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Real-Ear Measurements

The Basics

Amanda Wolfe, Au.D., CCC-A

Education and Training Audiologist

Starkey

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Learning Outcomes

1. Participants will be able to explain the benefits of utilizing real-ear measurements in the clinic
2. Make appropriate adjustments to the hearing aid based on a real-ear measurement
3. Identify one key learning to implement in the clinic to improve patient outcomes

Cost

Time constraints

Unsure of real-world benefit

Unsure how to
perform or interpret

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.

REM makes the difference

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.

Goals of REM

Goals

Verify Audibility

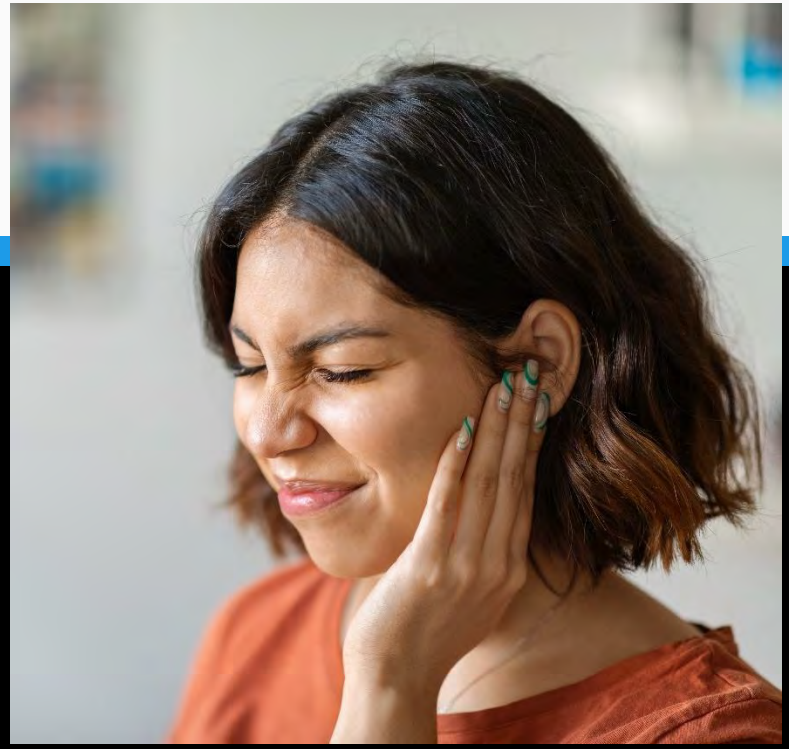
Verify Output

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

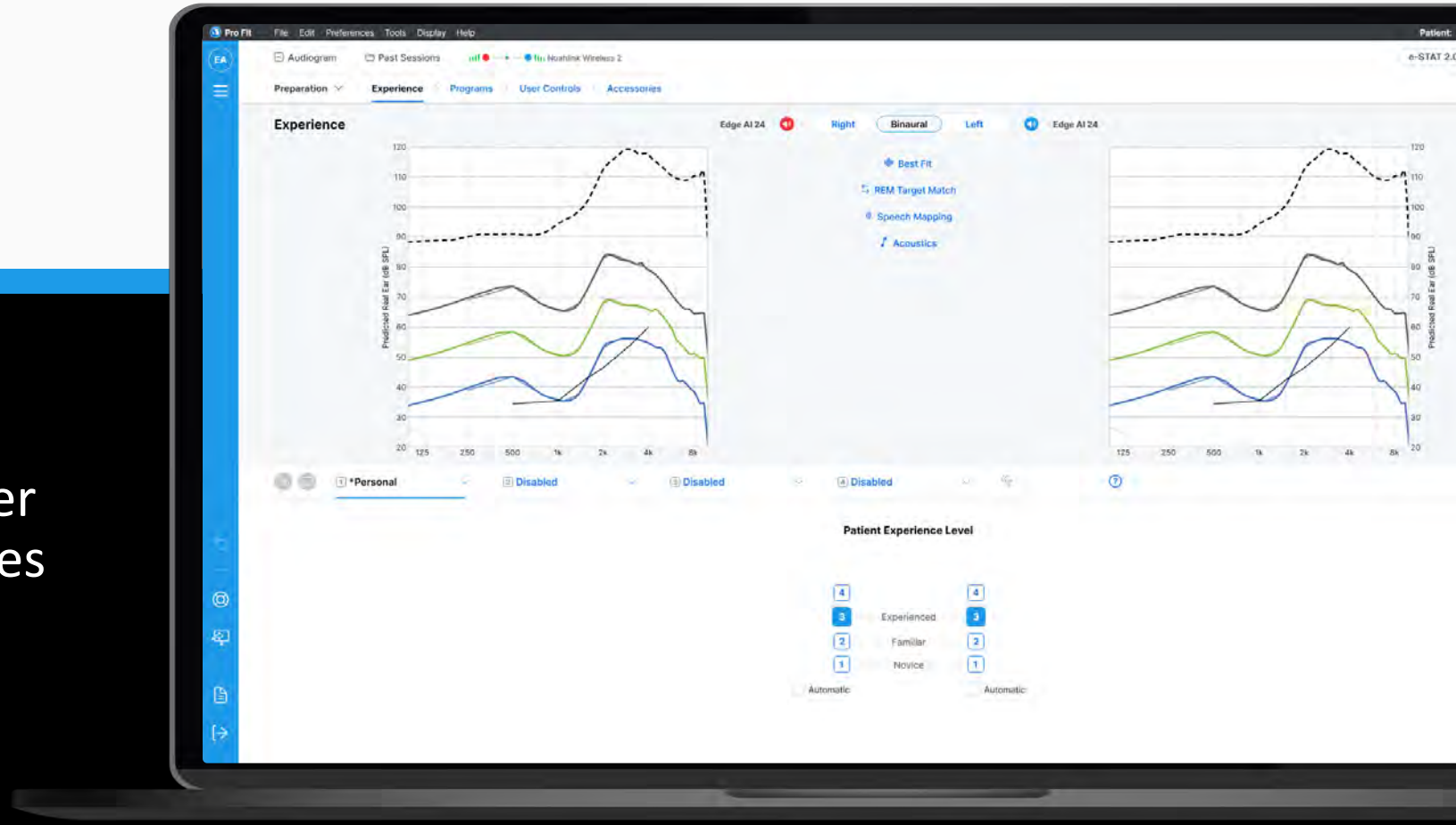
NAL-R *(Byrne & Dillon, 1986)*

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

eSTAT 2.0

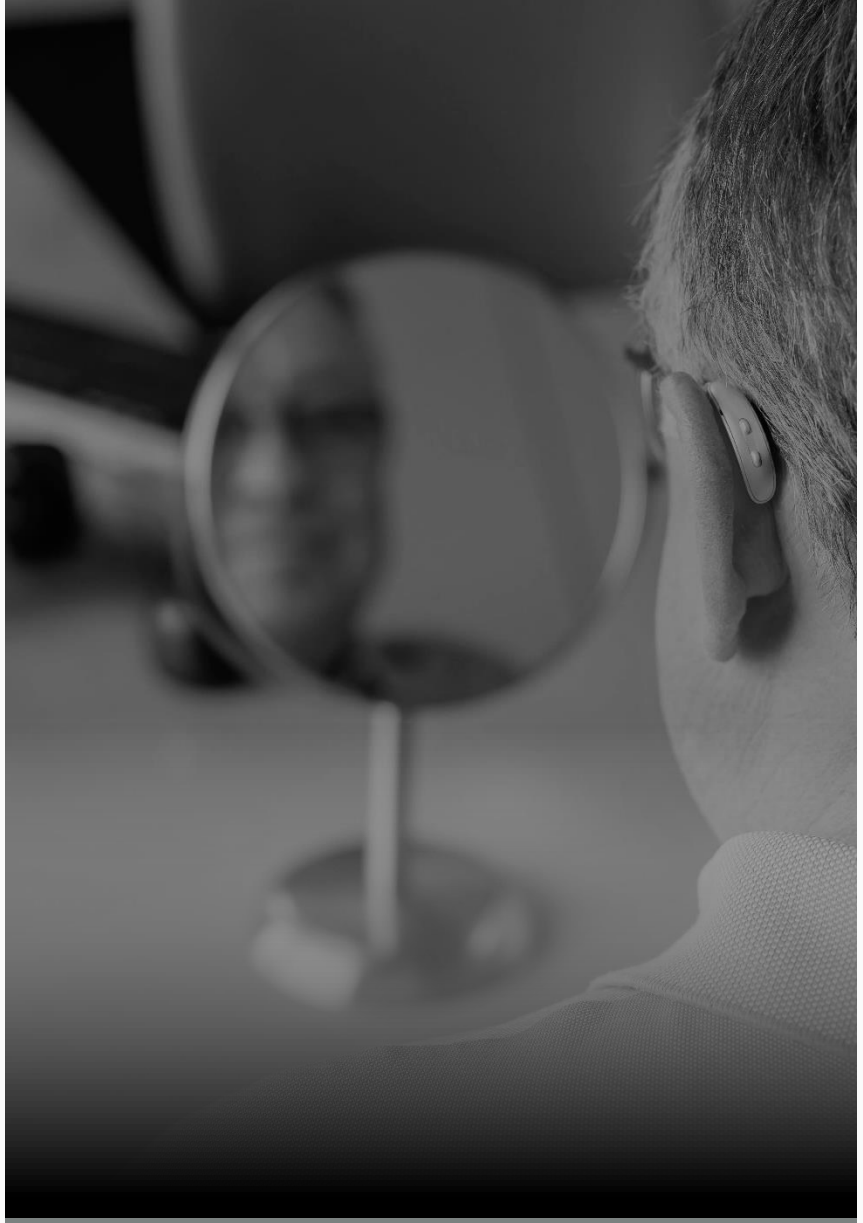
Proprietary Fitting Formula

Developed to provide more gain for soft speech and better audibility at higher frequencies



Fitting REM into your clinical protocol

Hearing Test



Fitting

Follow-up

REM Terminology

REUR

REOR

REOG

REAR

REAG

REIG

RECD

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)

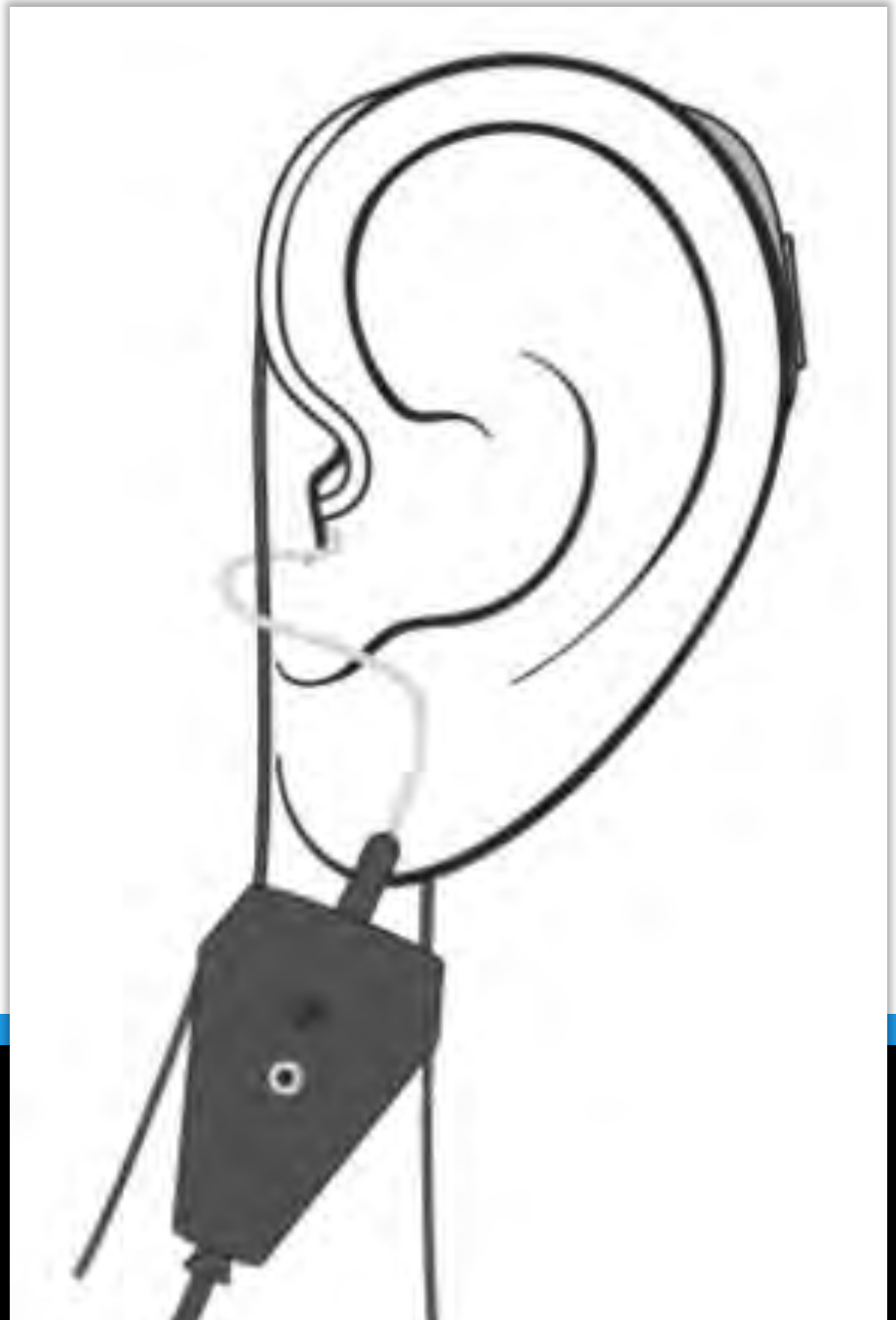
REM Setup

SETUP

Calibration

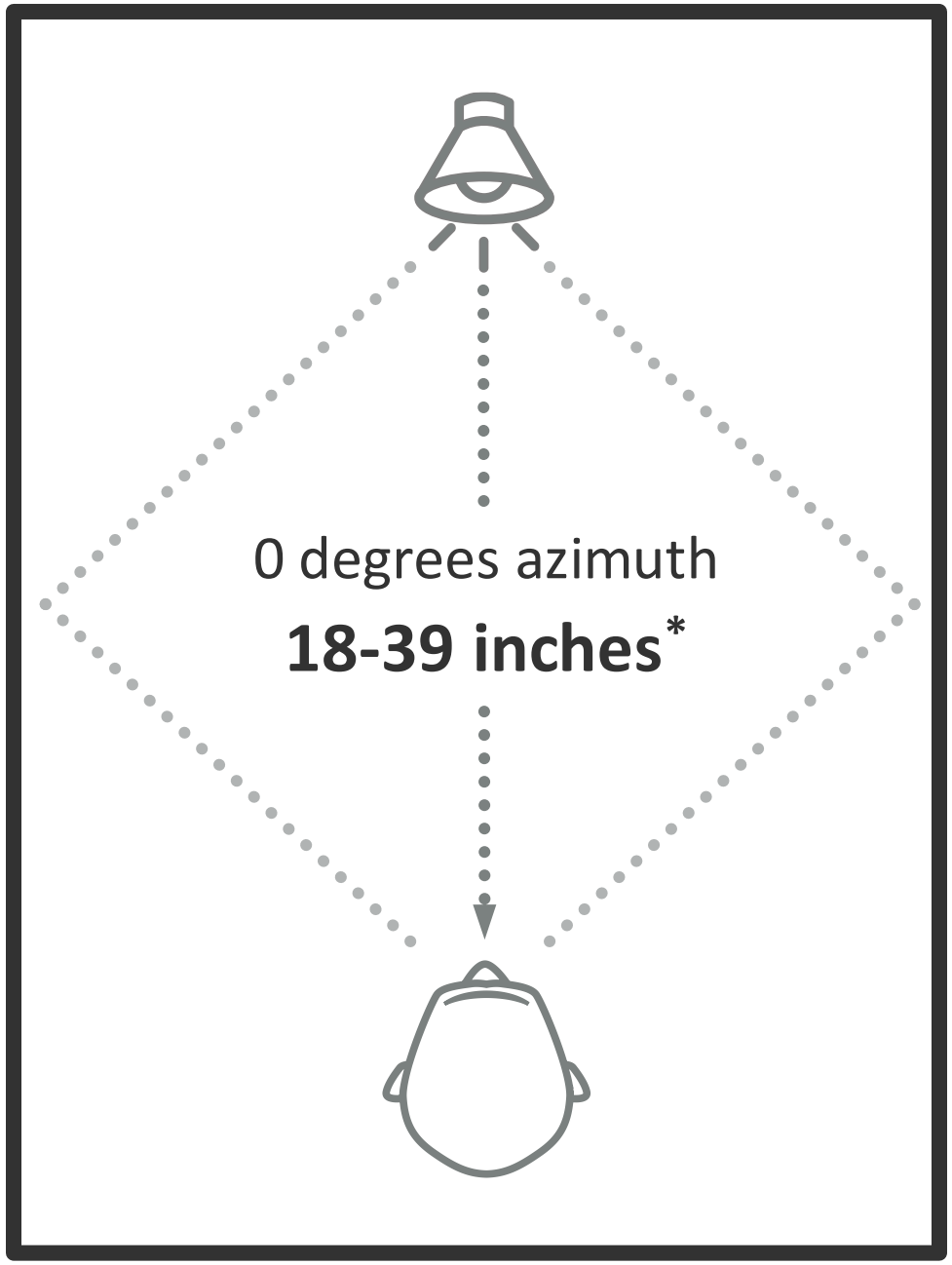
Compares frequency response of probe tube to flat frequency response of the external reference mic, and compensates for this difference in all subsequent measurements

May be stored or required before each use



SETUP

Speaker Alignment



*Follow instructions from real-ear system manufacturer

SETUP

On-Ear

Placement of reference microphone

- Near the head and away from acoustic influence of pinna or hearing aid

Positioning the probe tube

Goal: Within 2-5 mm of eardrum

- Adult males: ~30 mm
- Adult females: ~28 mm
- Children: ~20-25 mm

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

SETUP

Stimulus Types

ISTS

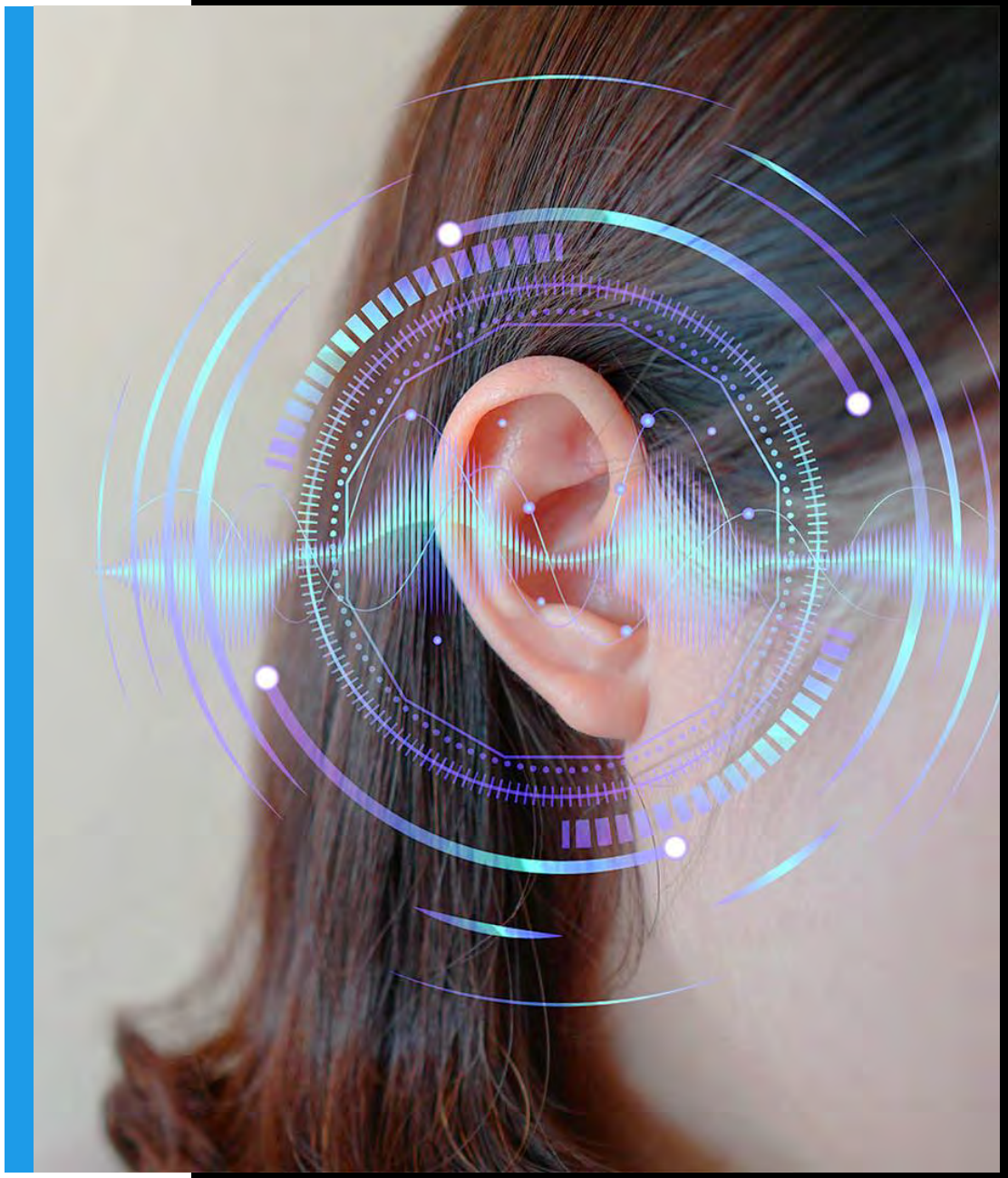
- Female talker
- Segments of 6 languages sliced together to match the average speech spectrum

ICRA

- Distorted speech signal

Carrot passage

- Male talker
- Filtered to provide the LTASS

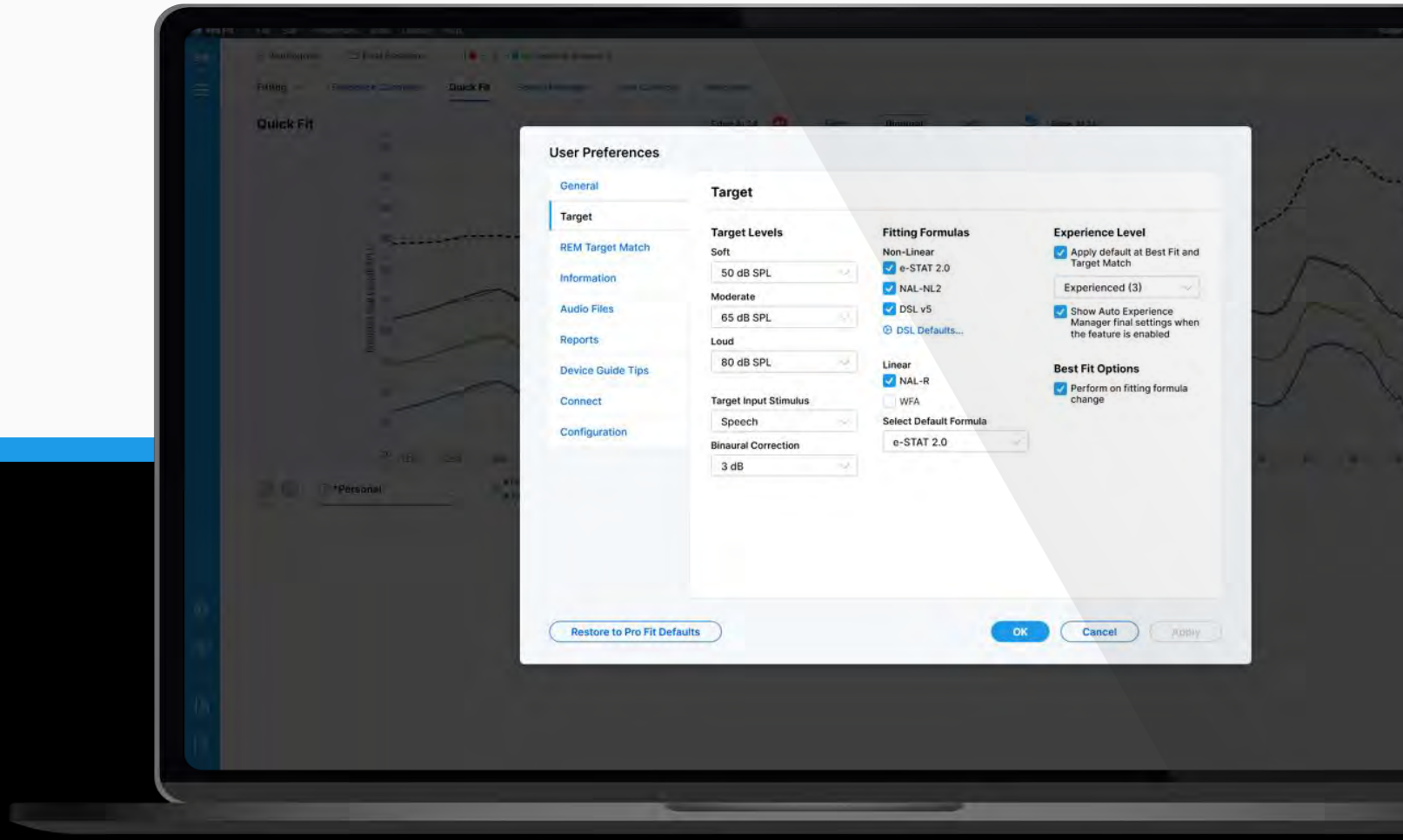


SETUP

Hearing Aid

SETUP

Hearing Aid



SETUP

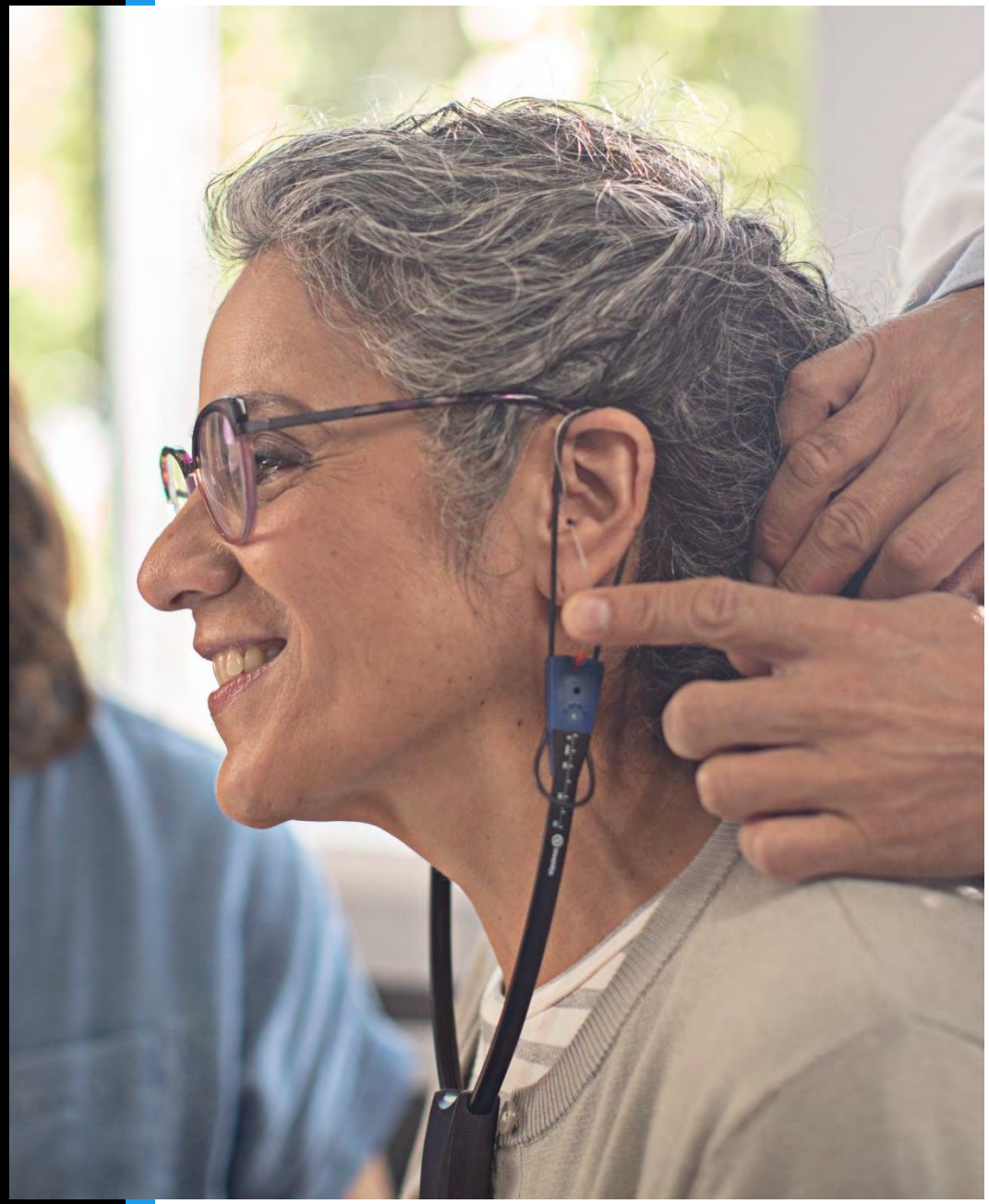
Patient Preparation

Remain quiet and still

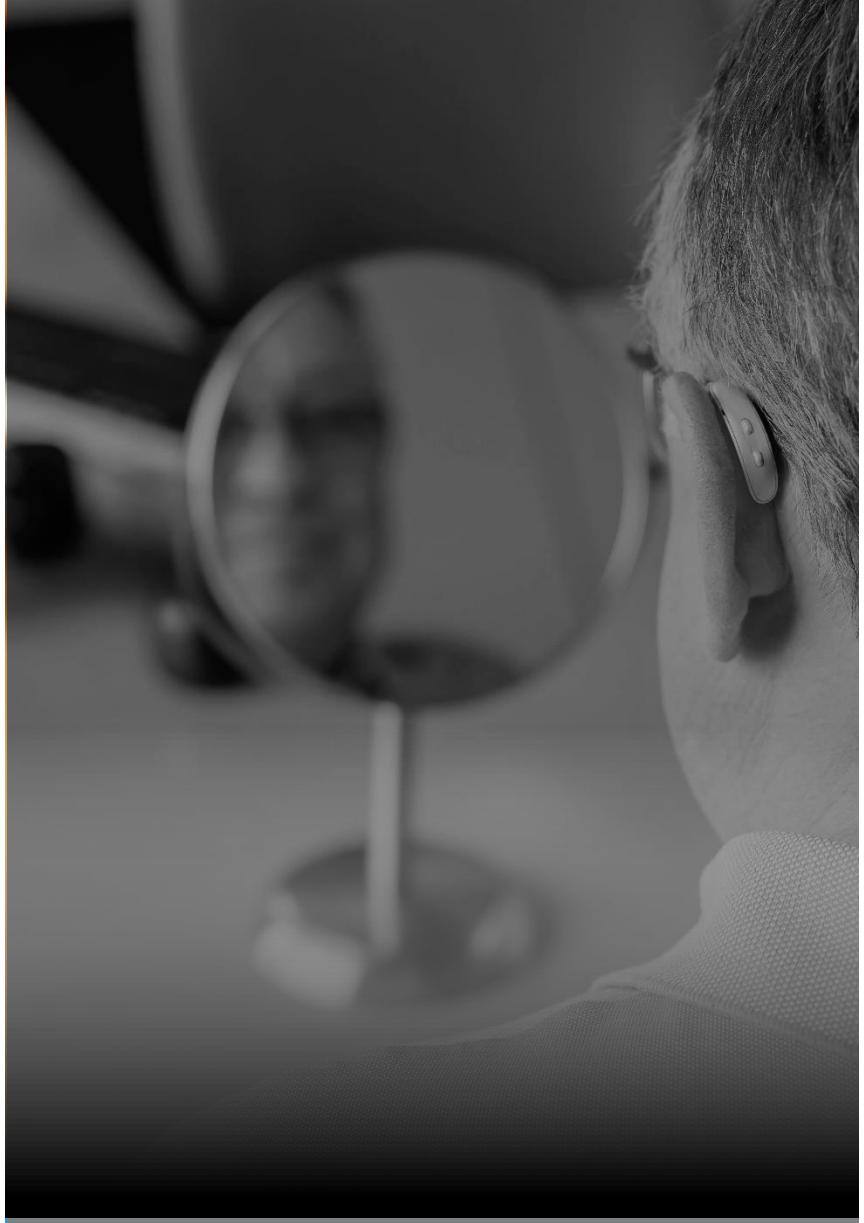
Be listening to speech at different volume levels

Do not need to repeat back or even understand stimulus

If signal gets uncomfortably loud, raise hand



Hearing Test



Fitting

Follow-up

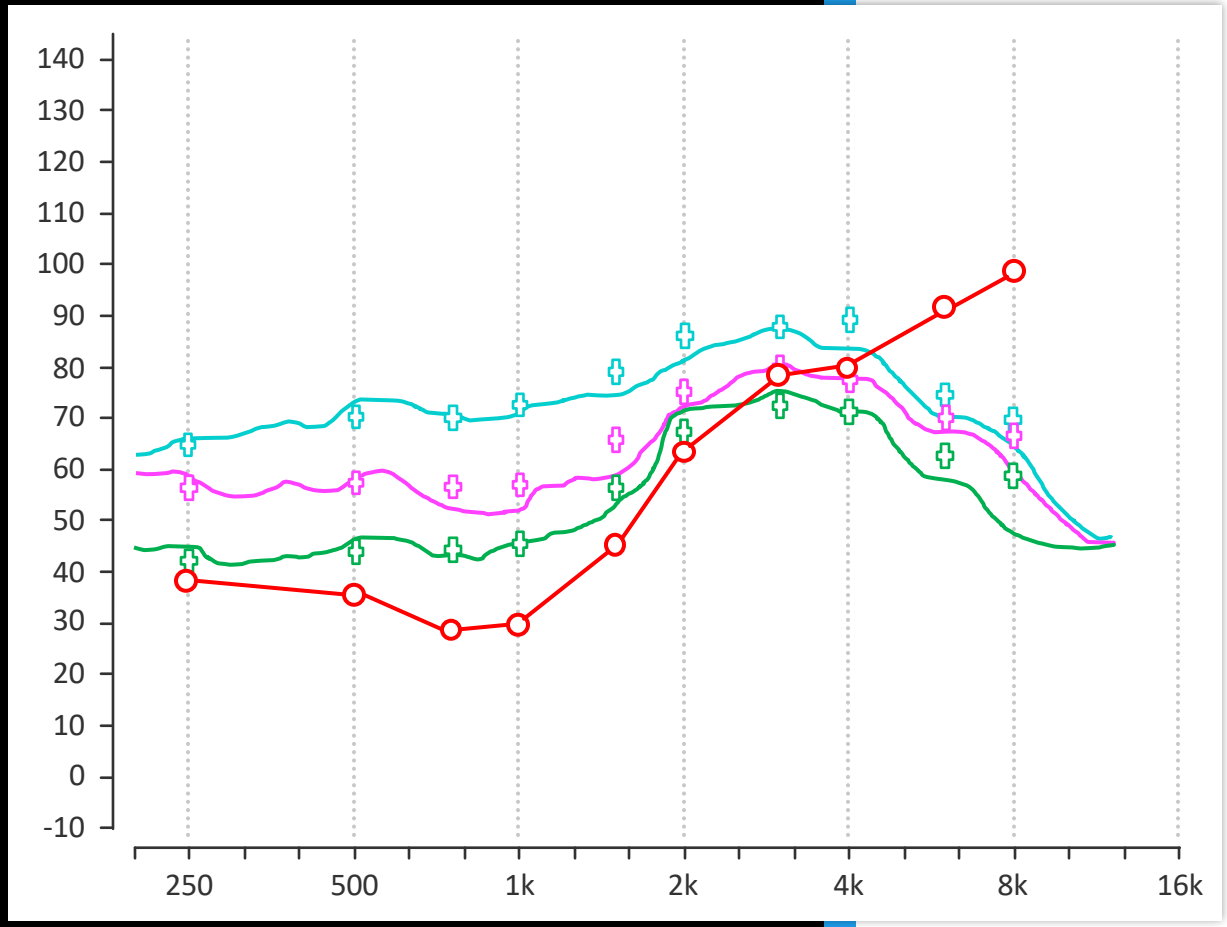
REAR Steps

Soft speech (50 dB SPL) is audible

Average speech (60-65 dB SPL) is comfortable

Loud speech (75 dB SPL) is not uncomfortable

Maximum Power Output doesn't exceed UCL



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

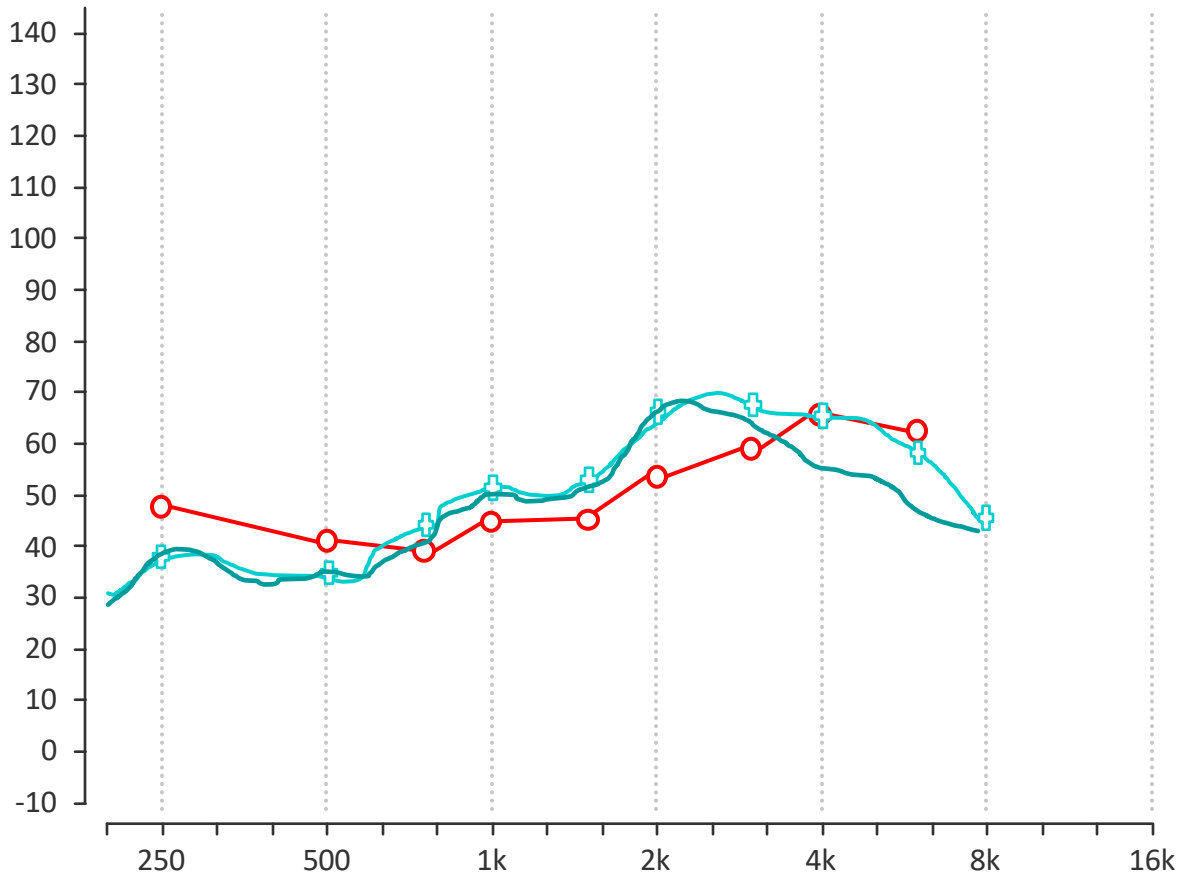
Now What?

Audibility and comfort verified

Our Role: Ensure patients are satisfied with their hearing aids

Audibility

Sound Quality


140
130
120
110
100
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50
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10
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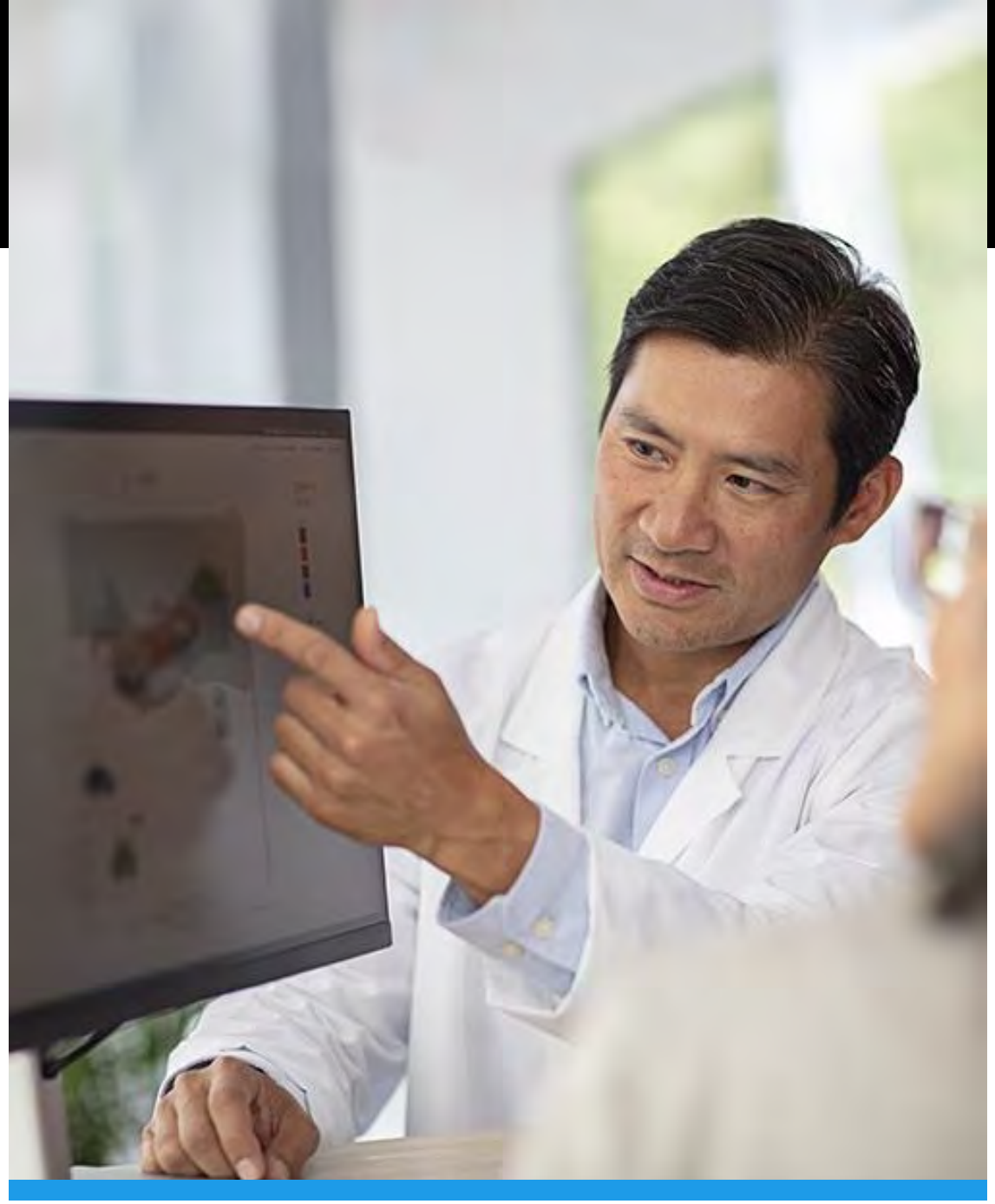
-10
250
500
1k
2k
4k
8k
16k



Audibility

Art

Verifying audibility

Thank You