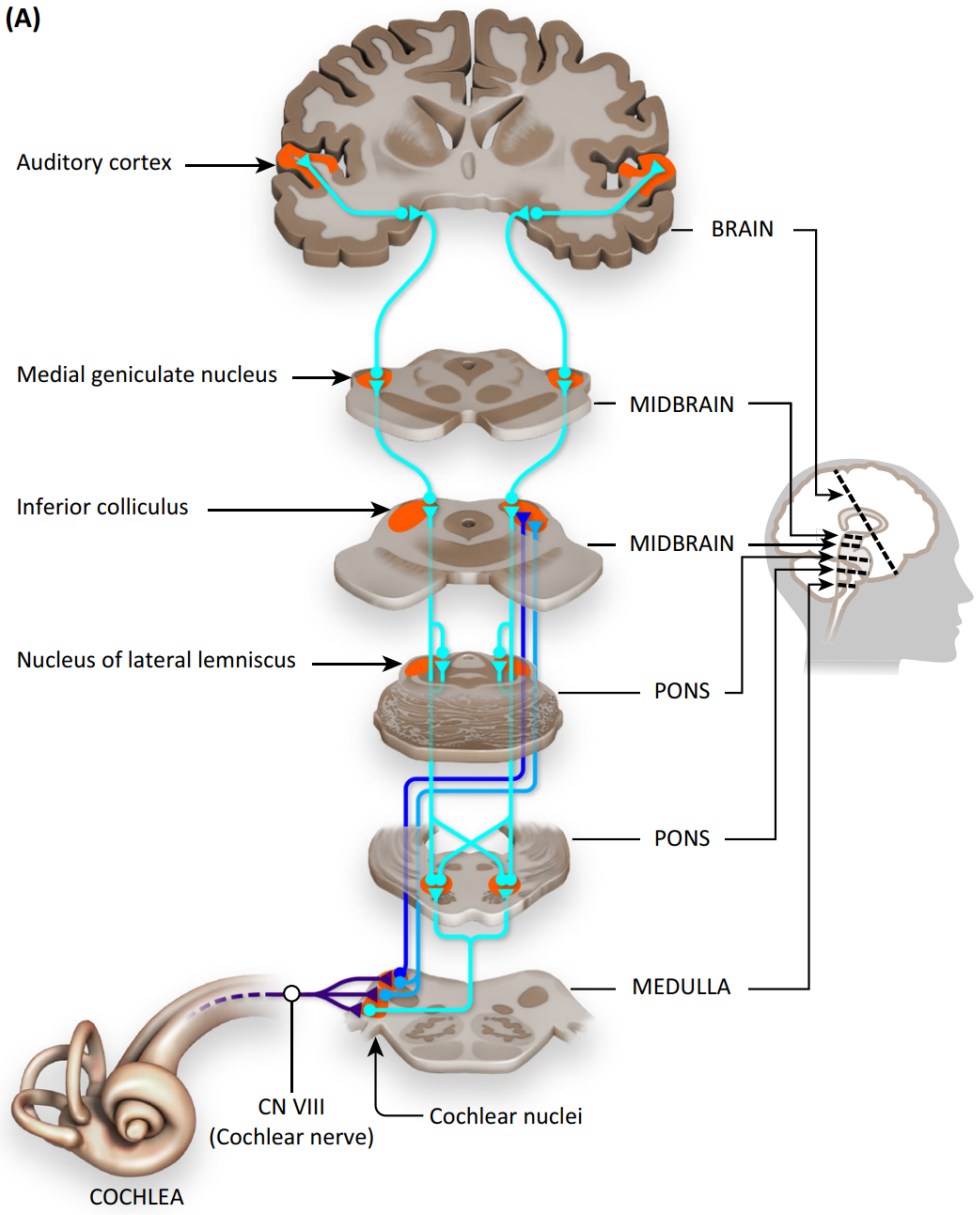
Aging

Peripheral changes →

1. a decrease in the number of outer hair cells
2. synaptic dysfunction and degeneration of cochlear nerve axons
3. cochlear afferent nerve terminals can be weakened even in the absence of hair cell loss



The figure shows the schematic of the ascending human auditory system.

Auditory brainstem changes →

1. altered temporal processing ability
2. detecting a brief temporal gap in a continuous tone
3. poorer speech perception
4. speech comprehension

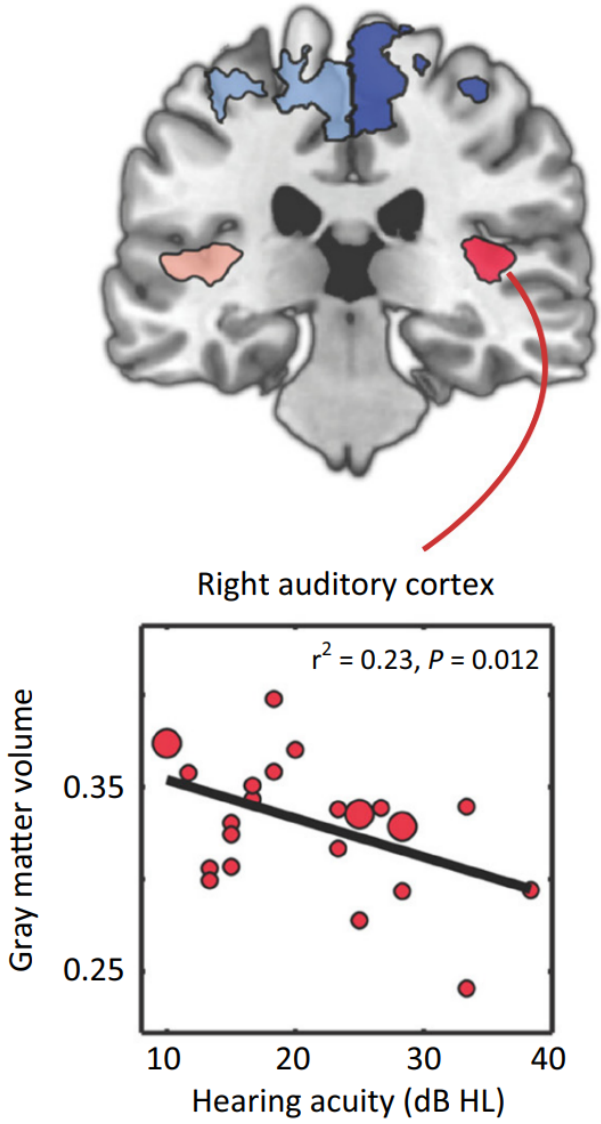
hearing aid → speech louder → does not necessarily help older adults improve their ability to understand speech

Aging affects temporal properties of auditory cortical responses resulting in delayed synchronous firing to the onset of voicing.

[Effects of age and age-related hearing loss on the neural representation of speech cues]

Auditory cortex changes →

1. Gray matter volume in the human auditory cortex is reduced in listeners with hearing loss
2. Several studies have shown a small but significant correlation between hearing acuity and the incidence of dementia



Larger circles indicate multiple participants with the same score. The higher hearing loss (HL) corresponds to lower gray matter volume.

[The Neural Consequences of Age-Related Hearing Loss]

Spatial Hearing

Background: pure tone audiometry and conventional speech recognition tests do not have the ability to detect and assess spatial hearing.

Suggestion: use spatial word in noise test and P-SHQ questionnaire

Hearing loss can deteriorate spatial hearing ability. Both objective and subjective spatial hearing tests are shown to be effective in detecting spatial hearing disorders.

ITDs: interaural time and intensity difference
-- lower frequencies
ILDs: interaural level difference

<u>Objective test:</u>
The words are presented in noise in 7 spatial locations Monosyllabic words were presented with ITD of 880, 660, 220, 0, - 220, - 660 and - 880 ls (at - 90, - 60, - 30, 0, + 30, + 60, + 90 Azimuth) in at the comfortable level of 30 dB SL. The negative and positive signs are representative of the left and right ear. For each spatial

location, 5 monosyllabic words were presented randomly in the presence of white noise, with a zero signal-to-noise ratio (SNR), and the word recognition score was calculated for each spatial location. A total of 35 monosyllabic words were presented randomly. After the presentation of each word, the person was asked to repeat the word. The total score for each spatial location was calculated in percentage.

Subjective test:

Spatial Hearing Questionnaire (SHQ)

24 questions about 8 dimensions and has a total score of 100. These eight dimensions include the female's voice, male's voice, child's voice, music, localization of the sound source, and speech recognition in the silence and in noise with and without spatial separation.

The study aimed to examine the relationship between psychophysical tests and self-assessment questionnaires in spatial hearing.

The Pearson test was used to assess the relationship between P-SHQ score and the score of the spatial word in noise test. The results showed a strong correlation between these two tests.

[The Correlation Analysis Between the Spatial Hearing Questionnaire (SHQ) and the Psychophysical Measurement of Spatial Hearing]

Procedure for Audiometry

The ear with the better sensitivity should be tested first, otherwise it depends on the fifth digit of the sample person identification number (SPID) to remove bias.

Removed eyeglasses, earrings, chewing gum, hair ornaments, hats, wigs, or anything else that might interfere with proper placement of the headphones.

Read instructions:
The beeping sounds will come in groups of three or four – beep beep beep. You only have to push the button once for each set. Also, you do not have to wait until you have heard all three.

Tools: AD226 audiometer
contains a software, that is capable of conducting the hearing test automatically

Set the frequency to 1000 Hz and the intensity level (using the left HL dB dial) to 30 dB. If the examinee does not respond, increase the intensity in 15 dB steps until a response is obtained. (Max 100 dB)

When a positive response is obtained from the examinee, drop the level in 10 dB steps and present the signal again until no response is obtained.

When there is no response, increase the intensity in 5 dB steps and present the signal each time until the tone can again be heard by the examinee. Count this response toward threshold.

Count responses made following an increase in stimulus intensity toward threshold (these
are called "ascending presentations"); do not count responses made following a decrease in stimulus intensity toward threshold (these are called "descending presentations").

Threshold is defined as the lowest intensity at which the tone has been heard by the examinee at least 50 percent of the time following a minimum of three ascending presentations at that level (e.g., at least 2 out of 3, 2 out of 4, 3 out of 5, etc.).

Summary
UP 5, DOWN 10, Count only Up

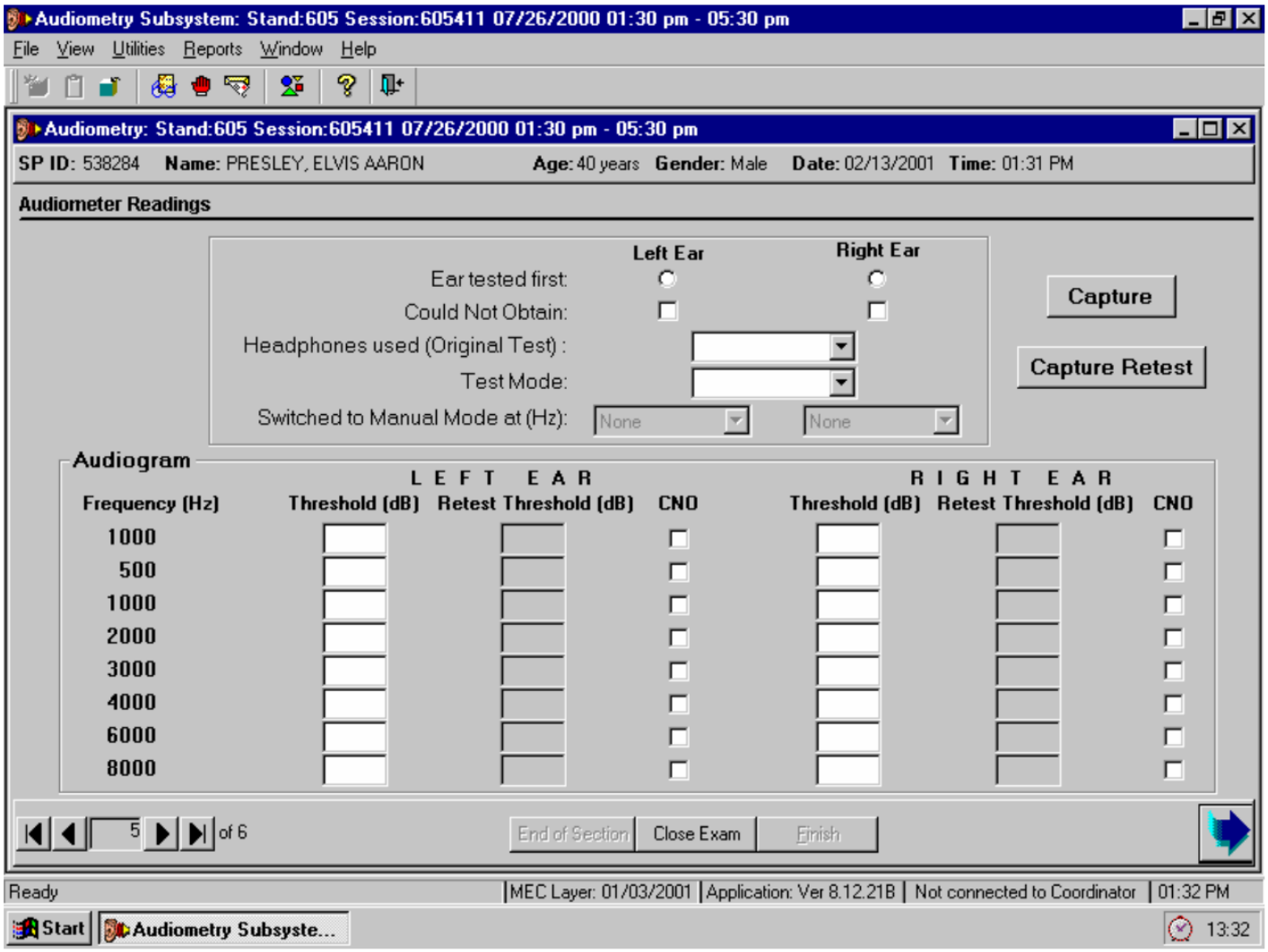
Change the test frequency to 500 Hz. Reset the intensity to 30 dB HL (or 15 dB above the threshold level at 1000 Hz, whichever is higher). Find the threshold.

Advance to 1000 Hz again. If the new threshold is within 10 dB of the original threshold at 1000 Hz, record the value. Otherwise, stop the test and reinstruct the examinee. It is very important that you monitor the test/retest variability.

Continue to test the remaining frequencies: 2000, 3000, 4000, 6000, and 8000 Hz. Always begin with an initial intensity of 30 dB HL or intensity level 15 dB above the threshold at the preceding frequency, whichever is greater

When thresholds have been obtained at all frequencies in the first test ear, switch to the other ear.

Optional extended range of the audiometer. Before testing in an extended range, listen through the headphones to rule out an equipment malfunction.



[AUDIOMETRY Procedures Manual CDC]

Paper from last time
uHear (Unitron, Victoria, Canada), EarTrumpet (PraxisBiosciences, Irvine, California), and ShoeBOX Audiometry (Clearwater Clinical, Ottawa, Canada) are the only Apple iOS-based applications that were shown to be reliable in establishing air conduction thresholds for individuals with normal and impaired hearing.

Apps

IOS	Android
Mimi Hearing Test	Mimi Hearing Test
Hearing Test & Ear Age Test	Hearing Test Pro
Hearing test - Audiometry,Tone	Hearing Test
HEARING AID, LIVE LISTEN, HEAR	AudioCardio
Easy Hearing Test	Hearing test -Audiometry,Tone
Jacoti Hearing Center	Hearing Age Test
HEAR BOOST, SOUND AMPLIFIER	HEARING AID,HEARING AMPLIFIER
AudioCardio	uSound for Samsung - Hearing test
MDHearing	MDHearing
Sound Scouts - Hearing Test	Tonal Tinnitus Therapy
Check Your Hearing	HEAR BOOST,SOUND AMPLIFIER
uHear	Sound Scouts -Hearing Test
Audicus Hearing Test	hearIQ
Signia Hearing Test	TruLink Hearing Control
Eartone Hearing Test	Eartone Hearing Test
Hearing Analyzer Lite	HEARING AID, LIVE LISTEN, HEAR
hearZA	hearZA
TruLink Hearing Control	

Name	Platform	Free	Noise check	Device setup (check earphone, do not disturb, Set certain volume)
Mimi Hearing Test	IOS	✅	✅	✅

Hearing Test & Ear Age Test	IOS	✅	❌	❌
Shoebox Audiometry *Not able to signup*	IpadOS	✅		
uHear	IOS	✅	❌	❌
Audicus Hearing Test	IOS	✅	❌	❌
Easy Hearing Test	IOS	✅	❌	✅
Hearing Test	Android	✅	❌	❌
AudioCardio	Android	✅	❌	❌

Name	Test 1	Test 2	Time to Complete (first test / second test)
Mimi Hearing Test	Pure tone Threshold test, use the mechanism of holding and releasing a button, need to identify a set of beeping sounds ranging from low frequency to high frequency with different volumes, the result will show an audiogram for both ears as well as a rough grading of the hearing level	Masked threshold test, holding and releasing buttons as identifying beeps in a background noise, the beeping volume will vary as the noise level stays constant. The result will be one of the four predefined hearing levels.	5 min / 2 min
Hearing Test & Ear Age Test https://apps.apple.com/us/app/hearing-test-ear-age-test/id1067630100	The test is supposed to play test frequency of 125hz to 8000hz and plot the result on the audiogram. This test did not function at the time of writing.	Ear Age Test, plays high frequency of sound and shows the frequency on the screen, the user can determine if the sound can be heard, and the result maps the frequency to the ear age.	6 min / 1 min

Shoebox Audiometry https://apps.apple.com/us/app/shoebox-audiometry-standard/id873272921			
uHear https://apps.apple.com/ca/app/uhear/id309811822	Hearing sensitivity Tap the button once hear the beep, does not require headphone. Also has a questionnaire.	Speech in noise Self adjusted noise level, change the dial so that you think you can still clearly understand the conversation.	5 min / 1 min
MDHearing https://apps.apple.com/ca/app/mdhearing/id1244278587	Customize and control your hearing aid settings for your specific needs		
Audicus Hearing Test https://apps.apple.com/us/app/audicus-hearing-test/id991194968	Pure tone Threshold test, the user can tap the button to acknowledge hearing the sound	NA	5 min
Easy Hearing Test https://apps.apple.com/us/app/easy-hearing-test/id1433904646	Similar to Audicus Hearing Test	NA	5 min
Hearing Test https://play.google.com/store/apps/details?id=mobile.eaudiologia&hl=en_CA&gl=US	single frequency tests, which provide users with a chart outlining the sound amplitude in decibels and also the different sound frequencies. The users can move the sound level around and draw the audiogram by themselves. Does not require headphones.	Number recognition test, the app would say numbers and ask the user to enter the corresponding numbers under different noise levels.	3 min / 3 min
AudioCardio https://play.google.co	Single frequency sound test, the test gives user		4 min

m/store/apps/details?id=com.audiocardio&hl=en_CA&gl=US	the scroll bar to select the volume that can be heard to generate a score. Does not require headphones.		