Pediatric Amplification – Components for Success

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Disclosures

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Abstract

There are many factors to consider when selecting and fitting amplification for children to ensure optimal audibility, acceptance, and functional benefit. Although the fitting and verification process can be accomplished with objective measures, the successful use of amplification also depends on the degree to which the child and family accept the instruments and the routines associated with consistent use. Furthermore, the child must experience functional benefit which may be influenced by the addition of a wireless remote microphone system in challenging environments such as classrooms, homes, and extracurricular venues. A review of the essential components to consider for each of these areas will be provided and reinforced with case study examples.

Acknowledgements

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List three (3) learning outcomes attendees will be able to demonstrate as a result of this course, related to the previous response.

• Attendees will be able to provide solutions to three common hearing aid acceptance complaints.
• Attendees will be able to describe informal measurement techniques of hearing aid benefit that can be completed in school settings.
• Attendees will be able to determine the appropriate remote microphone arrangement and settings that will enhance the signal-to-noise ratio in noisy environments.
Components to Pediatric Amplification

- **Audibility**
- **Fitting**
- **Acceptance**
- **Functional Benefit**

Selection of Features

Audiologists should provide recommendations for the necessary features on the hearing instrument (HI) to obtain maximum benefit particularly in noisy educational environments.

Several features to consider BEFORE selecting the HI.....

- **Most Agree:**
  - Deactivate the volume control
  - Locking battery door
  - Telecoil - allows access to many assistive devices such as FM systems or neckloops for cell phones
    - "Let's Loop America" movement will result in more induction loops provided in public places.

- **Direct audio input (DAI) capability**
  - Direct audio input (DAI) capability – allows access to FM receiver (ideally ear level)
  - Both t-coil and DAI – allows numerous options for receiving a signal from a remote microphone which can significantly increase speech recognition (Lewis, Crandell, Valente, & Horn, 2004; Lewis, Valente, Horn, & Crandell, 2005)

- **Directional microphone technology**
  - **Research:** Directional microphones can significantly improve speech recognition in noise (Lewis et al., 2004; Grazel, 1999; Calkley et al., 2014; Pittman and Hylaska, 2013)
  - Analyses of head orientation in children showed they looked in the direction of a talker for 40% of the time and received a 3dB advantage. (O'reg et al, 2013)
  - Systematic literature review led to the conclusion that directional microphones yielded improved speech recognition in controlled optimal conditions. However, more research is needed to determine the effectiveness of directional microphones in actual everyday listening environments. (McCreery et al., 2012)
Noise Reduction

• Digital noise reduction has been shown to improve speech recognition in noise for school-aged children. (Pittman and Hiipakka, 2013)

• Digital noise reduction does not have a negative effect on the overall perception of syllables, words or sentences. (Stelmachowicz et al., 2010; Pittman, 2011)

• Systematic literature review led to the conclusion that as long as the audibility of speech is not compromised, noise reduction may have benefits for comfort, sound quality, and cognitive processes. However, more research is needed to with younger children and those with severe hearing loss who may be more affected by changes in audibility that occur with noise reduction. (McCreery et al, 2012)

Nonlinear Frequency Compression

• Word recognition for children and adults with mild to severe hearing loss can be increased (average 7%) with nonlinear frequency compression. (McCreery et al., 2014)

• Listeners (children or adults) with severe hearing loss are likely to prefer nonlinear frequency compression. (Brennan et al., 2014)

• Benefits in speech recognition with nonlinear frequency compression are increased after six months of use. (Wolf et al., 2011)

• Systematic literature review led to the conclusion that research supports the benefits of nonlinear frequency compression, but audiologists must ensure that the audible bandwidth is maximized while minimizing any distortion effects that may happen with frequency lowering. (McCreery et al., 2012)

Fitting Amplification

• Desired Sensation Level Approach

Verification of Hearing Instruments

Audiologists should verify the HI fitting with efficient and reliable procedures to ensure benefit is received.

Verify with BOTH Electroacoustic and Behavioral procedures

Electroacoustic Simulations

• Seewald and colleagues have shown that software predictions can provide reasonable simulations of acoustic levels provided by amplification in small ears (Seewald & Scollie, 2003).
  • Predict a 2cc target for amplification
  • Compare to the 2cc output that would be predicted to occur in a child’s ear for a particular age and hearing aid style
  • (Ideally measure real-ear to coupler difference and include in the programming steps.)
**Electroacoustic Verification of FM Fittings**
(AAA Guidelines, 2011)
- Measure HA alone and then FM or HA+FM with same input
- Determine difference, ie. Offset
- Account for Offset in FM receiver settings
  - So if HA+FM is 5 dB higher than HA alone
  - Reduce FM Adv setting by 5 dB
- Verify OSL90 Similarity with high level inputs

**Behavioral Verification of FM Fittings**
(AAA 2011 Guidelines)
- Select appropriate speech recognition materials with multiple lists
- Test Conditions- Child in Booth, Examiner outside wearing FM Transmitter
  - HA-Quiet (Speech at 55 dB HL)
  - HA-Noise (Add Speech Noise at 50 dBHL)
  - HA&FM-Noise (Keep levels, Turn on FM Mic)
  - HA&FM-Quiet (Keep levels, Turn off noise)

**Speech Recognition Benefits of FM Systems used with Cochlear Implants**
Thibodeau, Schafer, Overson, Whalen, Sullivan (2005)

<table>
<thead>
<tr>
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<th>With and Without FM in Noise</th>
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<tbody>
<tr>
<td>CI alone</td>
<td>45.50 %</td>
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<tr>
<td>CI + FM</td>
<td>75.25 %</td>
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</table>

The average improvement when adding the FM system in noise was 29.75%

**Followup to Amplification Fitting**
Troubleshooting and Listening Checks-regularly
  - Caregivers
  - Teachers
  - Parents
Hearing Aid Checks- every 3 months
Electroacoustic Analysis-annually
  - Aids alone
  - Aids with Wireless Technology

**Behavioral Results TAKE-HOME**
Thibodeau, Schafer, Overson, Whalen, Sullivan (2005)

- BCIS5/50 45.50 % (CI alone)
- BCIFM55/50 75.25 % (CI + FM)

The average improvement when adding the FM system in noise was 29.75%
Acceptance of Hearing Instruments

Audiologists should present the technology in a positive way that encourages acceptance.

Positive paradigm:
Optimistic view or notion about life events

FM AUDIO DEMOS

• Acceptance facilitated by letting others hear the benefit... or experience the frustration!!

• EARRING CD ROM

Social Acceptance of Ear-Level Technology

• Bluetooth Receivers for Cell Phones
• Bluetooth Receivers for iPods?
• Optional uses for all increases cosmetic options!
• Children should have options:
  • Color?
  • Design?
  • Themes?

Implications of our Words!

• Avoid teaching Negative Paradigms
  • Match Hair Color
  • Small size
• Include family and peers in supporting Positive Paradigms
  • Share excitement regarding color choices
  • Offer remote microphone for parents to wear
  • Make open earmolds for siblings
• Encourage acceptance through scrapbook memories
Today Caroline is going to use the Gillette Center to get her first learning start.

It is her learning birthday because she will have her first time.

The Parent Page

Caroline has never been to a park before. She wants to see what it is like.

The Parent Page

The learning side of Caroline begins with a story. When she is done, she learns to see and feel the world.
Functional Benefit

• Measure Speech Recognition Benefit
• Establishing a sensitive, reliable, valid, and portable test is vital for the success of educational audiologists!

• Developed protocol to use Bluetooth speaker in quiet room to test speech recognition in noise!

Research Questions

• Is BKB-SIN testing with the recorded materials different than testing using live voice?
• Is BKB-SIN testing in the booth different than testing in a classroom setting?
• Is BKB-SIN testing using the Jam speaker and iPad potentially useful for verifying FM systems in the classroom?

Procedure

• 22 undergraduates
  • Normal hearing and native English speakers
• BKB-SIN testing in 5 conditions
  • 1) No FM in the classroom
  • 2) FM in the classroom
  • 3) No FM in the booth
  • 4) FM in the booth
  • 5) Recorded BKB-SIN in booth
Materials

- Jam Speaker
- iPad
- BKB-SIN testing materials
- Phonak iSense receivers
- Inspiro FM transmitter

Jam Speaker

- Bluetooth connectivity
- Connects up to 30 ft away
- Compatible with smartphones, iPads/iPods, mp3 players, notebooks, and eReaders
- Up to four hours of continuous use
- $40 (www.jamspeaker.com)

BKB-SIN Test

- Determines SNR loss
  - Increase in SNR required to correctly identify 50% of key words compared to normal-hearing listeners
- 18 list pairs of 10 sentences spoken by male speaker with multi-talker babble
- First grade level vocabulary
- Designed for ages $\geq 5$ years
- Pre-recorded SNRs decrease 3-dB from +21 to -6 dB SNR

BKB-SIN Test Background

- Beginning: 67 dBA
- End: 84 dBA

Booth Conditions (Live Voice and Recorded)

- Participant
- Researcher reads stimuli at 66 dBA

Classroom Condition

- Participant
- Researcher uses iPad to read stimuli at 66 dBA

Results

<table>
<thead>
<tr>
<th>SNR Averages Across Conditions</th>
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<tbody>
<tr>
<td>Classroom</td>
</tr>
<tr>
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<tr>
<td>$M$</td>
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<td>$SD$</td>
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Interfacing FM equipment with Hearing Instruments

Audiologists should fit HIs that allow access to FM technology so that learning may occur at optimum signal-to-noise ratios.

Complexity Issues

- Best FM/Digital receiver arrangement
- Compatibility with existing equipment
- Accepted by child/teacher
- Optimum Signal
- Durability
- Connections to Personal Aid
- Audio Shoes
- Software/tables to adjust HI
- Explanation of switches

Complexity Issues

- Communication Needs
  - School Personnel
  - Personal Audiologist
  - Family
- Use of FM/Digital at School
  - Changing Classes, Channel assignment
  - Interface with Computers
  - Appropriate Switch options for lecture/class discussion

Parent Education re: FM Systems

- Options for Interfacing with FM/Digital Equipment
- Request FM system before start of school
- Meet responsible personnel
- Request use of FM over breaks, special classes (driver’s ed?)
- FM/Digital Fitting Evaluations (include electroacoustic and behavioral verification)

Case Studies

- SM – HL secondary to Brain Tumor – High School
- MJ- Bilateral Implants- Jr High
- WC-Multiply Handicapped-Preschool