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)

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**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 (Auriemma et al., 2009)
- DNR did not adversely affect speech reception in noise (Auriemma 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

Frequency Transposition
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

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
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 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

• 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

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 fitted with the study hearing aids?
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.

Participants

- 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