Essential Components of the Pediatric Hearing Instrument Fitting Process

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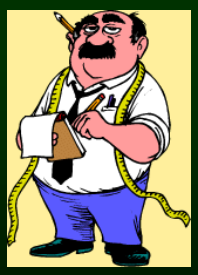
Modern Hearing Instrument Technologies

- **Directional Microphones**
- **Frequency-lowering Technologies**
- **Feedback Control Systems**
- **Digital Noise Reduction**
- **FM-systems**
- **etc.**

A Process for Individualising the Fitting of Amplification



The Fitting Process

ASSESSMENT

↓

SELECTION

↓

VERIFICATION

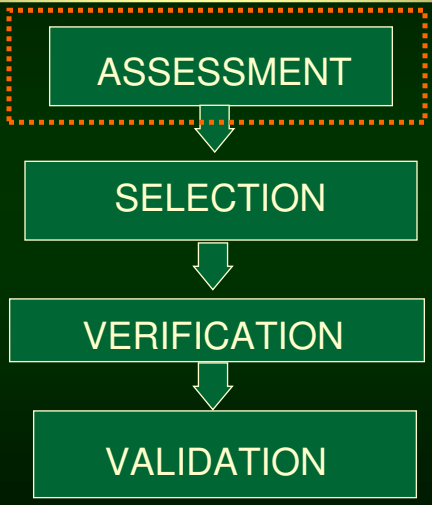
↓

VALIDATION

What we want to know . . .

That we have achieved a good match between the amplification characteristics of hearing instruments and the auditory characteristics of infants and children so that *the use of their residual auditory capacity can be maximized.*

The Fitting Process



Assessment Considerations for Fitting Infants and Young Children with Amplification

Component #1

We need ear-specific and frequency-specific threshold estimates for air and bone conduction before proceeding with the prescription and fitting of amplification for infants and young children.

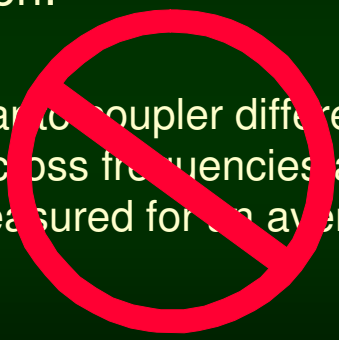
Component #2

We need to measure the external ear acoustics of the individual infant/child using the real-ear to coupler difference (RECD) procedure for the purposes of audiometry and hearing instrument fitting.

Why ????

Acoustic Transforms in Audiometry and Hearing Instrument Fitting

Assumption:

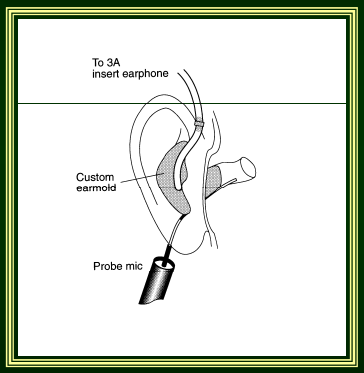


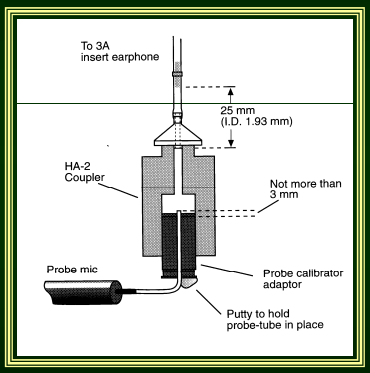
The real-ear to coupler difference (RECD) values across frequencies are equal to those measured for an average adult.

RECDs in Infants: Key Points

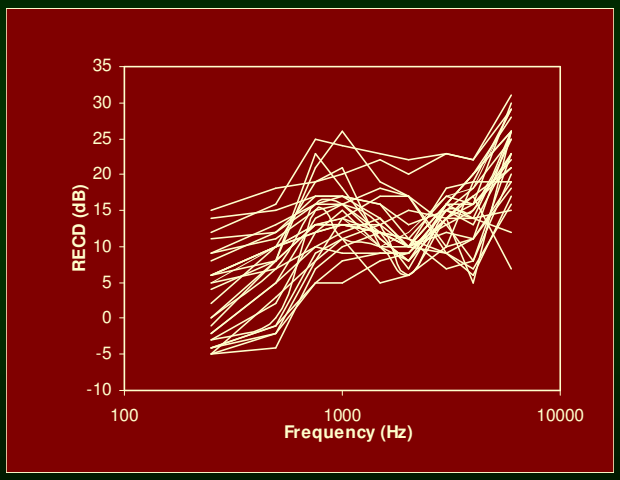
- RECDs in infants and toddlers differ significantly from average adult values.
- RECDs vary from infant to infant.
- RECDs will change for a given infant over time.

The Real-ear to Coupler Difference (RECD)





A sample of RECD values for infants



Component #3

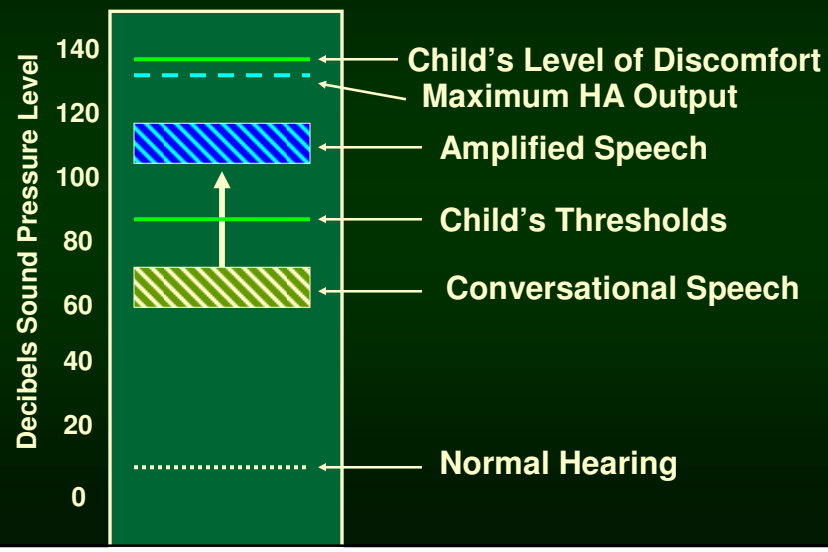
We need to convert all audiometric data from dB HL to dB SPL in the ear canal.

Why ?

Component #3

To ensure that we have a good match between audiometric characteristics of the child and amplification characteristics of the hearing aid all variables we are working need to be defined using a common point of reference.

The SPLogram

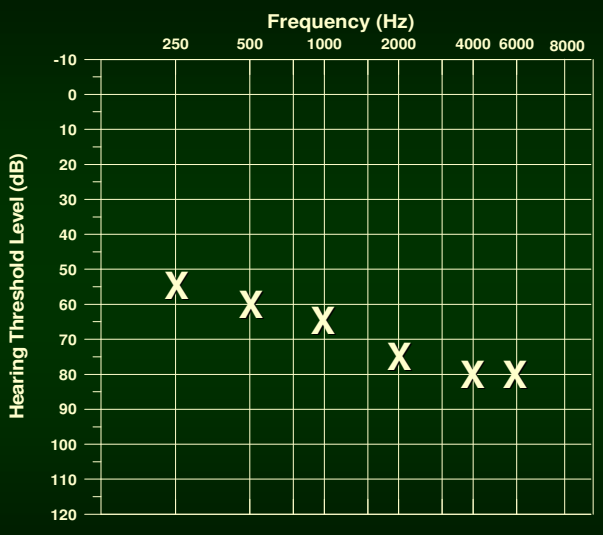


The DSL Method uses the RECD to…

- Convert audiometric measures obtained using insert phones from dB HL to dB SPL in the ear canal

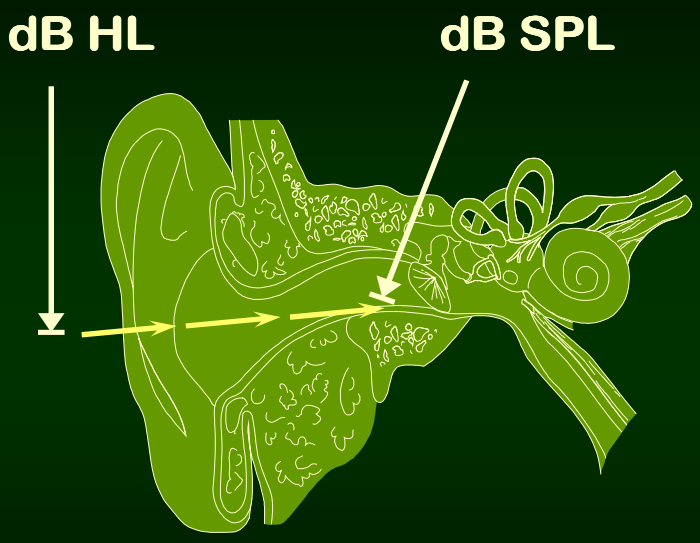
- Convert gain and output limiting requirements in the real ear to 2cc coupler equivalents

- Convert test box measurements of hearing instrument performance to estimated real-ear performance



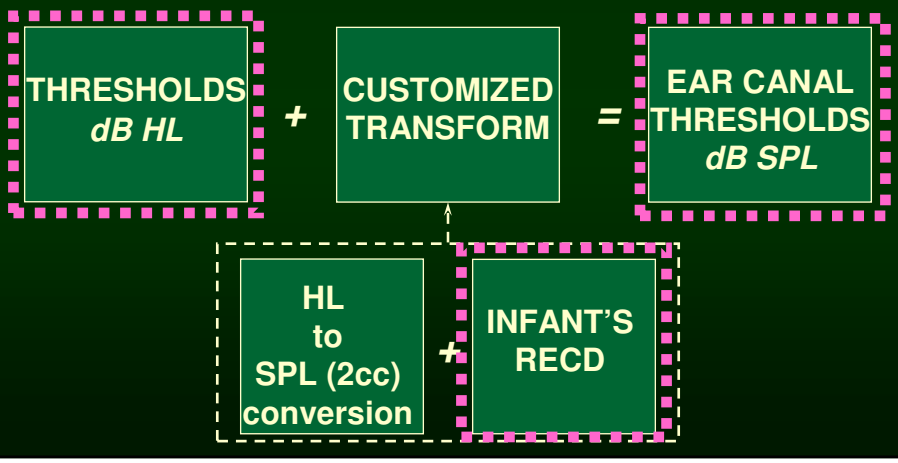
Audiometric Assessment

- Conducted with insert earphones
- Connect inserts to personal earmolds
- Measure the RECD

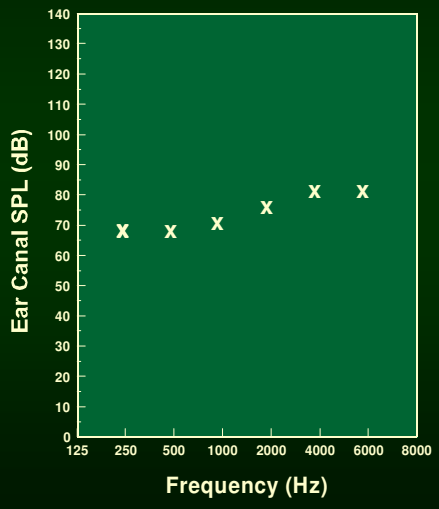


How are the RECD values used?
In AUDIOMETRY with Insert Phones

To Predict Real-ear Thresholds in dB SPL



The SPLogram



Using frequency-specific ABR measures for hearing instrument fitting

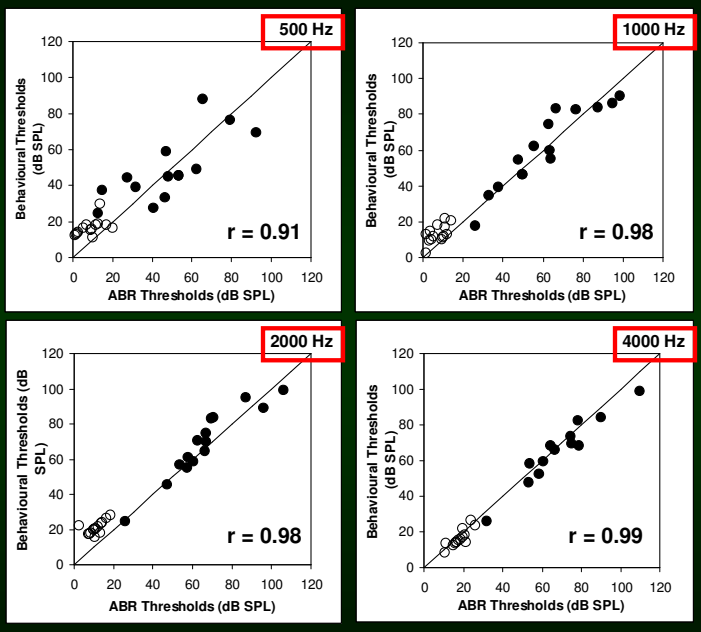
Accuracy of Predicting Behavioral Thresholds from ABR Threshold Estimations in RESPL

Bagatto, Seewald, Scollie, Liu, & Hyde

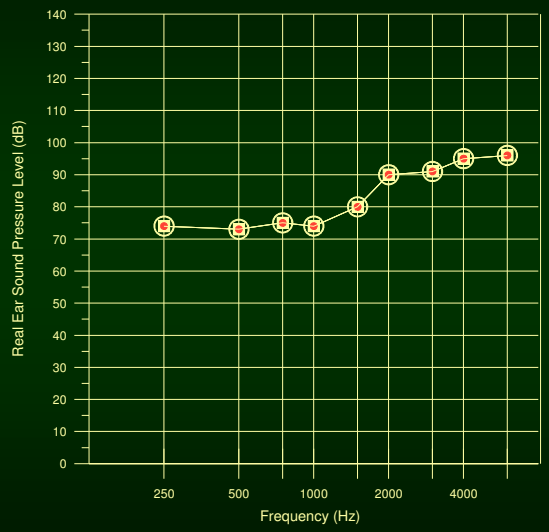
Trends in Amplification (2005)

Procedure

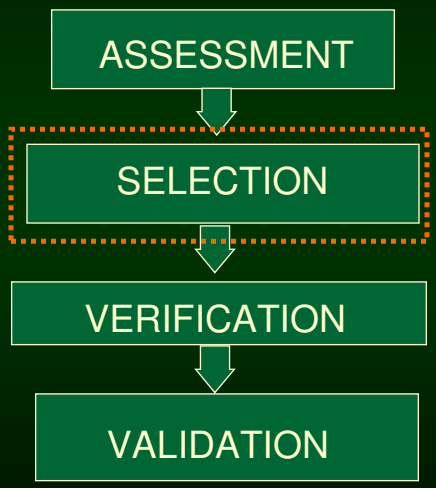
- Subjects
  - 15 children & young adults with SNHL
  - 15 young adults with normal hearing
- RECD measures
- Behavioural audiometry
  - .5, 1, 2, 4kHz
- FS-ABR threshold estimations
  - .5, 1, 2, 4kHz
- Insert earphones used



The SPLogram: In ear canal SPL



The Fitting Process



What we want to do. . .

To match the amplification characteristics of hearing instruments to the auditory characteristics of infants and children so that *the use of their residual auditory capacity can be maximized.*

Component #4

We need to use an evidence-based generic prescription procedure that has been developed specifically for application with infants and children (i.e. the DSL v5.0 Method)

Why not use a manufacturer-specific proprietary procedure ????

A Question . . .

How similar are proprietary algorithms for fitting infants and young children ?

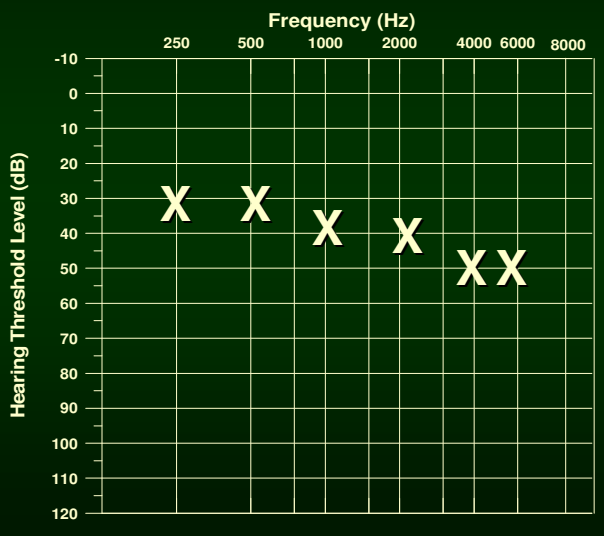
A Study

- **Instruments from five "pediatric friendly" manufacturers programmed using the proprietary algorithm**
- **Nine different audiograms were used (mild through profound)**
- **Average RECD for a 6 month old applied**

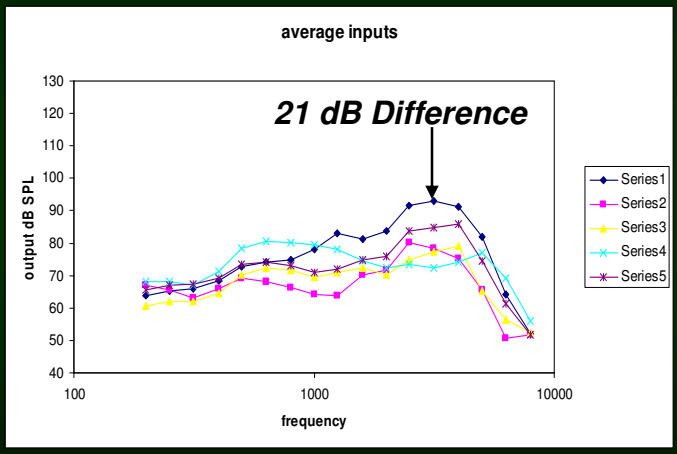
A Study

- **Simulated real-ear hearing instrument performance was measured for :**
  - **soft speech**
  - **average speech**
  - **loud speech**
  - **output limiting**

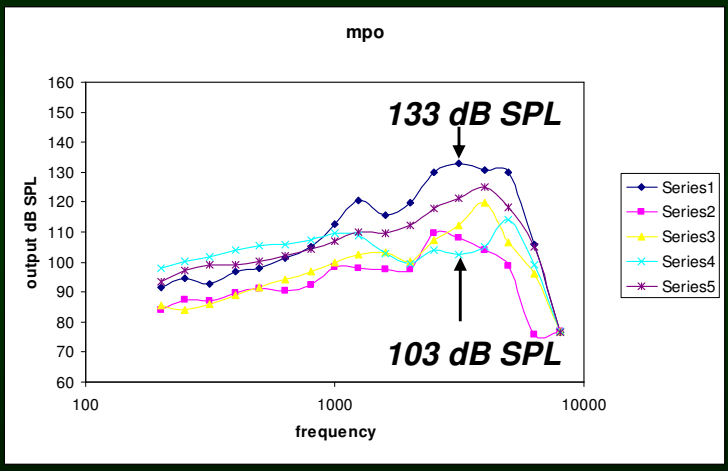
Sample Findings

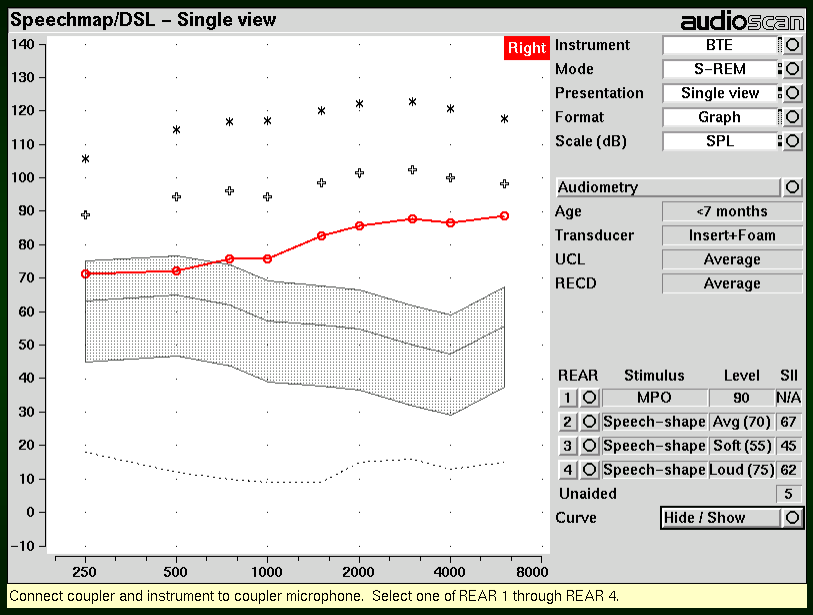


Sample Findings: Average Speech Input

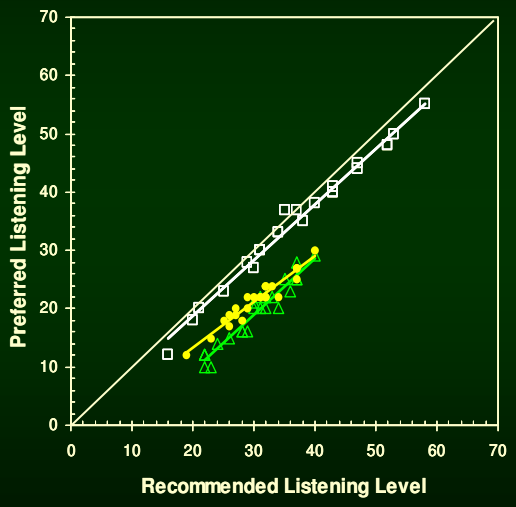


Sample Findings: Output Limiting Levels





Accounting for adult / child differences



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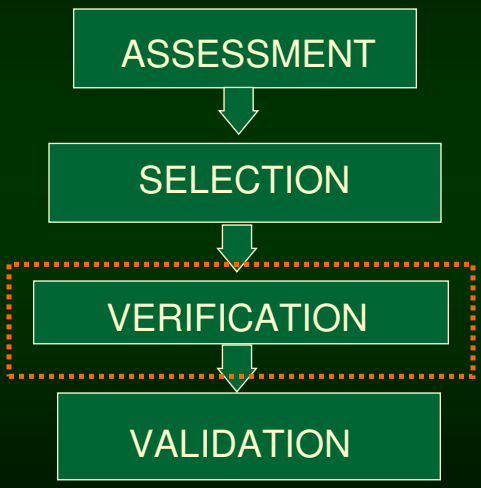
Acoustic Transforms

The Fitting Process



Component #5

We need to verify that the desired real-ear performance of the hearing instrument has been provided to the infant or child.

Why ?????

Electroacoustic Verification

Electroacoustic Verification

We need to know the levels of sound that a hearing instrument delivers into the ear of an infant or young child.

Consequently, comprehensive electroacoustic verification is an essential component in the pediatric hearing instrument fitting process.

The DSL Method uses the RECD to…

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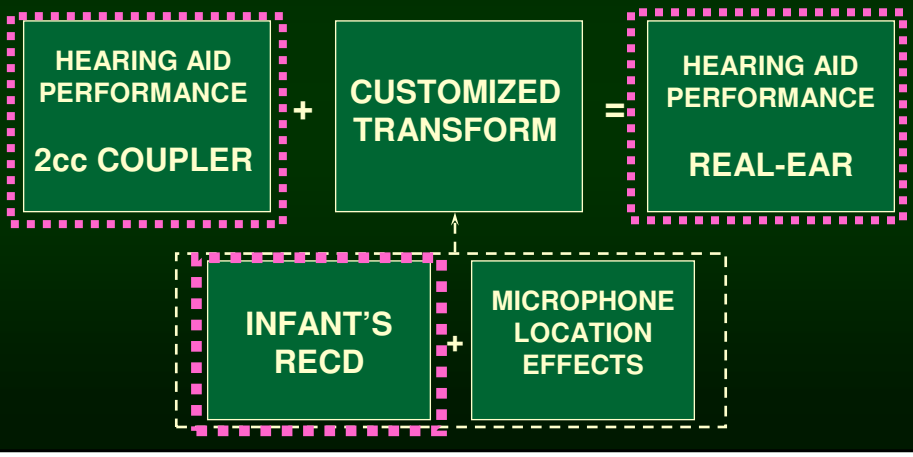
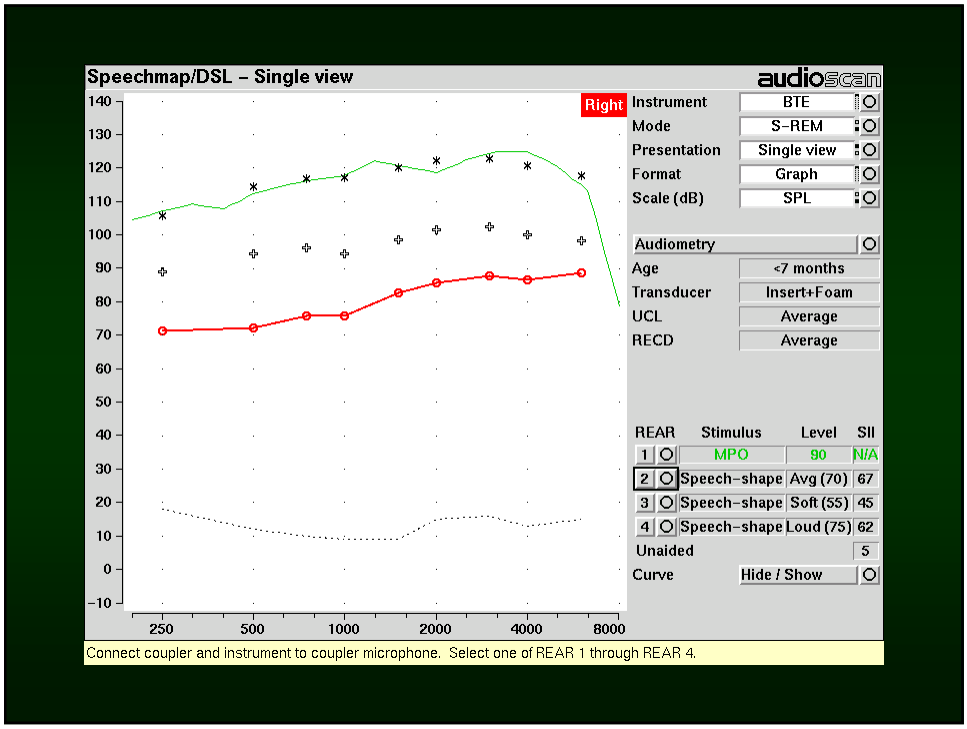
How are RECDs used??
In Hearing Instrument Fitting

To predict real-ear hearing aid performance




Speechmap/DSL – Single view
audioscan
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Instrument BTE
Mode S–REM
Presentation Single view
Format Graph
Scale (dB) SPL
Audiometry
Age <7 months
Transducer Insert+Foam
UCL Average
RECD Average
REAR Stimulus Level SII
1 MPO 90 N/A
2 Speech–shape Avg (70) 67
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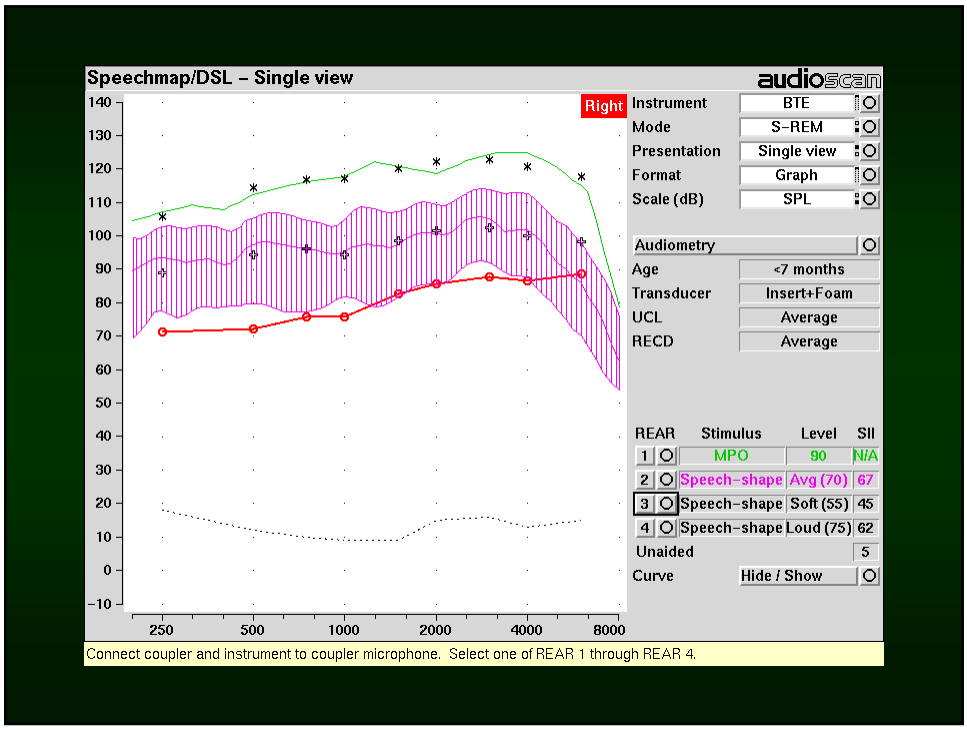
4 Speech–shape Loud (75) 62
Unaided 5
Curve Hide / Show
Connect coupler and instrument to coupler microphone. Select one of REAR 1 through REAR 4.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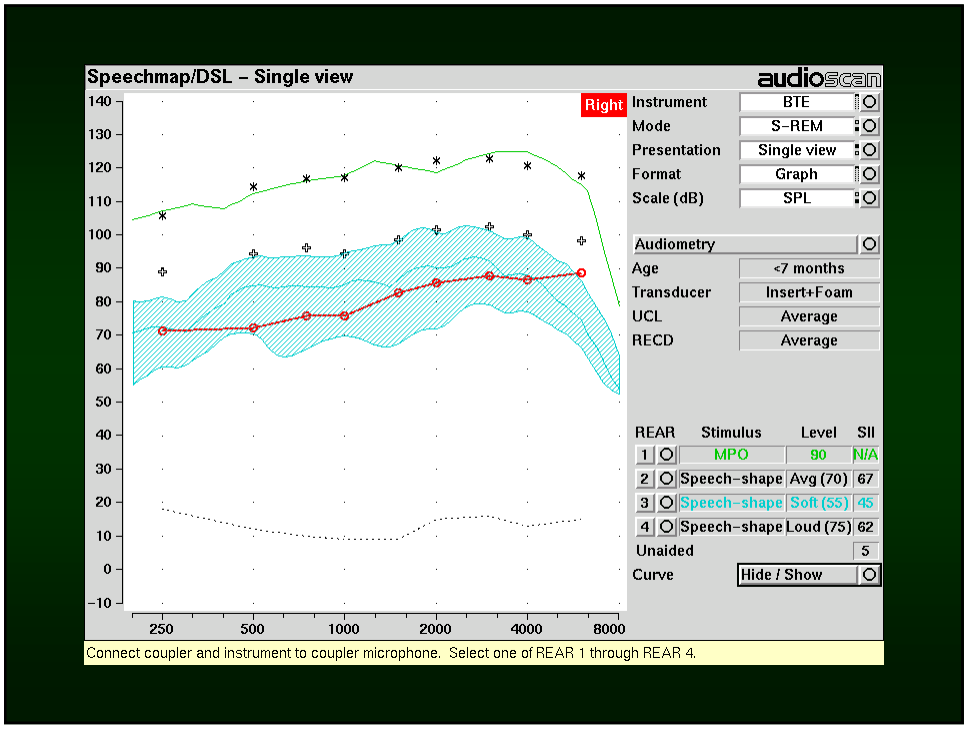
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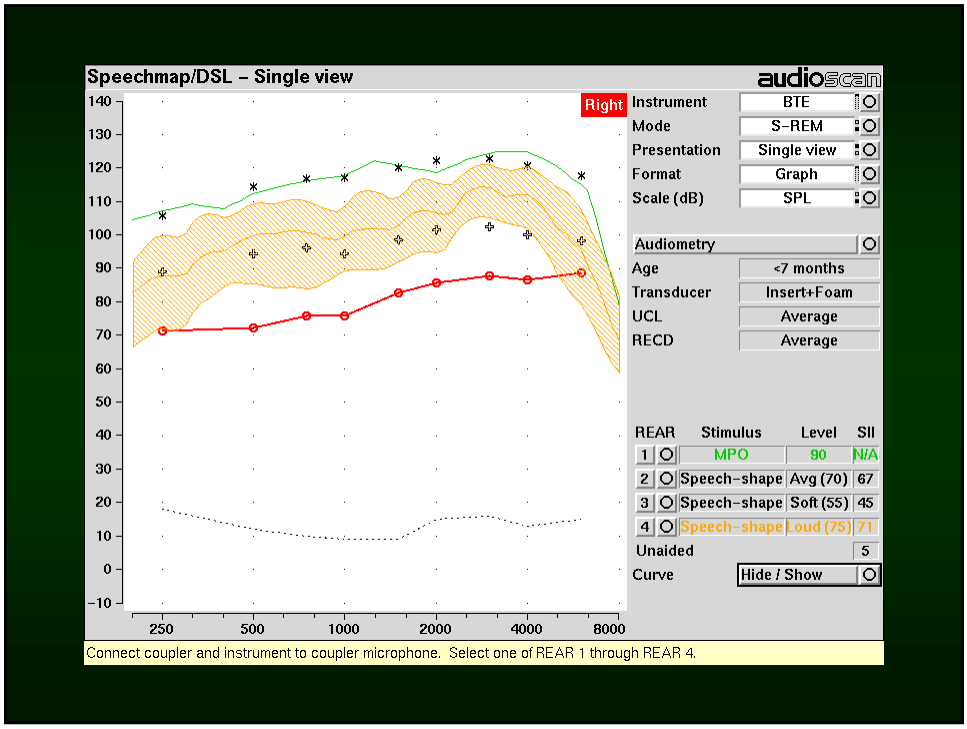
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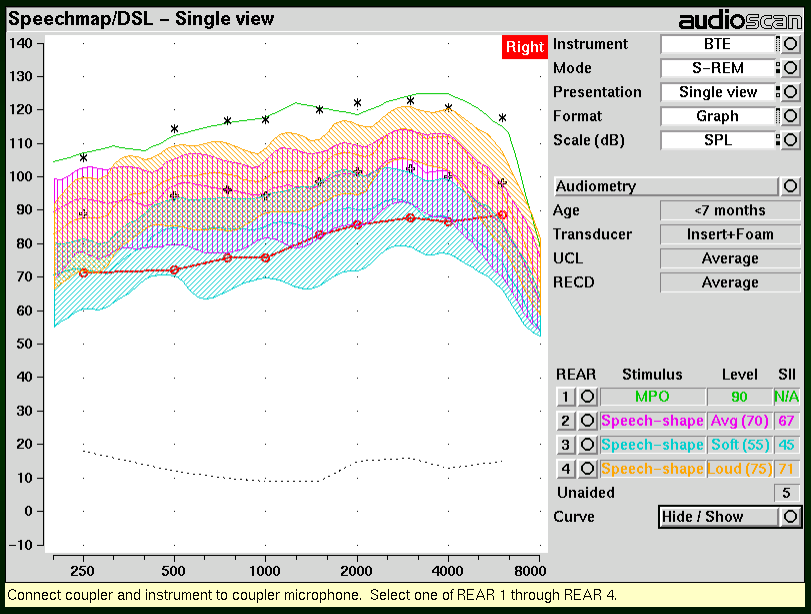
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A Case Study

A Case Study

- ***Failed newborn hearing screening***
- ***Diagnosed with a severe bilateral sensorineural hearing loss at 3 months***
- ***Fitted with binaural hearing aids at 4 months***
- ***Enrolled in an early intervention program at 5 months***

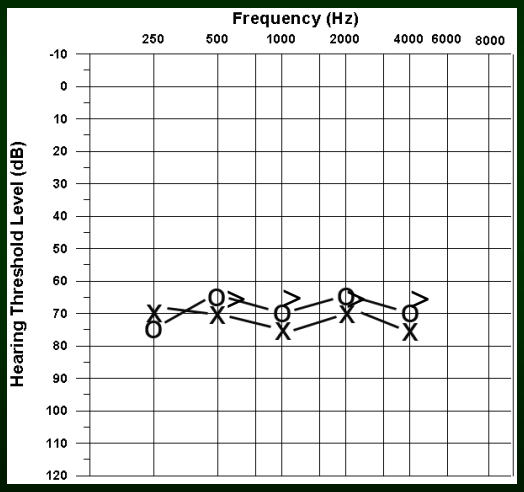
A Case Study

- **At 2 years of age the child was referred for a cochlear implant evaluation by his teacher due to a lack of progress with communication develop goals.**
- **The parents reported that he had acquired no speech and was communicating primarily through gestures.**

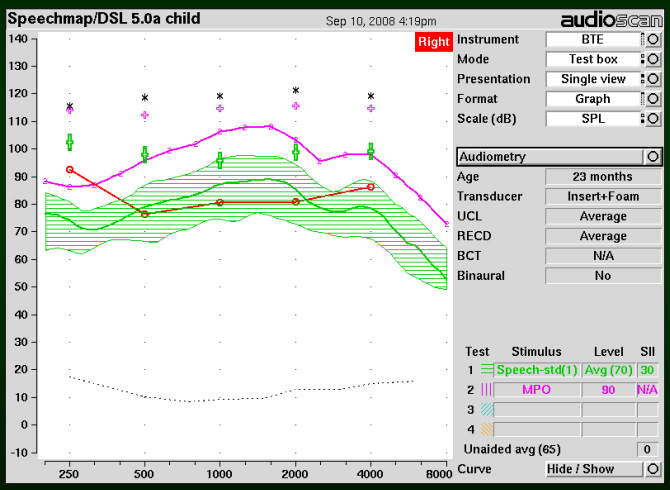
A Case Study

- **Prior to the cochlear implant evaluation, his hearing sensitivity was measured and the electroacoustic performance of his hearing aids was evaluated.**

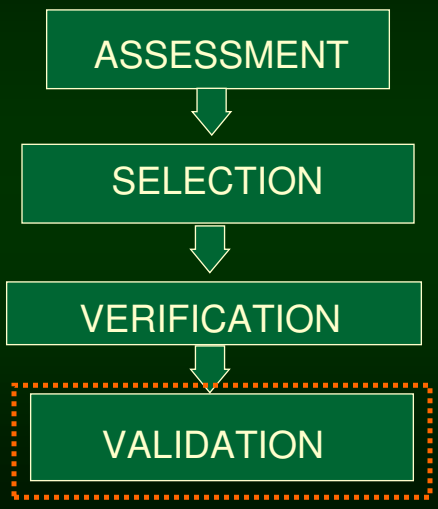
A Case Study: Audiometry



A Case Study: Hearing Aid Fitting



The Fitting Process

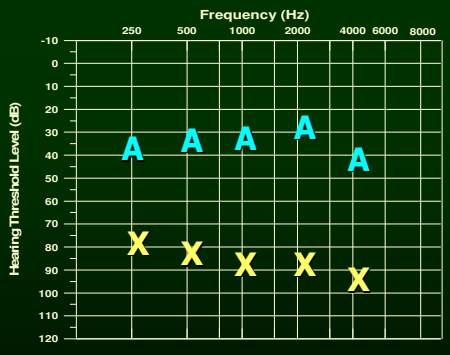


Component #6

We need to measure and monitor auditory performance with amplification over time.

Component #6

- ***Sound Field Aided Thresholds***



Component #6

Validated Auditory-related Outcome Measures for Infants and Children:

- LittlEARS Auditory Questionnaire (Tsiakpini et al, 2004)
- Parent's Evaluation of Aural/Oral Performance of Children (PEACH) (Ching & Hill, 2005)

Resources

- *Ontario Infant Hearing Program Protocols:*

http://ihp.mtsinai.on.ca/english/HealthProfessionals.htm

- *DSL Website:*

http://www.dslio.com

Resources

Diana Laurnagaray

Angelina Martinez
Beatriz Novaes
Beatriz Mendes

Marcela Escobar