

Relationship of Hearing Impairment to Dementia and Cognitive Dysfunction

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Hearing Loss Statistics

- 360 million people globally with “disabling” hearing loss
 - 328 million are adults
 - 32 million are children

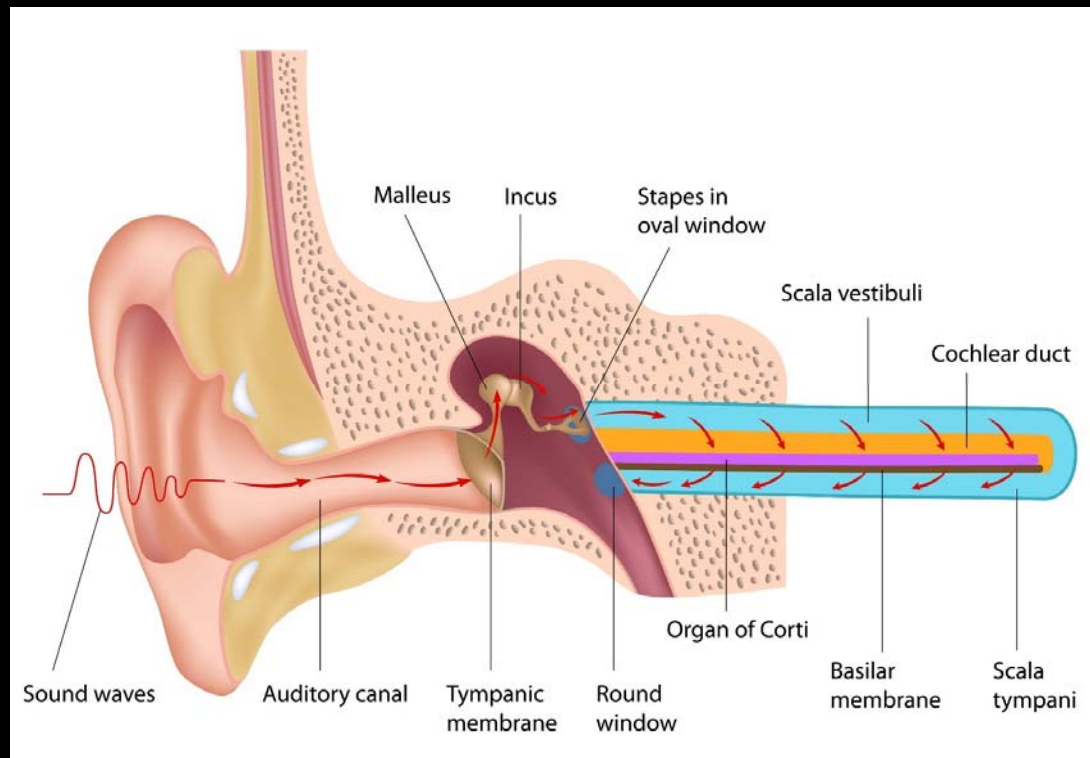
(World Health Organization 2012)

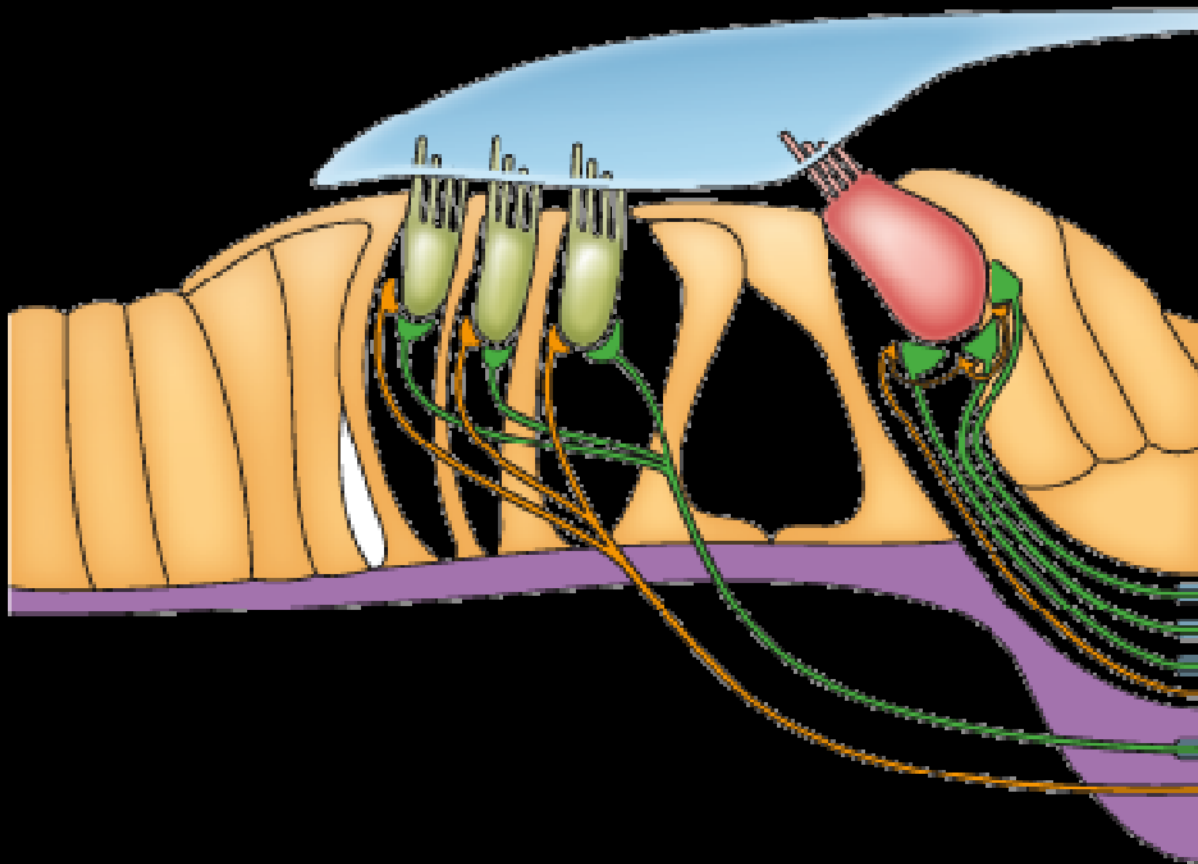
- In the United States:
 - 31.5 million people have hearing loss (10% of population)
 - 1.4 million children (18 or younger)
 - 1/3 of individuals over the age of 60
 - 65% of this population is under 65 yrs
 - Less than 20% of this population is adequately treated
 - Less than 12% of family doctors screen for hearing loss
 - On average, people wait 7-10 yrs to address hearing loss

(Better Hearing Institute)

- Hearing Loss (HL) is the 3rd most prevalent chronic condition in older Americans, after hypertension and arthritis.
- Impact of HL will increase as the population ages, but also because age-adjusted hearing loss has increased significantly since the 1960's.
- Hearing Loss is underdiagnosed in older patients (>70 yrs)
 - <12% of Internists offer hearing screening
- Hearing Loss is undertreated
 - <20% of those with a treatable hearing loss use amplification
- **STRONG** correlation of hearing loss to cognitive decline

How Do We Hear? (Anatomy Lesson)

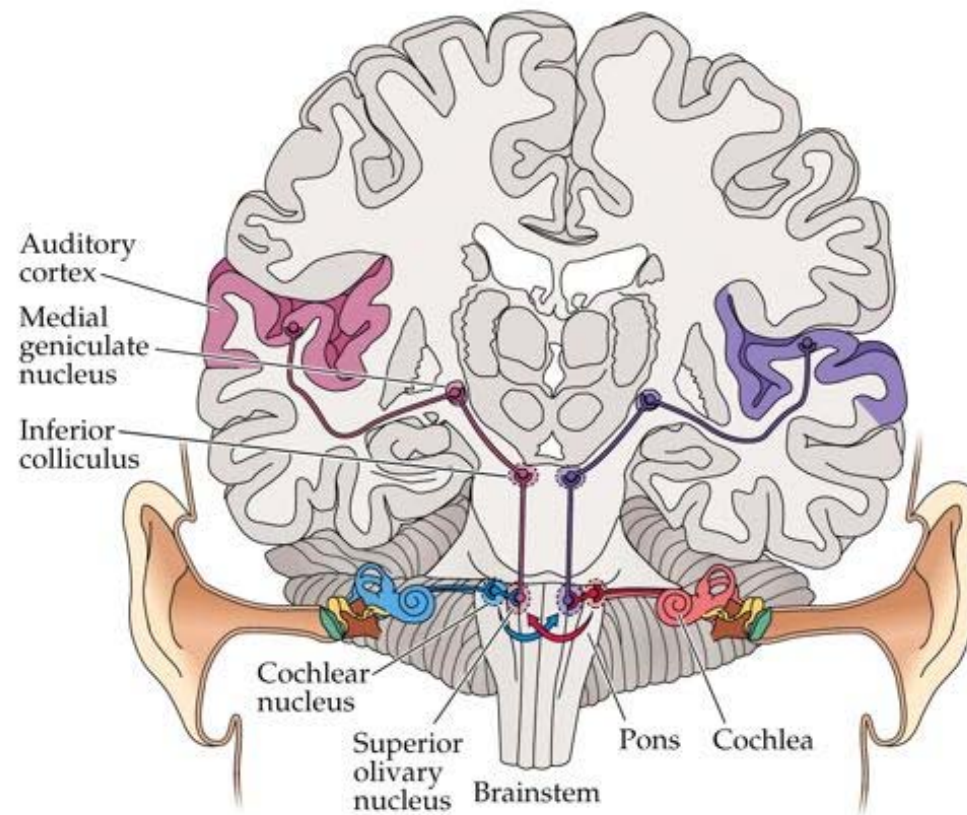




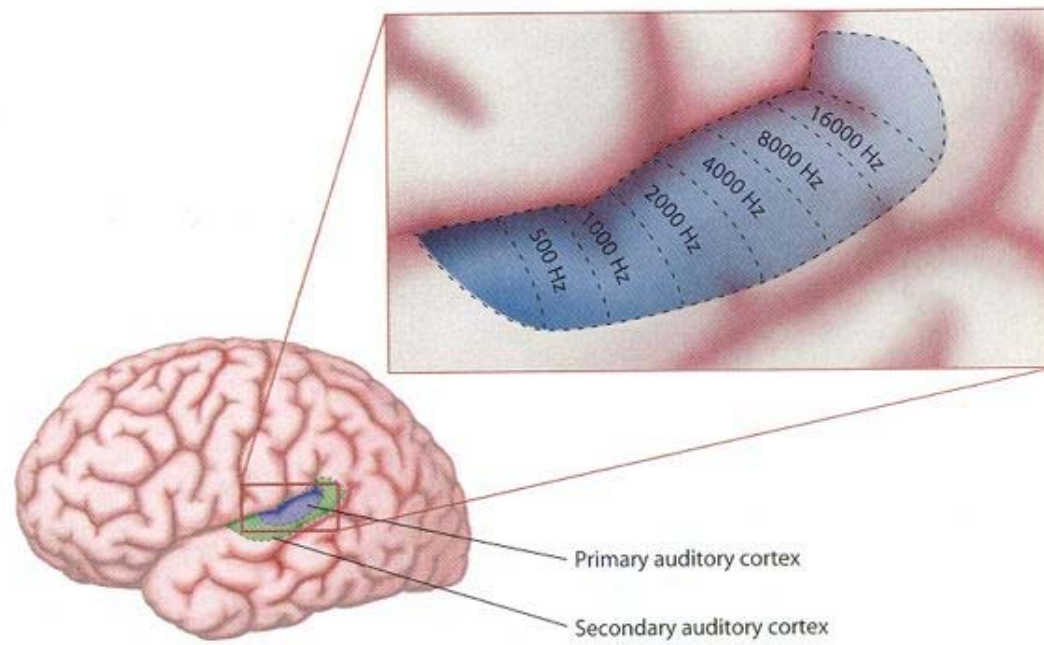


https://auditoryneuroscience.com/ear/dancing_hair_cell

Ascending auditory pathways



Cortical tonotopy

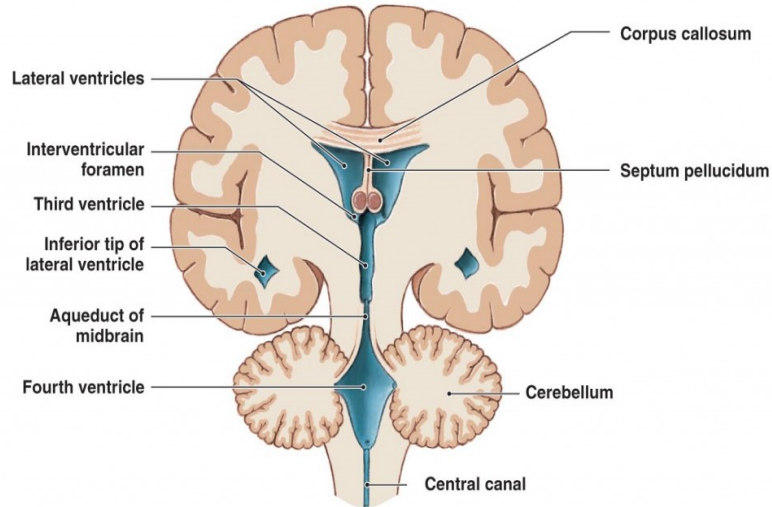


Dementia Statistics

- The prevalence of Dementia is projected to double every 20 yrs such that by 2050, more than 100 million or 1:85 will be affected worldwide. (Lin et al., *Arch Neurol.*, 2011; 68(2): 214-220)
- Current Epidemiologic strategies focus on identifying avenues to slow the progression of the disease as avenues of active prevention/treatment are currently unknown
- Candidate Factors Include:
 - Low Participation in Social/Leisure Activities
 - Sedentary State
 - Diabetes
 - Hypertension
 - Hearing Loss

Alzheimer's Disease in the Brain

Two views of the ventricles, which are filled with cerebrospinal fluid



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Alzheimer's disease

Healthy brain

Cerebral cortex:
Responsible for language and information processing

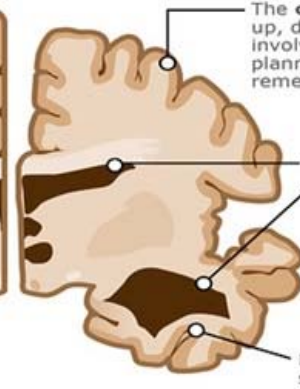
Hippocampus:
Critical to the formation of new memories

Alzheimer's disease brain

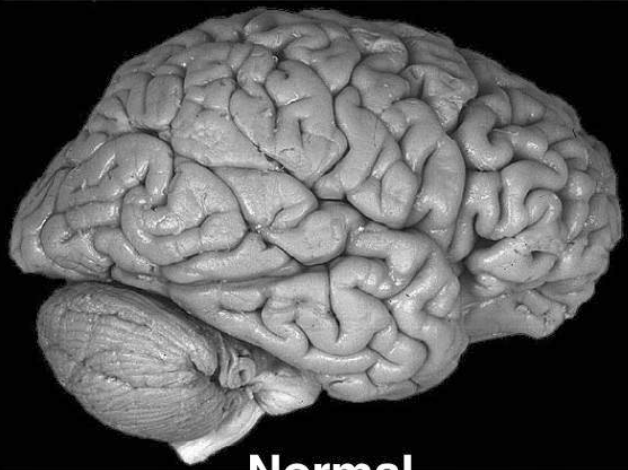
The **cortex** shrivels up, damaging areas involved in thinking, planning and remembering

Ventricles filled with cerebrospinal fluid grow larger

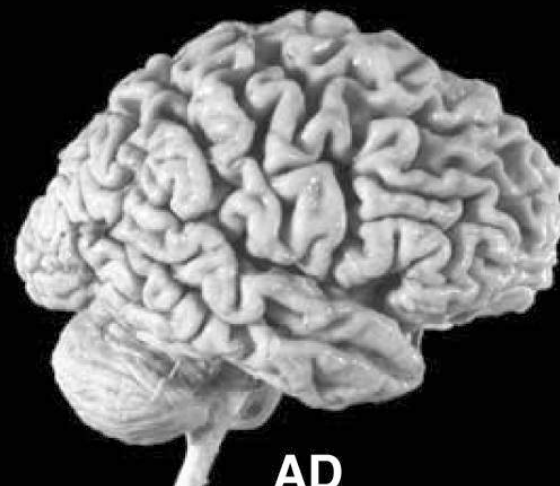
Hippocampus shrinks severely



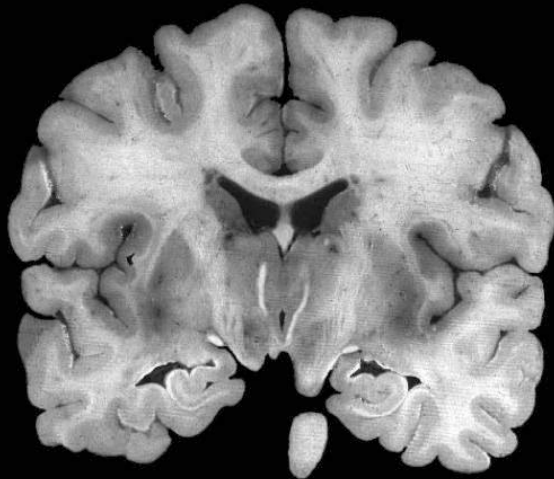
Brain Atrophy in Advanced Alzheimer's Disease

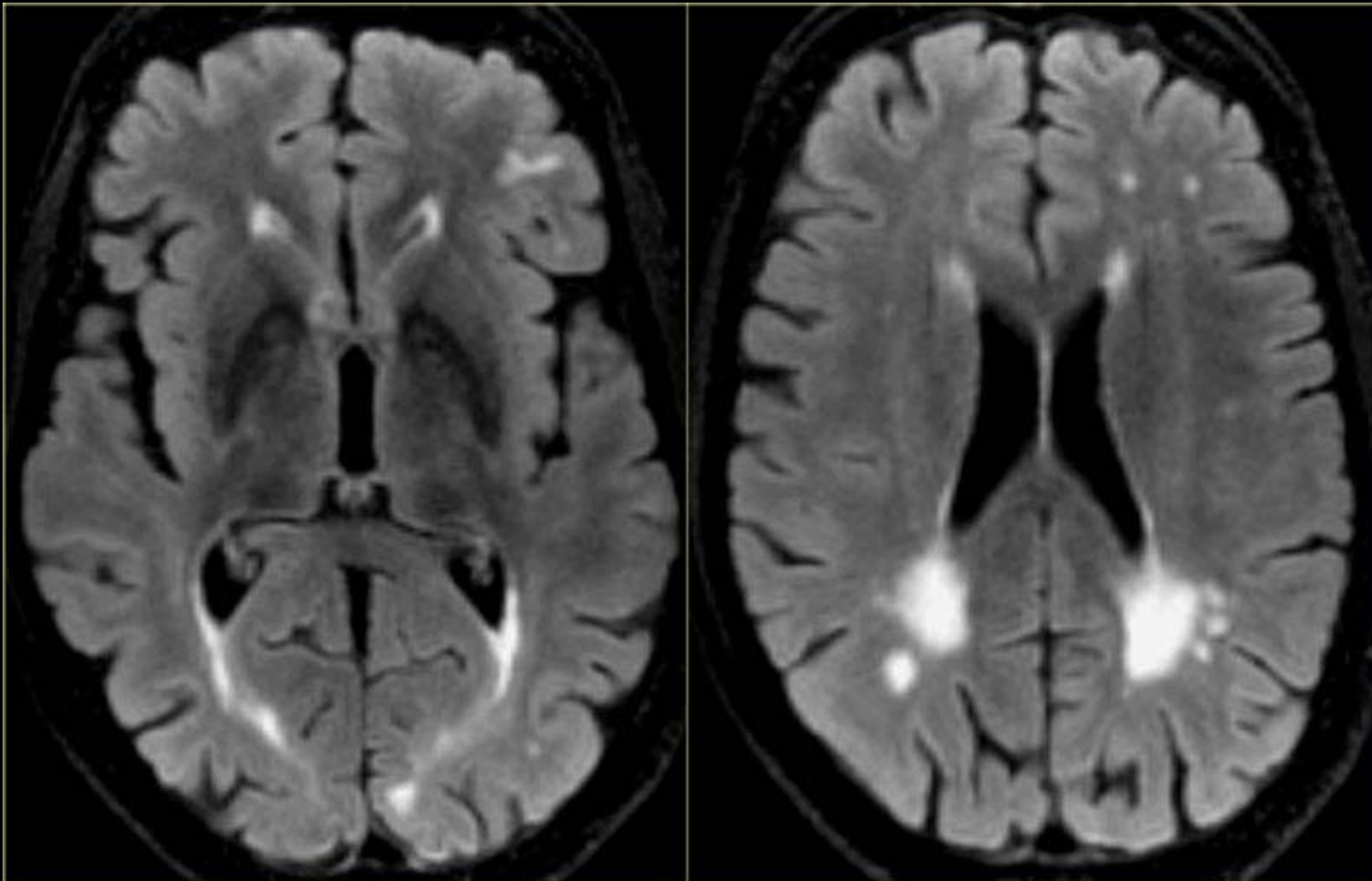


Normal

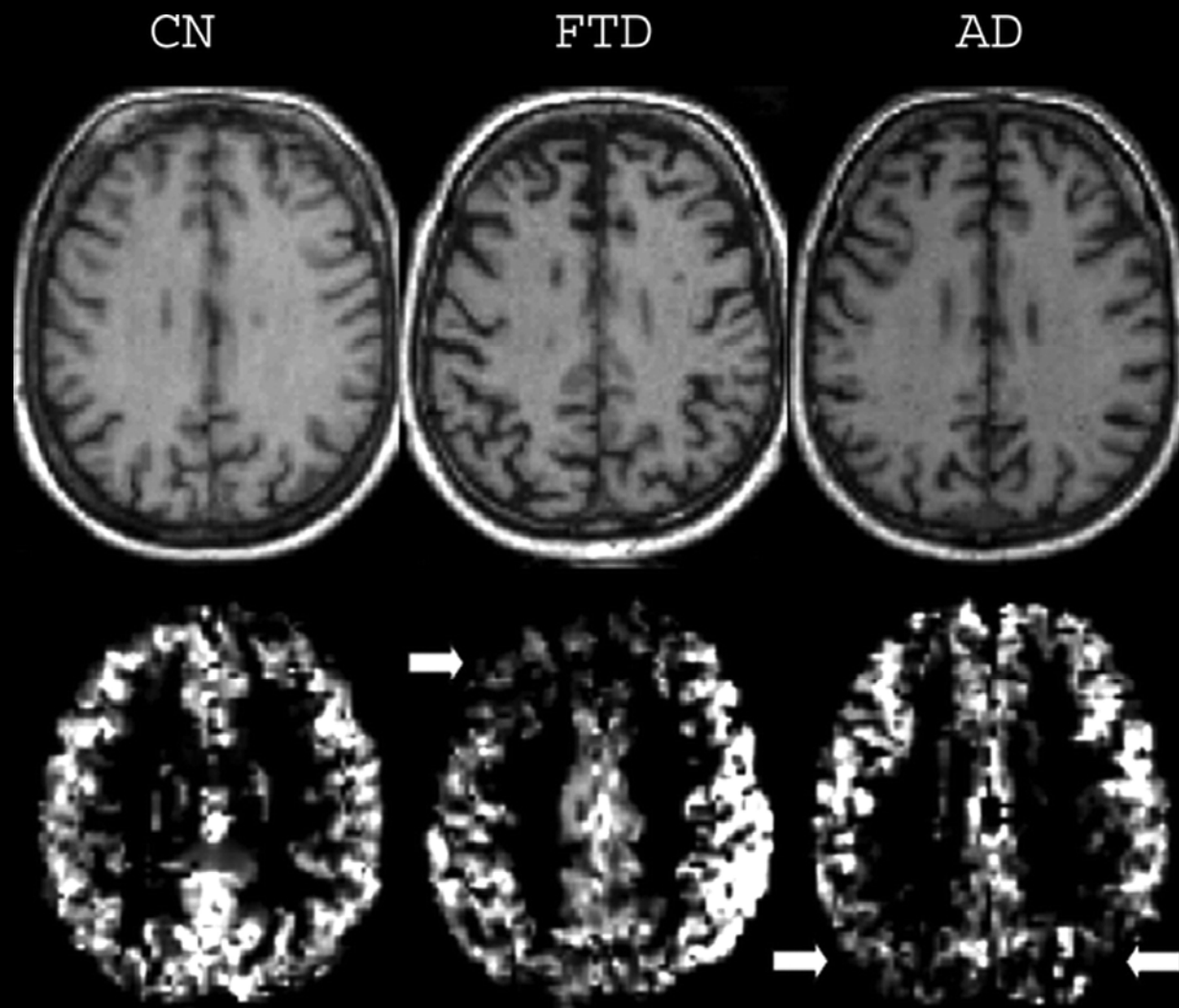


AD





Courtesy J. Burns, MD KUMC Neurology



Courtesy J. Burns, MD KUMC Neurology

Hearing Loss & Dementia

- In 1989, Uhlmann et al. found that the presence of untreated HL lead to poorer cognitive function in both normal and dementia patients.
 - Noted in hearing loss as mild as 25dB
 - **Increased risk of Advanced Dementia by 32%** (Increased with severity)
 - Described by Johns Hopkins in 2011 (Lin et al) in a longitudinal study of 639 subjects.
 - All were dementia free during initial evaluation
 - Subset of population with hearing loss
 - As hearing loss increased, severity of dementia correlated
 - **Participants >60yrs 36.4% risk of all-cause dementia associated with hearing loss**
- Arch Neurol. 2011;68(2):214-220.*
- Lin et al (2014) utilized MRI to determine brain shrinkage
 - Significant correlation with hearing loss in older adults and severity of dementia (% brain shrinkage)

“...participants whose hearing was already impaired at the start of the sub-study had accelerated rates of brain atrophy compared to those with normal hearing. Overall, the scientists report, those with impaired hearing lost more than an additional cubic centimeter of brain tissue each year compared with those with normal hearing. Those with impaired hearing also had significantly more shrinkage in particular regions, including the superior, middle and inferior temporal gyri, brain structures responsible for processing sound and speech.”

- Gurgel et al (*Otol Neurotol*, 2014 June; 35(5) 775-781) found that when controlling for gender, genetic factors, education, cardiovascular factors HL was shown to be an independent predictor of developing dementia.
 - Significant correlation between hearing loss and reduced cognitive function
 - HL may be a marker for cognitive dysfunction in adults age 65 and older
- National Council on Aging organized a study in which 2,304 individuals with HL as well as 2,090 significant others participated.
 - Those with HL who did not use amplification had increased depression, paranoid tendencies, suicide and less active in social activities and overall increased emotional turmoil
 - Use of amplification led to more confidence, better relationships, increased social interaction
 - Family members reported more benefit than those with HL
 - Most common reasons for not using amplification were:
 - Felt their hearing wasn't bad enough
 - They get along "fine" without them
- Smits et al (*Am J Epidemiol*, 1999; 150, 978-986) showed cognitive function is significantly tied to probability of surviving a 5 yr period. Speed of information processing was specific cognitive function that showed strongest correlation with mortality.

Use of Amplification

- In investigating the association of hearing aid use with cognitive function, hearing aid use is significantly associated with higher cognitive function scores
- Difference in age equivalence to cognitive reduction is 7 yrs per 25dB HL increase if left untreated.

Lin, *J Gerontol A Biol Sci Med Sci*, 2011 October; 66A(10):1131-1136

So...

- How do we explain the correlation?

The first theory was that hearing loss and progressive cognitive impairment are caused by a common neuropathologic process. However, hearing loss is generally agreed to be a peripheral process due to the reliance on cochlear transduction.

Higher order auditory processing (auditory perception) can be affected by AD neuropathology.

Current working theory is that hearing loss affects cognitive reserve (load). This means that when hearing loss is present, conditions exist where auditory perception is difficult (loss >25dB HL), and greater resources are dedicated to auditory perceptual processing to the detriment of cognitive processes such as working memory.

Questions?