# PART1: THE EAR

Dr. Lily V. Hughes, Audiologist
Fairbanks Hearing & Balance Center at the ENT Clinic

## WHY AM I HERE?

1 out of every 5 adults has hearing loss. That's more than 48 million people in the US alone!

## WHY AM I HERE?

Clinically significant hearing loss nearly doubles with each age decade such that 2/3 of adults over [illegible] have meaningful hearing loss!

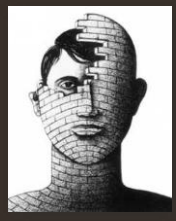

60 years of age

## HEARING LOSS: A SILENT EPIDEMIC

- 7 years = average time to diagnose and treat
- Unmet medical need = only 20% identified and treated
- The Invisible Handicap
  - MDs and health organizations are not informed about the links between hearing loss and chronic/infectious disease

## HEARING LOSS: A SILENT EPIDEMIC

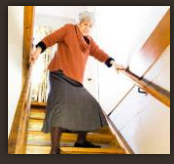
- **Anosognosia:** a deficit of self-awareness, a condition in which a person with some disability seems unaware of its existence.
  - Patient "denies" illness…
  - Lack of self-awareness..
  - Not denial, but true neurological processing deficit?

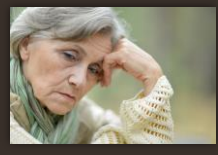


## SIMPLY PUT…

**Hearing loss is NOT just an unfortunate, inconsequential aspect of aging…**

**It affects our quality of life and sense of independence in many ways…**



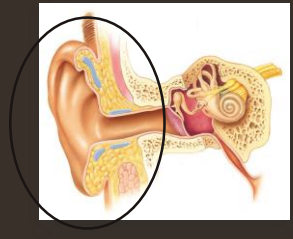


# A&P OF THE EAR

**How do we hear?**

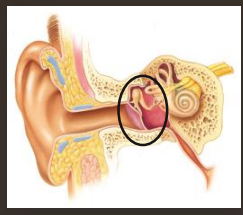
## HOW SOUNDS TRAVEL THROUGH THE EAR

1. Sound waves are picked up by the outer ear, which is made up of the pinna and the ear canal.



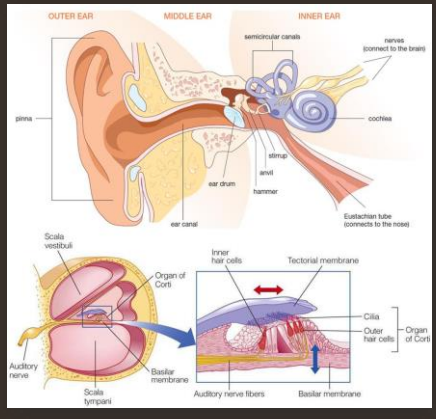
## HOW SOUNDS TRAVEL THROUGH THE EAR

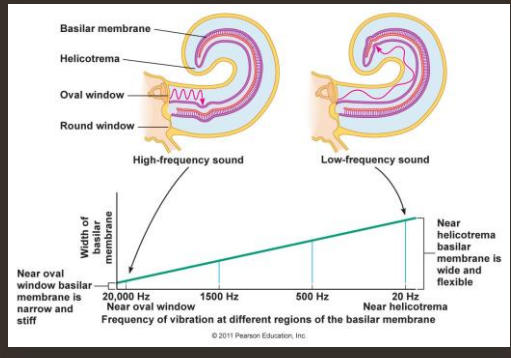
2. Sound is channeled to the eardrum, which vibrates when the sound waves touch it. The vibrations are picked up by three tiny bones known as the "hammer," "anvil" and "stirrup," which create a bridge from the ear drum to the inner ear.

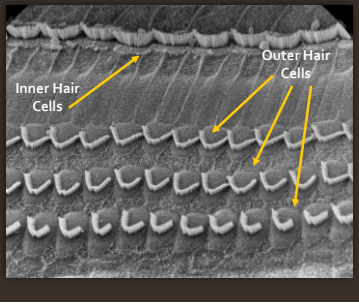


## HOW SOUNDS TRAVEL THROUGH THE EAR

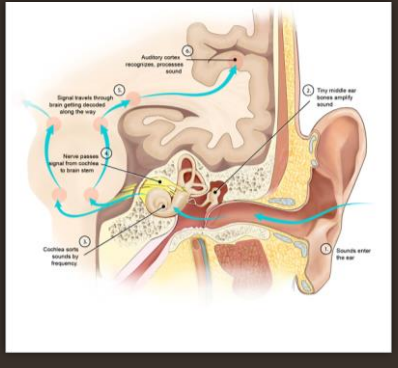
3. The vibrations move on to the cochlea – a spiral-shaped capsule housing a system of liquid-filled tubes.
4. When the sound waves reach the liquid it begins to move, setting thousands of tiny hair cells in motion.
5. The movements of the hair cells are transformed into electric impulses that travel along the auditory nerve to the brain itself.



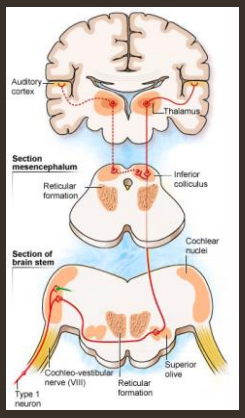



# THE EAR IS *JUST* THE BEGINNING…

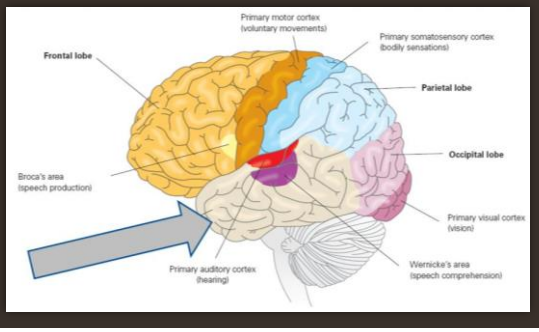


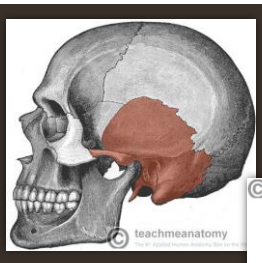

## AUDITORY BRAINSTEM

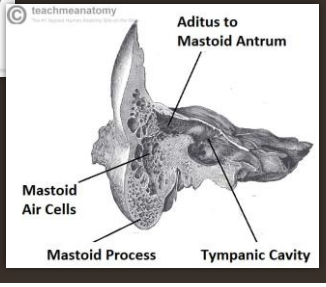
- **Cochlear Nuclei**: Important decoding of the basic signal, including duration, intensity and frequency.
- **Superior Olivary Complex**: Where a majority of the auditory fibers synapse there having already crossed the midline.
- **Inferior Colliculus:** These two relays play an essential role in the localization of sound.
- **Medial geniculate body (thalamus ):** Important integration occurs here for preparation of a motor response (i.e. vocal response).
- **Thalamus → Auditory Cortex**: Where the message is recognized, memorized and integrated into a voluntary response.




## CENTRAL AUDITORY SYSTEM

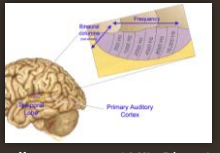



## TEMPORAL LOBE

- **Primary auditory cortex (AI):** involved in decoding the cochleotopic and tonotopic spatial representation of a stimulus.

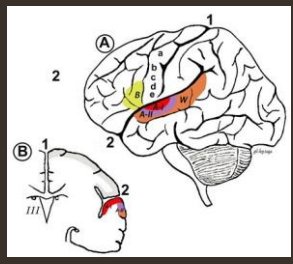



- **Secondary auditory cortex (AII):** Plays important role in sound localization and analysis of complex sounds: in particular for specific animal vocalizations and human language. It also has a role in auditory memory.

## CENTRAL AUDITORY SYSTEM

A. Lateral view showing **AI and AII and Wernicke's area (W)**. Auditory cortex projects to the regions of the frontal lobe involved in motor function for speech (a), the lips (b), jaw (c), tongue (d), larynx (e) and Broca's area (B).

B. Frontal view showing AI inside the Sylvian fissure (2) and Heschl's gyrus.

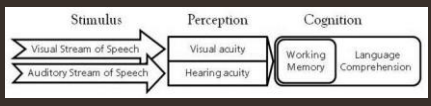


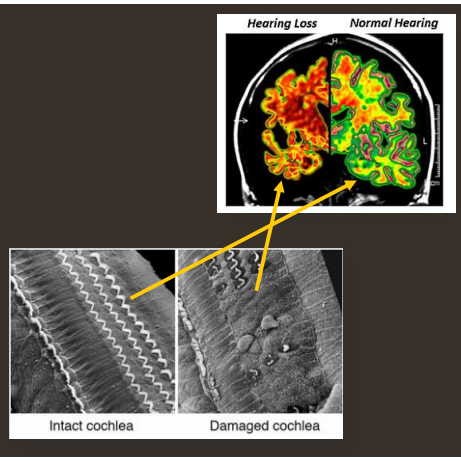

## HEARING VS. PROCESSING

- "Hearing" isn't just about volume, it's:
  - Localization
  - Spatial Orientation/Balance
  - Timing cues
  - Language development
  - **Short term → Long term memory exchange**

## EXCESSIVE COGNITIVE LOAD

- The brain has to recruit and use additonal brain resources to compensate for the impoverished auditory encoding by the impaired central auditory system
- The process can place "load" on the brain and rob resources that would otherwise have been dedicated to thinking, memory, and other processes…

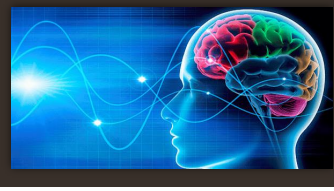


# WHEN THE BRAIN CHANGES
## (AND NOT ALWAYS FOR THE BETTER)

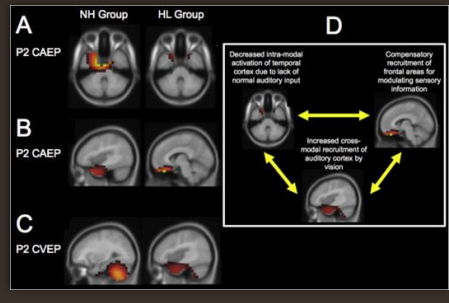
## NEUROPLASTICITY

- The brain's ability to change…
  - To reorganize itself by forming new neural connections throughout life
    - Response to changes in environment
    - Compensation for injury and disease



## CROSS-MODAL NEUROPLASTICITY

- Even in cases of mild hearing loss, when auditory cortical areas of the brain do not receive normal input (input is either decreased and/or degraded), areas of the brain which normally process sound may be "repurposed" by other intact modalities.
- Visual and vibrotactile modalities sometimes facilitate a re-assignment of "unused auditory anatomy" for their own purposes.



## MCGURK EFFECT

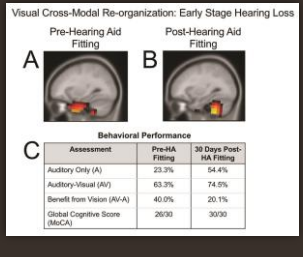
- The McGurk Effect occurs when there is a conflict between visual speech (the movements of someone's mouth and lips) and auditory speech (the sounds a person hears).
- And it can result in the perception of an entirely different message.

## MCGURK EFFECT & HEARING LOSS

- The McGurk Effect is something that we deal with every day…
- It's also has more to do with your brain's central processing than what you're hearing…
- The McGurk Effect shows us that reading lips is effective for those with hearing loss because visual cues are very important!

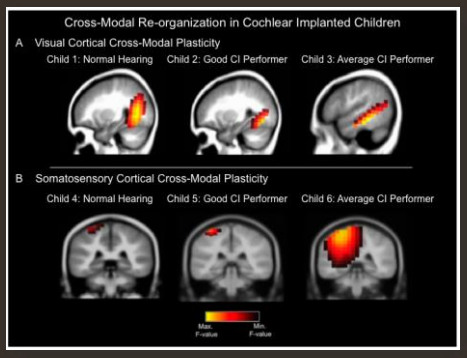
## CROSS-MODAL NEUROPLASTICITY

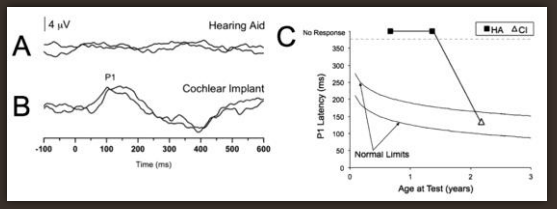
- Interestingly, these changes may occur *as soon as 3 months* after the onset of hearing loss and may be reversible by well-fitted hearing aids.




## NEUROPLASTICITY & HEARING LOSS

- As a profession, we're just beginning to unearth the widespread central effects of hearing loss on
  - Cognitive function,
  - Listening effort,
  - And social-emotional changes.
- We are learning to understand cortical brain changes associated with hearing loss, including developing objective brain-based tools (i.e. auditory brainstem response) …
- These tools may help clinicians determine:
  - When a patient should receive intervention,
  - What kind of intervention or rehabilitation would be ideal,
  - And may offer the ability to monitor how well a chosen intervention or rehabilitation method is working…




## PLASTICITY IN ADULTS

- Plasticity of the brain during development is remarkable. However, in adulthood brain plasticity is still observed in:
  - Learning
  - And repair after lesion
- Two examples of post-lesion plasticity in the human adult auditory brain:
  - A cochlear implant may give spectacular results in a suddenly deafened adult, as its brain shows a remarkable plasticity to adapt to this artificial ear sending stimulations quite different from those of a normal cochlea;
  - In presbycusis (deafness in older age), when the cochlea does not transmit high frequencies any more, neurons in the auditory cortex switch to decoding lower frequencies.

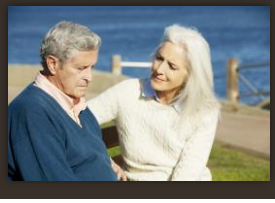
## HEARING LOSS & LONGTERM NEUROPLASTICITY

## PSYCHOSOCIAL CONSQUENCES

- Some **Social** consequences are:
  - Reduced social activity or problems participating in social activities
  - Problems communicating with your spouse, friends or relatives
  - Problems communicating at work
  - Isolation and Withdrawal
  - Lack of Concentration

## PSYCHOSOCIAL CONSQUENCES

- Some **Psychological** consequences are:
  - Embarrassment, shame , guilt and anger
  - Sadness or depression
  - Anxiety and Suspiciousness
  - Self-criticism and low self-esteem/confidence



## DEMENTIA

- **THERE IS NO PROVEN DIRECT RELATIONSHIP…**
  - Anyone who says, "if you don't treat your hearing loss, you'll get dementia" is false!
- However, evidence argues that hearing loss certainly doesn't help!
  - …"risk of developing dementia was 2, 3, and 5 times higher in those with mild, moderate, and severe hearing loss…"
  - "There is strong evidence that hearing impairment contributes to the progression of cognitive dysfunction in older adults…"

## HEARING LOSS VS. DEMENTIA

**Alzheimer's**

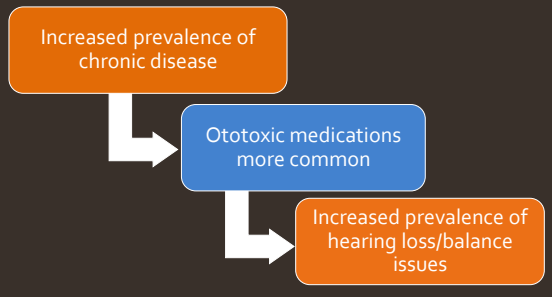
- Depression/anxiety/disorientation
- Reduced language comprehension
- Impaired short-term memory
- Inappropriate psychosocial response
- Loss of recognition (agnosia)
- Denial/defensiveness/negativity
- Distrust, suspicious of other's motives

**Untreated Hearing Loss**

- Depression/anxiety/social isolation
- Reduced speech comprehension
- Reduced cognitive input into memory
- Inappropriate psychosocial response
- Cognitive dysfunction
- Denial/defensiveness/negativity
- Distrust, feel that others are talking about them

- Source: Chartrand et al 2005

# HEARING & CHRONIC ILLNESS

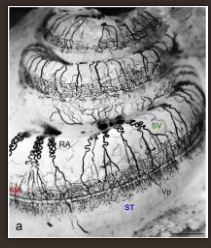



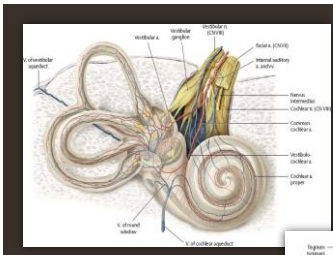

## CARDIOVASCULAR DISEASE & HEARING LOSS

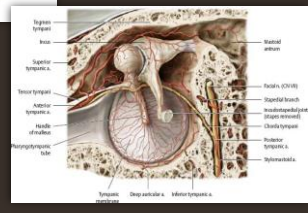
- "The ear may be the window to the heart…"
- Numerous studies confirm that there is frequently a link between cardiovascular disease and hearing loss.
  - When the arteries, veins, and heart are healthy, hearing is positively affected.
  - Inadequate blood flow is a heart issue, and it can negatively influence the peripheral and central auditory system (i.e. stria vascularis stroke, hair cell death, etc).

## CARDIOVASCULAR DISEASE & HEARING LOSS

- **Hearing Loss:** Strokes, DVT, PE, HBP…
- **Fall Risk:** Lower extremity fluid retention, neuropathy
- **Medications:** Loop diuretics, Pain Rx





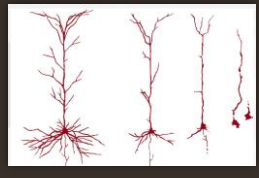
## DIABETES & EAR DISEASE

**Cochlear Microangiopathy**

- Micro vascular effects of diabetes may damage blood supply to the inner ear

**Neural Degeneration**

- 8th nerve atrophy



## DIABETES & EAR DISEASE

- **Hearing Loss:** People with diabetes are twice as likely to have hearing loss as those who don't.
- **Fall Risk:** Foot neuropathy and vision effects!
- **Medication:** Diabetic pain and infection control…

***For more information: www.theaudiologyproject.com***


## THANK YOU!

*Lily Hughes, AuD*
*Board Certified Audiologist*

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