Fitting Current Amplification Technology on Infants and Children
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• Personnel qualifications
• Candidacy
• Preselection issues and procedures
• Circuitry-signal processing
• Hearing instrument selection/fitting considerations
• Verification
• Hearing instrument orientation and training
• Validation
• Follow-up and referral

Preselection Issues & Procedures
• Style
• Bandwidth
• Memories/Volume control
• Earmold/Sound channel
• Microphone
• Controls for fine-tuning
• Telephone access
• Ability to couple to assistive listening technology
Bandwidth in Adults

- Increased bandwidth:
  - Mild to moderate hearing loss: improved performance (Skinner, 1983)
  - Moderate to severe hearing loss: improved, no change, or decreased benefit (Ching et al., 1998; Hogan & Turner, 1998; Turner & Cummings, 1999)

Bandwidth in Children

- Increased bandwidth:
  - Improved perception of speech sounds/speech (Kortekaas & Stelmachowicz, 2000; Stelmachowicz et al., 2001; Lindley, 2009)
  - Improved subjective benefit (Lindley, 2009)

Microphone

- Manual
  - Omnidirectional
  - Fixed-directional
  - ‘Fixed direction’
- Adaptive
  - Polar patterns are adaptive based on:
    - Frequency
    - Intensity
    - Temporal pattern
    - Sound source
- Remote microphone
**Microphone**

- Directional microphones:
  - Adults: improved performance in noise (Hawkins & Yaccullo, 1984)
  - Children: improved SNR in children (Auriemmo et al., 2009)

**Telephone Accessibility**

- Acoustic telephone
- Telecoil
  - Manual
  - Automatic
- Bluetooth/streaming

**Accessibility for Assistive Listening Technology**

- Electromagnetic
- Direct Audio Input
- Built-in Receivers
- Bluetooth/Streaming
Circuitry

- Avoid distortion
- Amplitude processing to insure audibility
- Output limiting (compression)
- Electroacoustic flexibility for changes in physical characteristics of child
- Allow frequency/output shaping
  - For audibility
  - For comfort

Current & Future Processing Schemes

- Automatic feedback control
- Multiple channels
- Expansion
- Compression
- Frequency transposition or compression (or spectral enhancement)

Feedback Reduction

- Feedback reduction is adaptive based on presence or absence
- Methods include:
  - Output limiting
  - Phase cancellation
  - ‘Notch’ filtering
  - combination
Digital Noise Reduction (DNR)

- Noise reduction is adaptive based on:
  - Frequency
  - Intensity
  - Temporal characteristics

Use of DNR for Children

- DNR resulted in improved SNR in children (Auriemmo et al., 2009)
- DNR did not adversely affect speech reception in noise (Auriemmo et al., 2009; Stelmachowicz et al., 2010)
- DNR did not adversely affect word learning in children under 10 years (Pittman, 2011)
- DNR improved word learning in children over 10 years (Pittman, 2011)

Frequency-lowering Techniques

- Frequency Transposition
- Frequency Compression
- Frequency Enhancement
Desired Sensation Level (DSL)

- A scientific approach to pediatric hearing aid fitting to ensure audibility of speech that accounts for factors uniquely associated with infants and children

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DSL

- Factors incorporated into DSL
  - Real ear to coupler differences (RECD)
  - Conversion of audiometric and electroacoustic variables to SPL as a function of frequency – the SPLogram

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Updates to DSL Needed Because…….

- Implementation of newborn hearing screening programs requires clinicians to set the hearing aids based on objective evidence based procedures
- New technologies such as digital signal processing algorithms, multichannel/multistage technology, multimemory programs
DSL 5.0

- DSL 5.0 includes an infant specific protocol
  - Uses estimated thresholds from frequency specific ABR
  - Updated normative data for RECD better suited to hearing aid fittings for infants

DSL 5.0

- DSL 5.0 targets
  - Based on age and etiology
    - Higher gain prescribed for congenital hearing loss
  - Treatment of missing data
    - Interpolate to fill in entire spectrum of targets for audiograms with two or more thresholds

DSL 5.0

- Compression characteristics
  - Target input/output algorithm modified to be clustered according to the number of channels of the hearing aid
COMPARATIVE OUTCOMES OF CHILDREN’S OWN HEARING AIDS AND HEARING AIDS PRESCRIBED BY DSL 5.0

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Purpose

• Do the outcomes observed after fitting to appropriate DSL 5.0 pediatric targets improve when compared to a child’s existing hearing aids and fitting characteristics?
• Do directional microphones improve speech recognition in noise for a pediatric population?
• Does modern feedback suppression improve the ability to meet targets in the high frequencies?
• Does patient satisfaction improve when

Methods

• Custom hearing aid satisfaction questionnaire specifically designed for this study (see handout)
  • 10 questions for parents
  • 10 questions for children
Methods

- The Hearing in Noise Test-Children (HINT-C) was used to determine a hearing in noise threshold for 50% correct recognition of speech. The HINT-C was administered using the original adaptive procedure. Sentences were presented to the child from a single speaker placed 1.5 meters at 0 degrees azimuth. Speech-shaped noise was presented through five speakers arranged behind the child in a 180 degree arc.

- The Phonetically-Balanced Kindergarten (PBK) list, presented in quiet at a fixed level of 65 dB SPL.

Participants

- All participants were existing hearing aid wearers, each child was fit bilaterally with S Series hearing aids for this evaluation.

- All measures compared the child's own aids and the study devices.

- The fittings were matched to DSL 5.0 prescribed targets. Probe measures were collected with an Audioscan Verifit.

- 6 children with mild-to-severe sensorineural hearing loss
  - 4 males, 2 females (Mean age = 11.5 yrs [SD = 2.51 yrs])
  - All children were previous hearing aid users
  - No documented cognitive disorders
Results

- Children with hearing loss generally under-fitted
- Approximation to DSL 5.0 targets improved with use of experimental aid
- Child and parent report of improved sound quality using experimental aid