

New features of the DSL v5



DSL philosophy

"DSL is more than just an algorithm for electroacoustic selection, it is a method consisting of sequential stages in a well-integrated hearing instrument fitting process. The emphasis of our work has been on audiometric assessment, hearing instrument selection, and verification of aided auditory performance."

Richard Seewald, 1995



The DSL goals

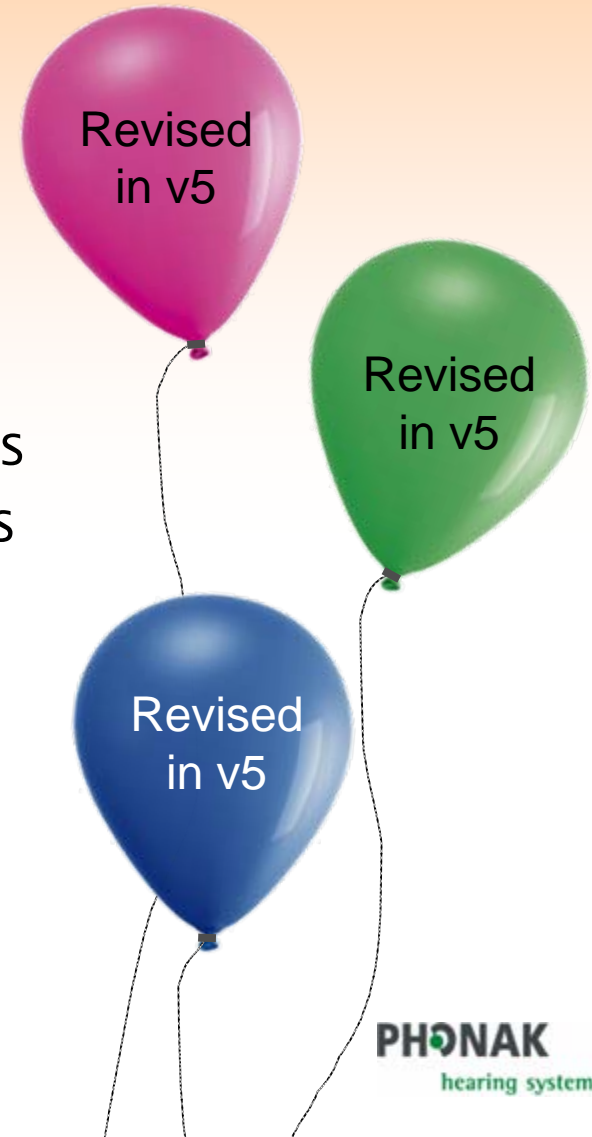
Reassurance and accuracy

- A safe and precise fit of hearing instruments especially for infants and young children is guaranteed by RECD values (individually measured or age appropriate averages)
- Ensures that the amplified speech signal is consistently audible, comfortable and undistorted
- Appropriate for both linear and non-linear signal processing strategies



The right fitting implies...

- Audiometric Assessment - using child specific audiometric data
- Electroacoustic Prescription - new targets for specific losses, environments and ages
- Verification - verifying the fitting with either 2 cc or real-ear measurements





Audiometric Assessment

Audiometric Assessment in DSL v5

- Compatibility with ABR Data **New feature**
- RECD norms **Updated**
- RECD measurement protocol **Updated**



Compatibility with ABR data

- Obtaining behavioral thresholds with conventional audiometry is not possible at a very young age, so an infant's hearing can be estimated using frequency specific ABR measurements
- Until now there were no clear guidelines on how ABR data could be used in prescriptive software



Compatibility with ABR data

- DSL v5 allows for the use of ABR threshold data referenced to normalized HL (nHL) or estimated HL (eHL)
- This means that hearing instruments can be selected and fitted accurately



What does nHL and eHL mean?

- ABR threshold estimates are referenced in dB *normalized HL (dB nHL)*
- ABR threshold estimates (dB nHL) are higher than behavioral thresholds
- *Estimated behavioral hearing threshold (eHL)* is used to denote a corrected nHL value that represents an estimated behavioral threshold



Converting nHL \rightarrow eHL

- Clinicians may use data referenced to nHL or eHL
- If thresholds are measured in nHL
 - corrections values will be applied within the DSL software to convert the nHL data to eHL
- dB nHL –Behavioral Correction Values = dB eHL



Converting nHL \rightarrow eHL

- If the equipment has a built-in behavioral correction (eHL)
 - ABR data can be entered directly into the hearing instrument prescriptive software



Converting nHL \rightarrow eHL

Have behavioral corrections been added to my threshold estimates?

Yes

- choose ABR (eHL)

No

- enter data in nHL
- software will apply DSL default or your own correction values

Audiometric Assessment in DSL v5

- Compatibility with ABR Data
- RECD norms Updated
- RECD measurement protocol



DSL i/o → DSL v5 RECD norms

- Updated frequency-specific RECD predictions by age for eartips and earmolds
- RECD predictions are available at 1 month intervals from birth up to 6 years



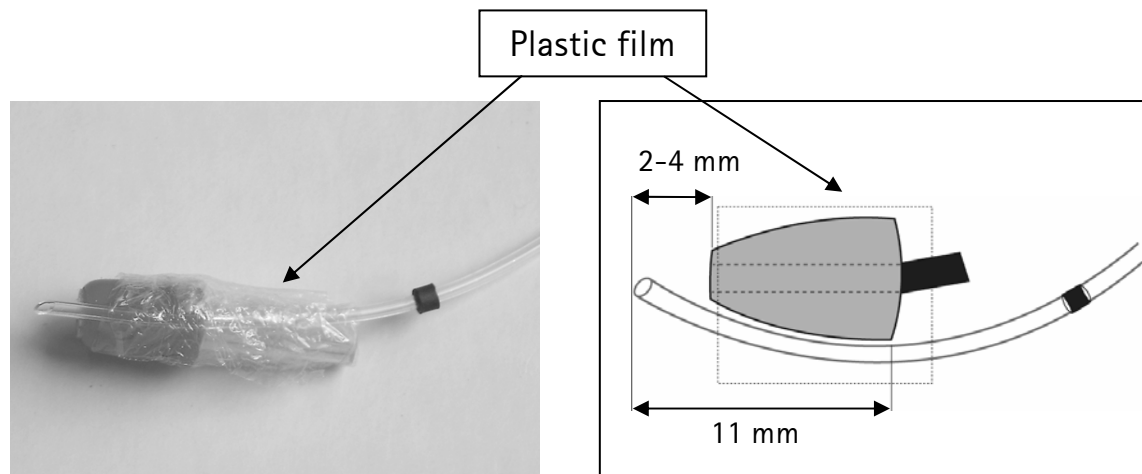
Audiometric Assessment in DSL v5

- Compatibility with ABR Data
- RECD norms
- RECD measurement protocol **Updated**



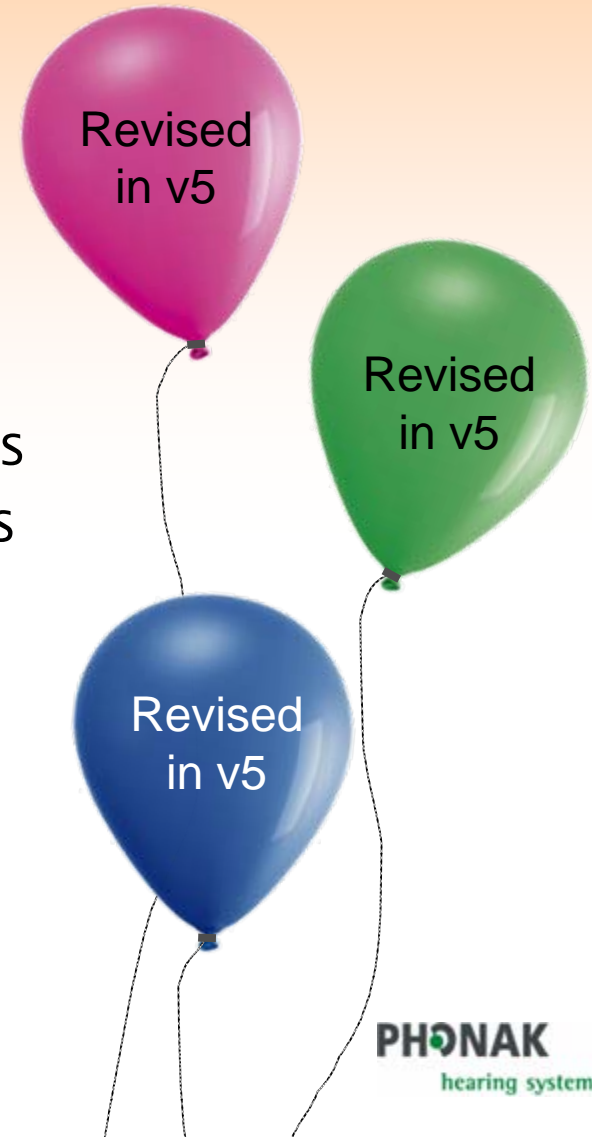
New technique for infant's ears

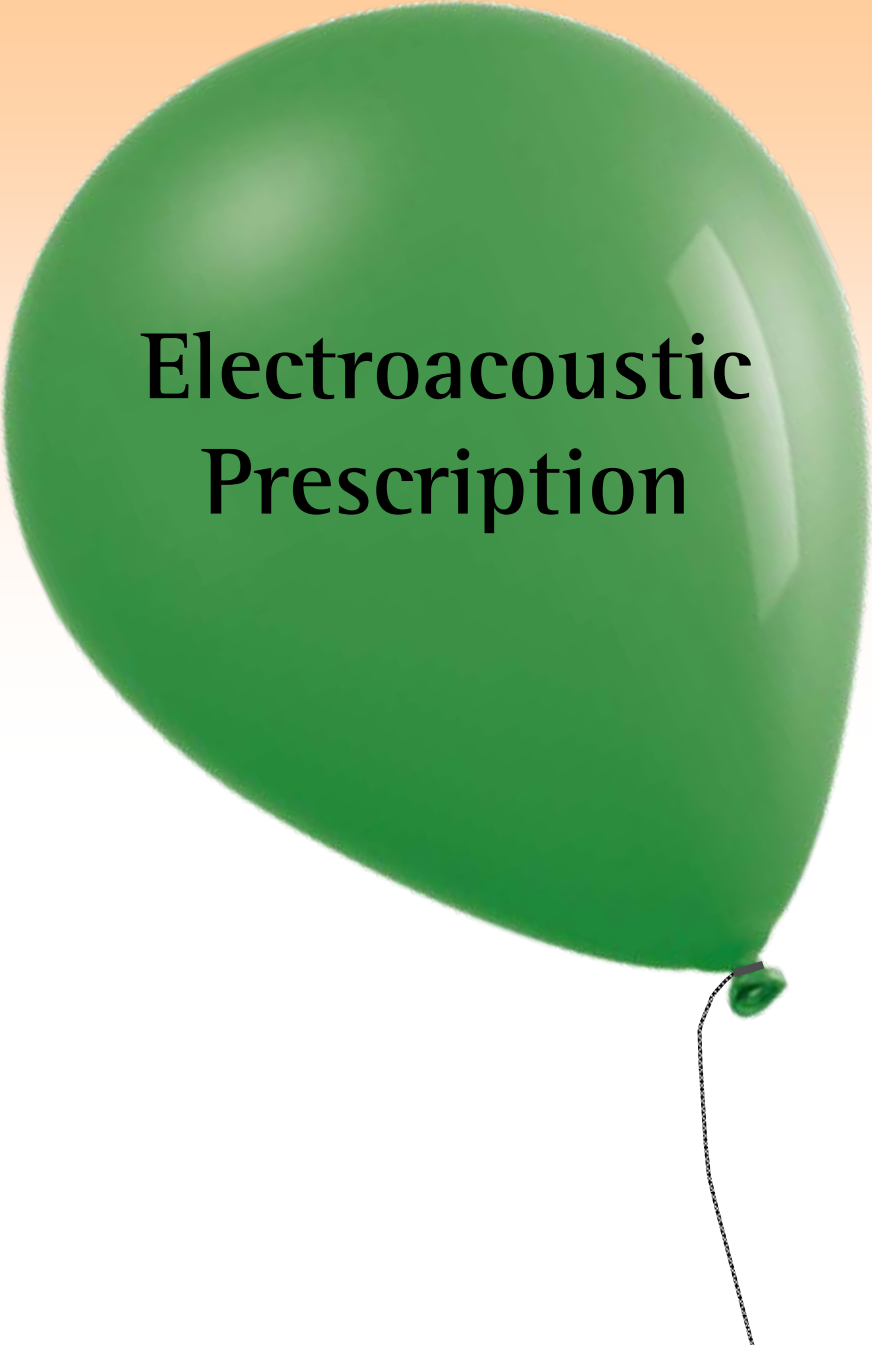
- Simultaneous insertion of the probe-tube and the tip into the ear canal
- Extension of the probe-tube approx. 2-4 mm beyond the tip results in:
 - Appropriate insertion depth (11 mm)
 - Reliable and valid RECD values for infants 2-6 months of age



The right fitting implies...

- Audiometric Assessment – using child specific audiometric data
- Electroacoustic Prescription – new targets for specific losses, environments and ages
- Verification – verifying the fitting with either 2 cc or real-ear measurements





Electroacoustic Prescription

Electroacoustic Prescription

- The DSL m [i/o] Algorithm
- Speech Input Levels
- Targets for Children and Adults
- Targets for Quiet and Noise
- Modifications for Conductive Losses
- Multichannel Compression



Targets for Children and Adults

A study by Lurnagaray and Seewald on Adult/Child preferred listening levels indicates an approximate difference of 8 dB in Preferred Listening Levels between adults and children.



Adult DSL v5 targets

- Provide a lower level of prescribed gain and compression ratio compared to children
- The differences between adults and children are largest for mild-to-moderate losses
- A smaller correction is applied with increasing hearing loss
- For hearing loss >80 dB HL the age-related difference is very small



Electroacoustic Prescription

- The DSL m [i/o] Algorithm
- Speech Input Levels
- Targets for Children and Adults
- Targets for Quiet and Noise
- Modifications for Conductive Losses
- Multichannel Compression

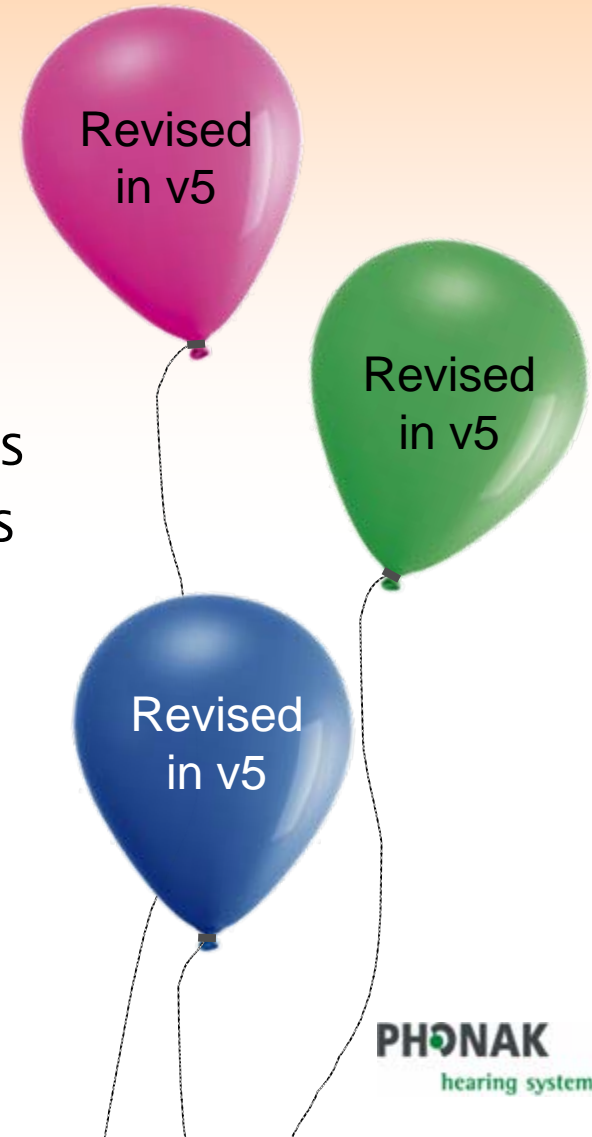


Modifications for Conductive Losses

- Listeners with a conductive and/or mixed hearing loss:
 - Have higher loudness discomfort levels
 - Prefer a higher level of gain
- DSL v5 provides higher Upper Limits of Comfort (ULC)
- Targets are limited to a maximum of 140 dB SPL in the ear canal
- Predictions of the ULC are increased by 25% of the air-bone gap

The right fitting implies...

- Audiometric Assessment - using child specific audiometric data
- Electroacoustic Prescription - new targets for specific losses, environments and ages
- Verification - verifying the fitting with either 2 cc or real-ear measurements





Hearing Aid Verification

Hearing Aid Verification in v5

- Signal Types and Levels
- Multi-Level Targets

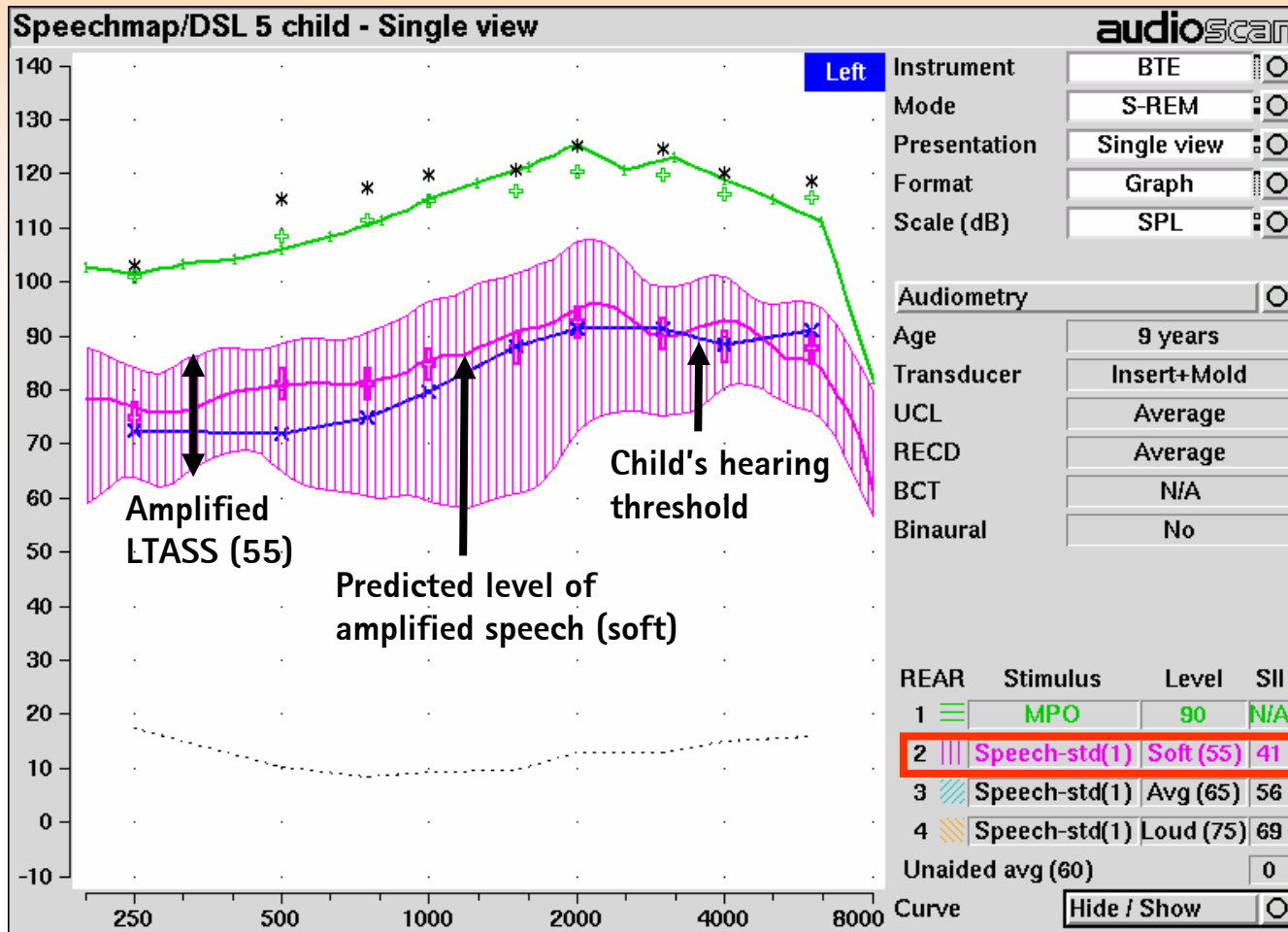


Possibility to verify: Signal Types and Levels

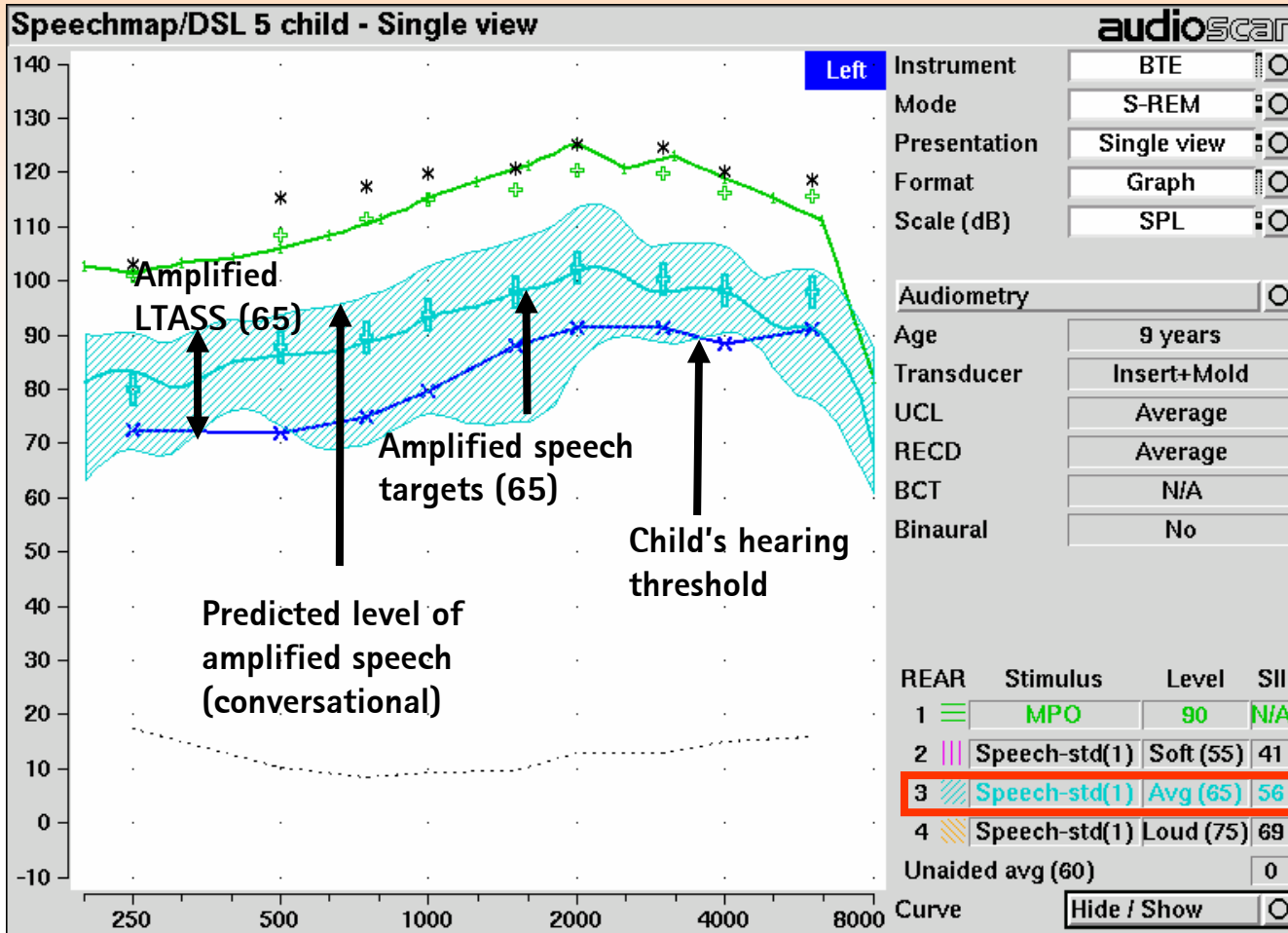
- Target signal types
 - Speech or Speech-Weighted Noise (recommended procedure)
 - Pure-tone signal types (only useful for input levels between 50-70 dB SPL)
- Input signal levels
 - Soft (50-55 dB SPL) speech signals
 - Conversational (60-70 dB SPL) speech signals
 - Loud (75-85 dB SPL) speech signals
 - MPO



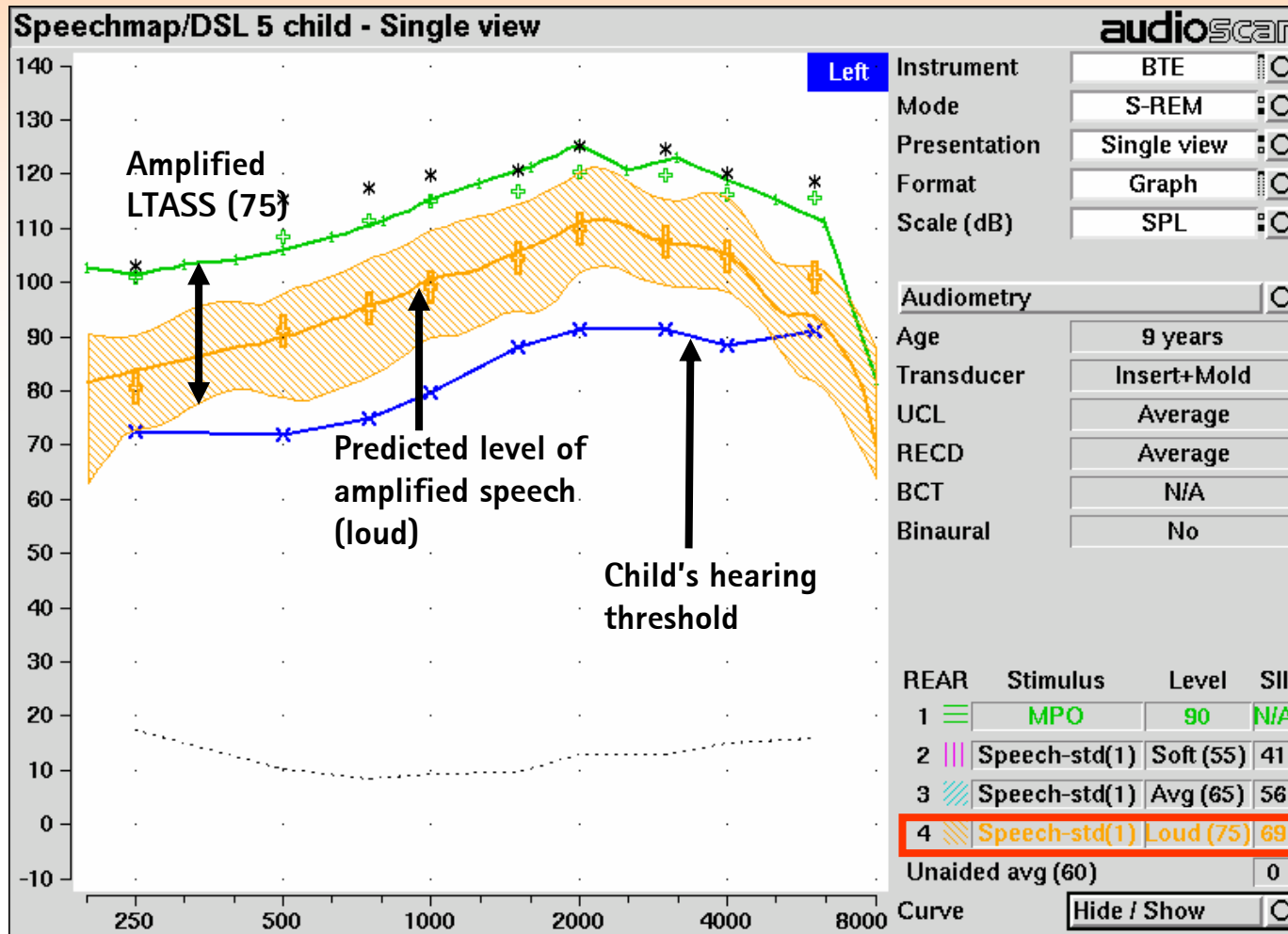
Speech map: Soft Speech



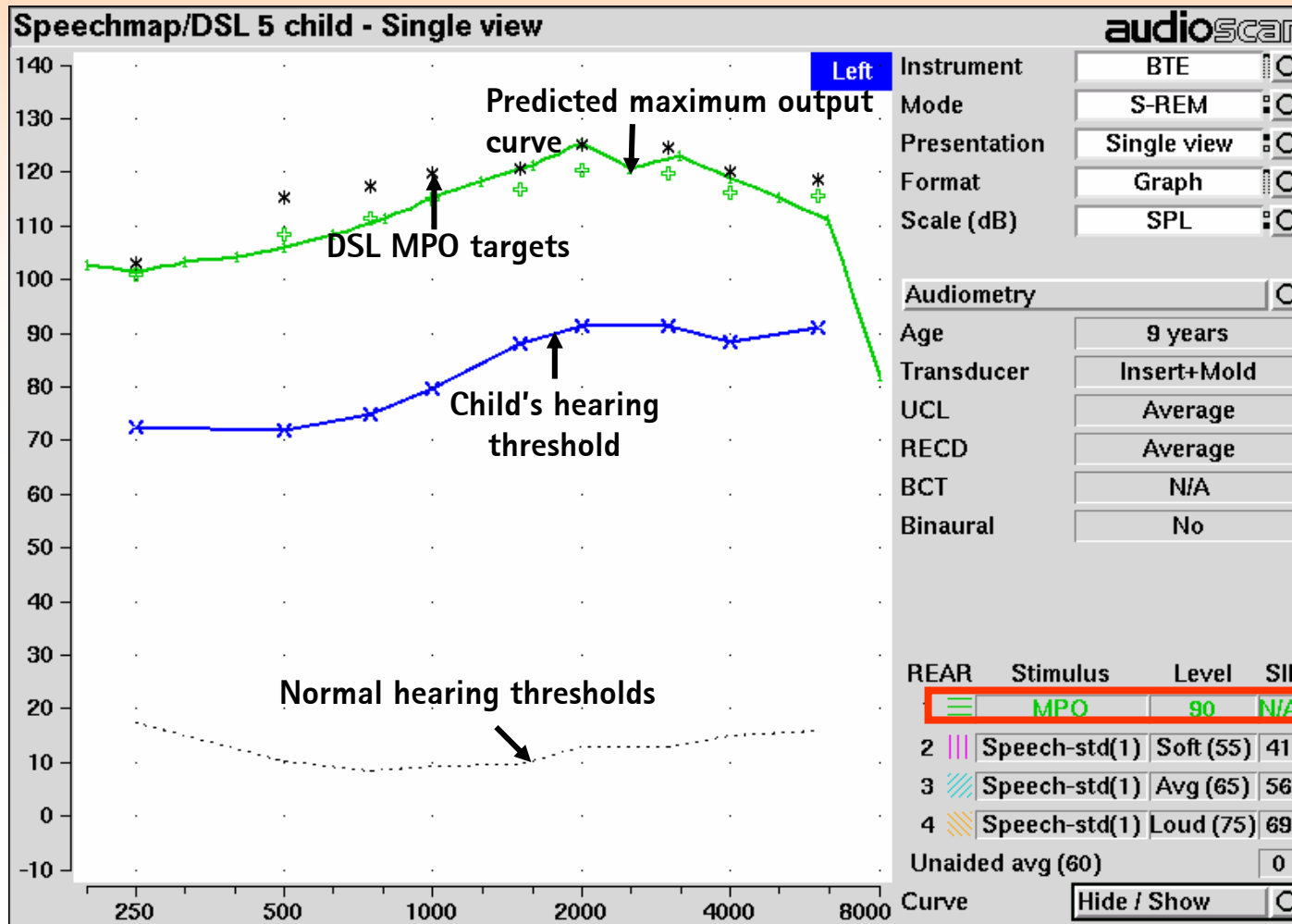
Speech map: Conversational Speech



Speech map: Loud Speech



Speech map: MPO



Hearing Aid Verification

- Signal Types and Levels
- Multi-Level Targets



Multi-Level Targets

Targets can be calculated for a wide range of input levels, for speech or pure tone signal types



DSL comparison

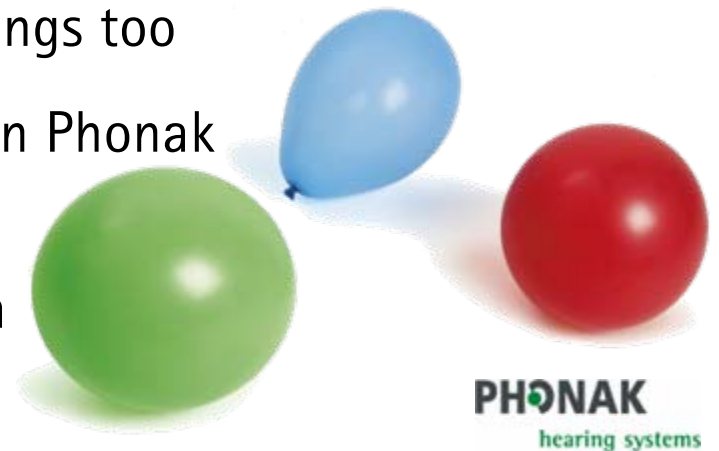
Feature	DSL i/o	DSL v5
RECD predictions	1 year intervals Foam ear tips	1 month intervals Foam ear tips or earmold
Possibility to enter ABR data?	No	Yes
Prescription for noisy environments?	No	Yes
Correction factors for conductive HL?	No	Yes
Different targets for adults/children?	No	Yes

DSL v5 in iPFG 1.7



DSL v5 and iPFG 1.7

- Easily selectable in iPFG 1.7 software
- The implementation was validated with the authors of DSL i/o
- UWO Professor Richard Seewald confirms: "We have thoroughly tested and evaluated the Phonak iPFG implementation of DSL v5, and found it to be in full compliance with our requirements"
- Significant improvements in supporting pediatric fittings but extends the benefits of DSL to adult fittings too
- Available for fitting of all new generation Phonak hearing instruments (iPFG instruments)
- DSL i/o is still available for fittings when required



DSL v5 changes in iPFG 1.7

- Updates to age related RECD values
- Automatic implementation of age specific RECD for adults and pediatrics
- Different targets for listening in quiet environments
- Compatibility with Auditory Brain Stem Response (ABR) measurements



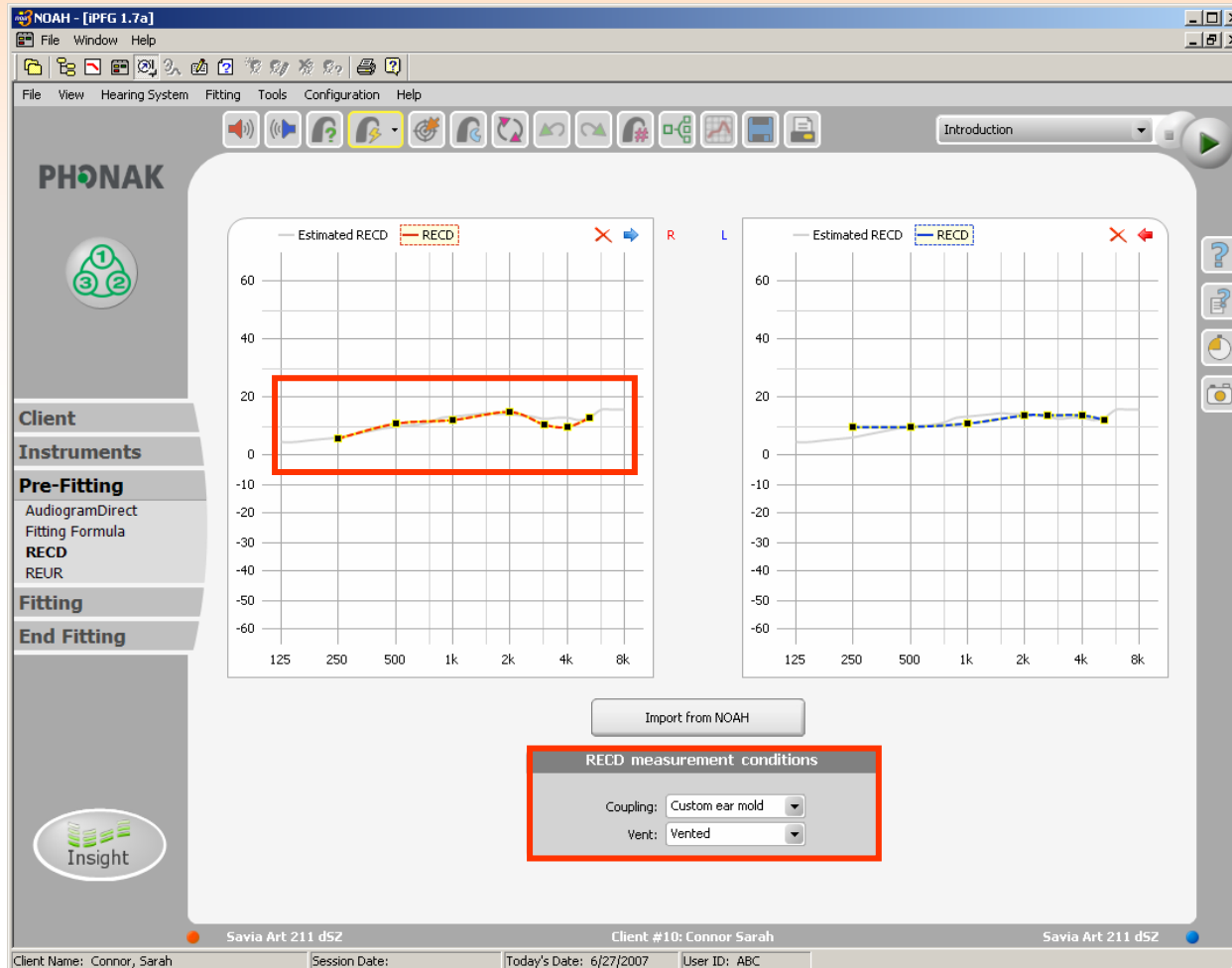
DSL Fitting Formula

The screenshot shows the NOAH software interface with a 'Select' dialog box open. The dialog box contains the following configuration options:

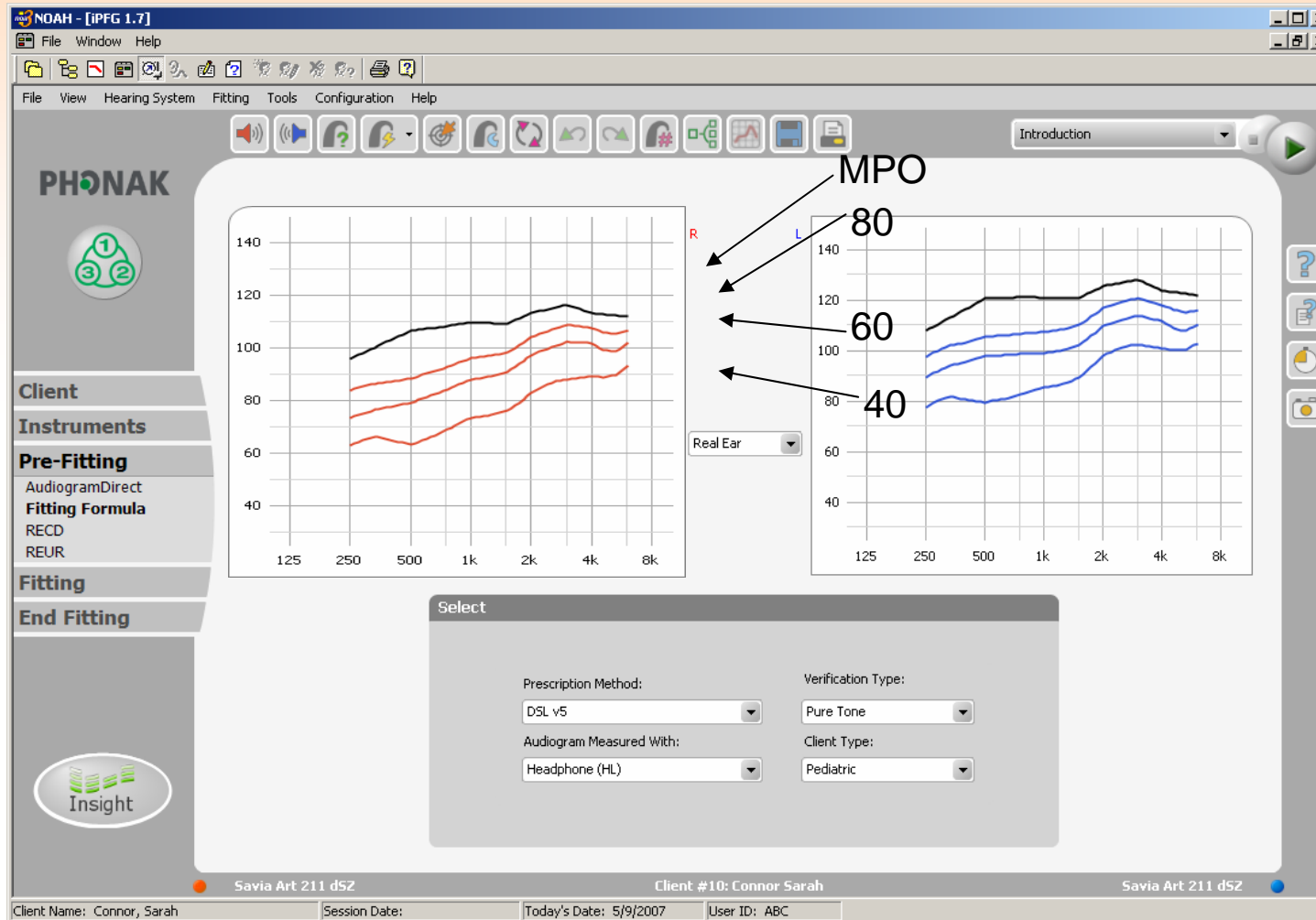
- Prescription Method:** DSL v5
- Audiogram Measured With:** Loudspeaker 0° (HL) (indicated by a red arrow)
- Verification Type:** Speech (indicated by a red arrow)
- Client Type:** Pediatric (indicated by a red arrow)

The background shows two audiogram plots for the right (R) and left (L) ears, with frequency on the x-axis and decibels on the y-axis. The plots show hearing curves for different frequencies, with the right ear plot showing curves in red and the left ear plot showing curves in blue.

Measured individual RECDs and REURs



Different targets for listening in quiet



Fine Tuning in iPFG

PHONAK

Client: Sarah Connor
Instruments: Savia Art 211 dSZ
Pre-Fitting: []
Fitting: [X]
Initial Fit
Follow Up Fit
Automatic Fine Tuning
Manual Fine Tuning
End Fitting: []
Insight

Introduction

1 Select Program

- AutoPilot Programs
 - Calm Situations
 - Speech in Noise
 - Comfort in Noise
 - Music
- Add. Automatic Programs
 - Acoustic Telephone
- Additional Programs

Program coupling

2 Select Parameter

- Very Loud (MPO)
- Overall Gain
- Loud (G80)
- Medium Loud (G60)
- Soft (G40)
- Very Soft (TK)
- Global Compression

3 Adjust Parameter

Overall Gain

R R+L L

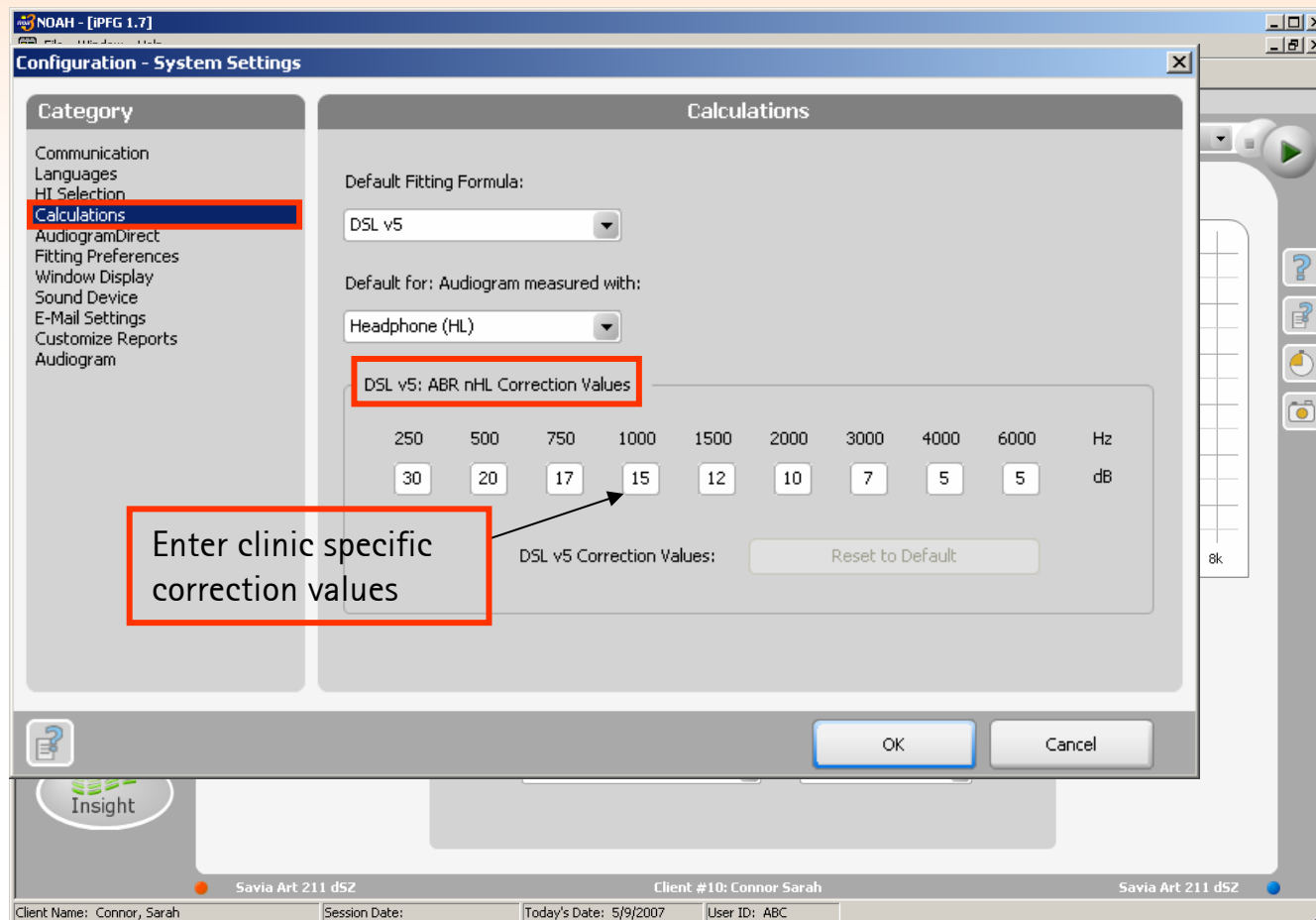
Real Ear
SPLogram
Show: Target

Savia Art 211 dSZ Client #10: Connor Sarah Savia Art 211 dSZ

Client Name: Connor, Sarah Session Date: Today's Date: 6/18/2007 User ID: ABC

Compatibility with Auditory Brain Stem Response (ABR) measurements

From iPFG System Settings, it is possible to change the default nHL correction values



Configuration - System Settings

Category

- Communication
- Languages
- HT Selection
- Calculations**
- AudiogramDirect
- Fitting Preferences
- Window Display
- Sound Device
- E-Mail Settings
- Customize Reports
- Audiogram

Calculations

Default Fitting Formula:
 DSL v5

Default for: Audiogram measured with:
 Headphone (HL)

DSL v5: ABR nHL Correction Values

250	500	750	1000	1500	2000	3000	4000	6000	Hz
30	20	17	15	12	10	7	5	5	dB

DSL v5 Correction Values:

Enter clinic specific correction values

OK Cancel

Client Name: Connor, Sarah | Session Date: | Today's Date: 5/9/2007 | User ID: ABC

Description of changes in iPFG

Description of Change	Details of change
Adult/pediatric targets	Large reduction for moderate losses Small reduction for severe losses
Interpolation	Greater number of target values across frequencies when working with partial audiograms.
Output limiting	Narrowband output limiting targets largely unaffected. Output limiting for speech may cause target reduction if hearing loss is severe or test level is high.
Binaural fittings for adults	Binaural correction for adults only. Will reduce targets for speech by 3 dB. Output limiting targets are not affected.
Conductive or mixed hearing loss	Increases gain for mild and severe losses, depending on magnitude of air-bone gap.

Useful References

- Bagatto, M.P (2001). Optimising your RECD measurements. *Hearing Journal* 53: 32, 34-36.
- DSL (<http://www.dslio.com/>)
- DSL 5.0 (Como satellite event presentation)
<http://www.phonak.com/professional/conference/como-2006>
- Munro, K (2004). Update on RECD Measures in Children. Chapter 5, *Sound Foundation Proceedings*, Chicago 2004
- Seewald RC and Scollie SD 1999. Infants are not average adults: Implications for audiometric testing. *The Hearing Journal* 52(10): 64-72.
- Bagatto M, Moodie S, Scollie S, Seewald R, Moodie S, Pumford J, Liu R (2005). Clinical Protocols for Hearing Instrument Fitting in the Desired Sensation Level Method. *Trends in Amplification* 9(4): 199-226.
- Moodie S, Scollie S, Seewald R, Bagatto M, Beaulac S (2007). *Phonak Focus* 37. The DSL Method for Pediatric and Adult Hearing Instrument Fitting: Version 5
- Susan Scollie, Richard Seewald, Sheila Sinclair-Moodie, Leonard Cornelisse, Marlene Bagatto, Steve Beaulac (2004). The Desired Sensation Level (DSL) Method in 2004: DSL $m[i/o]$ version 5.0