433 Teams

ENT

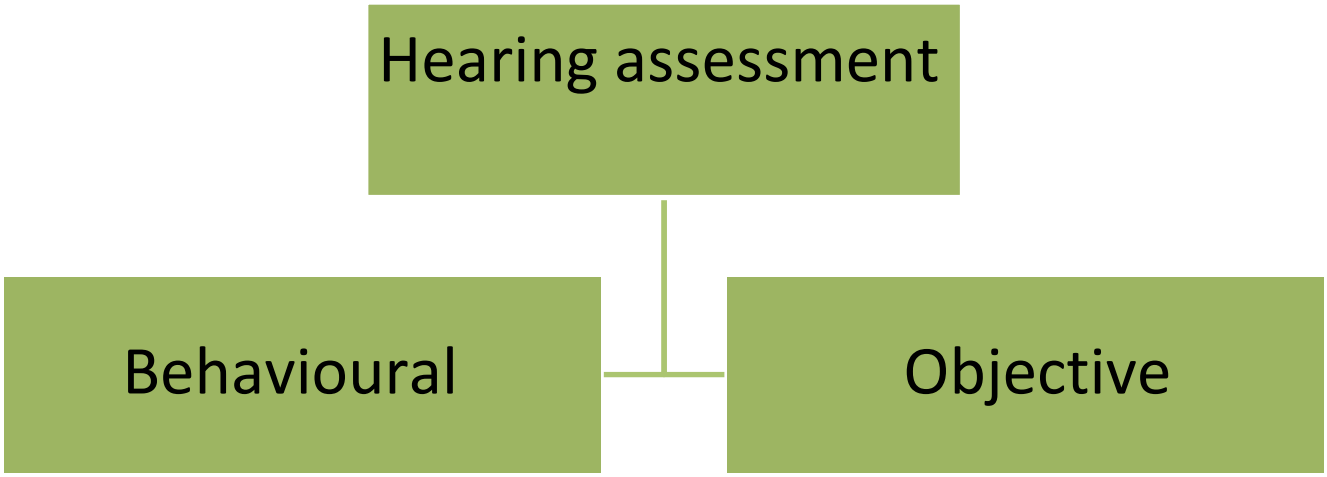
5

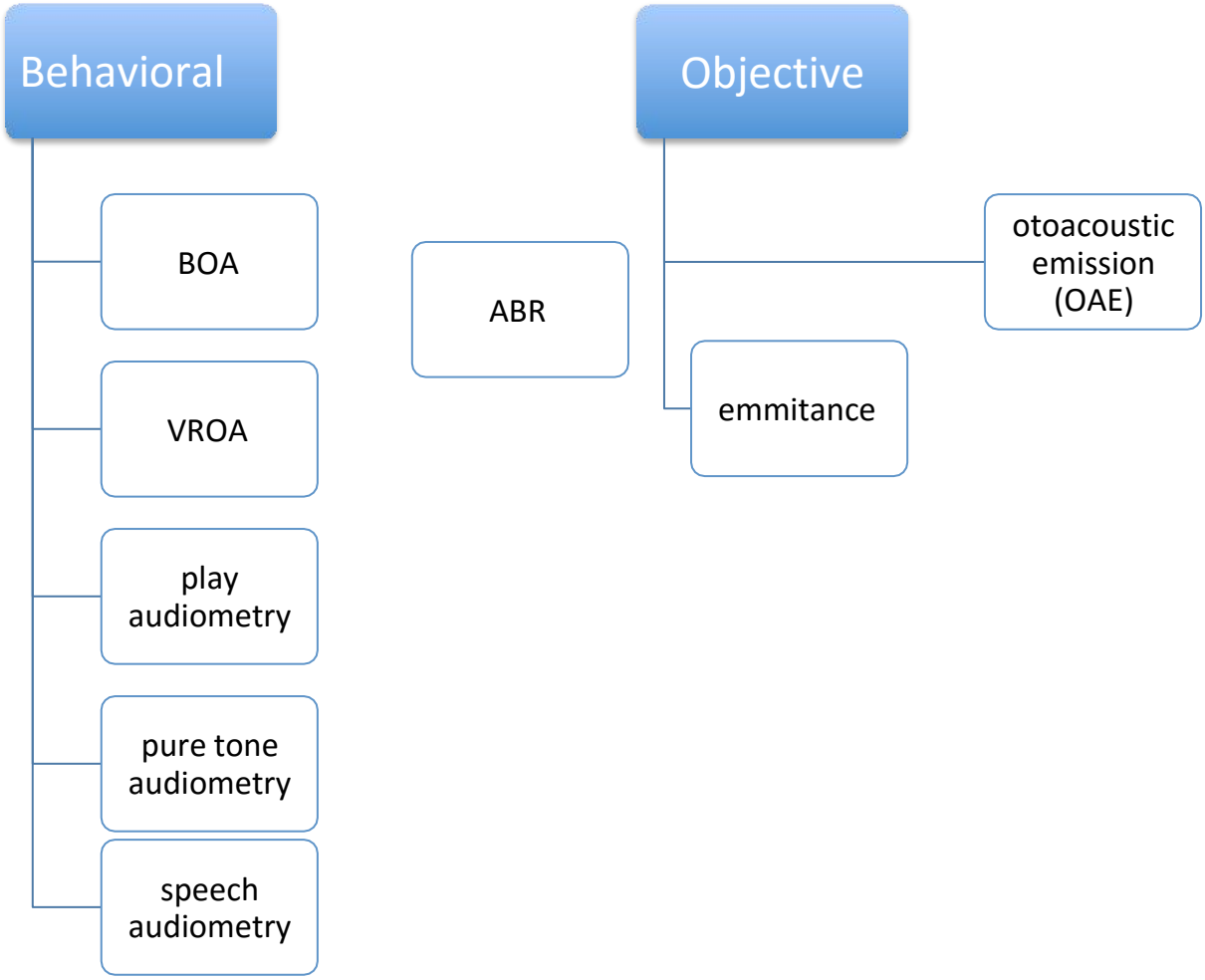
Audiology

Color index:

432 Team – **Important** – **433 Notes** – **Not important**

ent433team@gmail.com


Hearing assessment
Behavioural
Objective

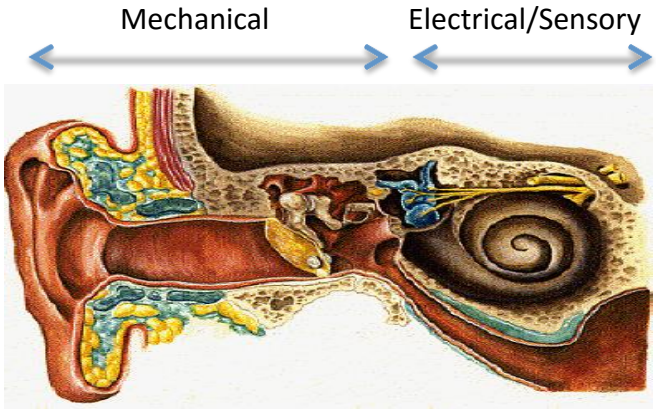

Behavioral
BOA
VROA
play audiometry
pure tone audiometry
speech audiometry
Objective
ABR
otoacoustic emission (OAE)
emmitance

Audiology

Audiology: The study of sound and hearing

Sound: The physical stimulus that evoke sensation of hearing.

Audiometry: The measurement of hearing sensitivity.



The nature of sound hearing goes through the 3 parts of the ear:
External/middle ear >> conductive hearing
Internal ear >> sensory hearing

Wave: is a series of condensations and refractions.

Sound:

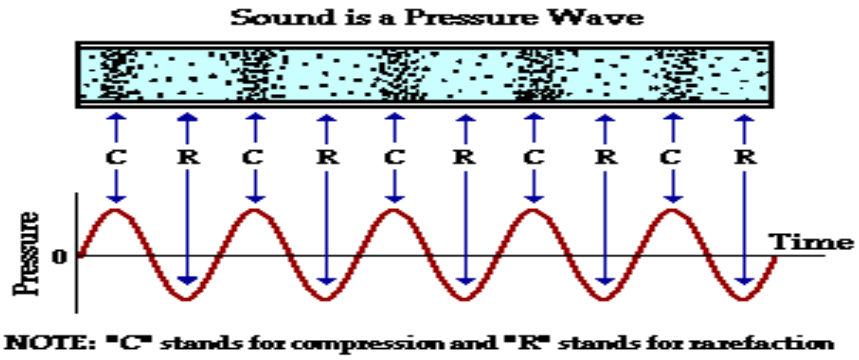
Is a form of vibration.

Vibration:

Is the to-and-fro motion of an object (guitar string, vocal folds, and diaphragm on an earphone or loudspeaker, tuning fork).

For sound to occur, must have:

SOURCE: Something has to be disturbed.
FORCE: Something has to disturb it.
MEDIUM (e.g. air): Something has to carry the disturbances.



CYCLE:

One complete period of compression and rarefaction of a sound wave.

PERIOD:

The amount of time that it takes to complete one vibratory cycle.

Characteristics of the waveform (amplitude x time)

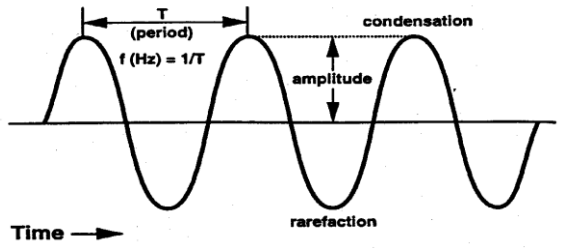


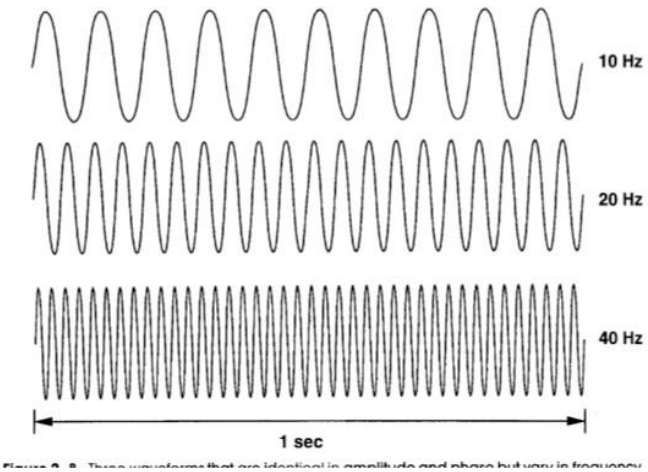
Figure 2–5. A sinusoidal waveform, describing the various properties of sound, including amplitude and frequency (f).

Frequency: The number of cycles that occur in one second (cycle/sec).

Pitch: Psychological percept of frequency. e.g., low frequency sounds = low pitch

Psychoacoustic >> is the perception of sound from human beings points of view (how people differentiate the sounds, e.g. the sound of your mother from your sister)

Hertz (Hz): Unit of measurement of frequency. 100 cycles per second = 100 Hz



Different frequencies in one second

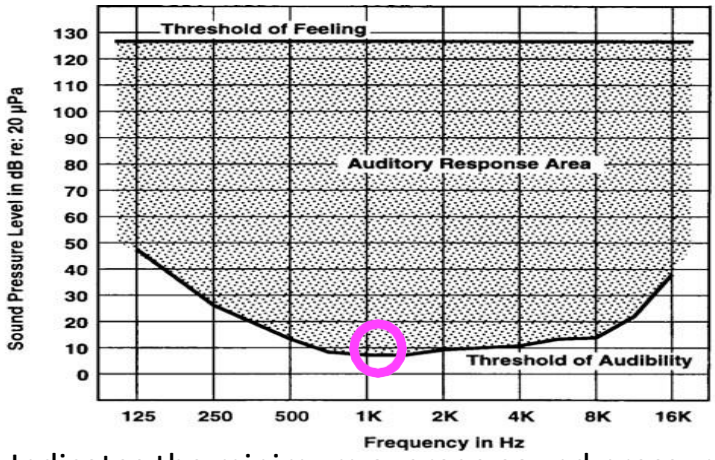
Humans:

20 Hz to 20 kHz. (20-20000HZ) But here we are interested in *(250-8000Hz)

- Below 20 Hz, we feel a vibration rather than hear a sound. Most of the common sounds that humans hear are from (500-8000HZ)
- Most people have very diminished sensitivity for frequencies > 8000-10, 000 Hz.

Bats (auditory specialists): 2 kHz-100 kHz. The

Minimal Audible Pressure Curve (dB SPL):



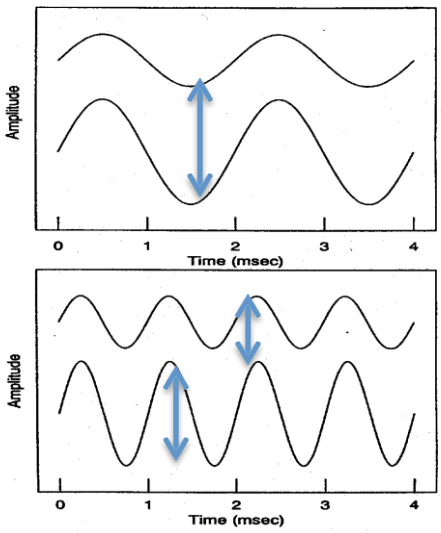
--- **Threshold of feeling** (above the normal limit): result in vibration of objects.
IT'S NOT A HEARING IT'S A FEELING
--- **Threshold of audibility**: the lowest intensity that can be detected by hearing.

Indicates the minimum average sound pressure levels by frequency for a group of people with normal hearing
(Zero is a value it doesn't mean that there is no sound here)

Amplitude/ intensity:
The quantity or magnitude of sound.

Decibel (dB):
Unit of amplitude used most frequently in clinical audiology. (Unit of intensity)

Loudness:
The psychological correlate of amplitude (measured in sones, phons).
Sones and phons: it's a unit of loudness.



High intensity >> damage the ear cells
When the intensity so high it will affect the area around the ear and you'll feel like a vibration.

The arrows represent different magnitudes/intensitie

Hearing loss prevention:

- Noise controls, hearing protectors
  - Primary prevention ⁉ reduction or elimination of HL (HL= hearing loss)
- Screening neonates, school age, elderly, industrial
  - Secondary prevention ⁉ early identification to reduce negative effect of HL
- Audiology services (hearing aids, rehab)
  - Tertiary prevention ⁉ services to deal with adverse effects of HL

Types of tests: Age based hearing assessment.

1. BEHAVIOURAL:

(e.g. ask him a question and he gives you an answer)

- Reliable & consistent response to sound
- Developmental age
- Not used in newborn screening

2. OBJECTIVE:

- No voluntary response
- Infants and young children
- Non compliant subjects
- People with developmental level that doesn't allow other testing.

Behavioral:	Objective:
PURE TONE AUDIOMERTY **PLAY AUDIOMETRY** **VROA** **BOA**	**Measure responses**

I. Behavioural:

A) Behavioural Observation Audiometry (BOA):

Observing changes in behaviour in response to sounds

Who? Very young babies (under 6mths corrected) or with similar functional age.

Test sounds & materials

- Calibrated (known frequency and intensity) noisemakers
- Audiologist records sound level (from sound level meter), sound type & observed response- observer determines whether response is present/absent

For Infants 7 months-3 years:

- Typically used behavioral techniques:
  - **Visual Reinforcement Orientation Audiometry** (VROA) for 6-18 months
  - **Play audiometry**
- Aim: to detect hearing impairment greater than 20-30 dB HL
- May incorporate objective testing if non-compliant or very difficult to test

B) Visual Reinforcement Orientation Audiometry (VROA):

  - Uses operant conditioned response and visual reinforcement
- Response typically head turn. Eye turn also possible
- Complex visual reinforcement usually lighted puppet theatre- color movement and light are important

C) Play audiometry (skipped by the doctor): For kids from 3-9

D) Pure Tone Audiometry: (Important) (for older children)

- Most common test
- Threshold of audibility (measures the threshold)
- Activation of auditory system
- Energy formatted into neural code
- Air conduction assesses entire system
- Bone conduction assesses cochlea onwards

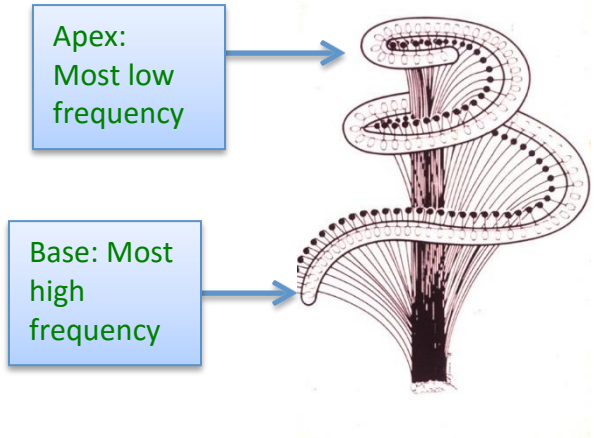
The pure tone audiometry tests a single frequency>> tests one part of the cochlea>> to get a specific frequency information.

Pure Tones:

- Auditory acuity
- Spectrally specific
- High frequency tones stimulate basal turn of the cochlea
- Low frequency tones stimulate apical turn of the cochlea

Tonotopic organization >> means that the frequencies are organized from the highest frequency to the lowest.

In general people lose the high frequency before the low

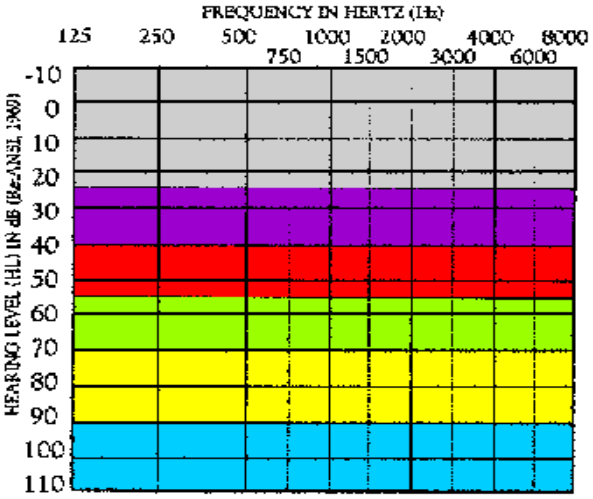


Assessment of thresholds:

- Octave (octave=interval between 2 frequencies) frequencies tested
- Bone conduction thresholds
- Mastoid or forehead used
- Mastoid preferred because less intensity required
- Occlusion effect
- Ascending series of tone presentations

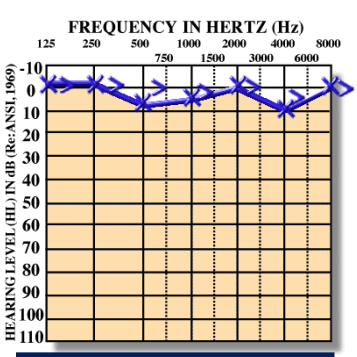
The normal process of hearing is through the air conduction, and from it we can know the degree of hearing loss. Bone conduction is not normal, here we bypass the external and the middle ear, and we use it to test th nerve, which is affected by sensory neural hearing loss.

Ranges of hearing loss:

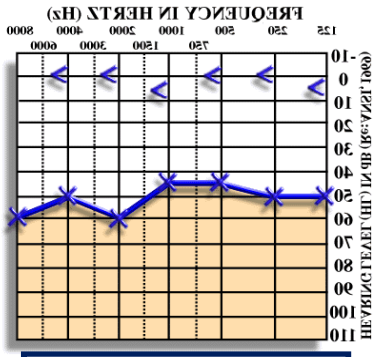


- -10 – 25 dB HL = Normal range
- 26 – 40 dB HL = Mild hearing loss
- 41 – 55 dB HL = Moderate
- 56 – 70 dB HL = Moderately Severe
- 71 – 90 dB HL= Severe
- Greater than 90 dB HL = Profound

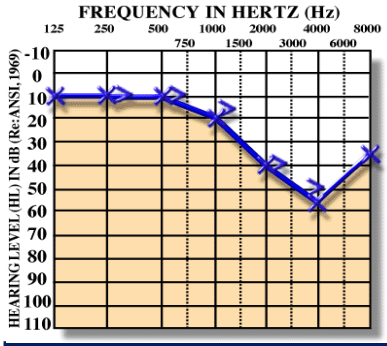
Important



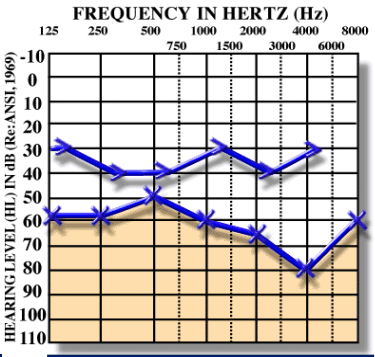
Normal hearing



Conductive hearing



Sensorineural hearing loss



Mixed hearing loss

Very important:

The diagram above has 2 lines. The upper line represents the sensory neural conduction. While the lower line always represents air conduction.

Put in your mind the left side of diagram (low freq) represents the apex of choclea while the right side represent the base (high freq).

Mostly the base is affected so the right side of the diagram has the problem.

If there was a problem with a huge gap between the neural and air conduction the management will be surgery to treat the air conduction.

If the gap was unremarkable but the problem is present then treat the sensory neural with hearing aids in case of mixed hearing loss.

E) Speech Audiometry: it tests a group of frequencies at the same time (500-8000)

- Speech Reception Threshold using spondaic words
- Standardized word lists
- Familiarization with spondees
- Ascending series of presentation
- Excellent speech discrimination in conductive hearing loss patients
- Poor speech discrimination in cochlear hearing loss patients
- Poorest speech discrimination in retrocochlear hearing loss patients

Clinical Masking:

- Non-tested ear can influence thresholds of test ear
- Shadow curve apparent without masking
- Interaural attenuation varies from 40 to 80 dB with air conduction
- Interaural attenuation is about 0 dB with bone conduction
- Compare bone conduction threshold of nontest ear with air conduction threshold of test ear to determine whether masking is necessary

Masking is exclusion of one ear while doing the test; we do it when there is a possibility of crossing over. Crossing over gives false results in the test

Plateau method:

- Mask the non-tested ear with progressively greater amounts of sound until threshold does not rise.
- Masking Dilemma

II. Objective Audiological Tests:

Electrophysiological Tests

1- Immittance

a. Ear Canal Volume
b. Tympanometry (test for middle ear)
c. Static Compliance
d. Acoustic Reflex, Decay, & Latency

Middle ear is a box shaped structure that is filled with air. Tested by: tympanometry. Which can assess:
--- If the middle ear filled with air or fluid
--- If there is fixation, fracture or dislocation of the ossicular bones
--- If the tympanic membrane is perforated
--- If there is eustachian tube dysfunction

a. Ear Canal Volume

- Measure at +200 mmH20
- Provides measure of volume of external ear canal
- Volumes based on age
- **Volumes greater than 2.5 suggest: Perforation or Patent V.Tube.**

b. Tympanometry (Important)

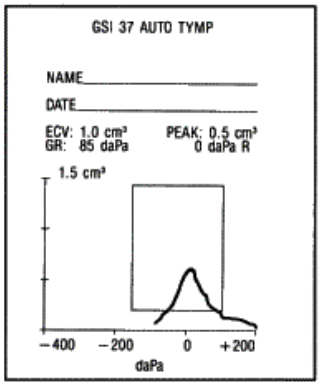
- Objective measure of the function of the TM and middle ear
- 5 or 6 basic shapes

Objective measure means that it can be used in infants, young children, mentally retarded, non-cooperative, & critically ill patients

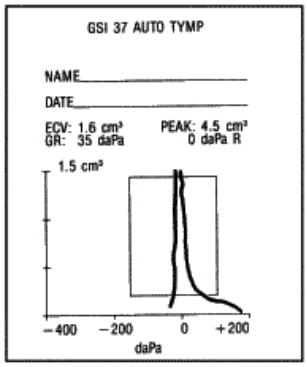
Benefits:

1- Not time consuming
2- No special preparations
3- No sedation

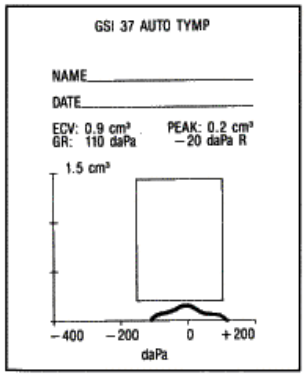
Tympanogram Types:



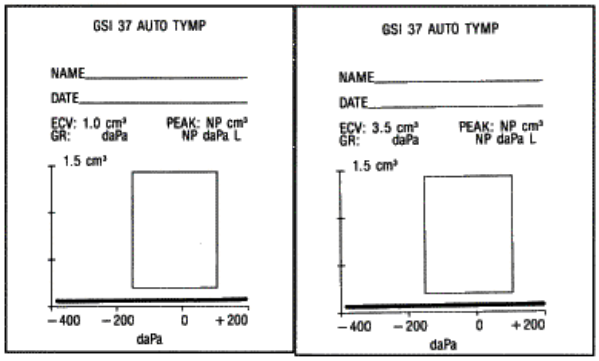
- Type A tympanogram (normal).
- Peak at zero pressure
- Amplitude (0.3-1.7)



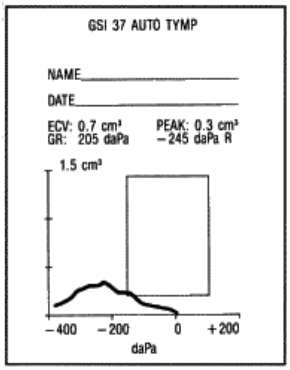
- High amplitude
- Pathology: ossicular dislocation



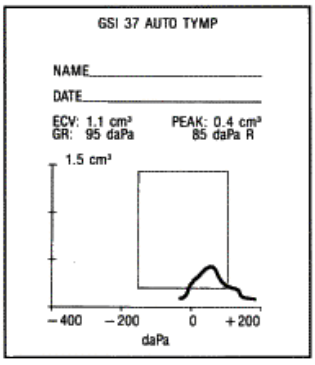
- Low amplitude
- Pathology: ossicular fixation



- Type B tympanogram (flat curve).
- Pathology: effusion (fluid) or perforation



- Type C tympanogram.
- Pathology: eustachian tube dysfunction



- Positive pressure
- Doesn't reflect pathological process (it happens when there is a lot of air inside the ear)

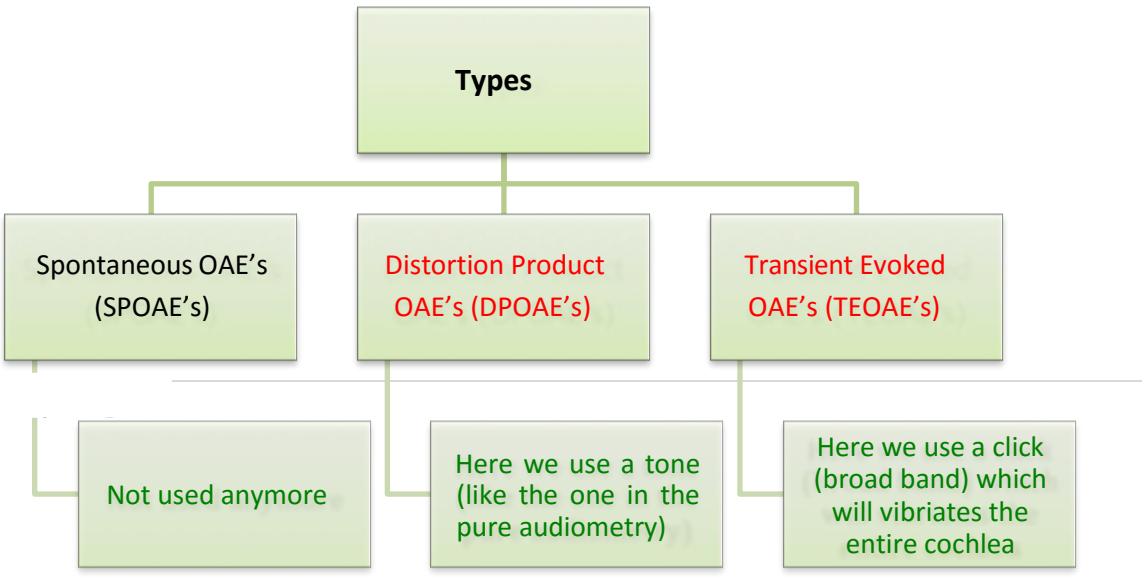
2- Otoacoustic emissions (oto= ear, acoustic= sound, emission= coming out) "objective test"

- Otoacoustic emissions are sounds that are produced by healthy ears (in the cochlea) in response to acoustic stimulation.
- OAE's arise because our ears have evolved a special mechanism to give us extra hearing sensitivity and frequency responsiveness. The mechanism is known as the cochlear amplifier and it depends on a specialized type of cell called "outer hair cells."
- It's the job of the cochlea to receive the sound energy collected by the outer and middle ear and to prepare it for neural transmission.

Purpose of OAE's (test for the outer hair cells of the cochlea)

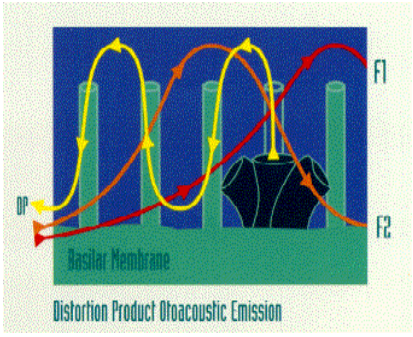
- The primary purpose of otoacoustic emission (OAE) tests is to determine cochlear status, specifically hair cell function (if we recorded emissions coming from the cochlea it means I have a normal or near normal cochlea)
- This information can be used to
  - Screen hearing
  - Partially estimate hearing sensitivity within a limited range
  - Differentiate between the sensory and neural components of sensorineural hearing loss
  - Test for functional hearing loss.

Types of OAE's



Distortion Product OAE's

- Result from the interaction of two simultaneously presented pure tones.
- Stimuli consist of 2 pure tones at 2 frequencies (ie, f1, f2 [f2>f1]) and 2 intensity levels (ie, L1, L2). The relationship between L1–L2 and f1–f2 dictates the frequency response.



DPOAEs

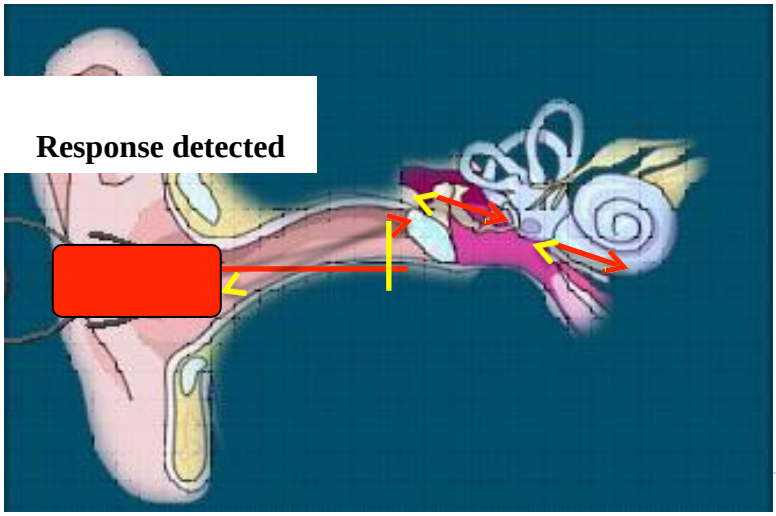
- 2 tone stimuli (F1 and F2)
- Cochlea hair cells generate a resonance

Transient Evoked OAE

- TEOAE's are frequency responses that follow a brief acoustic stimulus, such as a click or tone burst.

Recording OAE's

OAEs are measured by presenting a series of very brief acoustic stimuli, clicks, to the ear through a probe that is inserted in the outer third of the ear canal.



OAEs

- Otoacoustic emissions
- "Echo"-like response of outer hair cells of the cochlea
- Can only indicate functioning outer hair cells and good middle ear function.

Types of OAEs

- Spontaneous
  - 20-60% of population, related to age
  - Not clinically useful
  - Not related to tinnitus
- Evoked
  - Present in normal ears
  - Not present in ears with SNHL greater than 25-30 dB
  - Absent in presence of conductive hearing loss. WHY?

Acquisition

- Not affected by sleep but needs test subject to be still and compliant
- Very quick

The sound first starts as acoustic then ends in the nerve as electric signal to be analyzed by the auditory centers in the brain

Auditory brainstem response (ABR)

The most sensitive & accurate test in infants & young children

History

- First complete description in 1970s
- Response found between 1-15ms after stimulation.
- Recording has 7 peaks, peak five being the most prominent.
  - The amplitudes, latencies and relationship of those peaks can be used to diagnose certain pathological conditions.

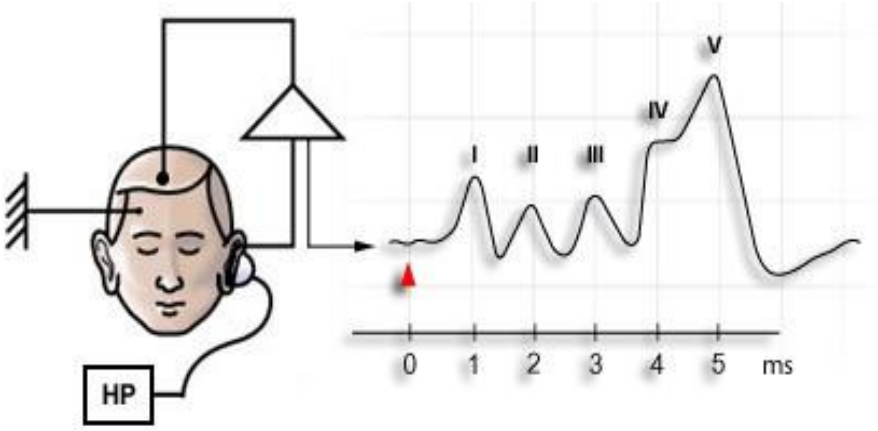
What is an ABR?

- The Auditory Brainstem Response **is the representation of electrical activity generated by the eighth cranial nerve** and brainstem in response to auditory stimulation

How is an ABR recorded?

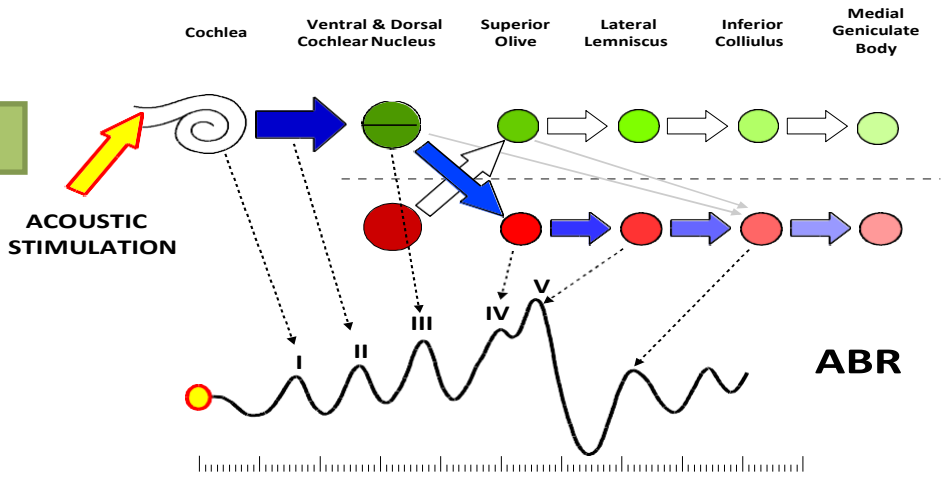
- Electrodes are placed on the scalp and coupled via leads to an amplifier and signal averager. EEG activity from the scalp is recorded while the ear(s) are stimulated via earphones with brief clicks or tones.
- A series of waveforms unique to the auditory neural structures is viewed after time locking the EEG recording to each auditory stimulus and averaging several thousand recordings.

Components

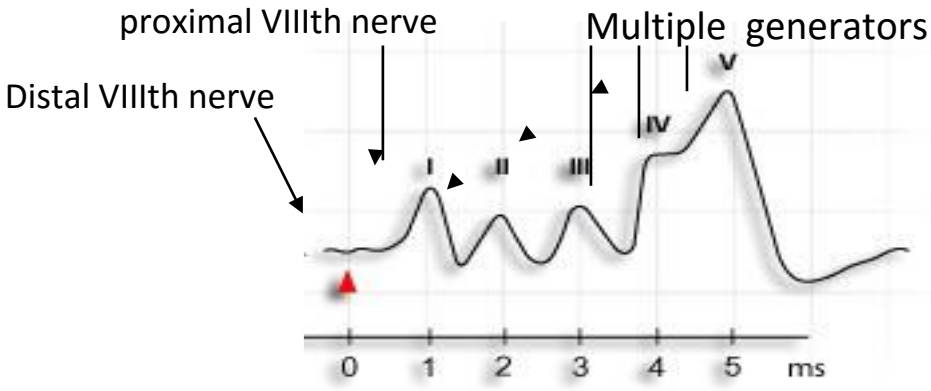


Wave V is the most important one. Normally we can record it after 5 milliseconds.

Generators of the ABR

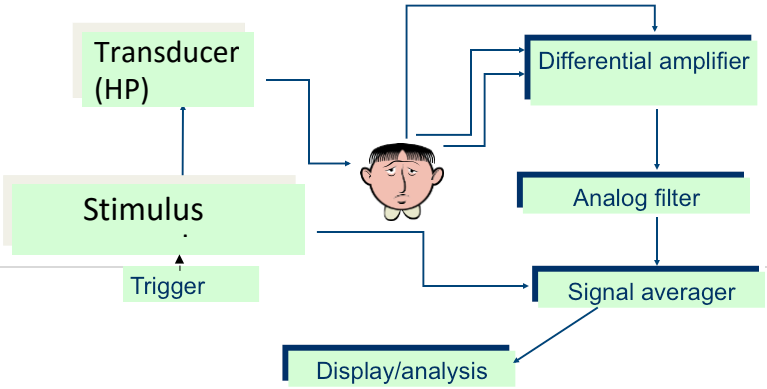


Anatomy

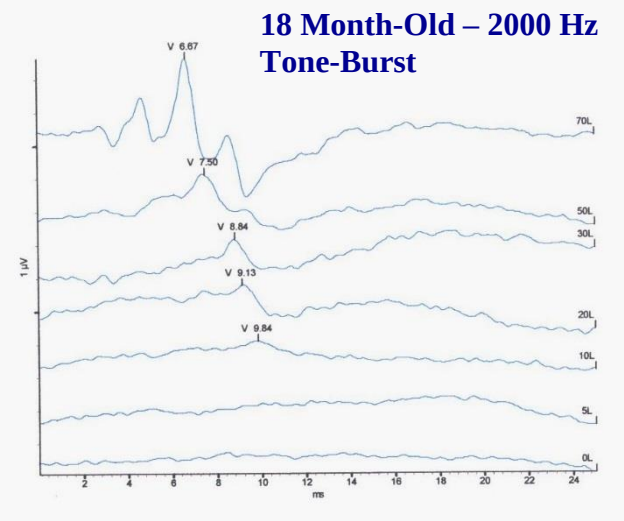


Stimulus & acquisition

- Short clicks or tone bursts used
- Rate of around 20/sec or faster
- Responses can be + or – 20dB on true thresholds, mixed in with EEG
- Electrodes on head (surface electrodes)
- Can be influenced by subject characteristics (age, gender, body temperature)
- Not affected by arousal state or most drugs



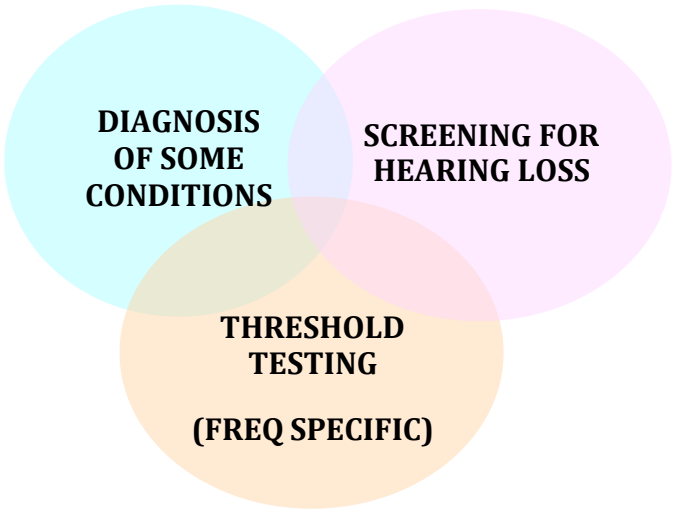
Example Normal Hearing



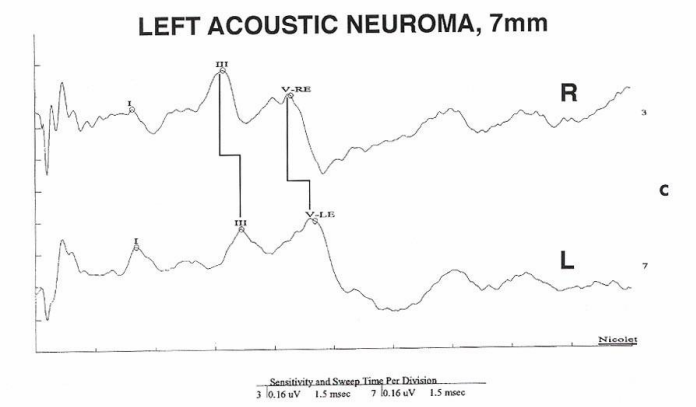
Clinical applications

- Basis of Newborn screening tests: non-invasive, high success rate
- Estimation of thresholds for difficult to test people
- Neurodiagnosis of VIIIth nerve/ brainstem problems
- Intraoperative monitoring
- Cochlear implant evoked responses
- Test-retest reliability

Why use ABR testing?



Retrocochlear lesion:



Done By:

Othman Abid
Khaled Al Nasser
Mojahed Otayf