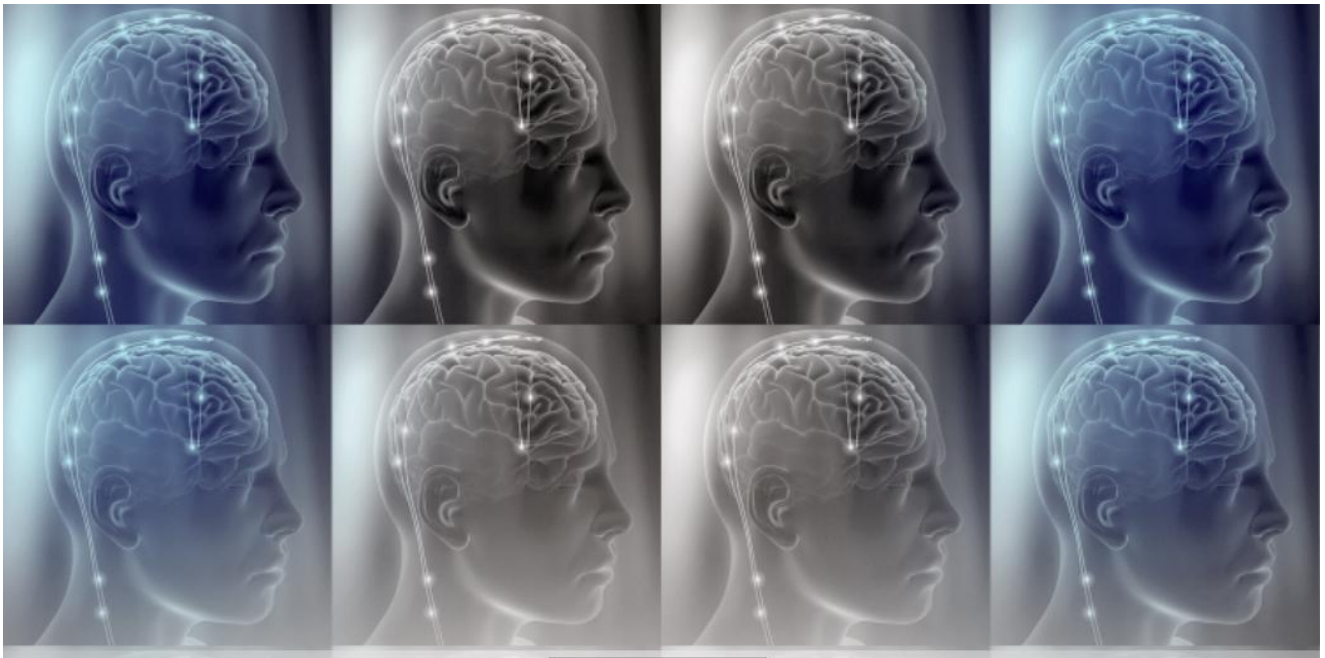

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CNS Central Nervous System

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Physiology Team

Audiometry

Important Terminology

▪ Air conduction:

It is the transmission of sound waves through air to the auditory cortex via auditory nerve, involving outer, middle and inner ears.

▪ Bone conduction:

It's the transmission of sound waves through the bones of the skull to the cochlea and then through the auditory pathways to the auditory cortex.

Air conduction is always better than bone conduction in a normal person.

▪ Masking sound:

Masking presents a constant noise to the non-test ear to prevent crossover from the tested ear. The purpose of masking is to prevent the non-test ear from detecting the signal (line busy), so only the test ear can respond.

e.g masking sound will be provided to the left ear, if the right ear is tested

▪ Audiogram

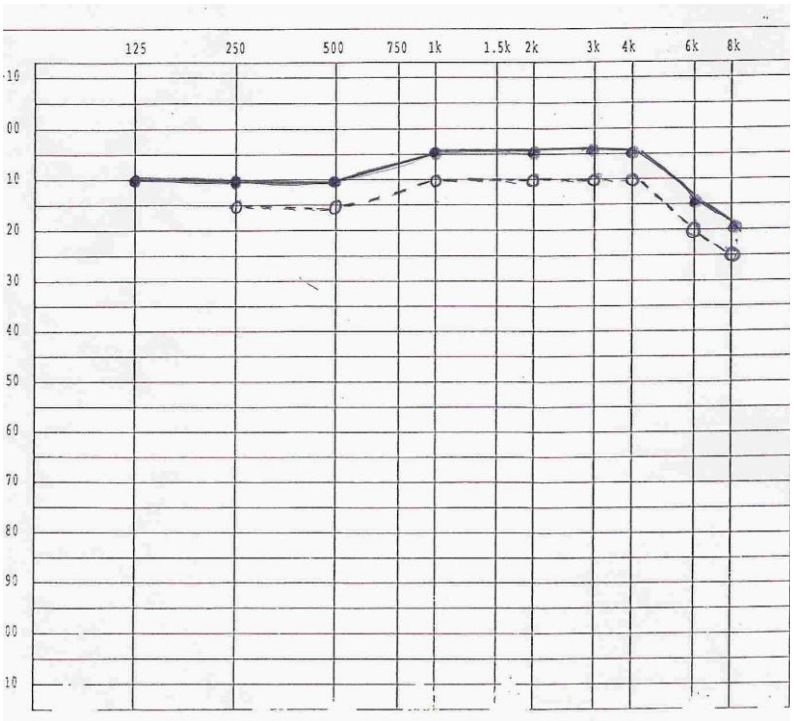
The audiogram is a chart of hearing sensitivity with

- frequency charted on the X- axis
- intensity on the Y-axis.

☒ Intensity is the level of sound power measured in decibels

☒ frequency (pitch) is the number of sound waves per second measured in Hertz.

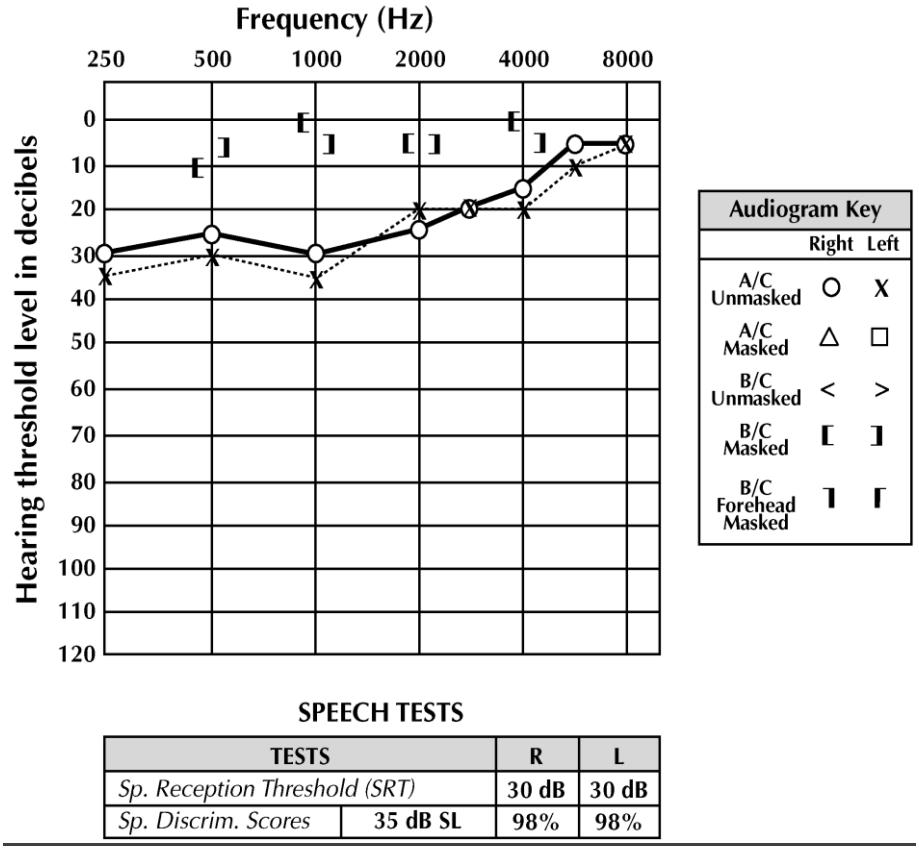
Audiogram of normal subject



TYPES OF HEARING LOSS

1- Conductive Hearing loss (deafness)

- The abnormality reduces the effective intensity of the air-conducted signal reaching the cochlea, but it does not affect the bone-conducted signal that does not pass through the outer or middle ear.
- Examples of abnormalities include perforated tympanic membranes, fluid in the middle ear system, or scarring of the tympanic membrane.
- So the bone conduction is better than the air conduction



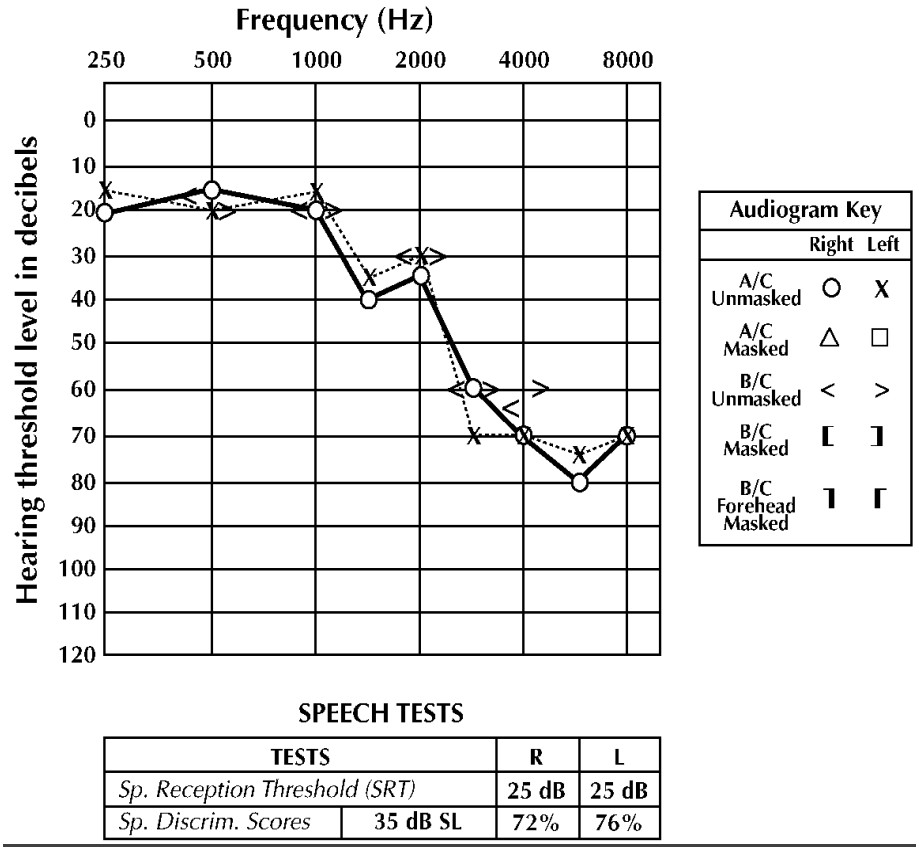
SPEECH TESTS

TESTS		R	L
Sp. Reception Threshold (SRT)		30 dB	30 dB
Sp. Discrim. Scores	35 dB SL	98%	98%

2- **Sensorineural Hearing loss (deafness)**

- This type of hearing loss is secondary to cochlear abnormality and/or abnormality of the auditory nerve or central auditory pathways. Because the outer ear and middle ear do not reduce the signal intensity of the air-conducted signal, both air- and bone-conducted signals are effective in stimulating the cochlea.

- So the air conduction is better than the bone conduction

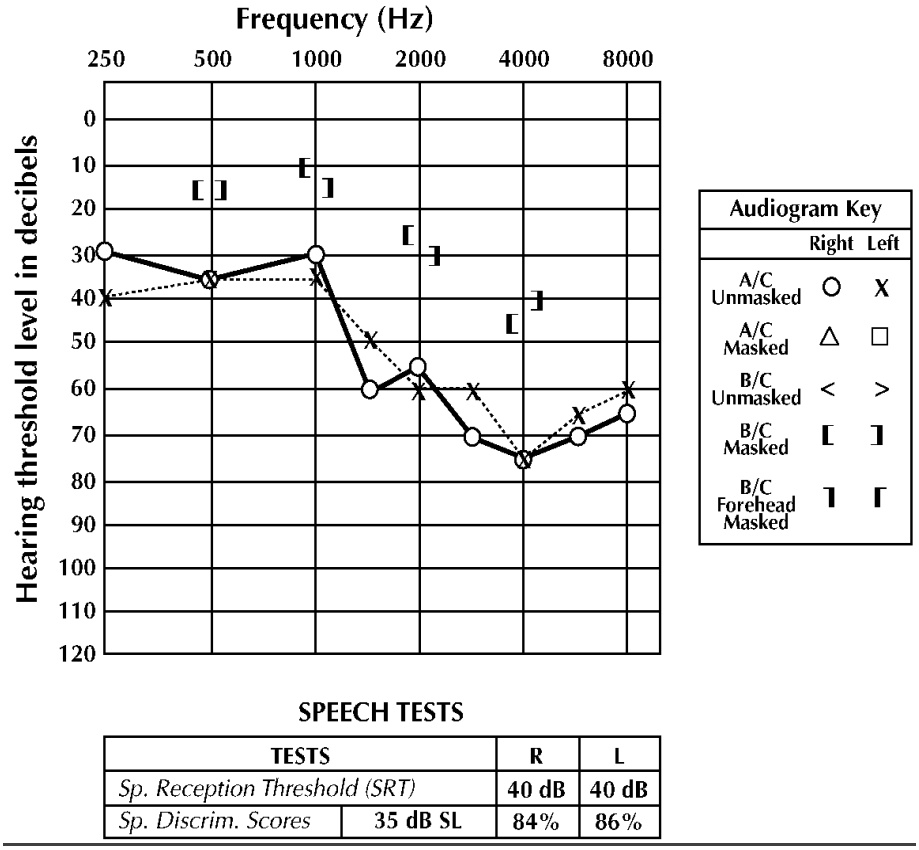


SPEECH TESTS

TESTS		R	L
Sp. Reception Threshold (SRT)		25 dB	25 dB
Sp. Discrim. Scores	35 dB SL	72%	76%

3- Mixed hearing loss

This type of hearing loss has sensorineural and conductive components



DEGREES OF HEARING LOSS:

Given below are the ranges of hearing thresholds for a given frequency of sound that determine the severity of hearing loss in a subject tested by audiometry:-

Range of hearing threshold	Degree of hearing loss
0-25 dB	**Normal hearing**
26-40 dB	Mild hearing loss
41-55 dB	Moderate hearing loss
56-70 dB	Moderate-severe hearing loss
71-90 dB	Severe hearing loss
>90 dB	Profound hearing loss

COMMON AUDITORY DISORDERS

- **Presbyacusis** (age related hearing loss)
- **Otitis media**: This condition is marked by fluid in the middle ear space.
- **Noise-induced hearing loss**
- **Otosclerosis**: The condition is caused by stapedial fixation in the oval window, stiffening the middle ear system.
- **Ménière disease** an inner ear disorder that affects balance and hearing.

TUNING FORK TESTS

1- Rinne's Test

It compares perception of sounds transmitted by air conduction to those transmitted by bone conduction through the mastoid

Technique

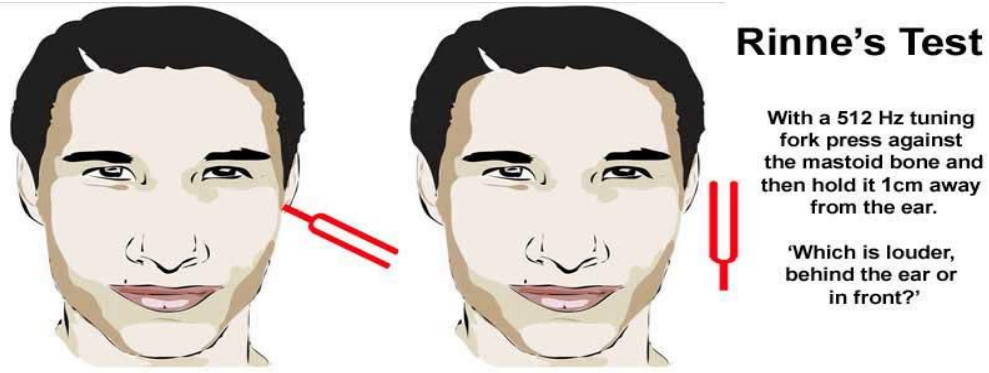
- First: Bone Conduction
  - Vibrating Tuning Fork held on Mastoid
  - Patient covers opposite ear with hand
  - Patient signals when sound ceases
  - Move the vibrating tuning fork over the ear canal
    - Near, but not touching the ear
- Next: Air Conduction
  - Patient indicates when the sound ceases

In Normal person :

- Air Conduction is better than Bone Conduction
  - Air conduction usually persists twice as long as bone
  - Referred to as "positive test"

Abnormal:

- Bone conduction better than air conduction
  - Suggests Conductive Hearing Loss.
  - Referred to as "negative test"

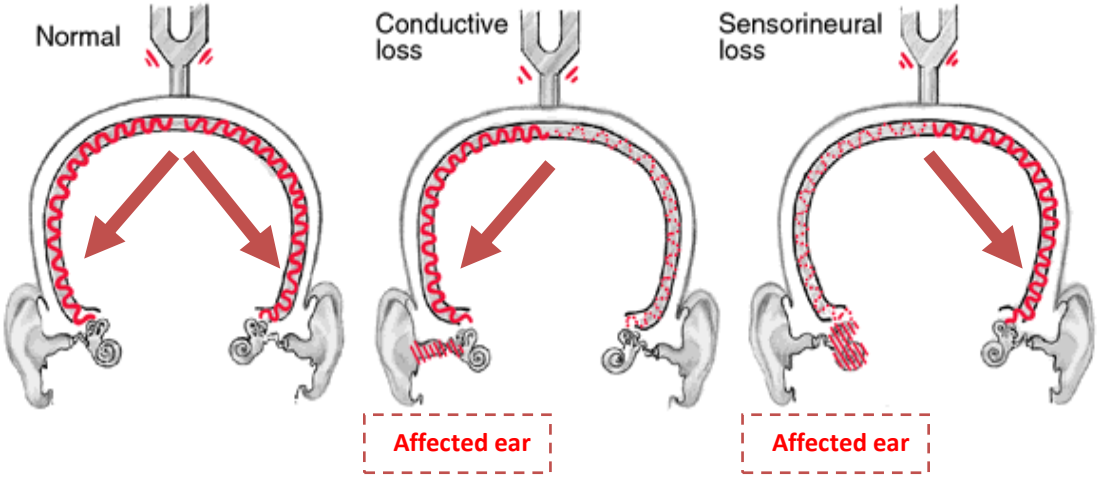


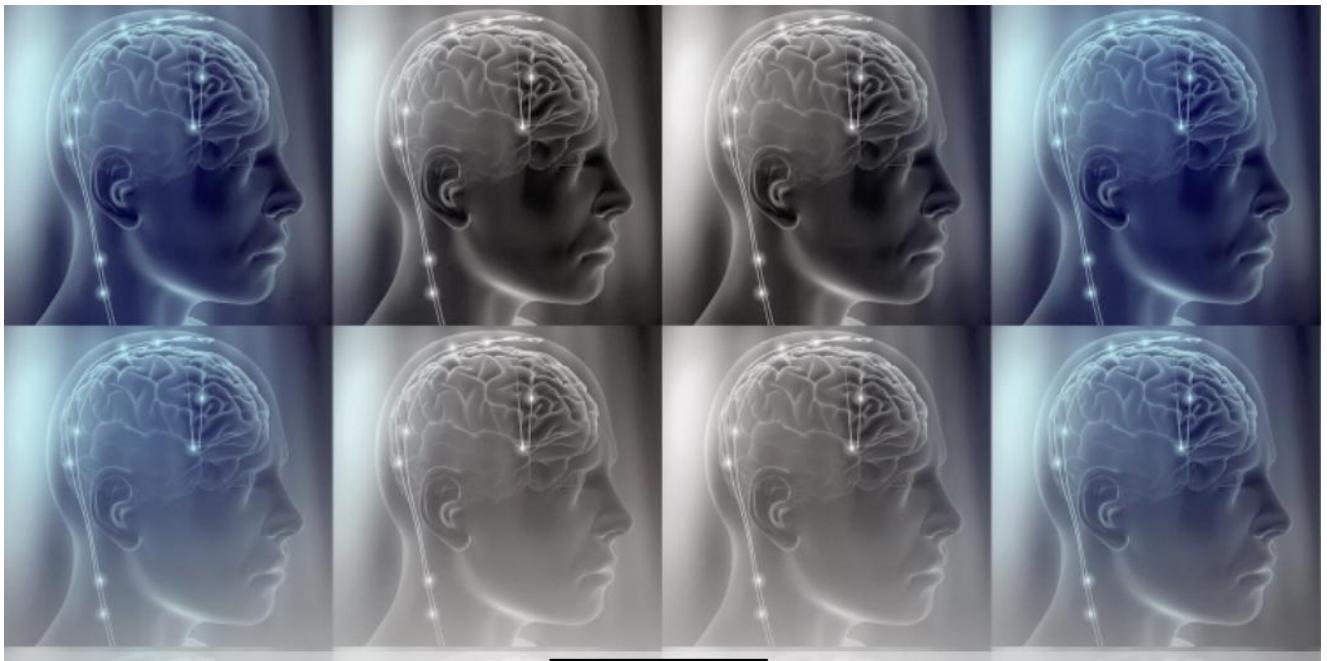
2- Weber Test

This test distinguishes between conductive and sensorineural deafness

Tuning Fork placed at midline forehead

- Normal: Sound radiates to both ears equally
- Abnormal: Sound lateralizes to one ear
  - Ipsilateral Conductive Hearing Loss OR
  - Contralateral Sensorineural Hearing Loss
  - Sound localizes toward the poor ear with a conductive loss
  - Sound localizes toward the good ear with a sensorineural hearing loss





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CNS Central Nervous System

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EMG

- **EMG**

  is a recording of the electrical activity of the skeletal muscle at rest & during contraction: (to evaluate the electrophysiology of a MU)

○ Motor Unit

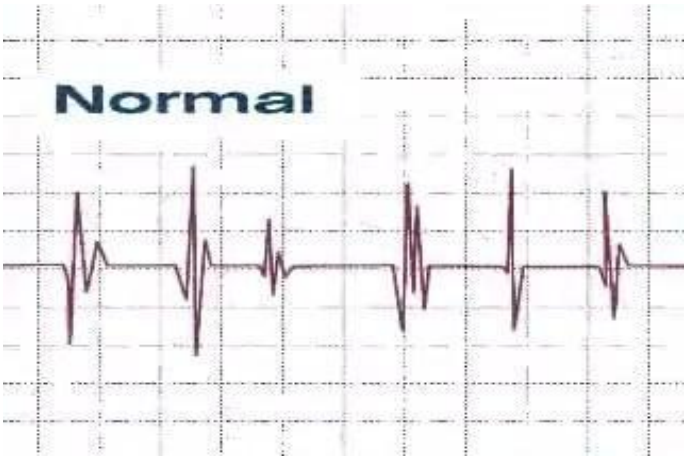
It's a motor neuron and the muscle fibers that are supplied by it. Normally a muscle is silent at rest.

○ Motor unit potential :

represents the summation of the potentials generated by muscle fibers belonging to the MU

○ Normal MUPs

- Bi –Triphasic
- Duration – 3–16 mSec.
- Amplitude – 300 muV – 5 mV



EMG Analysis

- The EMG is used to investigate both neuropathic and myopathic disorders (weakness,numbness,pain)

- The size, duration, frequency of the electrical signals generated by Muscle cells help determine if there is damage to the Muscle or to the nerve leading to that Mu.

  - **Myopathy**: progressive degeneration of skleletal muscle fibers
    Eg: Duchenne Muscular dystrophy

  - **Neuropathy :**Damage to the distal part of the nerve. peripheral neuropathy mainly affects feet and legs

In Neuropathic lesion or in myopathic (active myositis) the following spontaneous activity is noted as;

1-**Positive sharp waves:**. Small fibrillation APs

2-**Fibrillation potential:**→ Low amplitude, short duration potentials

a- Potentials are generated from a single muscle fiber.

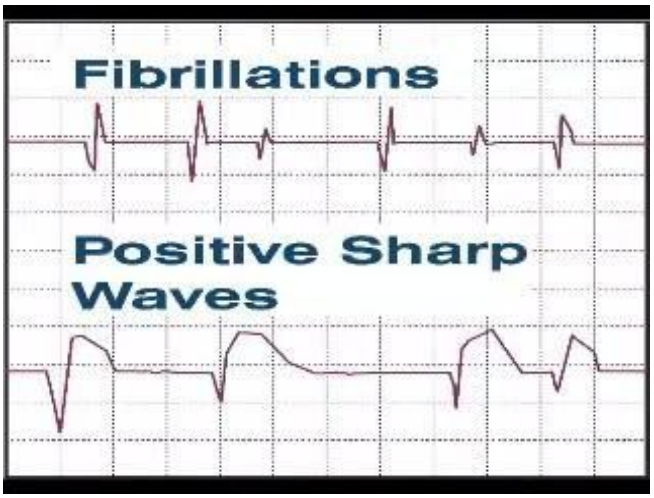
b- Hypersensitivity to acetylcholine.

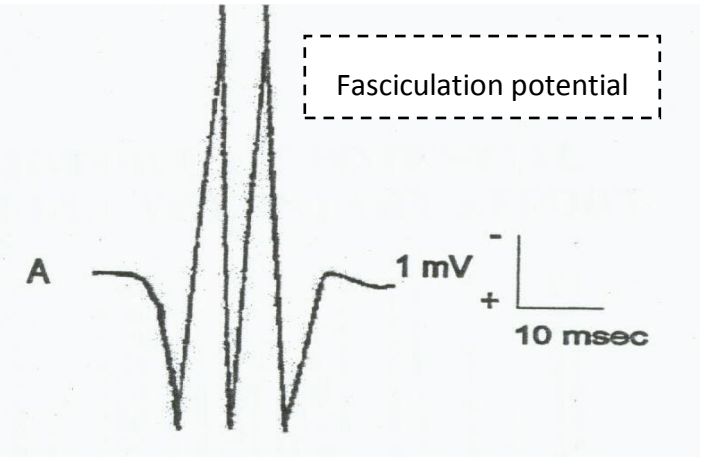
c- Cannot be felt and cannot be seen by the naked eyes.

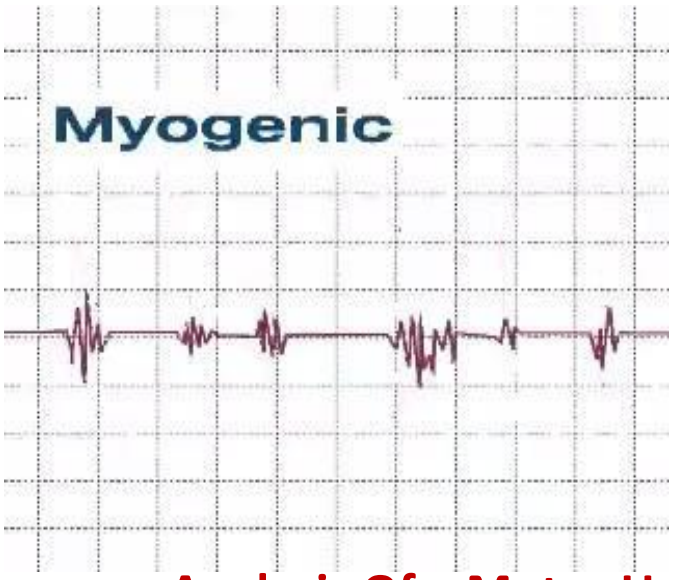
3-**Fasciculation potential**:

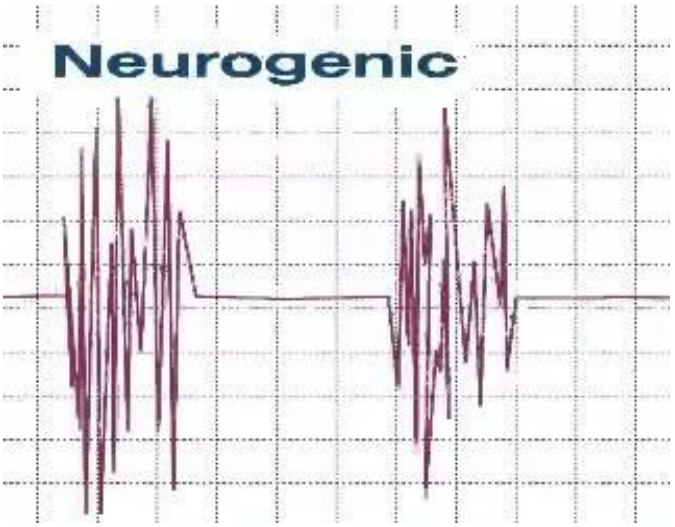
a-high voltage, polyphasic and have a long duration potential.

b-Appear spontaneously associated with contraction visible by the eyes and can be felt.









Analysis Of a Motor Unit Potentials (MUP)

MUP	Normal	neuropathic	Myopathic (Myopathy)
Duration m.sec	3-16	longer	shorter
Amplitude microvolt(µV)	300 to 5000 (µV)	larger	smaller
Phases	Biphasic/ Triphasic	Polyphasic	May be Polyphasic.
Interference pattern	Full.	Partial.	Full.

Nerve Conduction Study

A nerve conduction study (NCS) is a test commonly used to evaluate the function, especially the ability of electrical conduction, of the motor and sensory nerves of the human body

Example:

Stimulate of median nerve at two points until visible muscle contraction is seen and a reproducible Compound Muscle AP is recorded

Motor nerve conduction velocity (MNCV)

MNCV = Distance/L1-L2 (m/sec) **Note; the distance should be in mm, not in cm**

Distance :the distance between two electrodes

L1 = latency at elbow eg. 5m.sec

L2 = latency at wrist

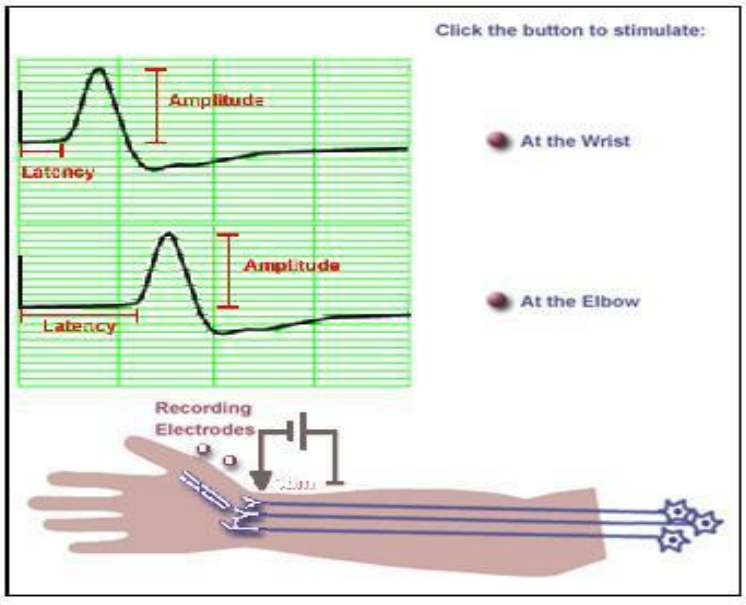
Normal values for conduction velocity

In arm 50 to 70 m/sec

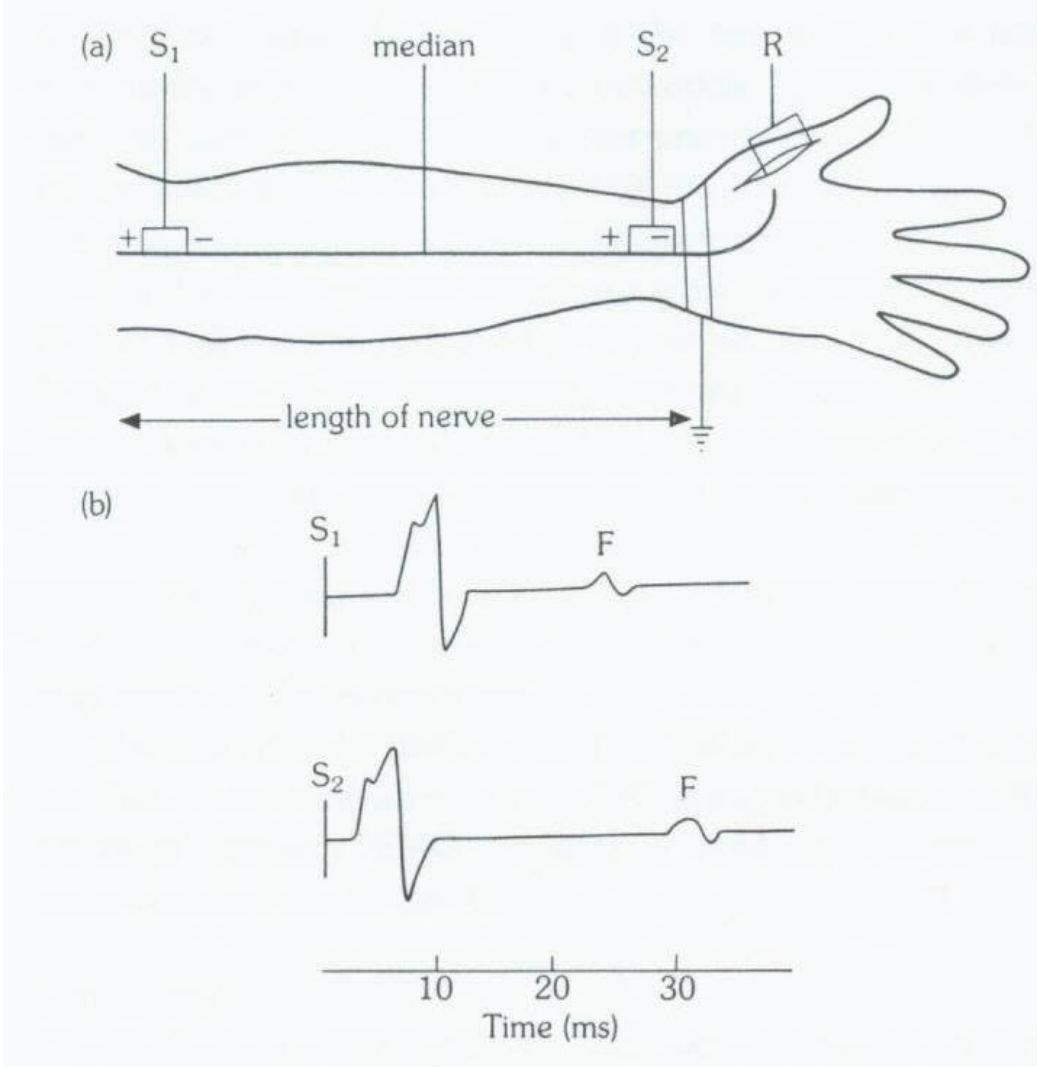
In leg 40 to 60 m/sec

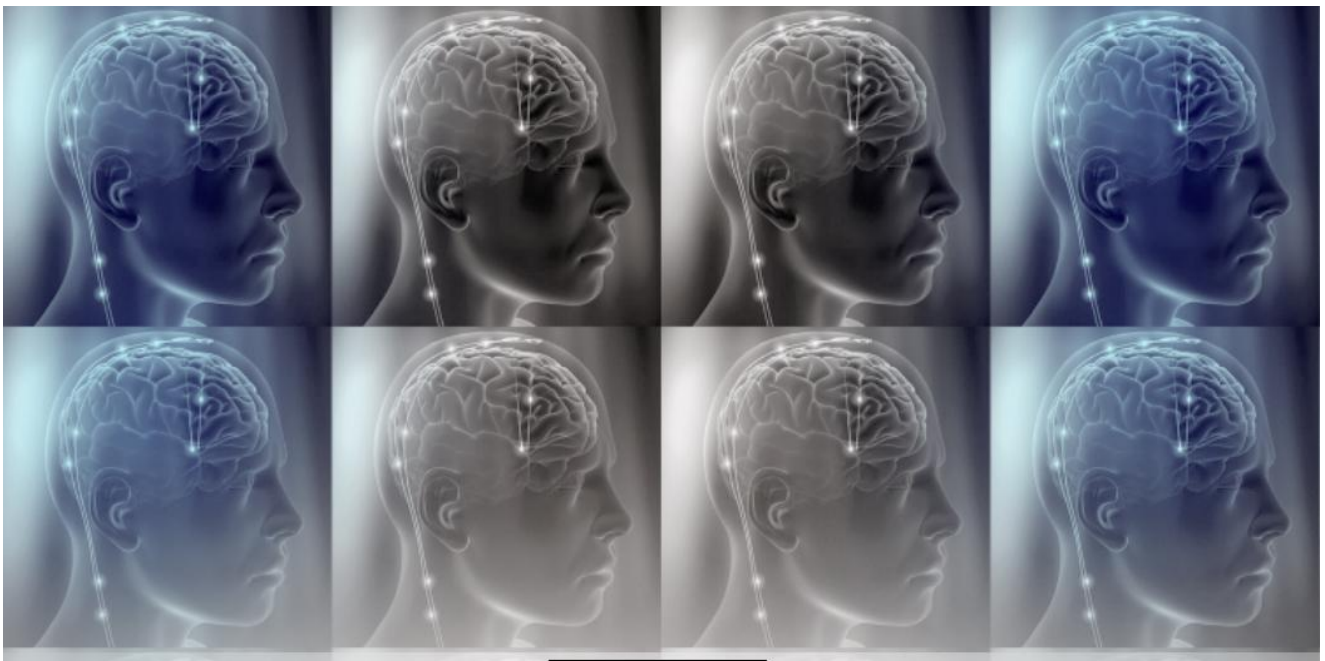
Abnormal if it is < 40 m/sec in leg

Abnormal if it is < 50 m/sec in arm



- Conduction is faster in myelinated fibres.
- Diseases which produce demyelinated peripheral nerves slow the conduction greatly (20-30 m/sec).


(a)
S1
median
S2
R
+
−
+
−
length of nerve
(b)
S1
F
S2
F
10
20
30
Time (ms)



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Visual Experiments

Test For Far Vision

Snellen's Chart

Visual acuity = d/D

d = the distance from where the subject is reading the chart.

D = the distance from which a normal subject can read that line.

- Normal Visual Acuity for far vision is 6/6 or 20/20 (in feet)

Refractive errors

Myopia (Nearsightedness)	Hypermetropia Hyperopia farsightedness
close objects are seen clearly, but the far objects appear blurred	far objects are seen clearly, but the near objects appear blurred.
light is focused in front of retina due to eyeball is too long or the cornea has too much curvature.	Light is focused behind the retina due to smaller eyeball or the lens is weak
Treated By concave lenses	Treated By convex lenses

Test For Near Vision

The near vision test is measuring your ability to read and see objects within an arm's distance from the body.

-This test is important if you have hypermetropia or presbyopia.

- Most clinics record the near vision as a Snellen fraction (distance equivalent) or as a Jaeger notation.

Jaeger's Chart.

Test For Astigmatism

Astigmatism is a type of refractive error that causes blurred vision mainly due to the irregular shape of the cornea and sometimes uneven curvature of the lens inside the eye can also cause Astigmatism

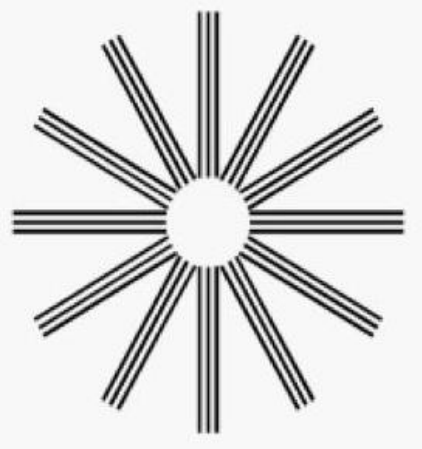
An irregular shaped cornea or lens prevents light from focusing properly on the retina.

- Astigmatism frequently occurs with other vision conditions like nearsightedness (Myopia) and farsightedness (Hypermetropia).

Treated By;

Adding cylindrical lenses in eyeglasses that will correct the astigmatism by altering the way light enters your eyes.

Astigmatism Chart



If astigmatism is present, some of the spokes will appear sharp and dark, whereas the others will appear blurred and lighter because they come to focus either in front of or behind the retina when they pass through uneven curvature of the cornea.

Demonstration Of Blind Spot

A blind spot, also known as a scotoma, is the place in the visual field where an object cannot be seen keeping one eye closed.

- This is due to the light rays from that part of the visual field focus on the optic disc of the retina which lacks the light-detecting photoreceptor cells.

-The optic disc of the retina is located medial to fovea centralis and is the part of retina through which the optic nerve leaves and blood vessels enter.

Blind Spot Card.

Keeping your right eye focused on the “plus” sign, gradually bring the blind spot card closer to your face until the “circle” drawn on the blind spot card disappears. This is the blind spot of your right eye.

Determination Of Near Point

Near point is the nearest possible distance at which the near object can be clearly seen.

- The near point of vision changes dramatically with age.

- Averaging about 8cm at the age of 10 and about 100 cm at the age of 70.

NEAR POINT	AGE
8 cm	10 YEARS
10 cm	20 YEARS
12.5 cm	30 YEARS
18 cm	40 YEARS
40 cm	50 YEARS
83 cm	60 YEARS
100 cm	70 YEARS

With the age, people will suffer from:

1- Loss of accommodation
2- Loss of lens elasticity
3- Near point recession

And this is known as **Presbyopia.**

-Treated By: **Bifocal lens**.

**Equipment:*

Common Pin

Test For Accommodation

The process of accommodation can be tested by

observing Purkinje-Sanson images in a dark room.

(you should know the accommodation reflex)

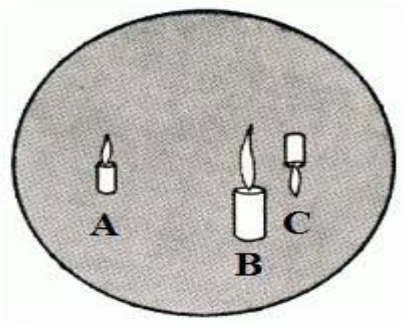
- Purkinje-Sanson images:

If a small bright light, usually a candle, is held in front of and a little to one side of the eye in a very dark room, three images are seen:

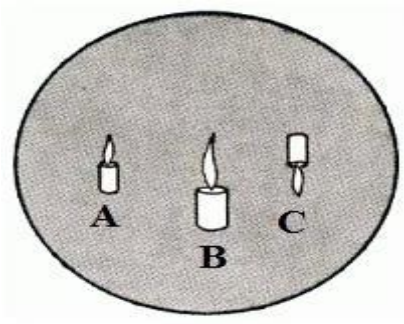
Images	BEFORE ACCOMODATION	AFTER ACCOMODATION
First	Bright, small and upright from cornea	image does not change (corneal curvature unchanged)
Second	Dim, large and upright from anterior surface of lens	image becomes smaller and moves toward the upright image (due to the ↑in curvature of anterior surface of lens)
Third	Small and inverted from posterior surface of lens	Changes very little the curvature of the posterior lens surface changes very little)

**Equipment;*

A candle and a dark room



Before Accommodation



After Accommodation

A = First image from Cornea

B = Second image from anterior surface of lens

C = Third image from posterior surface of lens

Conclusion:

The increased convexity occurs mainly in the anterior surface of the lens.

Test for Color Vision

Color vision

Is the function of the cones.

- There are three types of cones in our eyes; red,

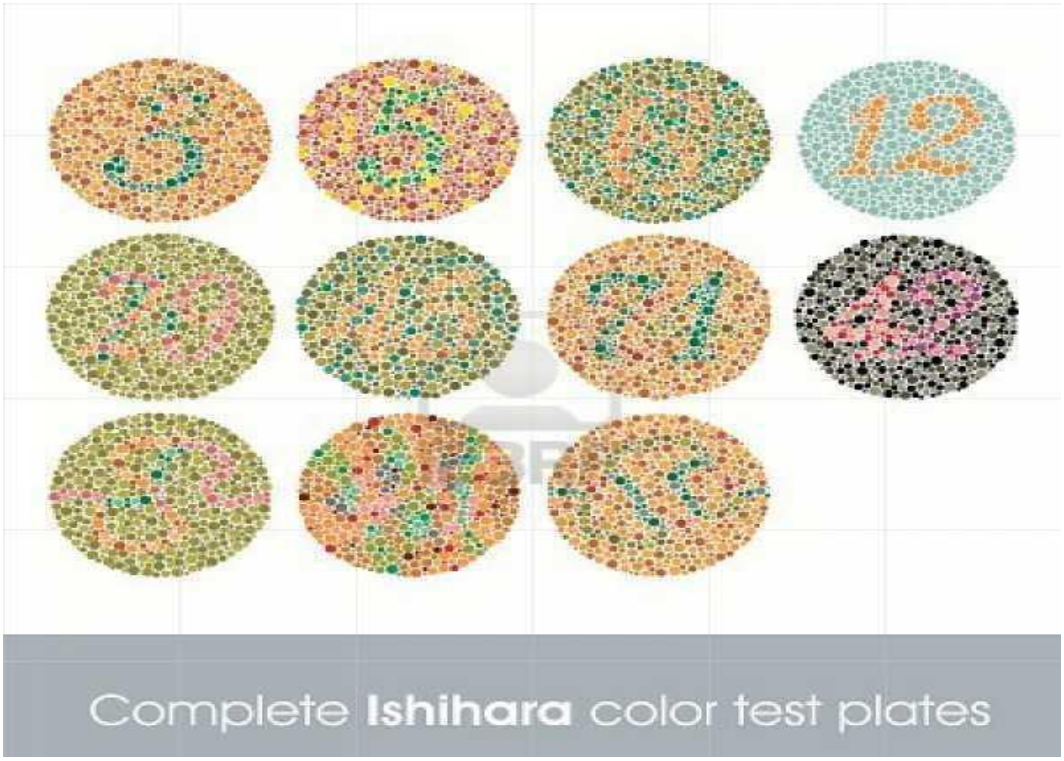
green and blue.

- The gene that causes defect in color vision is carried on the X chromosome, making the handicap more common among men (who have just one X chromosome)

than among women (who have two).

*Equipment;

Ishihara's Colored Plates.



TYPES	DEFINITION & PATHOLOGY
PROTANOPIA RED BLINDNESS	A form of colorblindness characterized by defective perception of red and confusion of red with green or bluish green due to the complete absence of red cones.
DEUTERANOPIA GREEN BLINDNESS	A form of colorblindness characterized by insensitivity to green, moderately affecting red–green hue discrimination due to the complete absence of green cones
TRITANOPIA BLUE BLINDNESS	A very rare visual defect characterized by the inability to differentiate between blue and yellow due to the complete absence of blue cones.
PROTANOMALY	A type of anomalous trichromatic vision with defective perception of red due to less sensitivity of red cones.
DEUTERANOMALY	A type of anomalous trichromatic vision in which the green cones have decreased sensitivity, mildly affecting red–green hue discrimination.
TRITANOMALY	A rare type of anomalous trichromatic vision in which the blue cones have decreased sensitivity, affecting blue–yellow hue discrimination.