

A stylized graphic of a human ear in profile, rendered in grey. To the right of the ear, there are three curved blue lines representing sound waves or radio signals.

Hearing Evaluation: Diagnostic Approach

BHPI
hearing for all 2024

Hearing Assessment

- Purpose
 - to quantify and qualify in terms of the degree of hearing loss, the type of hearing loss and configuration of the hearing loss
 - carried out for monitoring of already identified hearing loss

Hearing Assessment

- Purpose
 - aid in planning the appropriate medical or surgical intervention, prescription of hearing aids, provision of assistive listening devices, skills development through audiologic re/habilitation

Hearing Loss Descriptions

- **Type - conductive, sensorineural, mixed**
- **Degree - severity of hearing loss**

Type of Hearing Loss

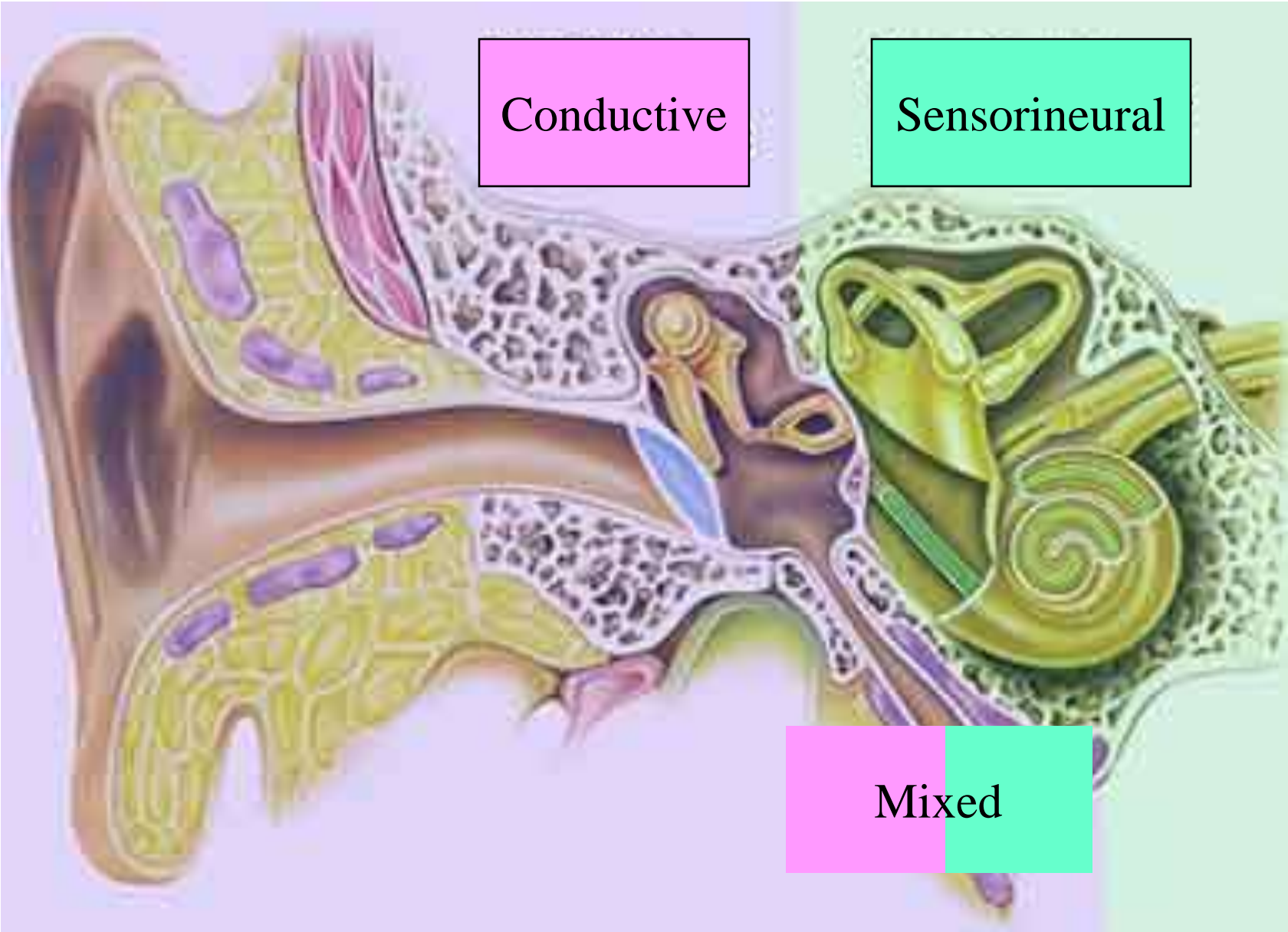
- Gives information on the point in the auditory system where the loss is occurring
- In relation to the site of abnormal condition, it can be categorized as:

Conductive Hearing Loss

Sensorineural Hearing Loss

Mixed Hearing Loss

Central Auditory Processing

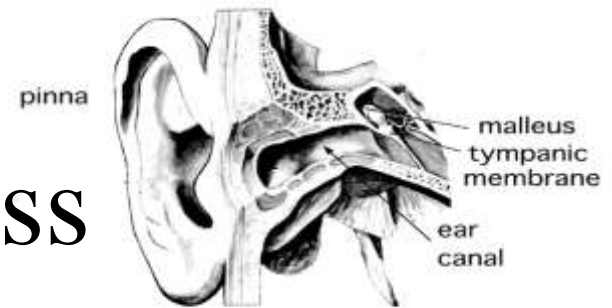


Conductive

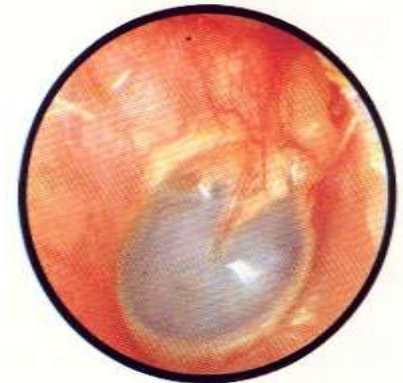
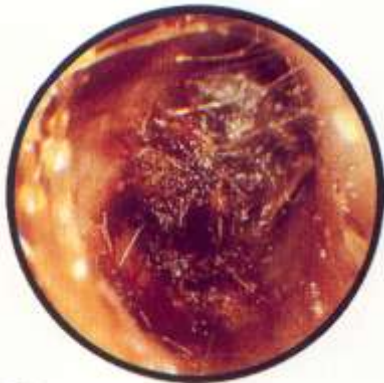
Sensorineural

Mixed

Conductive Hearing Loss

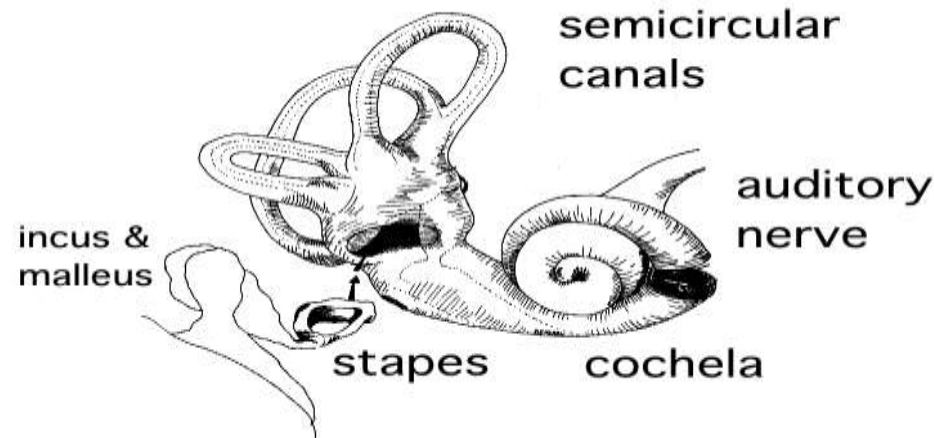


- A temporary or permanent hearing loss typically due to abnormal conditions of the external and/or middle ear



Sensorineural Hearing Loss

- Typically a permanent hearing loss due to disease, trauma, or inherited conditions affecting the nerve cells in the cochlea, the inner ear, or the eight cranial nerve



Inner Ear Diseases

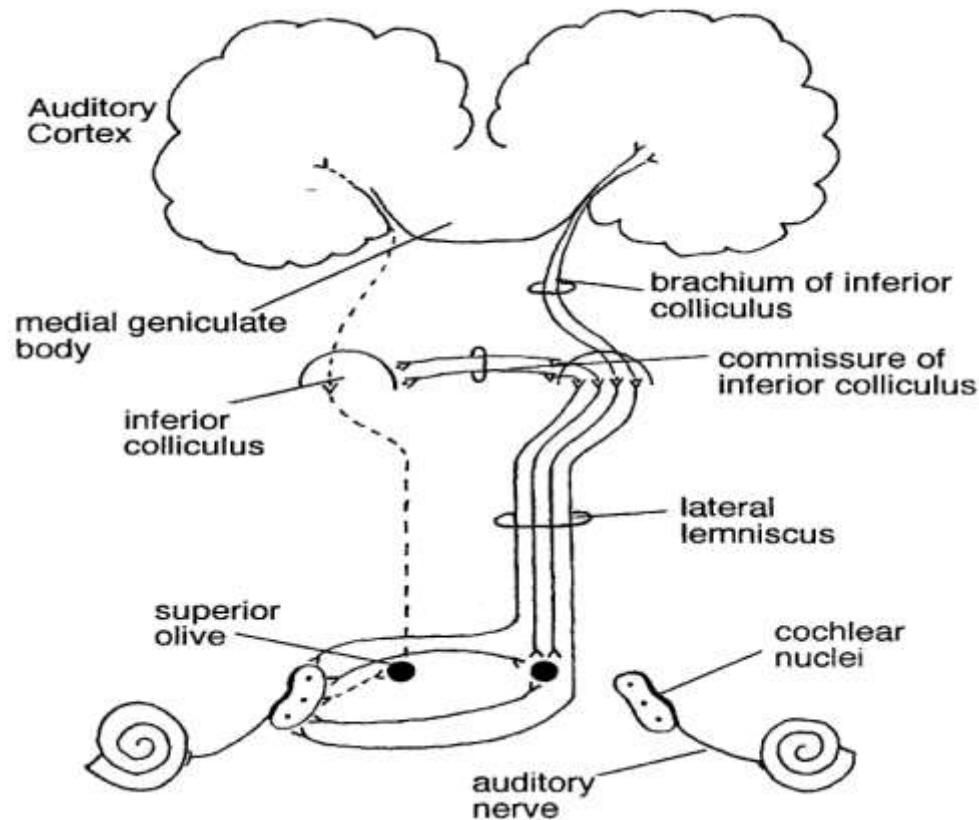
1. Age - >60 y/o (Presbycusis), bilateral HF SNHL
2. Ototoxic drugs – mycins, quinine, diuretics, bilateral HF SNHL
3. Mumps – Unilateral SNHL
4. NIHL – bilateral, symmetrical SNHL with dip at 4KHz
5. TORCH (Congenital) – Toxoplasmosis, Rubella, Cytomegalovirus, Herpes

Mixed Hearing Loss

- A combination of conductive and sensorineural components

Central Auditory Processing Disorder

- A condition where the brain has difficulty processing auditory signals that are heard



Degree of Hearing Loss

- Expressed in decibels based on pure tone average for different frequencies
- Discussed using descriptors related to severity:

Normal

Severe

Mild

Profound

Moderate

The Hearing Assessment Process

- Case History
- Physical Examination
- Tests of Hearing and Listening

Pure Tone Audiometry

- In testing hearing for tones, a *pure tone air conduction hearing test* is given to find out the faintest tones a person can hear at selected pitches (frequencies) from low to high
- During this test, earphones are worn and the sound travels through the air in the ear canal to stimulate the eardrum and then the auditory nerve

Pure Tone Audiometry

- The person taking the test is instructed to give some type of response such as raising a finger or hand, pressing a button, pointing to the ear where the sound was received, or saying "yes" to indicate that the sound was heard.

Pure Tone Audiometry

- In children, a more play-like activity (**conditioned play audiometry**) to indicate response can be used
- They may be instructed to string a peg, drop a block in a bucket, or place a ring on a stick in response to hearing the sound

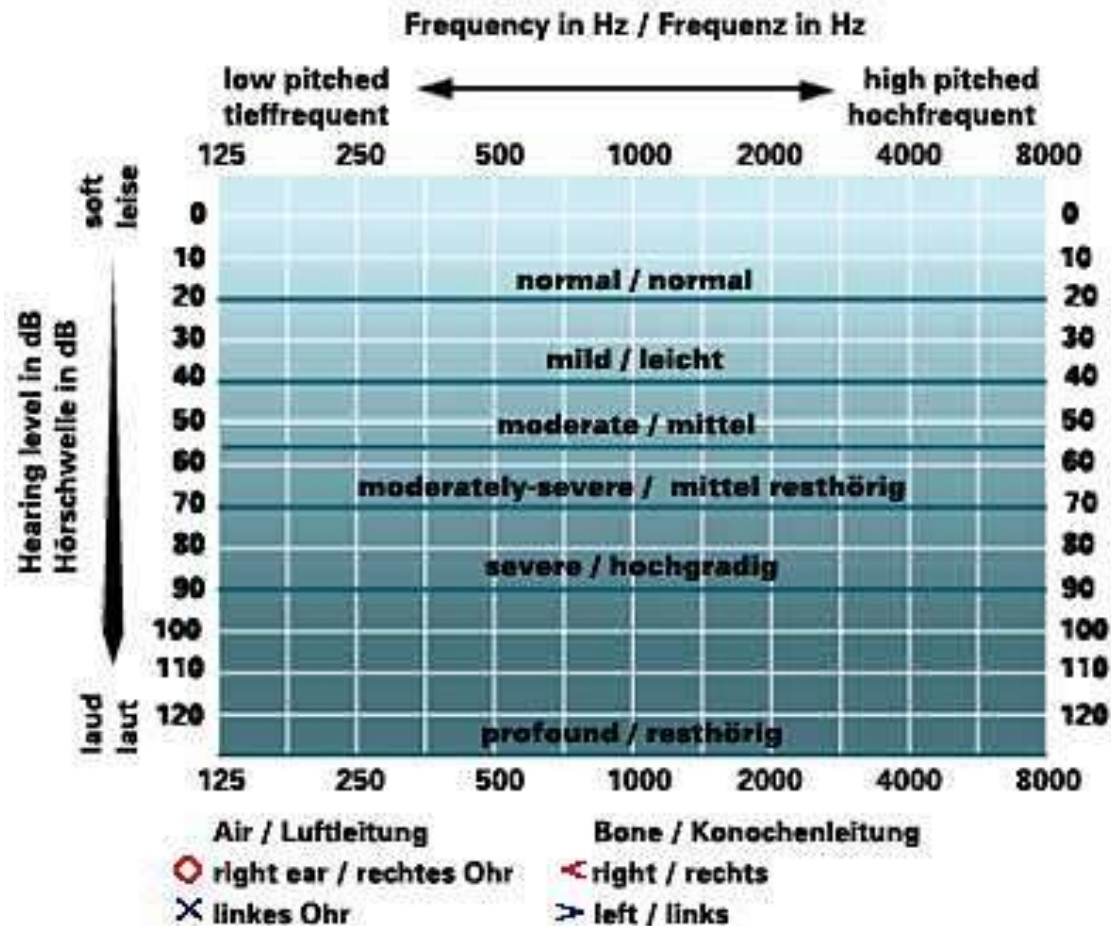
Pure Tone Audiometry

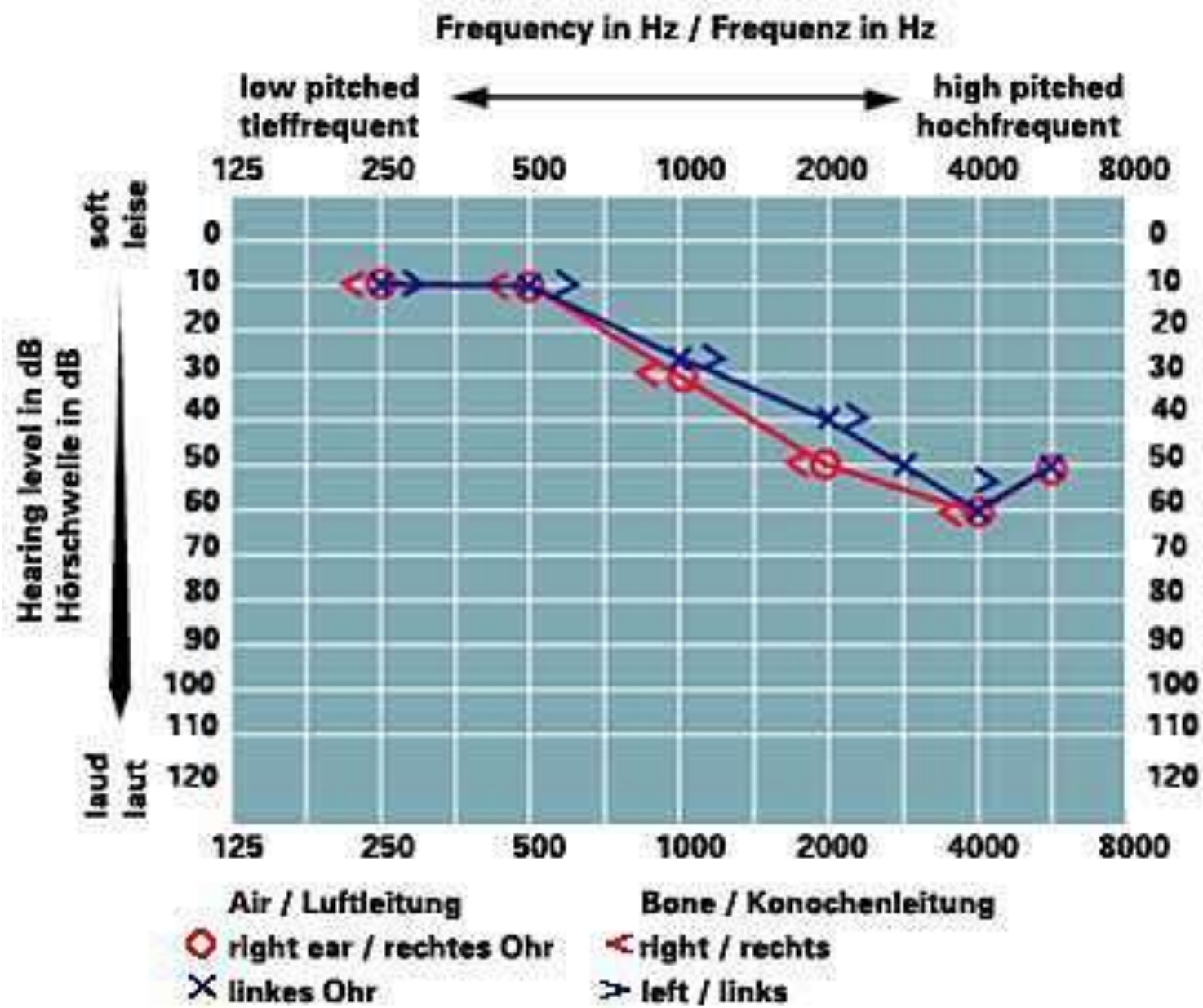
- Infants and toddlers are observed for changes in their behavior such as sucking a pacifier, quieting, or searching for the sound and are rewarded for the correct response by getting to watch an animated toy (**visual reinforcement audiometry**)

Interpretation

- The frequency or pitch of the sound is referred to in hertz (Hz)
- The intensity or loudness of the sound is measured in decibels (dB)
- The responses are recorded on a chart called an *audiogram* that provides a graph of intensity levels for each frequency tested

The Audiogram

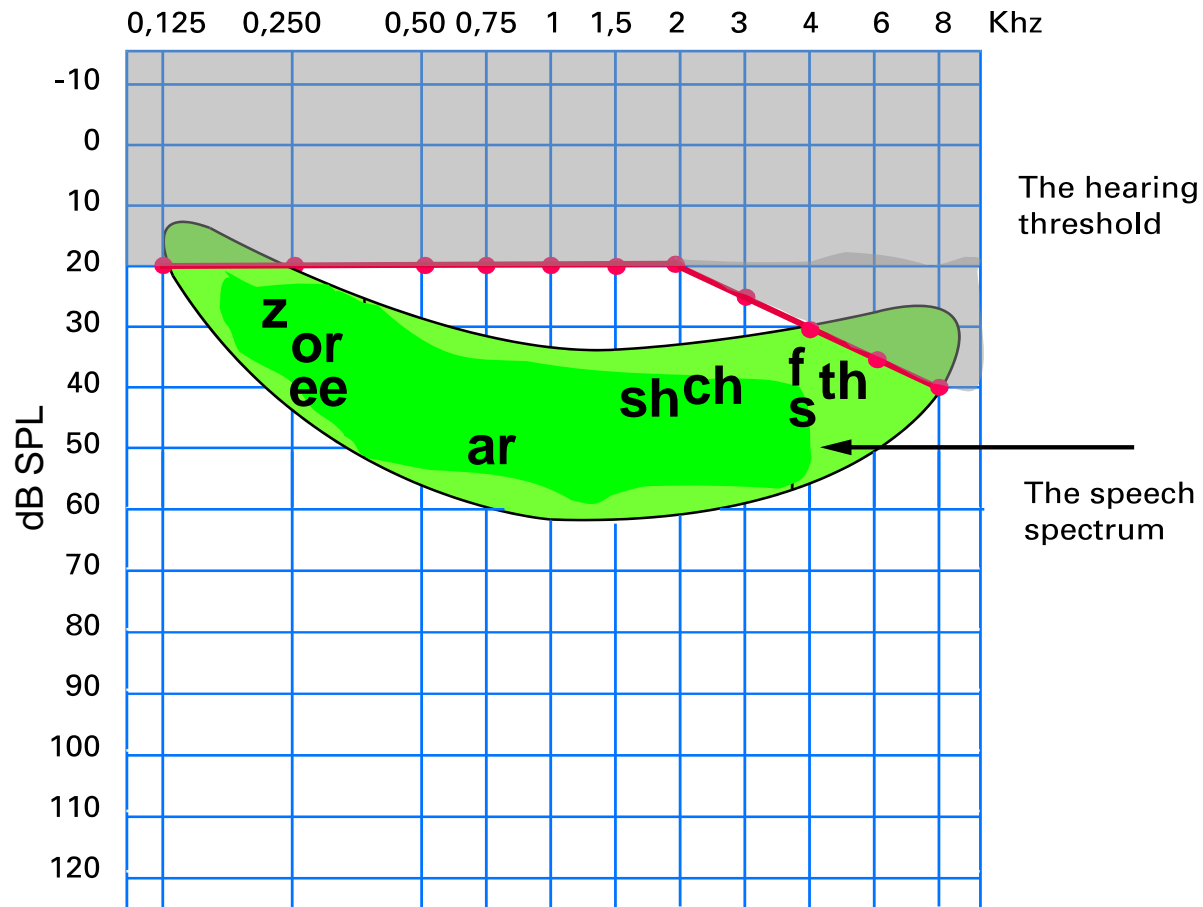




Relationship of Degree of HL to Everyday Functioning

- Mild loss
- 26-40dB
- Will miss consonants. At 30 dB can miss 25-40% of speech signal. Degree of difficulty depends on noise level, distance from speaker, and configuration of the hearing loss. Will benefit from hearing aid

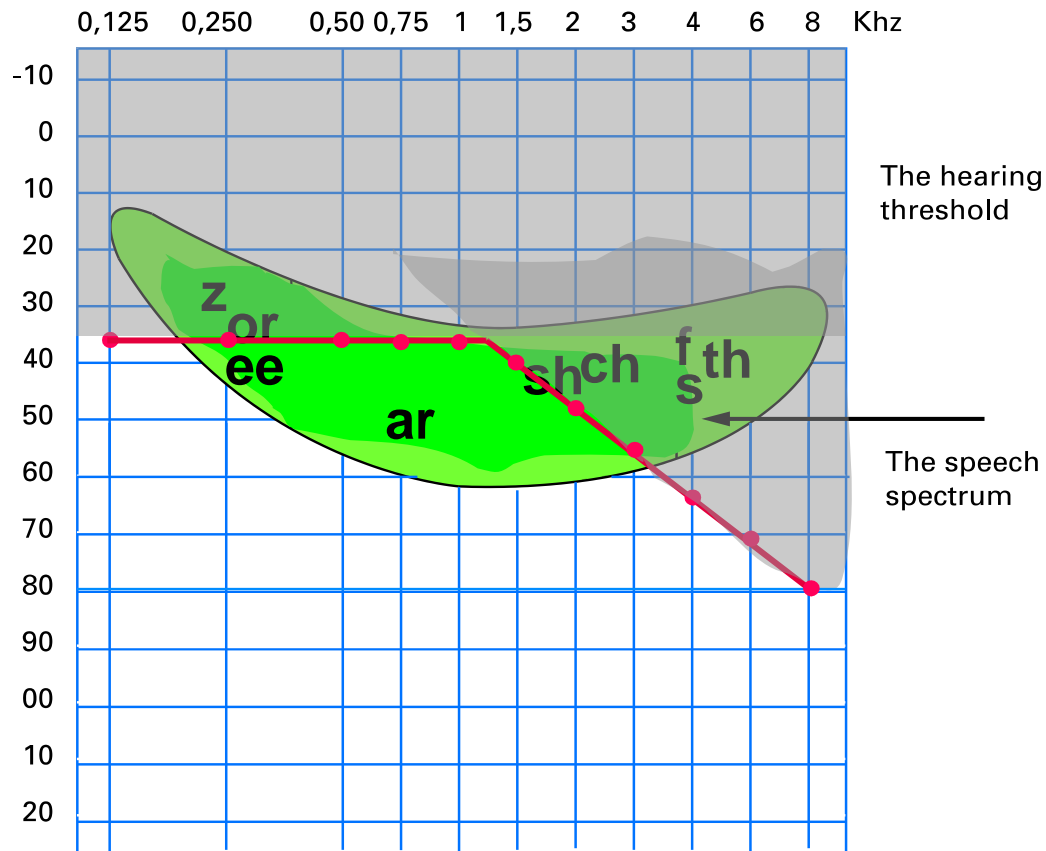
Mild Hearing Loss



Relationship of Degree of HL to Everyday Functioning

- Moderate loss
- 41-60 dB
- Can understand face-to-face conversation at a distance of 3-5 feet if structure and vocabulary is controlled. May miss 50-75% of a spoken message if the pure tone average is 40 dB. Will benefit from hearing aid.

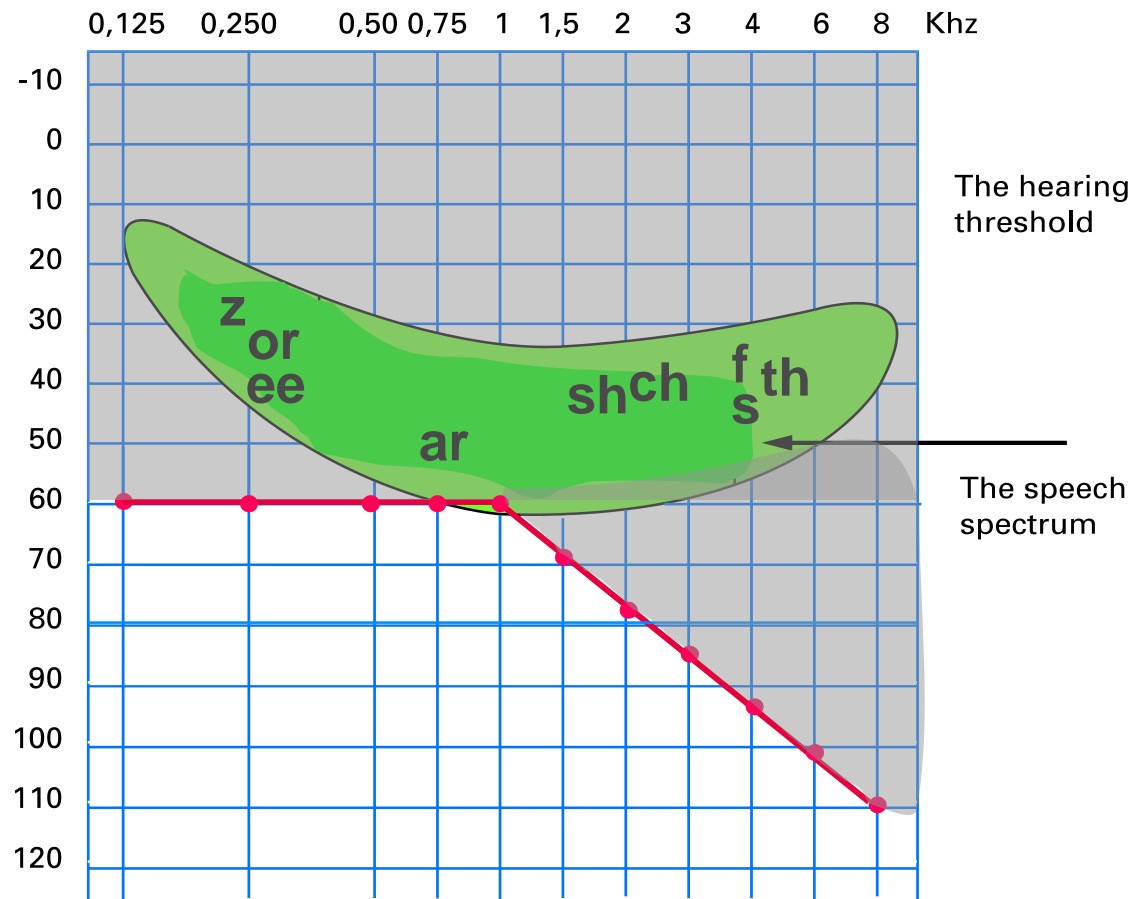
Moderate Hearing Loss



Relationship of Degree of HL to Everyday Functioning

- Severe loss
- 61-80 dB
- May not even hear voices, unless speech is very loud. Without amplification, the individual will not recognize any speech through listening alone. Can be a candidate for cochlear implantation.

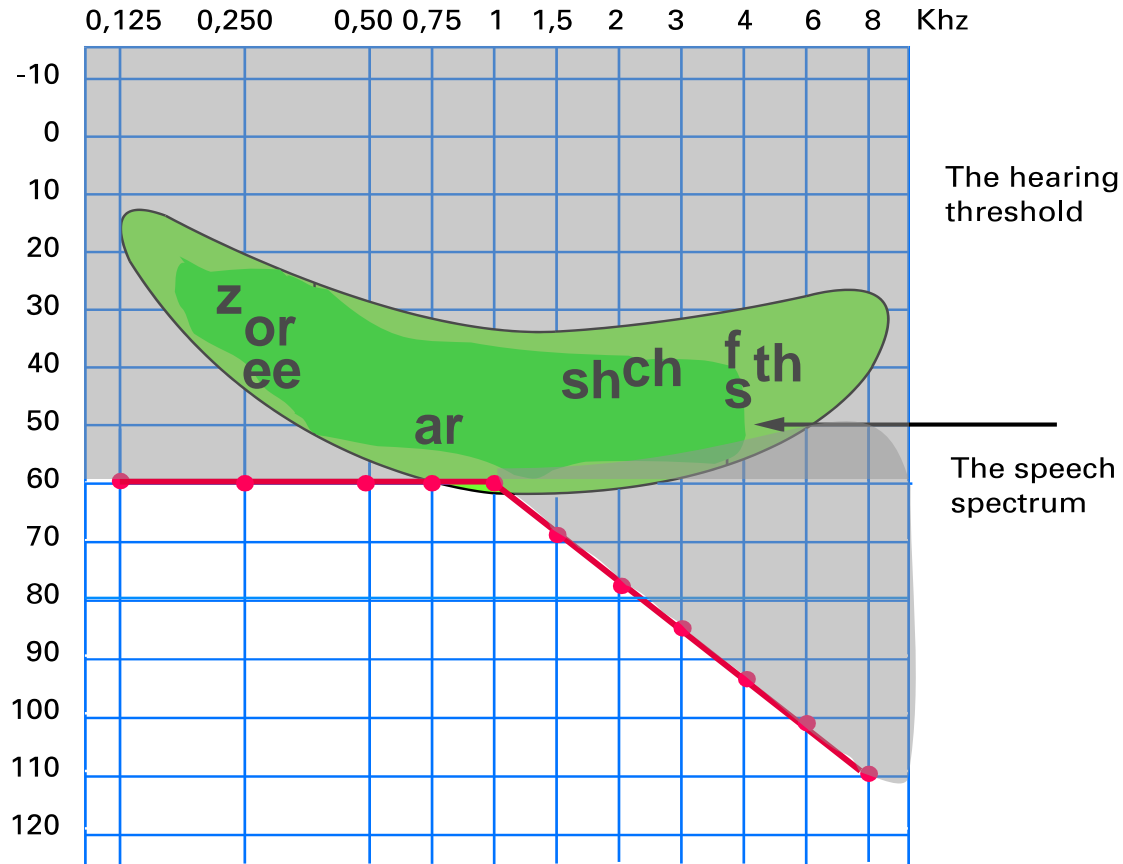
Severe Hearing Loss



Relationship of Degree of HL to Everyday Functioning

- Profound loss
- 81dB or greater
- May not be able to detect the presence of even loud sound without amplification. May perceive vibratory aspects of sound. Will rely on vision communication. Will benefit from cochlear implant.

Profound Hearing Loss



Treatment of Hearing Loss depends on which part of the ear is not working properly

Where is the problem?	Types of Hearing Loss	What can be done to help?	Does it help?
Outer Ear Middle Ear	Conductive	<ul style="list-style-type: none"> ✓ Medication ✓ Surgery ✓ Hearing aids 	
Inner Ear	Sensorineural	<ul style="list-style-type: none"> ✓ Hearing aids ✓ Cochlear implants 	<p>Sometimes</p> <p>Some severe and most profound</p>
Hearing Nerve	Neural	<ul style="list-style-type: none"> ? Hearing aids ? Cochlear Implants ? Brainstem Implant 	<p>Sometimes</p> <p>If some nerve fibers are working</p>

Objective Assessment Tests

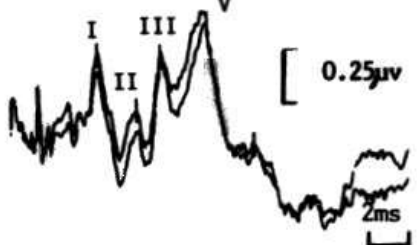
- Auditory Evoked Potential
 - Auditory Brainstem Response (ABR)
 - Brainstem Evoked Response Audiometry (BERA)
- Otoacoustic Emmission
- Acoustic Reflexes

Auditory Evoked Reponse

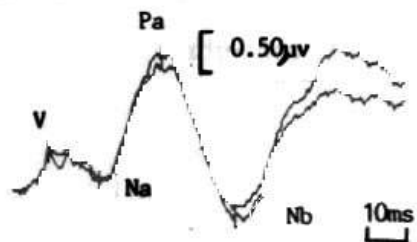
- AER - is an activity within the auditory system produced or stimulated by sound
- Two processes essential for detecting AER:
 1. Amplify the voltage - 100,000 x
 2. Signal averaging
 - noise - EEG, electrical and muscle activity movement of the jaw or neck



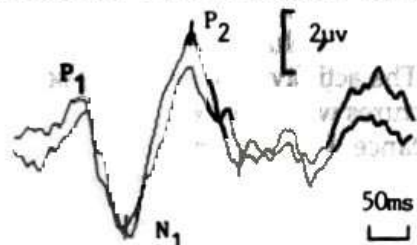
AUDITORY BRAINSTEM RESPONSE (ABR)



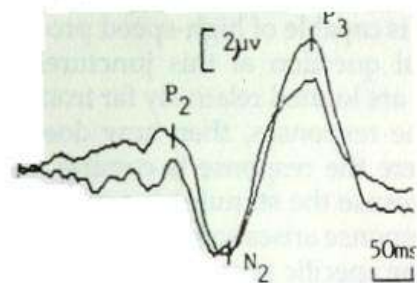
AUDITORY MIDDLE LATENCY RESPONSE (AMLR)

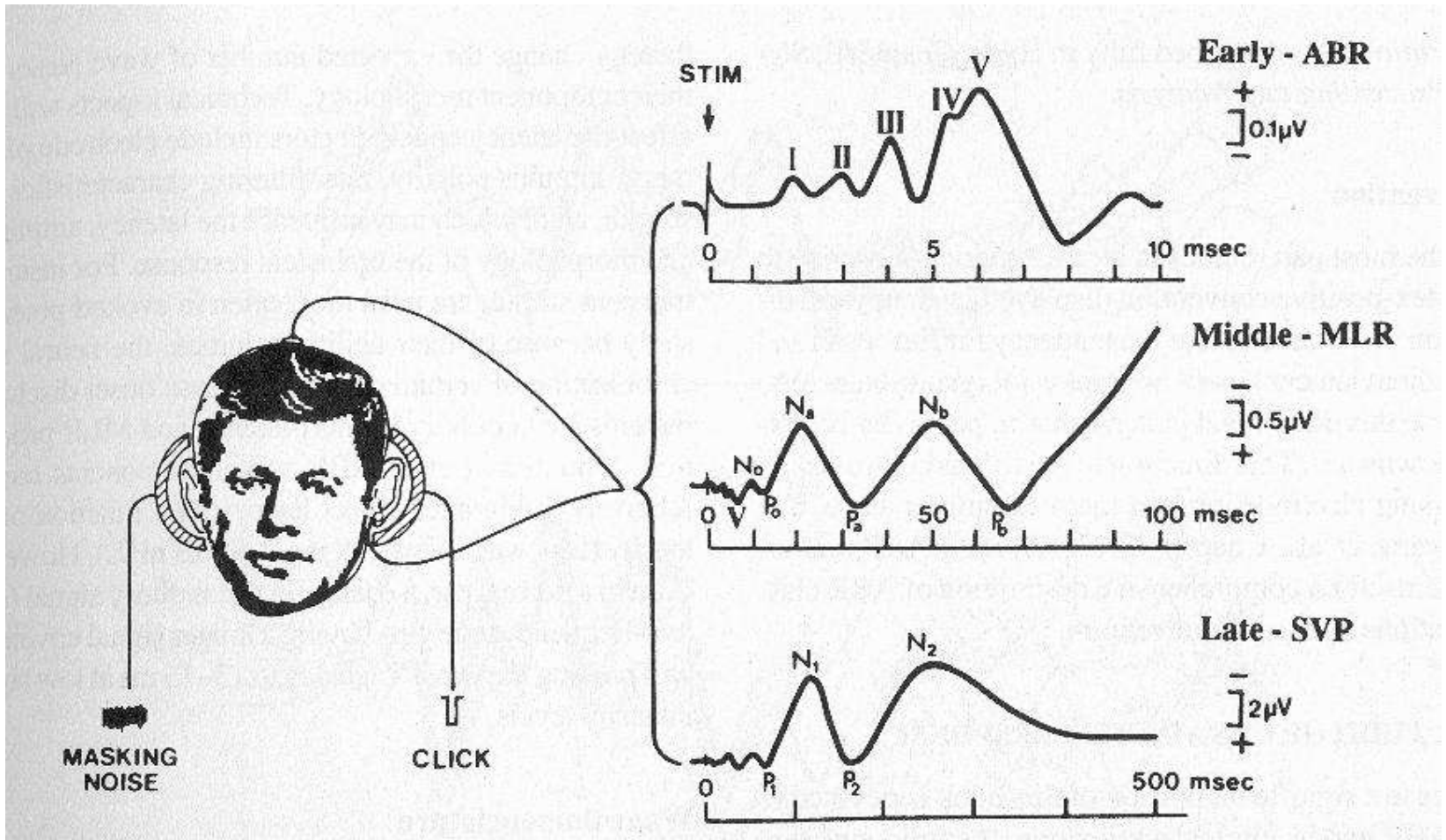


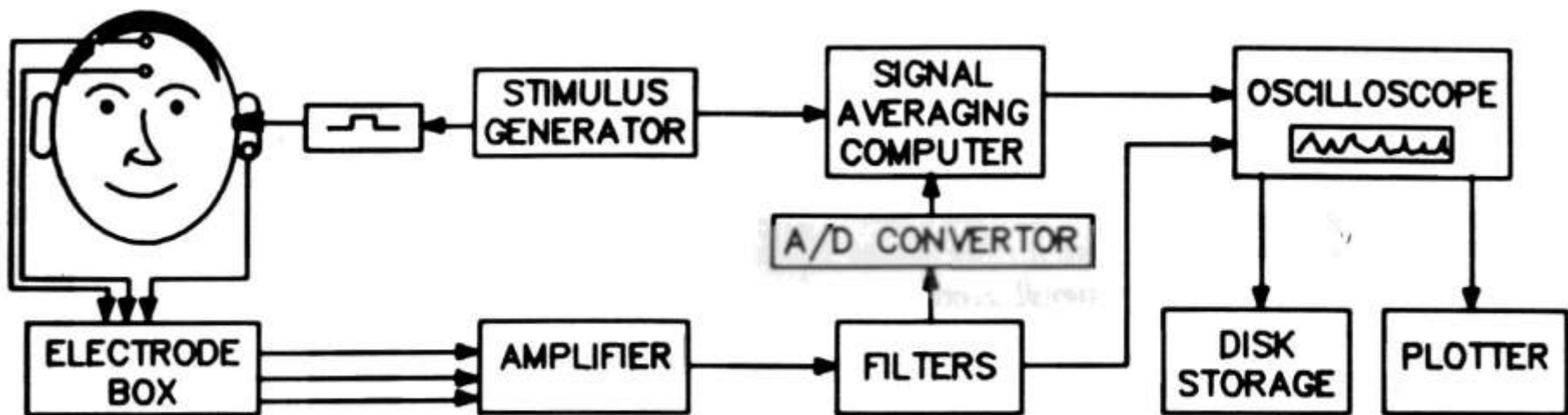
AUDITORY LATE RESPONSE (ALR)



AUDITORY P300 RESPONSE







Non Pathologic Subject Factors
<ul style="list-style-type: none"> . age . gender . body temperature . state of arousal . drugs . muscle activity

Stimulus Factors
<ul style="list-style-type: none"> . frequency . duration . intensity . rate . polarity . transducer . masking . presentation mode

Acquisition Factors
<ul style="list-style-type: none"> . electrodes . amplification . filtering . analysis time . signal averaging

Pathologic Subject Factors
<ul style="list-style-type: none"> . conductive hearing loss . cochlear hearing loss . 8th nerve dysfunction . brainstem dysfunction . cerebral dysfunction

Auditory Brainstem Response

Advantages

- Valid, Objective
- Ear Specific
- Air vs. Bone Conduction
- Independent of Subject State
- Independent of Cerebral Status
- Sound booth not required

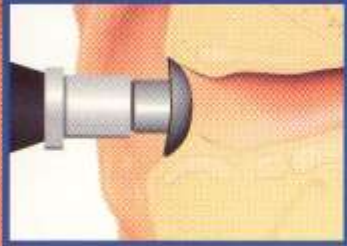
Auditory Brainstem Response

- Disadvantages
- Cost with respect to personnel, time, equipment
- Cannot detect hearing loss below 1000Hz
- Subjective analysis
- Lack of frequency specific information
- Not a behavioral response to hearing

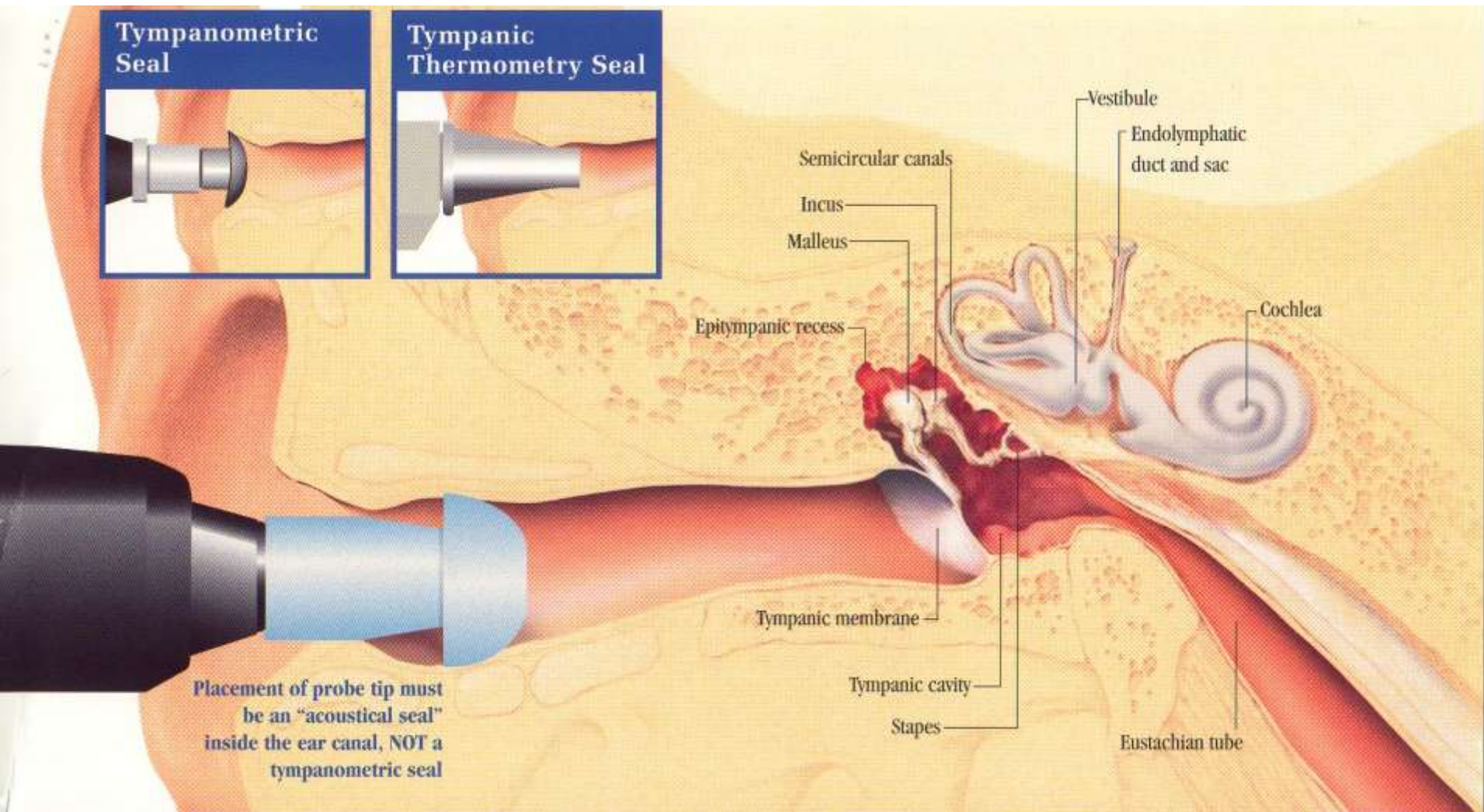
Otoacoustic Emissions

- Sounds generated by the cochlea that can be measured in the external auditory canal
- Produced by the motile activity of the outer hair cells

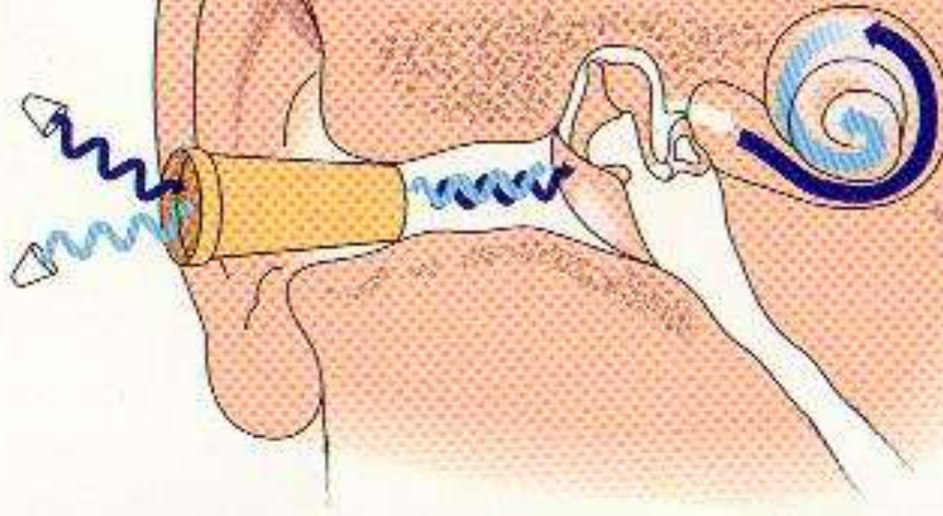
Tympanometric Seal



Tympanic Thermometry Seal



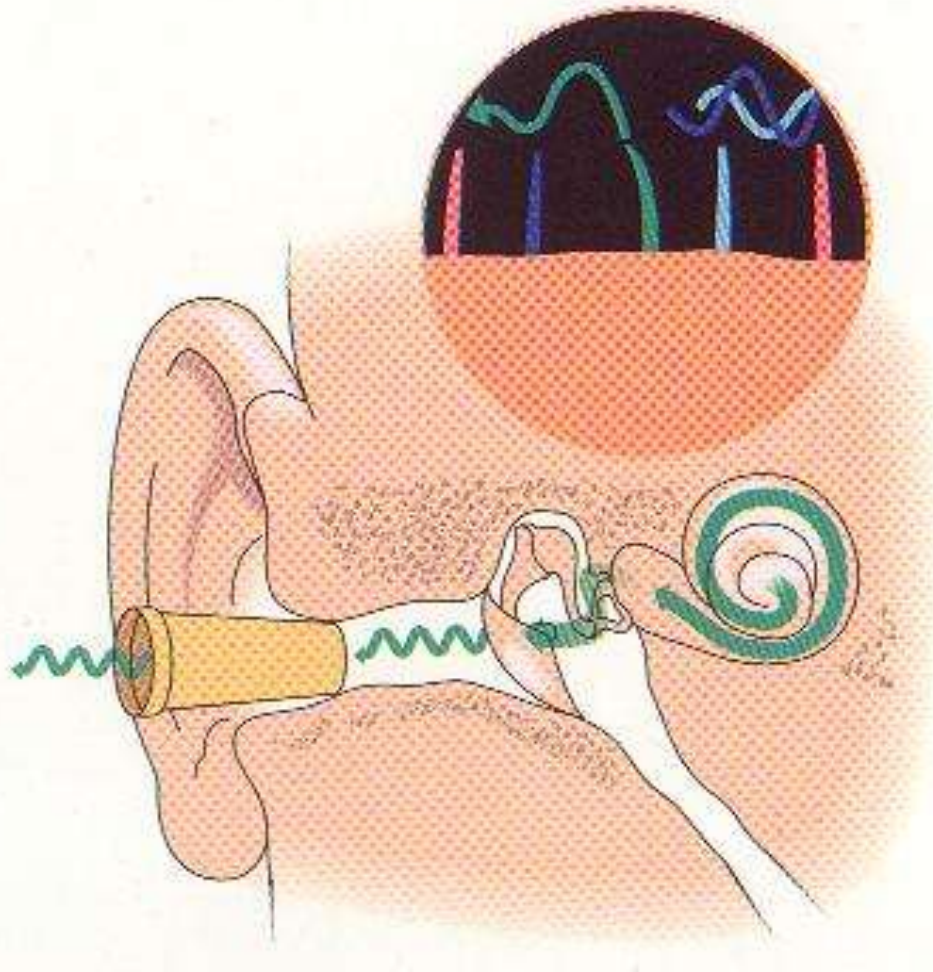
Placement of probe tip must be an "acoustical seal" inside the ear canal, NOT a tympanometric seal



Speakers within the EOAE probe present tones through the ear canal, which has been tightly sealed with an eartip, through the middle ear, and to the cochlea



Outer hair cells in the cochlea react to the tones by generating and emitting a third tone. This third tone (EOAE) travels in reverse direction back to the ear canal and is detected by the probe microphone



Using signal averaging techniques, the AudioPath separates the third tone from all other sounds within the ear canal and displays the data on graphical display



Otoacoustic Emissions

Advantages

- Simple, quick, non-invasive
- Objective, sensitive
- Cost efficient, frequency specific, instrument available
- Personnel training not needed

Otoacoustic Emissions

- Disadvantages
- Only pre-neural; not diagnostic
- Can't determine degree and nature of hearing loss
- Not a measure of behavioral response to hearing

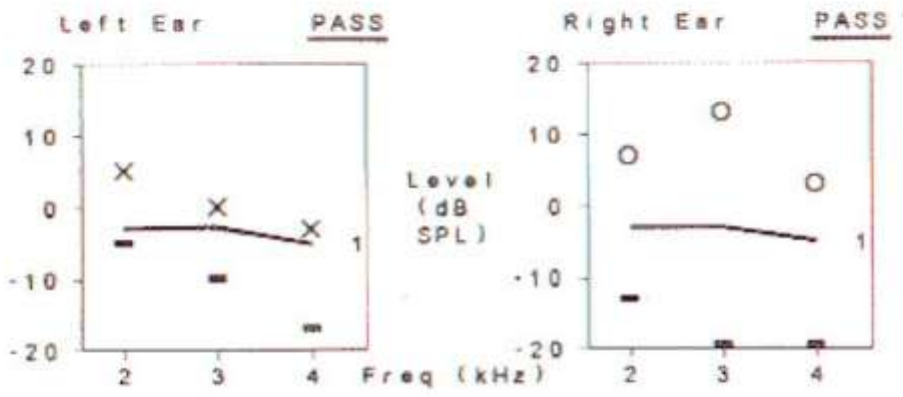
Otoacoustic Emissions

FAIL

- Debris in the external auditory canal
- Middle ear status

“PASS” Result:

Name _____ Date _____



X, O = Emission Level m = Noise Level

2K	3K	4K
5	0	-3
-5	-10	-17
10	10	14

DP
NF
DP-NF

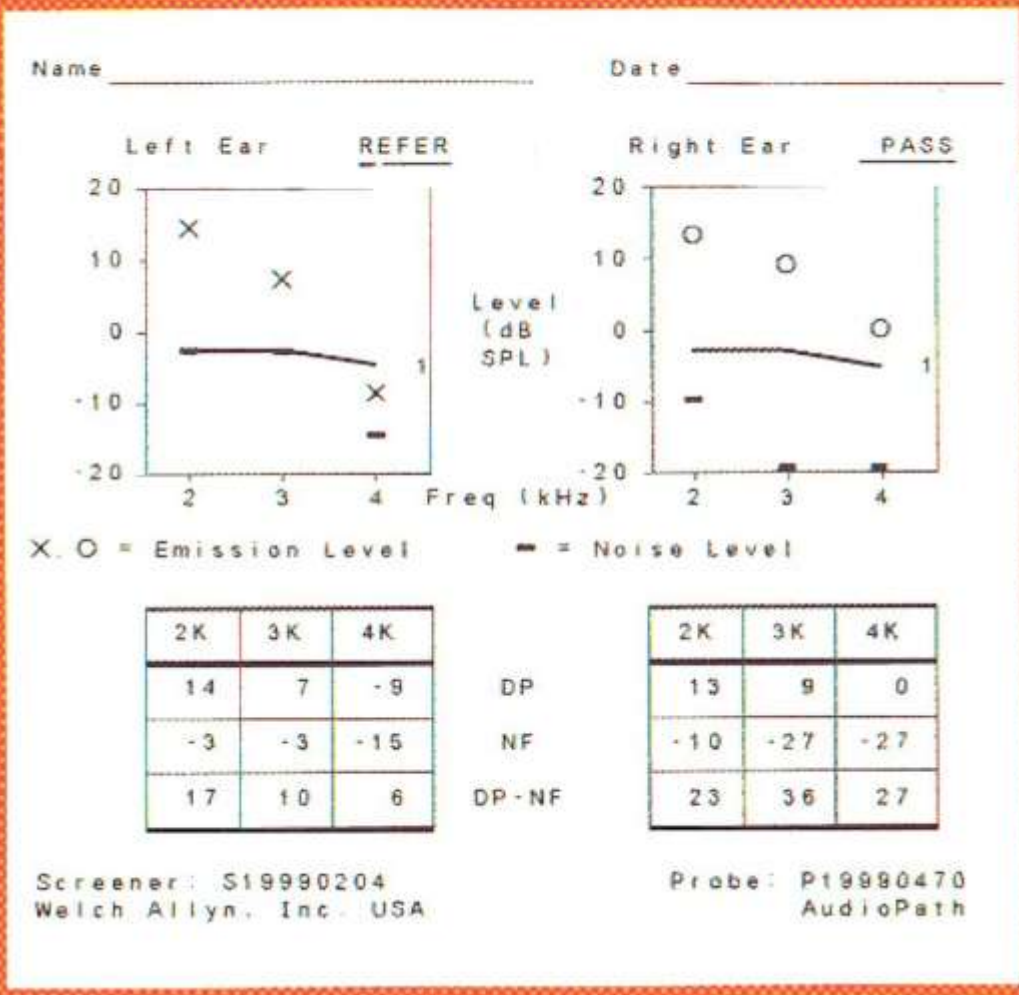
2K	3K	4K
7	13	3
-13	-20	-24
20	33	27

Screener: S19990204
Welch Allyn, Inc. USA

Probe: P19990470
AudioPath

- All DPs above the Pass/Refer line
- $DP-NF \geq 10dB$
- Indicative of:
 - at the time of testing, the cochlea responded well to the tones presented through the probe

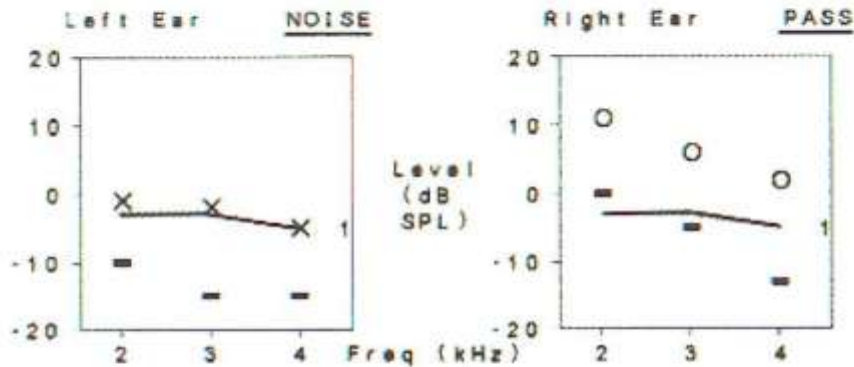
“REFER” Result:



- Any DP below Pass/Refer line
- Can be indicative of:
 - Problem at the outer hair cells
 - Fluid present within the middle ear
 - Ear canal and/or probe tip are plugged with debris

“NOISE” Result:

Name _____ Date _____



X, O = Emission Level ■ = Noise Level

2K	3K	4K
-1	-2	-5
-10	-15	-15
9	13	10

DP

NF

DP-NF

2K	3K	4K
11	8	2
0	-6	-13
11	11	15

Screeners: S19990760
Welch Allyn, Inc. USA

Probe: P19990853
AudioPath

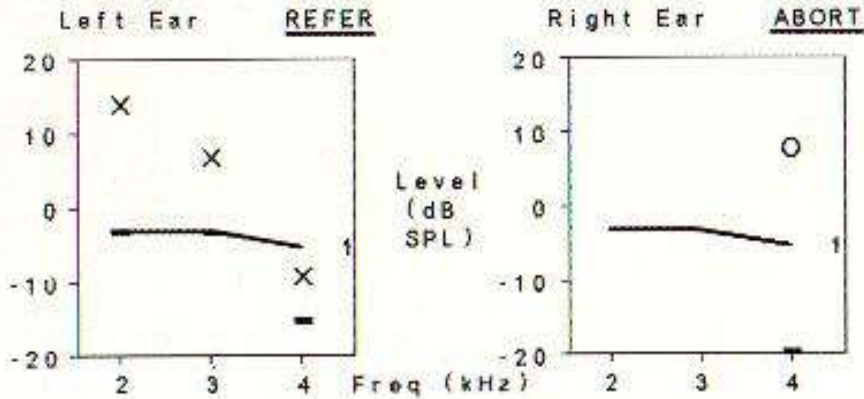
- Less than 10dB separation between DP and noise floor AND the noise floor level must be 0dB or below

- Most commonly seen at 2KHz due to biological noise or poor ear tip fit

- Can be indicative of:
 - Poor eartip fit
 - High ambient noise level
 - Collapsed ear canal
 - Biological noise

“ABORT” Result:

Name _____ Date _____



X, O = Emission Level — = Noise Level

2K	3K	4K
14	7	-9
-3	-3	-15
17	10	6

DP
NF
DP-NF

2K	3K	4K
		8
		-21
		29

Screener: S19990204
Welch Allyn, Inc. USA

Probe: P19990470
AudioPath

- The screener detected that the eartip was not making a good seal and stopped running the test
- Test is stopped by pushing the green button on the pod

Acoustic Reflex

- The lowest intensity of an acoustic stimulus at which minimal change in the middle ear compliance can be measured
- ART for normal hearing subjects is 70dB to 100dB

