EVALUATING THE EAR

Dr. Lily V. Hughes, Audiologist
Fairbanks Hearing & Balance Center at the ENT Clinic
THE PROFESSIONAL
OTOLARYNGOLOGIST—
EAR, NOSE, THROAT

A physician specially trained to provide medical and surgical treatment to the ears, nose, throat, and related structures of the head and neck.
Audioologist

Doctoral-level medical professional trained in diagnosing, evaluating and treating hearing and balance disorders for both adults and children.
HEARING AID DEALER

- Hearing Instrument Specialist, Hearing Care Practitioner, Hearing Aid Dispenser
- Licensed professional who screens hearing for the sole purpose of determining hearing aid selection.
<table>
<thead>
<tr>
<th><strong>Audiologist</strong></th>
<th><strong>Hearing Aid Dealer</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Doctoral degree (8 total years) required (AuD)</td>
<td>• 18-years of age, GED or greater education required</td>
</tr>
<tr>
<td>• State licensure required</td>
<td>• Business license required</td>
</tr>
<tr>
<td>• Board certification and/or clinical competence certificate required</td>
<td>• Manufacturer certifications and trainings optional</td>
</tr>
<tr>
<td>• Medically trained in the diagnosis and management of hearing and balance disorders, including the fitting of hearing aids and referral to physicians for surgical intervention</td>
<td>• Self-trained and/or manufacturer-trained in the selection, sales, and marketing of hearing aids</td>
</tr>
<tr>
<td>• May evaluate and treat all ages</td>
<td>• May test hearing in adults for the sole purpose of hearing aid candidacy only. No diagnosis allowed.</td>
</tr>
<tr>
<td></td>
<td>• Only allowed to treat adults</td>
</tr>
</tbody>
</table>
“SHOP” FOR THE PROVIDER

- Don’t get caught up in advertised pricing or sales gimmick...
- Why are you getting a “Free Test?”
- Did you get a diagnosis?
- Are there other treatment options (i.e. surgical)?
- Have you been evaluated by a physician?
- What are the qualifications of the hearing healthcare professional?
- Do you feel comfortable and confident having a relationship with this professional for the rest of your life?
TYPE, DEGREE, & CONFIGURATION
THE COMPREHENSIVE ASSESSMENT

- Physical Ear Examination
- Tympanometry & Acoustic Reflexes
- Audiogram
  - Speech and pure tones
- Additional Tests
  - Otoacoustic emissions – outer hair cell function
  - Auditory brainstem response – brainstem and cortex
  - Imaging (i.e. CT, MRI, MRA)
PHYSICAL EAR EXAMINATION (OUTER EAR)
Middle Ear Function:

- **Tympanometry**: Transfer of acoustic sound waves, via mechanical vibration, to the fluid waves of the inner ear;
- Eustachian tube’s ability to equalize air pressure on each side of the ear drum;
- **Acoustic Reflex**: Protection of the inner ear in response to loud sounds.
THE AUDIOGRAM – SPEECH TESTING

Speech Reception Threshold (in quiet)
- The patient is oriented to standardized 2-syllable words at an audible level. The same words are then reduced in loudness until they cannot be repeated by the patient.
- Assesses threshold of speech awareness (crosscheck with pure-tone average) and may be a predictor of primary auditory and secondary auditory awareness.
- Scored as a threshold

Speech Discrimination (in quiet)
- Random phonetically-balanced words are delivered at a calculated decibel level based on SRT.
- May be a predictor of working memory (accessing Broca’s area) and temporal lobe, secondary auditory center recall.
- Scored as a percent.
**THE AUDIOGRAM – PURE TONE TESTING**

**PITCH:** Frequencies from 250 Hz to 8000 Hz

**Frequency-Specific Thresholds**
- Air (acoustic) & Bone (vibratory) Conduction
  - Outer vs. middle vs. inner ear disorder
- Predicts threshold of sound awareness across the speech spectrum for acoustic and vibratory stimuli

**LOUDNESS:**
- Decibels (dB) from soft (0 dB) to very loud (120 dB)
TYPE OF HEARING LOSS
DEGREE OF HEARING LOSS
CONFIGURATION = SHAPE

SLOPING

FLAT

RISING
**EXAMPLE**

**TYPE:** Sensorineural Hearing Loss

**DEGREE/SHAPE:** Mild sloping to Moderately-Severe

**ADDITIONAL NOTES:**
- High-frequency
- SRT = PTA
- Excellent word recognition
**EXAMPLE**

**TYPE:** Mixed Hearing Loss (SNHL with an additional conductive component)

**DEGREE/SHAPE:** Mild sloping to Severe

**ADDITIONAL NOTES:**
- Known hearing loss with bilateral “plugged” ears after flying...
- SRT = PTA
- Good word recognition
EXAMPLE

**TYPE:** Conductive Hearing Loss

**DEGREE/SHAPE:** Moderate Flat

**ADDITIONAL NOTES:**
- Left middle ear fluid visualized
- Abnormal tympanometry
TYPE: Normal Sensitivity

DEGREE/SHAPE: N/A

ADDITIONAL NOTES:
- Left middle ear fluid resolved
- Normal tympanometry
Otoacoustic emissions (OAE)

- A low-level sound emitted by the cochlea either spontaneously or evoked by an auditory stimulus.
- Provides information related to the function of the outer hair cells.
OAE Clinical Uses
- Assessing/Confirmation of inner ear function patients who cannot behaviorally report:
  - Newborn hearing screening;
  - D.T.T. (young children) and individuals with developmental disabilities;
  - Patients in comatose state
- Differentiate between sensory and neural components of hearing loss (i.e. auditory neuropathy);
- Estimates underlying damage in otherwise normal sensitivity (i.e. tinnitus)
ADDITIONAL TESTING - OBJECTIVE

Auditory Brainstem Response (ABR)
- Neurological test of auditory brainstem and basic cortex function in response to auditory stimuli
ABR Clinical Uses

- Assessing/Confirmation of inner ear function patients who cannot behaviorally report:
  - Newborn hearing screening;
  - D.T.T. (young children) and individuals with developmental disabilities;
  - Patients in comatose state
- Differentiate between sensory and neural components of hearing loss (i.e. auditory neuropathy);
  - Threshold ABR: Type, degree, configuration
  - Neurodiagnostic ABR: tumor identification
ABR

Amplitude in μV

Latency in msec

0.25 uV

Normal
- all latencies WNL
- good morphology

Conductive hearing loss
- wave I latency markedly delayed
- interwave latencies WNL
- good morphology

Sensory hearing loss
- wave I latency slightly delayed
- wave I small or absent
- interwave latencies WNL
- poor morphology

Neural hearing loss
- wave I normal
- wave I - III latency delayed
- interwave latencies delayed
- poor morphology
**ADDITIONAL TESTING**

**Imaging**
- Magnetic Resonance Imaging (MRI)
- Computerized Tomography (CT)
- Magnetic Resonance Angiography (MRA)
CT
Uses radiation
Donut shape
Typically lasts 5 min
Good for seeing organs & bony detail

MRI
No radiation
Tanning bed shape
Can last 30 min or more
Good for seeing soft tissue
MRA

- Non-invasive diagnostic scan that uses a combination of magnetic resonance technology (MRI) and intravenous (IV) contrast dye to visualize blood vessels.

- **When (for MRI and CT too)?**
  - Tumor symptoms
  - Tinnitus
  - Asymmetric hearing loss
  - Dizziness
DISORDERS OF THE AUDITORY SYSTEM
HEARING DISORDERS

Congenital
- Genetics
- Malformations
- In-Utero Infections

Acquired
- Malformations
- Obstructions
- Infections
- Injury / Trauma
- Growths / Tumors
- Noise-exposure
- Ototoxicity
- Age-related
DISORDER: MALFORMATIONS / SKIN CONDITIONS
DISORDER: OBSTRUCTIONS
DISORDER: INFECTIONS
DISORDER: TRAUMA / INJURY

Fracture temporal bone

Transverse

Longitudinal
DISORDER: GROWTH / TUMOR
DISORDER: NOISE EXPOSURE
DISORDER: NOISE EXPOSURE

17-year old girl
- Low noise exposure
- Normal cochlea
- Receptors intact

76-year old man
- Low noise exposure
- Fewer receptors but still intact

59-year old man
- High noise exposure
- Damaged cochlea
- Receptors destroyed
DISORDER: NOISE EXPOSURE

Intact cochlea

Damaged cochlea
## LEVELS OF NOISE

### In decibels (dB)

#### PAINFUL & DANGEROUS
Use hearing protection or avoid

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>Fireworks</td>
</tr>
<tr>
<td></td>
<td>Gun shots</td>
</tr>
<tr>
<td></td>
<td>Custom car stereos (at full volume)</td>
</tr>
<tr>
<td>130</td>
<td>Jackhammers</td>
</tr>
<tr>
<td></td>
<td>Ambulances</td>
</tr>
</tbody>
</table>

#### UNCOMFORTABLE
Dangerous over 30 seconds

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>Jet planes (during take off)</td>
</tr>
</tbody>
</table>

#### VERY LOUD
Dangerous over 30 minutes

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>Concerts (any genre of music)</td>
</tr>
<tr>
<td></td>
<td>Car horns</td>
</tr>
<tr>
<td></td>
<td>Sporting events</td>
</tr>
<tr>
<td>100</td>
<td>Snowmobiles</td>
</tr>
<tr>
<td></td>
<td>MP3 players (at full volume)</td>
</tr>
<tr>
<td>90</td>
<td>Lawnmowers</td>
</tr>
<tr>
<td></td>
<td>Power tools</td>
</tr>
<tr>
<td></td>
<td>Blenders</td>
</tr>
<tr>
<td></td>
<td>Hair dryers</td>
</tr>
</tbody>
</table>

#### LOUD

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>Alarm clocks</td>
</tr>
<tr>
<td>70</td>
<td>Traffic</td>
</tr>
<tr>
<td></td>
<td>Vacuum</td>
</tr>
</tbody>
</table>

#### MODERATE

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>Normal conversation</td>
</tr>
<tr>
<td></td>
<td>Dishwashers</td>
</tr>
<tr>
<td>50</td>
<td>Moderate rainfall</td>
</tr>
</tbody>
</table>

#### SOFT

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Quiet library</td>
</tr>
<tr>
<td>30</td>
<td>Whisper</td>
</tr>
</tbody>
</table>

#### FAINT

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noises</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Leaves rustling</td>
</tr>
</tbody>
</table>

Over 85 dB for extended periods can cause permanent hearing loss.
### DISORDER: OTOTOXICITY

#### List of Known Ototoxic Substances

<table>
<thead>
<tr>
<th>Group</th>
<th>Example Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotics</td>
<td></td>
</tr>
<tr>
<td>Aminoglycoside antibiotics</td>
<td></td>
</tr>
<tr>
<td>Antibiotics</td>
<td></td>
</tr>
<tr>
<td>Macrolide antibiotics</td>
<td></td>
</tr>
<tr>
<td>Erythromycin</td>
<td></td>
</tr>
<tr>
<td>Clindamycin</td>
<td></td>
</tr>
<tr>
<td>Azithromycin</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Drugs</td>
<td></td>
</tr>
<tr>
<td>Salicylates</td>
<td></td>
</tr>
<tr>
<td>Acetylsalicylic acid (aspirin)</td>
<td></td>
</tr>
<tr>
<td>Nicotine</td>
<td></td>
</tr>
<tr>
<td>Quinine</td>
<td></td>
</tr>
<tr>
<td>Loop diuretics</td>
<td></td>
</tr>
<tr>
<td>Furosemide</td>
<td></td>
</tr>
<tr>
<td>Ethacrynic acid</td>
<td></td>
</tr>
<tr>
<td>Bumetanide</td>
<td></td>
</tr>
<tr>
<td>Platinum-based antineoplastic agents</td>
<td></td>
</tr>
<tr>
<td>Carboplatin</td>
<td></td>
</tr>
<tr>
<td>Cisplatin</td>
<td></td>
</tr>
<tr>
<td>Environmental Chemicals</td>
<td></td>
</tr>
<tr>
<td>Butyl nitrite</td>
<td></td>
</tr>
<tr>
<td>Nicotine</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td></td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td></td>
</tr>
<tr>
<td>Styrene</td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td></td>
</tr>
<tr>
<td>Tin</td>
<td></td>
</tr>
<tr>
<td>Hexane</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td></td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td></td>
</tr>
<tr>
<td>Xylene</td>
<td></td>
</tr>
</tbody>
</table>
DISORDER: PRESBYCUSIS / AGE
A NOTE ABOUT TINNITUS

- Affects 1 in 5 people;
  - Can sound like hissing, roaring, pulsing, whooshing, chirping, whistling, or clicking;
- About 10%–15% of adults have prolonged tinnitus requiring medical evaluation.
- 93% of tinnitus is caused by hearing loss of some degree!
A NOTE ABOUT WAX

It’s GOOD!

NO, it’s “NOT JUST WAX”

Yes, it can cause a decrease in hearing, but that is why...

- A hearing healthcare professional will and should ALWAYS rule out wax impaction
- NO Q-TIPS ALLOWED!
WHY CAN HEAR, I JUST CAN’T UNDERSTAND...
HEARING VS. PROCESSING

Hearing isn’t just about volume, it’s:

• Localization
• Spatial Orientation/Balance
• Timing cues
• Language development
• Short term → Long term memory exchange
REMEMBER...

Intact cochlea  Damaged cochlea

Hearing Loss  Normal Hearing
In speech, vowel sounds (A, E, I, O and U) are low in pitch while consonant sounds like S, F, Th, Sh, V, K, P and others are high in pitch.

Being able to hear vowel sounds is helpful and will alert you that speech is present, but it’s the consonant sounds that give speech meaning and help you distinguish one word from another.

Without being able to hear subtle differences between consonants, words like “cat” and “hat,” “parrot” and “ferret” and “show” and “throw” can be hard to differentiate.

This is why so many people with high frequency hearing losses brought about by natural aging (presbycusis) or excessive noise exposure have difficulty understanding even when they know sound is present.
When you have a high frequency hearing loss, you may have trouble:
- Following conversations in quiet and noisy places (hear but can’t understand).
- Talking on the phone.
- Understanding your favorite TV shows or movies even when you turn the volume up.
- Understanding female and young children’s voices because they tend to be higher in pitch.
- Enjoying music because it sounds distorted, especially at higher volumes.
- 74 y/o male
- 40+ year history of noise exposure
  (music teacher)
Healthy hair cells stand erect, and are able to accurately detect sound waves and send sound impulses to the brain.

Damaged hair cells are limp, blown out and will no longer stand erect. They are therefore unable to detect sound waves or send sound impulses to the brain.
TAKE HOME: “SHOP” FOR THE PROVIDER

- Don’t get caught up in advertised pricing or sales gimmick...
- Why are you getting a “Free Test?”
- Did you get a diagnosis?
- Are there other treatment options (i.e. surgical)?
- Have you been evaluated by a physician?
- What are the qualifications of the hearing healthcare professional?
- Do you feel comfortable and confident having a relationship with this professional for the rest of your life?
NEXT WEEK 2/25

- **3:45 to 4:15**: Hearing Screenings
- **4:15 to 5**: Q&A Panel on all things hearing loss
  - Myself
  - Dr. Brittany Mathisen, Audiologist
  - Dr. Thomas Hammond, MD (Ear, Nose, Throat)
  - Deanna, Audiology Assistant

- Monday 3/1: Hearing loss treatment, consumer protection, and product demos!
THANK YOU!

Lily Hughes, AuD
Board Certified Audiologist

Fairbanks Hearing & Balance Center
Medical Dental Arts
1919 Lathrop St. Suite 104
907-456-7768