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Protocolo de adaptación de audífonos en niños de 3 a 18 meses: adaptación y verificación

Hearing instrument fitting protocol in infants from 3 to 18 months of age: fitting and verification procedures
Hearing Instrument Fitting Protocol in Infants 3 to 18 Months of Age:

Fitting and Verification Considerations

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The Fitting Process

ASSESSMENT

SELECTION AND FITTING

VERIFICATION

VALIDATION
Presentation Outline

- Preselection Considerations
- Electroacoustic Selection and Fitting
Pediatric Hearing Instrument
Selection and Fitting

• Preselection Considerations
Hearing instrument features

**Physical characteristics:**

- BTE casing
- Pediatric sized earhook
- Filter in earhook that provides a minimum of 6 dB of attenuation at 1000 Hz.
- Tamper-proof battery doors
- A system for locking the volume control
- Direct audio input
Pediatric Hearing Instrument
Selection and Fitting

• Electroacoustic Selection and Fitting
The Electroacoustic-Based Approach to Fitting (from Erber 1973)

- Child’s Level of Discomfort
- Child’s Thresholds
- Conversational Speech
- Normal Hearing
In the real-ear

Connect coupler and instrument to coupler microphone. Select one of REAR 1 through REAR 4.
From real-ear to coupler

Real-ear → Acoustic Transform → Coupler
How are RECDs used??
In Hearing Instrument Fitting

To develop 2cc coupler performance targets

- HEARING AID PERFORMANCE
- REAL-EAR
- CUSTOMIZED TRANSFORM
- INFANT’S RECD
- MICROPHONE LOCATION EFFECTS

= HEARING AID PERFORMANCE
= 2cc COUPLER
Specification Window

Circuit Type:
- Linear
- WDRC (Fixed CR)
- WDRC (Variable CR)

Frequency (Hz)
- 250
- 500
- 750
- 1000
- 1500
- 2000
- 3000
- 4000
- 6000

HA2 Coupler
- SSPL
  - 94
  - 100
  - 102
  - 104
  - 111
  - 109
  - 107
  - 102
  - 103

Res. Gain
- 10

Full-on Gain
- 16
- 20
- 25
- 32
- 45
- 43
- 44
- 44
- 42

User Gain (Speech Input)
- 6
- 10
- 15
- 22
- 35
- 33
- 34
- 34
- 32

Compression Ratio
- 1.0
How well does this work???

Validation Studies
Preferred Listening Levels of Children who use Hearing Aids: Comparison to Prescriptive Targets

Scollie, Seewald, Moodie and Dekok
JAAA 2000
Scollie et al. (2000)

- N = 18  Mean age = 10 years
  Mild to Profound SN hearing loss

- The subjects listened to average conversational speech and adjusted their VC to the level they preferred.

- The subjects preferred VC setting, for an average speech input, was compared to DSL prescribed settings.
Preferred Listening Levels in Children

PLL / DSL Comparison

- Preferred Listening Level (dB)
- Recommended Listening Level (dB)

Graph showing the comparison between Preferred Listening Levels and Recommended Listening Levels for children, with DSL marked on the graph.
Preferred Listening Levels in Children

PLL / DSL Comparison

- On average, the children’s preferred listening level was 2 dB above the DSL v4.1 prescribed setting.
Preferred Listening Levels in Children

PLL / NAL Comparison

Recommended Listening Level (dB) vs Preferred Listening Level (dB)

NAL-RP/NL1
Preferred Listening Levels in Children

PLL / NAL Comparison

• On average, the NAL prescribed setting was 11 dB lower than the subject’s PLLs

• The PLLs were within 5 dB of the NAL prescribed settings for 9% of the subjects
Adult/Child Preferred Listening Levels

Scollie, Cornelisse, Seewald, Moodie, Bagatto, Laurnagaray, Beaulac & Pumford (2005)
DSL is just about right!
A New Wrinkle
A new wrinkle . . . .

Thresholds in dB HL or dB nHL

“Quick Fit” in Manufacturer’s Software
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

Frequency (Hz)

Hearing Threshold Level (dB)
Sample Findings: Average Speech Input

21 dB Difference
Sample Findings: Lound Speech Input

26 dB Difference
Sample Findings: Output Limiting Levels

- 103 dB SPL
- 133 dB SPL
Sample Findings

Frequency (Hz)

Hearing Threshold Level (dB)

X X X X X X X
Sample Findings: Output Limiting Levels

![Graph showing output limiting levels for different series.](image-url)

- **Series1**: 144 dB
- **Series2**: 120 dB

The graph illustrates the variation in output dB SPL across different frequencies for Series 1 to Series 5.
Connect coupler and instrument to coupler microphone. Select one of REAR 1 through REAR 4.
The Fitting Process

ASSESSMENT

SELECTION AND FITTING

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 residual auditory capacity can be maximized.
Verification: Measurement Options

I. Behavioral
   Sound Field Aided Thresholds

II. Electroacoustic
   A. Real-ear Measures
      1. REIR
      2. REAR x Input Level
      3. RESR
   B. Simulated Real-ear (coupler-based + RECD)
      1. Predicted REAR x Input Level
      2. Predicted RESR
Verification: Measurement Options

Behavioral Measures

Electroacoustic Measures

Stone and Adam (1986)
Verification: Measurement Options

I. Behavioral
   Sound Field Aided Thresholds

II. Electroacoustic
   A. Real-ear Measures
      1. REIR
      2. REAR x Input Level
      3. RESR
   
   B. Simulated Real-ear (coupler-based + RECD)
      1. Simulated REAR x Input Level
      2. Simulated RESR
How are RECDs used??

In Hearing Instrument Fitting

To predict real-ear hearing aid performance

HEARING AID PERFORMANCE

CUSTOMIZED TRANSFORM

REAL-EAR

2cc COUPLER

INFANT’S RECD

MICROPHONE LOCATION EFFECTS
Connect coupler and instrument to coupler microphone. Select one of REAR 1 through REAR 4.
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The Electroacoustic-based Approach to Fitting (from Erber 1973)

- Child’s Level of Discomfort
- Maximum HA Output
- Amplified Speech
- Child’s Thresholds
- Conversational Speech
- Normal Hearing

Decibels Sound Pressure Level

- 140
- 120
- 100
- 80
- 60
- 40
- 20
- 0
How well does this work???

Validation Studies
Repeatability of RECD Measures:

- $N = 90$ infants/children & 10 adults
- RECD measures obtained twice using the DSL method recommended protocol
Repeatability of RECD measures as a function of age group

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Mean Diff. (1st - 2nd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5 months</td>
<td>1.6</td>
</tr>
<tr>
<td>6 - 12 months</td>
<td>1.5</td>
</tr>
<tr>
<td>13 - 18 months</td>
<td>1.6</td>
</tr>
<tr>
<td>19 - 24 months</td>
<td>1.7</td>
</tr>
<tr>
<td>25 - 36 months</td>
<td>1.9</td>
</tr>
<tr>
<td>Adult</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Predictive Validity of a Procedure for Pediatric Hearing Instrument Fitting

Seewald, Moodie, Sinclair & Scollie

American Journal of Audiology (1999)
Predictive Validity of RECD Measures:

- $\text{N} = 14$ children, Ages: 3 -12 years
- **MEASURES:**
  - RECD measures
  - Coupler measures (2cc gain / SSPL)
  - Real-ear measures (REAG / RESR)
- Predicted values compared to direct measures
Predictive Validity of RECD Measures:

95% Confidence Intervals

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 2.9 dB</td>
<td>2.4</td>
<td>2.4</td>
<td>1.7</td>
<td>2.2</td>
<td></td>
</tr>
</tbody>
</table>

± 2.3 dB for 95% of subjects across frequencies
How well does it work???

Conclusion:

It is possible to derive accurate predictions of real-ear hearing aid performance on the basis of RECD measures.
Thus,

When this approach to hearing instrument fitting is taken with infants/ children, it is not necessary to try to measure an aided audiogram or make conventional probe microphone measures in the initial stages.
The “Coupler Approach”
(Simulated Real-ear)

Relative Advantages

• Does not require a behavioral response
• Provide an accurate estimate of the maximum real-ear SPL
• Predicted REARs are measured with speech-like inputs
The “Coupler Approach” (Simulated Real-ear)

Relative Advantages

• The variability associated with sound field probe microphone measures with children is eliminated.

• All electroacoustic response shaping can be performed under the controlled acoustic conditions of the hearing instrument test box.
The “Coupler Approach”
(Simulated Real-ear)

Relative Advantages

• This approach significantly reduces the amount of measurement time and cooperation required with each child.
Some Limitations

• This approach to verification does not quantify auditory performance with amplification. . . it is only predictive.

• It does require one probe microphone measurement.

• Care must be taken in selecting test signals
Some Current Issues in Verification

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Questions, Questions, Questions . . .

- Is it possible to verify the electroacoustic performance of digital instruments - And, if so, how should we do this ??

- Can electroacoustic measurements using clinical test signals be used to predict the levels of amplified speech for digital instruments?

- If we can’t verify electroacoustic performance, should we be fitting digital instruments to infants?
The Problem . . .

• Many DSP instruments are designed to detect modulations to decide if they are receiving ‘speech’ or ‘noise’.

• Some of our common clinical test signals (eg. pure tones) do not modulate and thus are processed as “noise”.
What you should know . .

• All digital instruments do not implement noise reduction / speech enhancement strategies.

• For most that do, it is possible to turn off this feature for electroacoustic verification.

• If the NR/SE processing cannot be turned off, special care must be taken in test signal selection (eg. Modulated signals)
General Guidelines

For verification of digital hearing instruments:

• Turn the noise reduction / speech enhancement feature off.
• Use speech-weighted test signals.
• Use modulated signals.
• Study performance for low, average and high-level “speech” inputs - (55, 65, 75 dB SPL).
Connect coupler and instrument to coupler microphone. Select one of REAR 1 through REAR 4.
Muchas gracias !