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Optimizing Accuracy in Fitting Pediatric Hearing Aids Using Real Ear Measures

15 FEBRUARY 2024

Presented by Dr. Alida Naudé

Learner Outcomes

- After this course, participants will be able to describe the fundamental principles of Real Ear Measures (REM) and their application in pediatric hearing aid fittings.
- After this course, participants will be able to identify the unique challenges involved in conducting REM with pediatric patients, including considerations for ear canal size and patient cooperation.
- After this course, participants will be able to describe how to integrate REM findings with holistic care strategies for children with hearing loss, enhancing overall treatment effectiveness and patient outcomes.

BRIEF OVERVIEW

1

(a) Overview of Pediatric Hearing Loss and
(b) the Significance of Accurate Hearing Aid Fitting

2

(a) What are Real Ear Measures (REMs) including
(b) its role in Adult vs Pediatric Audiology

3

(a) Importance of REM in Pediatric Fittings including
(b) Equipment and Setup for Pediatric REM

4

Overcoming Challenges in Pediatric REM

5

Analyzing REM Results

6

Conclusion with key takeaways



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Overview of Pediatric Hearing Loss

Statistics
Basic Facts

Impact on Development
and Communication

Early Detection
Management

Pediatric hearing loss refers to a partial or total inability to hear sound in one or both ears among children.

- Present at birth (congenital)
- Acquired due to illness, injury or exposure to loud sounds
- Impact of hearing loss on a child can vary widely depending on the severity, type of hearing loss, and the age at which it occurs
- Early detection and (appropriate) intervention are crucial for minimizing the impact on a child's development





Statistics and Basic Facts

Incidence	Varies worldwide Estimated 1-3 per 1 000 babies (US) Can increase with age (infections, trauma, exposure)
Types of Hearing Loss	Sensorineural Conductive Mixed
Causes	• Genetic factors • Complications during pregnancy / childbirth • Certain infectious diseases • Chronic ear infections • Exposure to loud sounds • Ototoxic mediations

Impact on Development and Communications

- Language and Speech Development

Hearing is critical for the development of speech and language skills. Children with hearing loss may experience delays in speech and language acquisition, affecting their ability to communicate effectively.

- Cognitive Development

Hearing loss can also impact cognitive development, leading to challenges in areas such as learning, memory, and attention. Early intervention can help mitigate these challenges.



Impact on Development and Communications

- Social and Emotional Development

Difficulty in hearing can affect a child's ability to interact with peers and adults, potentially leading to social isolation, decreased self-esteem, and difficulties in forming relationships.

- Academic Achievement

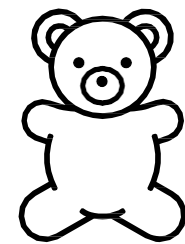
Children with hearing loss often face challenges in academic settings where hearing is essential for participation in classroom activities and learning. They may require special accommodations or educational settings to support their learning needs.



Early Detection and Management



Newborn Hearing Screening



- Many countries have implemented UNHS programs to detect hearing loss early.
- Early detection allows for timely intervention, which is crucial for the child's language, social, and cognitive development

Early Detection and Management



Intervention and Support



- Depending on the type and severity of hearing loss, interventions may include the use of:
 - Hearing aids
 - Cochlear implants
 - Sign language
 - Special education services
 - Early intervention programs are designed to support the child and family in developing communication skills

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Significance of Accurate Hearing Aid Fitting

Importance

Long-term Implications

Importance

The Crucial Role of Precision in Pediatric Hearing Aid Fitting

- In the realm of pediatric audiology, precision isn't just a goal, it's a necessity.
- Every child's hearing loss (and ear) is as unique as their fingerprint, requiring a tailored approach to hearing aid fitting.
- Accurate fitting ensures that hearing aids not only amplify sound but do so in a way that's tailored to the specific contours of a child's hearing loss including the unique earmold characteristics.
- This customization is critical for speech development, academic achievement, and social integration – core pillars of a child's growth.



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What are Real Ear Measures (REM)?

Definition

Purpose



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Real Ear Measures - Definition

Real-ear verification / hearing aid verification

- Quality assurance to ensure that the hearing aid meets the requirements and expectations.
- Verification: Does the hearing aid meet the specified requirements according to a target.
- Validation: Does the hearing aid meet the user's needs and requirements.



Real Ear Measures - Definition

Real-ear verification / hearing aid verification

VALIDATION

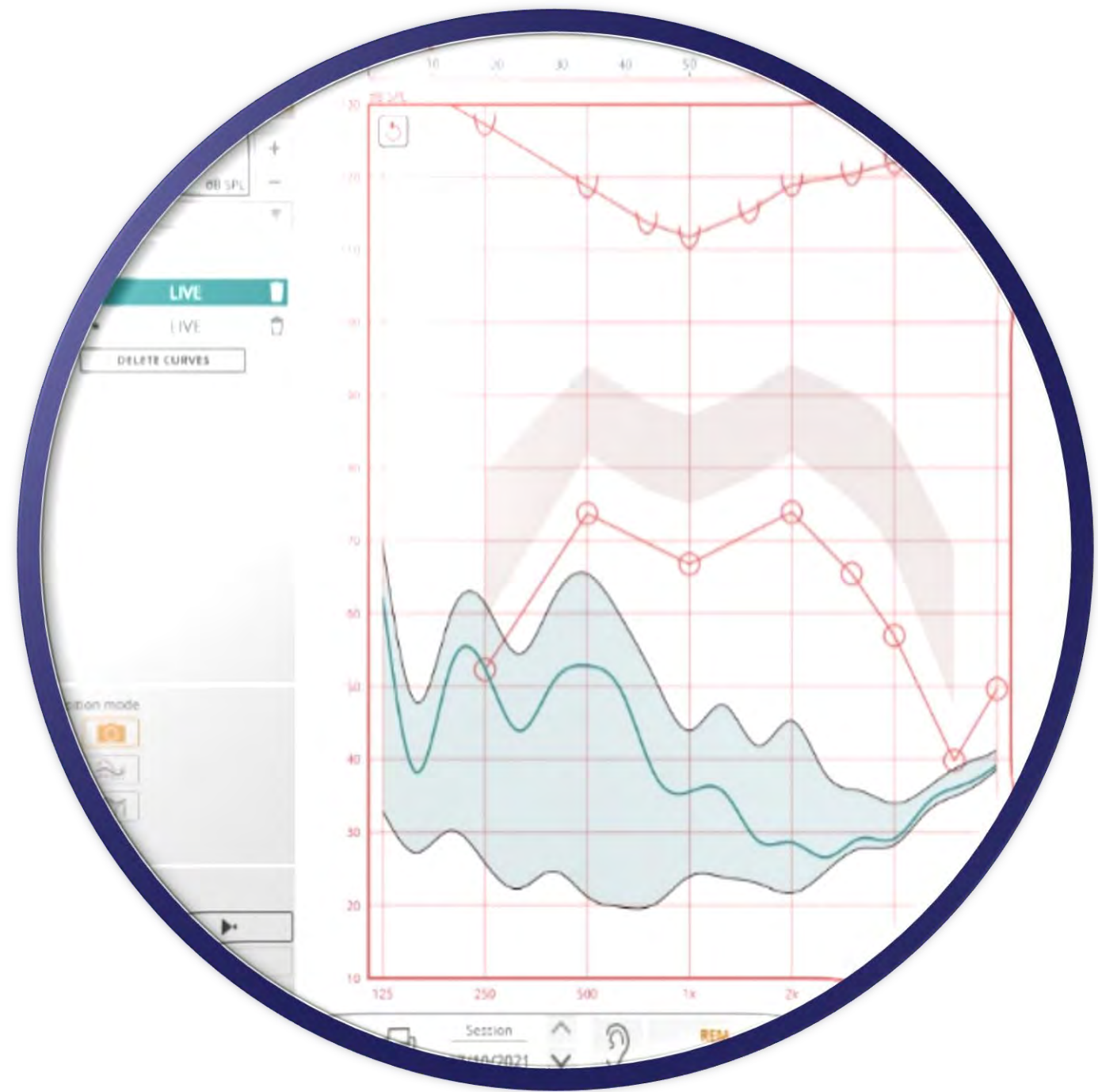
Functional assessment
Requires acclimatization
Often binaural
Subjective
Co-operation and clear response needed

VERIFICATION

Hearing aid assessment
No delay
Provides monaural data
Objective
Minimal co-operation especially using RECD



Real Ear Measures - Definition



- An objective measure that assess how well a hearing aid amplified sound within the ear canal
- What is the hearing aid doing inside the ear canal?
- A thin probe microphone is placed within a few mm of the ear drum and a sound stimulus is delivered to the ear via a loudspeaker



Real Ear Measures - Purpose

- REM ensures that hearing aids are programmed to meet each child's unique hearing needs
 - This is the heart of personalized audiology
 - It is not about volume
 - It is about how sound travels and resonates within the unique contours of an individual's ear canal (ear canal length and middle ear impedance)



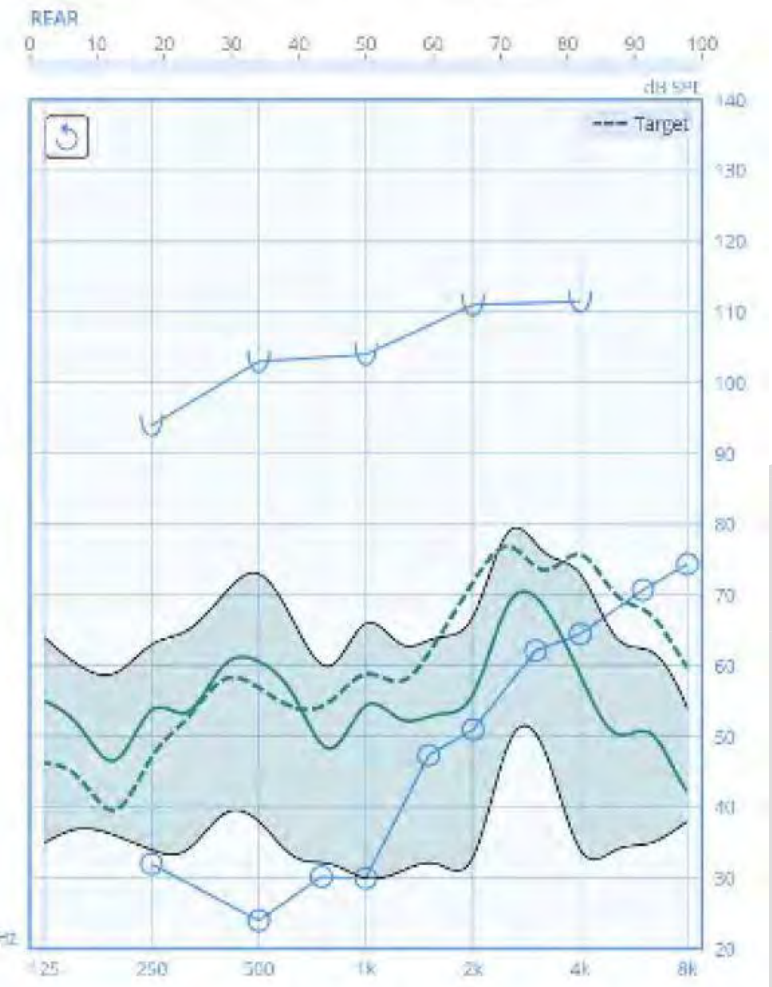
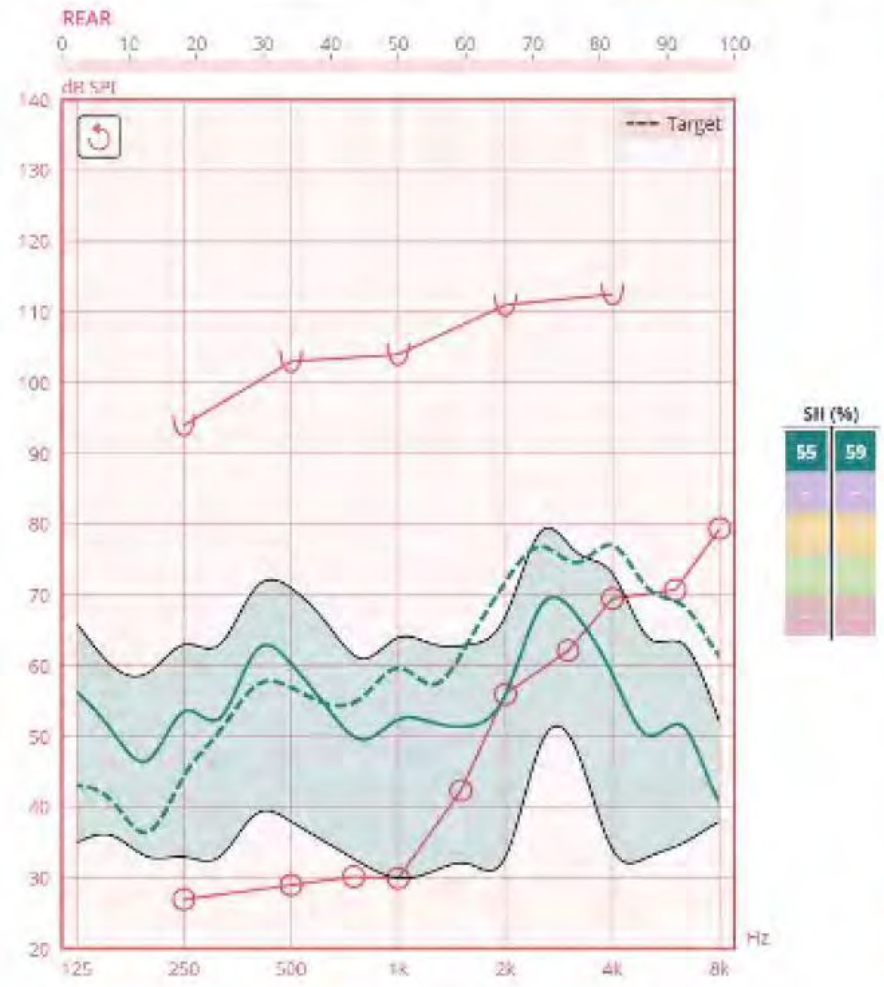
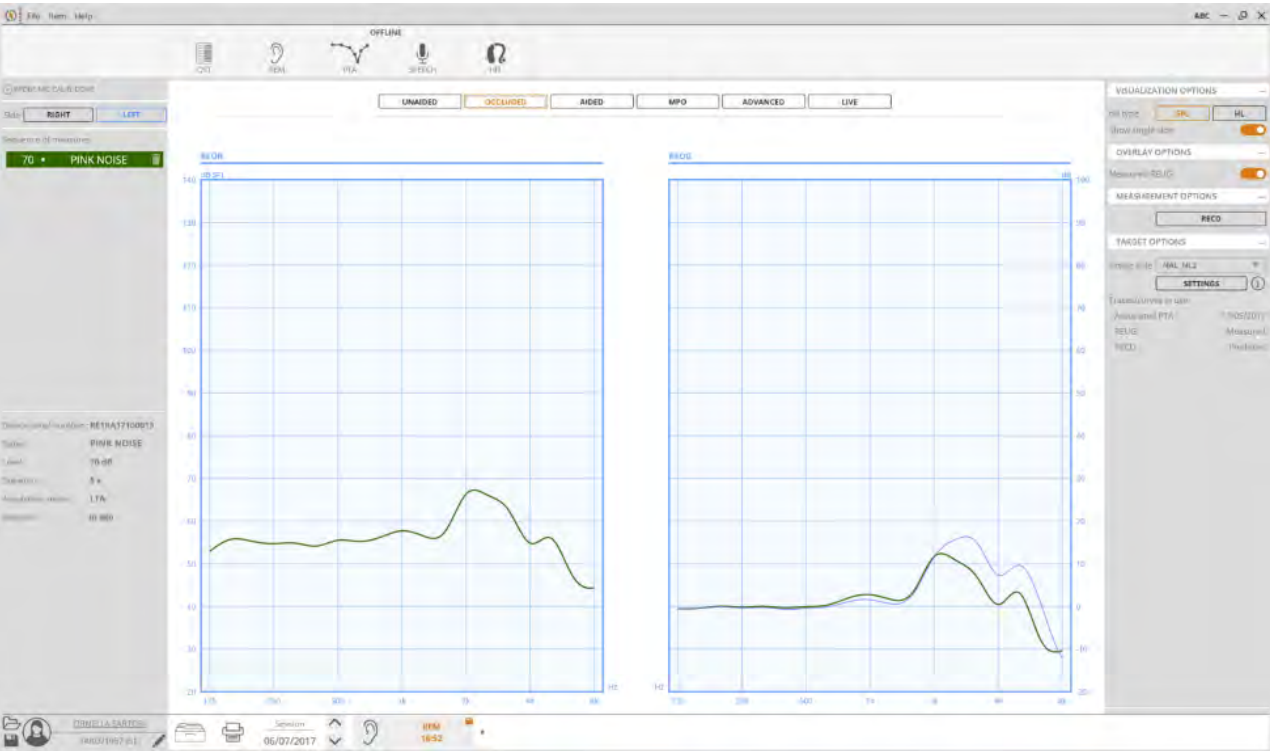
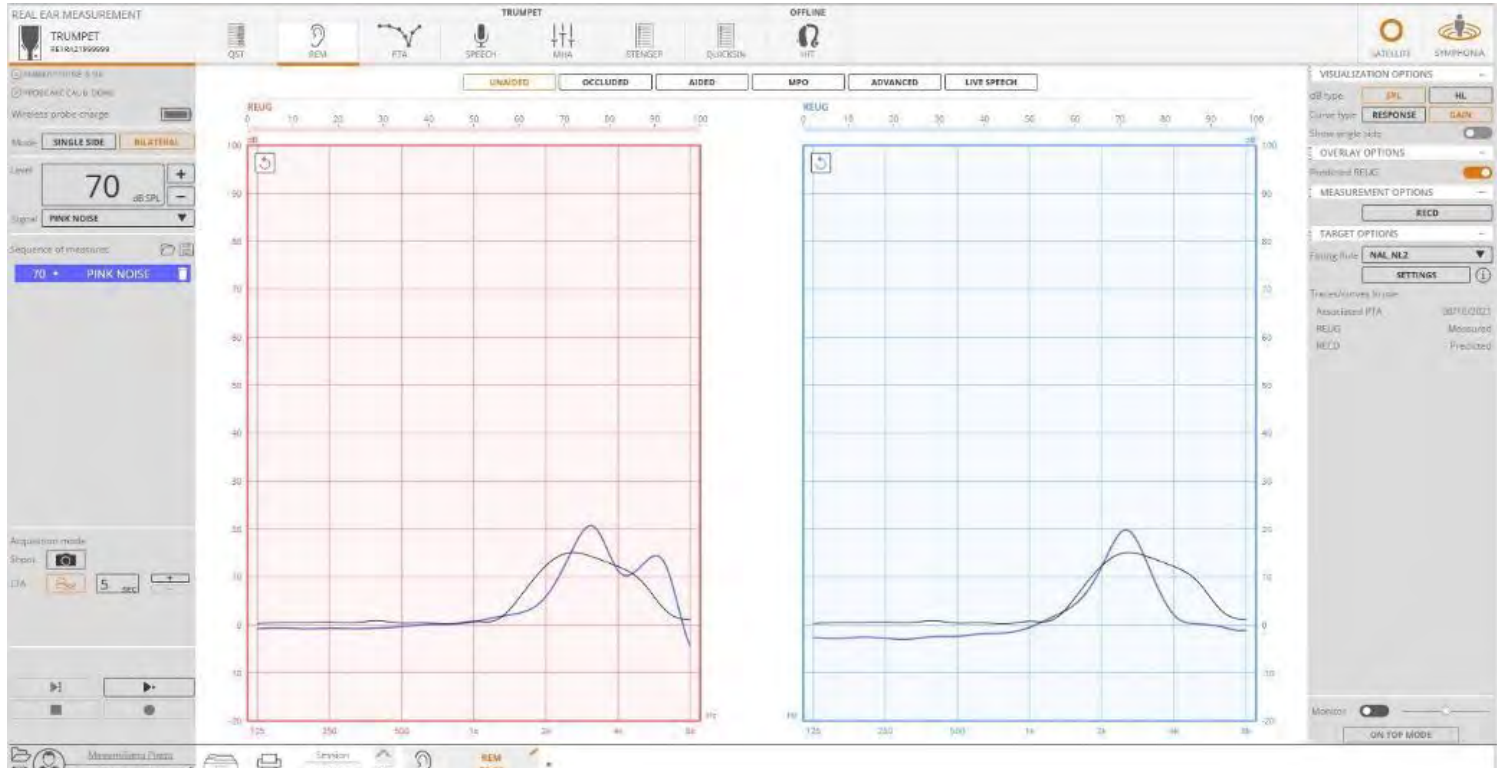


Real Ear Measures - Purpose



- REM ensures that hearing aids are programmed to meet each child's unique hearing needs (continue)
 - By inserting a tiny mic into the ear alongside the hearing aid, we can measure how sound is amplified and modified by the hearing aid in situ
 - This real-world data is invaluable, allowing us to fine-tune hearing aids so they complement the natural acoustics of the ear, ensuring clarity, comfort, and natural sound for children

Measurement





Isn't the
manufacturer's
first fit good
enough?



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doi: 10.3766/jaaa.17005.

Differences in Word and Phoneme Recognition in Quiet, Sentence Recognition in Noise, and Subjective Outcomes between Manufacturer First-Fit and Hearing Aids Programmed to NAL-NL2 Using Real-Ear Measures

Michael Valente¹, Kristi Oeding¹, Alison Brockmeyer¹, Steven Smith¹, Dorina Kallogjeri¹

Affiliations + expand

PMID: 30222541 DOI: 10.3766/jaaa.17005

Abstract

Background: The American Speech-Language-Hearing Association (ASHA) and American Academy of Audiology (AAA) have created Best Practice Guidelines for fitting hearing aids to adult patients. These guidelines recommend using real-ear measures (REM) to verify that measured output/gain of hearing aid(s) match a validated prescriptive target. Unfortunately, approximately 70-80% of audiologists do not routinely use REM when fitting hearing aids, instead relying on a manufacturer default "first-fit" setting. This is problematic because numerous studies report significant differences in REM between manufacturer first-fit and the same hearing aids using a REM or programmed-fit. These studies reported decreased prescribed gain/output in the higher frequencies for the first-fit compared with

Does 'First Fit' lead to a good target match?

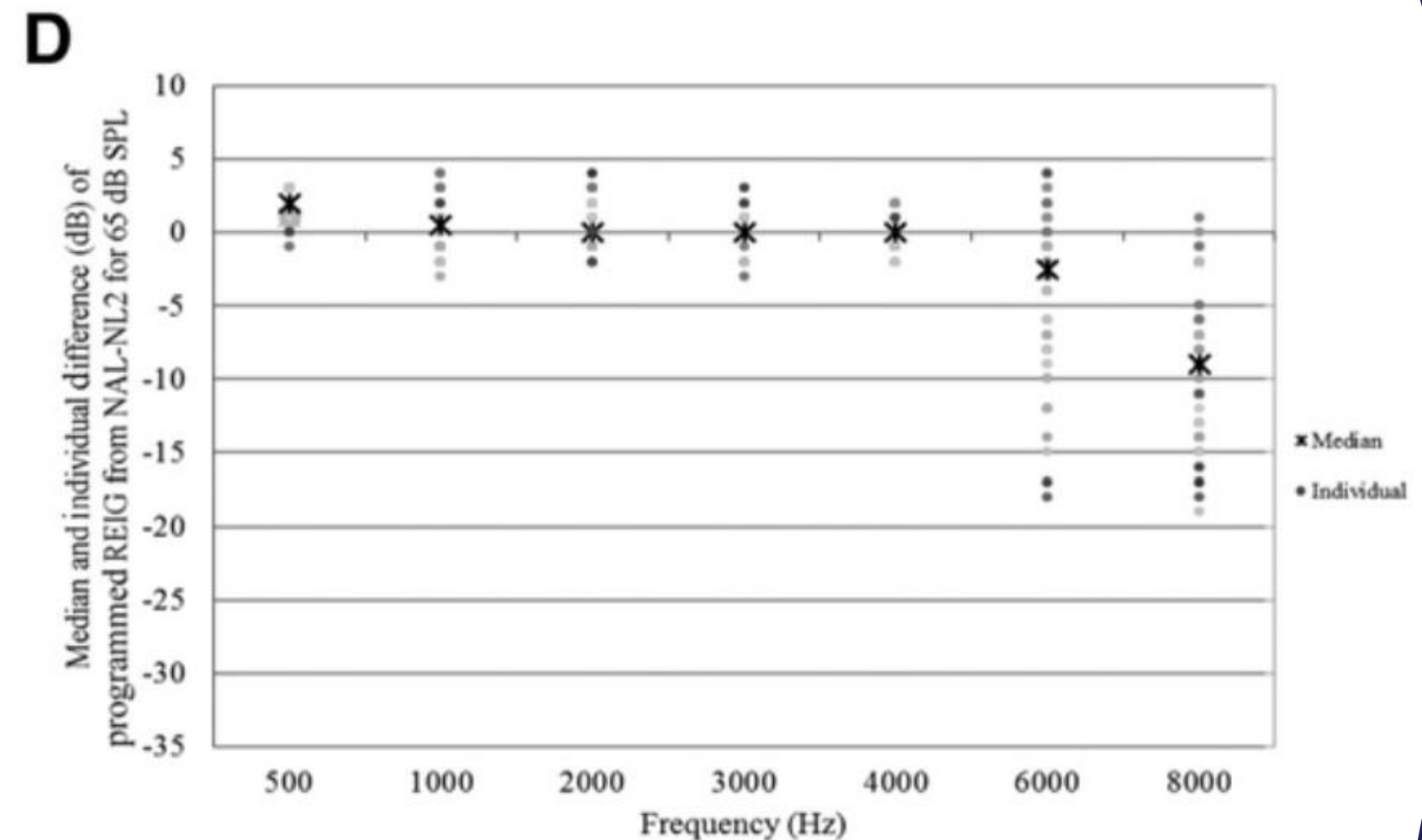
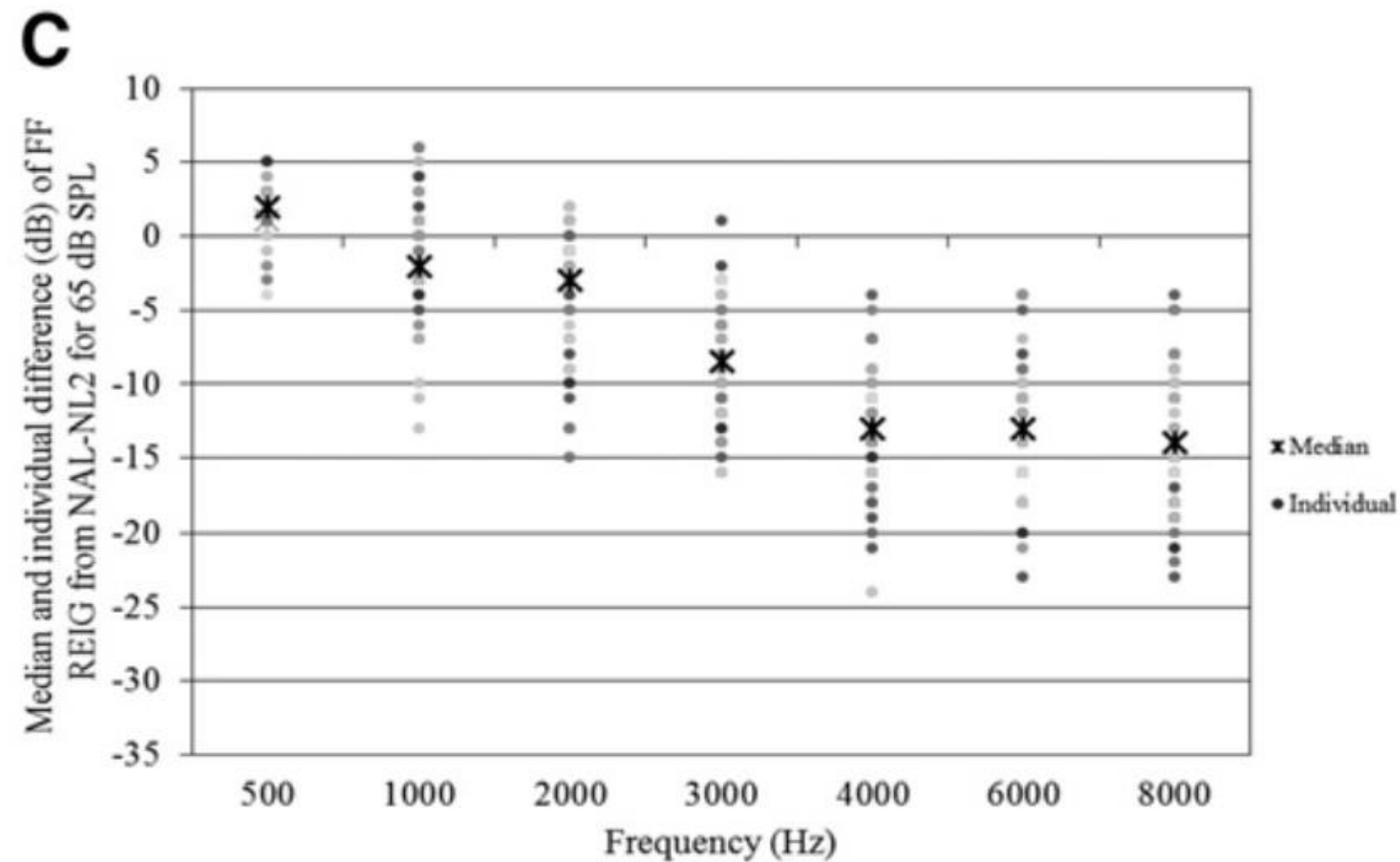


Figure 2. Scatterplot of the individual REIG using the first-fit (FF) setting for a 65 dB SPL input (C), A value of 0 dB represents no difference between NAL-NL2 and REIG at 500–8000 Hz, symbols below 0 dB represent under amplification, above 0 dB represent overamplification, and X represents the median REIG.

Speech understanding First Fit vs Verification

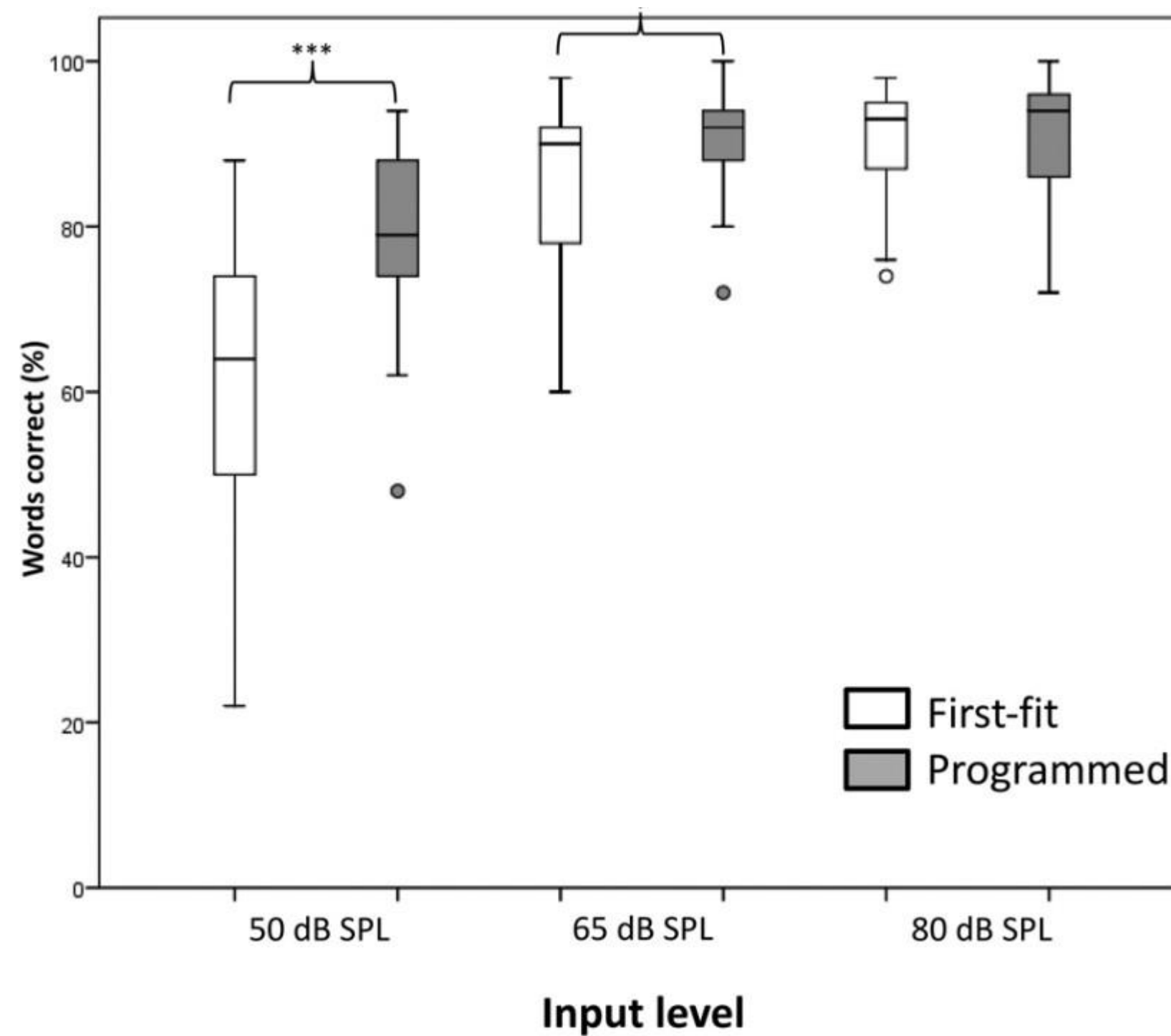


Figure 3. Whisker box plots for CNC word scores at 50, 65, and 80 dB SPL for the FF and programmed-fit settings.

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Adult vs Pediatric Audiology

Comparative Analysis

Challenges



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Comparative Analysis of REM in different age groups including specific challenges

- Core principles remain the same – need for adaptability
 - Key differences:
 - Physical ear canal size
 - Behavioral aspect
 - Protocol
- Tips and tricks
- RECD



RECD

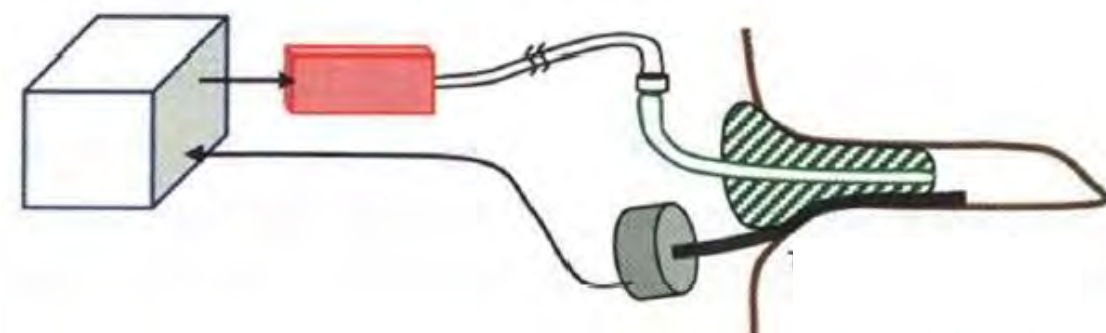
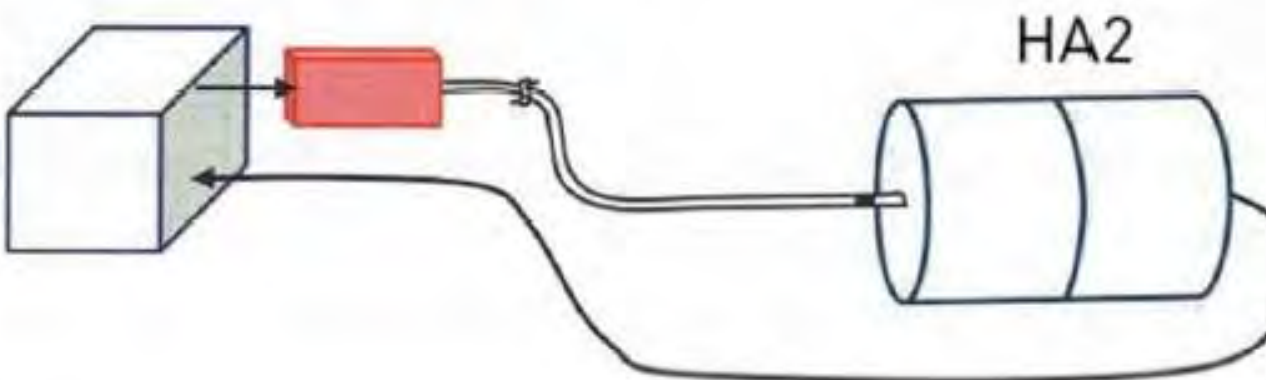
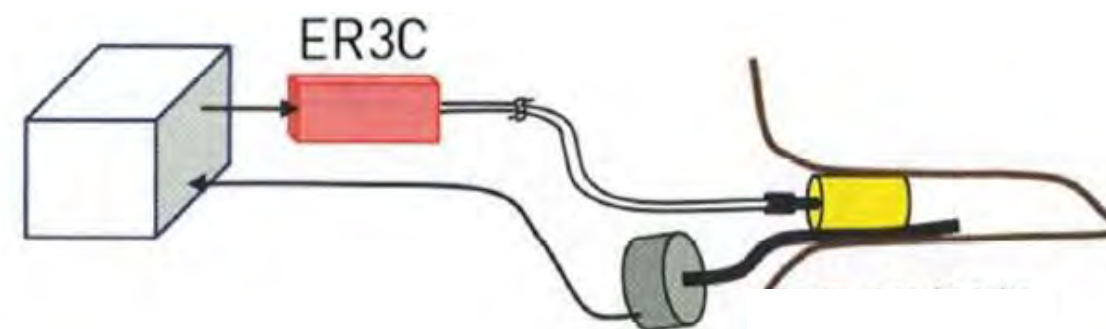
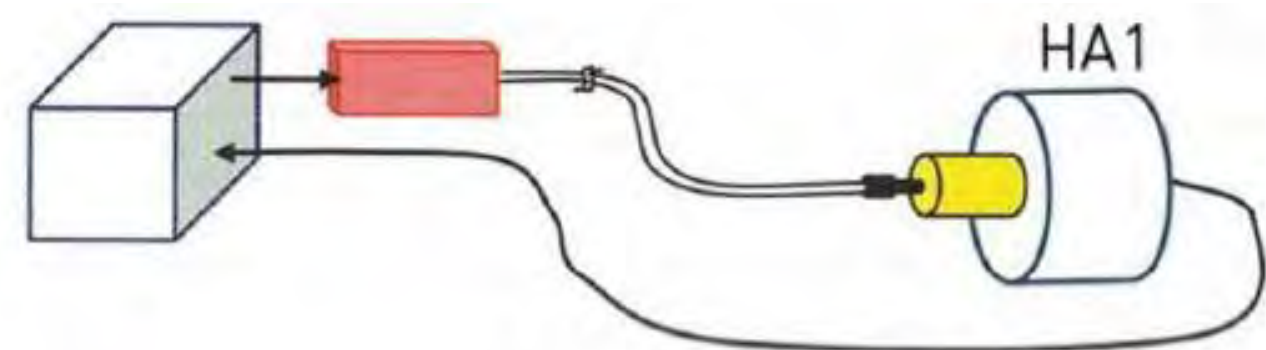
Real-ear-to-coupler difference

- This measure considers the unique ear canal and earmold characteristics in comparison to a coupler that simulates an average ear canal.
- It is a quick measurement and can be used in simulated real-ear verification measures. The coupler measurements allow the REM fitting to be performed inside a standard 2cc coupler instead of the patient's real ear.



RECD

Real-ear-to-coupler difference



RECD

Real-ear-to-coupler difference

- Average RECD values do exist for one-month age intervals through the age of 5 years, individual variability of averages is high
- First fit is better than average RECD
- Between-ear RECD values are highly correlated
- McCreery & Walker (2017) recommend measuring RECD as part of hearing aid verification every 3 months in the first year of life, then every 6 months - age of 3 and annually thereafter in children with no risk factors of progressive hearing loss.



RECD

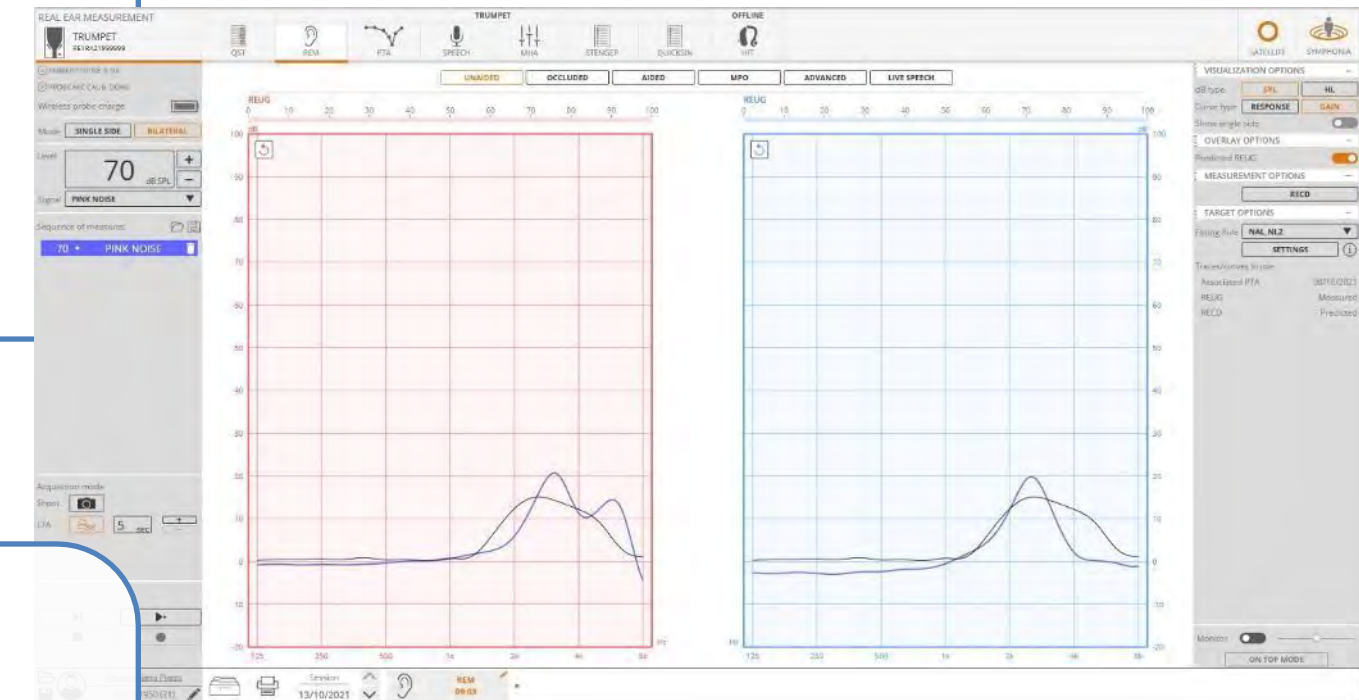
Real-ear-to-coupler difference

Coupler Response

- RECD transducer is connected to a std coupler
- A signal is introduced via the transducer and SPL as a function of frequency is measured within the coupler

Ear Canal Response

- Probe mic place in child's ear (10-15mm from ear canal opening – watch live placement!).
- The RECD transducer is connected to a foam tip (or ear mould tubing) and inserted into the ear canal with the probe mic
- SPL is then measured in the ear canal and the difference calculated



RECD

Real-ear-to-coupler difference

Verifying Audibility

- Attach the hearing aid to the coupler and microphone in the test box
- Confirm setting for average speech input levels in relation to the targets of the hearing aid software
- Best match to target while optimizing audibility of speech

Verifying Advanced Features

- Frequency lowering
- Automatic noise reduction
- Feedback suppression
- Directional microphones



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Importance of REM in Pediatric Fittings

Benefits

Examples



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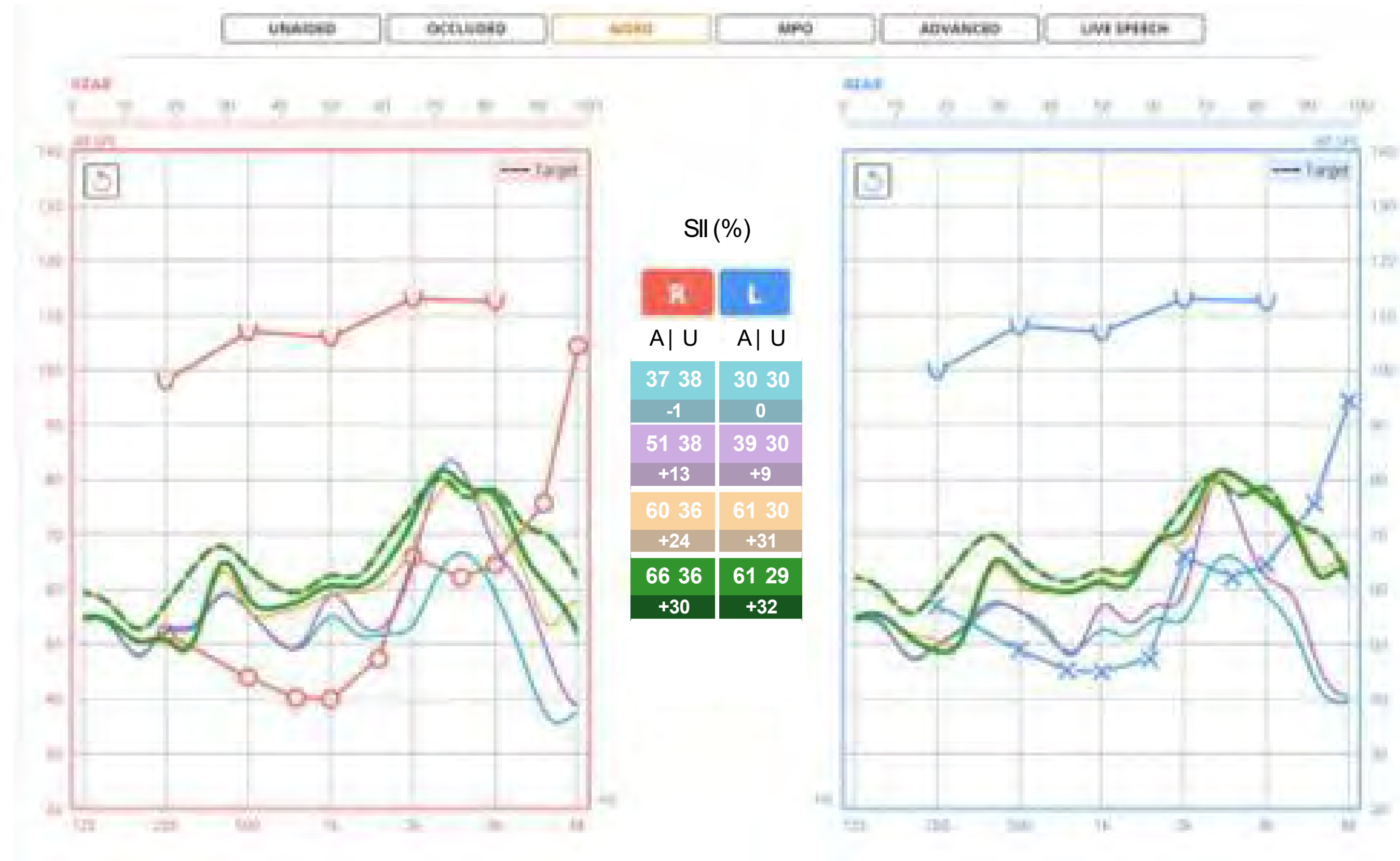


Benefits

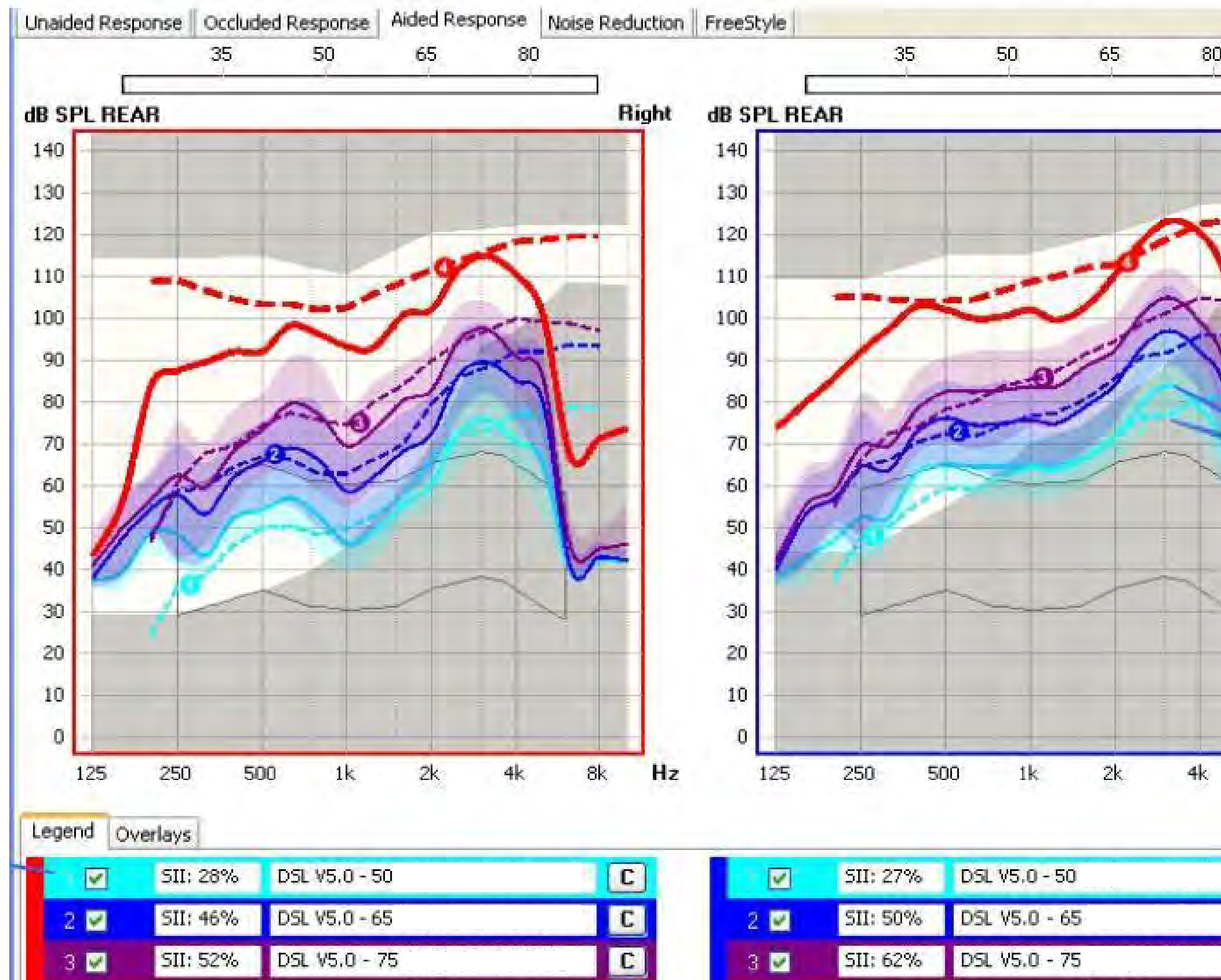


- REMs precision allows for custom-tailored hearing aid settings, directly translating to clearer sound perception for your users.
- By aligning the device's output with the child's specific hearing loss profile, REM ensures optimal speech development and learning.
- Not only enhances auditory experiences but also fosters greater engagement and confidence in social and educational settings – the difference this makes in a child's world is unexplainable

Example of importance



Example of importance



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Equipment and Setup for Pediatric REM



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Equipment



2cc coupler

+

	adapter	BTE
	adapter	ITE
	adapter	RIC



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Overcoming Challenges in Pediatric REM



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Strategies



- Shorter, more engaging test sequences
- Gradual acclimatization to the equipment
- Use engaging distractions
 - Visual or auditory stimuli
 - ✓ Blow bubbles
 - ✓ Coloring in
 - ✓ Tablet
 - Our elephant



Strategies



- Team up
- Get parents involved
- Babies – use sleep
- Children – Clear instruction

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Analyzing REM Results



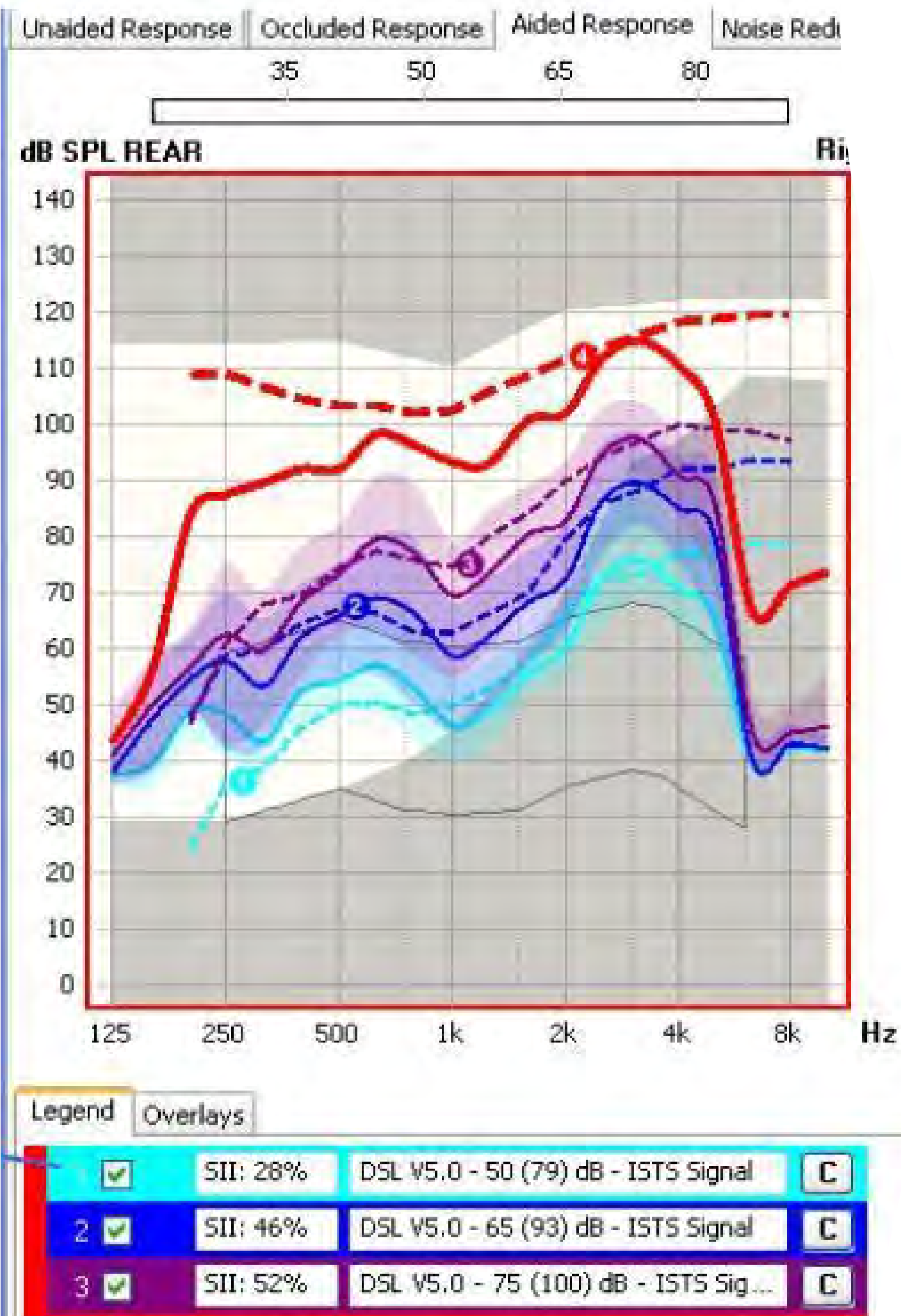
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Analyzing

- Speech mapping
 - Objective Assessment: Measures how sound (speech) is amplified by the hearing aid and delivered in the ear canal. Uses a probe mic placed in the ear canal alongside the hearing aid
 - Real Speech Stimuli including live voice
 - Visualization of Speech: Targets and SII
 - Metric used to quantify how much of speech is accessible to a listener (0 – 1)



Analyzing

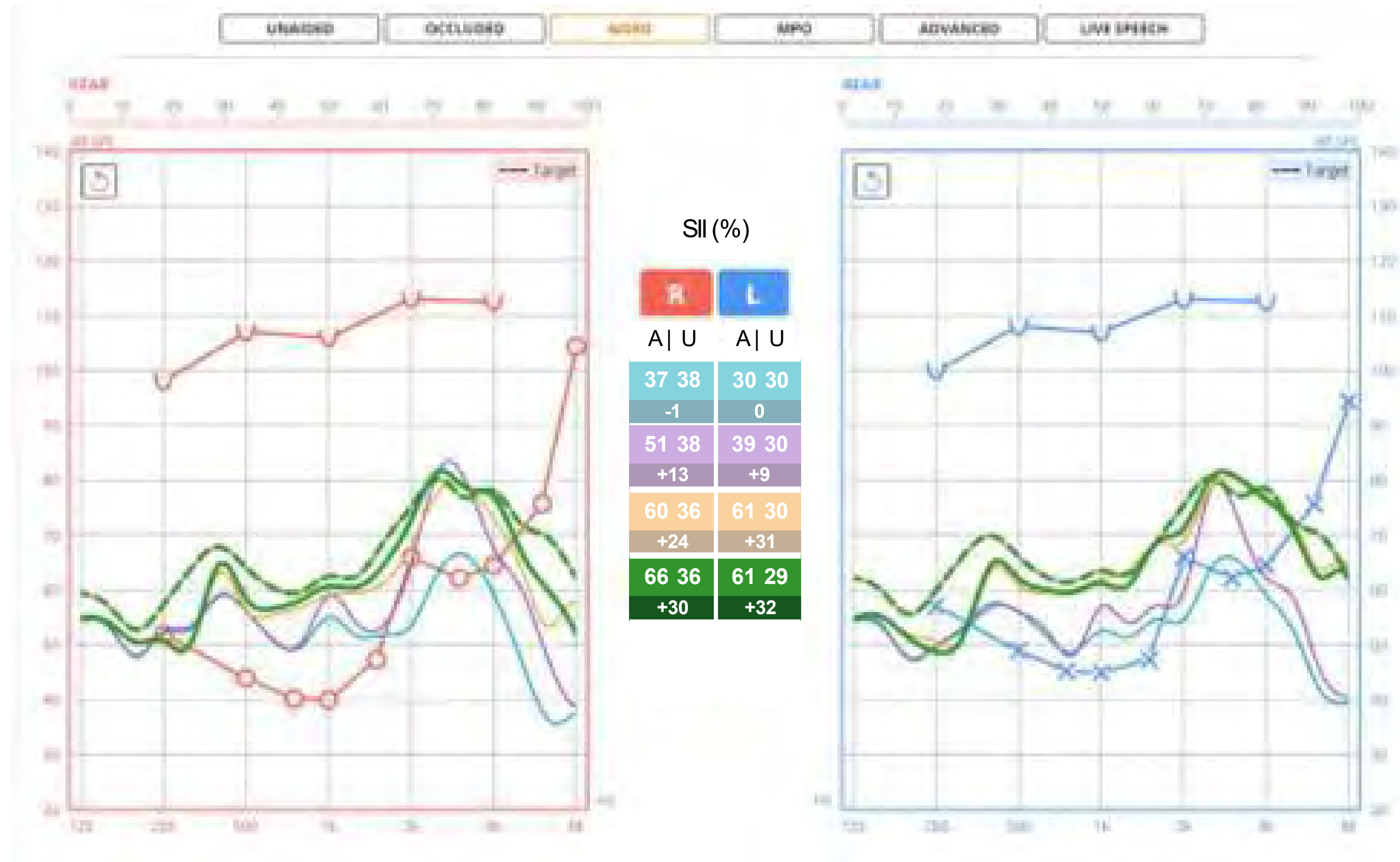


- What does the fit to target look like?
- SII: soft, average and loud sounds
- MPO
- Can we improve audibility of soft sounds while keeping average speech comfortable?

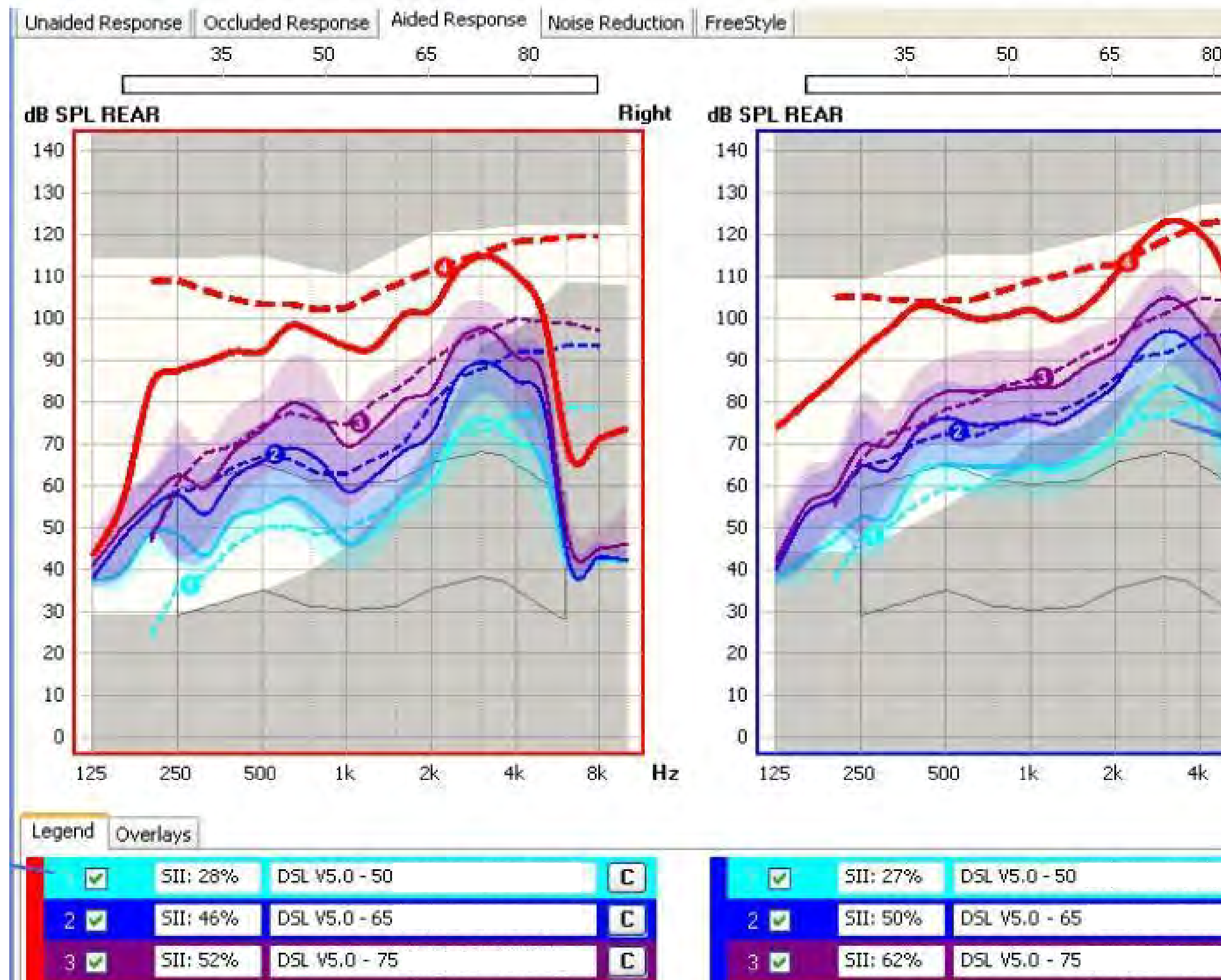


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Example of importance



Example of importance



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Conclusion with key takeaways



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We need to think about how we measure outcome as part of quality assurance in a population that cannot communicate their needs to us and do not have a reference for comparison.

We need to consider if we are practicing evidence-based practice in line with:

Our board guidelines

Person(child)-centered hearing care

REM's precision allows us to tailor hearing aids to the unique acoustics of a child's ear, ensuring they receive the most natural and effective auditory experience possible.



This approach not only enhances speech clarity and understanding but also supports overall developmental growth in communication, education and social interaction.

We can simulate REM's using RECD - an easier way to perform REM's and also test features of the hearing aid. Although average RECD values exist the variability is great and compromises the fitting.

Verification

Year 1: every 3 months

Year 2: Every 6 months

Year 3 onwards: Annually



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