This handout is for reference only. It may not include content identical to the powerpoint. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.

Understanding Hearing Loss for Speech Language Pathologists - Part 1

Presenter:  Jane R. Madell, PhD, CCC A/SLP, LSLS Cert AVT

Moderated by:
Amy Natho, M.S., CCC-SLP, CEU Administrator, SpeechPathology.com
SpeechPathology.com Expert eSeminar

Need assistance or technical support during event?
Please contact SpeechPathology.com at 800-242-5183

Earning CEUs

- Log in to your account and go to Pending Courses under the CEU Courses tab.
- Must pass 10-question multiple-choice exam with a score of 80% or higher
- Two opportunities to pass the exam
Interested in Volunteering to be a Peer Reviewer?  

APPLY TODAY!

3+ years SLP Professional Experience Required

Contact Amy Natho at anatho@speechpathology.com
Learning Objectives

As the result of this continuing education activity, participants will be able to:

• Explain the importance of auditory access for auditory brain development
• Identify testing that is required for a complete audiological evaluation
• Describe procedures to determine if technology is providing sufficient benefit.

Types of Auditory Problems

• Hearing loss
  • Mild to profound
• Auditory processing disorder
• Auditory attention disorder
• Sound sensitivities
Basic Assumptions

1. Hearing is critical for language development
2. Even a mild hearing loss can interfere with language development
3. It is possible to obtain reliable auditory information on infants and children of any age and any developmental status
4. Reliable auditory information is critical to appropriate management.
5. Early and appropriate technology is the single most important habilitative tool available to infants and children with hearing loss.
6. Appropriate technology is critical for appropriate habilitation and educational placement.

Why Is Earlier Identification Critical?

- Infants with hearing loss who are appropriately fit with hearing aids prior to 6 months of age can have speech and language development commensurate with their typically hearing peers.
- Infants fit at 12 months are 1 SD below their peers
- Infants fit at 18 months are 2 SD below their peers
- Infants fit at 24 months are 3 SD below their peers

Yoshinata- Itano
Why Do We Need Excellent Auditory Access?

- Most children with HL are educated in the mainstream
- Facilitate spoken language development
- Facilitate psychosocial development
- Language is best learned through audition
  - Provides the most information
  - Permits incidental learning
  - Provides subtle information not available visually
  - Hearing is an open channel – we cannot close it off

LANGUAGE AND THE AUDITORY BRAIN

www.JaneMadell.com
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 achieve the families goal?
• 95% of children with hearing loss are born to hearing and speaking families.
• Acoustic accessibility is critical if a child with hearing loss is going to learn to listen and talk.

How Does The Auditory Brain Work

• Hearing loss results in significant changes in the higher auditory centers.
• The auditory cortex is directly involved in speech perception and language processing in humans (Kretzmer ie al, 2004).
• Normal maturation of central auditory pathways is a precondition for the normal development of speech and language skills in children (Sharma et. al, 2009)
How Much Practice Is Needed To Influence Neural Structure?

- Malcolm Gladwell: 10,000 hours of practice
- Hart and Risley: 46 million words heard by age 4
- Dehaene: 20,000 hours of listening as a basis for reading
- Pittman: 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 (1995)

<table>
<thead>
<tr>
<th></th>
<th>PARENTS</th>
<th></th>
<th></th>
<th>CHILDREN</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Professional</td>
<td>Working class</td>
<td>Welfare</td>
<td>Professional</td>
<td>Working class</td>
<td>Welfare</td>
</tr>
<tr>
<td>IQ age 3</td>
<td>117</td>
<td>107</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocab size</td>
<td>2,179</td>
<td>1,498</td>
<td>974</td>
<td>1,116, 525</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Utterances per hour</td>
<td>487</td>
<td>301</td>
<td>176</td>
<td>310</td>
<td>223</td>
<td>168</td>
</tr>
<tr>
<td>Average Diff Words per Hour</td>
<td>382</td>
<td>251</td>
<td>167</td>
<td>297</td>
<td>216</td>
<td>149</td>
</tr>
<tr>
<td>Average Words per Hour</td>
<td>2,153</td>
<td>1,251</td>
<td>616</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Words per 14 hour day</td>
<td>30,142</td>
<td>17,514</td>
<td>8,624</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appropriate Technology plus acoustic accessibility = Enriched Auditory Exposure

AUDITORY BRAIN DEVELOPMENT

Acoustic Access

• Sufficient acoustic access is the most important factor affecting children with hearing loss
• Technology is often not programmed well enough to meet the needs of acoustic accessibility
• Auditory environments must be appropriately managed
• Technology must be programmed to provide sufficient auditory access
• If the child is not progressing as expected – and everyone has appropriately high expectations – suspect the technology/acoustic accessibility first.
Hearing Loss and APD is Really 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 responsible for assuring brain access by managing hearing loss, technology, and acoustic environments.

If A Child Is Not Progressing Well

- 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.
Description of Hearing Loss

- Pure tone average
  - 500, 1000 and 2000 Hz
- Description of hearing loss across all frequencies
  - eg – Mild to severe
- Describe air and bone conduction HL
CAN WE CALL IT THE SPEECH BEAN?

Transducers

- Air conduction
  - Tests the entire auditory system
  - Soundfield, or earphones
- Bone conduction
  - By passes outer and middle ear
  - Tests inner ear directly
  - Bone vibrator places behind on the mastoid
Types Of Hearing Loss

- Conductive
- Sensorineural
  - Sensory – in the cochlea
  - Neural – beyond the cochlear
- Mixed

Conductive Hearing Loss

- Damage to outer or middle ear
- Otitis Media
- Structural deformities
- Cholesteotoma
- Foreign bodies
Conductive Hearing Loss

• Damage to the inner ear
  – Hair cell damage in the cochlea
  – Damage to the VIIIth cranial nerve (e.g. tumor)
  – Auditory dysynchrony

• Causes
  – Congenital
  – Genetic
  – Fever
  – Viral

• Progressive

Sensori-neural Hearing Loss

• Damage to the inner ear
  – Hair cell damage in the cochlea
  – Damage to the VIIIth cranial nerve (e.g. tumor)
  – Auditory dysynchrony

• Causes
  – Congenital
  – Genetic
  – Fever
  – Viral

• Progressive

www.JaneMadell.com
Sensorineural Hearing Loss

Auditory Processing Disorders

- Normal hearing
- Reduced ability to hear well when the signal is distorted or when there is competing noise
- Identification by an audiologist after conducting an APD evaluation
- Requires team management
- May or may not be associated with language learning disorder

www.JaneMadell.com
Sound Sensitivities

- May be a physical or psychological problem
- Measured in a test booth by an audiologist
- Parents, therapists and teachers can contribute to the evaluation by noting if specific sounds or specific situation cause sound sensitivity reactions or if reactions are general.

Auditory Attention Disorder

- Child has difficult attending to auditory information but can attend to visual information
  - Child can look at books and play appropriately with toys but has difficult when asked to listen and follow conversation
Factors That Affect Auditory Learning

- Hearing
- Access to auditory information
- Amount of auditory deprivation
  - Hearing loss
  - Middle ear disease
- Good and constant language modeling
- Controlling the auditory environment
  - Noise
  - Distance from the talker

Hearing Screening in Infants

- Newborn hearing screening
  - Otoacoustic Emissions
  - Auditory Brainstem Response screen
- What does it tell you?
  - OAE screen
    - Pass – no worse than mild hearing loss
    - Refer – Fluid? Debris? HL?
  - ABR screen (broad frequency click)
    - Pass – no worse than mild HL at some frequency
    - Refer – hearing loss?
- (key word – screen)
  - Hearing at that moment only
  
  www.JaneMadell.com
Diagnostic Tests

- ABR
  - Provides information about intactness of auditory pathway
  - Not a direct measure of hearing
- OAE
  - Measures outer haircell function
  - Not a measure of hearing
- Immittance
  - Measures middle ear function
  - Not a measure of hearing
- Behavioral responses
  - Only direct measure of hearing
Behavioral Evaluation

- Direct measure of hearing
- Direct response of hearing measuring responses from the child
- Observation audiometry
  - Birth to 6 months (cognitive age)
  - Response – changes in sucking
- Visual reinforcement audiometry
  - 6 to 36 months (cognitive age)
  - Response – conditioned head turn
- Conditioned play audiometry
  - 30 months to 5-6 years (cognitive age)
  - Response – “listen and drop”
- Standard audiometry
  - > 5-6 years (cognitive age)
  - Response – hand raise or button push
FACTORS THAT EFFECT RESULTS

• Developmental age
• Neurologic status
• Behavioral status
• Middle ear status
What Should We Be Looking For From Testing?

- Ask to see test results – not just the report
- Degree of hearing loss
  - Was the appropriate test used?
    - (BOA, VRA, Play, ABR etc.)
- Speech perception testing
  - Under earphones
  - In soundfield without technology
  - With technology
- Is the child hearing well enough to manage in a classroom?
SPEECH PERCEPTION

What Should We Be Looking For From Speech Perception Testing?

- Ask to see test results
- Speech perception testing
  - Under earphones at a comfortably loud level
  - In sound field – no technology
    - Normal and soft conversational levels in quiet
    - Normal conversation level in noise
  - With technology
    - Normal conversation (50 dBHL) (R, L, B, FM)
    - Soft conversation (35 dBHL) (B, FM)
    - Normal conversation in noise (B, FM)
- If speech perception is poor, what can you expect
  - In learning language
  - In the classroom
Types of Speech Perception Tests

- Threshold tests
  - Speech awareness threshold
  - Speech reception threshold
  - Speech discrimination testing

SPEECH THRESHOLD TESTS
Speech awareness/detection threshold

- Softest level at which a person knows speech stimulation is present
- Reported in dB
- Common stimuli
  - Conversational voice
  - Music
  - 6 sound – a, i, u, sh, s, m (Ling)
  - 3 sound – ba, sh, s (Madell)
SPEECH THRESHOLD TESTS
Speech Reception threshold

• Softest level at which a person can identify speech stimuli.
• Reported in dB
• Common stimuli
  – Standard spondee pictures
  – Standard spondee words
  – Familiar objects or toys
  – Body parts
  – Numbers

Speech Perception

• Tested at suprathreshold levels
• Scored in %
• Under earphones testing usually performed at 40 dBHL
• With technology (R, L, B) testing performed at
  – 50 dBHL
  – 35 dBHL
  – 50 dBHL+5 SNR
Measuring Outcomes Using Speech Perception

- Speech perception measures can
  - Unaided performance in typical listening situations
  - Demonstrate benefit with hearing aids or cochlear implants
  - Demonstrate improvement in functioning over time
  - Identify problems that develop over time
    - Reduction in functioning
    - Equipment deterioration or failure
  - Identify perception errors
  - Demonstrate habilitation/rehabilitation needs
  - Assist in selecting the appropriate educational environment

www.JaneMadell.com

What Does A Child Need To Hear?

- Children with typical hearing understand 90-100% in quiet and in noise

- Excellent  90-100%
- Good       80-89%
- Fair       70-79%
- Poor       < 70%
# When Should Speech Perception Be Measured By The Audiologist?

- When hearing loss is identified
- At re-evaluations
- When selecting technology
- When changing technology settings
  - Hearing aids
  - Cochlear implants
  - FM systems

---

- If we do not test, we will not know
  - What the person hears
  - More important – *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
### Selecting Test Materials

- Linguistically appropriate
  - Not too easy or too hard
- Appropriate level of complexity
- Single vs multiple tests
  - One test does not give all the info

www.JaneMadell.com

### Speech Perception Test Stimuli

- Single words
  - Limited clues
  - Response will likely be limited to familiar words
  - Word vs phoneme scoring
- Nonsense syllables
  - Even fewer cues
  - Responses provide best indication of what is heard
- Sentences
  - Can use knowledge of the language to fill in blanks
  - May provide an unrealistically high score

www.JaneMadell.com
Factors Which May Affect Speech Perception

- Degree of hearing loss
- Length of hearing loss
  - Length of profound hearing loss
- Experience with technology
- Demands on using audition
  - Educational setting
  - Family demands
- Language level
- Etiology of hearing loss
- Appropriateness of
  - Hearing aid settings
  - MAPping strategy, rate, etc.
- Experience of audiology and/or implant team

Suggested Protocol

- Monosyllabic words
  - Normal conversation 50 dBHL (R, L, B)
  - Soft conversation 35 dBHL (B)
  - Normal conversation 50 dB+5 SNR (B)
<table>
<thead>
<tr>
<th></th>
<th>Right</th>
<th>Left</th>
<th>Binaural</th>
<th>Binaural + FM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WORDS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 dB HL Words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35 dB HL Words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 dB HL +5 S/N words</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonemes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SENTENCES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiet 50 dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quiet 35 dB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise 50 dB+5S/N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MONITORING TECHNOLOGY**

www.JaneMadell.com
Goals of Technology

• Reduce sensory deprivation
• Maximize use of residual hearing
• Provide input sufficient for auditory learning
• Lay foundation for auditory academic learning
• Facilitate socialization
• Facilitate information access/extended learning/incidental learning
• Safety
• Comfort

Never Assume!!

• Technology needs to be tested if we want to know how a child is performing
The Real Goal of Testing

- Is the child hearing speech at a soft enough level
  - Can she hear the teacher/parent/primary talker?
  - Can she hear conversation around her?
  - Can she use hearing for incidental learning?
- Is speech clear enough?
  - Distortion
  - Noise
  - Reverberation

What Needs To Be Tested With Technology?

- Real ear testing
- Aided threshold testing – Right and Left
- Speech perception testing
  - Normal conversation 50 dBHL (R, L, B)
  - Soft conversation 35 dBHL (B)
  - Normal conversation 50 dB+5 SNR (B)
The Audiologists Role

• Accurate identification of degree and type of hearing loss
• Evaluation and selection of technology
• Modify technology as needed
• Evaluate auditory progress
• Monitor classroom functioning
• Identify other disabilities and refer as needed
• Work cooperatively with other team members
• Collect information from SLP’s and teachers about auditory and language function
• Provide support to children and families

The Speech-Language Pathologists Role

• Monitor language and literacy development
• Monitor auditory development
• Communicate with audiologist about auditory skills and need for change of technology settings
• Work with other professionals including teachers and other therapists
• Provide support for the child and the family
### The Role of the Listening and Spoken Language Specialist

- Monitor auditory development
- Develop a therapy program using a normal auditory development sequence
- Work with audiologist to determine when perception is indicates a need for a change of technology or technology settings.
- Educate others working with the child about hearing loss and the effect on academics and literacy

www.JaneMadell.com

### What can we do to change what a child hears?

- Make sure technology is worn full time
  - Change hearing aid settings
    - Limit of high frequencies with hearing aids
    - What do high frequencies tell us?
    - Receiver limitations
  - Change hearing aids
  - Cochlear implants
    - What do they provide?
    - Determining candidacy
- Auditory based language therapy
When A Hearing Aid Is Not Enough

- Hearing aids cannot provide enough gain to hear normal and soft conversational speech
- Child not making sufficient auditory gains
- Consider cochlear implant

www.JaneMadell.com