CHILDREN WITH COCHLEAR IMPLANTS: MANAGING THE COMPLEXITY OF ACOUSTIC ACCESSIBILITY
December 10th, 2012
Jane R. Madell, Ph.D, CCC-A/SLP, LSLS Cert. AVT
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Welcome!
HOPE: Helping Cochlear’s implant recipients achieve their personal best.

Our Presenters

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Purpose

• If the family’s desired outcomes for their child include spoken language, literacy, social competencies, and life development consistent with hearing peers, then beginning in infancy, every encounter, location, and environment must be viewed from an acoustic accessibility perspective.
• In order for a child’s auditory brain centers to grow and develop, the child’s brain must be stimulated with sufficient quality and quantity of auditory events.
• This course will assist clinicians in determining if technology is providing optimal auditory access.

Learner Outcomes

As a result of this Continuing Education Activity,
• Participants will identify the acoustic complexity of auditory access in all of a child’s learning domains e.g. home, school, social events.
• Participants will recognize the complexity of transitioning from hearing aids to cochlear implants as a management strategy for acoustic accessibility.
• Participants will explain strategies for repairing poor acoustic accessibility including environmental management, and using FM systems.
Families Desired Outcome

- The family’s desired outcome guides us – ethically and legally.
  - What is your long term goal for your child?
  - Where do you want your child to be at age 3, 5, 14, 20?
  - What does it take to get there?
- 95% of children with hearing loss are born to hearing and speaking families.*
- This talk is all about the context of acoustic accessibility through professional collaboration if the family chooses listening and talking for today’s child who is deaf or hard of hearing.

* A full list of references are included at the end of this presentation.

Why Is Audiological Information Critical?

- Because of advances in technology and new research about brain neuroplasticity,
  - the audiologist’s role has expanded in pediatric sectors.
  - the landscape of deafness has changed.
  - families, audiologists and listening and spoken language specialists need to be sure they are stimulating auditory brain development.

Main Ideas

- Hearing is a first-order event for the development of spoken communication and literacy skills.
- Anytime the word “hearing” is used, think “auditory brain development”!!
- Acoustic accessibility of intelligible speech is essential for brain growth.
- Signal-to-Noise Ratio is the key to hearing intelligible speech.
- Our early intervention programs and classrooms must take into consideration the listening capabilities and acoustic access of our children.
THE BRAIN BASIS OF LISTENING, LANGUAGE AND LITERACY

New Brain Research

Basic neural research now provides data that substantiates the necessity of accessing and stimulating auditory brain centers. There is a science behind our practice!

How Does The Auditory Brain Work?

- Important changes have been shown in the higher auditory centers due to hearing loss/deafness.
- The auditory cortex is directly involved in speech perception and language processing in humans. ²
- Normal maturation of central auditory pathways is a precondition for the normal development of speech and language skills in children. ³
How Much Practice Is Needed To Influence Neural Structure?

- Dehaene (2009): 20,000 hours of listening as a basis for reading.  
- Pittman (2008): Children with hearing loss require three times the exposure to learn new words and concepts due to the reduced acoustic bandwidth caused by the hearing loss.  

Hart And Risley (1999): Implications Of Practice

- 7,430 words – 79 IQ
- 12,810 words – 107 IQ
- 21,105 words – 117+ IQ

Appropriate Technology plus acoustic accessibility + Enriched Auditory Exposure = AUDITORY BRAIN DEVELOPMENT
The Real Ear

Acoustic Access To The Brain

- This is the biggest problem worldwide, for all degrees of hearing loss.
- Technology often is not programmed to today’s possibilities.
- Auditory environments are not managed.
- **Evidence must be obtained**, daily, about how the technology is functioning.
- If the child is not progressing as expected – and everyone has very high expectations – suspect the technology/acoustic accessibility first.

It’s All About The Brain

- Hearing loss is not about the ears; it’s about the brain!
- Hearing aids, FM systems and cochlear implants are not about the ears; they are about the brain!
- They are “brain access” tools.

- And, the audiologist is the professional who makes brain access possible by managing hearing loss, technology, and acoustic environments.
If The Child Is Not Progressing As Expected

- Suspect technology first:
  - Is the child hearing well enough?
  - Is the child hearing high frequencies?
- Is the child wearing technology consistently?
  - If a child is using technology for only 4 hrs./day, it will take 6 years for the child to hear what a typically hearing child hears in one year.®

If the child is not progressing as expected

- Does the family have appropriate expectations?
- Are they requiring use of technology?
- Are they providing auditory stimulation?
- Do they expect the child to listen and talk?
- Do the clinicians working with the child have appropriate auditory expectations?
- Do all of the child’s environments allow sound transmission from the talkers to the child...e.g. acoustic accessibility? Is noise and reverberation managed?

What does the technology need to be doing to meet the needs of acoustic accessibility?

- The child needs to hear throughout the frequency range
  - 6000 and 8000 Hz really do matter.
  - Missing high frequencies results in missing grammatical markers for pluralization, possessives, and missing non-salient morphemes (e.g. morphemes that are not stressed during conversation such as prepositions).
What does the technology need to be doing to meet the needs of acoustic accessibility?

- The child needs to hear at a soft enough level
  - Soft speech is about 35 dBL.
  - If a child cannot hear soft speech, she will not hear:
    - Peers in the classroom or on playground.
    - Will not “overhear” conversation and will have limited incidental learning.
    - Will have reduced language and literacy skills.
    - Moeller (2013) reported that in her research 40% of children fit with hearing aids were under fit. 9
- Aided hearing at 0 dB is not the goal.
  - This can cause distortion.

The technology needs to be distortion free

- Children with HL have more difficulty managing distortion.
- Sources of distortion in the technology:
  - Timing or activation of special features.
    - May reduce audibility of some of the frequency range.
- If the child is not making progress, consider these factors
- Distortion between
  - HA and FM
  - HA and CI
  - CI and CI
  - FM input (Personal FM and SF)

External distortion

Noise and reverberation
- What effect does this have on the cochlear implant?
- What does noise do to the technology?
Speech Intelligibility

What does intelligible speech look like?

- Every speech sound needs to be audible.
- At typical and soft conversational levels.
- At distances and up close
  - “Overhearing/incidental” is critical
  - 90% of what infants and young children know about the world they learn incidentally.  

The Audiology Fruit

Killion And Mueller - 2010

Sill Count-the-Dots Audiogram Form


Can we call it the speech bean?

From Jane Madell's website at www.janemadell.com

How does the child’s auditory environment effect technology decisions?

- Noise – smart phone SML apps
  - How noisy is the home?
  - Is the child in daycare?
  - What after school activities does the child participate in?
  - Should the infant/child have an FM?
- Noise is a factor even for infants.
- Helping families learn to turn off noise
  - Turn off dishwasher during dinner.
  - Turn off background radio/TV.
  - Music is only useful when it is adult directed.
  - Otherwise it is noise

www.janemadell.com & www.CarolWear.com
Spatial Processing Disorder (SPD)
Dillon (2012) 11
- A specific form of auditory processing disorder.
- Reduced ability to separate speech from noise using spatial cues.
- Most apparent in noisy situations.
- Major reason why children with SNHL fail to do well in noise.
- Children with SNHL cannot use spatial cues to determine where to focus their attention.
- With current technology, there is always going to be a problem with acoustic access.
  - By virtue of HL they have a specific processing disorder.
  - We MUST be mindful of acoustic access to provide children with SNHL the ability to overcome SPD.

Why is speech perception important?
- It determines how children perform in all daily activities.
- It provides information about auditory brain access for language and cognitive development.
- It provides a clue about auditory brain development.

If You Do Not Test Speech Perception, You Will Not Know:
- What the person hears.
- More importantly – what the person does not hear.
- If there has been a change in perception.
- If there is something you can do to improve auditory functioning.
What is Good Speech Perception?

- Speech perception qualifiers (Madell et al, 2011) 12
  - Excellent  90-100%
  - Good  80-89%
  - Fair  70-79%
  - Poor  < 70%
- If the child’s speech perception is not good enough, what do we need to do to repair it?

THE FREQUENCIES OF PHONEMES

Vowel Frequency Bands 13

<table>
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<tr>
<th>POSITION</th>
<th>VOWEL</th>
<th>1st FORMANT</th>
<th>2nd FORMANT</th>
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<tr>
<td>Back</td>
<td>Who</td>
<td>430</td>
<td>1170</td>
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<tr>
<td></td>
<td>Would</td>
<td>540</td>
<td>1410</td>
</tr>
<tr>
<td></td>
<td>Know</td>
<td>670</td>
<td>1250</td>
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<tr>
<td></td>
<td>More</td>
<td>640</td>
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<tr>
<td>Middle</td>
<td>Off</td>
<td>1030</td>
<td>1370</td>
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<tr>
<td></td>
<td>Art</td>
<td>1020</td>
<td>1750</td>
</tr>
<tr>
<td></td>
<td>Must</td>
<td>850</td>
<td>1590</td>
</tr>
<tr>
<td></td>
<td>Learn</td>
<td>580</td>
<td>1740</td>
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<tr>
<td>Front</td>
<td>And</td>
<td>1110</td>
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<td></td>
<td>Then</td>
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<td></td>
<td>Take</td>
<td>610</td>
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<tr>
<td></td>
<td>His</td>
<td>530</td>
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<td></td>
<td>Ease</td>
<td>370</td>
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Consonant Frequency Bands

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<tr>
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<tr>
<td>p</td>
<td>1000-2500</td>
</tr>
<tr>
<td>t</td>
<td>2500-4000</td>
</tr>
<tr>
<td>k</td>
<td>2500-4000</td>
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<td>g</td>
<td>2000-2500</td>
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<td>m</td>
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<td>n</td>
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<td>s</td>
<td>600-1000</td>
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<tr>
<td>z</td>
<td>2000-3000</td>
</tr>
<tr>
<td>j</td>
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</tr>
<tr>
<td>x</td>
<td>800-1000</td>
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<td>z</td>
<td>400-800</td>
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<td>r</td>
<td>200-400</td>
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<tr>
<td>l</td>
<td>1500-2000</td>
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What you miss if you don’t hear above 4000Hz

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<tr>
<td>b</td>
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<td>d</td>
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<tr>
<td>h</td>
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<td>2000-3000</td>
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Consonant Testing

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<th>Far Quiet</th>
<th>Close Noise</th>
<th>Far Noise</th>
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How do we know that the child’s technology is providing sufficient acoustic accessibility?

- Evidence obtained in the sound room
  - Thresholds
  - Speech perception tests
- Evidence of a child’s progress in attaining desired outcomes
  - One-year progress in one year
- Parental observation of listening and learning at home
- Therapist/teacher observations
- Lena

Transitioning from Hearing Aids to CIs

- Evidence to support transitioning from HA’s to CI’s
  - Is the child receiving acoustic access to all frequencies at a sufficiently soft level to hear normal and soft conversation?
- Evidence that is irrelevant in determining the need for better acoustic accessibility
  - Child likes his hearing aids.
  - Child’s progress in language and academics.
    - Why is this irrelevant?
      - What does it take to sustain progress, not just attain it.
      - Without good acoustic access the child will miss incidental information both inside and outside the classroom and will start to fall behind
    - Sustaining requires ongoing access to incidental knowledge and information in ever increasing complex and nuanced learning situations.
  - Can we wait?

How Do We Know Auditory Access Is Sufficient?

<table>
<thead>
<tr>
<th></th>
<th>Right</th>
<th>Left</th>
<th>Bispectral</th>
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<tbody>
<tr>
<td>50 dBHL</td>
<td>76%</td>
<td>68%</td>
<td>72%</td>
</tr>
<tr>
<td>35 dBHL</td>
<td>56%</td>
<td>26%</td>
<td>64%</td>
</tr>
<tr>
<td>50 dBHL+SNR</td>
<td></td>
<td></td>
<td>48%</td>
</tr>
</tbody>
</table>
How Do We Know Auditory Access Is Sufficient?

- Technology thresholds
  - If not sufficient,
    - Reprogram or change technology
    - Acoustically-tuned earmolds
    - Remote microphone is not a substitute for well programmed primary technology
  - YES, YOU CAN PERFORM AIDED THRESHOLD TESTING
    - Present from below expected threshold
    - Short presentation will not turn on compression

Repairing Speech Perception Deficits

- Auditory brain access with equipment.
- Auditory exposure –
  - Listening age.
  - Hrs/day equipment is worn.
- Auditory environments
  - Do we need FM at home? Playground?
- Daily auditory enrichment and embellishment
  - Parent focused, guided by the Listening and Spoken Language Specialist (LSLS).

Summary

- The purpose of a CI is to get sound to the brain
- We need to get sound to the brain to develop auditory neural centers for listening, language, literacy and learning to have friends.
- All of a child’s environments need to be acoustically accessible in order for auditory events to reach the microphone of the CI
- All practitioners and families must be mindful of noise, reverberation and distance in all of a child’s learning domains.
References

Additional Sources
- Journal of Speech Language and Hearing Research. 7(2), 795-797.
Upcoming Online Sessions

Next Up:
Tuesday January 15th, 3:00 pm ET
Working with Children with Vision Loss and Other Disabilities Post Cochlear Implantation (Professional Focus)
Charlotte Collins Ruder, MS, CCC-SLP/A, Cincinnati Children’s Hospital Medical Center
Susan M. Bashinski, PhD, Associate Professor of Special Education at East Carolina University

Thursday January 24th, 3:00 pm ET
An Itinerant Teacher’s Work is Never Done: Supporting Mainstream Educators (Professional Focus)
Judith S. Sexton, MS, CEO, LLD Cert. AVEd, Director, Clarke Schools for Hearing and Speech/Pennsylvania

Contact Cochlear Americas

• For inquiries and comments on this seminar or a HOPE program, please contact: hope@cochlear.com

• For a Certificate of Participation, please send your completed Feedback Form to:
  hopefeedback@cochlear.com

• Thank you for attending this presentation!!

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