Audiology Booth Basics: Understanding Hearing Assessments and Reading Audiograms

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Pittsburgh, PA

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Financial Disclosures

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No honorarium is being accepted for this presentation.

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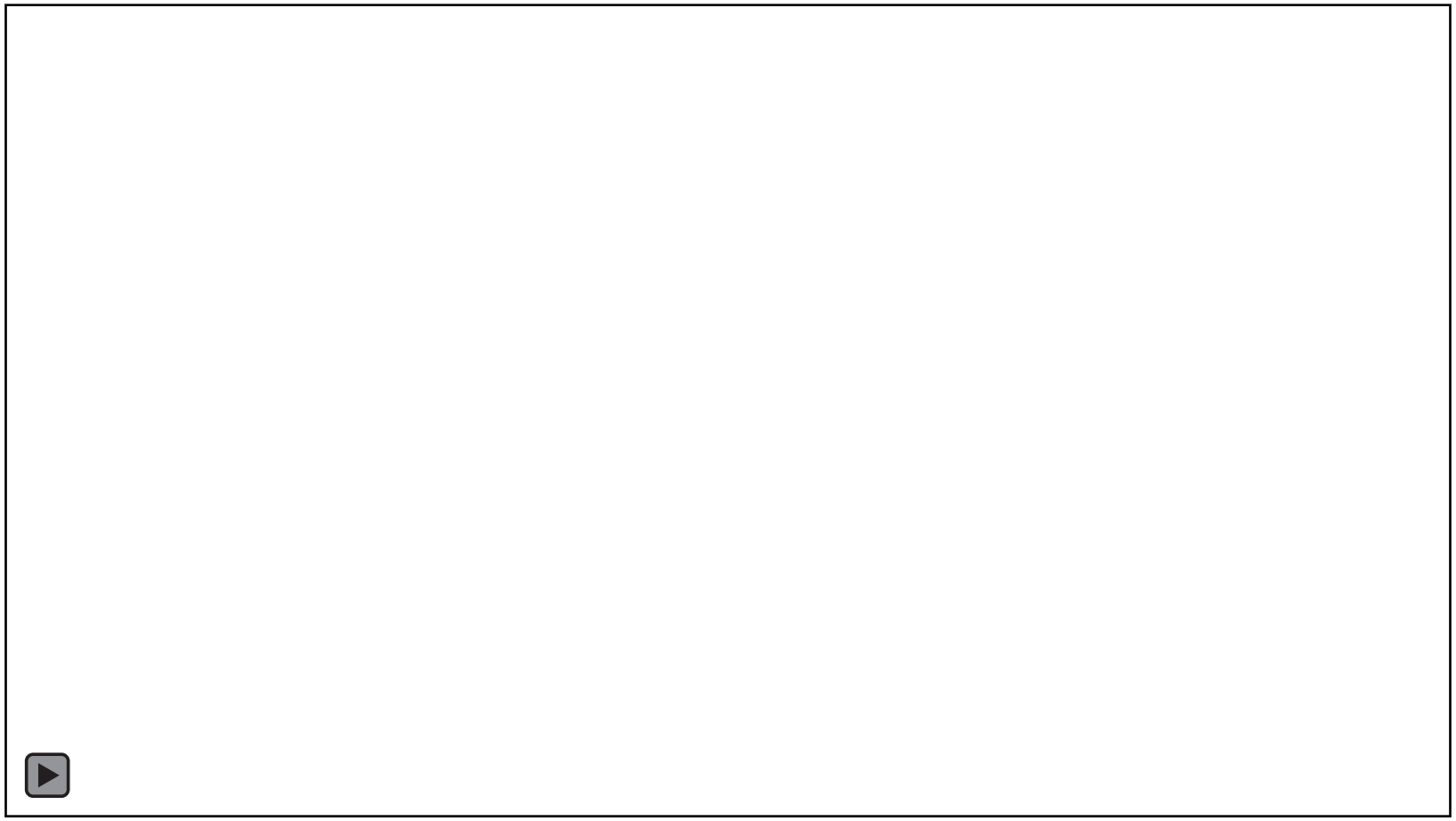
“Oh Crap”



Wolfe, 2009

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Peeling back the curtain…



- **Reduces anxiety:** Minimizes stress and fear of the unknown for families.
- **Facilitates preparation:** Sets expectations and allows practice at home for smoother, more fruitful appointments.
- **Enhances communication:** Equips families to ask informed questions and aligns professionals with expectations.
- **Builds trust in process:** Increases confidence in clinical recommendations through greater knowledge.
- **Promotes collaboration**: Ensures a unified approach among professional, enhancing support for children and families.

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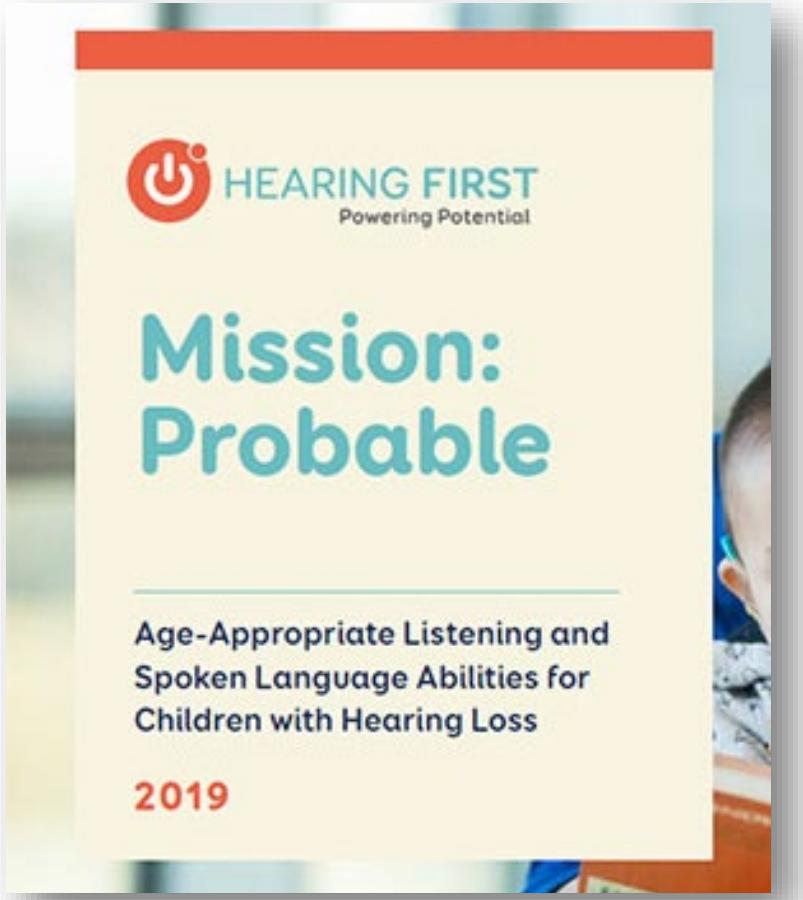
Great Outcomes Are “Probable!”





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Agenda and Learner Objectives

- **What we hear:** Key Properties of Sound
- **Auditory System Anatomy:** Key Structures
- **Audiogram Essentials:** Symbols, types and levels of hearing loss
- **Overview of Hearing Tests:** Physiological & Behavioral
- **Real-World Application:** Sample Case Studies
- **Key Takeaways:** Top Tips and Insights
- **Interactive:** Open Q & A

Learning Objectives:

- Recognize audiogram symbols and what they represent.
- Identify 3 different audiology tests and their purpose.
- Distinguish between types of hearing loss on audiograms.

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Properties of Sound

Frequency, Intensity, Time

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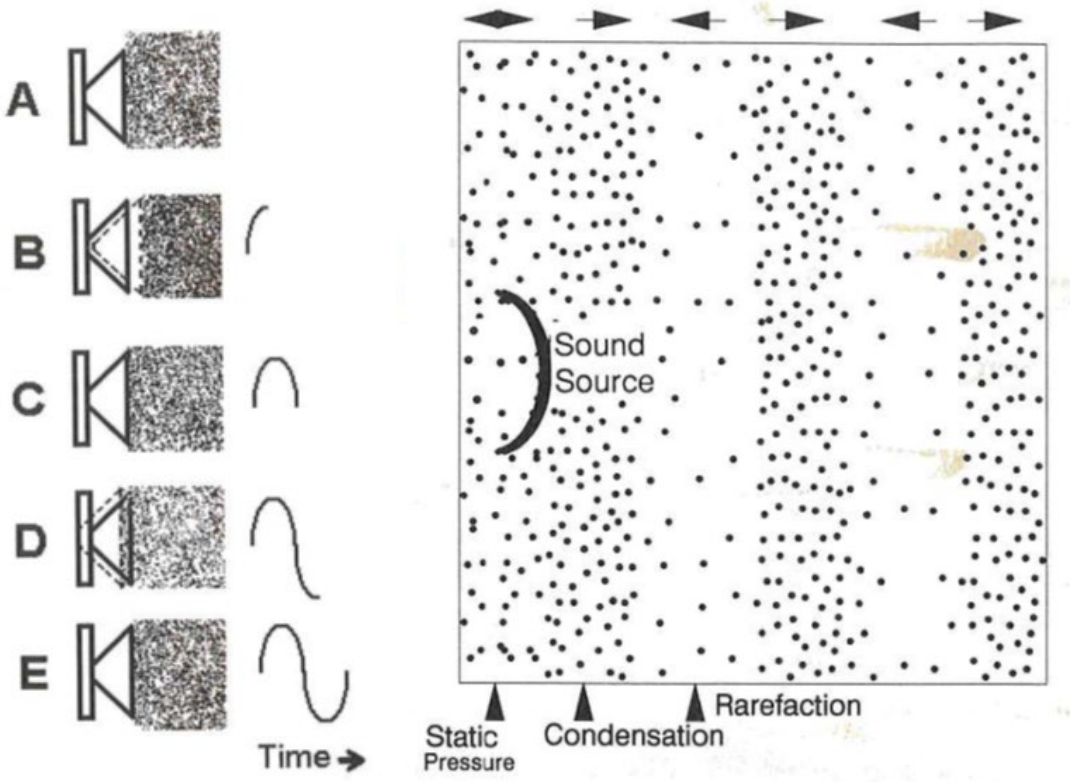
Key Properties of Sound and Hearing

- Most commonly, sound is created by the vibratory displacement of air molecules





Deli, 2012

Key Properties of Sound and Hearing

- At a basic level, sound is described across three basic dimensions
  - Frequency
  - Intensity
  - Time

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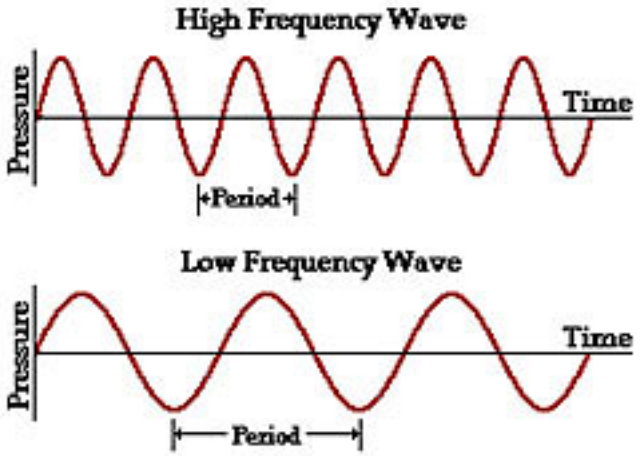
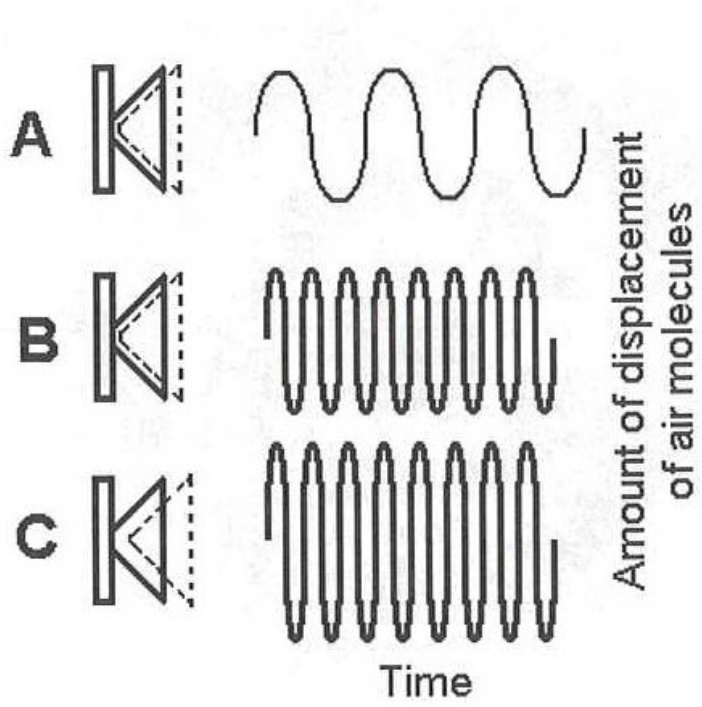
Frequency

Frequency refers to the number of cycles completed per second





Psychophysical Correlate: Pitch

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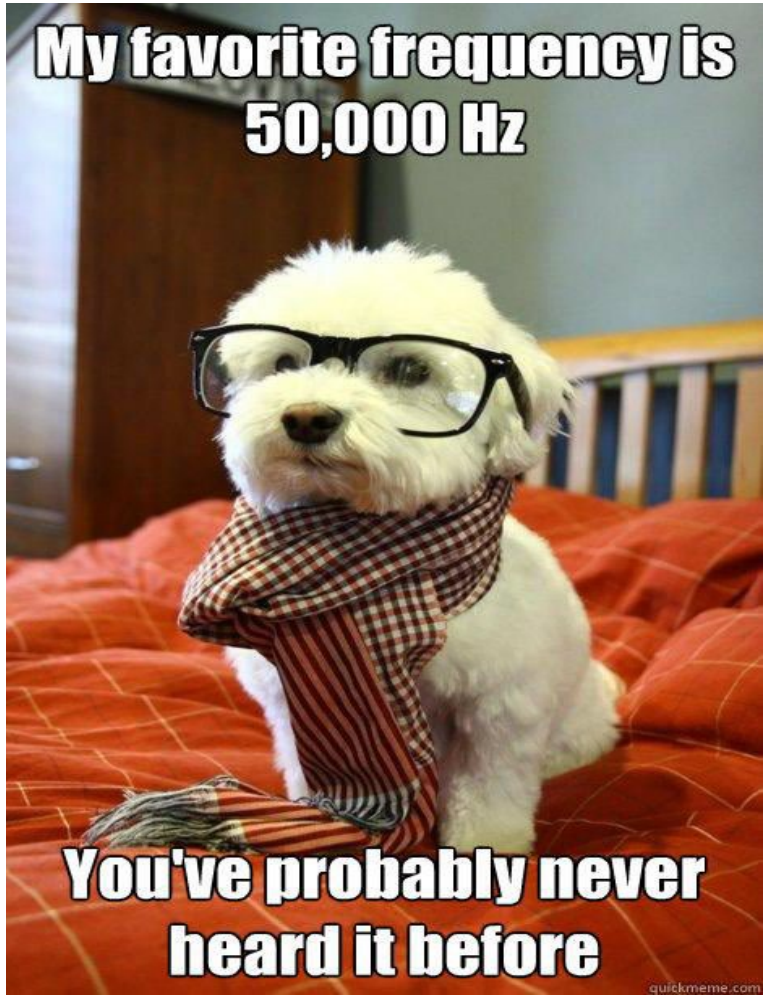
Hertz (Hz): Unit of Measurement for Frequency

The audible frequency range for humans is 20 to 20,000 Hz





Many adults do not hear well above 12,000 Hz

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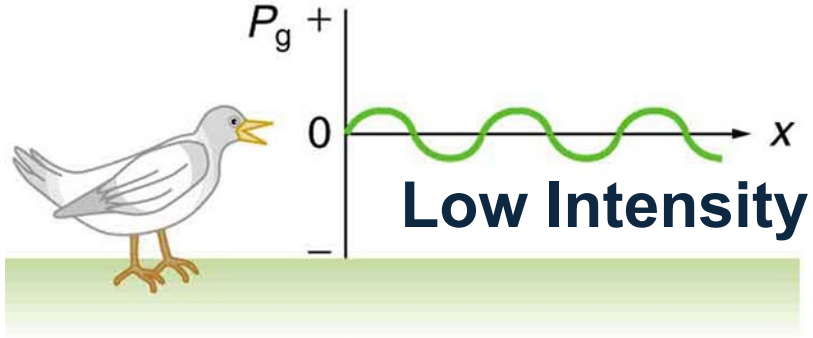
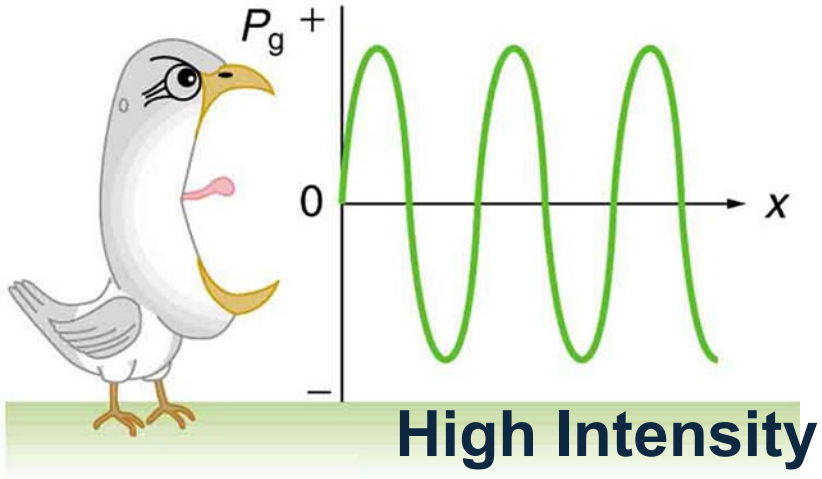
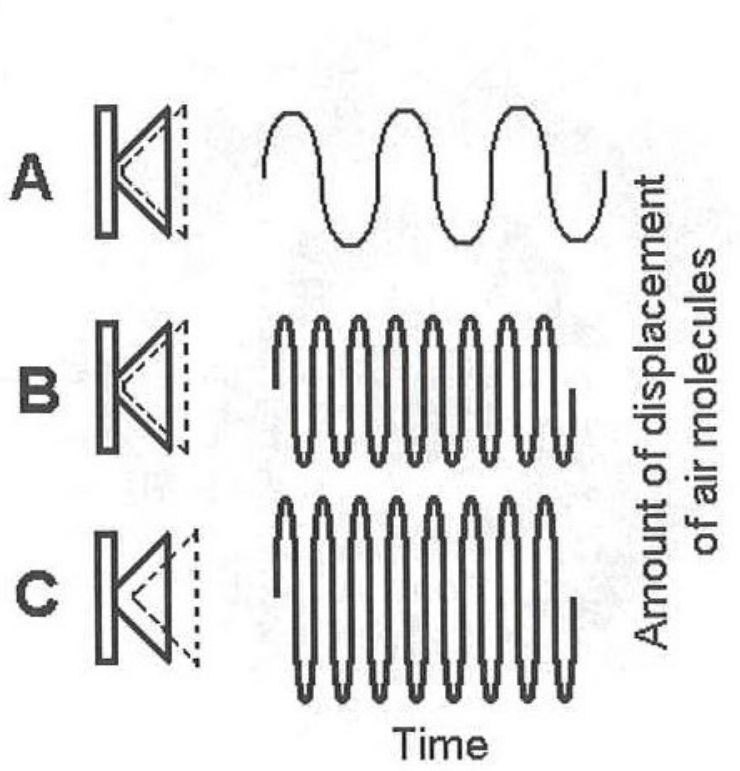
Intensity

Intensity refers to the magnitude of acoustic displacement







Psychophysical Correlate: Loudness

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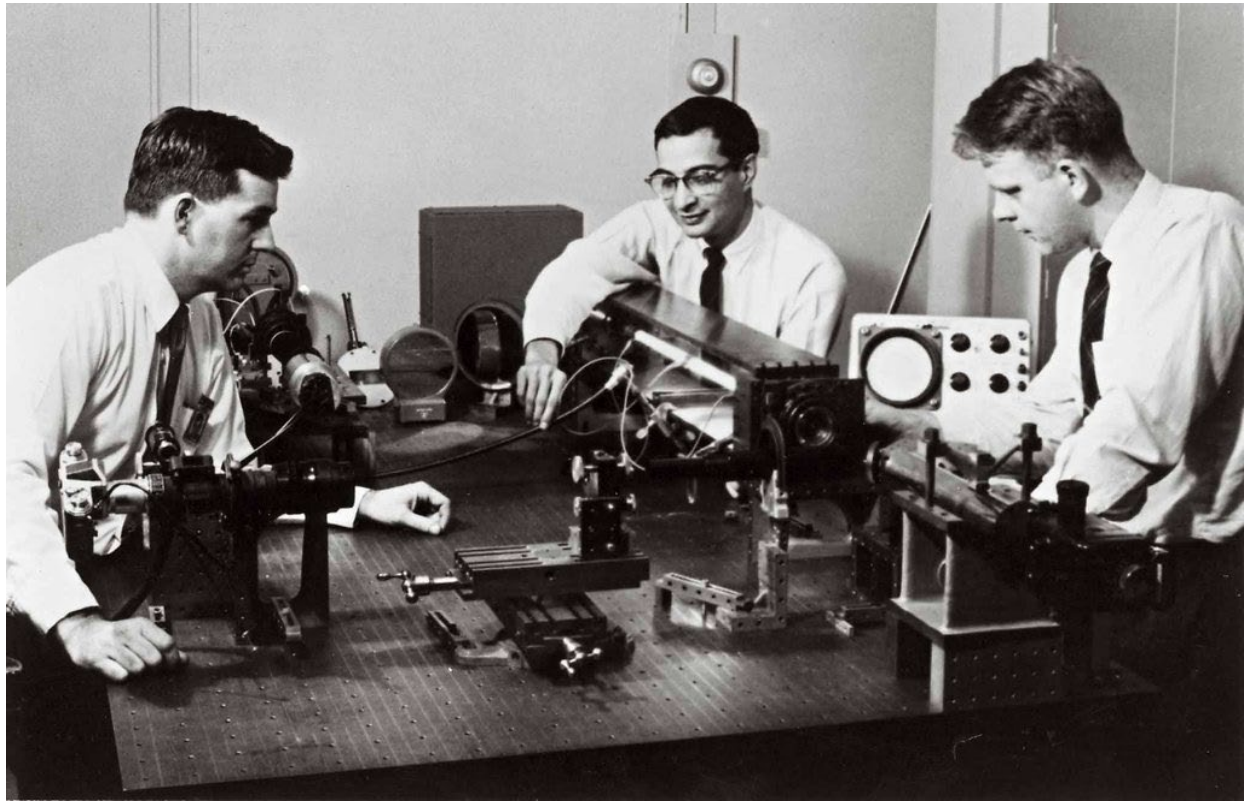
The Decibel: Unit of Measurement for Intensity



Decibel: Originated with Bell Telephone Laboratories in the 1920s

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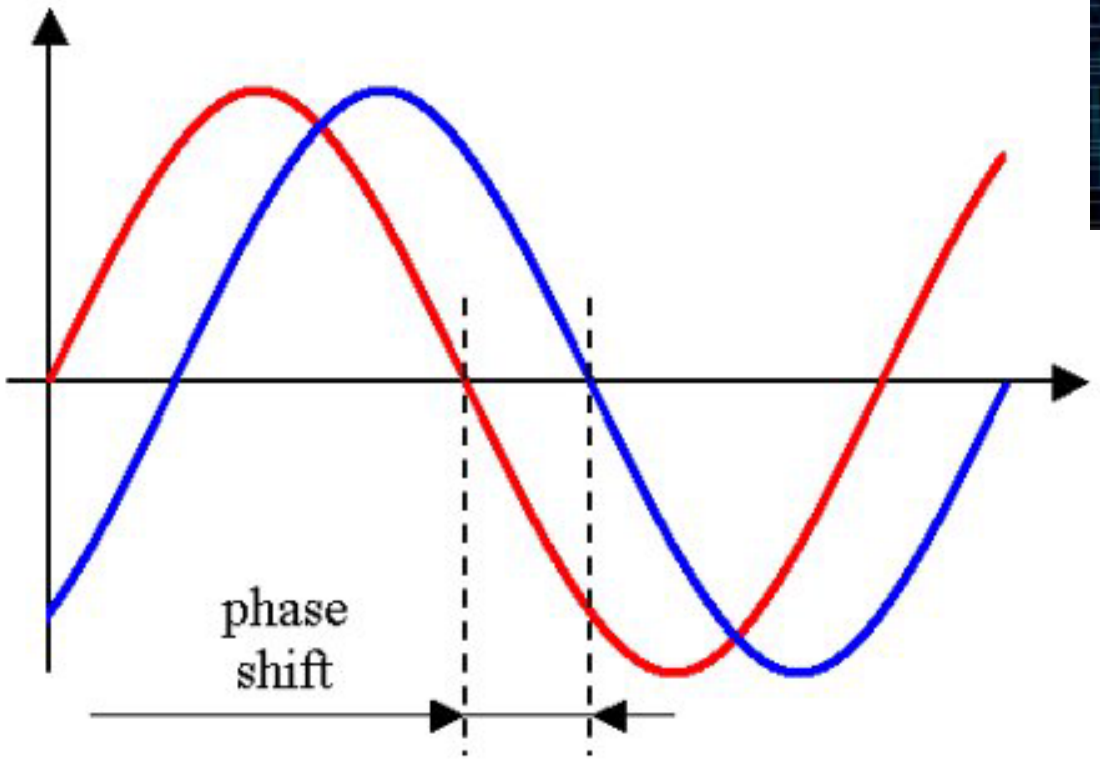
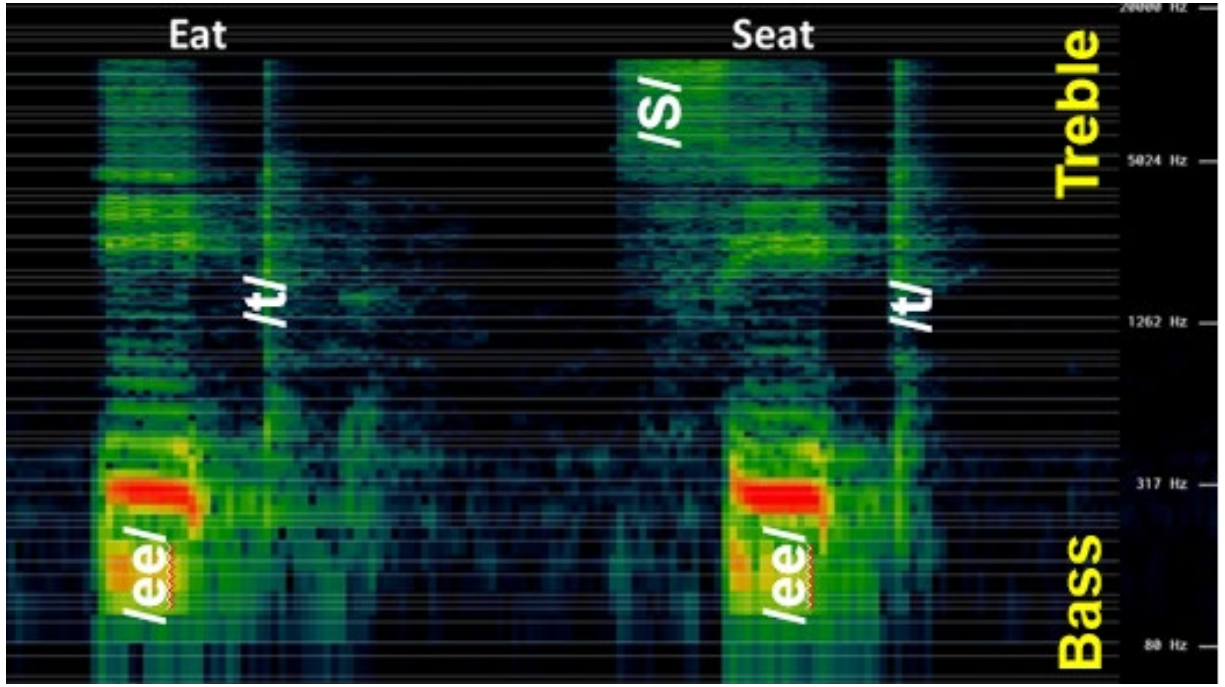
Time





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Auditory Anatomy

The Journey of Sound: From Pinna to the Brain in 15 Minutes!

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Outer Ear: Collecting Sound



Pinna & Ear Canal: Nature's Sound Funnel

- **Pinna:** Captures sound waves and helps with determining where sound is coming from
- **Ear Canal:** Directs sound to eardrum
- Outer ear anomalies can cause **conductive hearing loss**

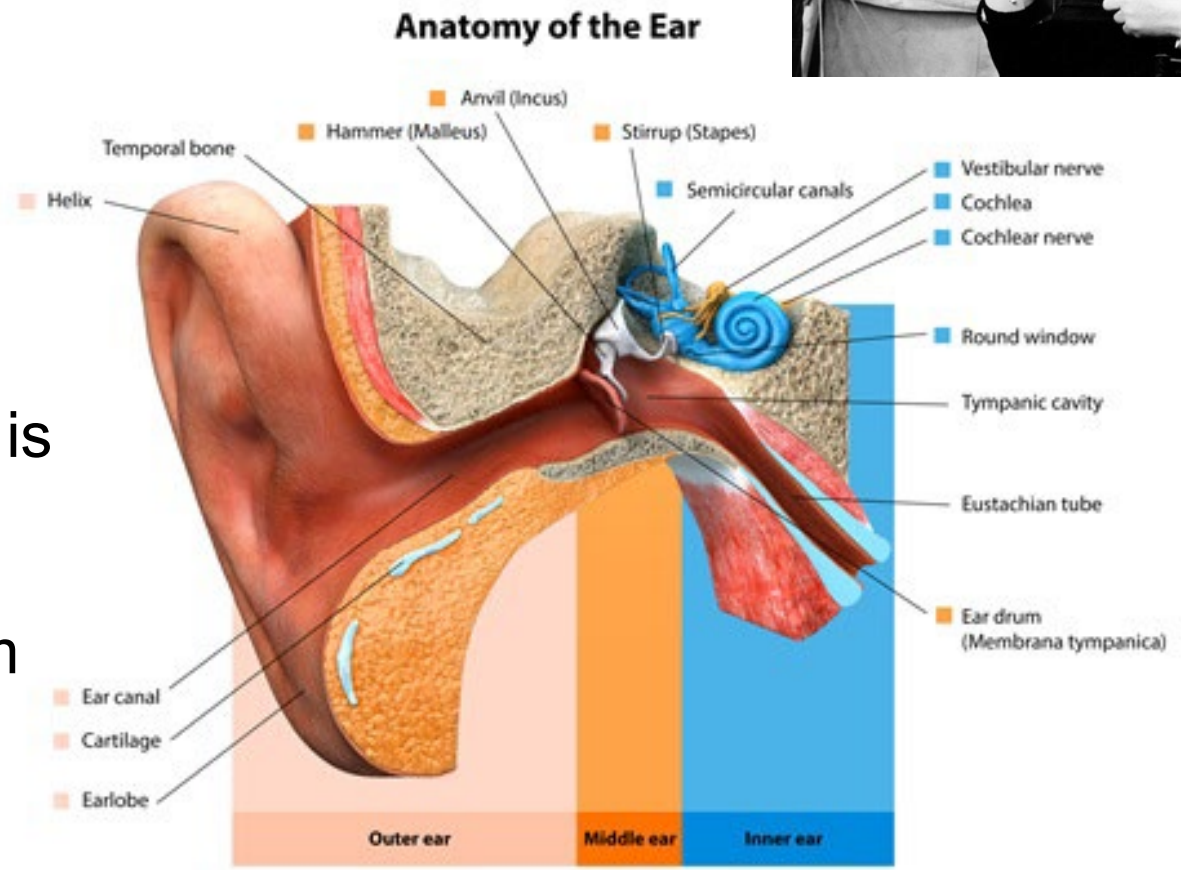

Photo Credit: Johns Hopkins Medicine

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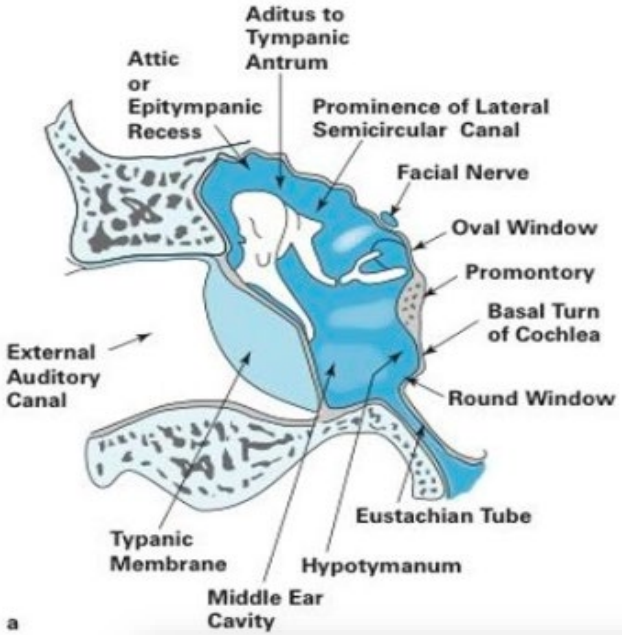
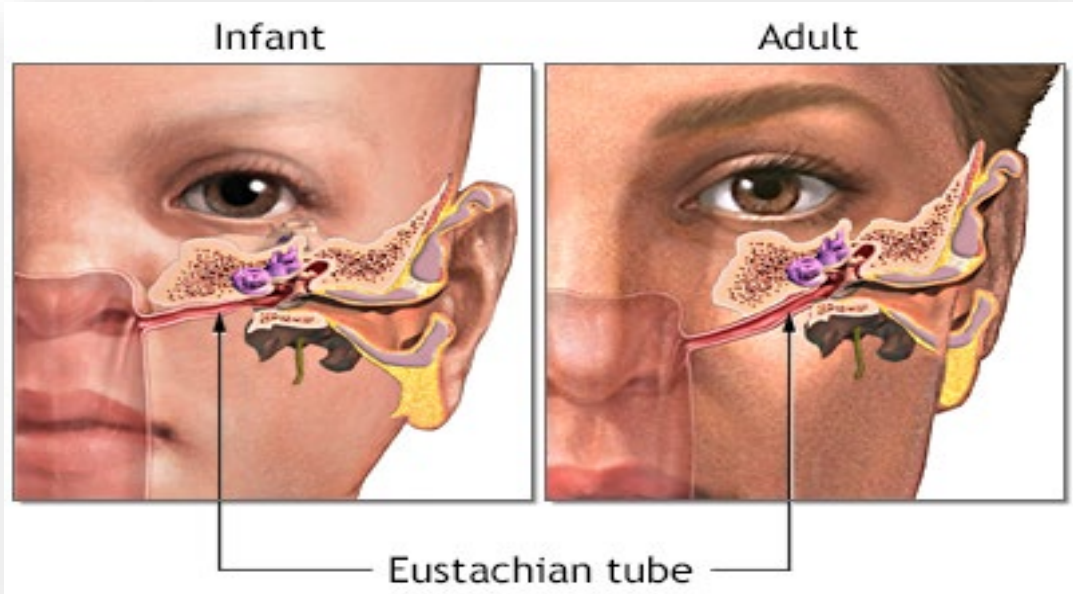
Middle Ear: Amplification Station

- **Middle ear** amplifies and transfers sound to the inner ear
- **Eardrum:** Vibrates from incoming sound waves
- **Ossicles:** 3 tiny middle ear bones (malleus, incus, stapes), transfer sound from eardrum to oval window – entrance of inner ear
- **Eustachian Tube:** Maintains pressure balance in front of and behind the eardrum; changes with age
- Middle ear dysfunction can cause c**onductive hearing loss**







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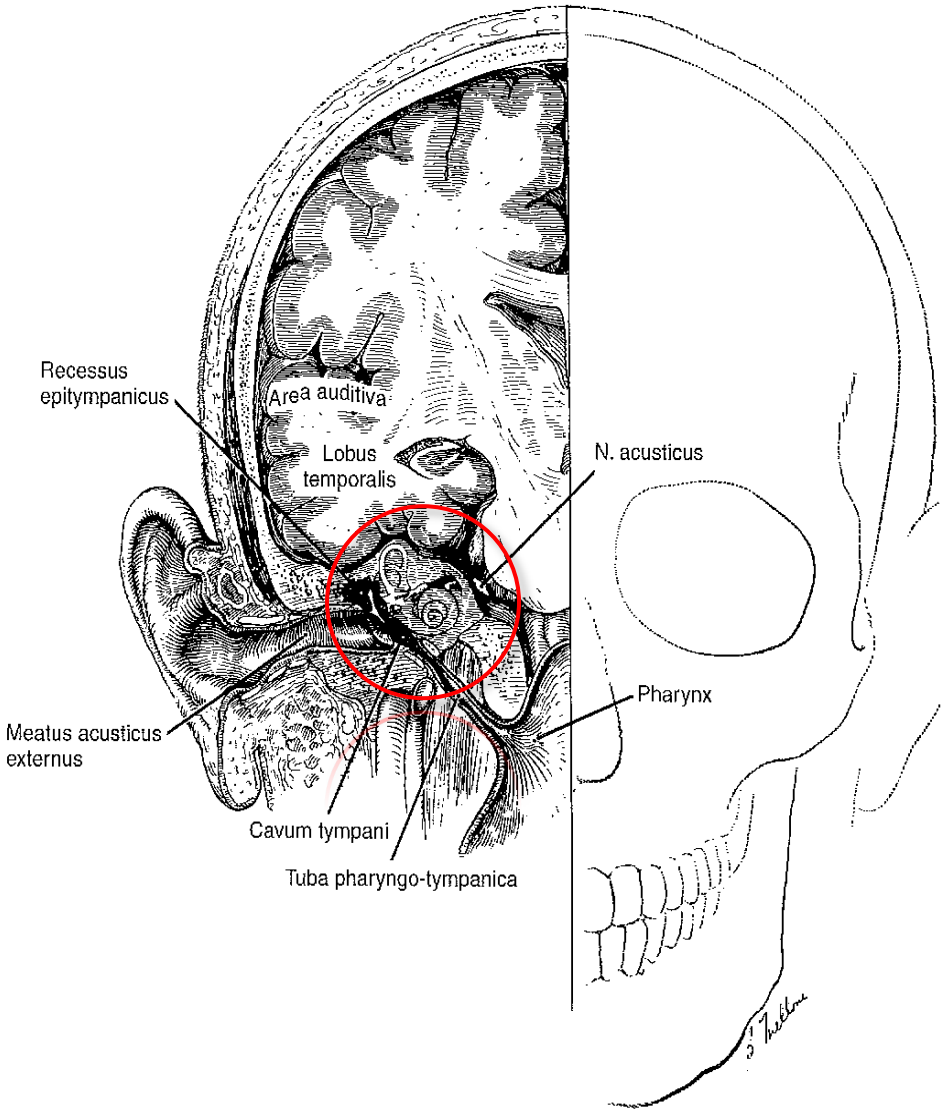
The Inner Ear



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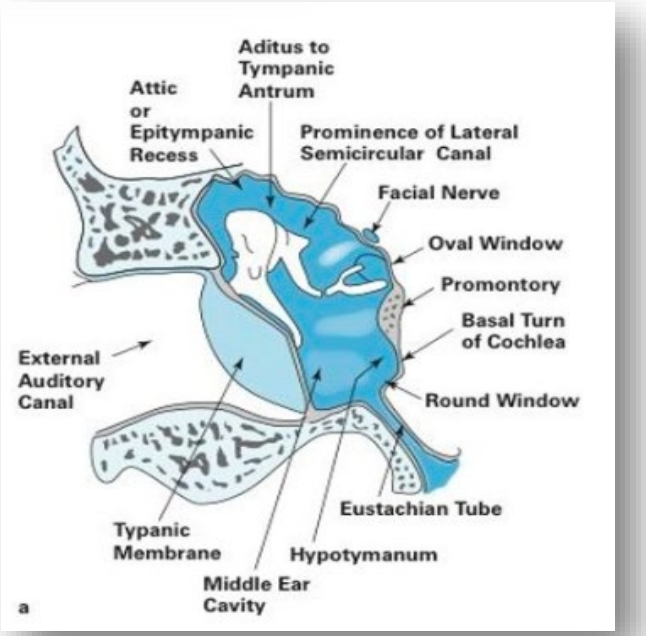

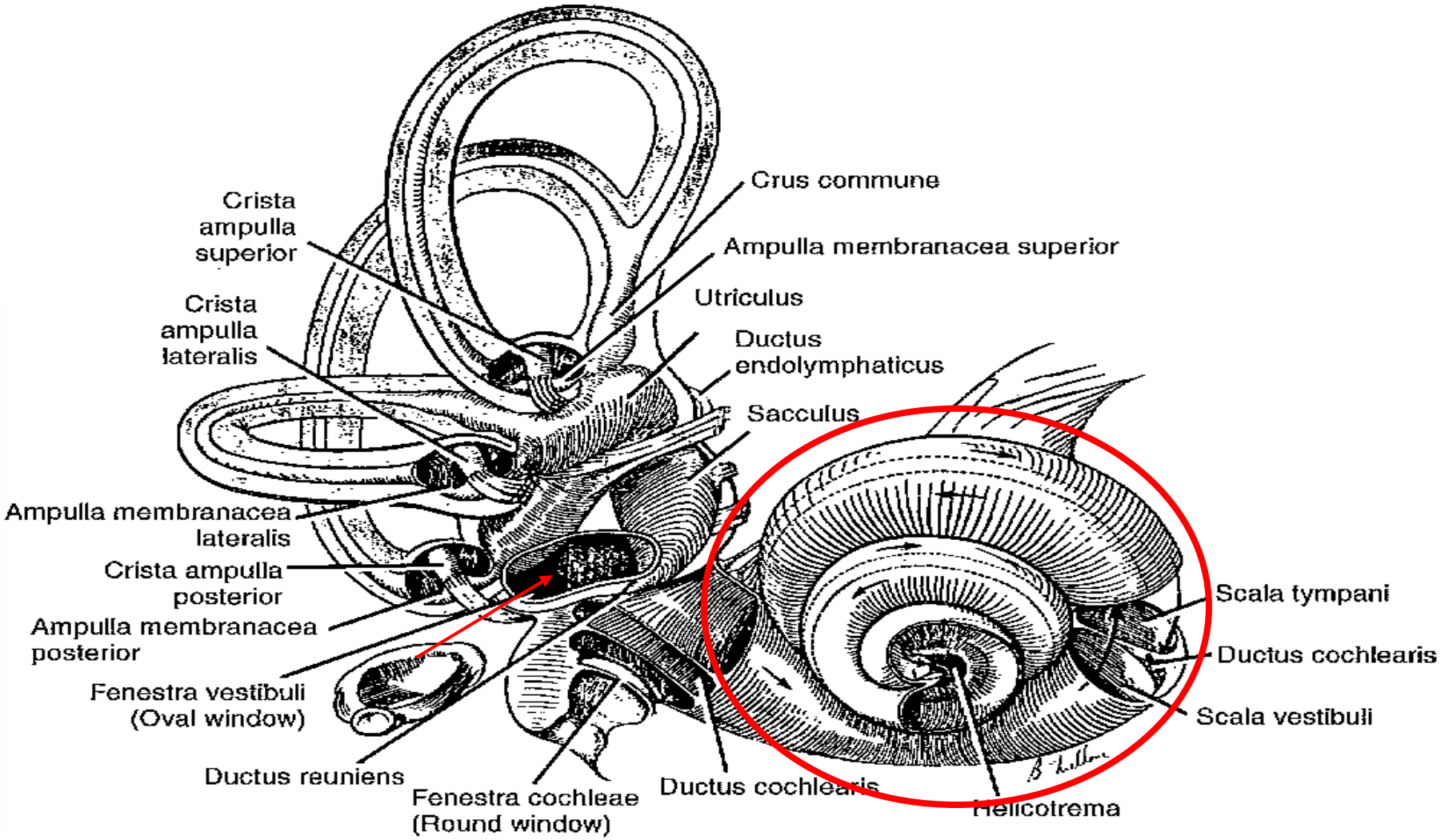

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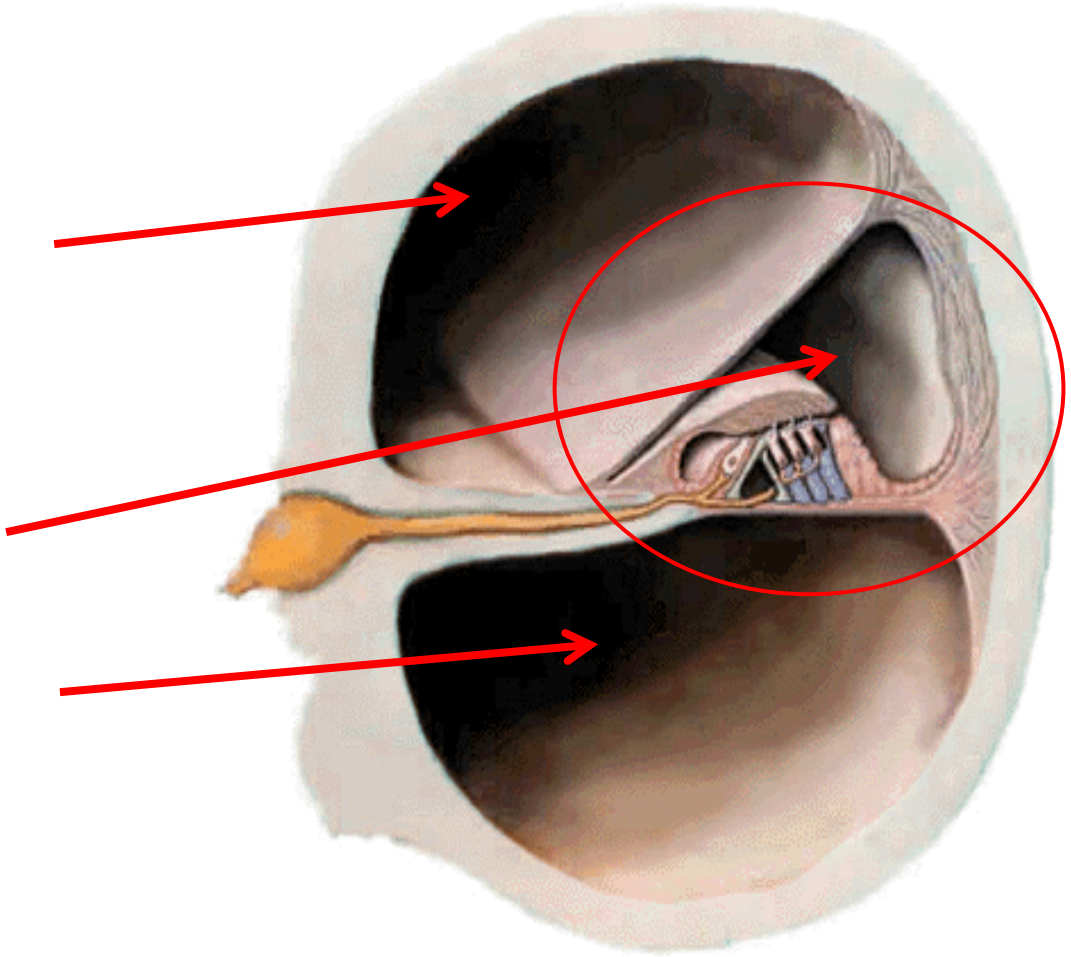
The Cochlea

- The bony labyrinth of the cochlea is divided into three fluid-filled chambers:
- The Scala Vestibuli
- The Scala Media
- The Scala Tympani



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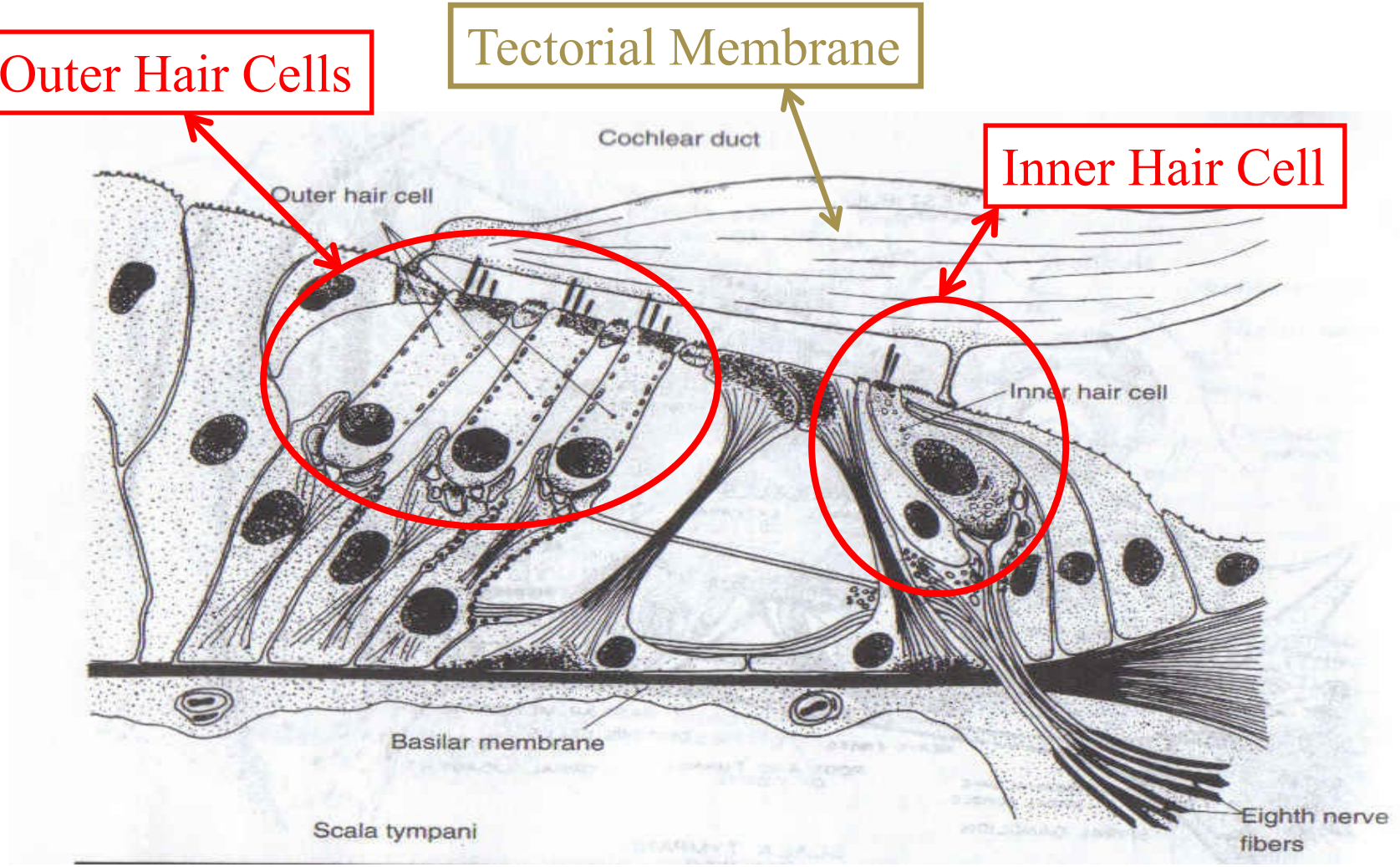
Cochlear Hair Cells



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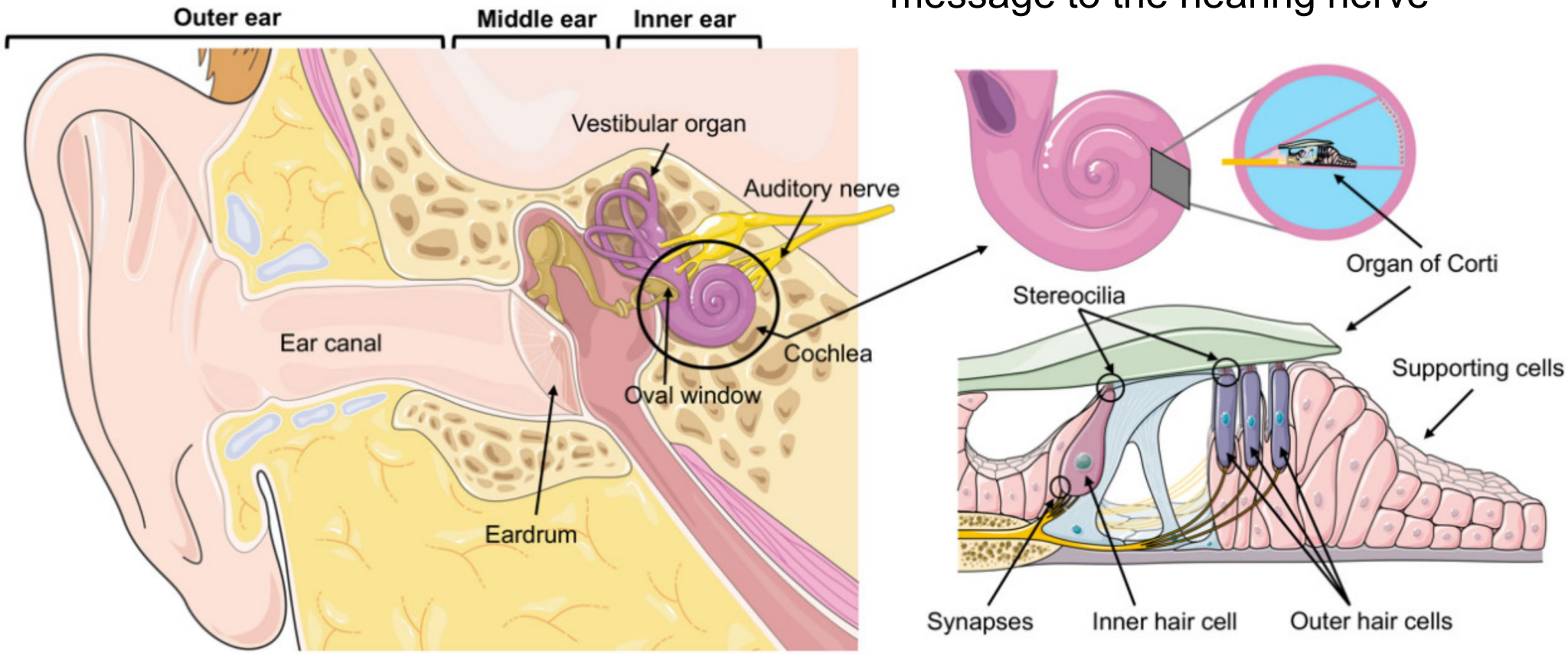
Cochlear Hair Cells

When stimulated:

- **Outer Hair Cells (OHCs)-** Vibrate causing a boost in soft-to-medium sounds
- **Inner Hair Cells** – Sends the sound message to the hearing nerve



<u>Most</u> Sensorineural hearing loss occurs here.

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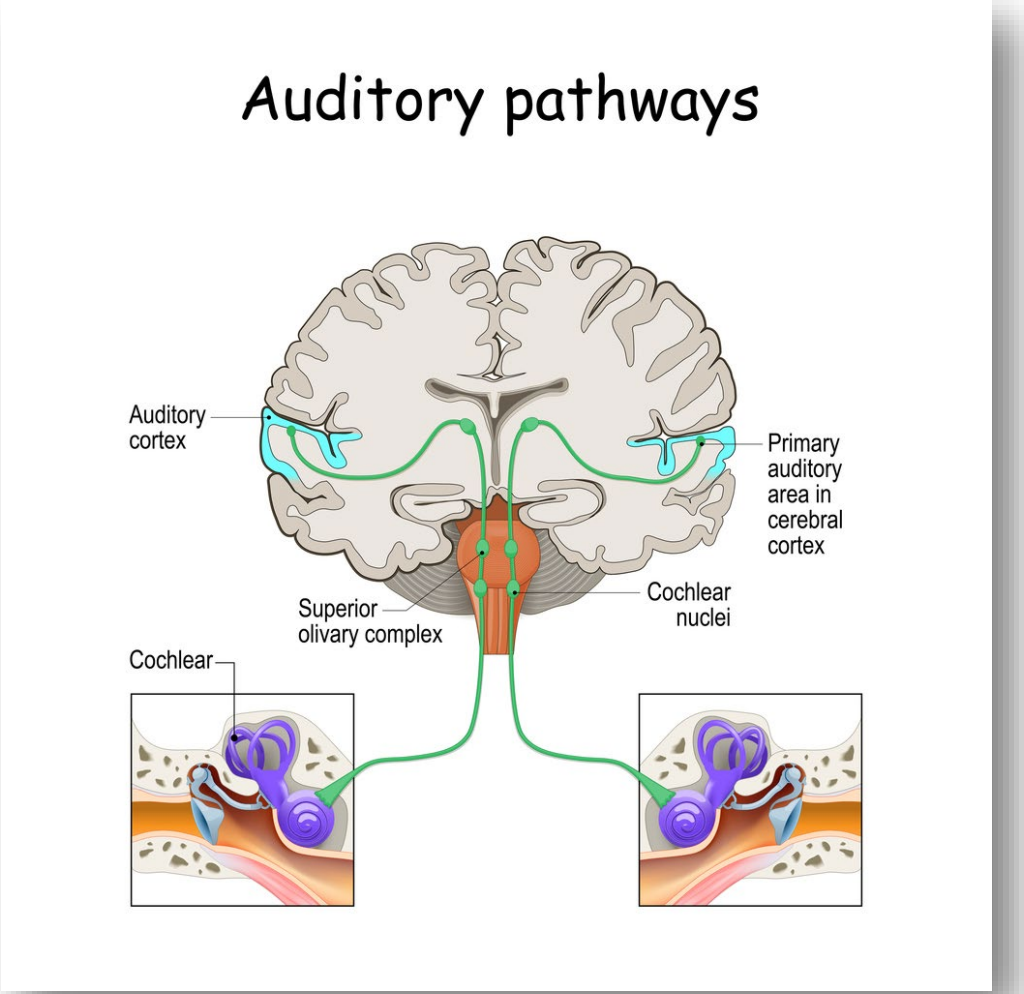
Auditory Pathway: Ear to Brain

- **Hearing Nerve:** Transmits signals from the cochlea to the brainstem and onto the brain.
- The sound signal is relayed from different groups of brain cells along the way from the hearing nerve to the auditory area of the brain.
- **Sensorineural hearing loss** can result from damage or dysfunction in the auditory nerve or central auditory pathways, not just the cochlea



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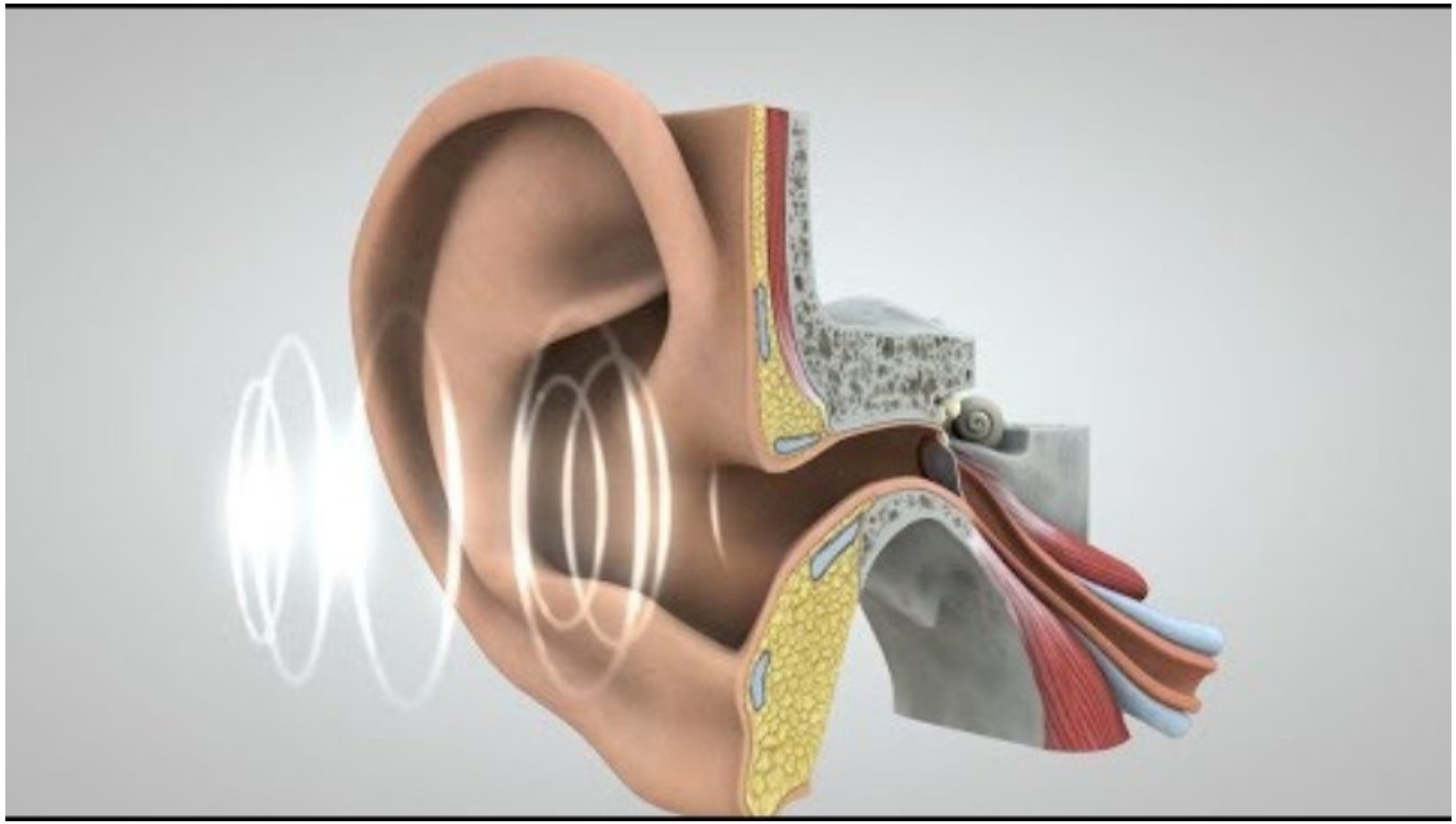
The Journey of Sound to the Brain (NIDCD)



https://www.youtube.com/watch?v=eQEaiZ2j9oc

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Audiogram Basics

Graph of Hearing

Symbols

Types and Degree of Hearing Loss

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Hold onto your earmolds - It's Audiogram time!

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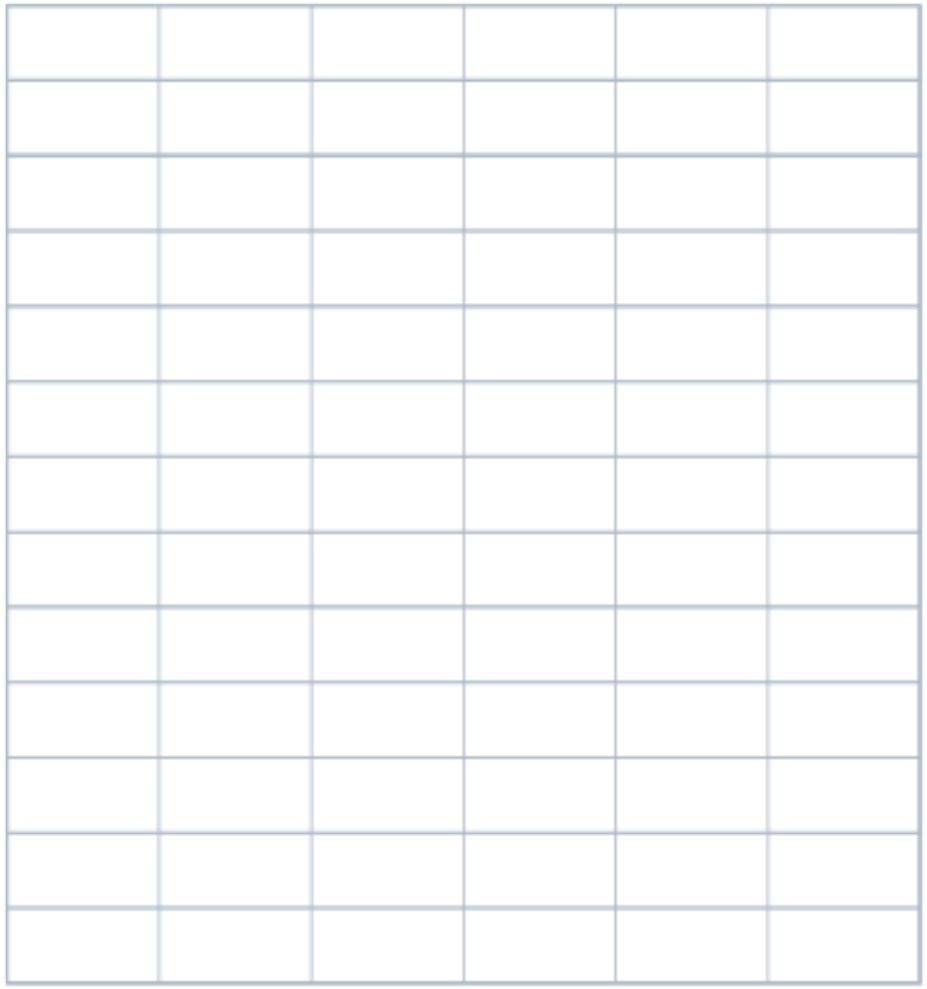
What is the audiogram?

- Graph or map of hearing
- Shows the lowest level at which a person can detect different sounds
- Loudness (up and down)
- Pitch (side-to-side; low to high)
- Symbols 101



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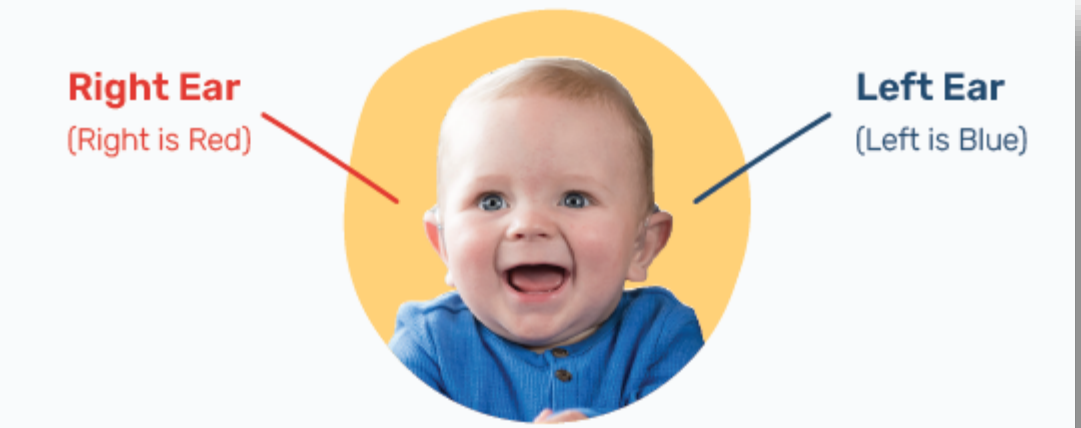

O	The softest sound your child can hear WITHOUT hearing technology using earphones	X
<	The softest sound your child can hear with bone conduction testing	>
↙	An arrow pointing down, on any symbol, indicates no response at that frequency (pitch) and intensity (loudness)	↘
S	The softest sound your child can hear with sound-field testing (both ears together)	S
C	The softest sound your child can hear WITH their cochlear implant(s)	C

Audiogram Symbols 101

- Thresholds (AC) Rt, Lt
- Bone Conduction Rt, Lt
- Soundfield
- Other possible symbols:
  - Masking
  - No Response (NR)

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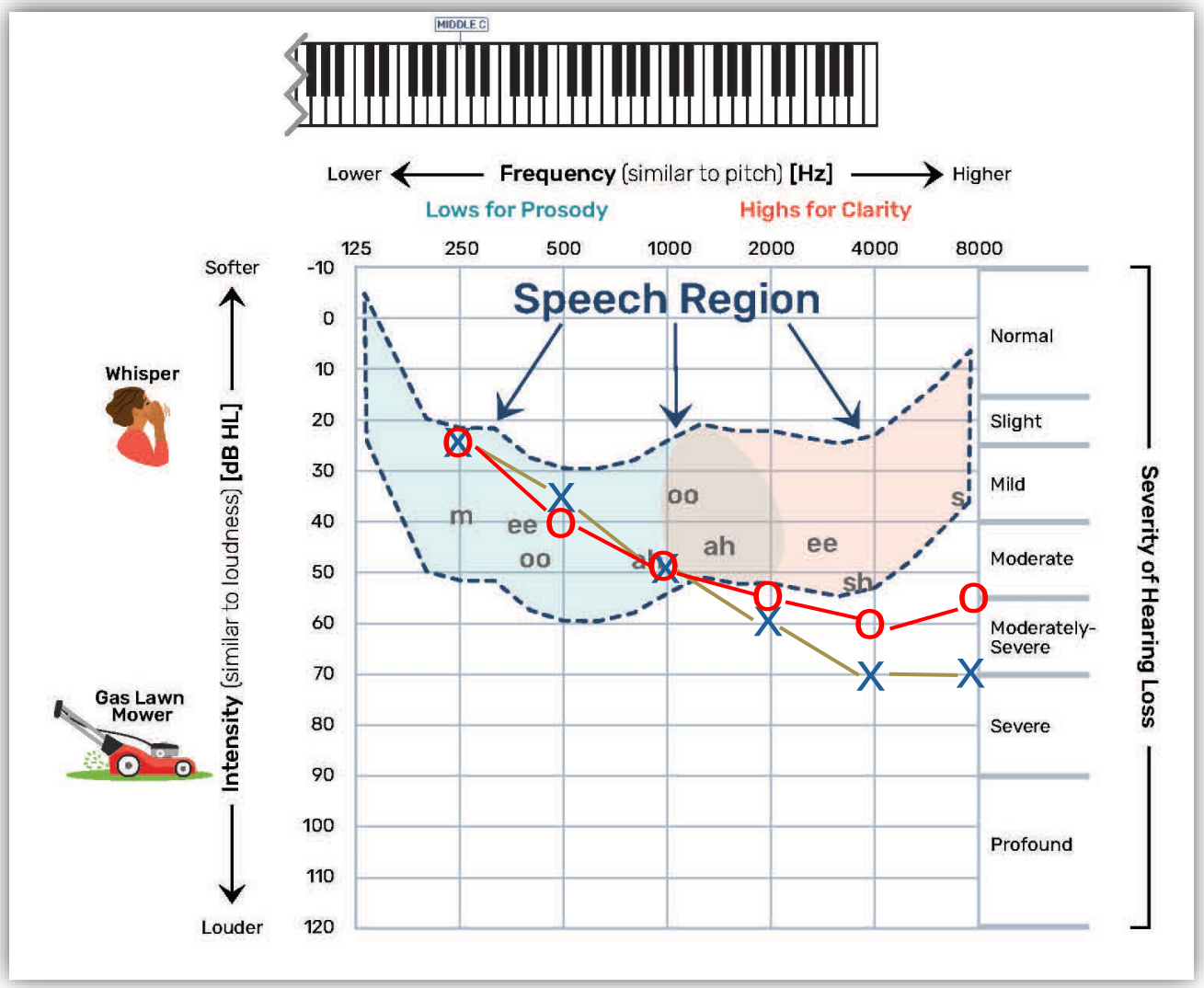
The Audiogram



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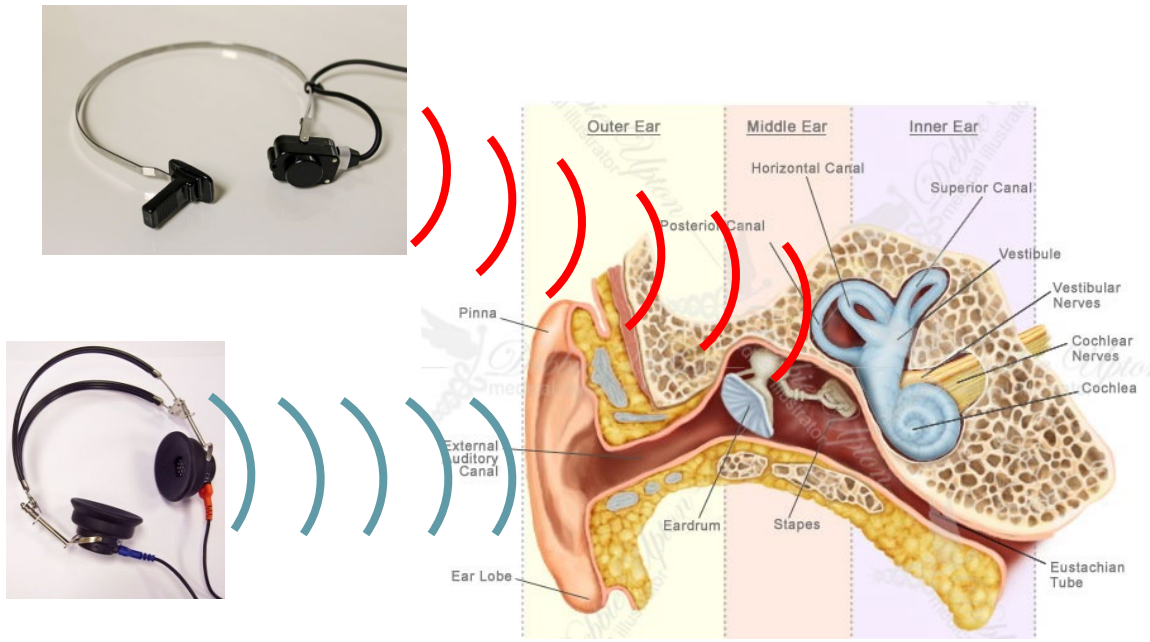
Air and Bone Conduction

- The staple of an audiologic evaluation is the assessment of air and bone conduction pure tone thresholds

- Allows for the assessment of outer, middle, and inner ear function



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Air Conduction Audiometry

Presentation of acoustic stimuli to the external ear

Signal must travel through external and middle ear to get to inner ear

Earphone vs. Sound Field

These are all represented by different symbols



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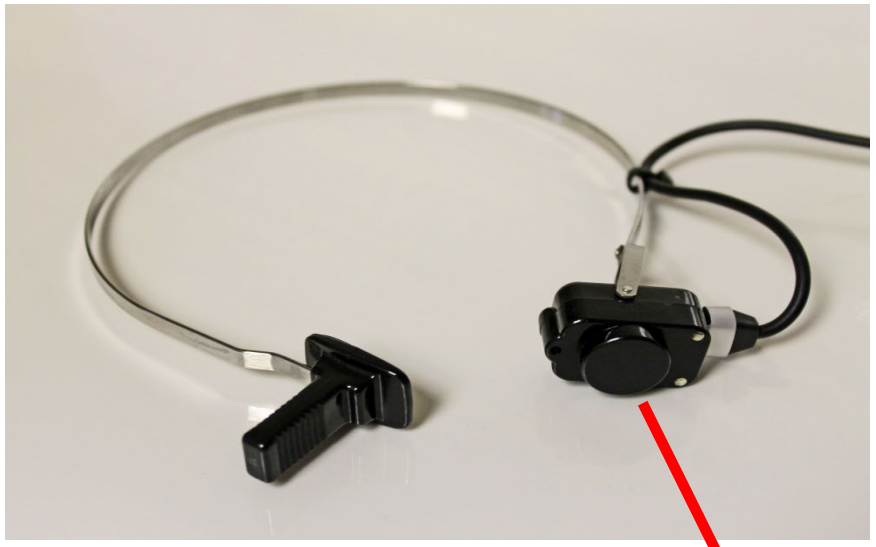
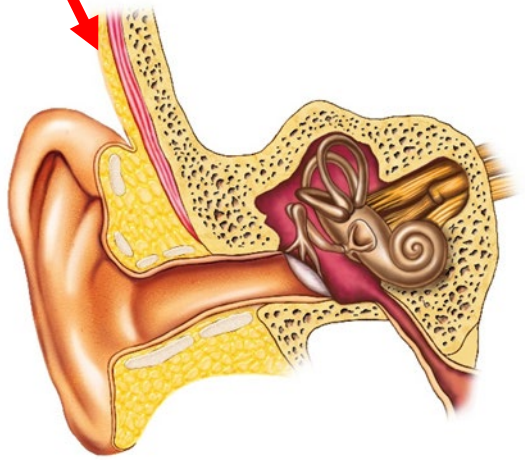
Bone Conduction Audiometry





- Ideally, the bone conduction stimulator is placed on the bone behind the ear
- Vibrations bypass the external and middle ear and are delivered directly to the cochlea
  - Evaluation of sensory function (permanent hearing)

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Type of Hearing Loss

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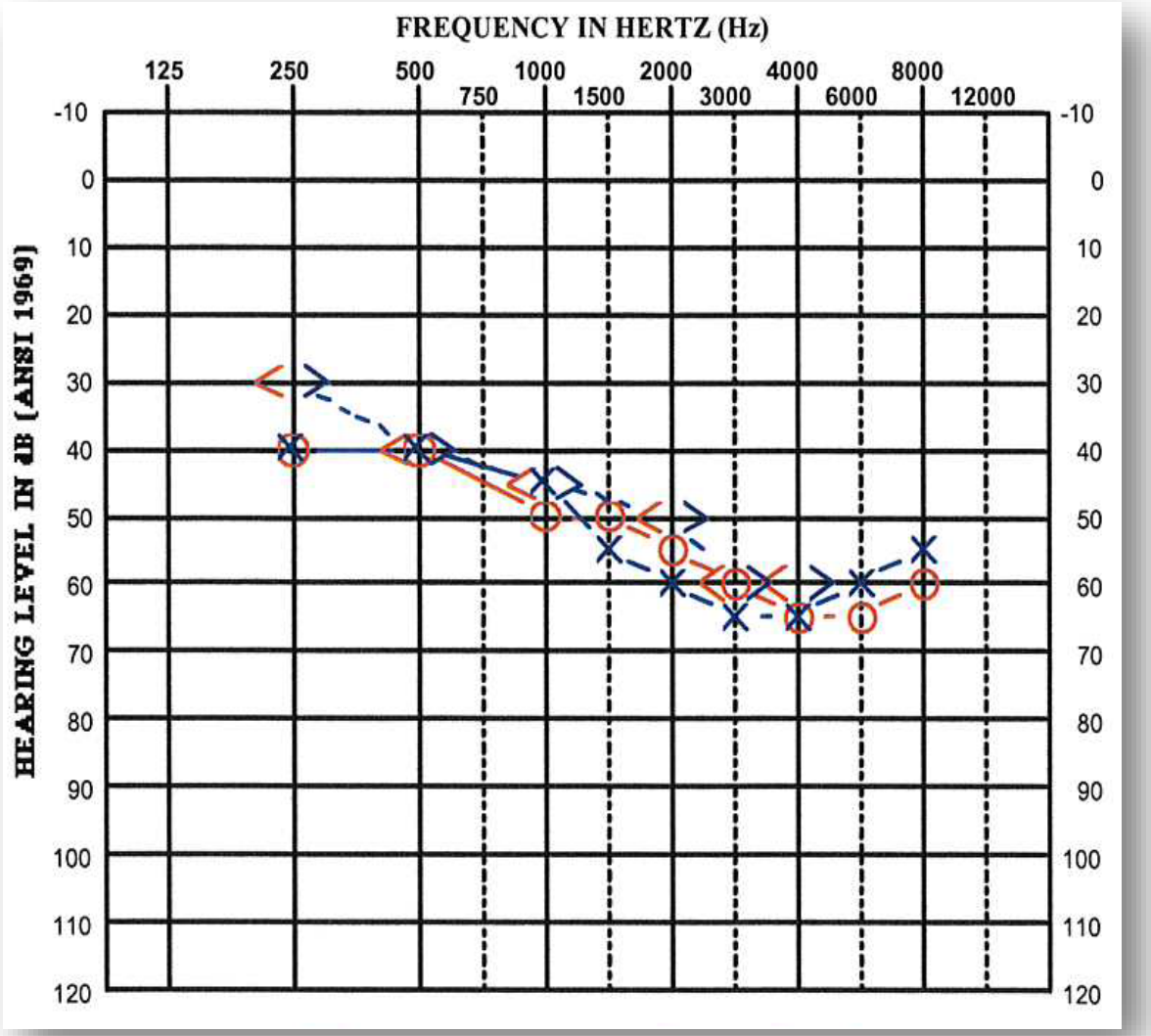
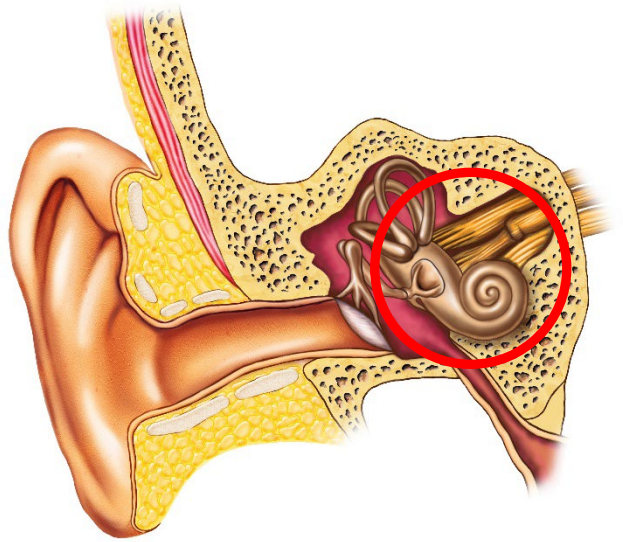
Sensorineural





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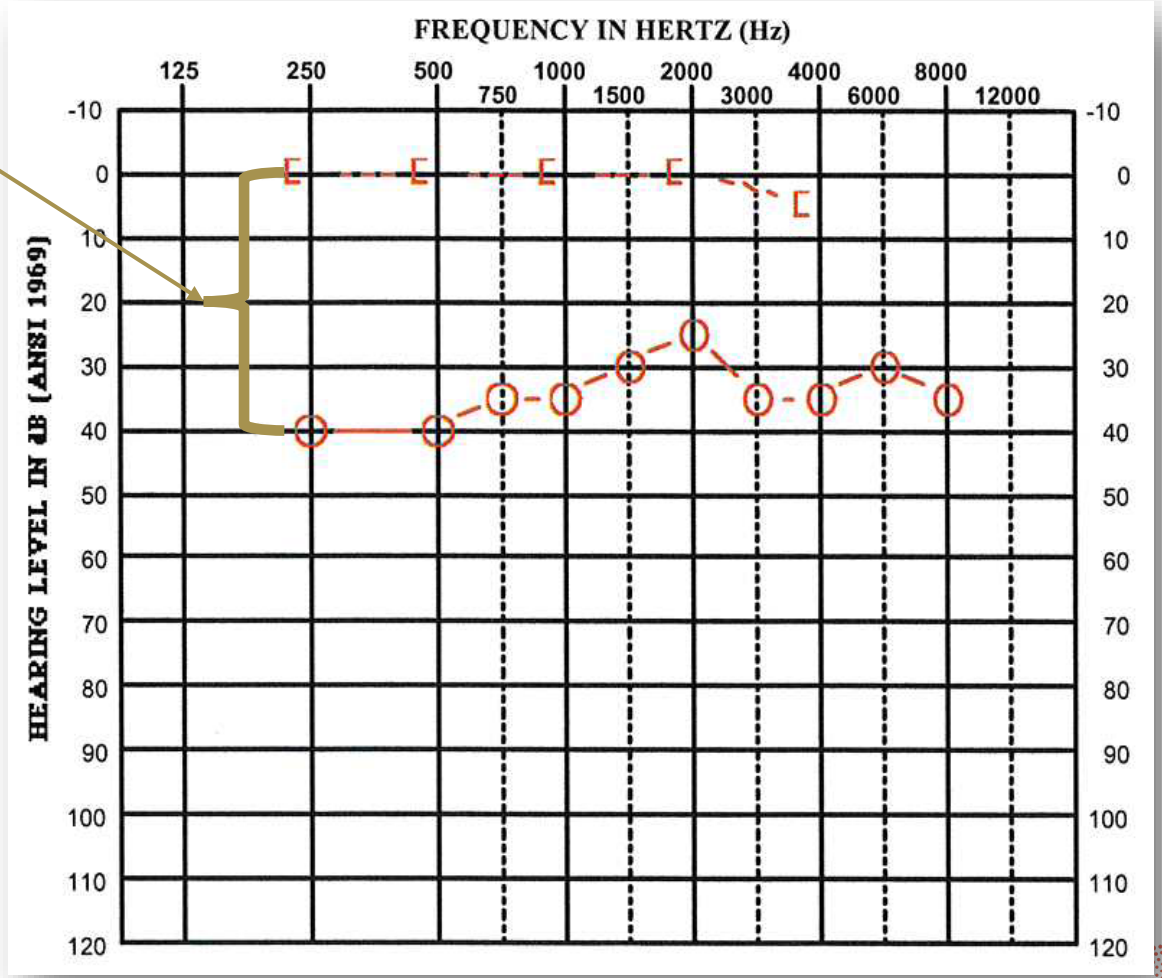
Conductive Hearing Loss

Air-bone gap



Otitis Media with Effusion



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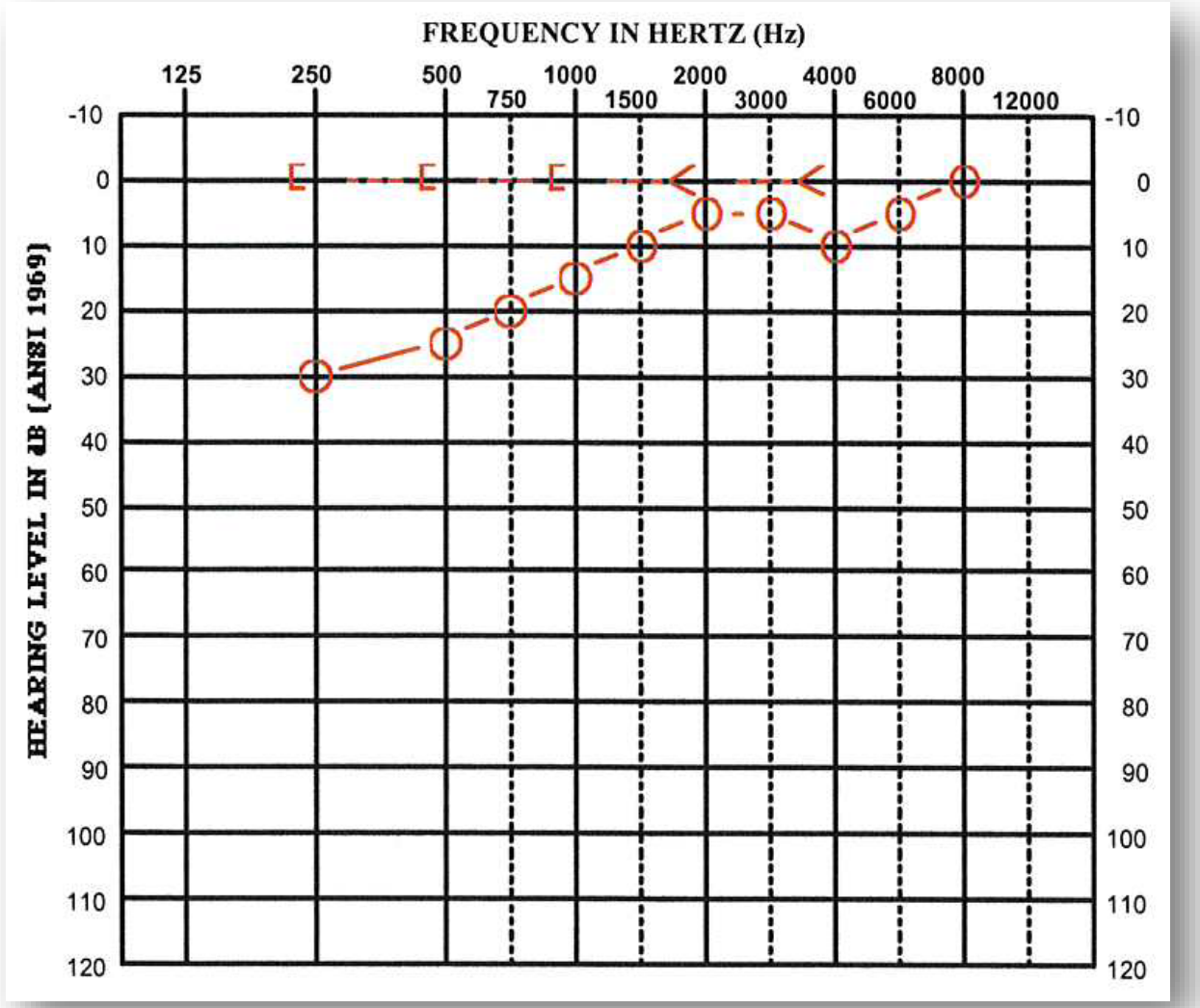
Low-Frequency Conductive Hearing Loss



Negative Middle Ear Pressure
Retracted Tympanic Membrane



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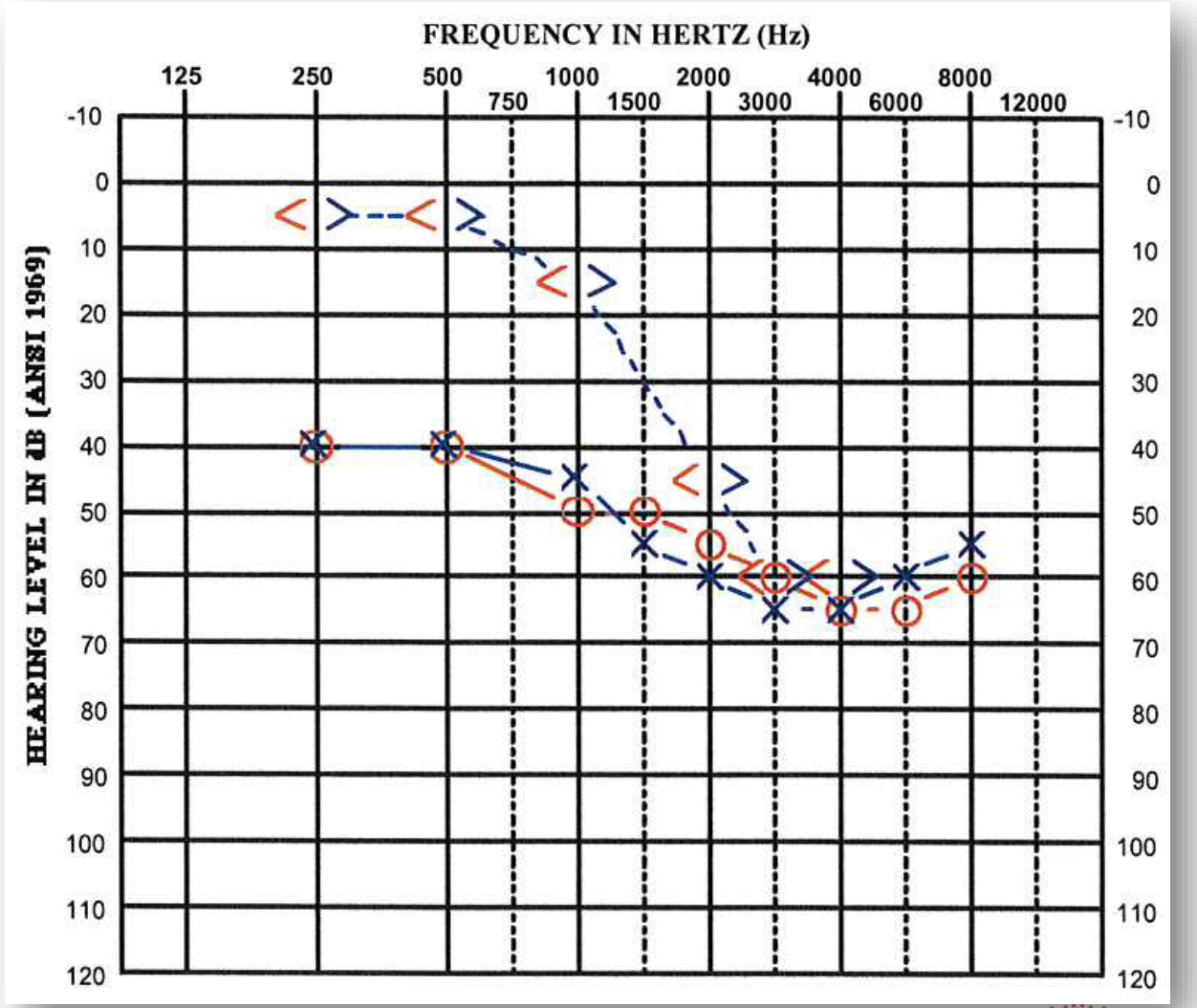
Mixed Hearing Loss



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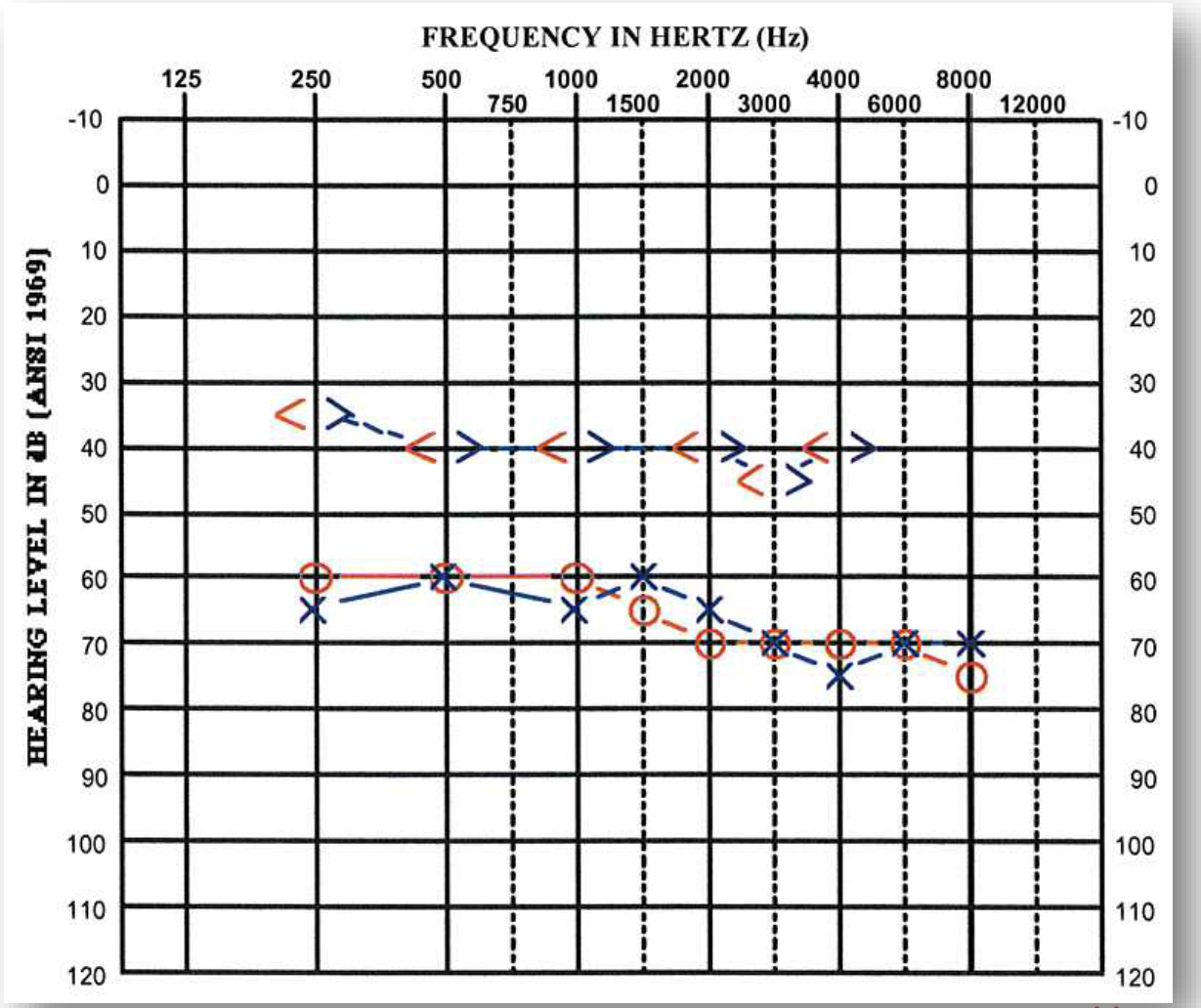
Mixed Hearing Loss



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Degree (Level) of Hearing Loss

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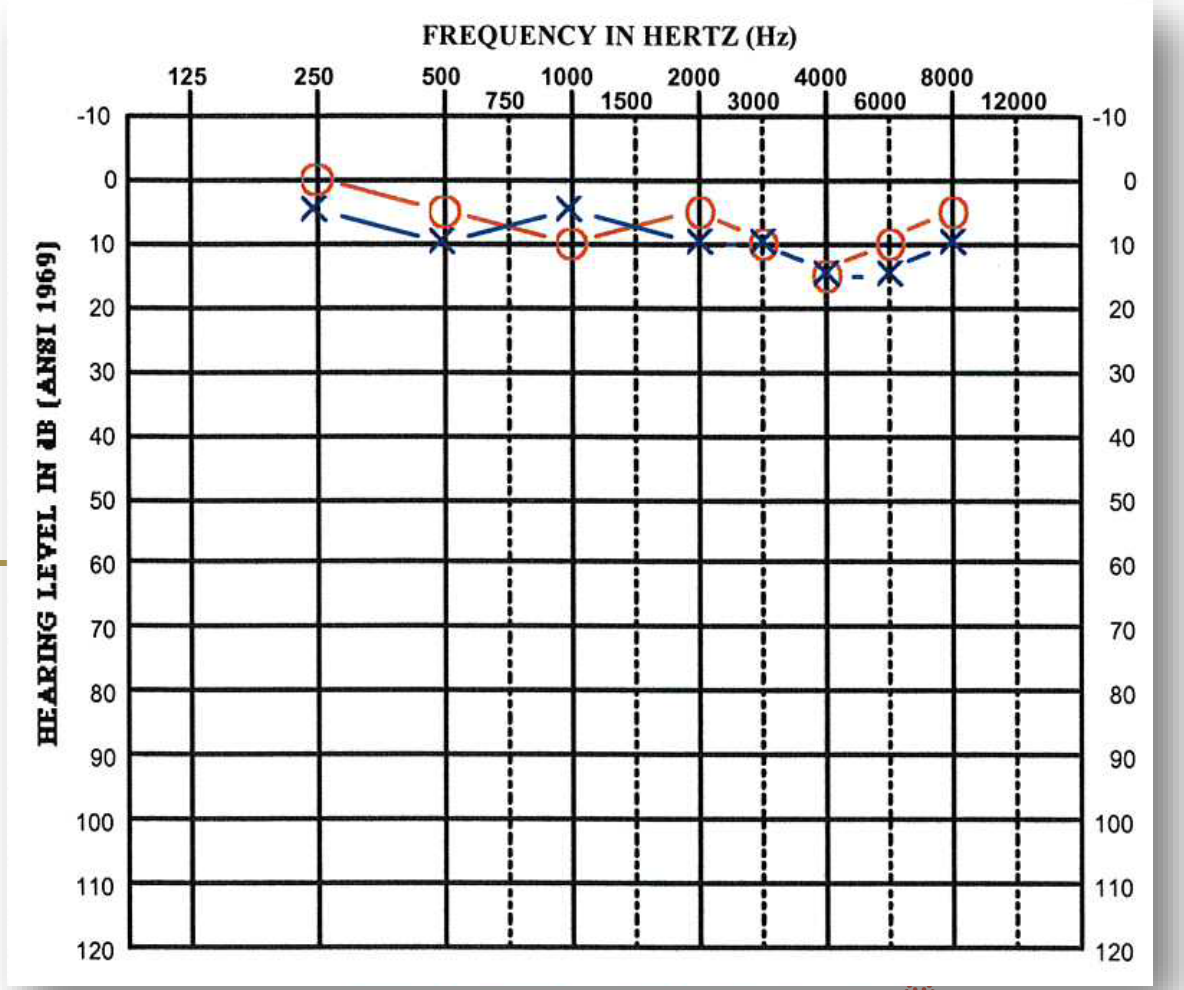
Normal Hearing Sensitivity

Adults: 0-25 dB HL

Children: 0-15 dB HL



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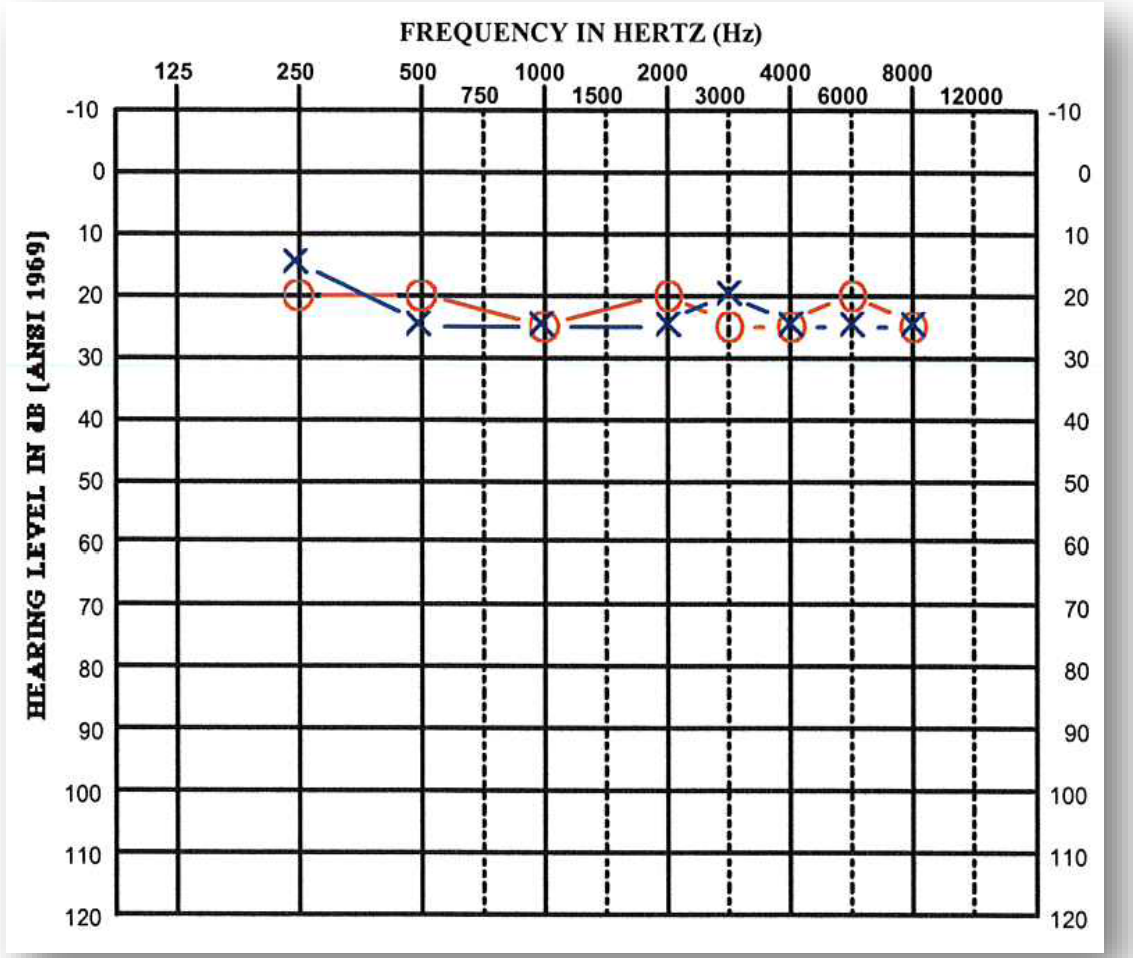
Slight Hearing Loss -- Children

Children: 15-25 dB HL



A child with slight hearing loss may miss up to 30% of average conversational speech without the use of hearing devices

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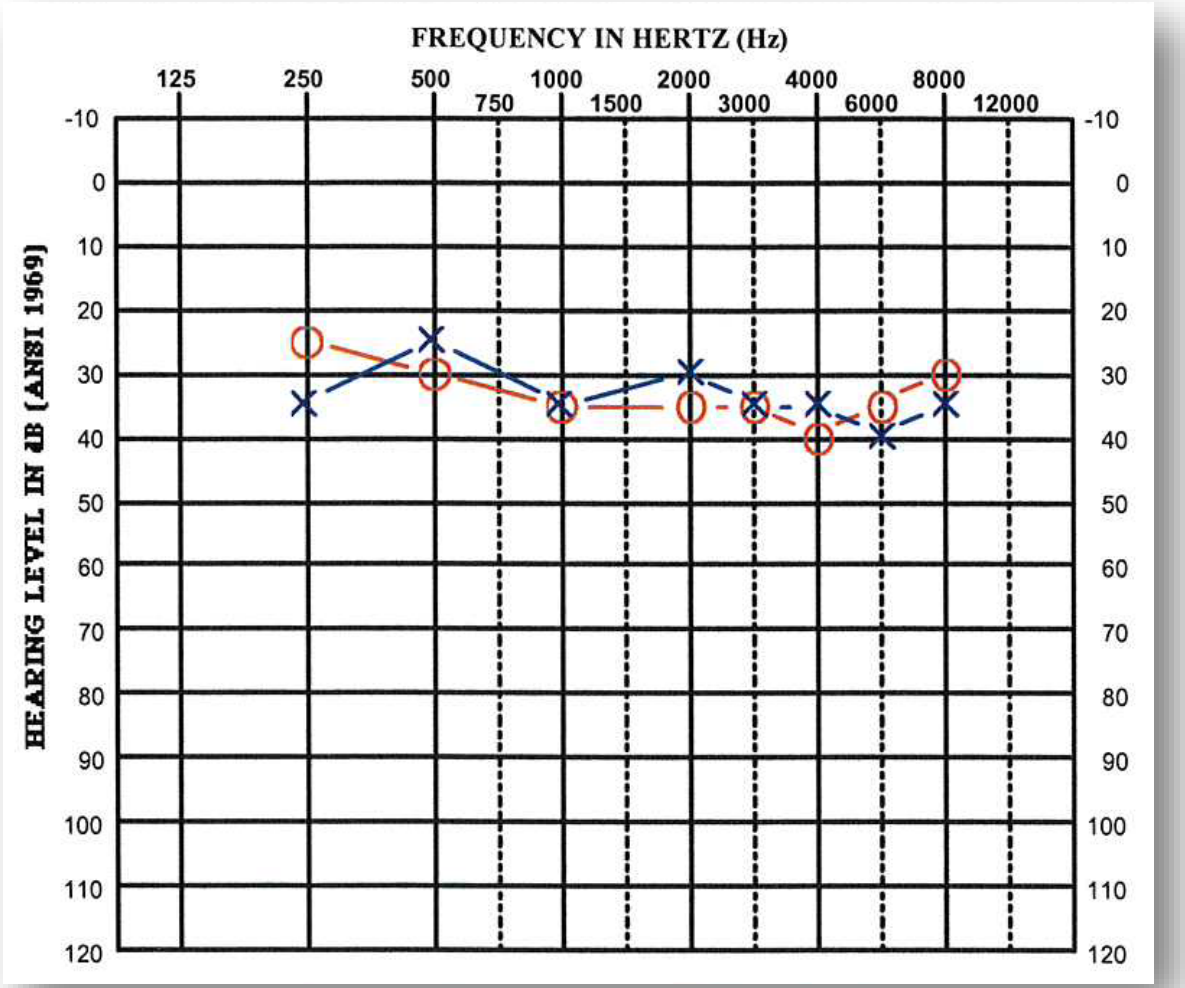
Mild Hearing Loss

25-40 dB HL

Without appropriately fitted hearing devices, a child with mild hearing loss may miss 35% to 60% of the speech around them



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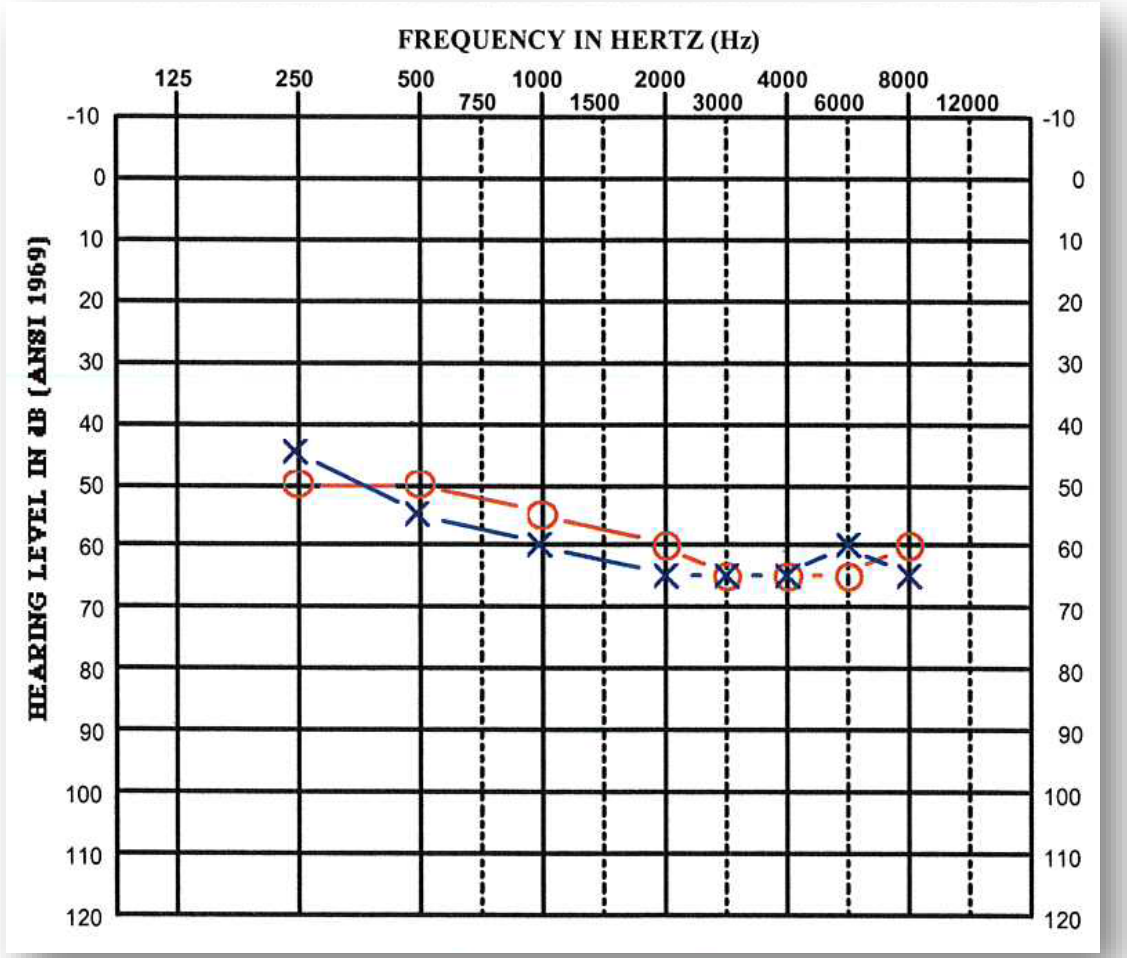
Moderate Hearing Loss

41-69 dB HL

Without appropriately fitted hearing devices, a child with moderate hearing loss may miss up to 80% or nearly all of the speech information in a typical conversation



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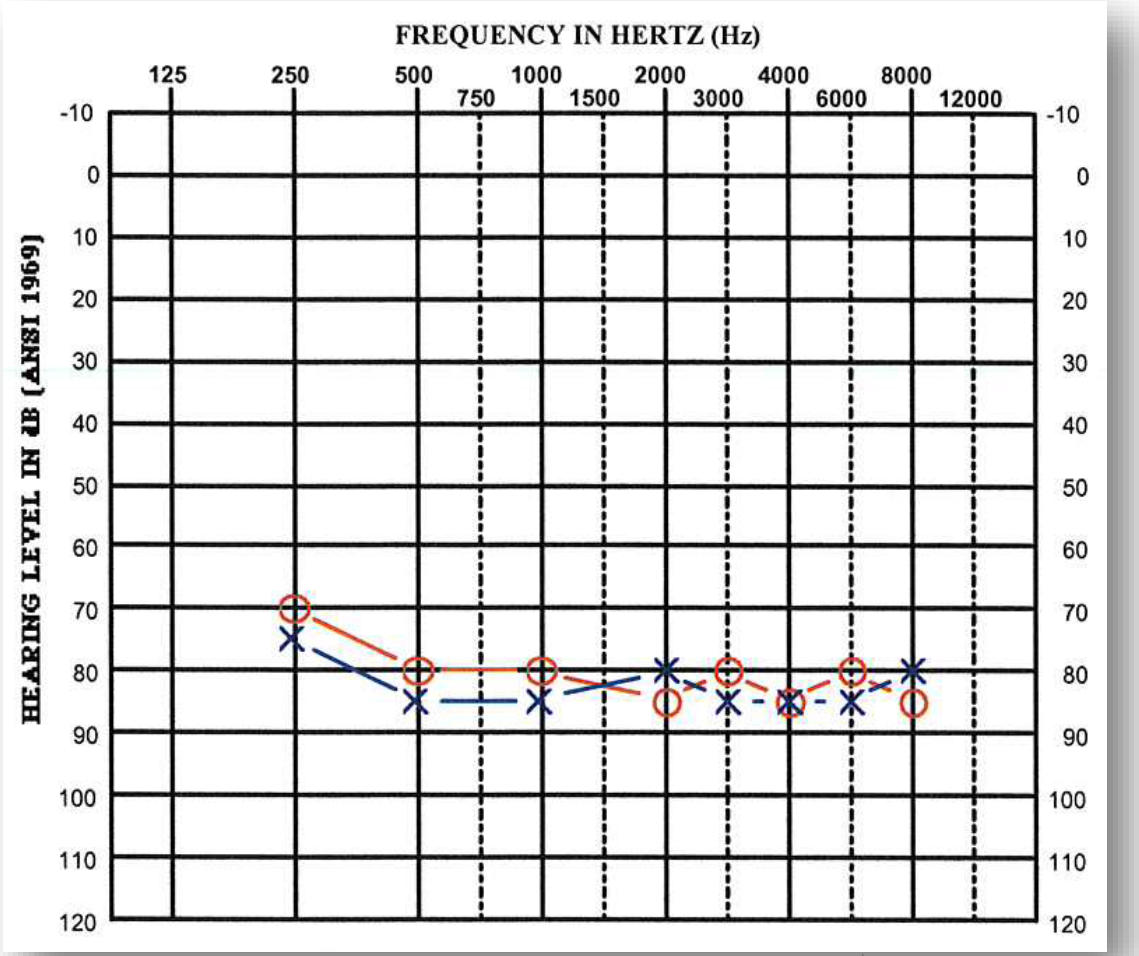
Severe Hearing Loss

Without appropriately fitted hearing devices, a child with severe hearing loss will miss all of the speech information in a typical conversation

70-89 dB HL



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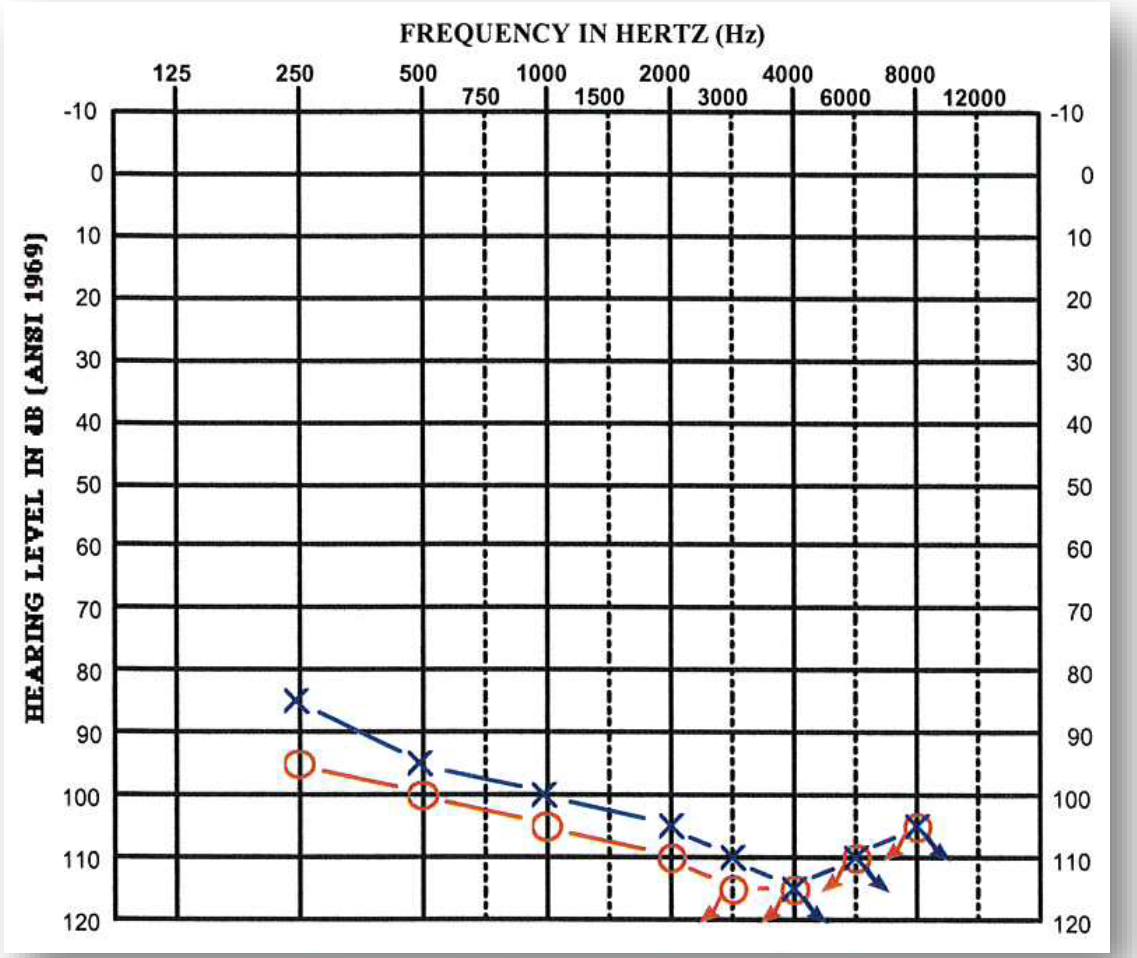
Profound Hearing Loss

Without appropriately fitted hearing devices, a child with severe hearing loss will miss all of the conversation at all levels.

91 dB HL and up



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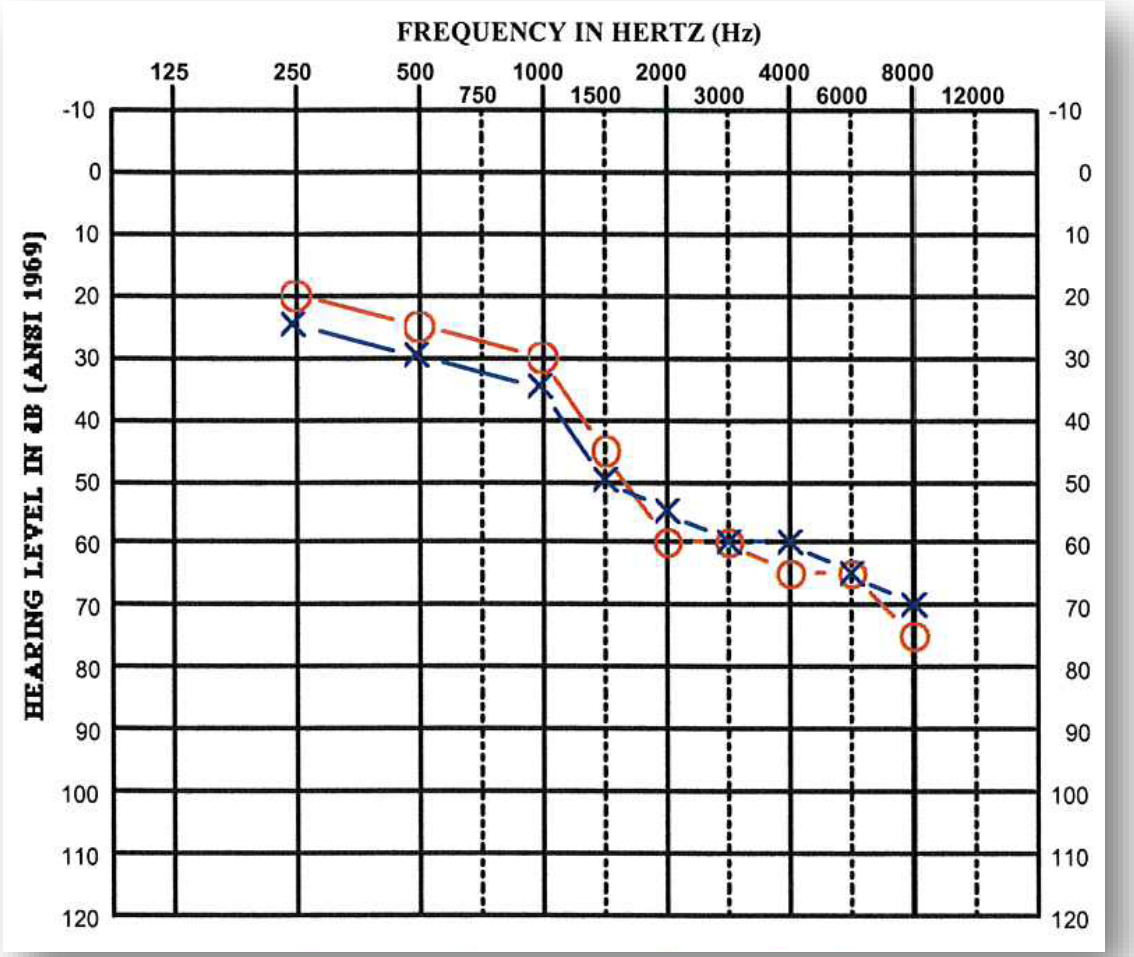
Mild to Moderate Hearing Loss

Ski-slope



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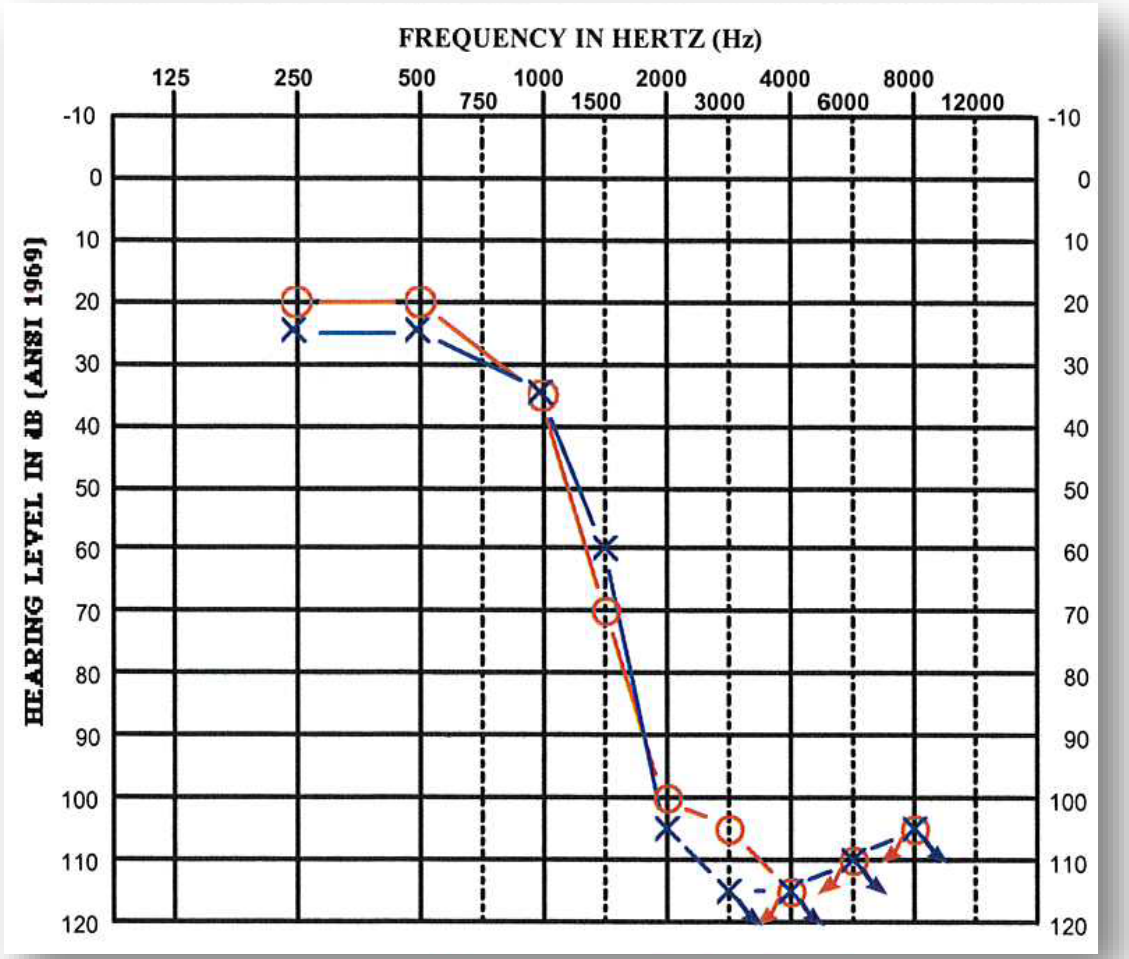
Mild to Profound Hearing Loss

Precipitously Sloping



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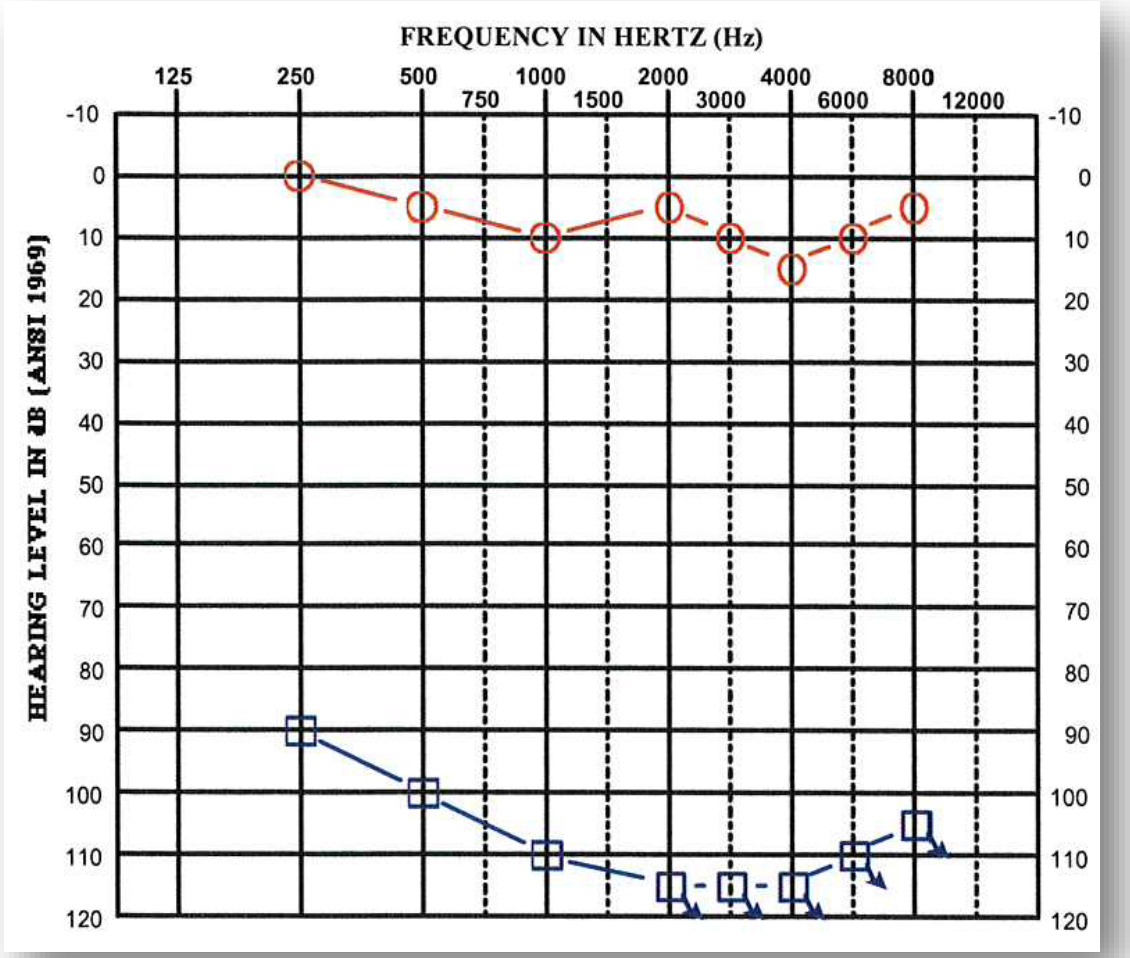
Unilateral

When hearing loss in in severe to profound range in one ear:
Single-sided Deafness (SSD)
AKA: Limited Usable Hearing Unilaterally (LUHU)



Hearing loss is described as asymmetrical when there is more than 30 dB difference between ears

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Assessment of Auditory Function

Overview of hearing tests

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Overview of Hearing Assessments

- **Foundational:**
  - Case History
  - Visual inspection outer ear
  - Otoscopy
- **Physiological – no response required**
  - Tympanometry & Acoustic Reflexes
  - OAEs
  - ABR
  - ASSR
  - CAEPs*
- **Behavioral – participation or response required**
  - VRA
  - CPA
  - Conventional Audiometry
  - Speech Audiometry
  - BOA*



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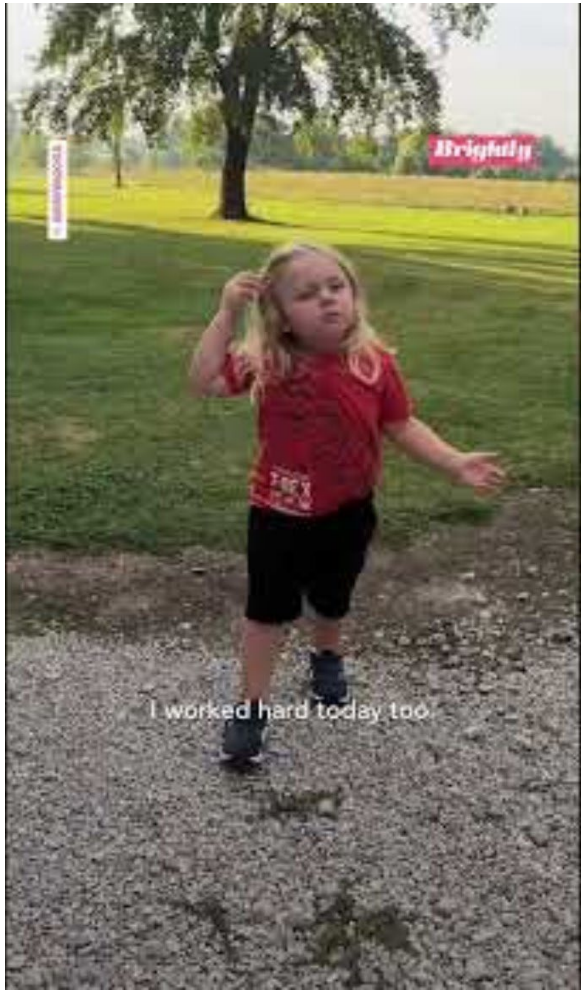
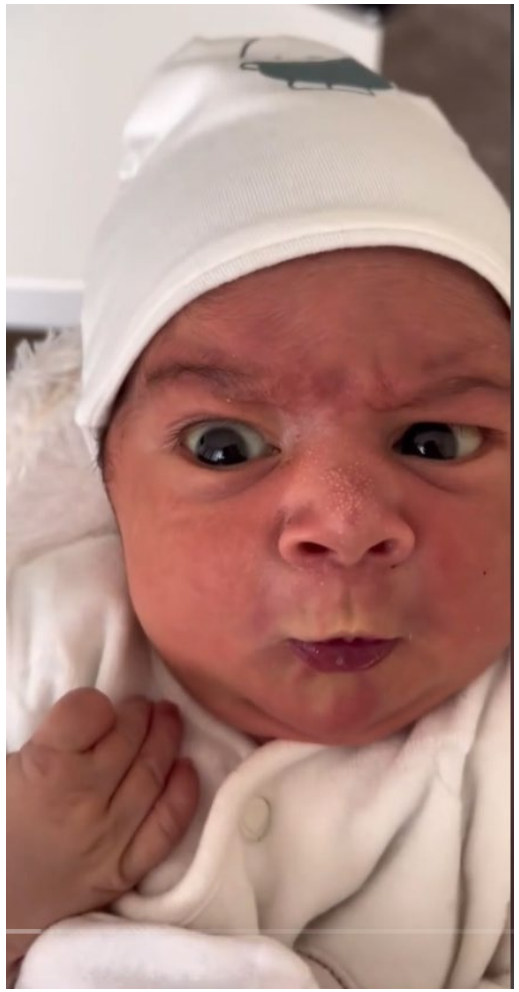
How many tests? “Working hard”





0 - 0:14

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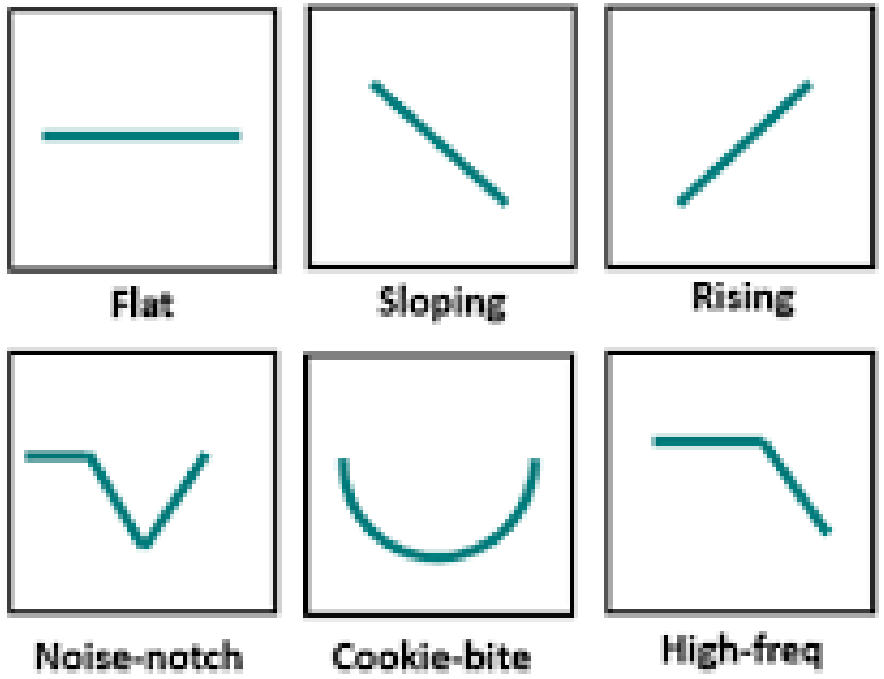
Goals of Pediatric hearing assessment

- Determine **whether hearing loss exists**
- Determine if hearing loss is in **one or both** ears
  - Unilateral or Bilateral
- Determine the **type of hearing loss**
  - Conductive, Sensorineural, Mixed
- Determine the **degree of hearing loss**
  - Severity: slight to profound
- Determine the **configuration or shape**
  - Pattern based on intensity and frequency
  - Flat, sloping, cookie bite, etc.



First Look

Otoscopy

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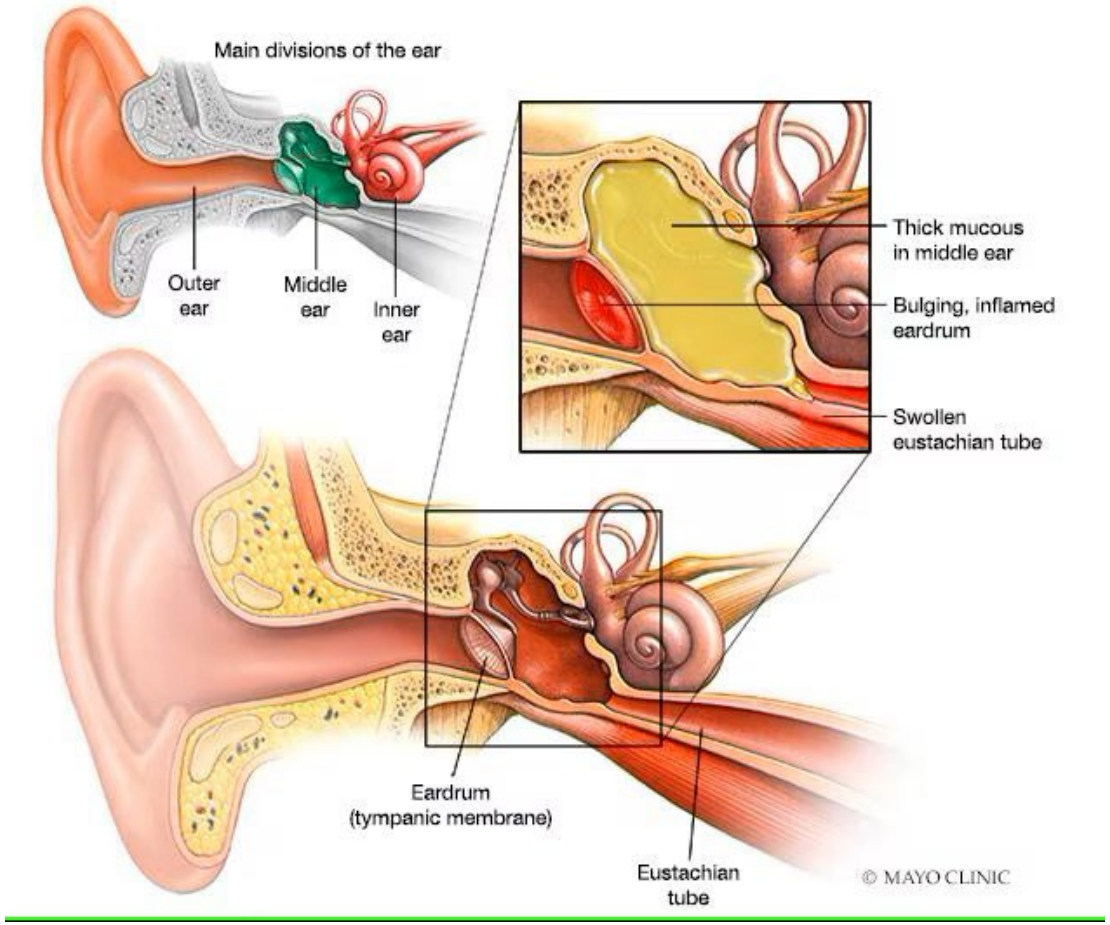
Otoscopy (aka Ear Light)

- Look into the child's ear canal with an ear light
- Look at ear canal and eardrum
- Clear passage, note any redness, irritation, fluid, wax, etc.





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Physiological Measures: “Immittance” Testing

- **Tympanometry**
- Acoustic Reflexes

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Quiet and Still = Quick and Easy

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Tympanometry

What It Is: Measures eardrum movement in response to pressure changes.

How It's Performed:

- Eartip inserted into ear canal. Need airtight seal.
- Pressure changes introduced while sound is played
- The instrument records how the eardrum moves and allows sound to pass to ossicles
- Completed in seconds (quiet patient).





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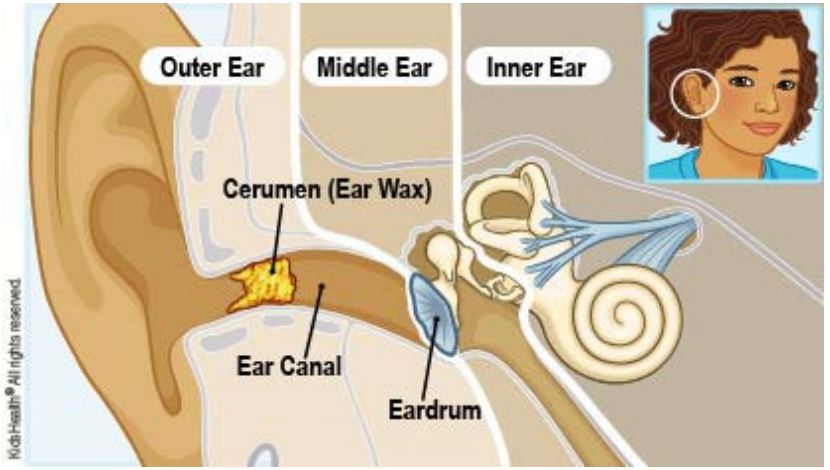
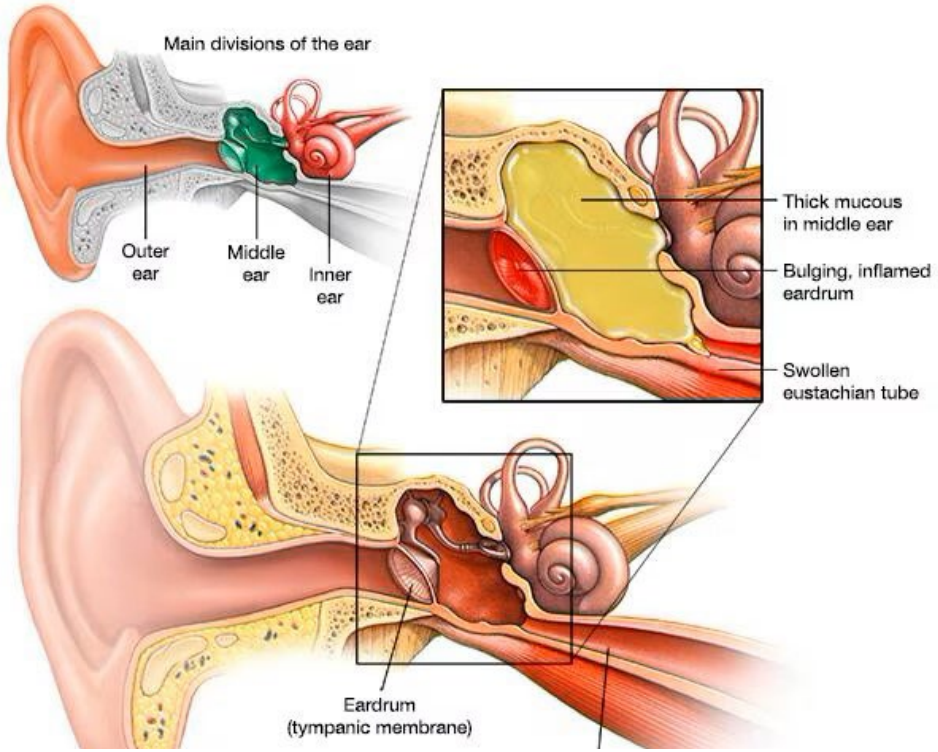
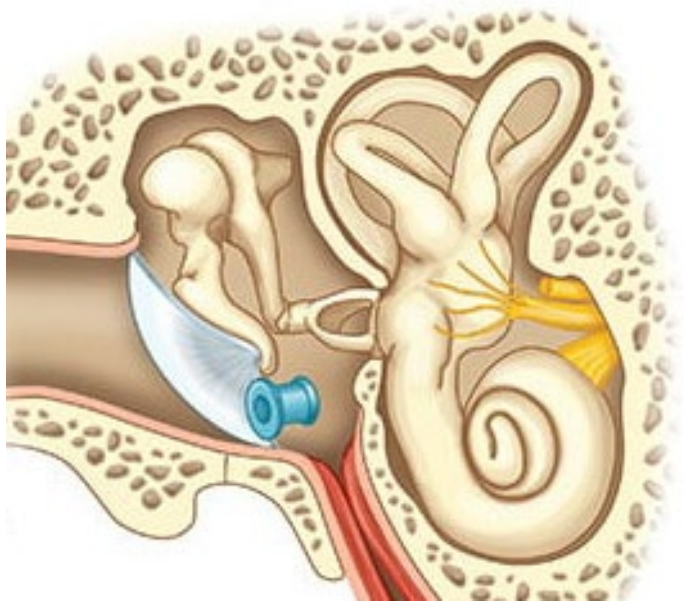
Tympanometry

What It Tells Us:

- Middle ear pressure (e.g., normal, negative pressure).
- Tympanic membrane movement (normal, above or below, or absent)
- Ear canal volume (e.g., wax plug, nonintact eardrum, PE tube).







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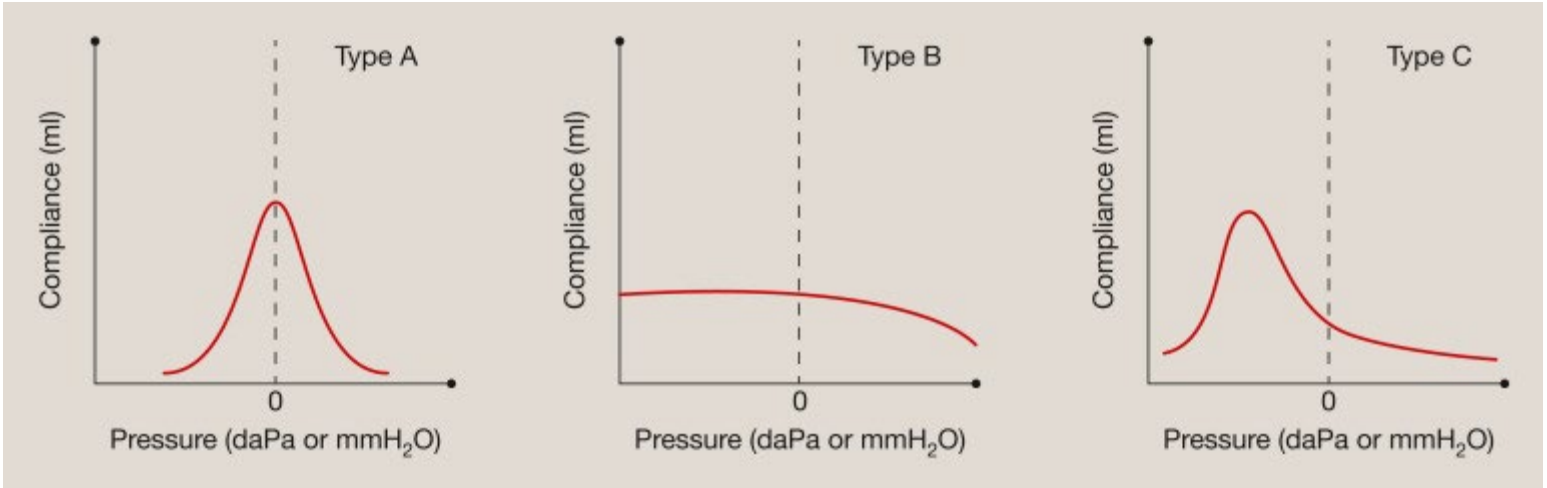
Tympanometry Intepretation: Mountain or Road

- A = movement
- B = flat, no movement
- C = negative pressure
- A Subtypes – stiff or hypercompliant



https://doi.org/10.1016/j.pop.2021.07.010

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See it in Action: Tympanometry (Boys Town)



https://www.youtube.com/watch?v=MfcXAKno0lg

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Physiological Measures: Middle Ear Measures

- Tympanometry (and Wideband Reflectance)
- **Acoustic Reflexes**

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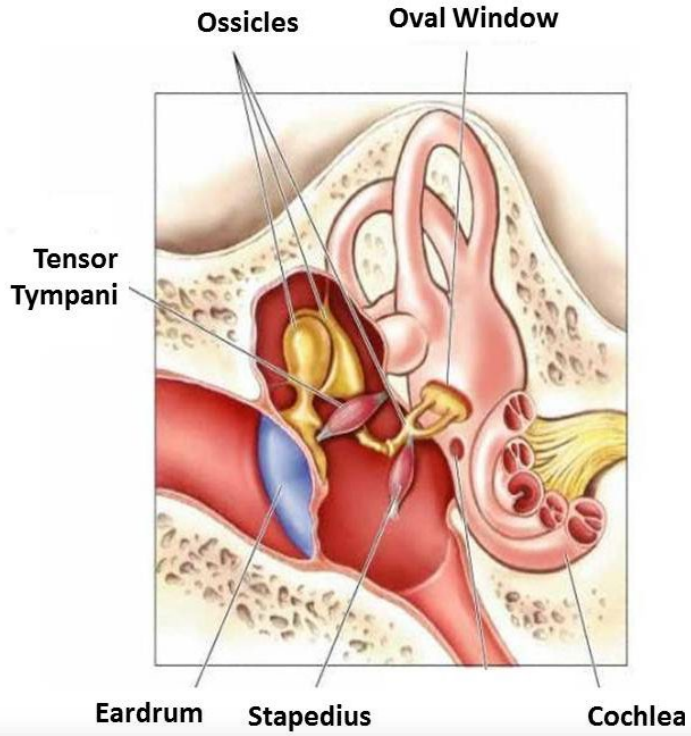
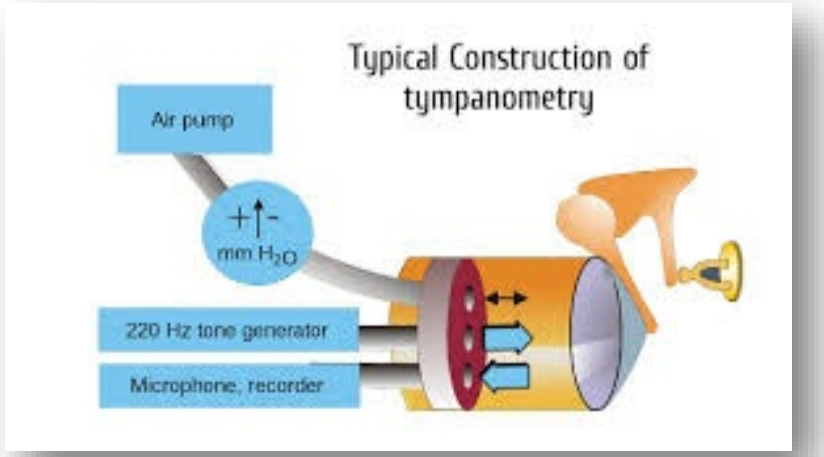
Acoustic reflex testing

- **What It Is:** Evaluates reflexive contraction of the middle ear muscle in response to loud sound.
- **What It Tells Us:**
  - Helps identify type of HL
- **How It's Performed:**
  - Loud sound presented from an ear tip at different frequencies
  - Sound causes middle ear muscle to contract
  - Reflexes can be present WNL, elevated, absent
  - Completed in a few seconds or no more than a couple of minutes





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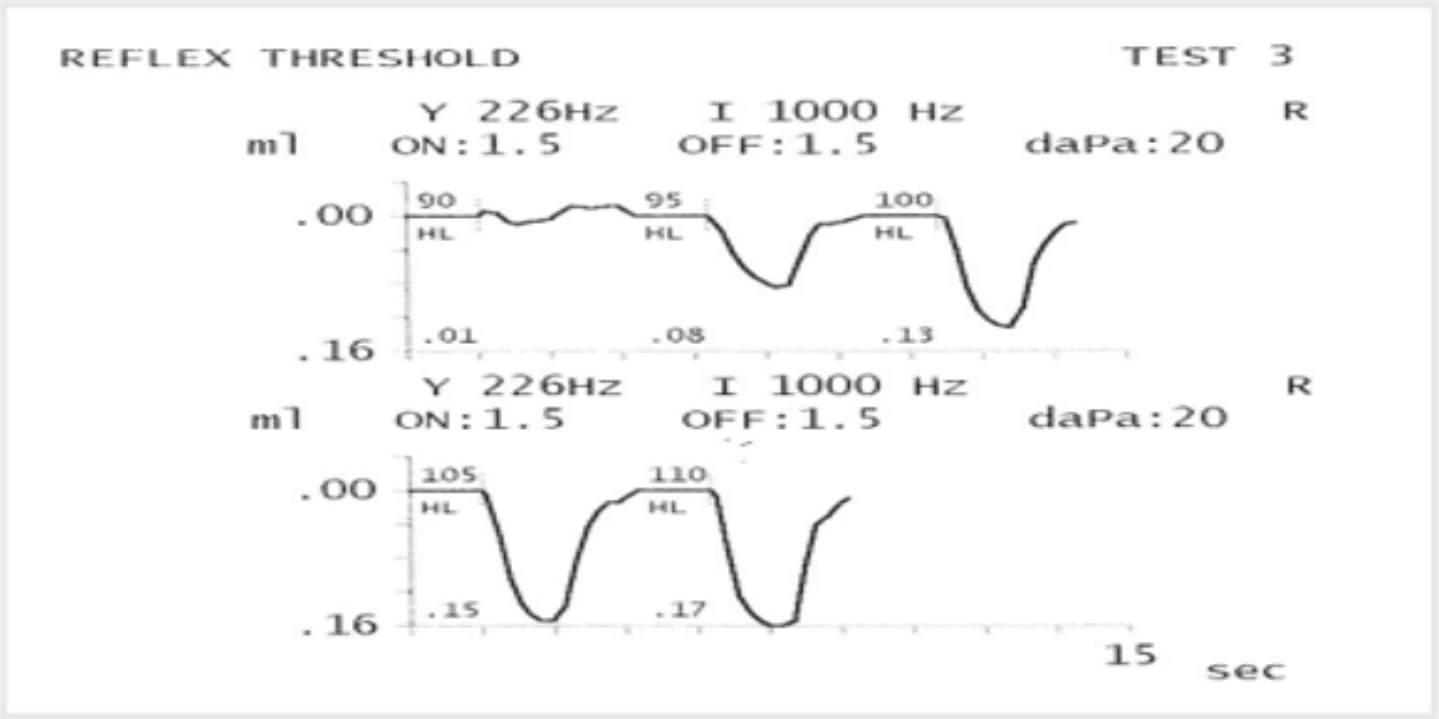
What do we look for…



Possible Findings:

- Present
- Absent
- Elevated

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Physiological Measures

Otoacoustic Emissions

Auditory Brainstem Response

Auditory Steady State Response

Cortical Auditory Evoked Potentials

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Otoacoustic Emissions

What They Are:

- **Soft sounds** generated by the **inner ear (cochlea)** in response to **sound**.
- Produced by the **outer hair cells** of the **cochlea**, indicating **cochlear function**.
- The movement of the outer hair cells sets the **ossicles** into motion and causes the **eardrum** to vibrate like a diaphragm of a loudspeaker.
- Recorded in the **ear canal** with a probe/earphone that contains a highly sensitive microphone.

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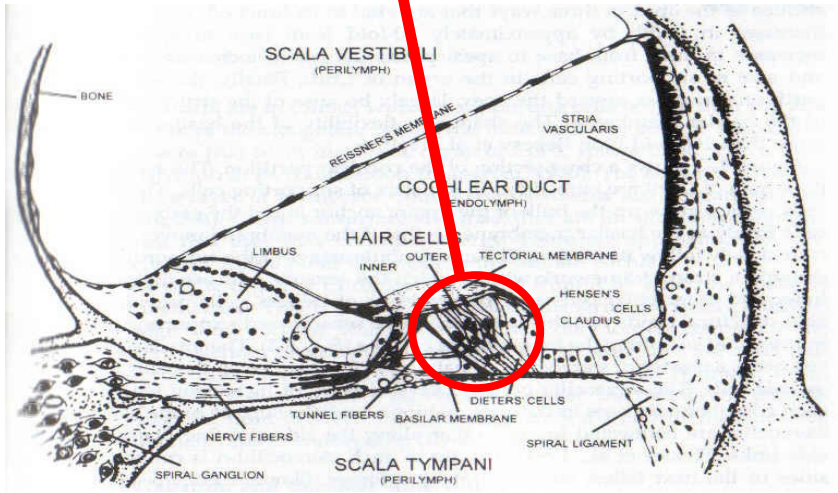
1.



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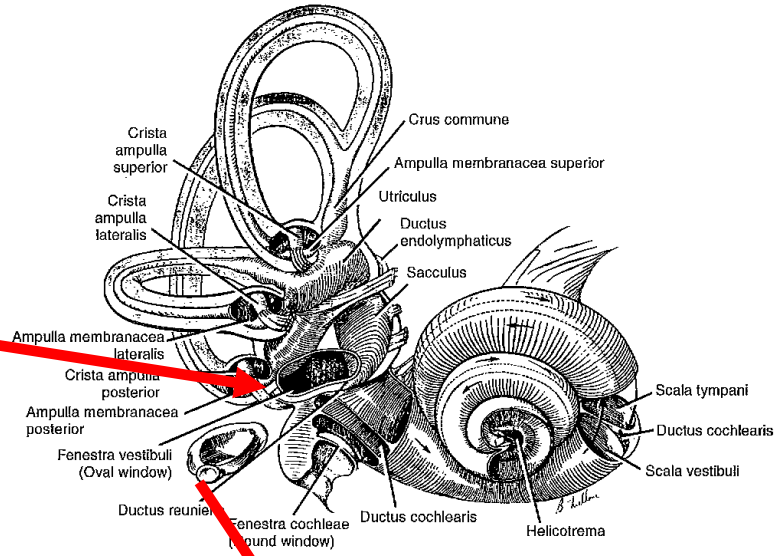

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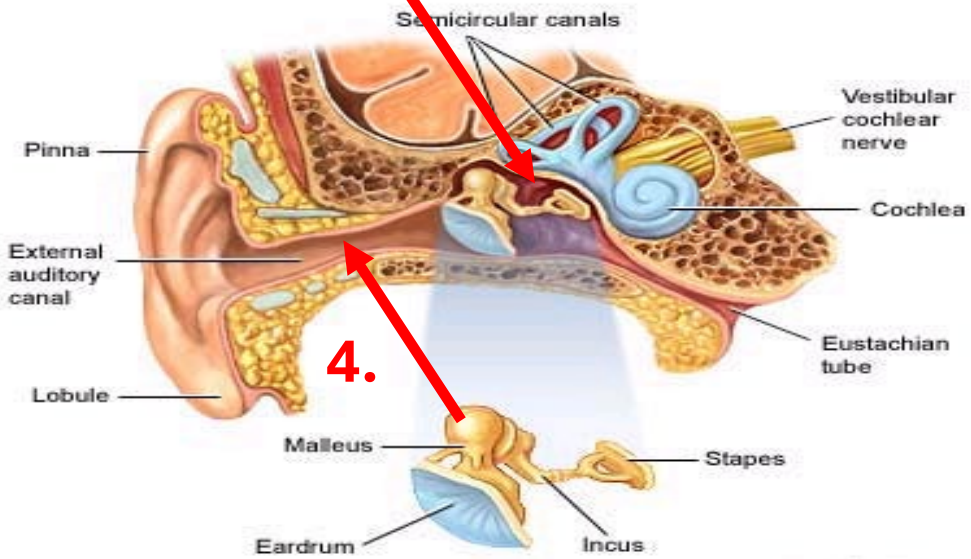

4.

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Otoacoustic Emissions

What They Measure:

- **Function of the outer hair cells** in the **inner ear**.
- Helps assess **hearing sensitivity** and **cochlear health**.
- Quick screening for hearing loss, especially in newborns and young children – **When OAEs are present/normal, hearing sensitivity is most likely to be normal**

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Otoacoustic Emissions

How It's Performed:

- A **small probe** is placed in the **ear canal**, presenting **clicks** or **tones**.
- The **probe measures the sound response** that bounces back from the **cochlea**.
- **Non-invasive**, **painless**, and often **completed in seconds to no more than a few minutes**.





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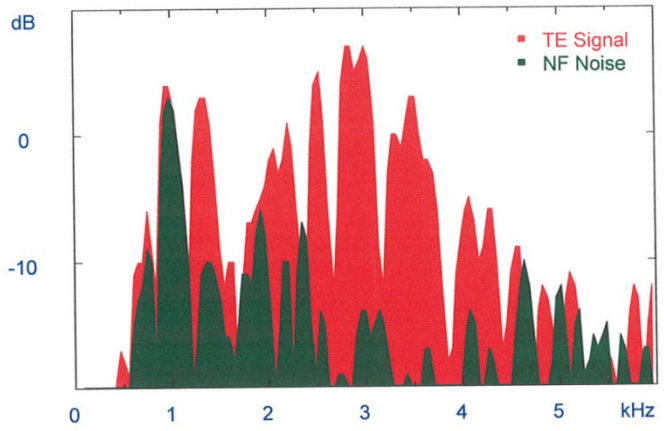
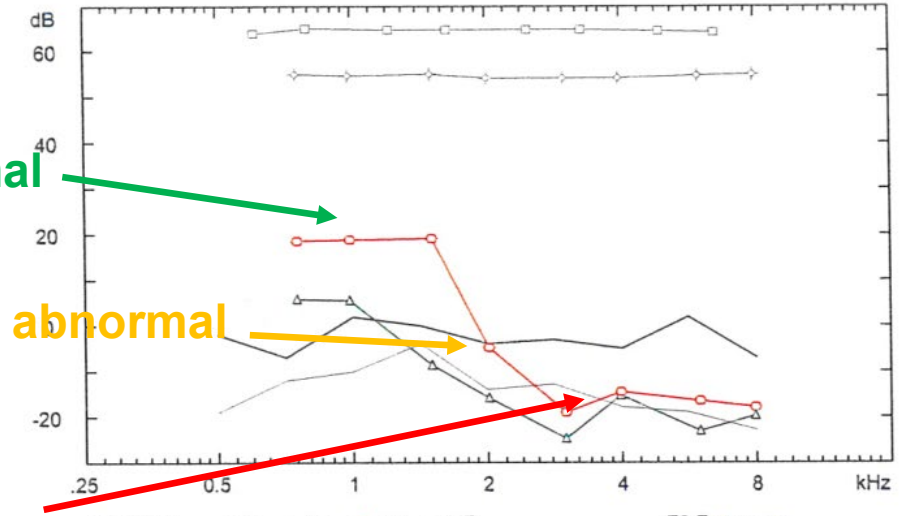
What we look for…
OAE Interpretation

- Low Noise Floor (NF)
- Sufficiently large OAE amplitude
- Positive SNR: DP-NF ≥ 3-6 dB
- Repeatable response



Right: 20-Jun-07: Stab:100% : TE Screen, 70% at 3/4 freq. for Pass: 07F20T00.TE

Frq(kHz)	Repro(%)	TE(dB)	NF(dB)	TE-NF(dB)	Result
1.0	28	10.0	8.9	1.1	-
1.5	88	8.8	-2.6	11.4	Pass
2.0	62	8.7	1.9	6.8	Refer
3.0	98	16.5	-3.3	19.8	Pass
4.0	85	8.8	-2.3	11.1	Pass
1.2-3.5	92	17.7	4.1	13.6	-



Normal

Present but abnormal

Absent

Right: 17-Apr-12: -: 750-8000 Hz Diagnostic Test: 12D17D01.OAE

L1(dB)	L2(dB)	F1(Hz)	F2(Hz)	GM(Hz)	DP(dB)	NF(dB)	DP-NF(dB)
64.2	55.1	6516	7969	7206	-18.0	-19.7	1.7
64.6	54.9	4922	6000	5434	-16.6	-23.3	6.7
64.8	54.1	3281	3984	3616	-14.6	-15.5	0.9
64.9	54.4	2484	3000	2730	-18.9	-24.8	5.9
64.7	54.2	1641	2016	1818	-4.7	-15.8	11.1
65.0	55.1	1219	1500	1352	19.1	-8.8	27.9
65.2	54.8	797	984	886	19.0	5.6	13.4
63.9	55.0	609	750	676	18.6	5.9	12.7

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Likelihood of OAE/Degree of HL

Absent with middle ear dysfunction (Type B tymps).

Present and robust OAEs generally rule out all but mild hearing loss.

However, they can also be present in cases of ANSD.

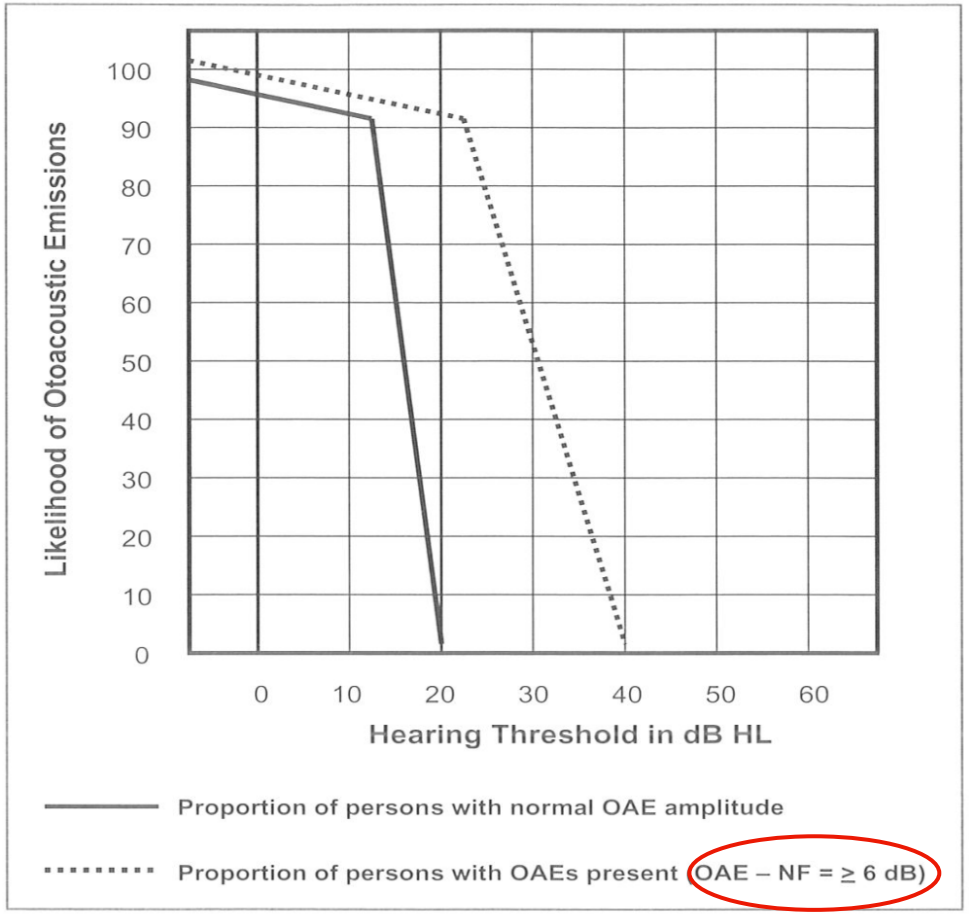

FIGURE 6–11. Likelihood of detecting a normal otoacoustic emission (OAE), that is, amplitude within normal limits, or the presence of any OAE activity (>6 dB) as a function of hearing threshold level.

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Physiological Measures

Otoacoustic Emissions

Auditory Brainstem Response (ABR)

Auditory Steady State Response (ASSR)

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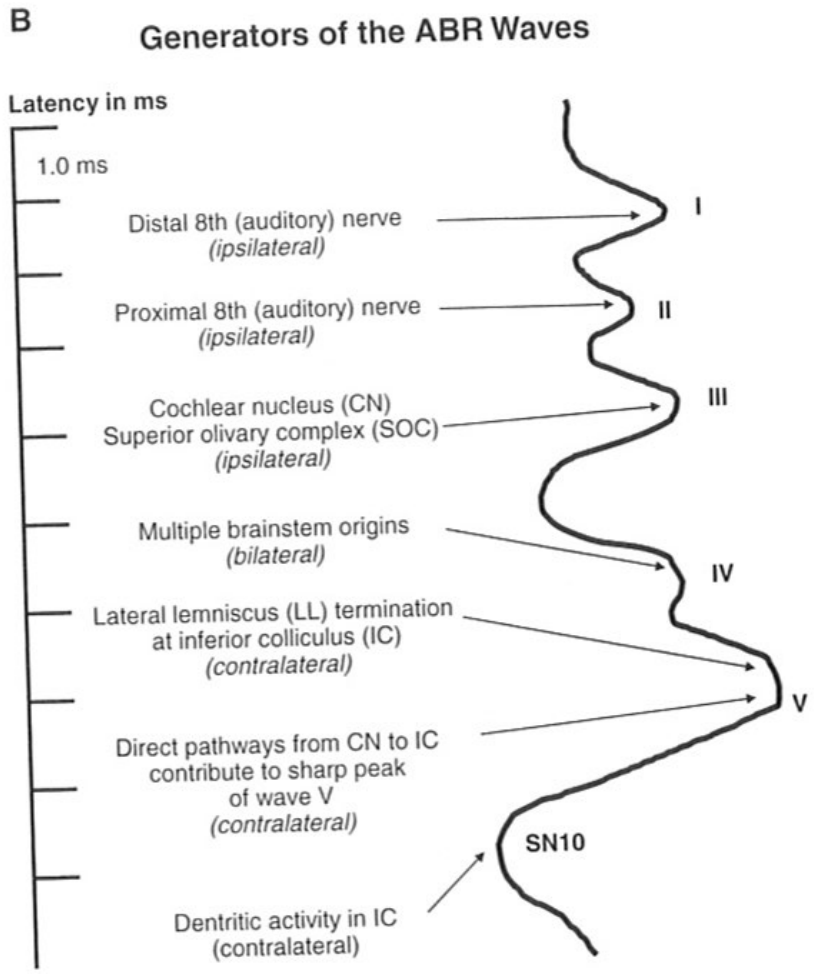
What is an ABR?

The auditory brainstem response (ABR) is a waveform with several peaks and troughs that are produced by electrical potentials recorded from neural generators in the brainstem in response to a click or tone burst



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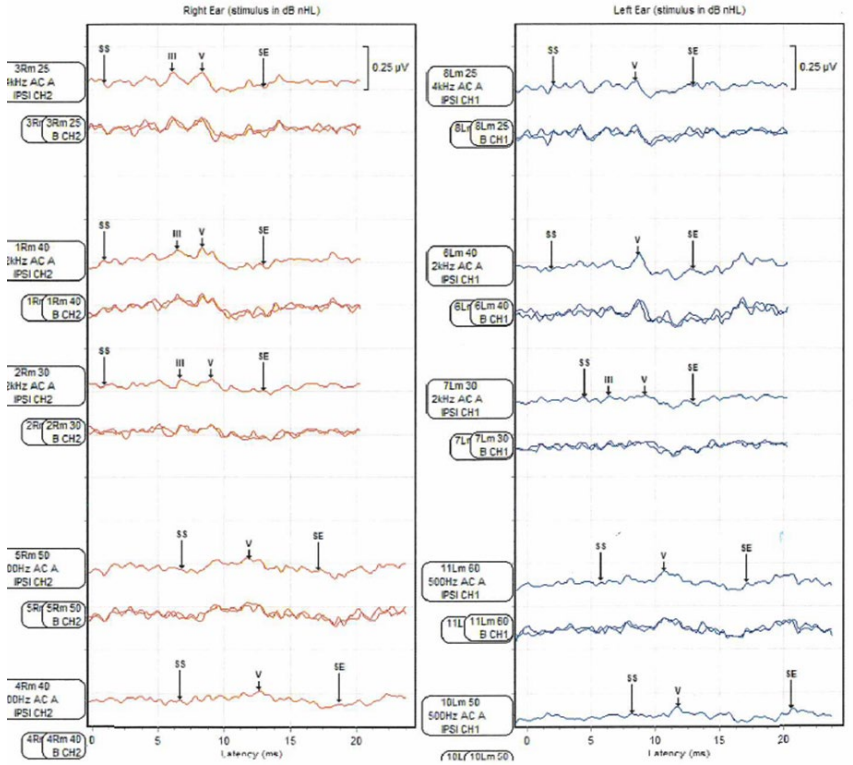
Auditory Evoked Potentials

- Layman's Definition: "Brainwaves (electrical activity) are elicited by the presentation of sound and recorded by wires that are taped to the head."







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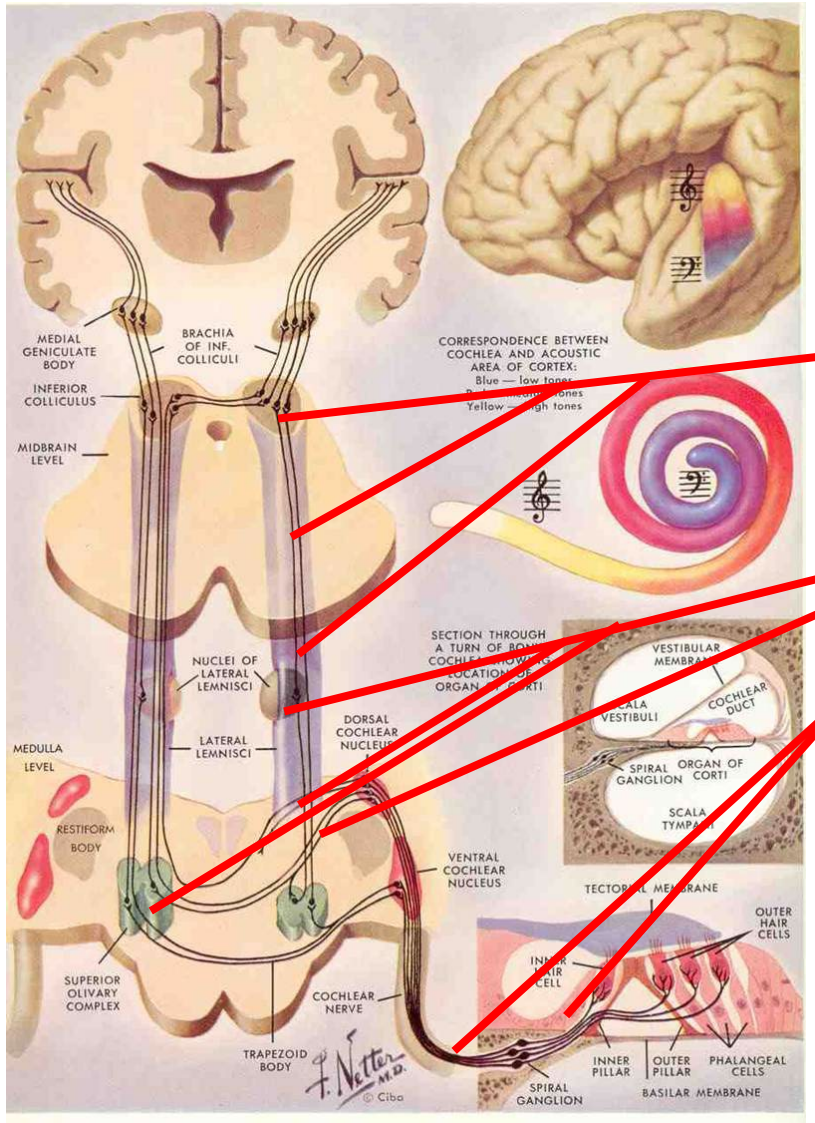
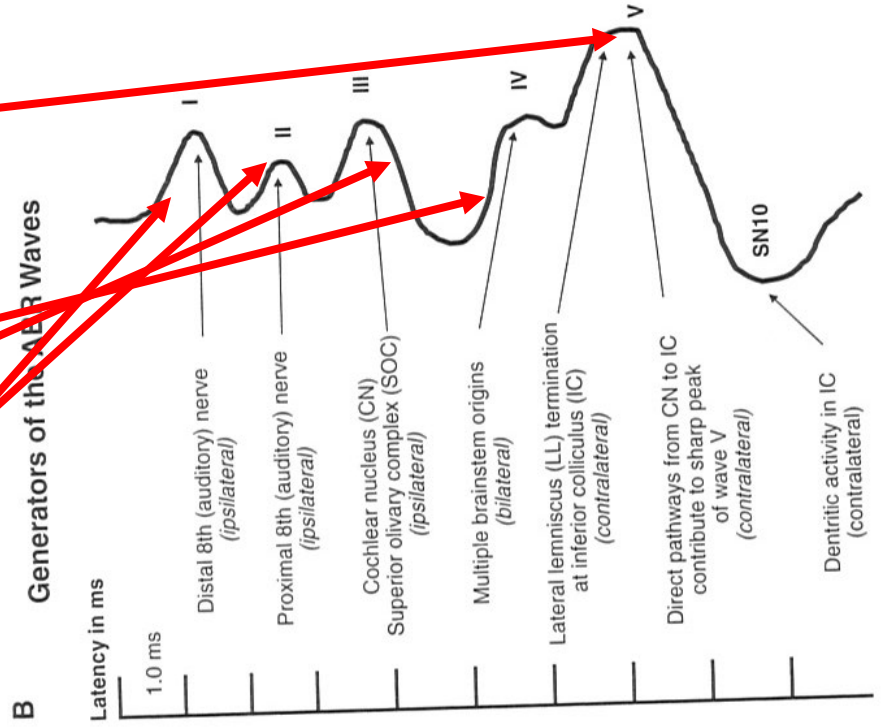
What is the ABR?





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The auditory brainstem response (ABR) is a waveform with several peaks and troughs that are produced by electrical potentials recorded from neural generators in the brainstem in response to a click or tone burst

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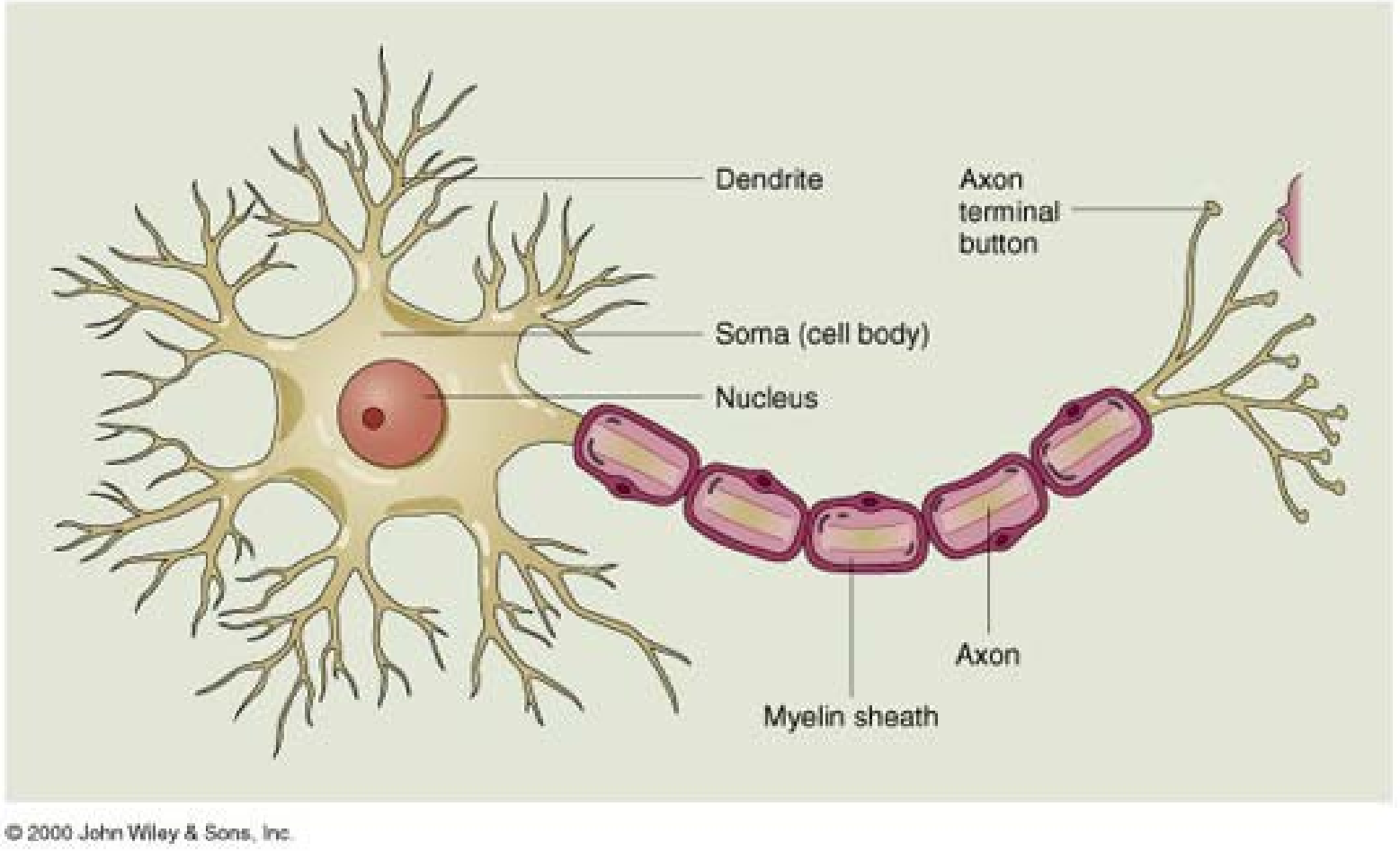
Neuronal Physiology

Why are brain waves described as electrical potentials?





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You may have heard or read ABR (brain waves) described as electrical responses

The foundation of neuronal physiology resides with electron theory

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Auditory Brainstem Response (ABR)

- **What It Is:**
  - An **objective test** that measures the response to sounds in the **brainstem**. When nerve cells fire together, they produce a response that can be measured at the scalp.
- **What It Tells Us:**
  - **Hearing thresholds:** Estimates the **softest sounds** the **ear can detect**.
  - **Neural function:** Assesses the **integrity** of the **auditory pathway** from the **cochlea** to the **brainstem**.
  - **Identifies hearing loss: Type** (e.g., sensorineural, conductive) and **degree** (mild to profound).
- **How long does it take:** 15 min – 2 hours (test time)



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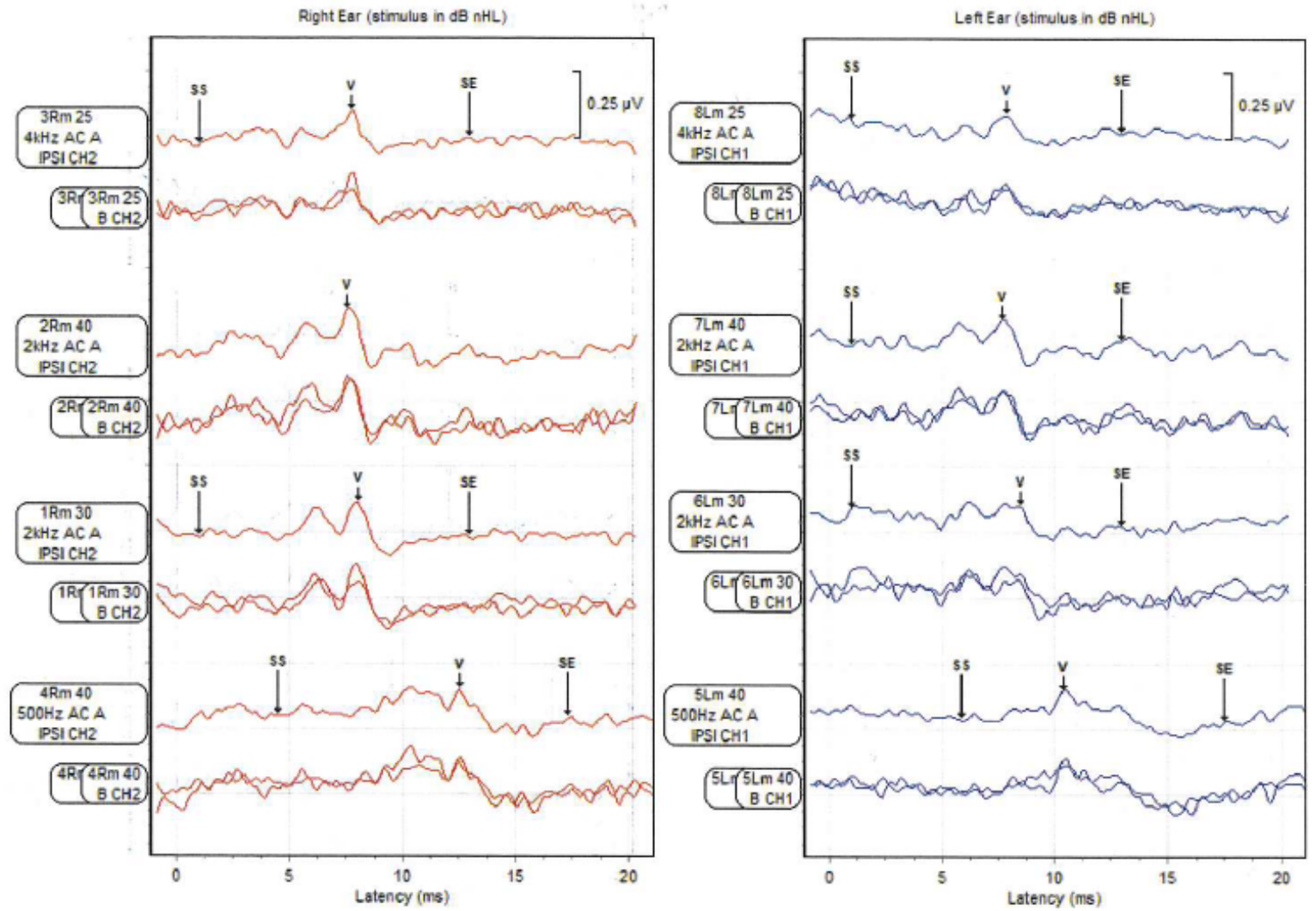
Auditory Brainstem Response (ABR)

- **How It's Performed:**
  - **Electrodes** are placed on the scalp (forehead and behind the ears).
  - **Sounds** (e.g., **clicks, tone bursts, chirps**) are played through **earphones** or a bone conduction device.
  - The loudness of the sounds is adjusted up and down to find the lowest level of sound that produces responses from brainstem neurons or ABR waveform.
  - The test is **painless**, **non-invasive**, and often done while the **child is sleeping naturally** (but can be performed with mid sedation or anesthesia as needed).
  - Test time is **variable**.



AEP GRAPH



ABR WAVEFORM DATA

		Corr. Coef.	RN (µV)	SNR	Time (ms) I	I'	II	III	IV	V	V'	I-III	III-V	I-V	Amp (µV) I-I'	V-V'	Ratio (V-V')/(I-I')	SS	SE
1	R 30 CH2	0.78	0.015	—	—	—	—	—	—	8.05	—	—	—	—	—	—	—	0.97	12.95
2	R 40 CH2	—	0.019	—	—	—	—	—	—	7.53	—	—	—	—	—	—	—	—	—
3	R 25 CH2	0.75	0.011	—	—	—	—	—	—	7.74	—	—	—	—	—	—	—	0.97	12.95
4	R 40 CH2	0.88	0.015	—	—	—	—	—	—	12.53	—	—	—	—	—	—	—	4.51	17.32
5	L 40 CH1	0.78	0.015	—	—	—	—	—	—	10.35	—	—	—	—	—	—	—	5.87	17.53
6	L 30 CH1	0.68	0.018	—	—	—	—	—	—	8.47	—	—	—	—	—	—	—	0.97	12.95
7	L 40 CH1	0.83	0.012	—	—	—	—	—	—	7.64	—	—	—	—	—	—	—	0.97	12.95
8	L 25 CH1	0.74	0.010	—	—	—	—	—	—	7.85	—	—	—	—	—	—	—	0.97	12.95

Corr. Coef. = Correlation Coefficent, RN = Residual Noise

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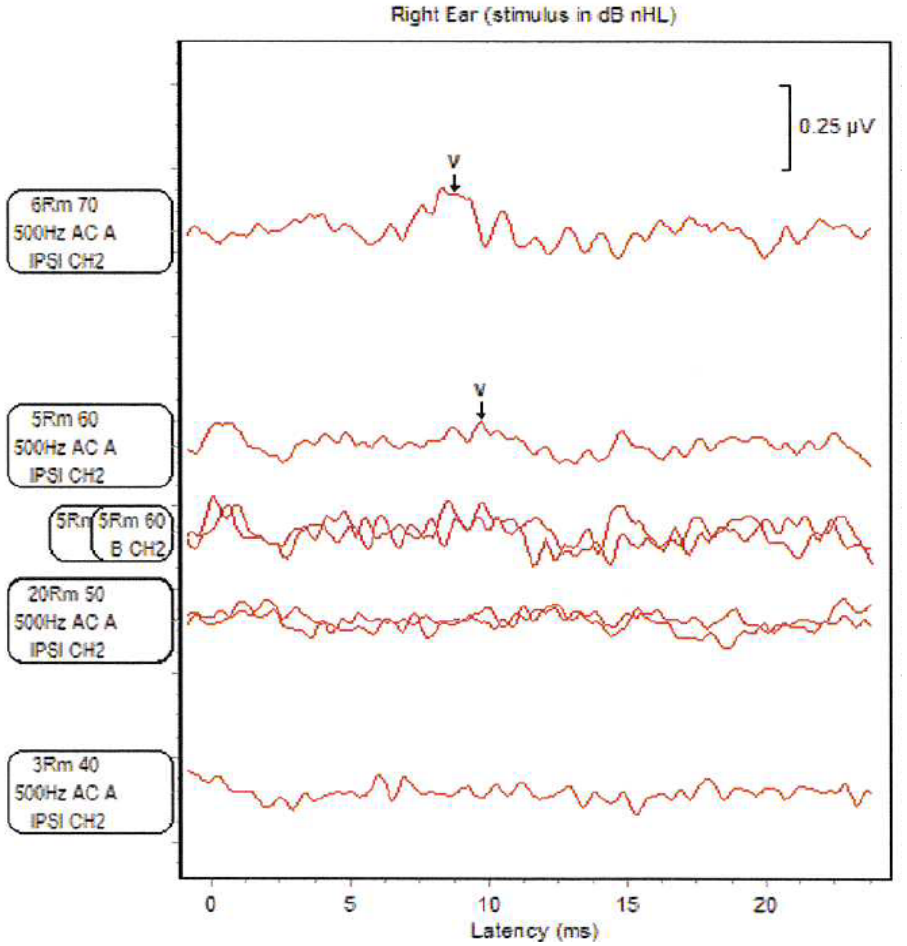
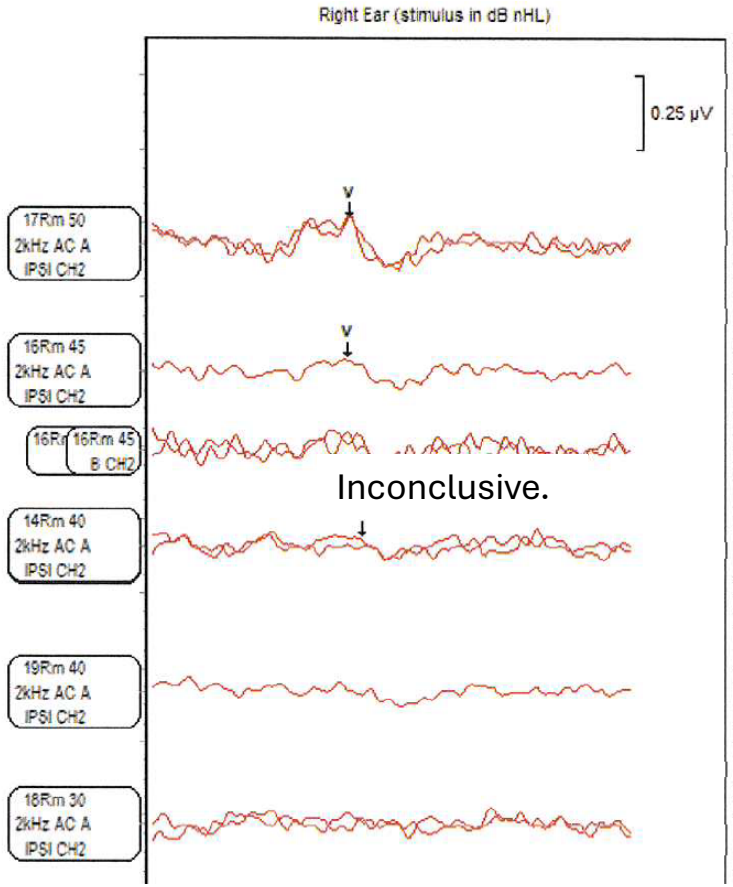
ABR Protocol - SNHL

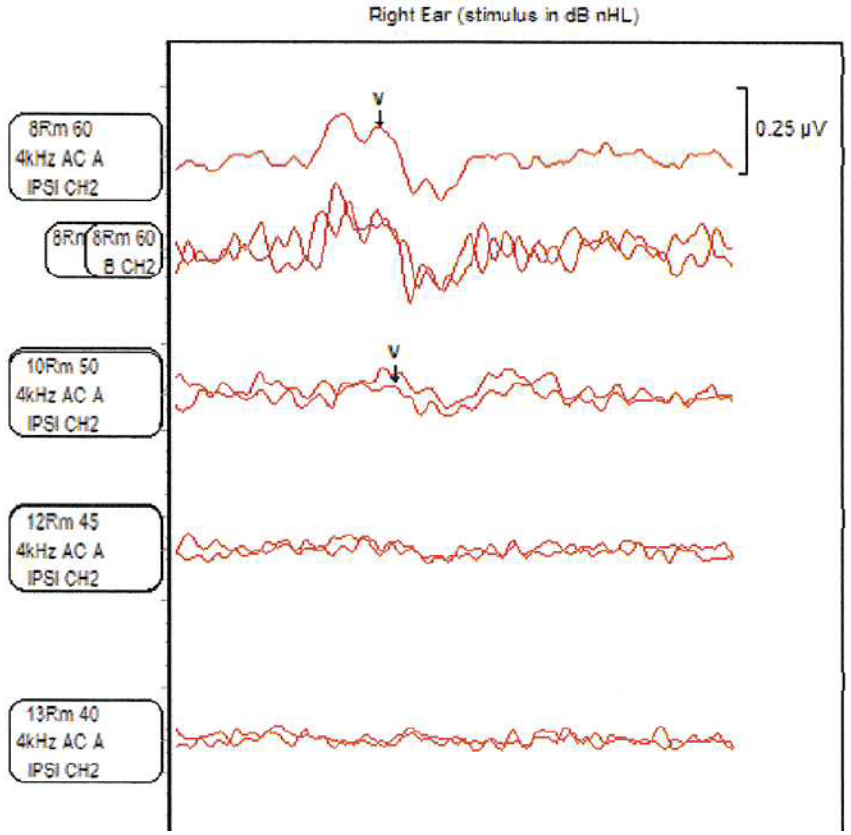
1000 Hz tympanometry was WNL



60 dB nHL – 15 dB = 45 dB eHL



45 dB nHL – 5 dB = 40 dB eHL



50 dB nHL – 0 dB = 50 dB eHL

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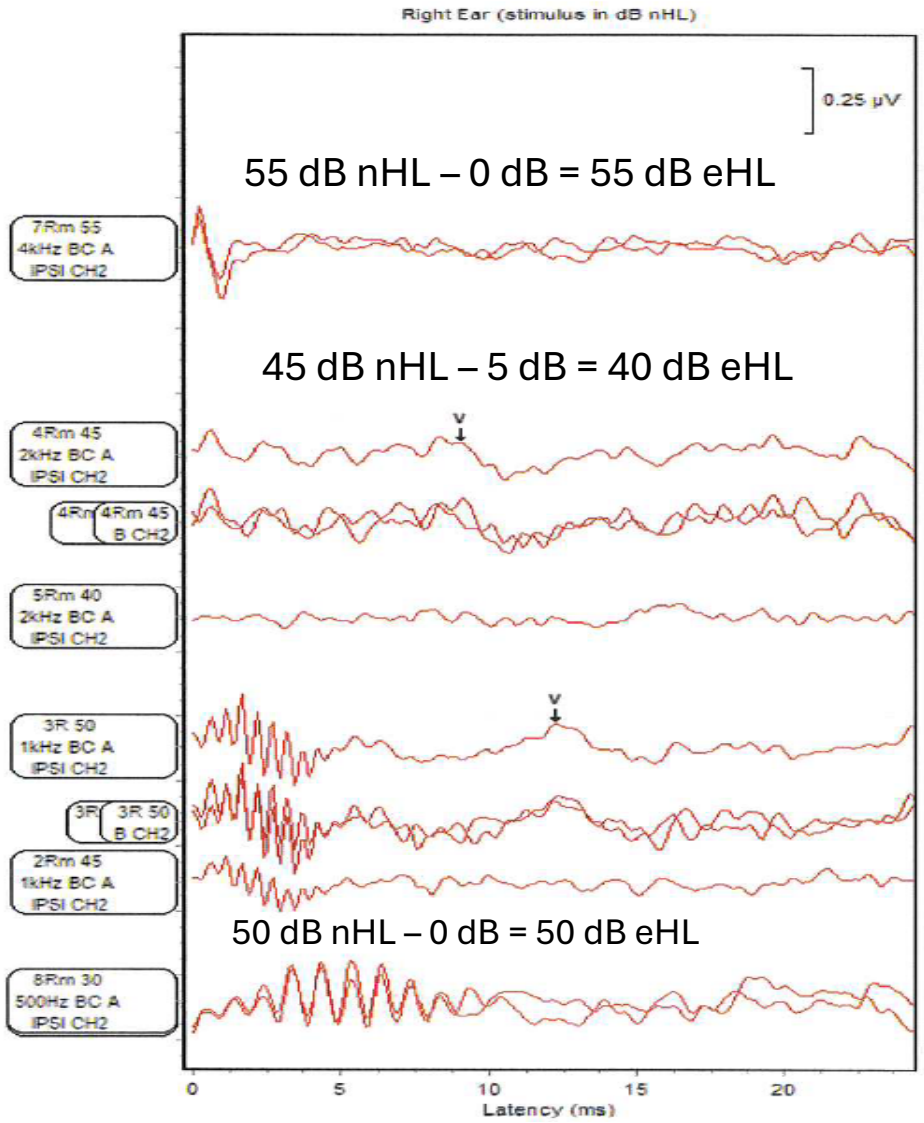
ABR Protocol - SNHL

AC Thresholds

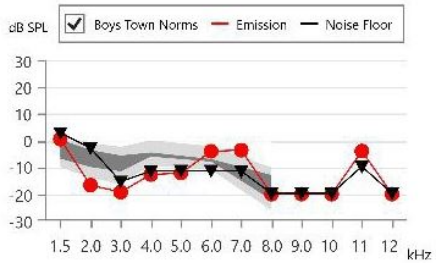
60 dB nHL – 15 dB = 45 dB eHL

45 dB nHL – 5 dB = 40 dB eHL

50 dB nHL – 0 dB = 50 dB eHL

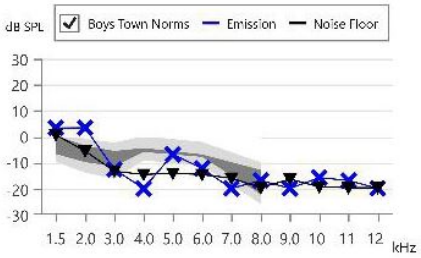


Ear Right Frequencies for Pass
Test Result Min. Amplitude
Protocol DP 1.5-12 Pass SNR
Probe S/N GI2008924



F2	L1	L2	DP	NF	SNR
1.5	62	50	0.5	2.6	-2.1
2.0	61	56	-16.7	-3.0	-13.6
3.0	66	55	-19.2	-15.6	-3.7
4.0	64	55	-12.7	-11.7	-1.0
5.0	65	54	-12.1	-11.5	-0.6
6.0	73	61	-4.0	-11.5	7.5
7.0	72	62	-3.6	-11.7	8.1
8.0	72	65	-20.0	-20.0	0.0
9.0	74	65	-20.0	-20.0	0.0
10	74	64	-20.0	-20.0	0.0
11	74	63	-3.9	-9.9	6.0
12	75	59	-20.0	-20.0	0.0

Ear Left Frequencies for Pass
Test Result Min. Amplitude
Protocol DP 1.5-12 Pass SNR
Probe S/N GI2008924



F2	L1	L2	DP	NF	SNR
1.5	65	55	3.3	0.4	2.9
2.0	65	55	3.4	-5.9	9.3
3.0	64	54	-12.7	-13.6	1.0
4.0	65	55	-20.0	-14.9	-5.1
5.0	65	54	-6.8	-14.5	7.6
6.0	70	61	-12.3	-14.9	2.6
7.0	70	65	-20.0	-16.3	-3.7
8.0	75	65	-16.9	-20.0	3.1
9.0	74	65	-20.0	-16.7	-3.3
10	75	61	-15.8	-19.6	3.8
11	75	56	-16.9	-20.0	3.1
12	71	50	-20.0	-20.0	0.0

1000 Hz tympanometry was WNL

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ABR – OIHP Conductive Hearing Loss

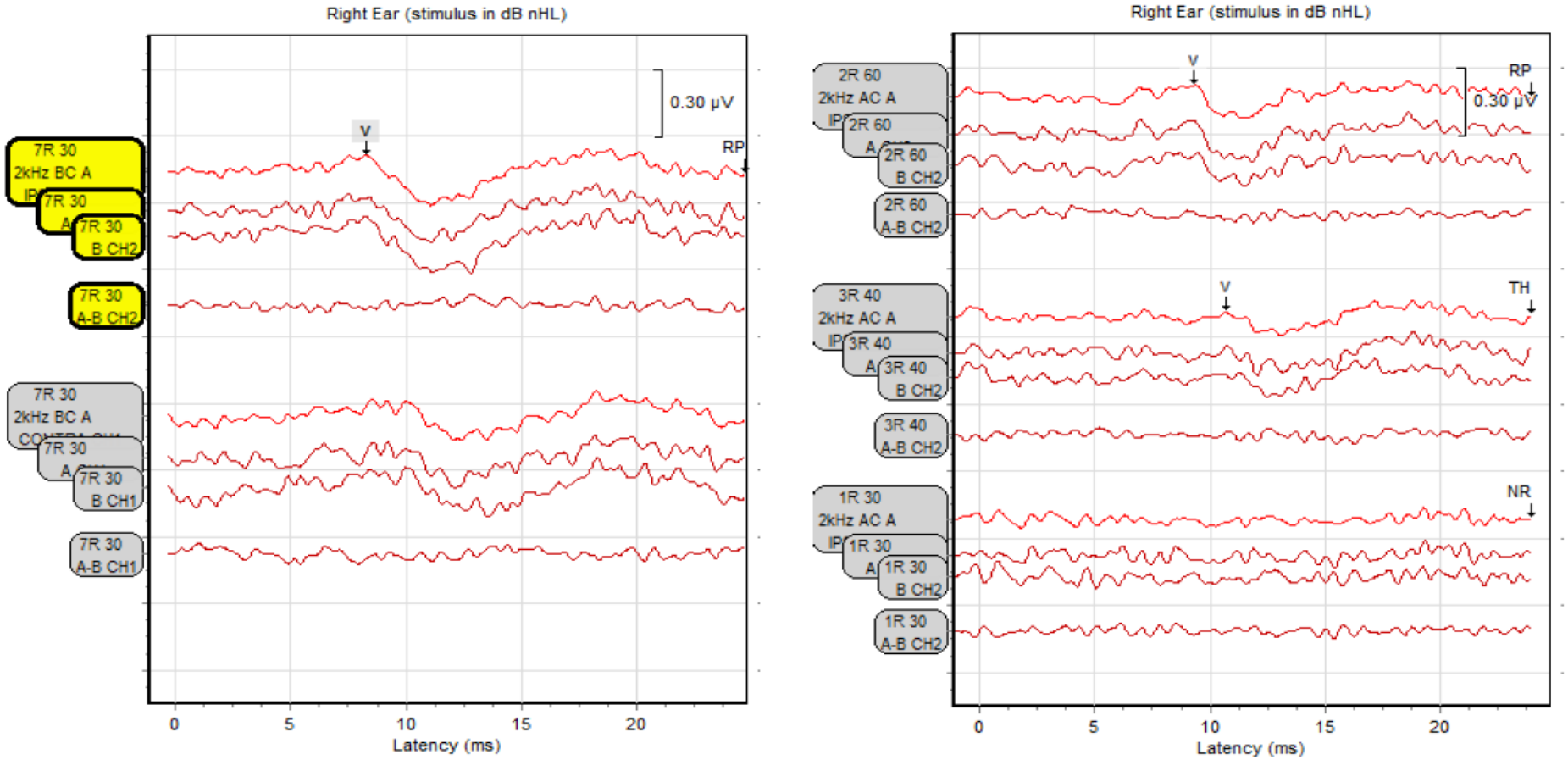

Figure 3.09.1 Example of proper response judgement and labelling.

OIHP, 2020

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Screening versus Diagnostic ABR

Feature	Screening ABR	Diagnostic ABR
Purpose	Pass/ refer test to determine if at-risk for hearing loss	Detailed assessment of auditory functioning
Time	~5-10 min	~30-120 min
Stimulus	Click (broader frequency range)	Click and Tone-bursts
Threshold Detection	No, just pass/ refer	Yes, determines softest level “audible”
Transducer	Air Conduction (Earphones)	Air & Bone Conduction
Use Case	Newborn hearing screening, Rapid Screening in Clinic	Diagnosing degree and type of auditory dysfunction, determining estimated audiogram

Auditory Evoked Potentials
Setting the Stage for Diagnostic ABR



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Natural Sleep vs. Sedation



- ABR testing is usually completed while an infant sleeps naturally from birth to about 6 months of age

- After 6 months of age, many infants will not sleep soundly for testing to be completed → ABR testing requires light anesthesia so testing can be completed in restful state

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Setting the Stage: Natural Sleep

- Communicate with the family regarding the importance that the baby sleeps
  - Schedule ABR to coincide with naptime
  - Deprive child of sleep at least 1.5-2 hours prior to appointment (longer for older children)
  - Someone should ride in backseat with child to try to prevent sleep in car
  - Deprive child of eating at least 1.5-2 hours prior to appointment
  - Baby should arrive hungry. Do not feed until after electrodes are applied. Parent may hold infant while electrode sites are being prepared.
- Provide a comfortable environment for the baby
  - Following feeding, ensure diaper is dry
  - Swaddle (keep clean blankets in stock)
  - Provide appropriate furniture



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Skin Preparation and Electrode Placement

- Use an alcohol prep and exfoliating cleanser to clean the skin.
- Electrode stickers are placed on scalp.
- Baby is fed and quieted. Cell phones turned off (to reduce any electrical noise).
- Electrode leads attach to sticker electrodes.
- Insert earphones placed.
- Test begins.









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Pro Tip: Electrode Placement

- 2 Electrodes on high forehead: Ensure adequate separation between both
- Electrodes behind the: In line with ear canal or slightly below; Avoid placing on mastoid so there's space for bone conduction stimulator



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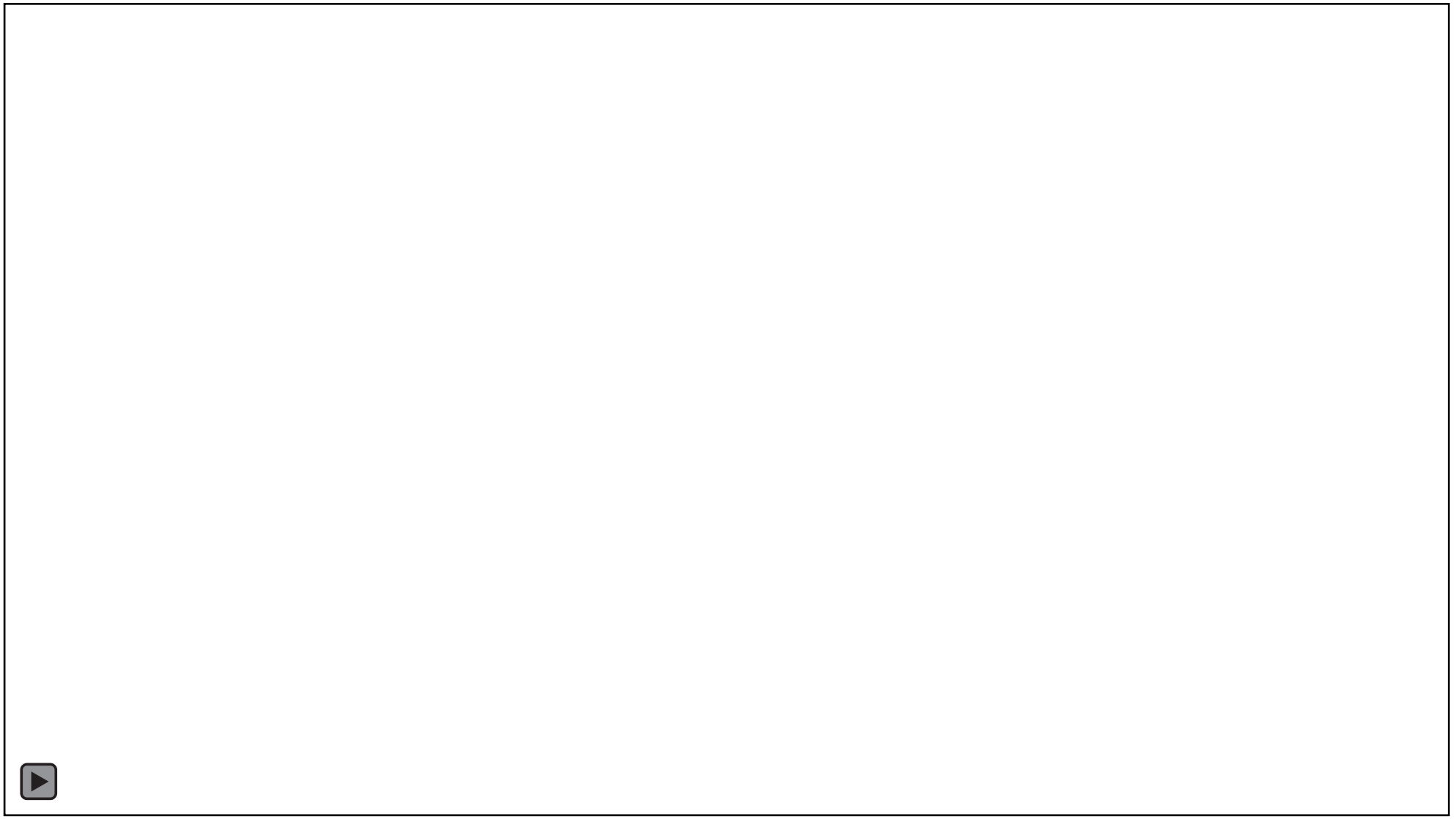
ABR in Action



Wolfe, 2013

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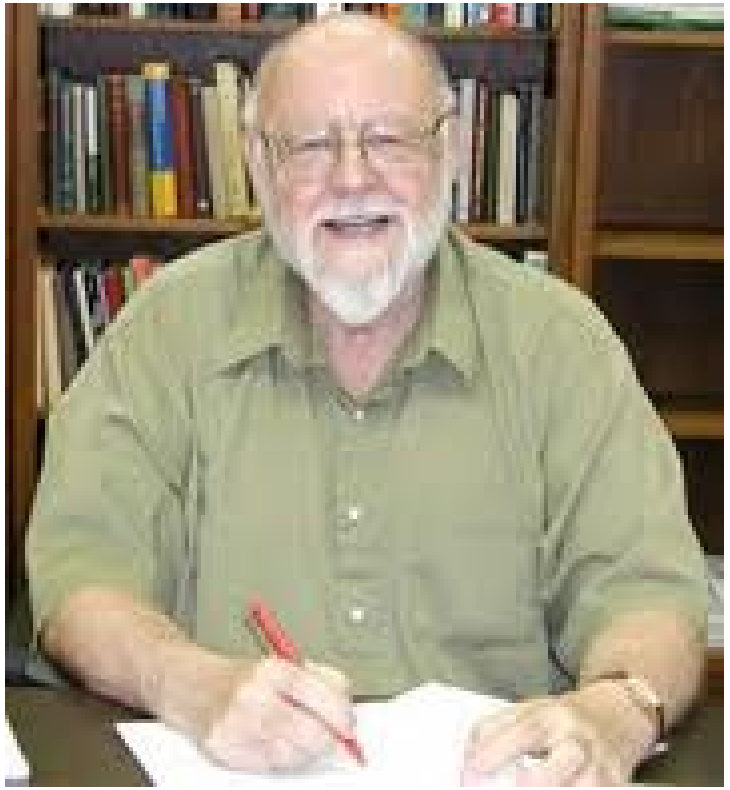
Patient Preparation for Sedated ABR

- Typically not considered until a minimum of 6-9 months old
- Important to communicate to the family that the child must not eat or drink for at least 12 hours prior to the procedure if done under light anesthesia
- Important to ensure child is seen by physician to rule-out contra-indications to sedation
  - Respiratory/cardiac/seizure disorders
  - Allergies to medications
- More information on sedation to follow…

ABR Analysis - Rely on the Crosscheck

- ABR waveform analysis should be related to results of other objective measures of auditory function
  - OAEs
  - Tympanometry
  - Acoustic Reflex Thresholds



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Auditory Steady State Response Testing

What is it?

- Electrophysiological response that can be used to estimate thresholds like ABR but automatic with some notable differences
  - Automatic response detection (no peak picking) based on statistical likelihood of response being present (Less subjective than ABR)
  - Allows for simultaneous multifrequency testing (potentially shorter than ABR)

How to do it?

- Electrodes placed on the scalp to record responses.
- Modulated tones presented to the child's ears.

What does it show?

- ASSR can be used to estimate hearing thresholds

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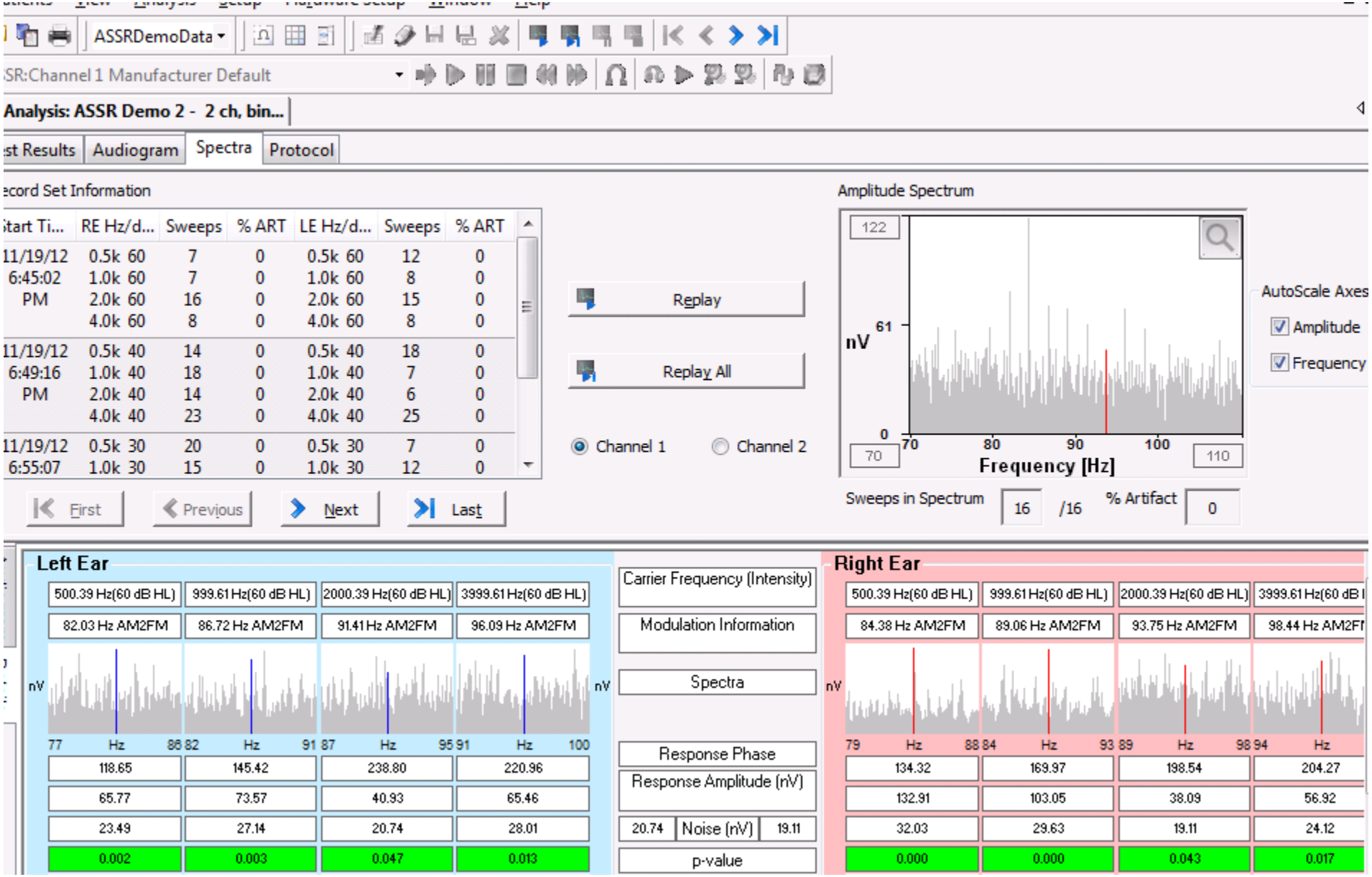



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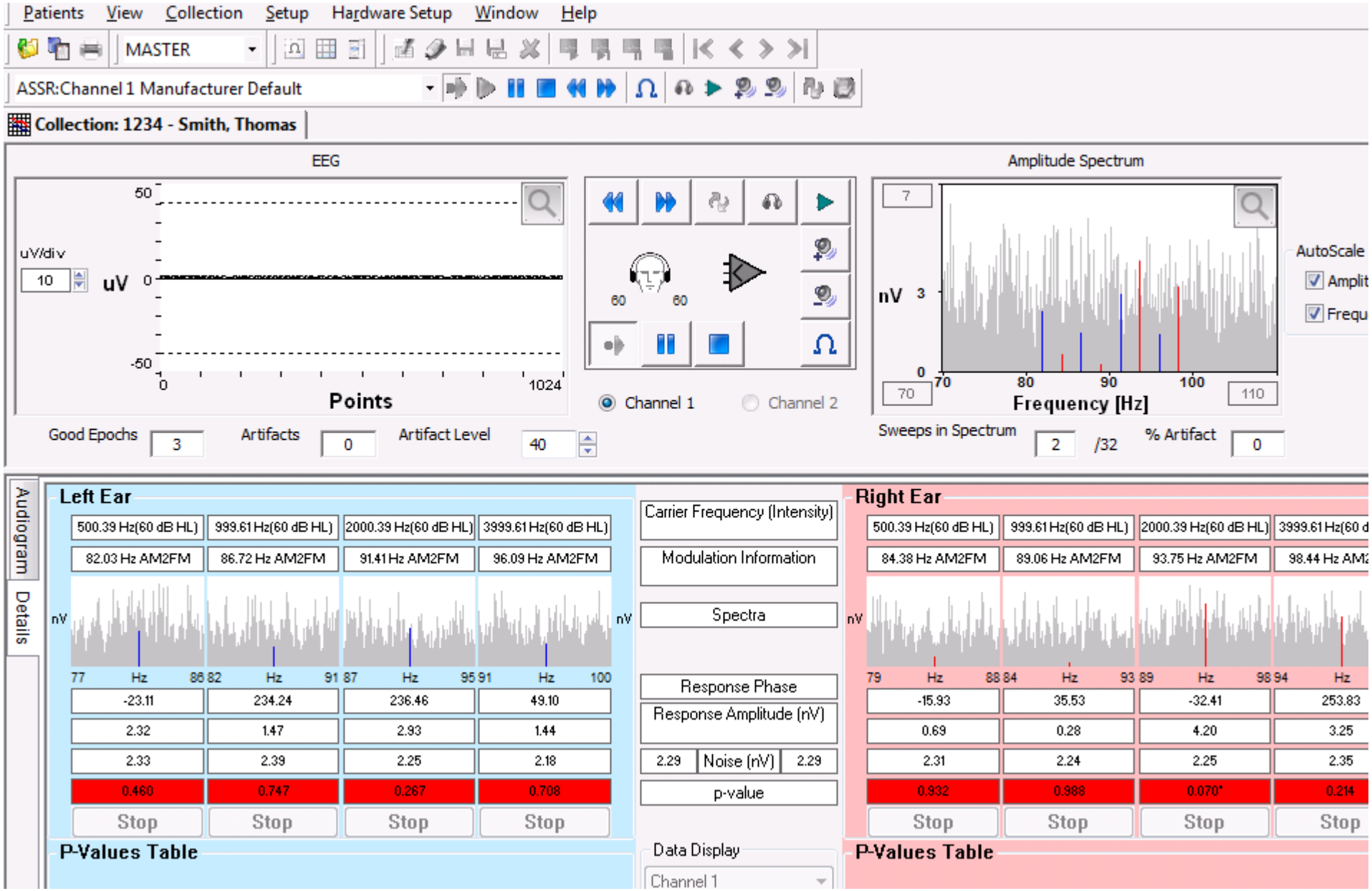



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Behavioral Audiometry of Auditory Function in Children

VRA

CPA

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Physiologic vs. Behavioral



- Physiologic
  - Physiologic responses from the auditory system are measured and analyzed by the computer of the testing equipment
  - Quiet, still and/ or sleeping
    - Tympanometry, OAEs, ABR, ASSR

- **Behavioral**
  - **Test sounds are presented, and the audiologist subjectively analyzes and records a behavioral response from the child**
  - **Awake and participating**
    - Visual reinforcement audiometry
    - Conditioned play audiometry
    - Conventional audiometry (say yes or raise your hand when you hear the beep)
    - Speech perception testing



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VRA/CPA Principles

- Must have a solid evidence-based protocol and set of procedures that is universally implemented
- Ideally, communication should take place between the audiologist and assistant throughout the assessment
- Frequency-specific information is desired
- Filling in all the information may take time

Visual Reinforcement Audiometry (VRA)

How it's performed:

- Child sits in booth in highchair or on parent's lap
- Test sounds presented while child is looking straight ahead
- If sound is audible, child will turn in response
- The head-turn is reinforced or rewarded by the activation of an animated toy or video





Photo courtesy of IHS

Visual Reinforcement Audiometry (VRA)

- Standard of care for behavioral assessment of hearing thresholds (minimum response levels) for children at a developmental age of 6 to 24 months

- Some children with hearing loss do not attend to VRA task until 8 to 12 months of age
- Requires baby has the neck strength to sit upright and turn their head toward a sound

VRA



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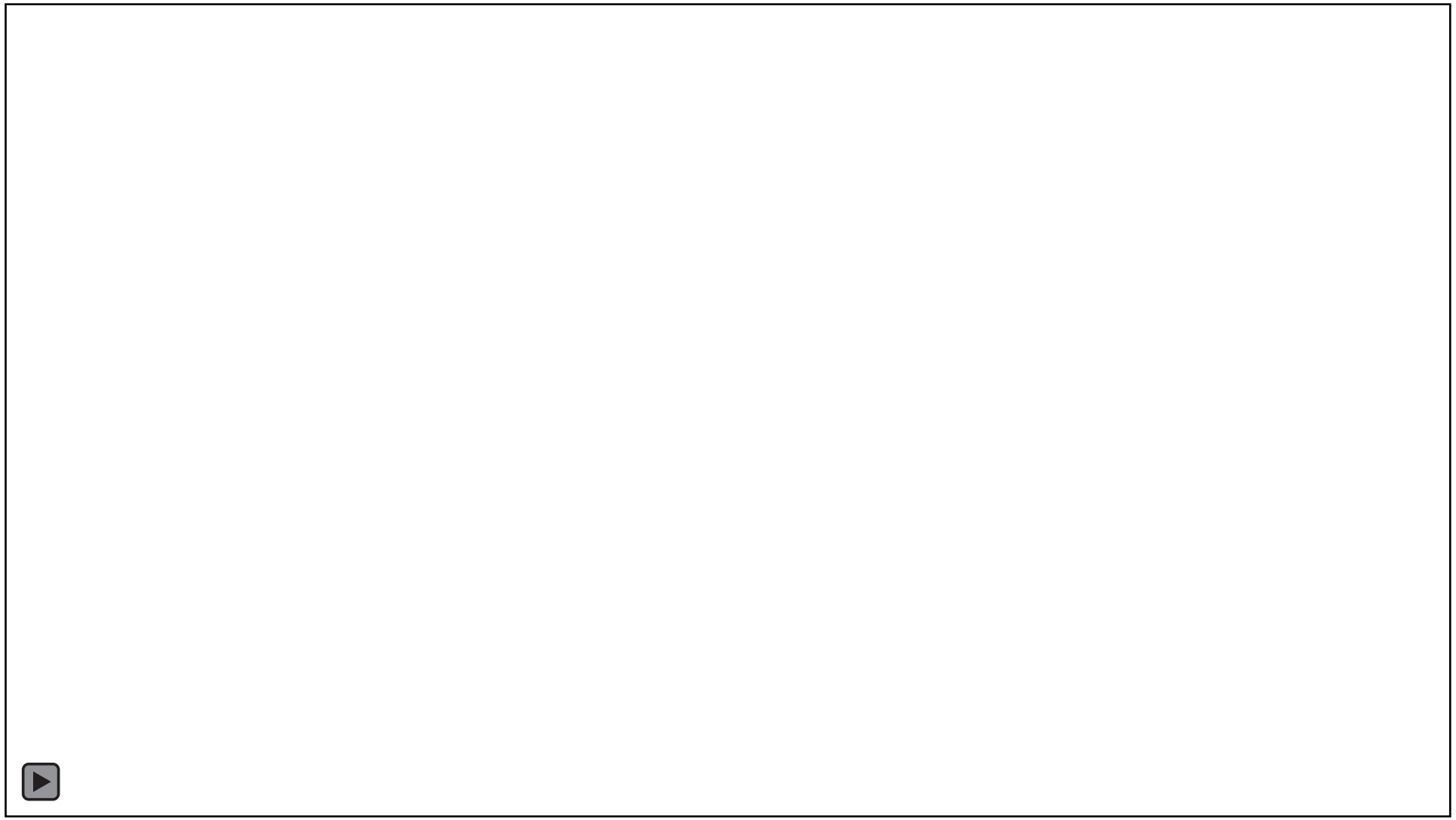
VRA



Courtesy of Sara Neumann, AuD

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Soundfield or Inserts?

- Begin with insert earphones to satisfy our goal of obtaining ear-specific information
- Remember, some behavioral is better than none and will contribute to cross-check
  - Go to soundfield if child refuses to wear insert earphones
  - Attempt soundfield if child does not respond to stimuli presented via earphones





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Conditioned Play Audiometry (CPA)

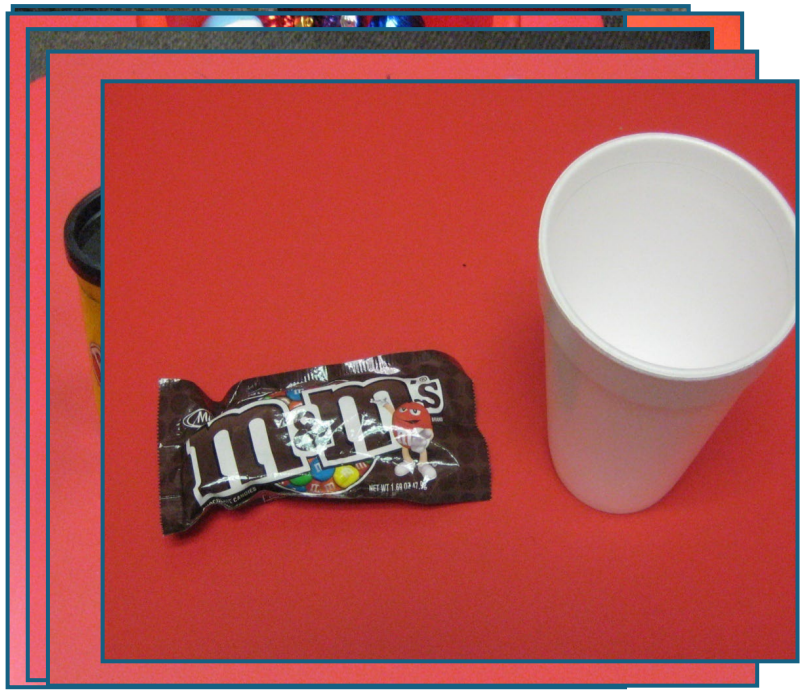
- Test sounds (e.g., pure tones, speech sounds) are presented, and the child completes a game-based action when the response is heard

- Standard of care for behavioral assessment of hearing thresholds (minimum response levels) for children at a developmental age of 24 months to 60 months

- Some children will complete as early as 18-24 months, whereas some won’t participate until children are 3 years old or even older for some children with developmental delays

Conditioned Play Audiometry – Keep it Fun!

- Conditioned play audiometry tasks are only limited by the imagination
- Find an action that can be completed easily and quickly across many repeatable trials
- Should be fun and engaging but not so fun the child will not listen to test stimuli



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Electronic Gadgets



Neumann, Smith, & Wolfe, 2020

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The Big Red Switch













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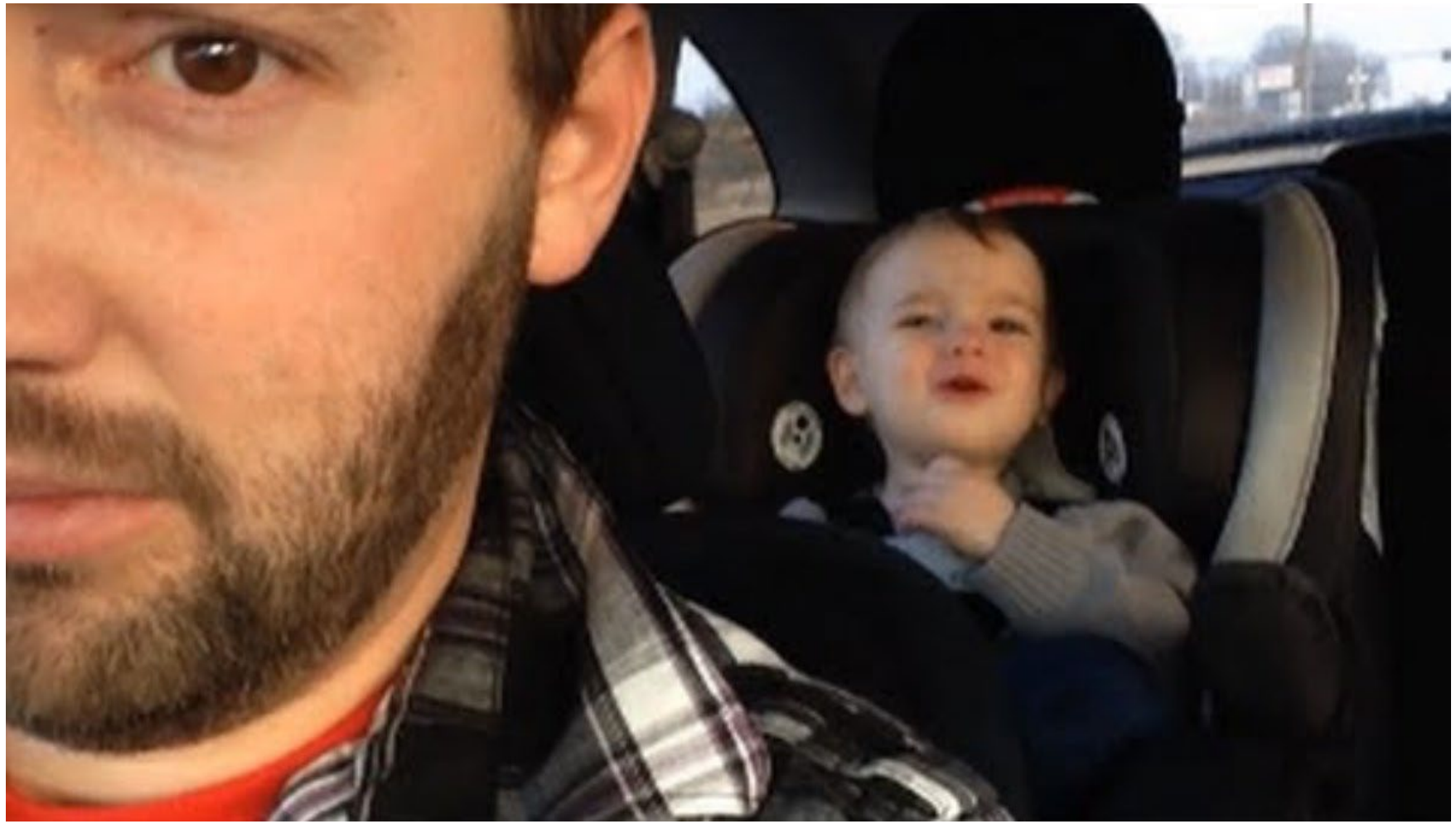
Other Tips for Booth Testing

- Send family home with foam tips to “practice” wearing in ears at home → reduces fear and anxiety
- Include siblings or friend if the child is hesitant to participate
- Don’t ask if child wants to play. Instead, state, “you get to play this fun game!”
- It’s best if child sits alone and parent sits nearby as needed

Do you want to play some listening games!? (0-0:30)



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Evaluating Speech Perception in Children

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Speech Perception Assessment

- Speech Detection Threshold
- Speech Recognition Threshold
- Word Recognition Assessment
  - Closed-set
  - Open-set
- Sentence Recognition Assessment
  - In quiet
  - In noise

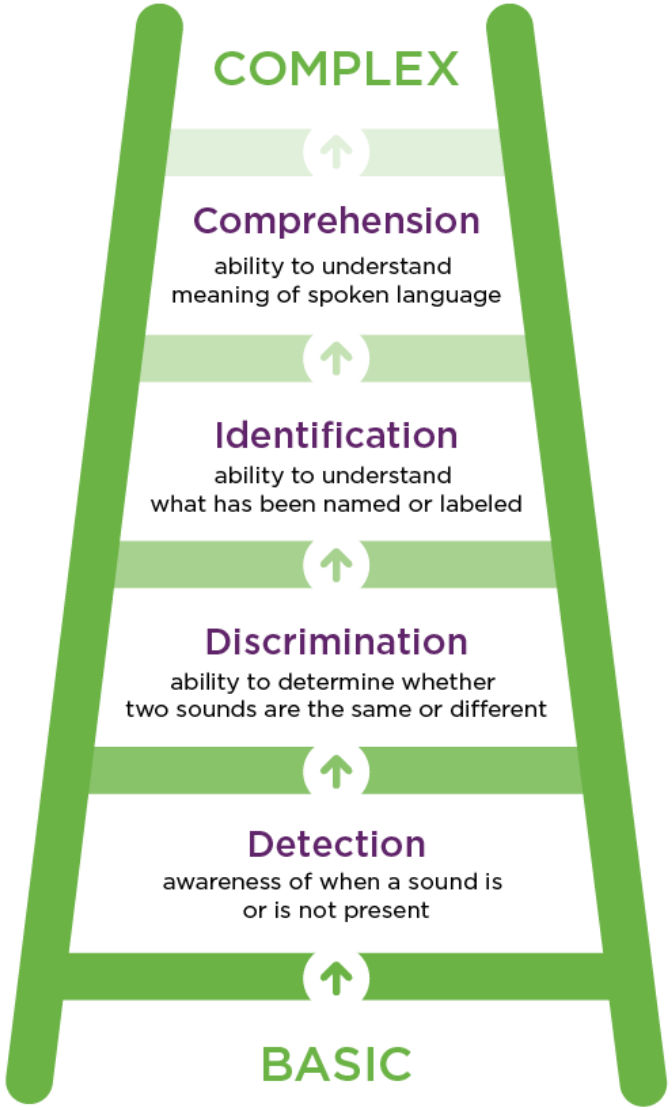

Photo Credit: https://www.clarkeschools.org/clarke-speaks-up/auditory-hierarchy/

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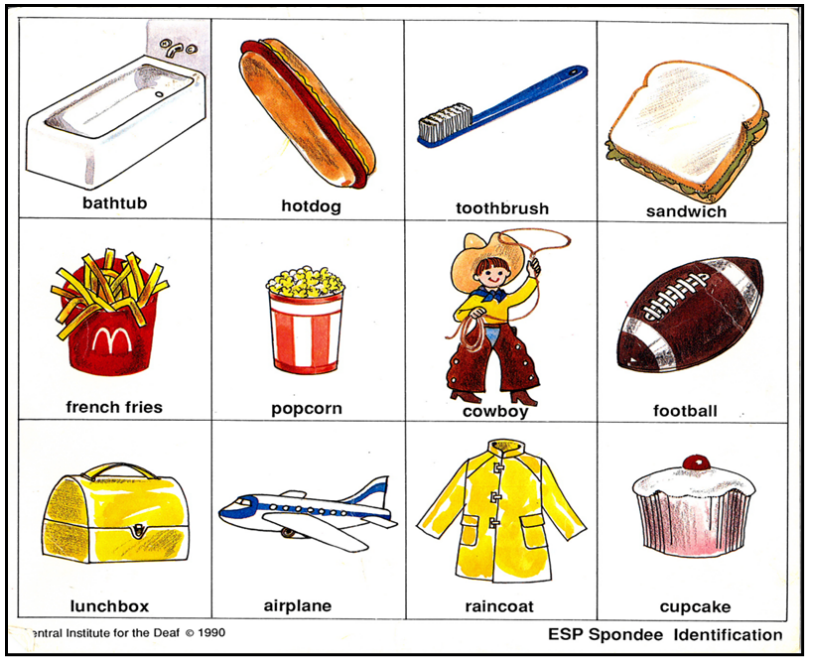
Speech Detection Threshold

- Best for babies or young children who can’t repeat words
- Method is similar to VRA or CPA but uses speech instead of tones or noise
- Measures the softest speech they can just barely hear on 50% of presentations
- Helps confirm or crosscheck other results

Speech Perception Assessment

- Speech Recognition Threshold – Determine lowest level required for a child to identify a two-syllable word (spondee)





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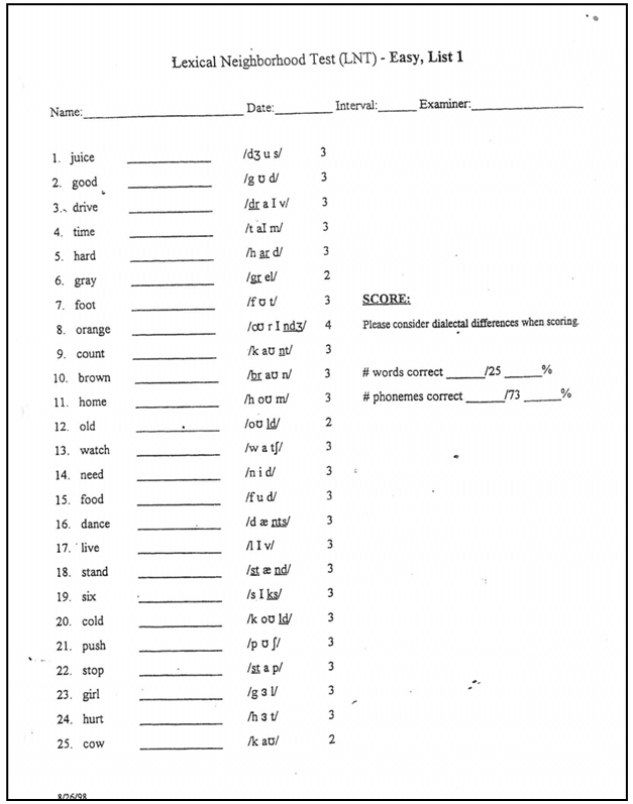
Speech Perception Assessment

- Word Recognition Assessment – Speech stimuli are presented at a level that is fully audible to the child who repeats back the word or points to a picture associated with the word
  - Closed-set
  - Open-set



Lexical Neighborhood Test (LNT) - Easy, List 1

Name:_____ Date:_____ Interval:_____ Examiner:_____

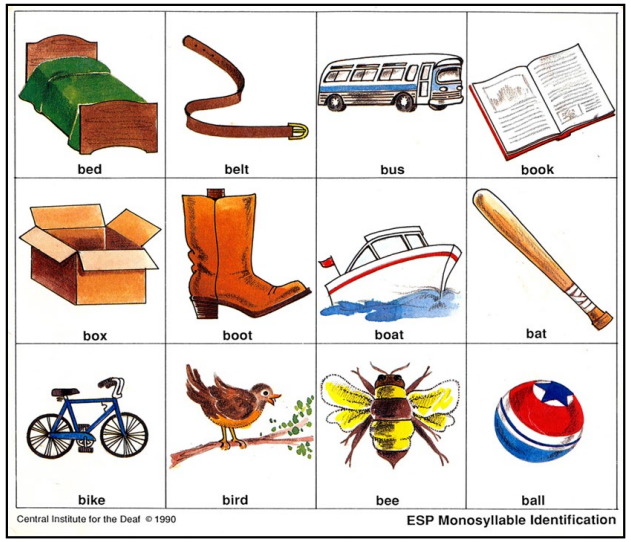
1.	juice	_____	/dʒ u s/ 3
2.	good	_____	/g ʊ d/ 3
3.	drive	_____	/dr a I v/ 3
4.	time	_____	/t aI m/ 3
5.	hard	_____	/h ar d/ 3
6.	gray	_____	/gr eI/ 2
7.	foot	_____	/f ʊ t/ 3
8.	orange	_____	/ɔʊ r I nd͡ʒ/ 4
9.	count	_____	/k aʊ nt/ 3
10.	brown	_____	/br aʊ n/ 3
11.	home	_____	/h oʊ m/ 3
12.	old	_____	/oʊ ld/ 2
13.	watch	_____	/w a tʃ/ 3
14.	need	_____	/n i d/ 3
15.	food	_____	/f u d/ 3
16.	dance	_____	/d æ nts/ 3
17.	live	_____	/l I v/ 3
18.	stand	_____	/st æ nd/ 3
19.	six	_____	/s I ks/ 3
20.	cold	_____	/k oʊ ld/ 3
21.	push	_____	/p ʊ ʃ/ 3
22.	stop	_____	/st a p/ 3
23.	girl	_____	/g ɜ l/ 3
24.	hurt	_____	/h ɜ t/ 3
25.	cow	_____	/k aʊ/ 2

SCORE:

Please consider dialectal differences when scoring.

words correct _____/25 _____%

phonemes correct _____/73 _____%



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Speech Perception Assessment

- Sentence Recognition Assessment
  - In quiet
  - In noise

Pediatric Az Bio Sentence Test Score Sheet

Name: _____

Date: _____

List 1

Sentence	Text	Poss	Score
1	He dreamed of being in a rock band.	8	
2	Have you ever been to Disney World?	7	
3	The coconut fell from the tall tree.	7	
4	The tiny seed grew into a big tree.	8	
5	He fell asleep with his window open.	7	
6	My brother and I have a big tent.	8	
7	My grandma's house smells like cookies.	6	
8	His grandfather fell asleep on the sofa.	7	
9	I like to eat wheat bread.	6	
10	I like to play with my sister.	7	
11	My dad and I walked for a long time.	9	
12	The baby monkey swings from the trees.	7	
13	She pushed her kids on the swing.	7	
14	Put your thinking cap on.	5	
15	I packed my own lunch today.	6	
16	The triangle has three corners.	5	
17	I learned to fish at summer camp.	7	
18	They went ice skating on the frozen pond.	8	
19	We will vote for a new president in November.	9	
20	The hockey player didn't have any teeth.	7	

Words Correct	**0**
Words Possible	**141**
Percent Correct	**0.0%**

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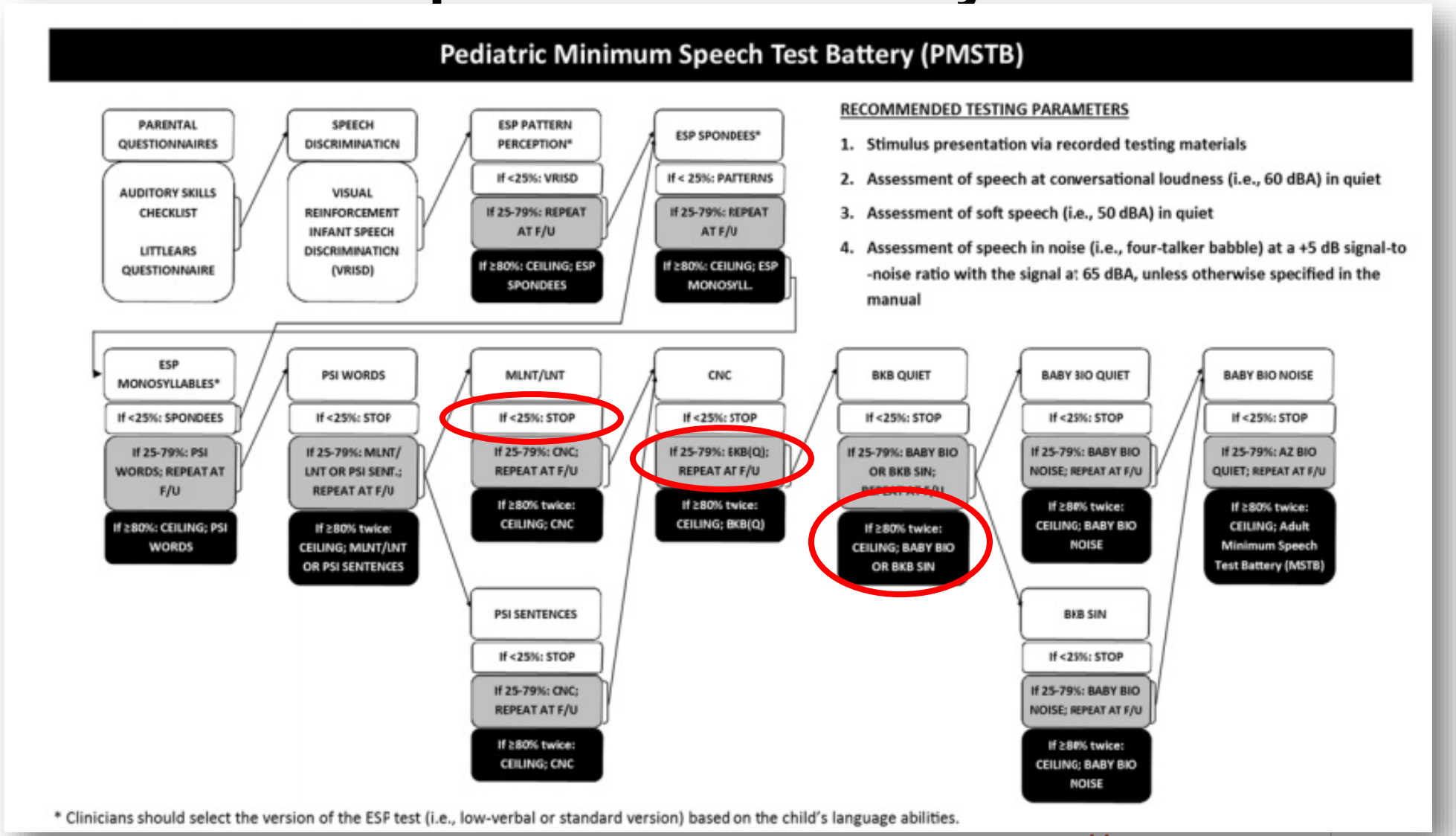
Pediatric Minimum Speech Test Battery



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Common Speech Perception Tests

- Ling 6 Sound Test
- Early Speech Perception Test
  - Low Verbal: 2 years old and up
  - Standard: 3 years old and up
- NU-CHIPs: 2.5 years on Peabody Picture Vocabulary Test (consider language age)
- MLNT: 2-4 years of age
- LNT: 3-6 years of age
- PBK-50: 5+ years
- HINT-C: 6-12 years of age
- CNC: 7+ years of age
- BKB-SIN: 6+ years of age
- BabyBio: 5-6+ years of age
- AzBio: 9-10+ years of age

Speech Perception Goal

- With appropriately selected and customized hearing technology, children with hearing loss should correctly perceive at least 80% of speech test stimuli in the best aided condition in quiet

Behavioral Observation of Auditory Responses (BOA)

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Behavioral Observation of Auditory Responses (BOA)

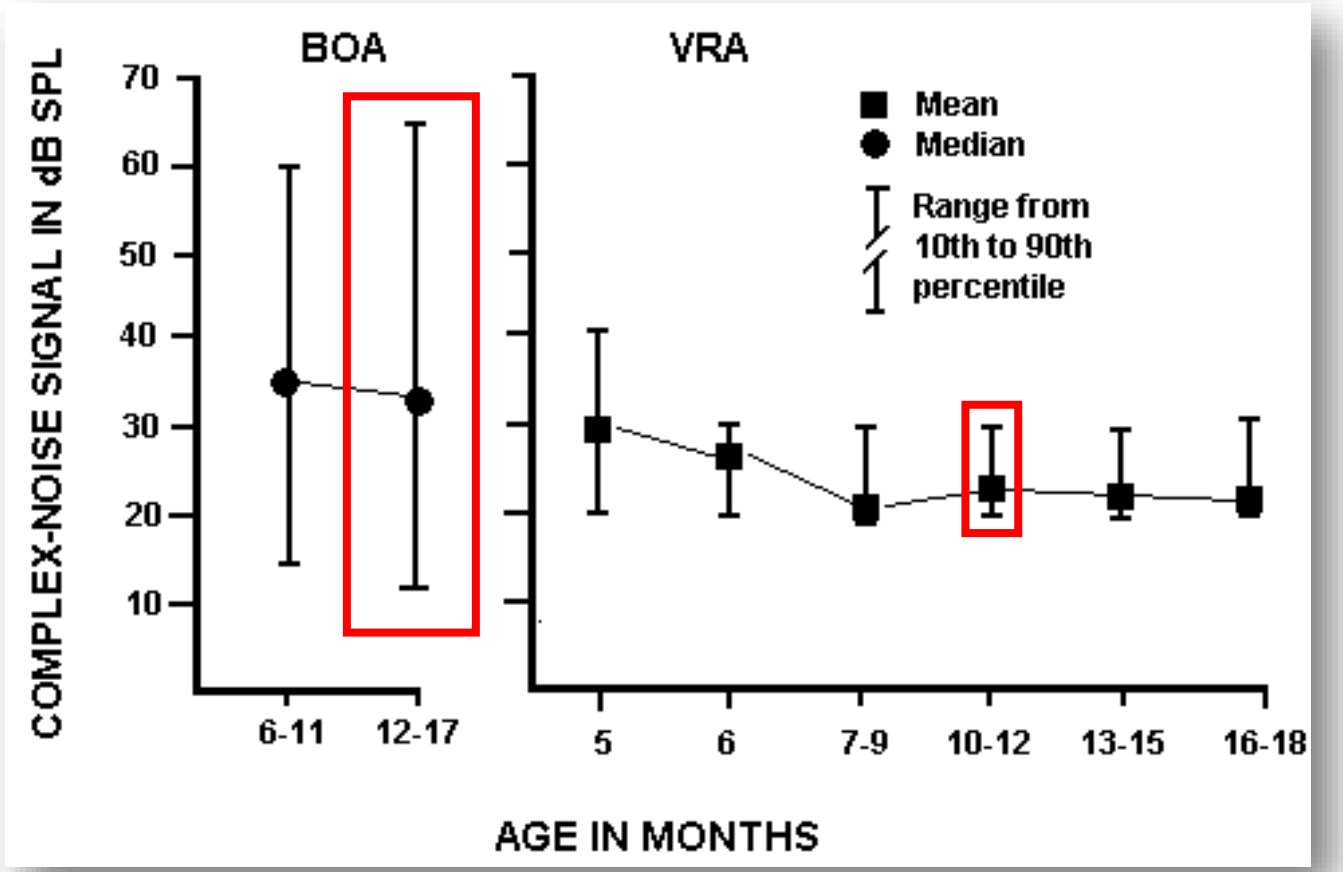
- *Most* experts in pediatric audiology do not consider BOA to be a viable technique to measure auditory thresholds in infants

BOA Limitations

- Great inter-subject variability
- Typically developing infants vary substantially as a function of age, stimulus type, and stimulus level.
- Infants habituate quickly.
- Examiner bias more likely to affect results because a variety of responses may be accepted
  - Eye widening/eye blinks
  - Change in facial expression (grimace, “smile,” etc.)
  - Sucking response
  - Change in breathing/respiratory pattern
  - Startle
  - Arousal from sleep
  - Head turn
  - Limb movement

BOA Variability

BOA is not really audiometry, because we cannot routinely obtain threshold



Wilson, Moore, & Thompson, 1976

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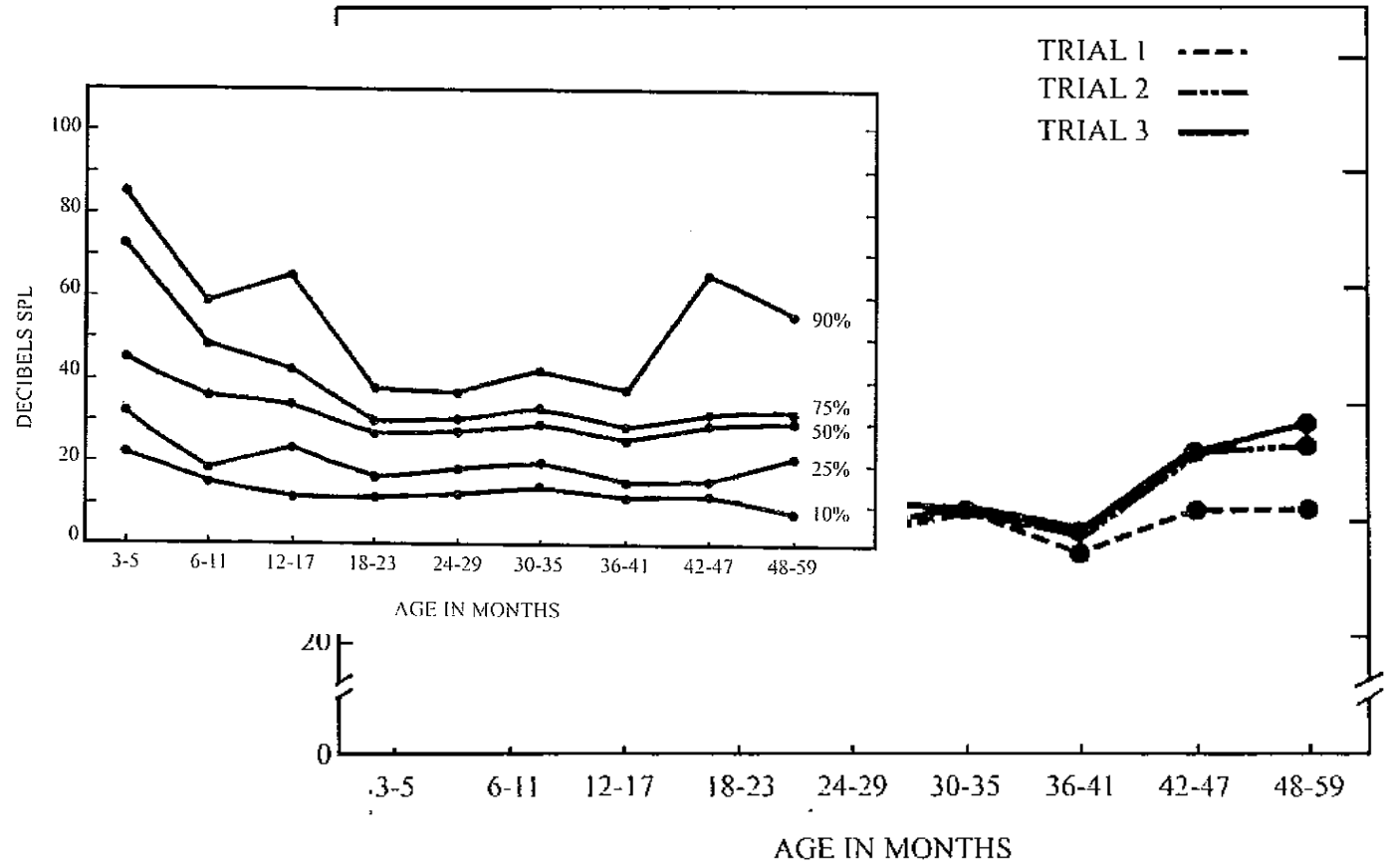
BOA Limitations



Thompson and Weber, 1974

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Behavioral Observation of Auditory Function: The Final Word

- For children diagnosed with hearing loss during the first few months of life, we can attempt BOA at 3-4 months of age.
- If **consistent**, **reliable** responses are observed that are significantly better than ABR estimated thresholds, then the audiologist should consider additional testing and hearing aid adjustment.
- If responses are poorer than ABR estimated thresholds, no change should be made to hearing aids.
- BOA (sucking response) information is one more component of a comprehensive battery of assessments used to evaluate an infant's auditory status.
  - ABR/OAE/Acoustic immittance
  - AVT assessment and observations
  - Parent report
  - LittlEars, PEACH, etc.
- BOA can be helpful for caregiver counseling.
- **There is no peer-reviewed evidence indicating BOA can attain threshold responses**

Summary and Key Take Aways

- A combination of tests are used to assess the hearing of infants and young children.
- Some tests require a response from the child, while others do not.
- Most tests require children to be quiet and still so planning and preparing for your visit can be helpful.
- Children can get tired and bored quickly, so testing often happens over multiple visits and may be repeated.
- Knowing the process can make visits easier.
- Check out Hearing First for helpful, free resources and always contact your audiologist with questions.

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Questions



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