Auditory Development
or “Hearing and the Brain”

Jeanie Hamilton, AuD, FAAA, CCC-A
Pediatric Audiologist

Stephen Hill, MS
Audiology Intern
How is the Brain Involved?

- The *ear* catches and funnels sound
- The *brain* makes sense of it
  - What is this sound?
  - What does it mean to me?
  - What do I know about it?

*Video: How we hear*
Who are We?

What is an Audiologist?
• A health care professional trained in the evaluation and rehabilitation of hearing and balance disorders.
What Does an Audiologist Do?

Assessment
• Hearing tests
• Newborn hearing screening
• Balance assessments
• Auditory processing assessments

Treatment
• Hearing Aids
• Cochlear Implants
• Auditory rehabilitation
Different Roles of the Audiologist

- Interdisciplinary Team Member
- Educational Audiology
- Parent/Family Advocate
- Clinician
- Researcher
- Interdisciplinary Team Member
Early Detection and Identification

Failed newborn hearing screen:

- **Permanent** hearing loss (3 out of every 1000 births)
  OR
- **Temporary**: Sound wasn’t able to get into the auditory system (fluid/congestion from birth, etc.)

**1-3-6 Plan**

- Hearing screening by 1 month of age
- If failed: audiologic and medical evaluations to **confirm** hearing loss by 3 months of age
- If hearing loss: **intervention** by 6 months of age
  - Hearing aids, cochlear implants, etc.

*Source: American Academy of Pediatrics, 1999 – Revised in 2011*
Hearing Loss Terms

• **Conductive:** Hearing nerve is functioning normally, but something is blocking the path
  – *Sometimes reversible or clears up with time*
  – Fluid, wax, foreign objects

• **Sensorineural:** Hearing loss in hearing nerve
  – **Permanent**
  – Family history/genetics, environmental exposure, noise damage, sometimes cause is not known

• **Mixed:** Nerves showing hearing loss, and also something blocking the path
  – Nerve hearing is permanent, but blockage may be reversible
How we test hearing

• Birth to 6 months
  – **Auditory Brainstem Response (ABR)** electrical impulses sent from the inner ear to the brain
  – **Otoacoustic Emissions (OAE’s)** sounds created by the vibrations of hair cells in cochlea
How we test hearing

- 6 months to 2 ½ years
  - **Visual Reinforcement Audiometry**: Child’s responses to sound are reinforced with a visual event
How we test hearing

• 2 ½ years to 6 years
  – Conditioned Play Audiometry: Children are trained to perform a play activity in response to sounds
## Normal Development

<table>
<thead>
<tr>
<th>AGE</th>
<th>Hearing Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 3 months</td>
<td>Startles to loud sounds</td>
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<tr>
<td></td>
<td>Smiles when spoken to</td>
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<td></td>
<td>Recognizes voices</td>
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<tr>
<td>4 to 6 months</td>
<td>Moves eyes in direction of sound</td>
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<td></td>
<td>Notices toys that make sound</td>
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<td></td>
<td>Pays attention to music</td>
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<tr>
<td>7 to 12 months</td>
<td>Turns head in direction of sound</td>
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<td></td>
<td>Enjoys peek-a-boo</td>
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<td></td>
<td>Listens when spoken to</td>
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<td></td>
<td>Recognizes common words like “cup”</td>
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<tr>
<td>12 to 24 months</td>
<td>Can point to body part</td>
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<td></td>
<td>Follows simple commands</td>
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<tr>
<td></td>
<td>Understands simple questions</td>
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<tr>
<td></td>
<td>Listens to simple stories and songs</td>
</tr>
<tr>
<td>AGE</td>
<td>Hearing Milestones</td>
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<tr>
<td>--------------</td>
<td>--------------------------------------------------------</td>
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<tr>
<td>2 to 2 ½ years</td>
<td>Answers questions from a story</td>
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<td></td>
<td>Starts to understand meaning (go vs stop)</td>
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<td></td>
<td>Follows 2 step requests</td>
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<tr>
<td>2 ½ to 3 years</td>
<td>Can describe an event or vacation</td>
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<tr>
<td></td>
<td>Answers simple questions about familiar topic</td>
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<td>3 to 4 years</td>
<td>Can retell stories</td>
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<td></td>
<td>Can repeat sentences</td>
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<td></td>
<td>Identifies object when described</td>
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<tr>
<td></td>
<td>Hears when called from another room</td>
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<tr>
<td>4 to 5 years</td>
<td>Can recall simple facts from a story</td>
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<td></td>
<td>Understands rhyming</td>
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<tr>
<td>5 to 6 years</td>
<td>Learning letter-sound associations</td>
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</tbody>
</table>
What To Watch For – Red Flags

• Delay in speech/language development
• Having trouble understanding requests
• Pulling or complaining about ears
Red Flags

- Risk Factors
  - Family history of hearing loss
  - Newborn hearing screening, pass? Pass, at risk?
  - Prematurity and/or NICU stay
  - Pathology of body systems (Cardiac, Musculoskeletal, Neurologic, Skin, Endocrine-metabolic, Visual-eye, Kidney disorders)
  - Persistent ear infections
  - Persistent middle ear fluid without infection
Red Flags

• Otitis Media with Effusion (OME)
  – Build up of fluid without the onset of symptoms like fever and pain

• Acute Otitis Media (AOM)
  – Onset of infection and symptoms including swelling and pain
What this can mean

- Influence of effusion (fluid) over time
  - Mild to moderate hearing loss
    - Temporary
    - May take weeks or months to clear
  - Auditory deprivation
  - Delayed language development
  - Greater risk for delayed reading and educational concerns

How is hearing related to reading?

- Hearing is **IMPORTANT**?

  First Order Event

  It is the foundation for all spoken language
Building Blocks

- **Sounds (Phonemes)** – Identify what sounds *mean*
- **Vocabulary** – All of the words we *know*.
  - Learning *new* words is based on experience
- **Semantics** – *meaning*
  - D-O-G = what we know as a dog
- **Morpheme** – parts of words with meaning
  - eg. -ing endings are morphemes. Go + ing = going (2 morphemes)
- **Syntax** – structure and putting things in the right order
- All of these things build from the **bottom up!**
  - First we must hear *sounds*, we put them together to make words, we put words together to make *sentences* and we associate sentences with *information*
How is hearing related to reading?

- Spoken language builds reading skills
- Listening experience in infancy is critical for adequate language and literacy development.
- Vocabulary is one of the biggest predictors of kindergarten success
  - How many words you know and use
## Acquiring Vocabulary

<table>
<thead>
<tr>
<th>Age</th>
<th>Number of Words</th>
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<tbody>
<tr>
<td>2</td>
<td>300</td>
</tr>
<tr>
<td>2.5</td>
<td>500</td>
</tr>
<tr>
<td>3</td>
<td>900</td>
</tr>
<tr>
<td>4</td>
<td>1,500</td>
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<tr>
<td>5</td>
<td>2,500</td>
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<tr>
<td>6</td>
<td>13,000</td>
</tr>
<tr>
<td>7</td>
<td>20,000</td>
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</tbody>
</table>
Reading

• Understanding of sounds building words
• Poor hearing during infant and toddler years affect understanding of words and sounds
  – Two issues
    • 1 – less benefit from treatment (i.e. speech/language therapies)
    • 2 – missed opportunities to hear spoken language, conversation, overhearing...

How to grow Auditory Brain Centers

- *Read, read, read* aloud every day.
- Name *objects* in the environment as you encounter them in daily routines.
- Talk about and *describe* how things sound, look, feel.
- *Compare* how objects or actions are similar and different in size, shape, smell, color, or texture.
How to grow Auditory Brain Centers

• Talk about *where* objects are located
  – Prepositions: such as in, on, under, behind, beside, next to, between.
  – Prepositions are the bridge between concrete and abstract thinking

• Describe *sequences*: Talk about the steps involved in activities as you are doing the activity. Sequencing is necessary for organization.
Ideas for increasing auditory/language experiences

- Talk with your child all the time about what they are thinking and doing (conversations)
- Create experiences and talk about them
- Draw pictures and tell stories with them
- Use complex language, explain, and link it to the experiences
- Read aloud with your child using challenging books
Tips for Reading Aloud

• Read aloud to your child. It’s never too early to begin and never too late to start
• Read more challenging material as your child learns to read along
• Establish a regular time to read
Tips for Reading Aloud

• Show enthusiasm about what you are reading
• Choose a story, poem, news story to grab the child’s interest
• Cut the session short if interest lags
• Link the story to life and other books
• Ask the child to predict the outcome through the reading of the story
Tips for Reading Aloud

• Start with picture books, build to storybooks and novels
• Vary the length and subject matter of your readings
• Go on a “book walk” prior to starting the book
  – Point out the title, author, illustrator
  – Discuss illustration on cover
  – Predict what the story will be about based on the title and illustration on cover
Takeaway

• Having access to sounds is critical for brain development.

• Listening, speech/language development and reading skills depend on auditory exposure and experience!

• If hearing loss is detected and treated early in life, it is often possible for children to progress with other kids their age.

Source: Kiese-Himmel, 2008
References


Thank You

Jean.Hamilton@cchmc.org

Stephen.Hill@cchmc.org