

Optimizing Patient Success

Using Real Ear Measurements in Hearing Aid Fittings

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Hear better. Live better.

Real Ear Benefits



Contributes
to higher
patient satisfaction



Provides
a personalized
fitting experience



Delivers a verified
hearing aid
performance

Barriers to Real Ear Integration



**Time
Constraints**



Cost



Interpretation



Audioscan
Verift 1 and 2



Otometrics
Aurical FreeFit



Inventis
Maestro Trumpet



MedRx
Avant REM Speech+

Soft speech and
environmental sounds
are audible



Average speech
is comfortable



Loud sounds
are not uncomfortable



Fitting Formulas

Independent Fitting Formulas

NAL-NL2 (*Dillon 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 (*Scollie, 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

Proprietary Fitting Formula

E-Stat 2.0

- Designed to complement Starkey's compression architecture
- More gain for soft sounds
- More gain in the higher frequencies
- Improved vent modeling

Simulated Versus In-Situ

Simulated REM

Coupler Measurement

- Measurements made with a coupler in the test box.
- Assumes the microphone location effect and the real-ear to coupler difference
- Applies these average transfer functions to the measured data

In-Situ REM

In-Situ

- Measurements made on the ear
- Transfer functions not needed

Response and Gain Terminology

REAR

Real Ear Aided Response

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.

(ANSI S3.46-1997)

RECD

Real Ear to Coupler Difference

Difference in decibels, as a function of frequency, between the SPL at a specified measurement point in the ear canal and the SPL in a 2cc coupler, for a specified input signal.

Not defined in ANSI S3.46-1997

Difference in dB across frequencies, between the SPL measured in the real-ear and in a 2cc coupler, produced by a transducer generating the same input signal.

SII

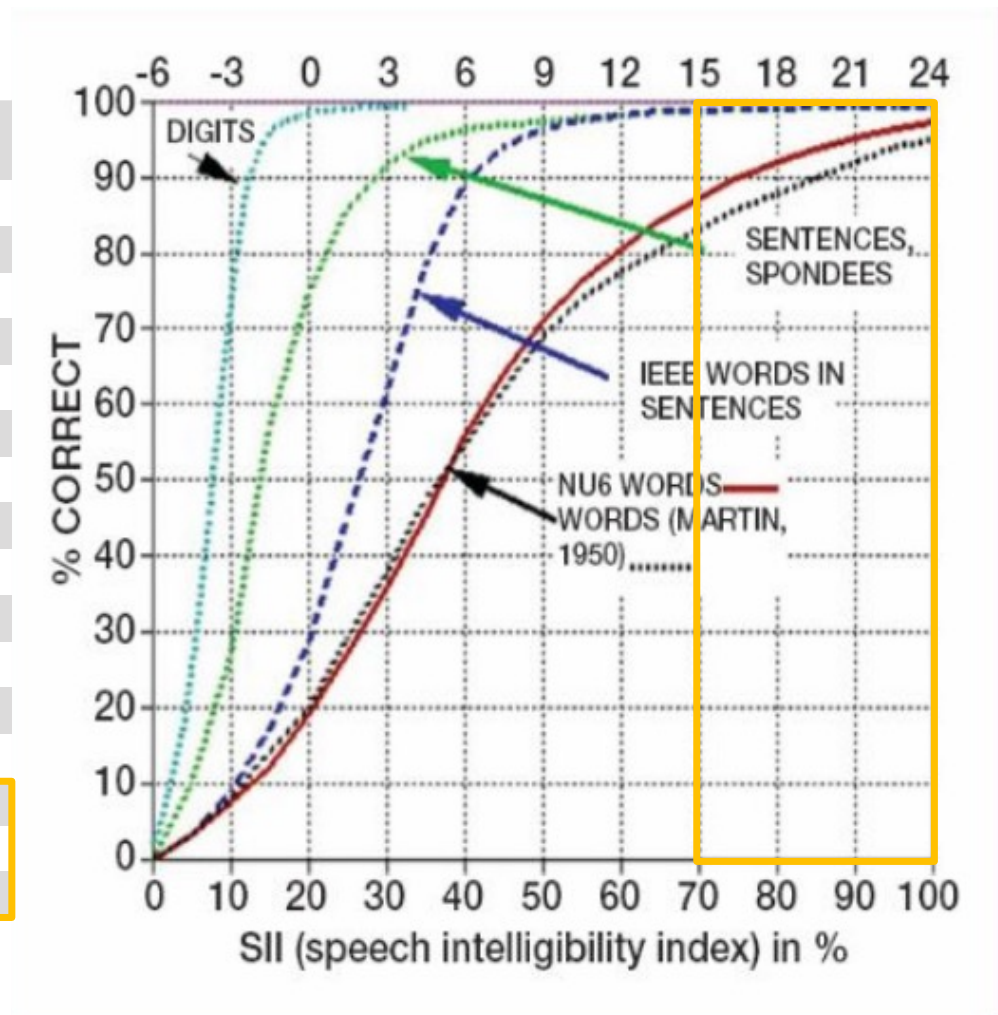
Speech Intelligibility Index

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)

SII (%)	% Cor.	% Cor.	% Cor.
	Digits	IEEE Sentences	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)



Real Ear 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

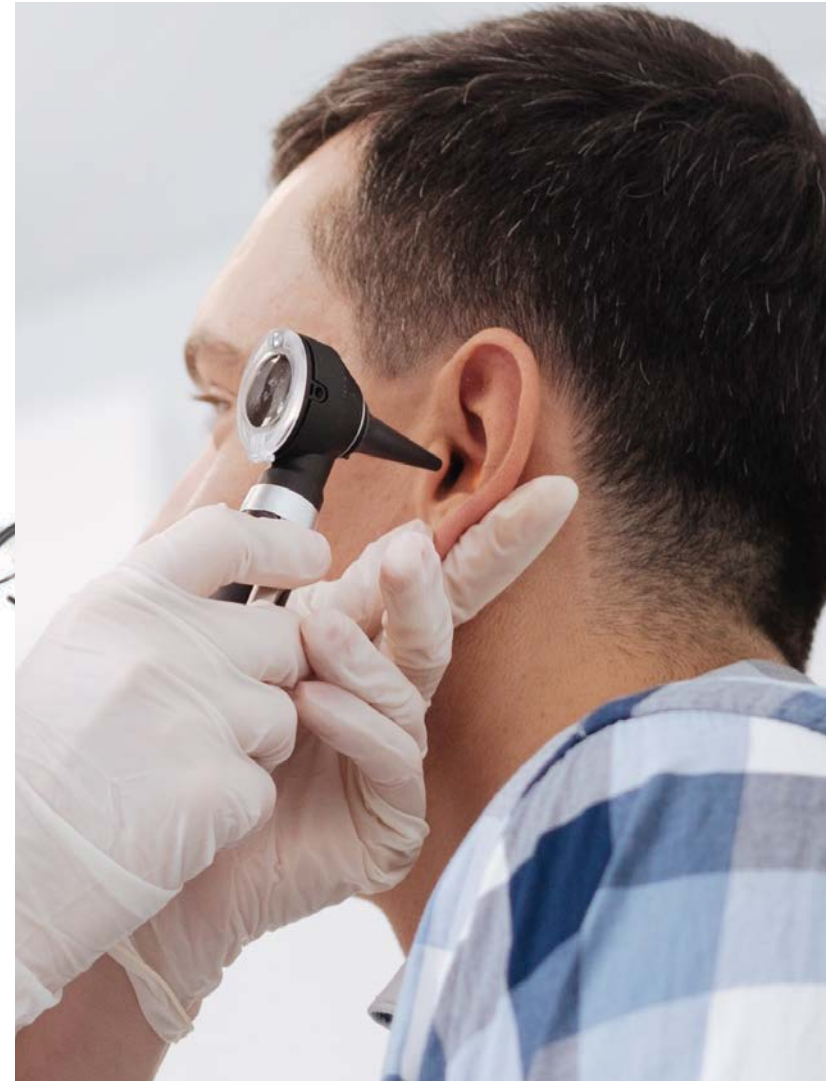
On-Ear

- 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
(*International Speech Test Signal*)
 - Female talker
 - Segments of 6 languages sliced together to match the average speech spectrum
- ICRA
(*International Collegium of Rehabilitative Audiology*)
 - Distorted speech signal
- Carrot passage
 - Male talker
 - Filtered to provide the LTASS

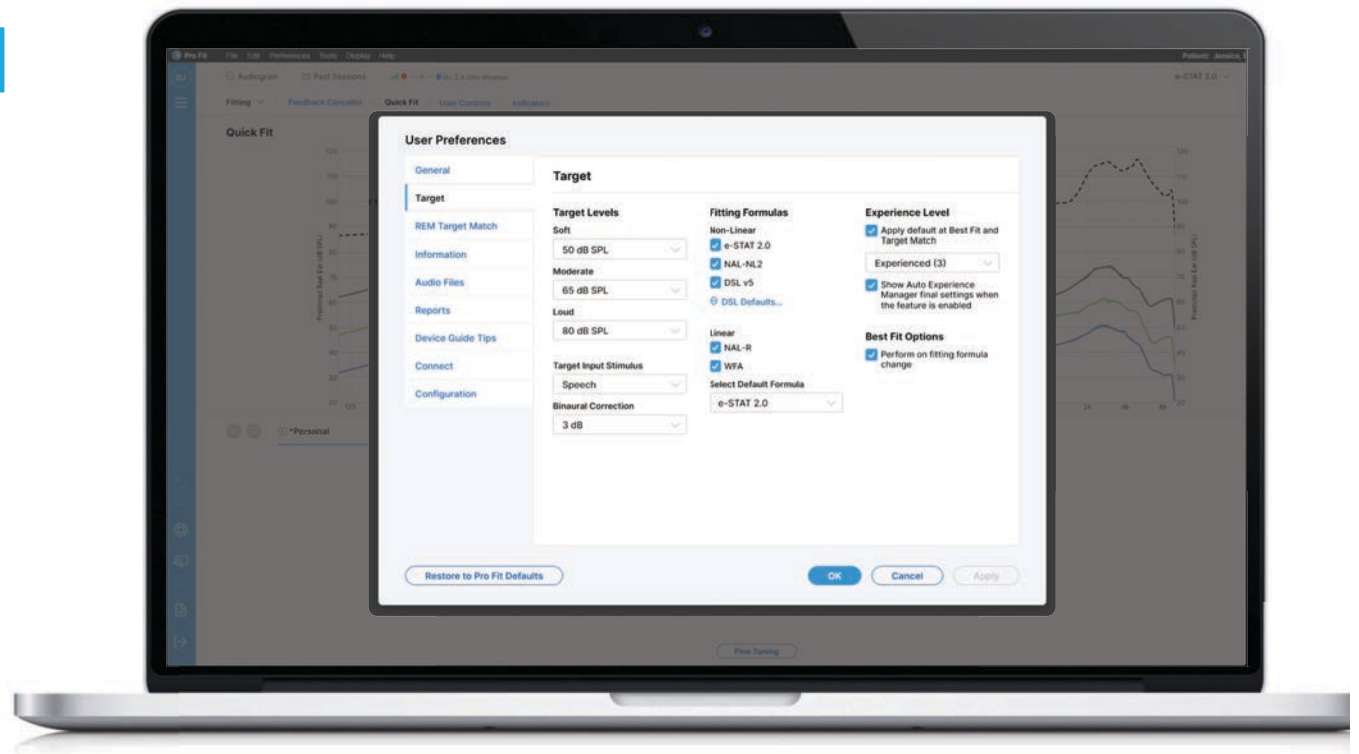


SETUP Hearing Aid



SETUP

Hearing Aid



SETUP

Patient Preparation

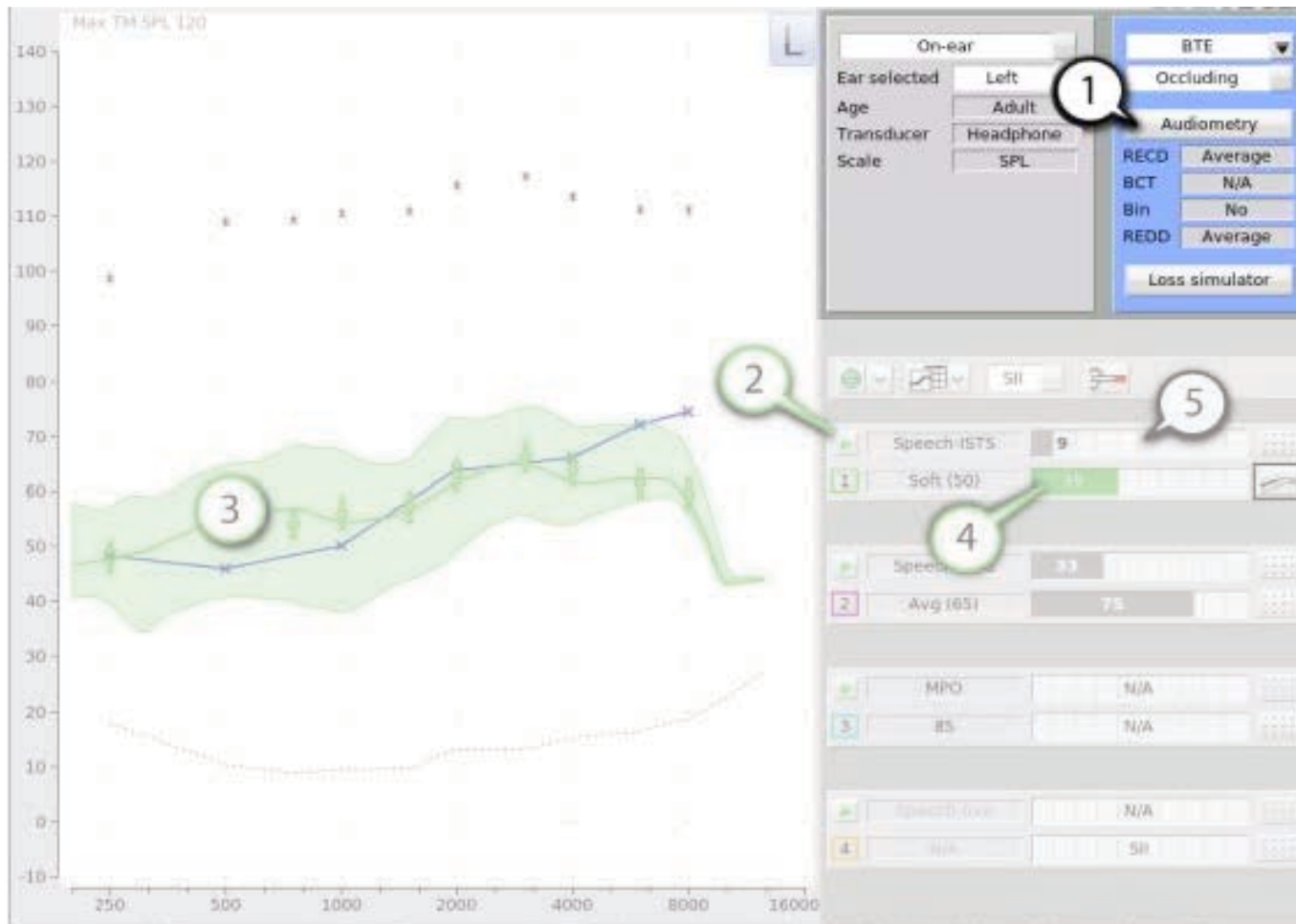
- Remain quiet and still
- Be listening to speech at different volume levels
- Do not need to repeat back or even understand stimulus
- If signal gets uncomfortably loud, raise hand





Real Ear Interpretation

Using the Verifit 2 REM System



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

Image taken from the Audioscan Verifit User Guide

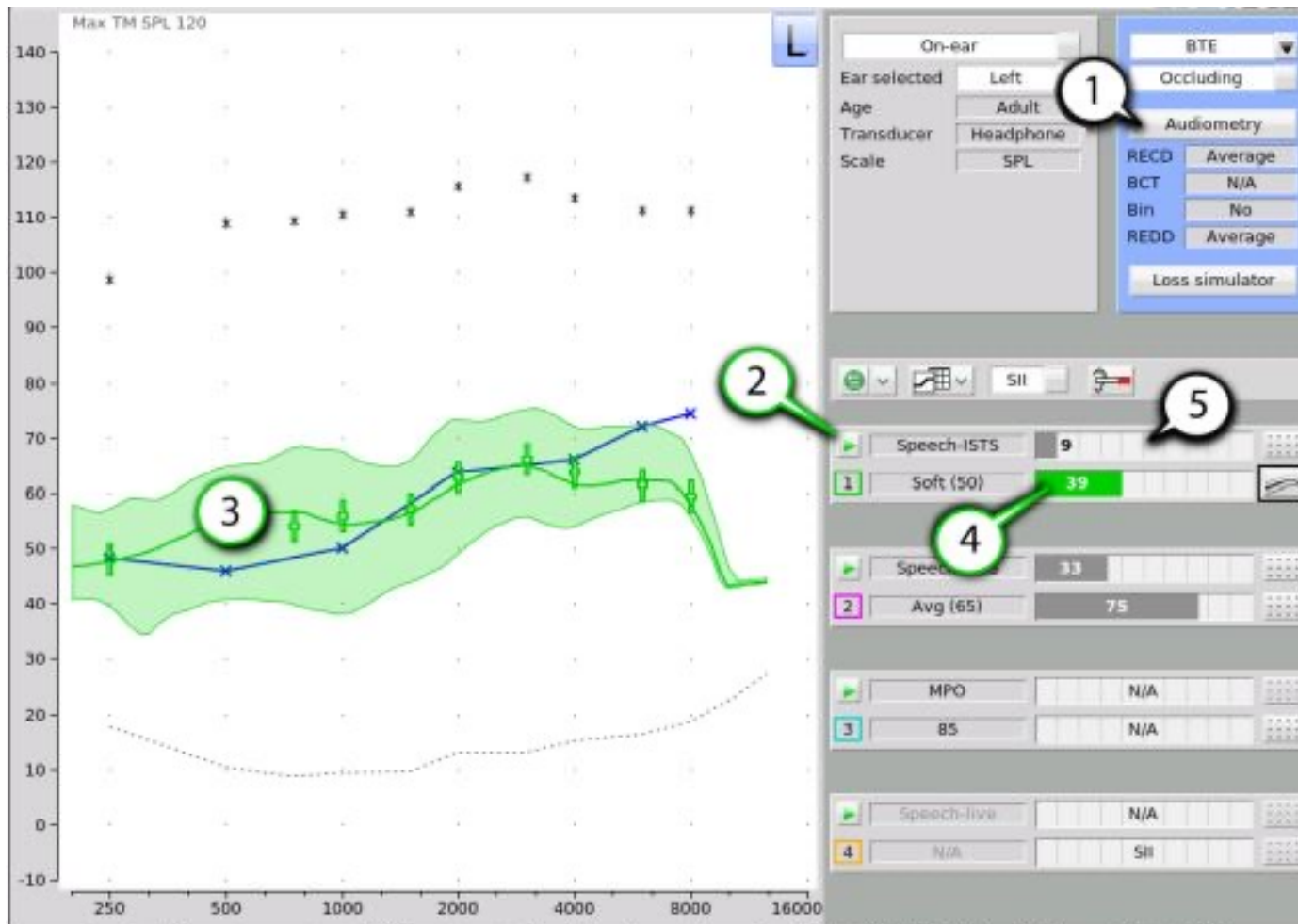
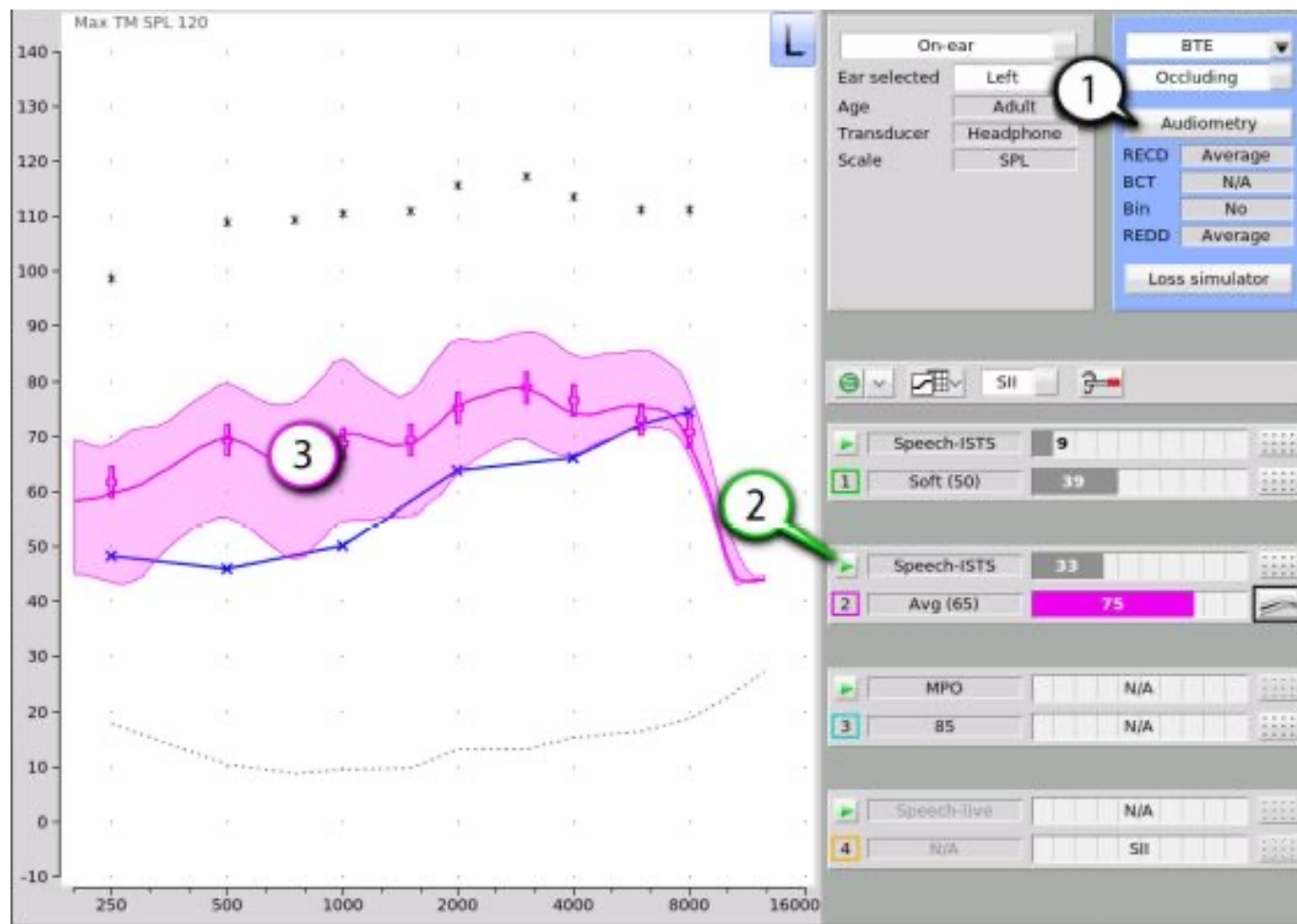
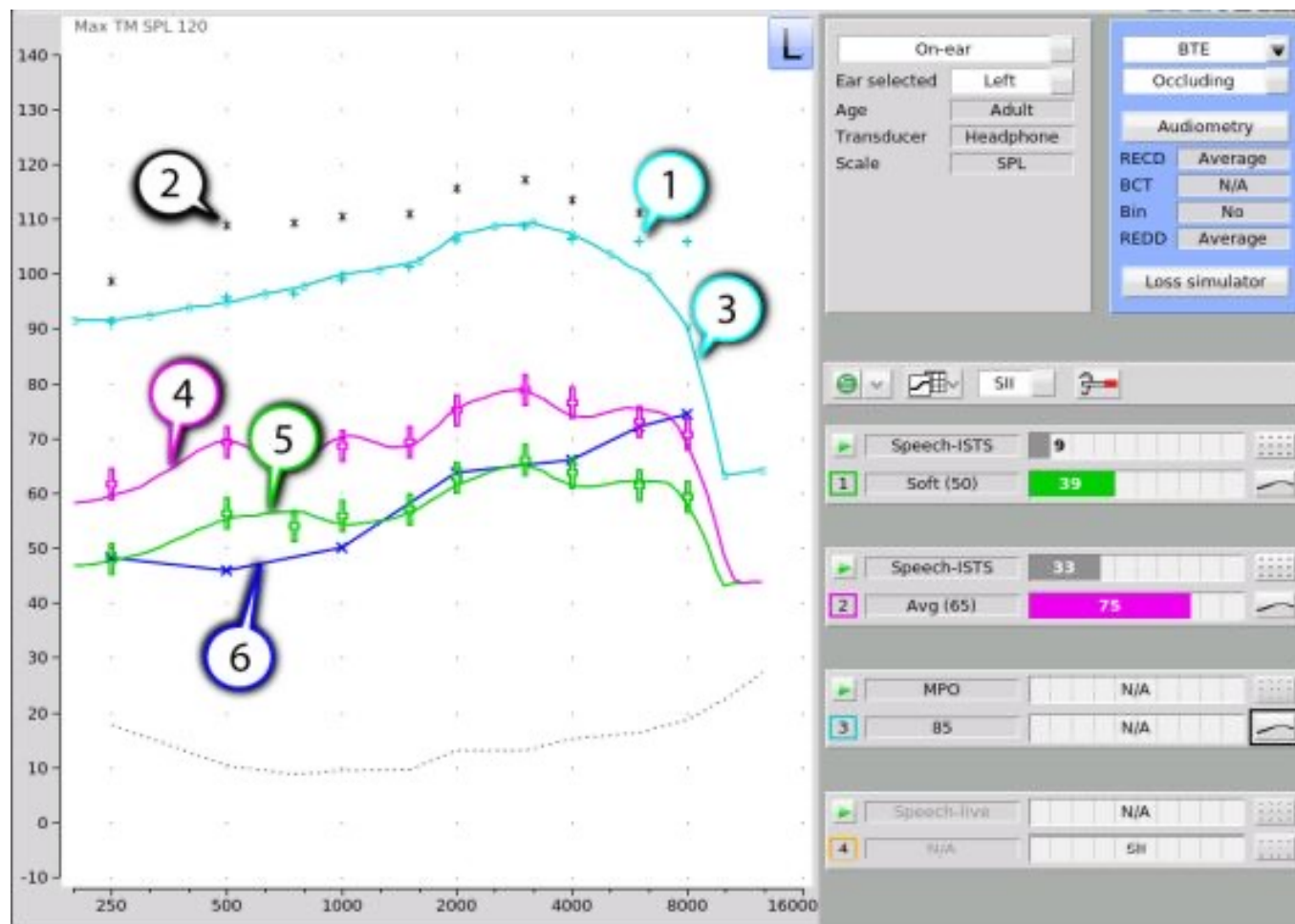


Image taken from the Audioscan Verifit User Guide



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

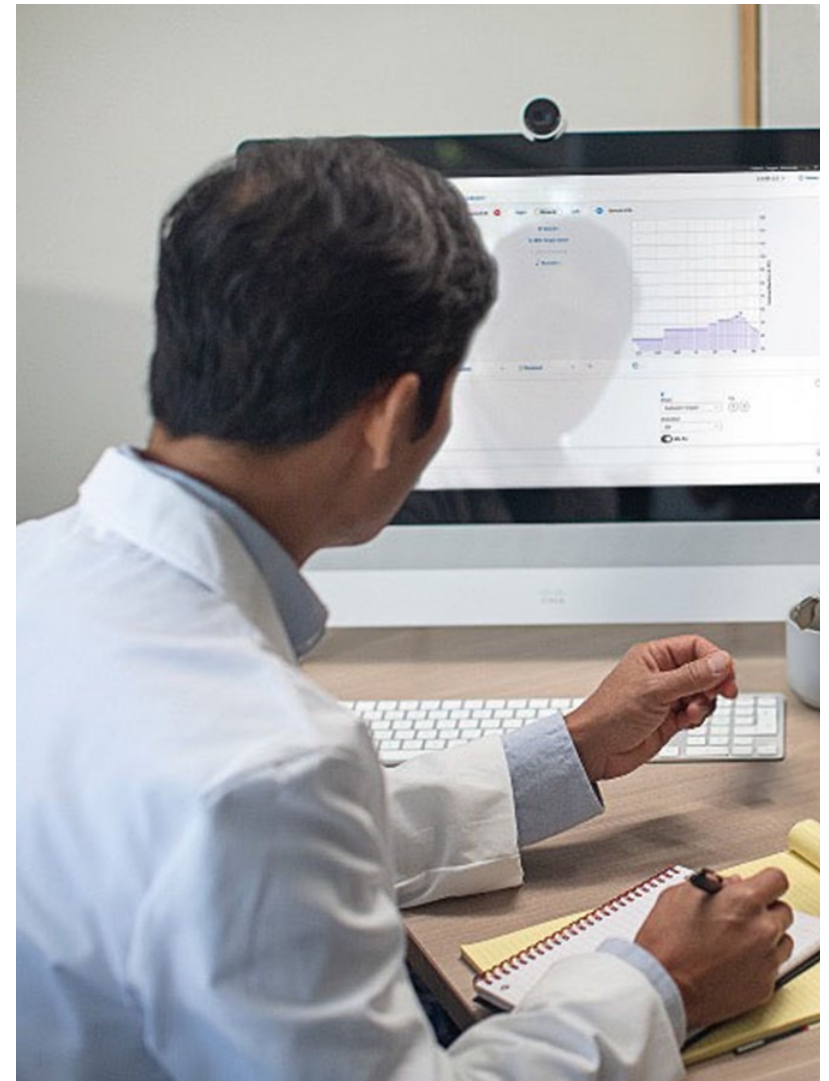
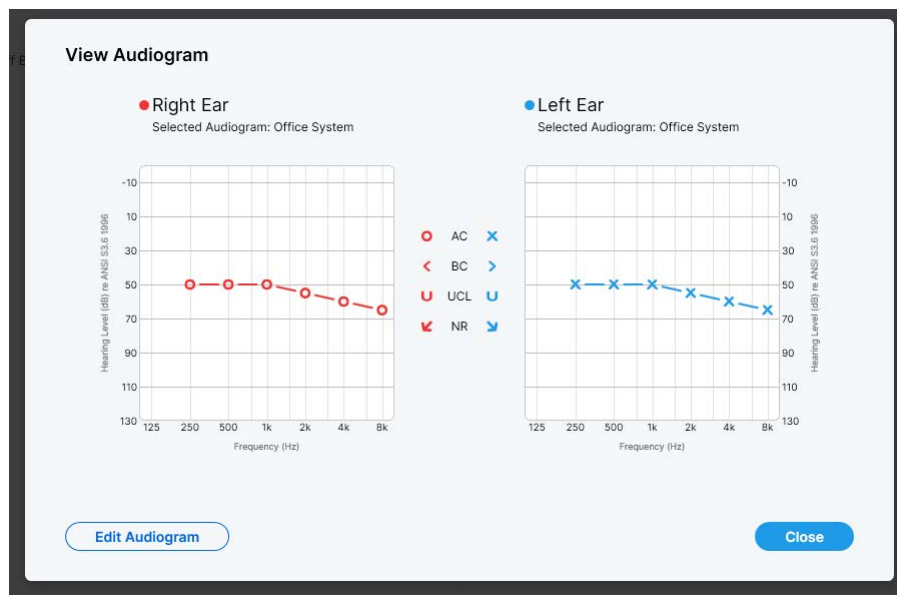
Image taken from the Audioscan Verifit User Guide



- 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

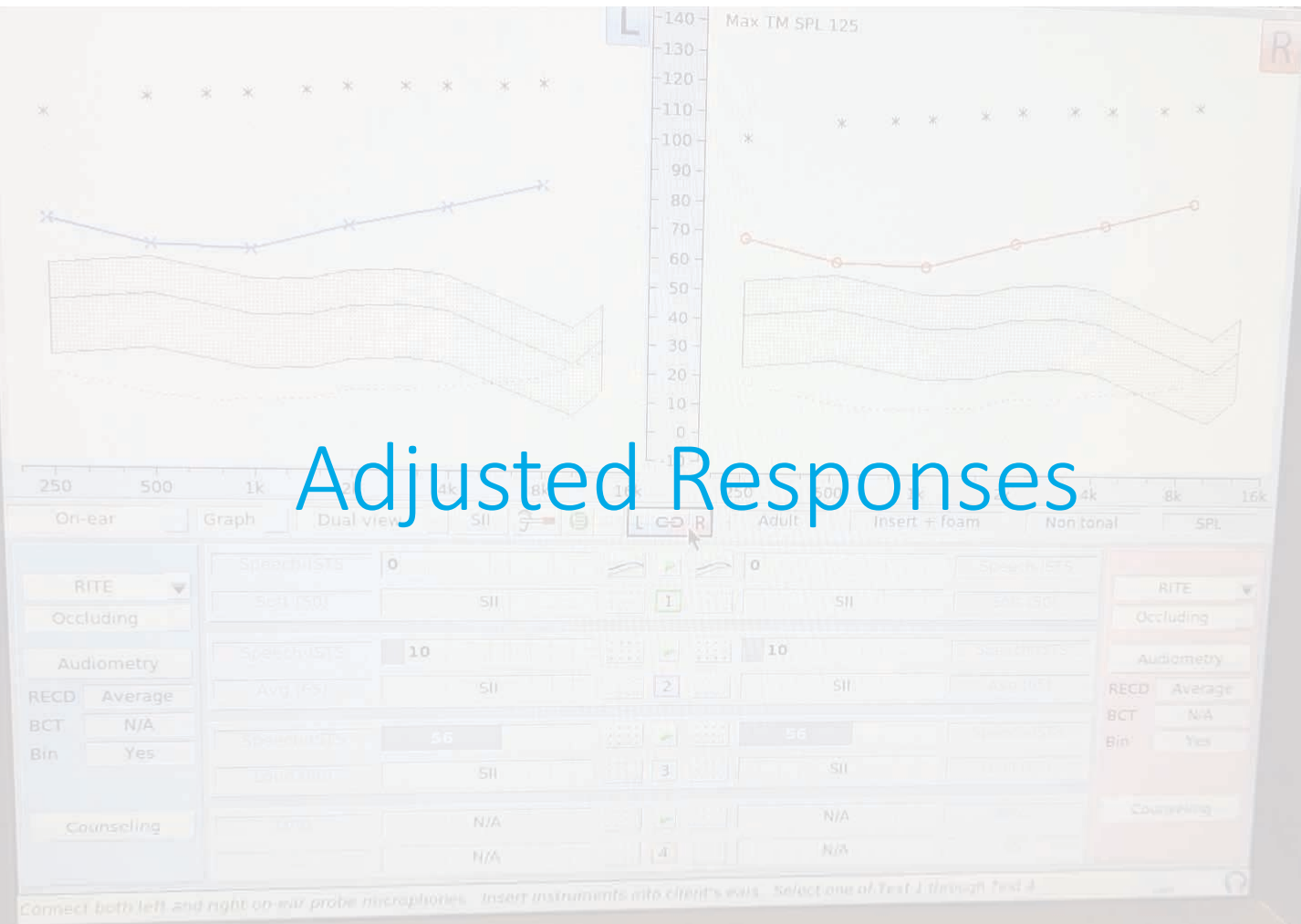
Patient Audiogram



The screenshot displays the VeriFit 2 software interface for initial measurements. The top section shows two audiograms, one for the Left ear (L) and one for the Right ear (R). Both audiograms show a flat line at 125 dB HL across all frequencies, indicating no hearing. The bottom section contains a control panel with various settings, including RITE, Occluding, Audiometry, RECD, BCT, Bin, Counseling, and a table of measurements.

Initial Measurements

Adjusted Responses



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 %

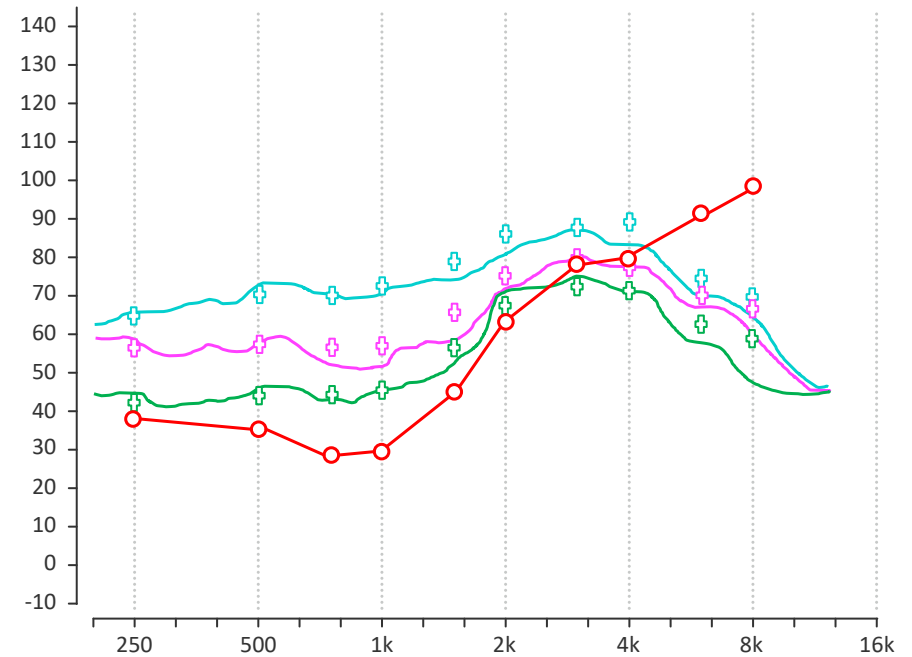
Using SII for Counseling

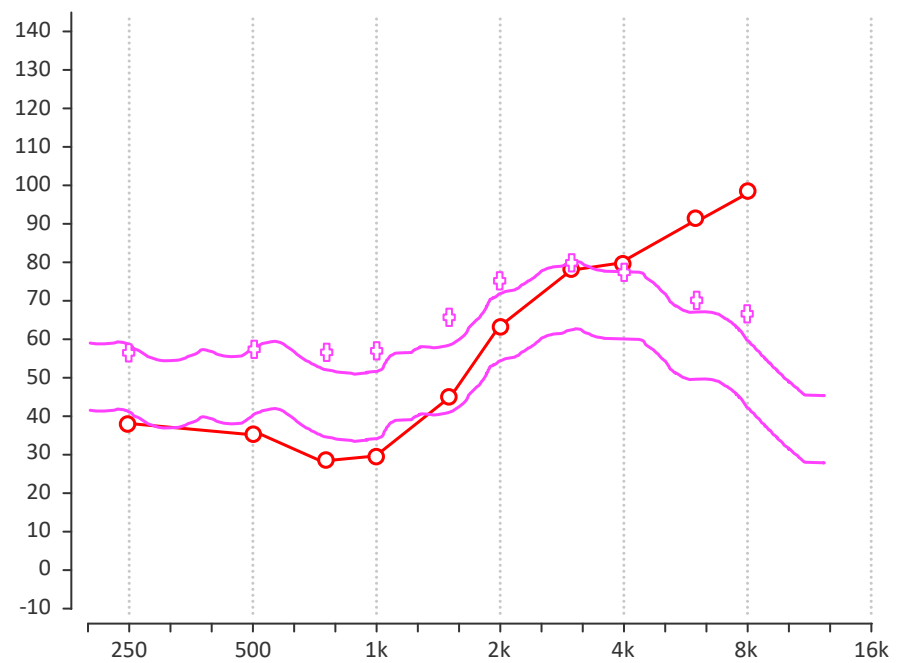
	50 dB SPL		65 dB SPL		80 dB SPL	
	Left	Right	Left	Right	Left	Right
Unaided SII	0%	0%	10%	10%	56%	56%
Aided SII (pre)	6%	11%	32%	34%	63%	64%

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%

1. Soft speech (50 dB SPL) is audible
2. Average speech (60-65 dB SPL) is comfortable
3. Loud speech (75 dB SPL) is not uncomfortable
4. Maximum Power Output doesn't exceed UCL





REM for CROS Verification



Verifying CROS
Hearing Aids



Verifying BiCROS
Hearing Aids

CROS Verification

1

Measure REAR for the better ear

- Position the speaker at 45° to better ear
- Position reference mic and probe tube at better ear
- Position CROS instruments in ear and turn on
- Measure better ear only

2

Measure REAR on the poorer ear

- Position the speaker at 45° to the poorer ear
- Position reference mic at poorer ear
- The probe tube remains in the better ear
- The response measured should match response from step 1

3

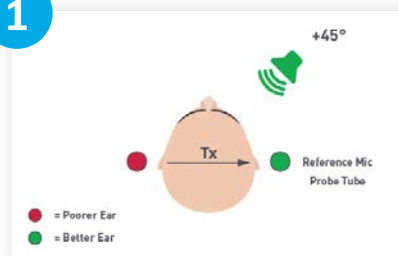
Measure REAR at 0°

- Position the speaker at 0°
- Position reference mic at poorer ear or at better ear
- The probe tube remains in the better ear
- The response measured should match response from step 1

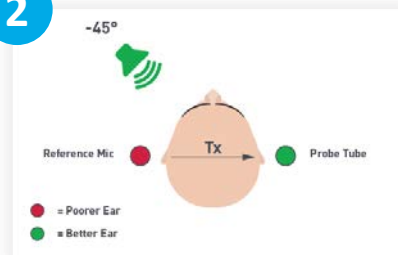
- *All measurements made at same stimulus level*
- *All 3 curves should be consistent*

CROS Setup

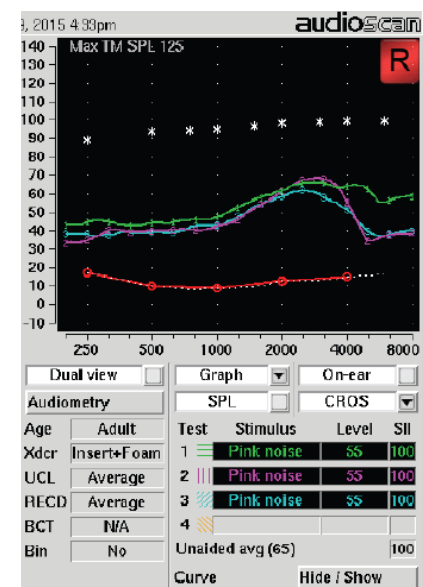
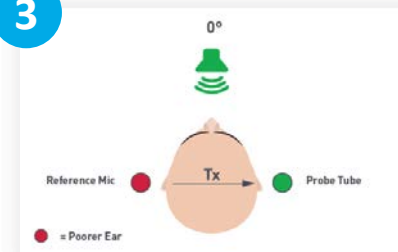
1



2



3



— = Step 1

— = Step 2

— = Step 2

BiCROS Verification

- *All measurements made at same stimulus level*
- *Both curves should be consistent*

1

Measure REAR for the better ear

- Position the speaker at 45° to better ear
- Position Reference Mic and probe tube at better ear
- Position BiCROS instruments in ear and turn on
- Measure Better Ear Only

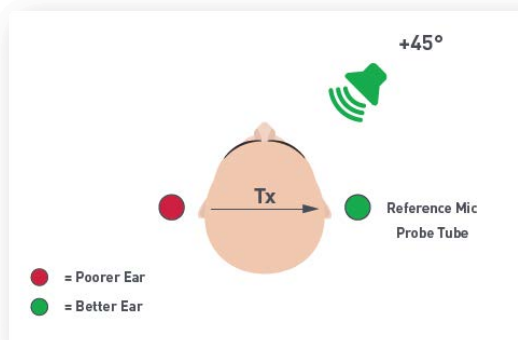
2

Measure REAR on the poorer ear

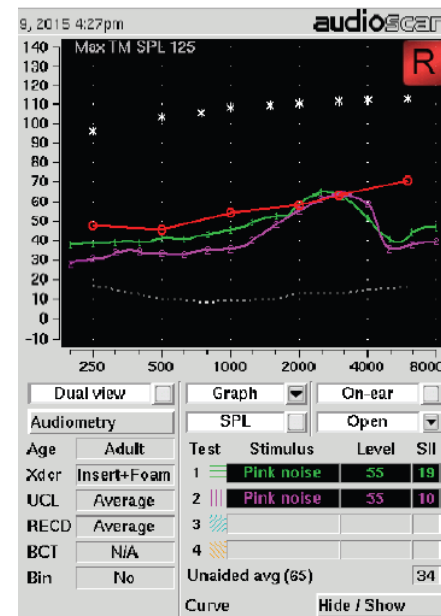
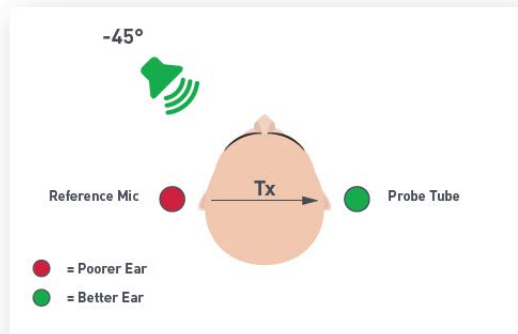
- Position the speaker at 45° to the poorer ear
- Position Reference Mic at poorer ear
- The probe tube remains in the better ear
- The response measured should match response from Step 1

BiCROS Setup

1

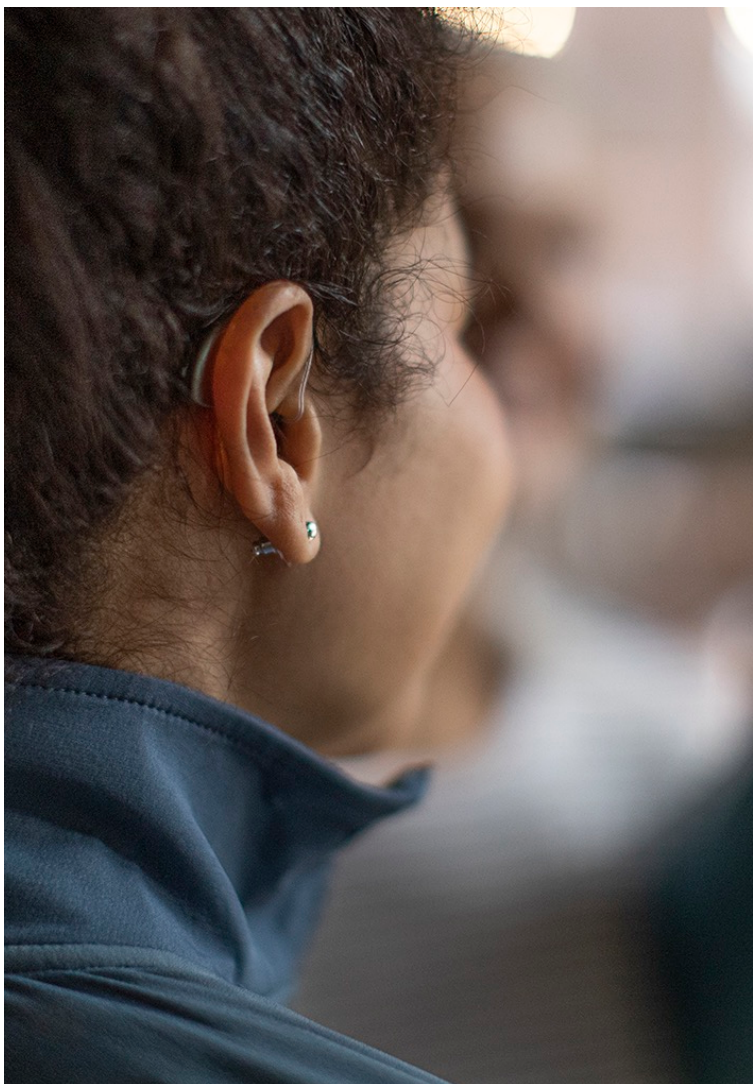


2



— = Step 1

— = Step 2



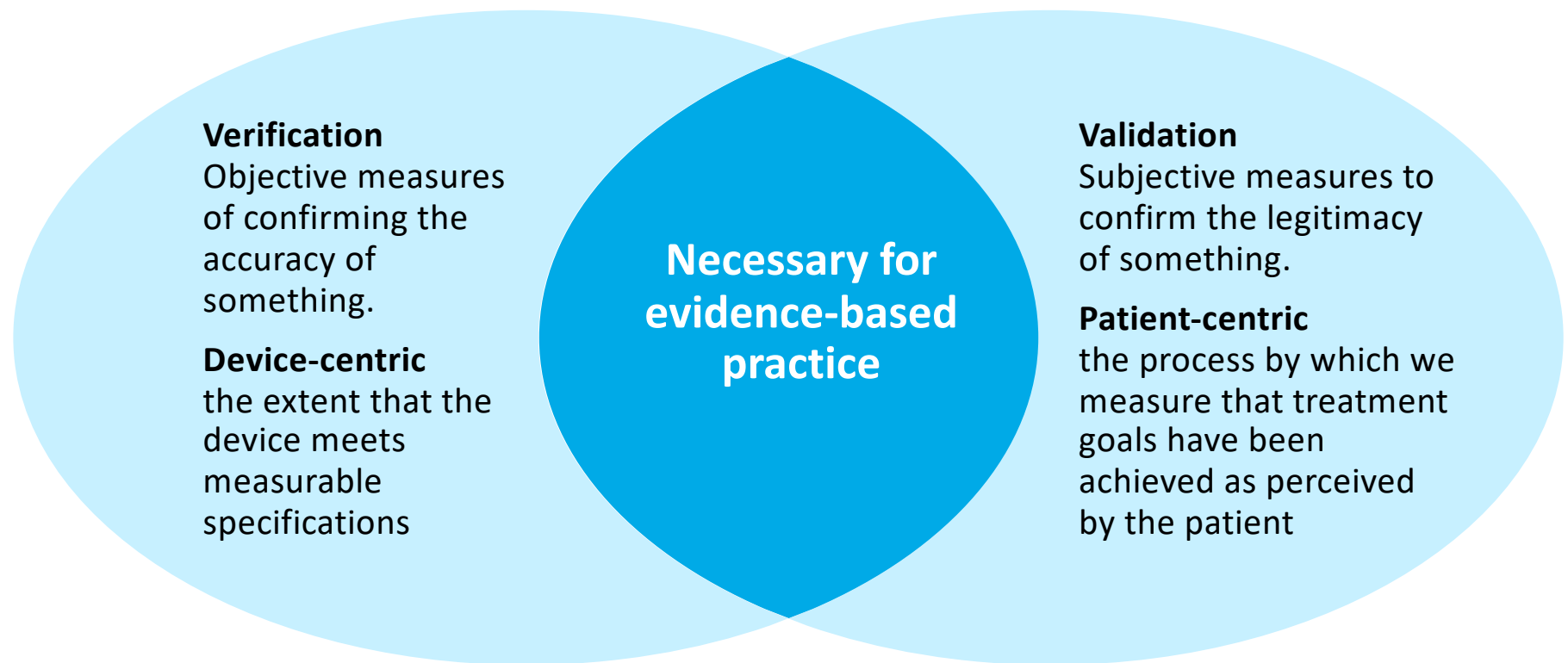
Real Ear Integration

Incorporating Real Ear into Your Office Flow

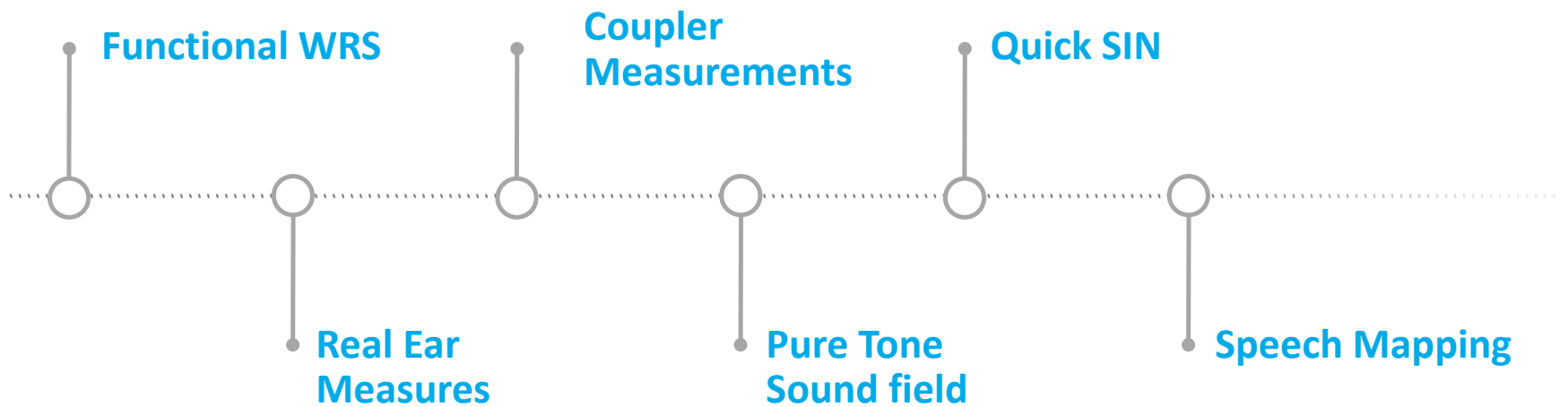


Hear better. Live better.

Verification VS Validation



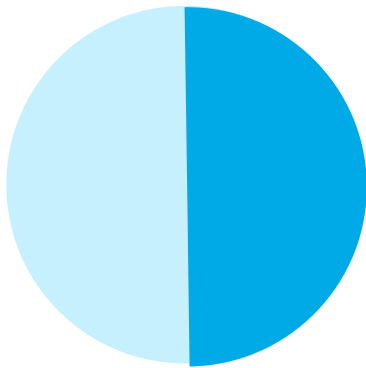
Types of Verification



Typical Hearing Aid Fitting Flow

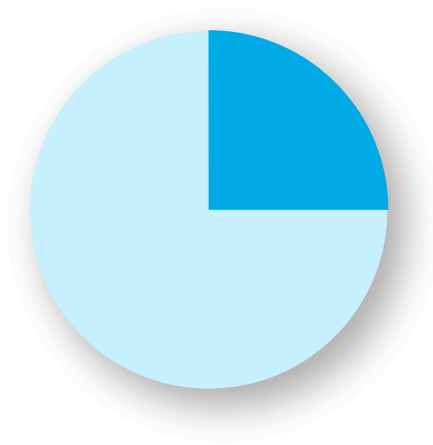


Ideal First Fit Timing



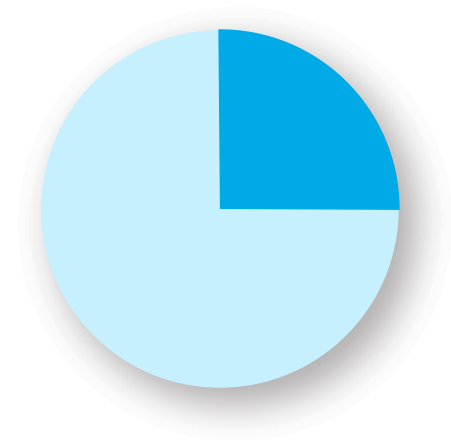
30 Minutes

Counseling



15 Minutes

Fitting



15 Minutes

Setting up extras
& other

Where Does Real Ear Fit?



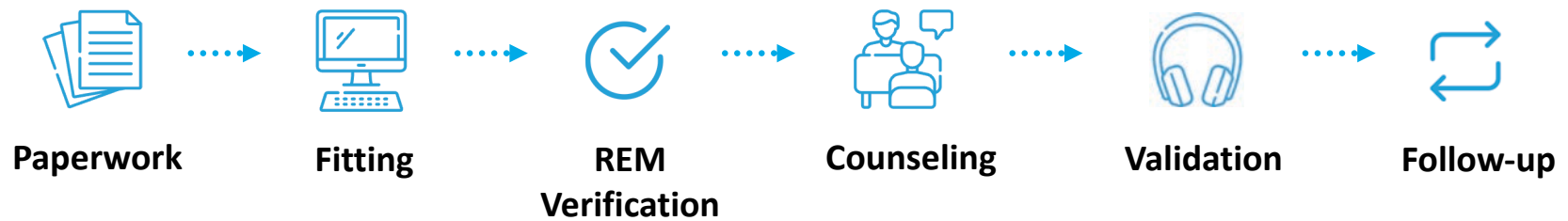
15 Minutes
Fitting

Initial Programming of Hearing Aids

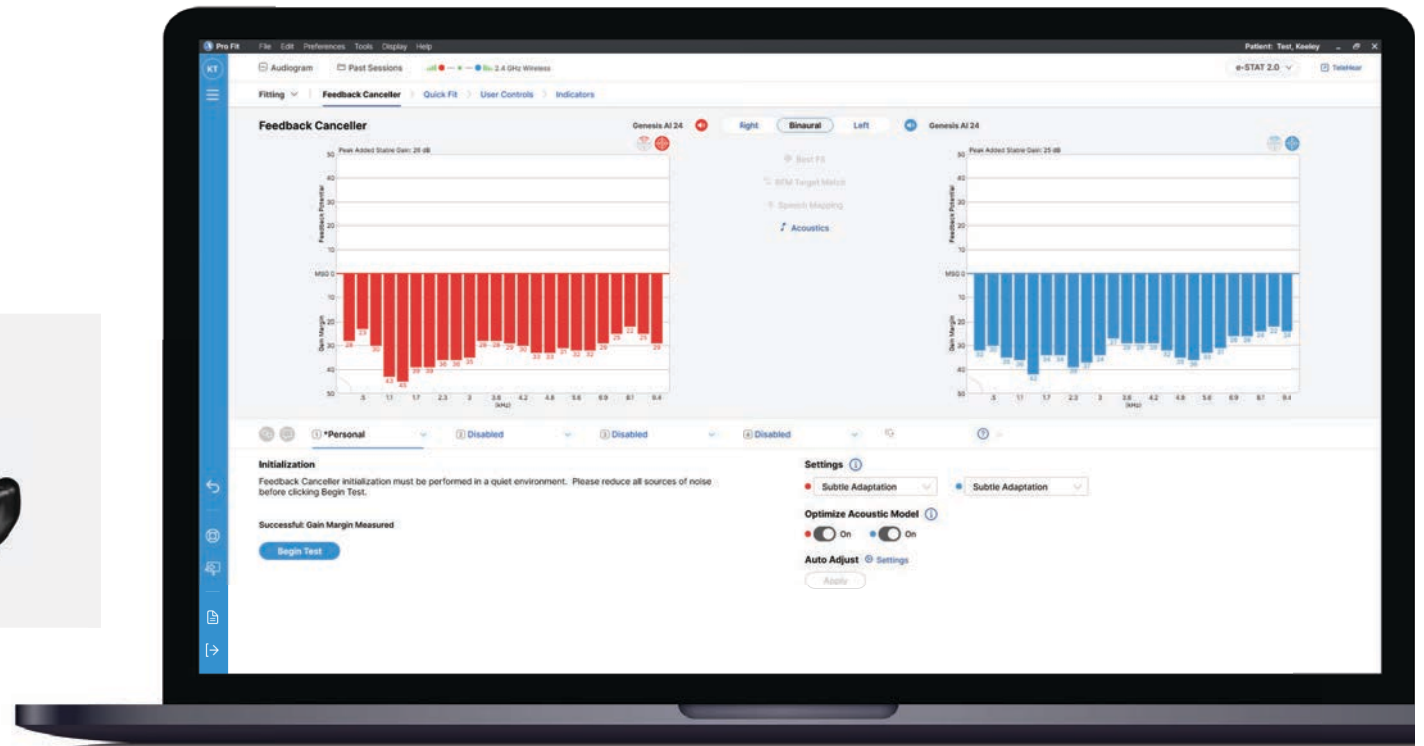
Adjusting for patient comfort

Setting up user controls and additional programs

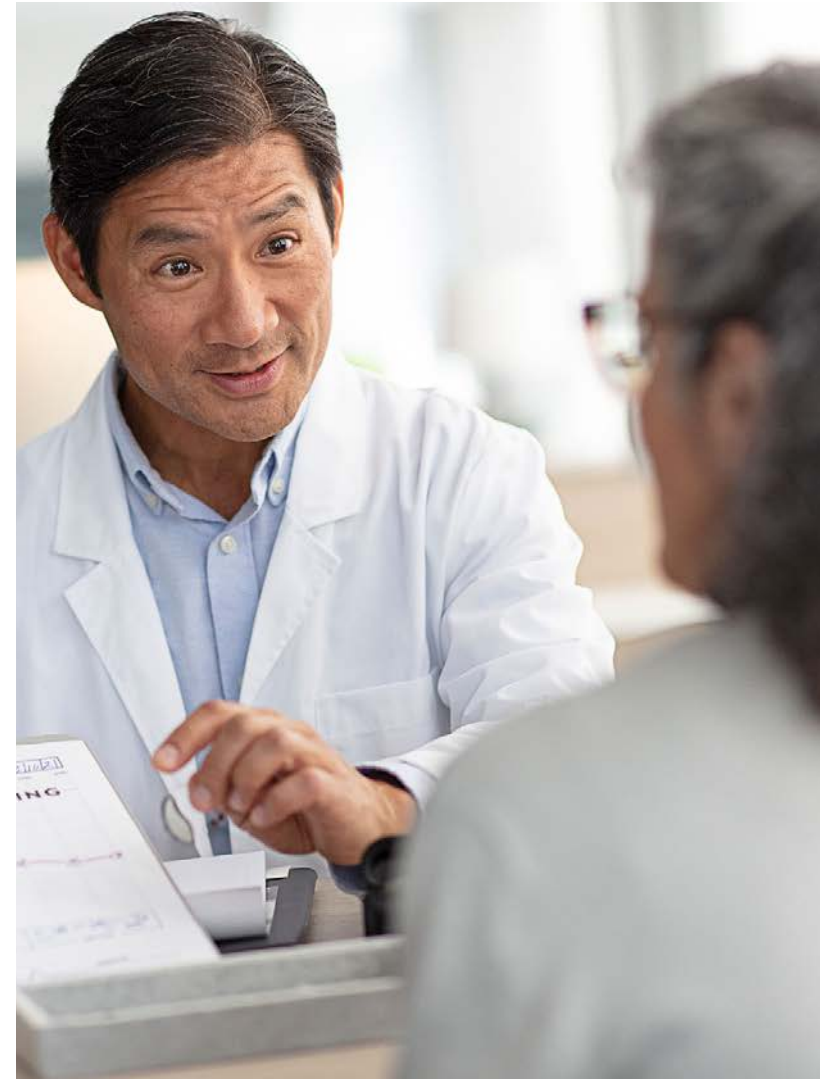
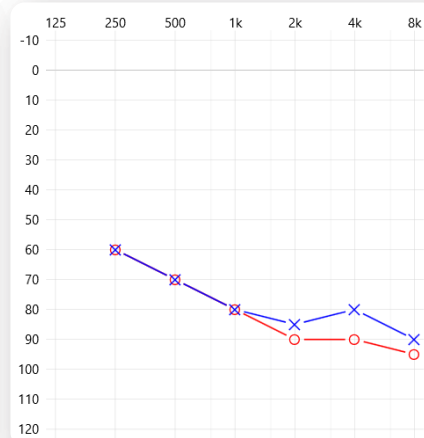
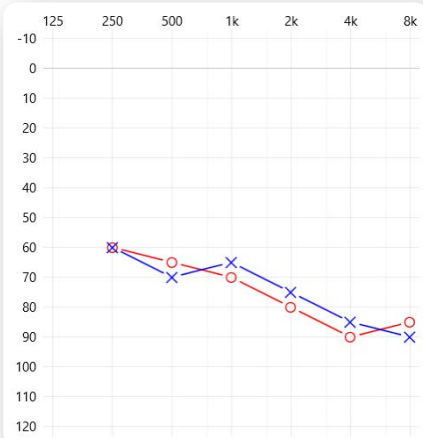
Hearing Aid Fitting Flow with REM



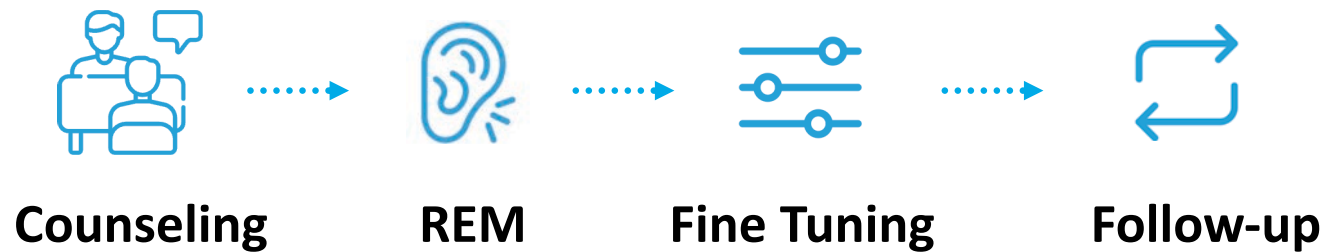
Acoustic Changes



Annual Audio Appointment



Hearing Aid Follow-Up Flow with REM

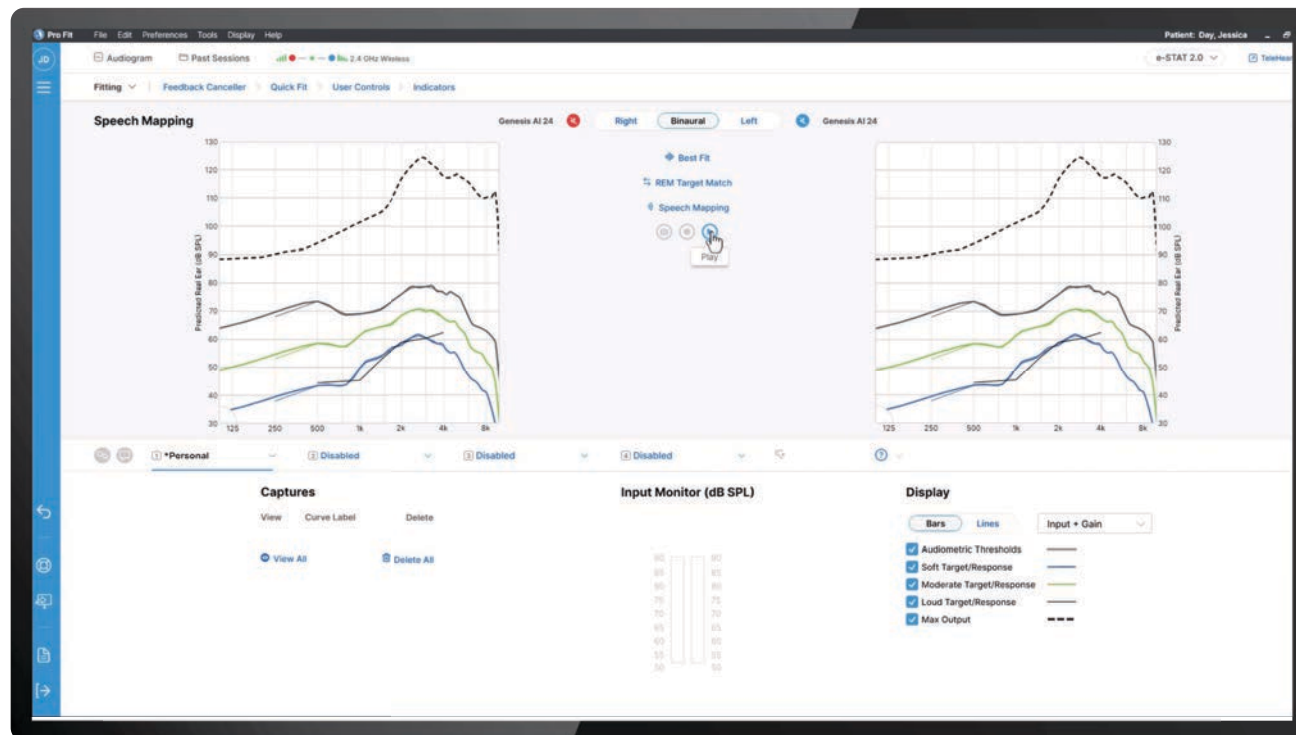




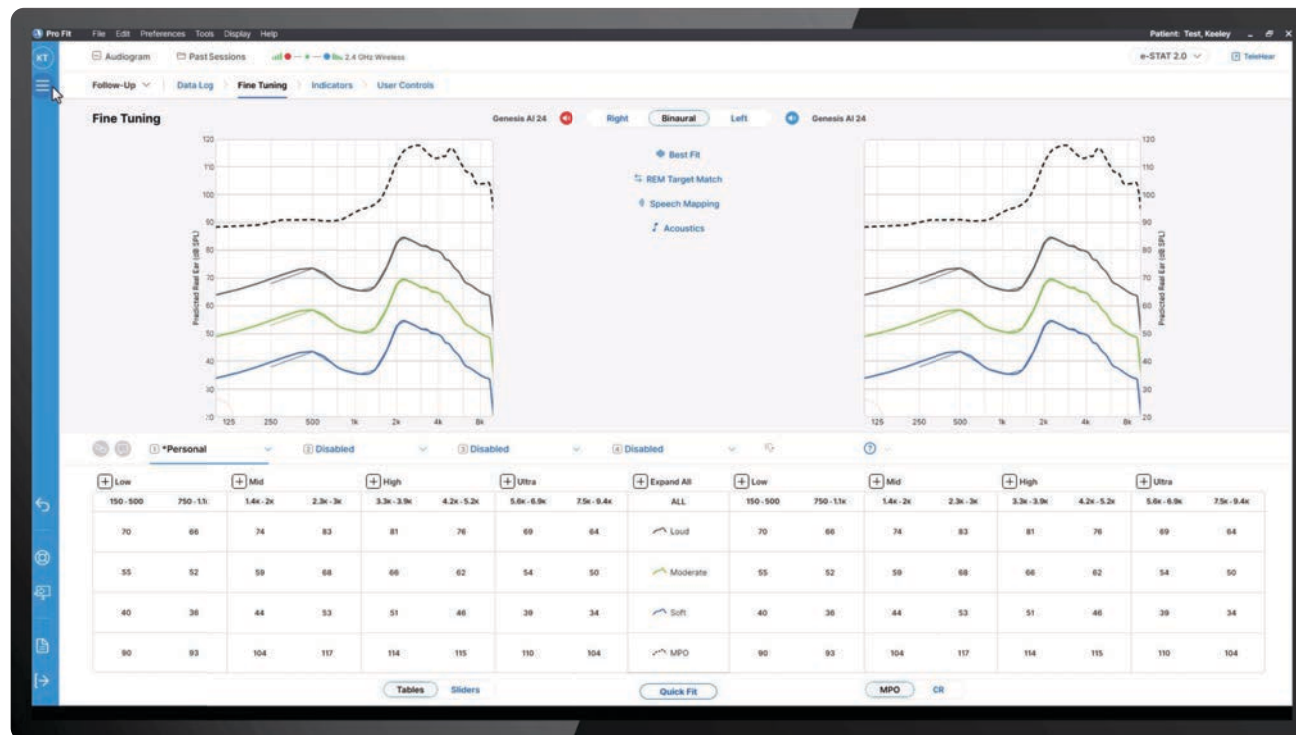
Additional Tools

Pro Fit Software Tools That Assist
with REM Verification

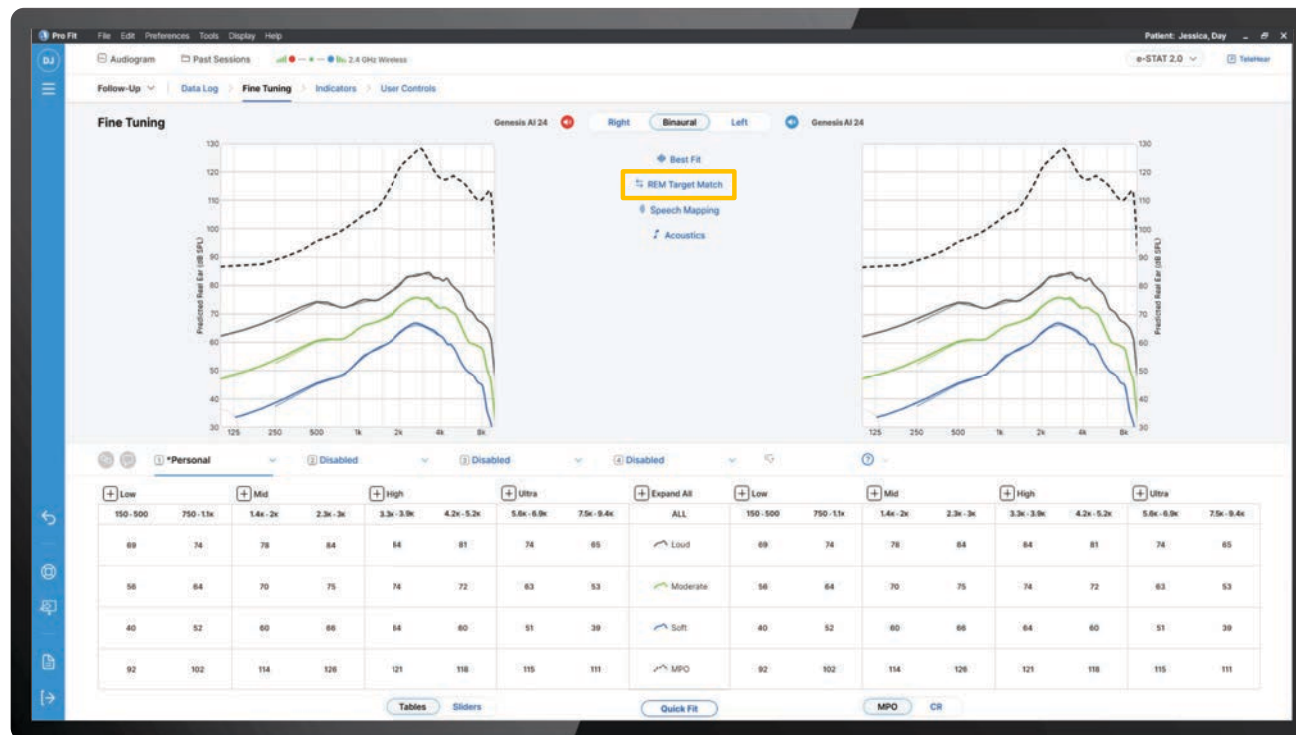
Speech Mapping



Verify Comfort



REM Target Match



REM Target Match Features



Fully integrated workflow via the REM Target Match Tool



Allows for **simultaneous binaural real ear measurements***



Automatic target matching for both the e-STAT 2.0 proprietary and standard prescriptive formulas



Live display of measurements relative to target



Allows for manual fine tuning to further personalize a fitting as needed

*Audioscan Verifit 1 only allows for monaural measurements

Internal Study

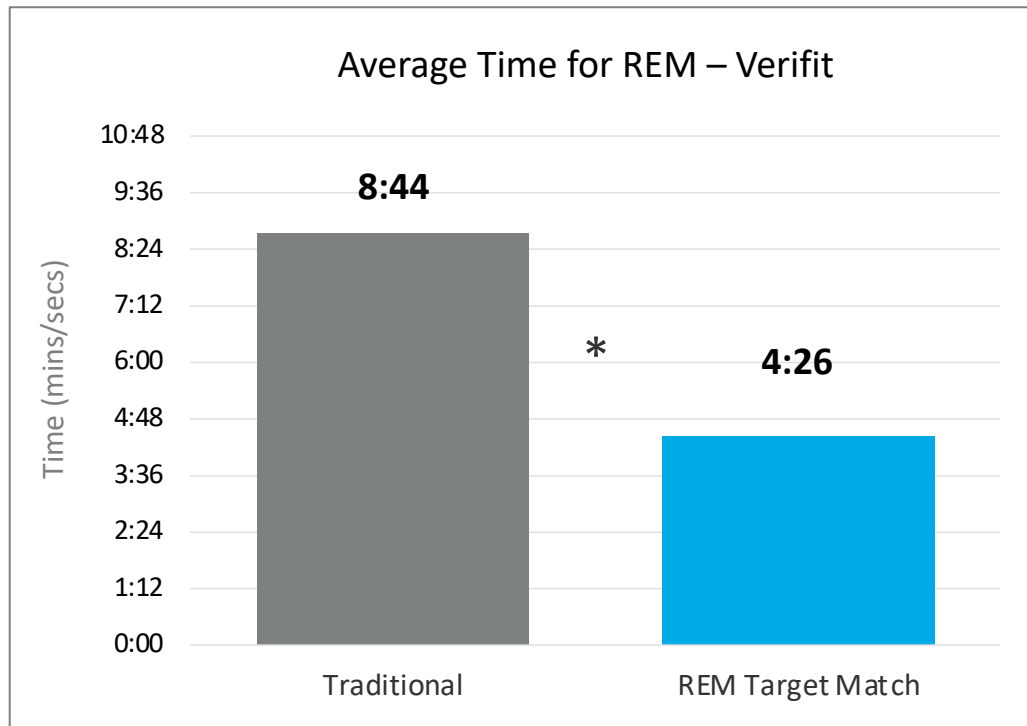
Accuracy data for REM Target Match

Methods

- Normal-hearing participants
 - 7 female, 3 male
- 3 hearing loss configurations
- 3 real ear measurement systems

Results

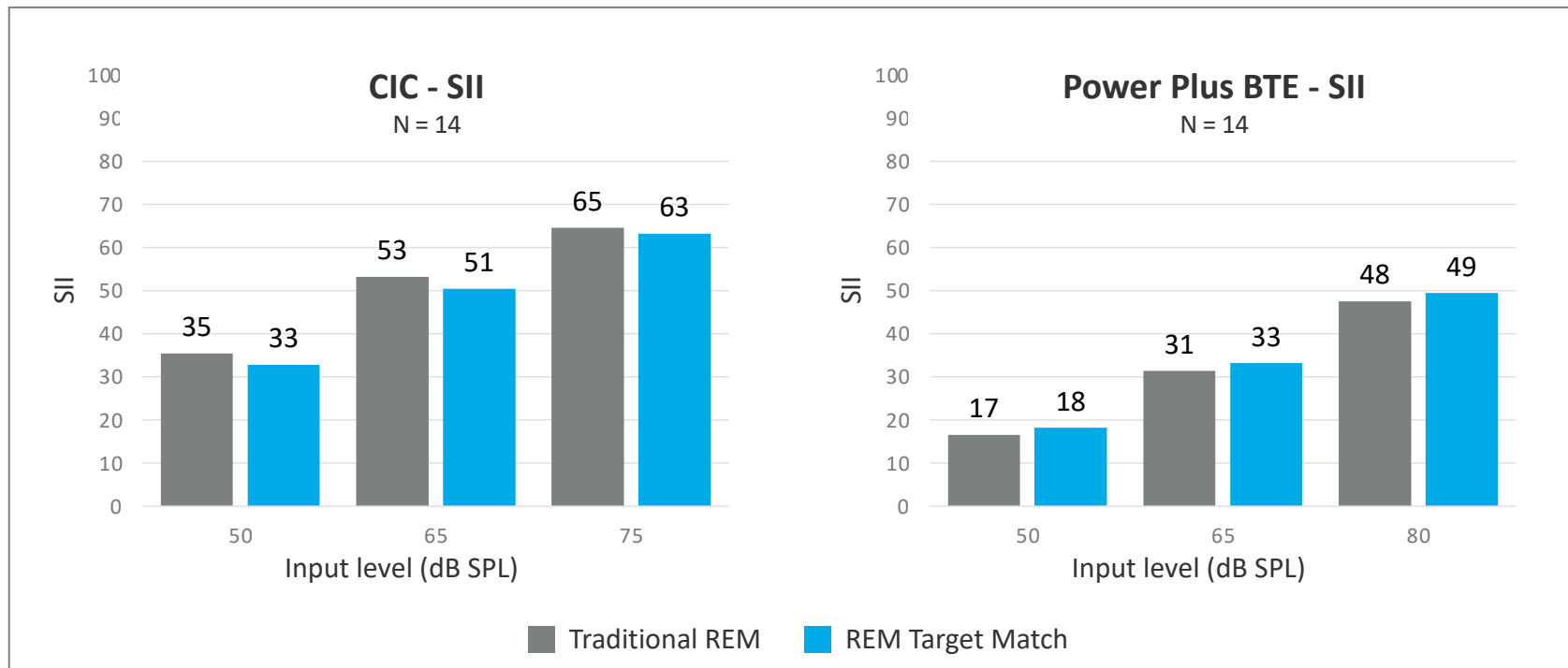
- **REM Target Match performed equivalently or within tolerance** compared to traditional manual REM fitting and performed consistently across all REM systems.



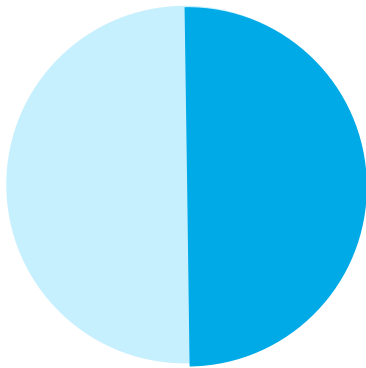
* = $p < 0.001$

REM Target Match
can be done in
half the time of
traditional real ear
measurements

REM Target Match provides equivalent levels of audibility compared to traditional real ear measurements

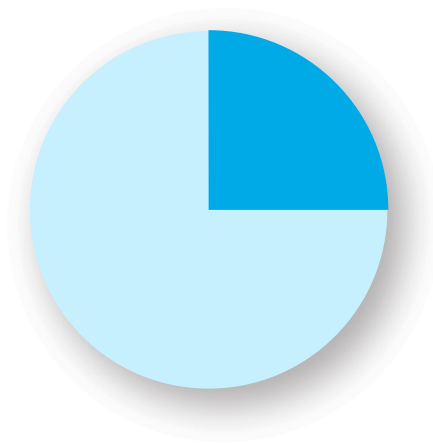


Ideal First Fit Timing



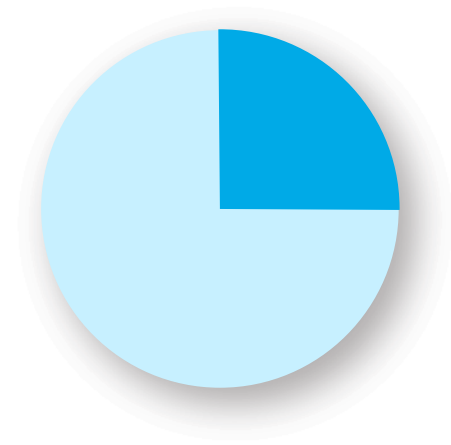
30 Minutes

Counseling



15 Minutes

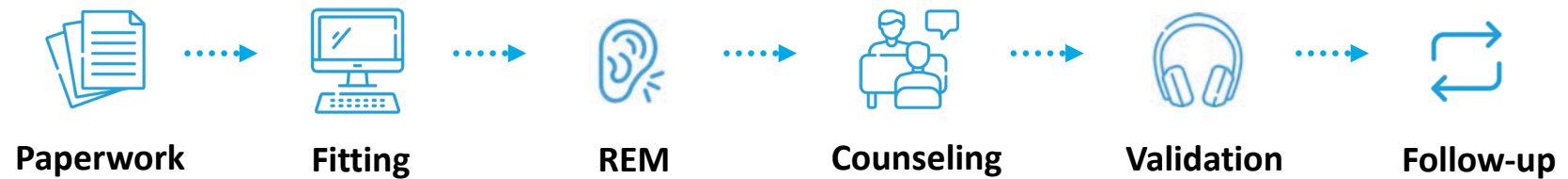
Programming + REM



15 Minutes

Setting up extras
& other

Hearing Aid Fitting Flow with REM



Real Ear Protocol Options



REM Target Match



SII Comparison



E-Stat 2.0 vs NAL 1/2

Real Ear is a great starting point.

Real Ear can be used for multiple hearing losses and listening situations.

Real Ear can be used with proprietary fitting formulas.

Real Ear is a great counseling tool for patients.

Real ear curves can also be used to verify advanced features in the aids.

Take Home
Message

Resources

Neuro & Thrive Platforms

QUICKTIP

REM Target Match

REM Target Match is a feature for verifying hearing aid fittings with real ear equipment and the fitting software. REM Target Match provides a streamlined process for automatically matching real ear targets to provide a more accurate and efficient fitting experience.

Compatibility Requirements

- Pro Fit 2023.0 or higher or Inspire X 2020.1 or higher.
- Requires Noah Version 4.5.1 or higher.
- Compatible with the following real ear systems:
 - Otometrics Aurical FreeFit
 - MedRx Avant REM
 - Inventis Trumpet
 - Audioscan VeriFit1
 - Audioscan VeriFit2
- Compatible with all technology tiers and styles for Muse/NOV/A4/Summit/AGXsm products and forward.

Step 1: Setup

Connect the hearing aids, then on the QuickFit screen, select **REM Target Match**.

- From the REM Target Match tool, select the ear to be measured (Right, Left, Binaural) at the top of the screen.
- View the experience level, fitting formula and acoustic options. Exit the tool to make any necessary changes to these items before continuing. Changes cannot be made within the tool. When using the Audioscan VeriFit, select the desired VeriFit target and stimulus you wish to use.
- Ensure the real ear system you wish to use is powered on and selected in the bottom left corner of the tool.

NOTE: For fitting software to connect with the Audioscan VeriFit, the VeriFit IP address must be entered in Preferences.

- Click **Launch** to begin.
- In the bottom left corner the name of the real ear system will display with a red circle. Once the real ear system has finished launching, the circle will turn green indicating the real ear system has been successfully launched.
- Click **Next** to proceed.

CROS System Verification Protocol

Our wireless CROS System takes audio from an ear-level microphone and wirelessly transmits it to the opposite ear via Near-Field Magnetic Induction (NFI) technology, optimizing patients' hearing experience. Real ear verification is an important step in the fitting process as it ensures the CROS system is providing adequate gain for optimal performance.

Recommended process for measuring the head-shadow effect:

Step One: Measure the real-ear unaided response (REUR) for the better ear: [Fig. 1]

- Position the speaker at 45° to the ear.
- Position the reference microphone at the better ear (i.e. same side as speaker).
- Insert the probe tube into the better ear.
- Measure the better ear only.

Step Two: Measure the REUR with sound directed towards the poorer ear: [Fig. 2]

- Position the speaker at 45° to the poorer ear.
- Position the reference microphone at the poorer ear (i.e. same side as speaker).
- The probe tube remains in the better ear (i.e. opposite side as speaker).
- Collect the real ear measurement for sound on the poorer ear side.

The difference between the two measures (for the same input level) obtained in steps 1 and 2 represents an estimate of the head shadow effect for this patient. [Fig. 3]

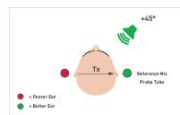
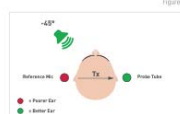
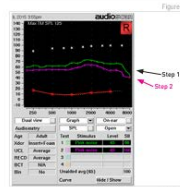




Figure 1

Figure 2

Figure 3

Starkey

Trumpet

REM System and PC Controlled Audiometer



DESIGNED, ENGINEERED AND MANUFACTURED IN ITALY

Orchestral perfection
A full line of Audiology Equipment

- Bilateral testing
- Standard meas. (REUG/R, REAG/R, REIG, REO/R)
- Speech mapping
- PTA and Speech audiometry (AUD version)
- Built-in speaker for REM and audiometry
- Wireless probes (opt.)

inventing audiology

Additional Learning Opportunities

Audiology Online

- Real-Ear Measures 101
- Starkey at a Glance: Verifit REM Target Match
- Real Ear Measures:
A Deep Dive
- Advancing the Leading Edge of Hearing Aid Fittings with Real Ear Measures



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COURSE CODE

V000R

Victor Zero Zero Zero Romeo

CODE CLOSES

02/20/2024

QUESTIONS ABOUT CONTINUING EDUCATION?

CONTACT

ceu_inquiries@starkey.com

Thank You.



Hear better. Live better.