Masking

INTRODUCTION

- When the vision being tested, one eye is covered to be certain that the uncovered eye is the one tested and this cover is called masking
- Masking principle is also applied in hearing tests. But, covering the untested ear is not enough to eliminate its participation

- As a result, **noise** needs to be introduced to non-tested ear to raise its threshold and eliminates its response to the signal presented to the tested ear
- Clinical masking allows accurate assessment for each ear separately by withdrawing the non-tested ear (NTE) while testing the other ear (tested ear/ TE))

WHY DO WE NEED TO MASK?

- In AC testing

By headphones and inserts- if the presented stimulus sufficiently loud, it escapes through the headphones or through bone conduction, passes across the head and stimulate the other ear

- In BC testing-

The presented stimulus passes almost equally to both cochleae

WHY DO WE NEED TO MASK?

- If we are going to assess the auditory function of each ear, we must be sure that the contra-lateral (opposite) ear is not participating in responding
- So, we need to prevent the cross hearing

CROSS HEARING

- Happened when the tone presented to the (TE) transmitted a cross the head and heard in the (NTE) and it responds instead of the TE, so the resulted audiogram is known as **(Shadow Curve**).

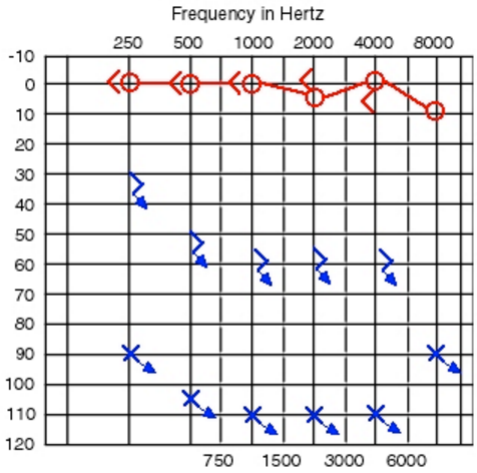
- TE: The Ear Being Tested , Receive the tone.
- NTE: The Ear that not being tested , receive the noise in masking.

SHADOW CURVE / SHADOW AUDIOGRAM

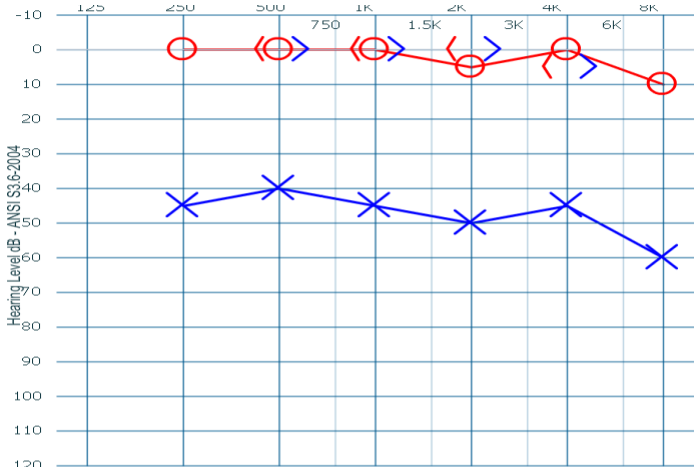
- An audiogram reflecting cross-hearing before masking application
- Shadow curves usually seen when thresholds of the ear with greater hearing loss (e.g. severe or profound) are a reflection (mimic) of thresholds of the ear with normal or near normal hearing levels.

ILLUSTRATION EXAMPLE:

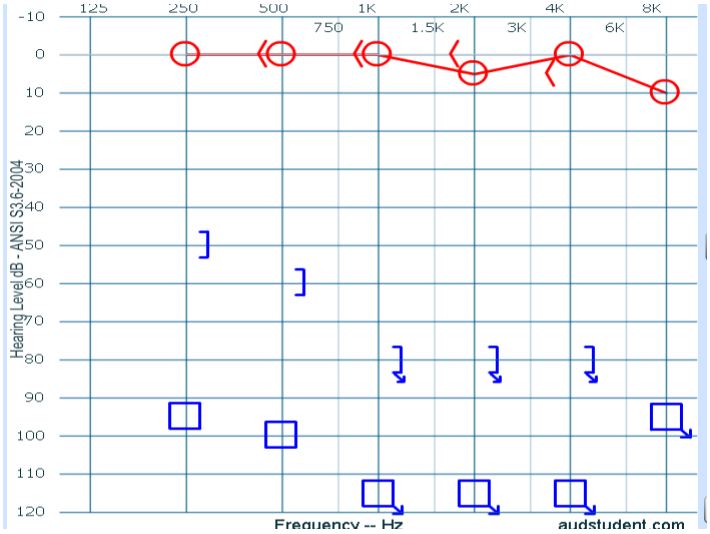
Expected Audiogram



Shadow curve (resulted audiogram/ unmasked audiogram)



Masked Audiogram (Audiogram after applying masking)



INTER-AURAL ATTENUATION (IA)

- The amount of energy lost during the transmission of sound (by AC or BC) to the contra-lateral ear
- Example; when a 95 dB HL presented to the TE and 45 dB HL reaches the NTE, the amount of lost energy = 95-45= 50 dB

  IA = 50 dB

INTER-AURAL ATTENUATION (IA)

- IA is also known as transcranial transmission loss
- It's is preferable to have a high IA value to reduce the possibility of crosshearing
- IA values are varied for AC and BC stimuli
- IA ranges from 45 to 70 dB from 250 to 8000 Hz for supra-aural (Average about 60 dB). And 70 to 100 dB for inserts (average 80 dB).
- But 40 dB is commonly use by (BSA, 2011) and ASHA (1978) for supra aural headphones and 70 dB for inserts

TABLE 4.3 Interaural Attenuation for Pure Tones Using Supra-Aural and Insert Earphones According to (A) Coles and Priede (1968), (B) Zwislocki (1950), (C) Sklare and Denenberg (1987)

	Interaural Attenuation		
Frequency in Hz	*A—Supra-aural Earphones*	*B—Supra-aural Earphones*	*C—Insert Earphones*
250	61	45	89+
500	63	50	94+
1000	63	55	81
2000	63	60	71
4000	68	65	77

IA FOR BONE CONDUCTION TESTING

- It's significantly less than the AC IA : both cochleae enclosed in each temporal bone of the same skull
- When skull starts to vibrate, both cochleae are stimulated
- For mastoid placement: IA values varied across frequencies and patients, it varied roughly from 0-15 dB at 2000 & 4000 Hz among patients
- IA is commonly defined to be 0 dB, so crossover is likely all the time

MASKING, TO OVERCOME THE CROSS HEARING

- The process used to overcome the crosshearing by temporarily elevating the hearing threshold of NTE by a known amount of energy to enable an accurate assessment of the TE thresholds
- This achieved by presenting a masking noise to the NTE at appropriate intensity level to prevent it from detecting the test signal and participating in responding and at the same time measuring the accurate thresholds for the TE

TYPES OF MASKING NOISE

- Type of used noise in masking depends on signal being masked
- If the signal is a wide spectrum, like speech, the masker should be wide spectrum too. I.e. Broad band noise BBN (white noise)
- BBN is not a good choice to mask pure tone as it is inefficient and unnecessarily loud
- critical bands noise optimally to be used. I.e. **Narrow band noise(NBN)**

WHEN TO MASK? "MASKING RULES"

- BC masking rule

Generally accepted masking rule for BC, if there is an air-bone gap (ABG) within the tested ear that is more than 10 dB

ABG (TE) >10 dB

Example

@ 1000 Hz

RE (NTE)	LE (T E)
AC = 50 dBHL	AC =70 dBHL
BC = 45 dBHL	BC = 45dBHL

AC masking rules

- AC masking is needed at any frequency whenever real BC threshold of NTE is more acute than AC threshold of TE by equal to or greater than IA (40 dB for supra-aural earphones or 70 dB for insert earphones

AC (TE) – BC (NTE) ≥ IA (40 or 70 dB)

- Masking needed at any frequency whenever the difference between the Right and left ear AC thresholds is equal or greater than IA (40 dB or 70 dB)

AC (TE) – AC (NTE) ≥ IA (40 or 70 dB)

Example 1

@ 1000 Hz, IA = 40

RE LE

NTE TE

AC =10 dB HL AC=60 dB HL

BC= 10 dB HL BC= 10 dB HL

Example 2

@ 1000 Hz, IA = 40 dB

RE LE

NTE TE

AC = 10 dB HL AC = 60 dB HL

EFFECTIVE MASKING LEVEL (EML)

- Masking noise should be calibrated in term of Effective Masking Level (EML)
- EML is the level of noise that is equal to the hearing level of a pure tone at the same frequency.
- If the masking level is already calibrated in the audiometer in terms of EML, no need to measure the patient's thresholds for masking noise prior to the hearing test with masking.
- When the masking level is not calibrated to EML then, patient's thresholds for masking noise is required before start the hearing test
- Threshold for masking noise is the lowest intensity level at which the noise can be detected

- Effective masking level (EML)/ Minimum Effective Masking Correction (MEMC):
- The difference in decibels between the level of a given tone and the level of given noise that just masks the tone (makes the tone inaudible).

INITIAL MASKING LEVEL (IML)

- IML FOR AC MASKING
- IML = AC Threshold (NTE) + Minimum Effective Masking Correction (MEMC) + Safety factor (SF)

- IML= AC T (NTE) + 5 dB + 10 dB

IML= AC T (NTE) + 15 dB

IML FOR BC MASKING

- What is Occlusion effect (OE)

It is the improvement of BC thresholds at low frequencies when the ear canal occluded (covered) by any means (ear plugs, ear moulds, earphones)

OE usually present at 1000 Hz or less

- So, (NTE) needs to be covered while the (TE) needs to be left unplugged except at 3000 and 4000 Hz plug can be used

	250 Hz	500 Hz	1000 Hz
OE in dB	15	15	10

IML FOR BC MASKING

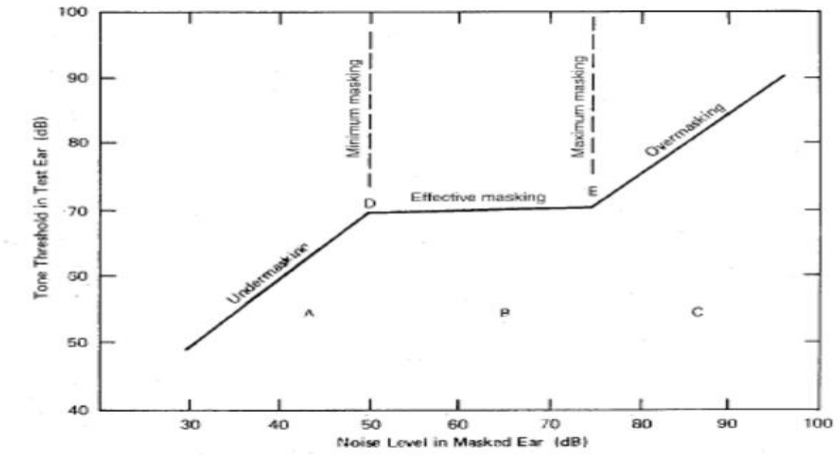
- IML for BC = AC threshold (NTE) + 15 dB (MEMC + SF) + OE

IML = AC T (NTE) + 15 dB + OE

Central Masking

- It's a brain phenomenon that occurs when the signal and noise are presented to different ears
- No crossover for both noise or signal
- It's a phenomenon where a threshold shift of the (TE) results from the introduction of a masking signal into the (NTE) that is NOT due to crossover

Masking Chart



Instructions to patient

- patient should be asked to respond to all tones regardless of which ear they perceived in
- Patient need to be warned that they will hear a rushing noise in one ear which may increase in intensity
- Ask the patient to disregard or ignore this noise and just respond to the tones
- Ask the patient to indicate whenever any of tone or noise become uncomfortably loud to them

Instructions to patient

"in the next test, you will hear the sounds (tones) again, just as before. I would like you to press the button (responding switch) as soon as you hear the tone and release it as soon as it disappears. Do this even if you just hear a very faint sounds, and no matter at which side you hear the sounds".

Masking Methods

- plateau : Different levels of masking noise @ which there is no threshold shift in the TE (using 10dB increments at one time) .
- Plateau method is typically used

  - A gradual increase in masking in the NTE to find a plateau

  - A range of masking levels (over 20 dB increase) in which there is no increase in threshold of the TE

  - Most audiologists use 3 consecutive masked levels using 5 dB steps or 2 consecutive masked levels using 10 dB steps with the same response to be a threshold.

Headphones placement for BC masking

- Minimum masking level :

MML = AC (NTE)

- Maximum masking level :

The highest masking noise level that can be used without causing over masking to occur

MaxML = IA + BC (TE)

- Two problems that can occur when masking:
- **Undermasking:** Erroneous thresholds are obtained as a result of not presenting enough masking noise to the NTE.
- **Overmasking** : Results when there is too much noise put into the NTE. when the sound is intense enough, the masker noise can cross over and be detected in the TE

MASKING DILEMMA

- A masking dilemma occurs when both ears have large air- bone gaps, and masking can only be introduced at a level that results in overmasking.
- It occurs when the initial minimum amount of masking we need to use already exceeds the maximum amount of masking or already at the level of overmasking
- Common in bilateral CHL with large air bone gap

Masking Symbols