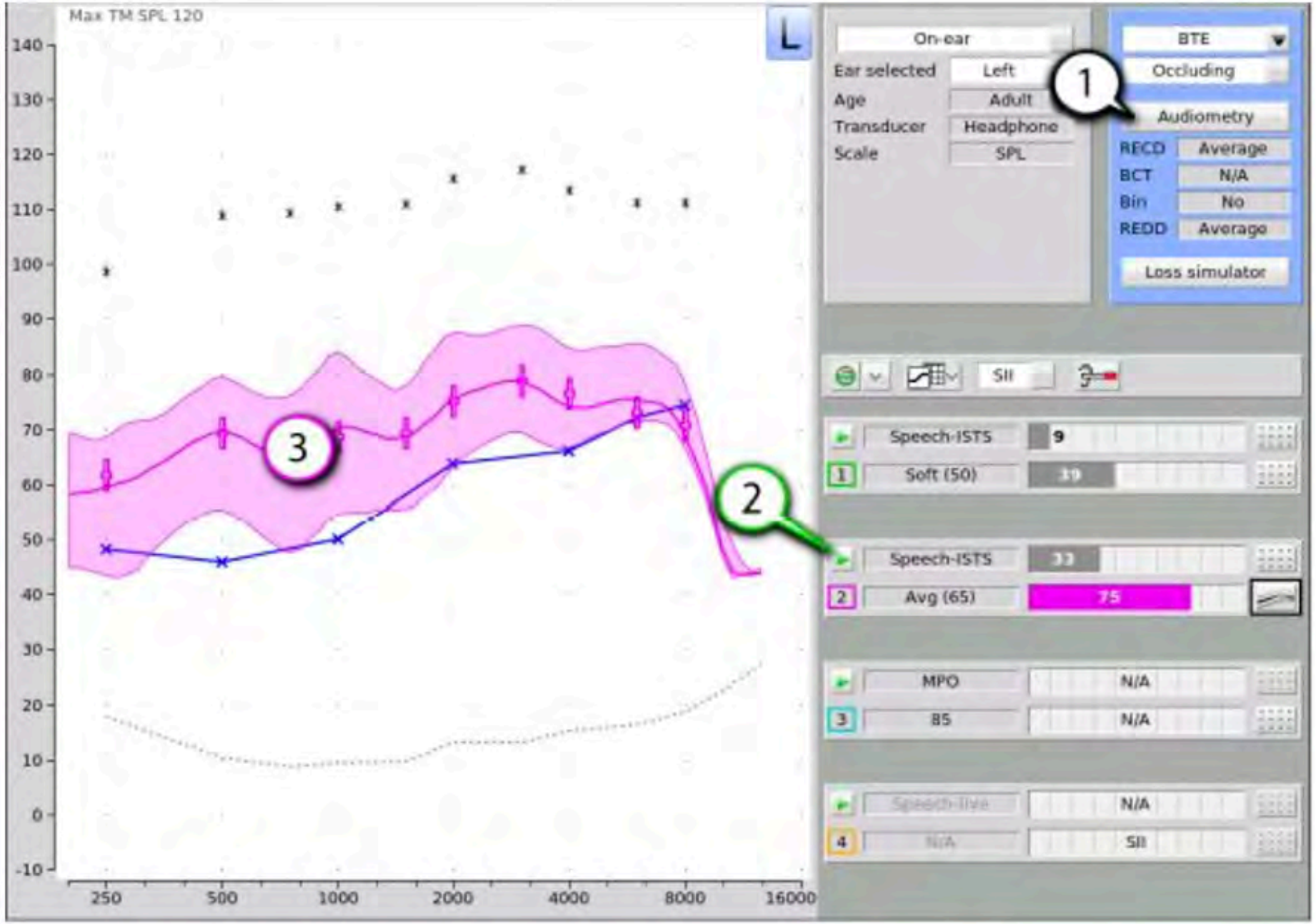

Verifit 2
Advanced Verification
On-ear
Test box
Speechmap
Directional
Noise reduction
Manual control
Calibration
WRECD
Occlusion
Feedback
Insertion gain
ANSI / IEC
Distortion
Input/Output
Battery drain
Multicurve
Telecoil
L R
Left/Right
Print
Session
?
Help
Setup
Right-click mouse at any time
to return to this menu.
Version: 4.22.2
August 7, 2020
Serial number: C1776
Network address: 10.33.16.123



1. Audiometry Entry
2. Start test
3. Aided envelope
4. Aided SII
5. Unaided predicted SII

Image taken from the Audioscan Verifit User Guide


Speechmap/NAL-NL2
Verifit 2
Max TM SPL 125
L
Max TM SPL 125
R
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
250
500
1k
2k
4k
8k
16k
On-ear
Graph
Dual view
SII
Adult
Insert + foam
Non tonal
SPL
RITE
Occluding
Audiometry
RECD
Average
BCT
N/A
Bin
Yes
Counseling
Speech-ISTS
Soft (50)
Avg (65)
Loud (80)
MPO
N/A
0
10
56
SII
1
2
3
4



1. Audiometry Entry
2. Start test
3. Aided envelope

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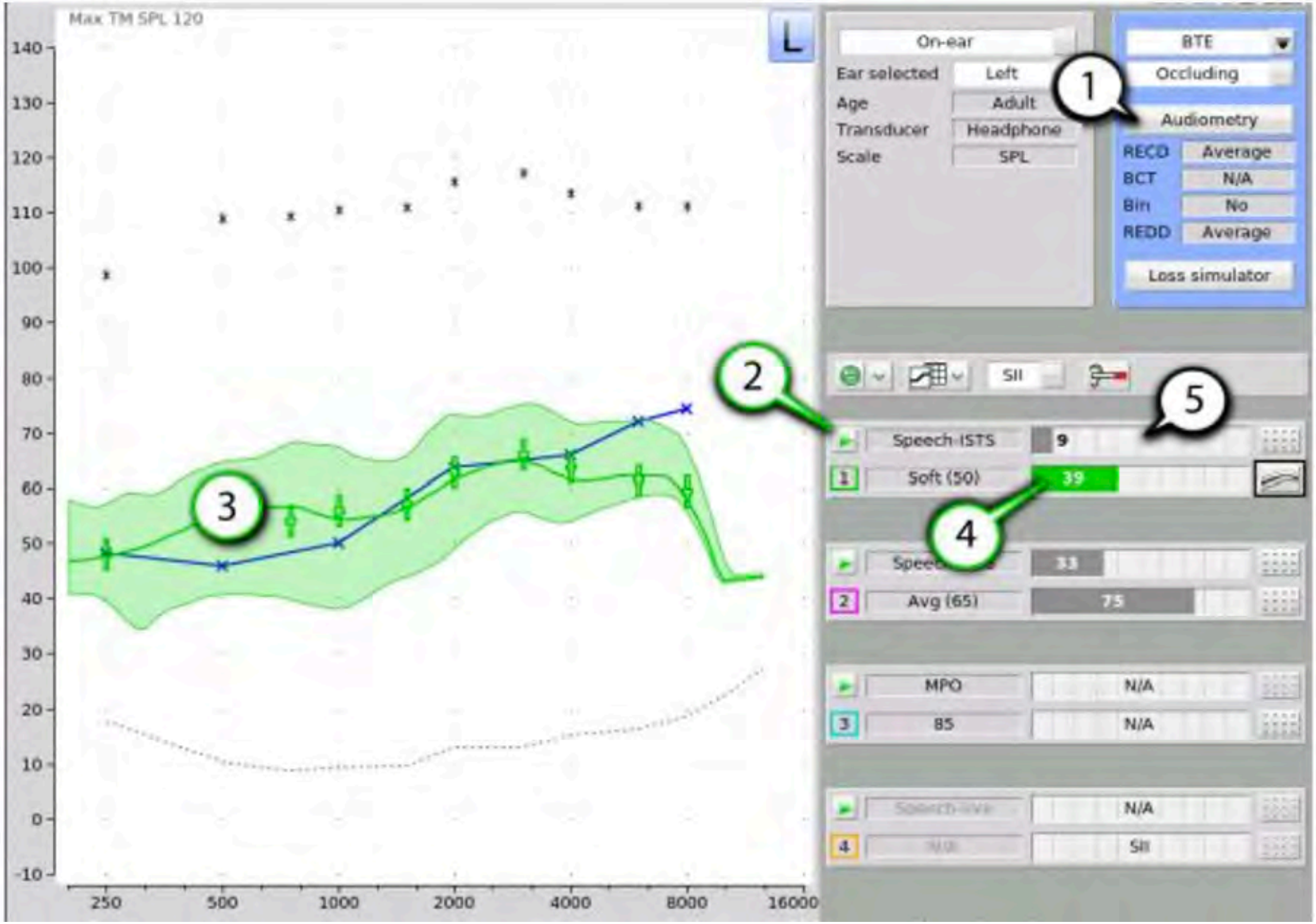
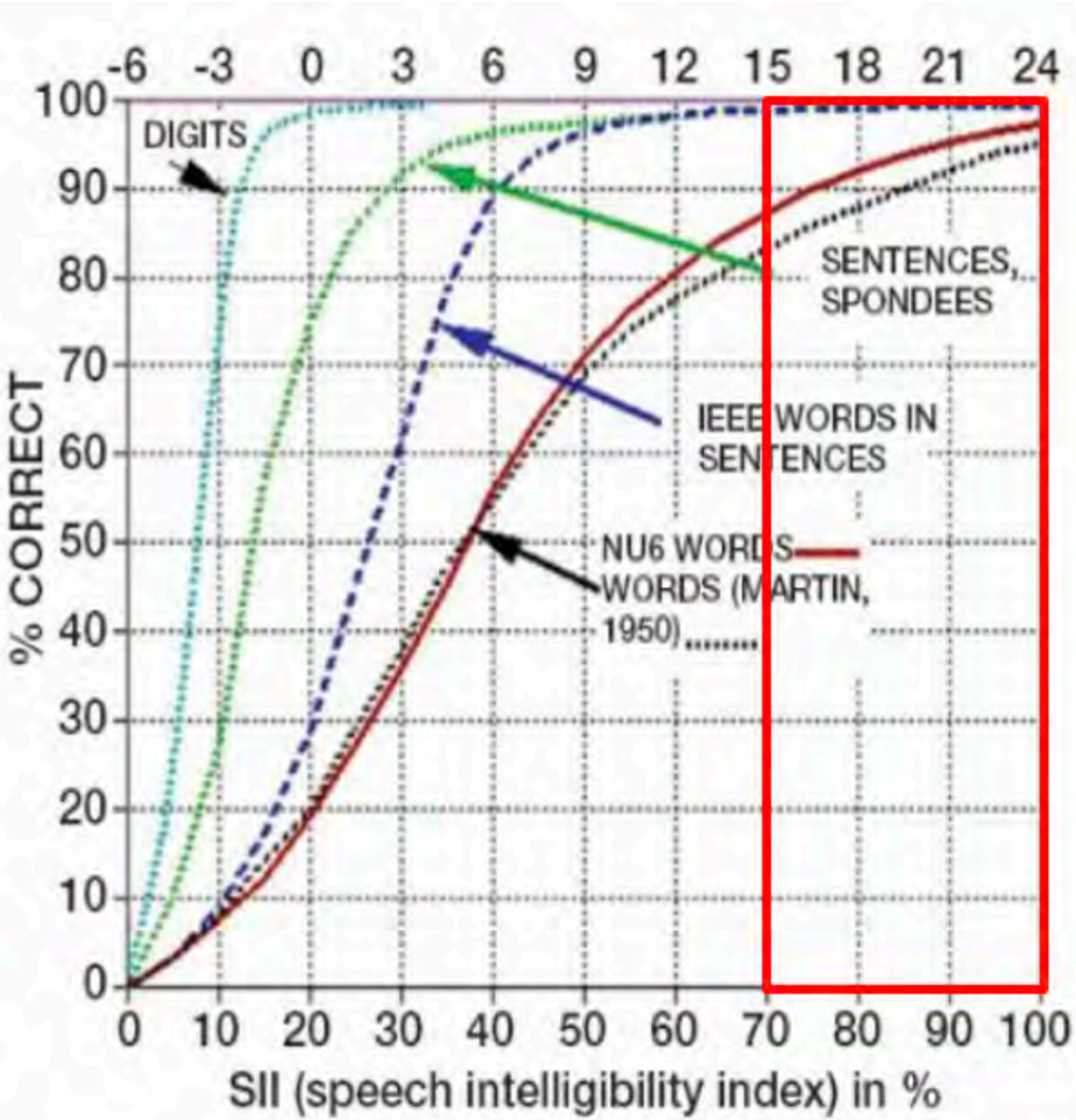


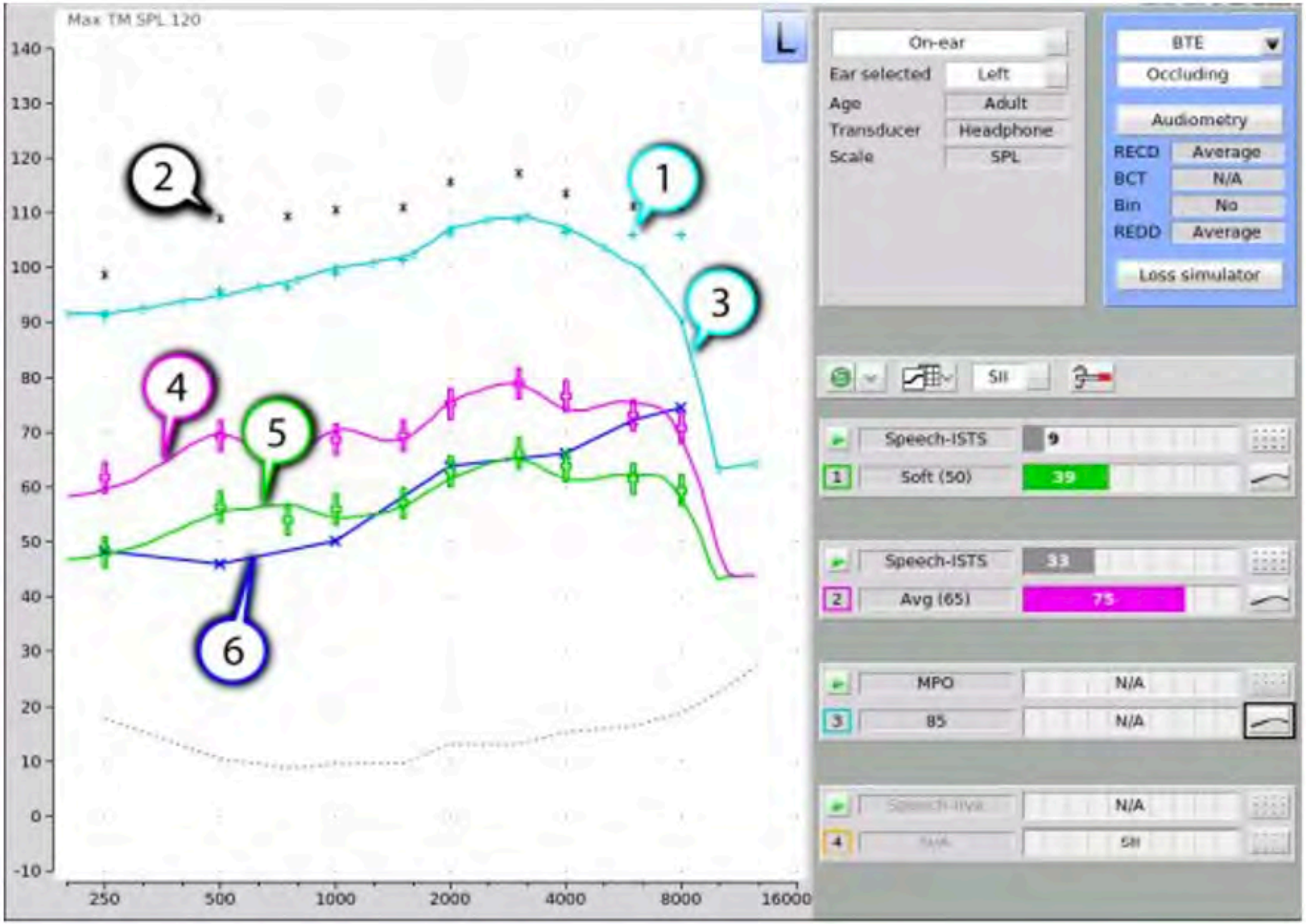
1. Audiometry Entry
2. Start test
3. Aided envelope
4. Aided SII
5. Unaided predicted SII

Image taken from the Audioscan Verifit User Guide

SII (%)	% Cor. Digits	% Cor. IEEE Sentences	% Cor. NU6 Words
0	0	0	0
5	30	4	4
10	80	9	8
15	96	13	11
20	98	19	19
25	99	43	27
30	100	60	36
35	100	74	45
40	100	89	56
45	100	94	63
50	100	96	70
55	100	98	76
60	100	99	81
70	100	99	87
80	100	100	93
90	100	100	96



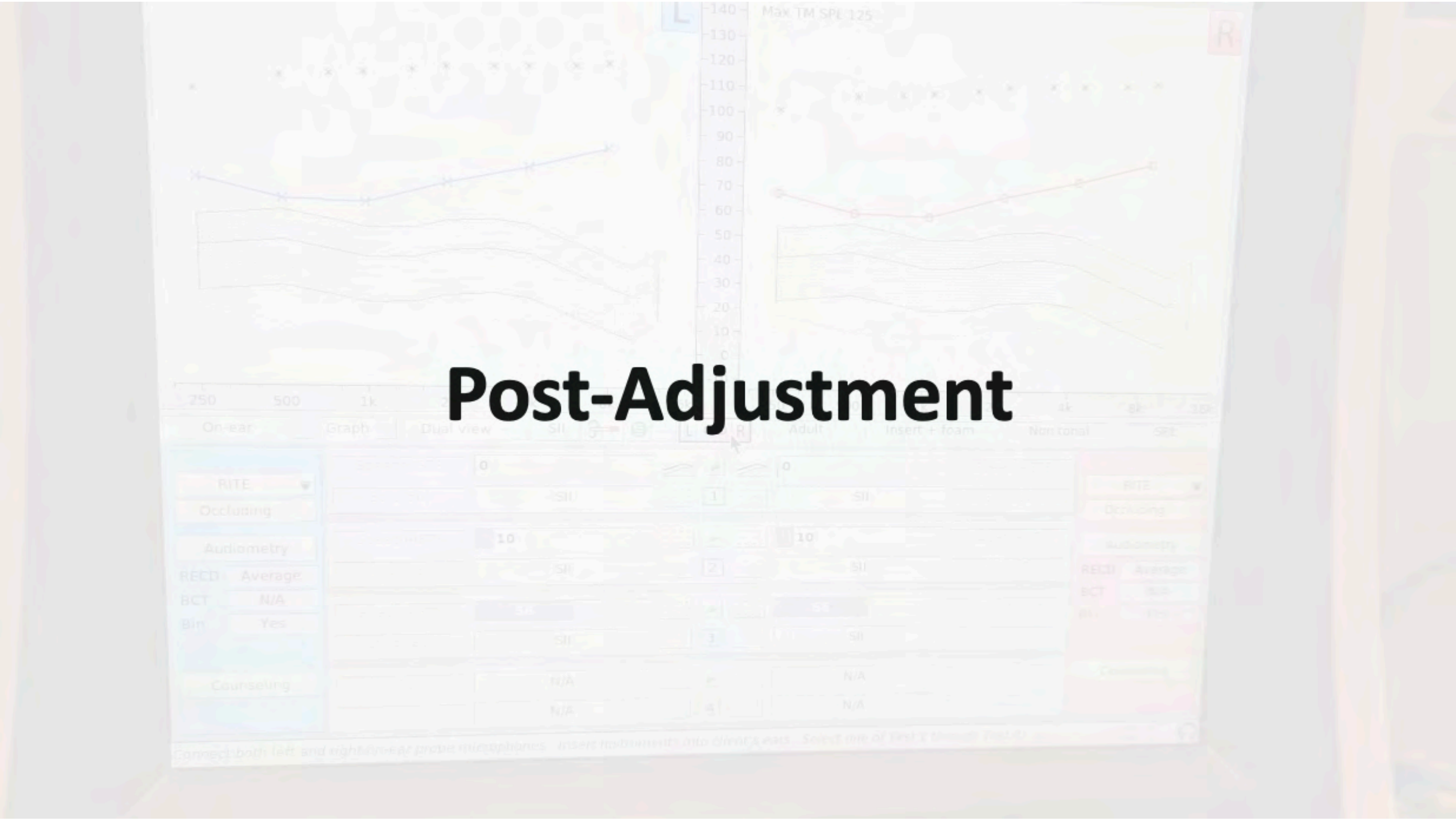
(Killion and Mueller, Hearing Journal, January, 2010 pp 10-15)



1. DSL REAR90 Target
2. Estimated UCL
3. Measured MPO
4. LTASS 65
5. LTASS 50
6. SPL Threshold

Image taken from the Audioscan Verifit User Guide


Pre-Adjustment


Post-Adjustment

Using SII for Counseling

	50 dB SPL		65 dB SPL		80 dB SPL	
	Left	Right	Left	Right	Left	Right
Unaided SII	0 %	0 %	10 %	10 %	56 %	56 %
Aided SII (pre)	6 %	11 %	32 %	34 %	63 %	64 %
Aided SII (post)	31 %	35 %	54 %	57 %	69 %	70 %

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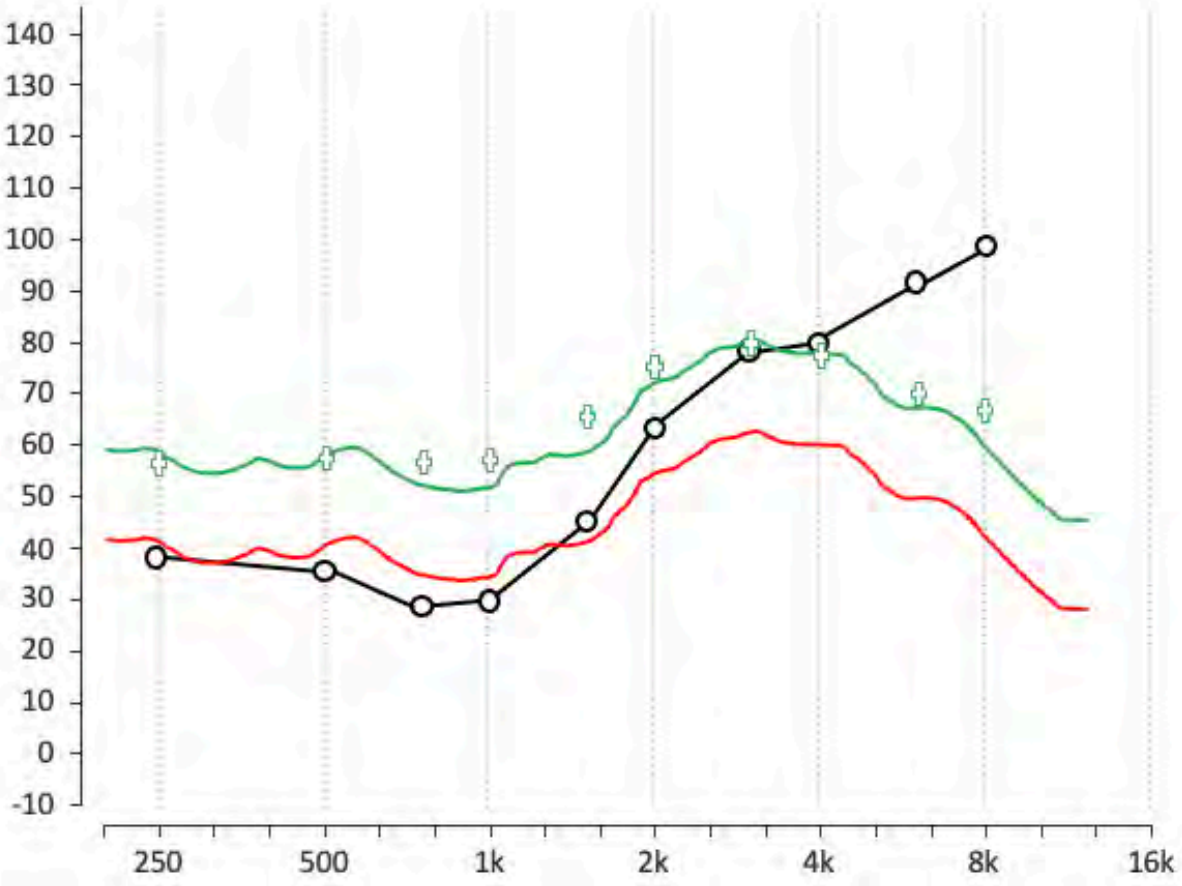


Match to Target *(SII)*	**55**
Patient Preference *(SII)*	**22**

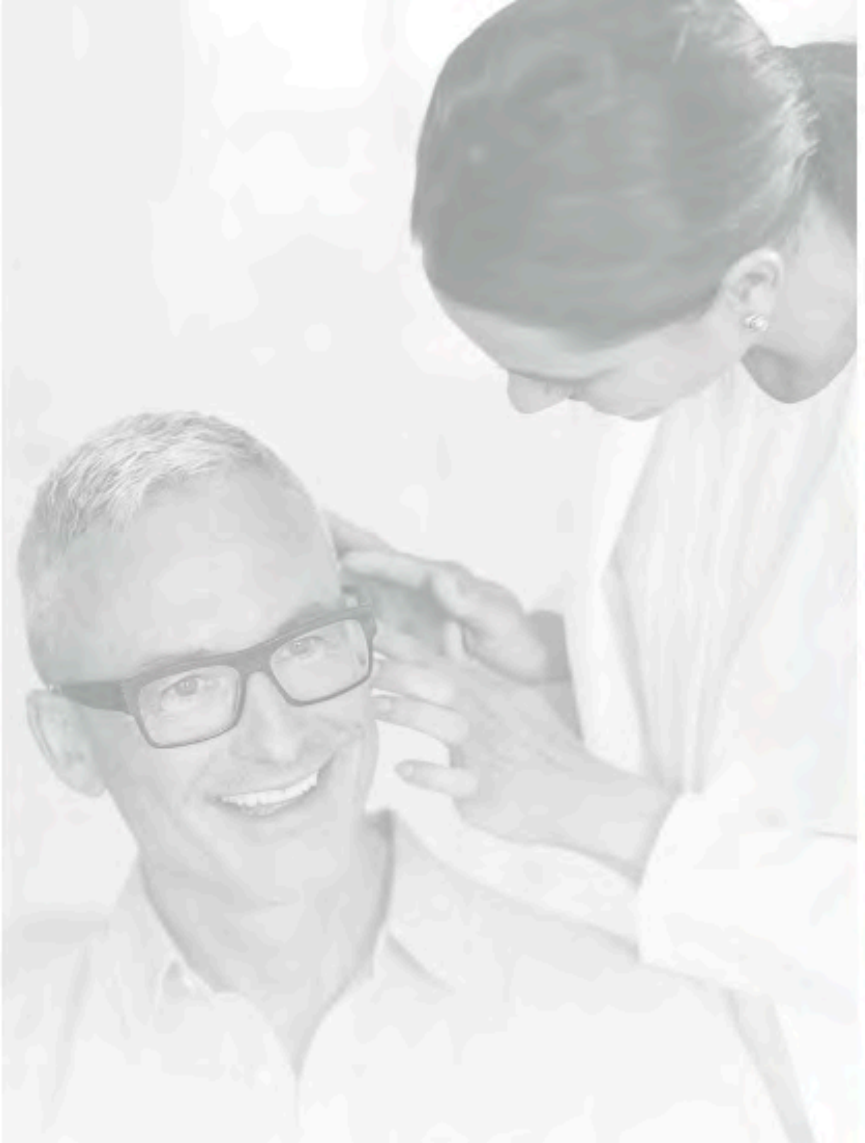
1. Encourage acclimatization to higher gain settings and provide a volume control

2. Adjust hearing aid gain to a middle ground

3. Program hearing aid memories with different gain settings

4. Start at lower gain settings and increase hearing aid gain over time

Hearing Test



Fitting

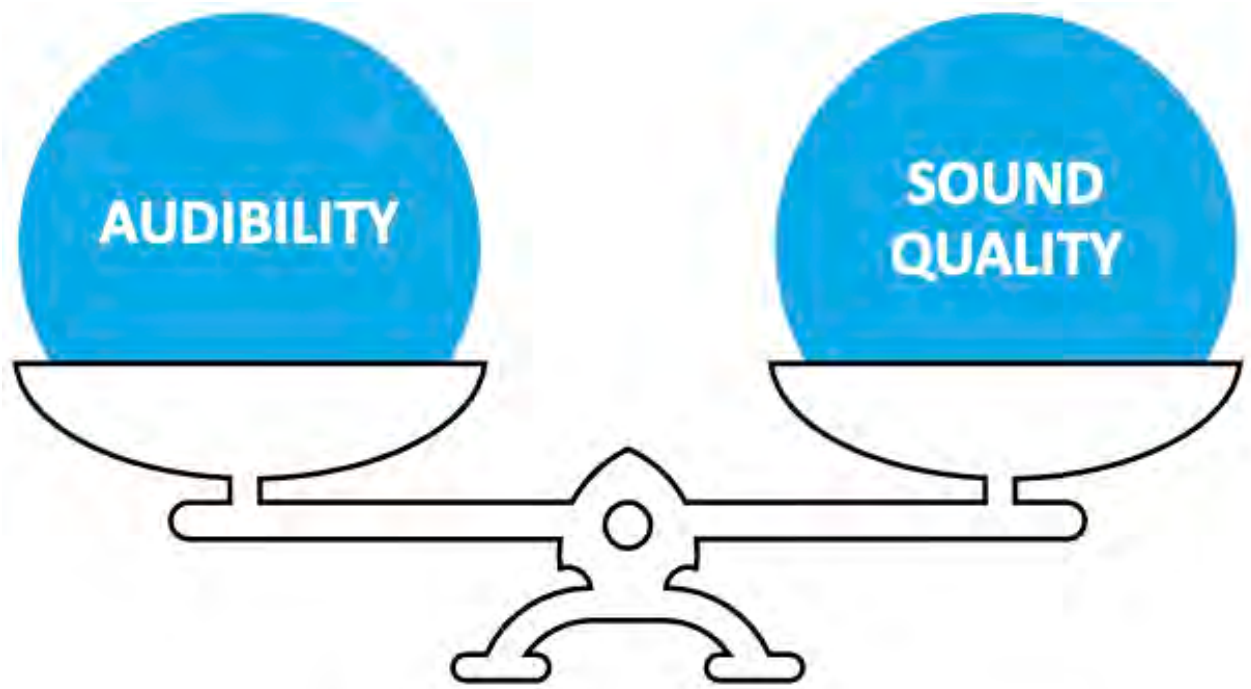
Follow-up

Now What?

Audibility and comfort verified

Our Role

Ensure patients are satisfied with their hearing aids



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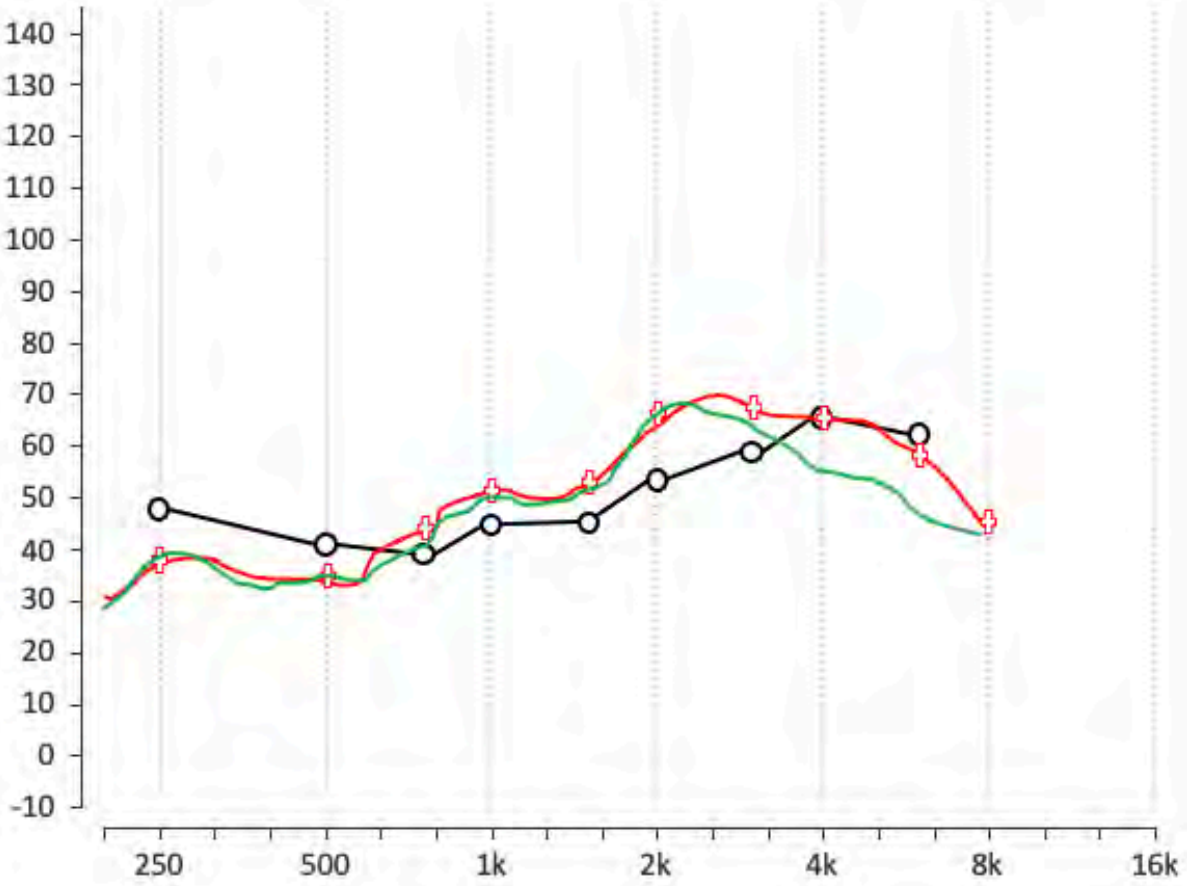
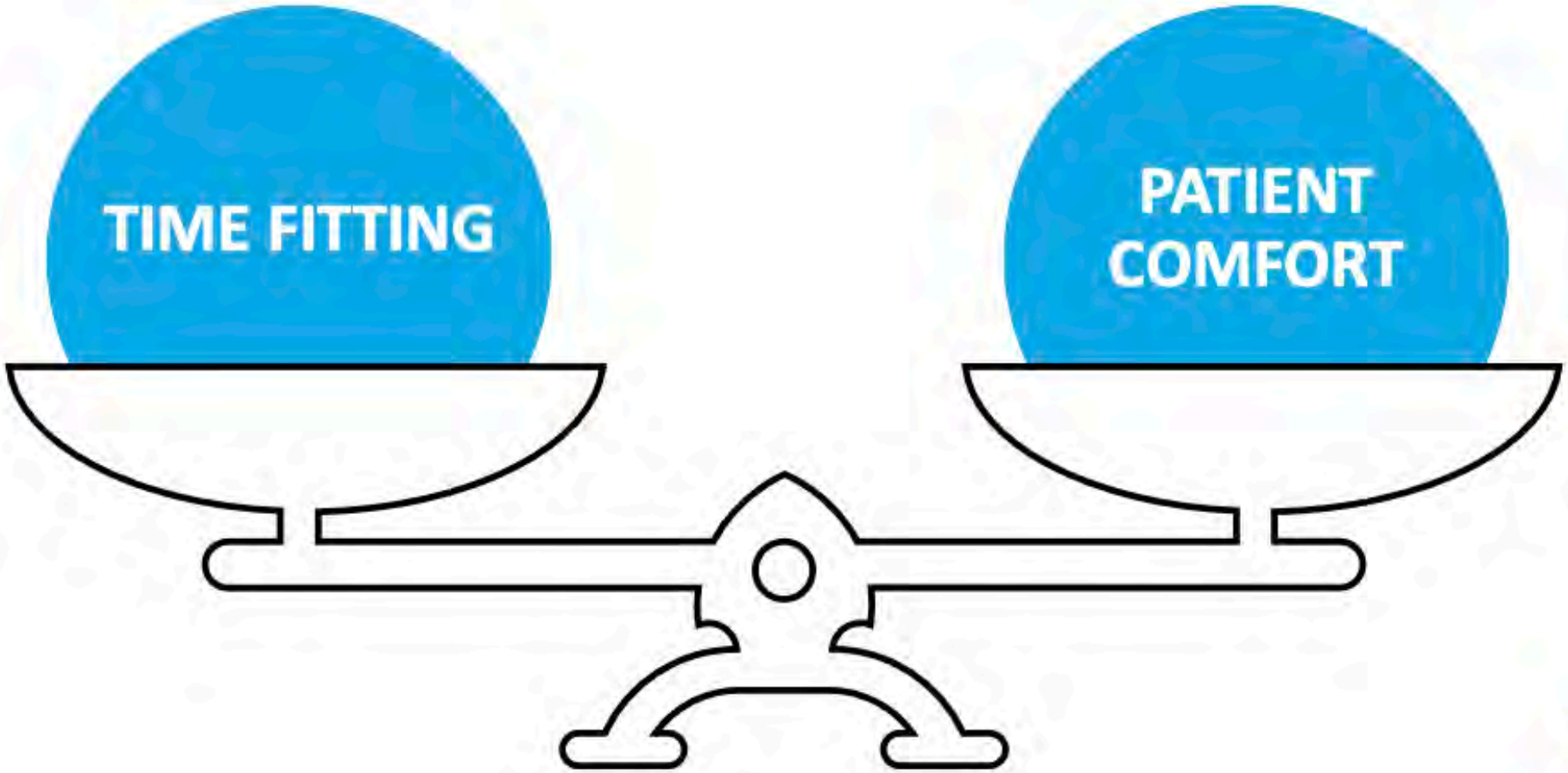

140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
250
500
1k
2k
4k
8k
16k

Real World Balancing Act



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Hear better. Live better.

Greater perceptual benefit with REM

Reduced Listening Effort

Improved Speech Understanding

Reduced Patient Visits

Kochkin S. (2011) MarkeTrak VIII: Reducing patient visits through verification and validation. *Hearing Review, 18*(6),10-12.

Real-Ear Measurements

Equipment Troubleshooting

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Minimal to No Aided Benefit

Culprit

Compromised Probe Tube

Hearing aid receiver blocked

Earmold outlet blocked

Troubleshooting Tips

Check the probe tube

- Clear of cerumen
- Positioning/depth
- Replace the probe tube

Check the hearing aid or earmold

- Clear of cerumen
- Listening check
- Test box measurements

Check the REM system and hearing aid setup

- Demographics, audiogram, acoustic coupling
- Fitting formulas match

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Curves are not Changing

Culprit

Disconnected hearing aid

Compromised probe tube

Hearing aid receiver blocked

Earmold outlet blocked

Troubleshooting Tips

- Check the connection
- Check the probe tube
  - Positioning/depth
  - Replace the probe tube
- Confirm adjustments are being made correctly
- Check the hearing aid or earmold
  - Clear of cerumen
  - Listening check
  - Test box measurements

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Verifying audibility

STARTING POINT

Real-world Performance

Sound Quality

Validation Measures

Learn More

American Academy of Audiology
https://www.audiology.org

American Speech and Hearing Association
https://www.asha.org

Audioscan Verifit®
User's Guide 4.28

Visit audiologyonline.com and StarkeyPro.com to register for more training classes

Thank you

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