

Hearing Damage

Protection

A) Natural

- 1) We have no earlid, like the eyelid, but evolution may change that due to overexposure only coming about with the dawn of the industrial revolution
- 2) along with relaying the air pressure changes of the outer ear to the inner ear, the ossicles, or bones in middle ear, protect the inner ear from loud noises and sudden pressure changes
- 3) a loud noise triggers the tightening of the eardrum and the pulling away of the stirrups from the inner ear (called "acoustic reflex")
 - i) triggered by sound levels between 80-95 dB, depending on ear sensitivity
 - ii) but reflex takes time, so not suitable for protection from explosive sounds

B) Artificial

- 1) Cotton plugs are ineffective, unless soaked in Vaseline or soft wax
- 2) soft deformable plastic are effective, giving a reduction of 20-30 dB
 - i) only if they provide a tight seal, otherwise they only provide a 5-15dB reduction
 - ii) musicians have specially made ones that drop all frequencies by 15 dB
- 3) earmuffs can be effective, but seal is difficult to maintain
- 4) new protectors are being made which dig a small channel in the centre to act as a low-pass filter, and only pass low frequencies
 - i) provide up to 30dB reduction at high frequencies
 - ii) cut off at about 1000Hz, and since speech is in the 1000-4000 range, it gets filtered too

Temporary Hearing Loss

- a) the ear deals well with large amounts of noise in a short time
 - 1) it desensitizes, especially for high frequencies
 - 2) permanent problems can result if the exposure continues or is repeated frequently
- b) if exposure is too loud sounds is sustained for a certain period **physiological fatigue** can set in, requiring 16 hours to disappear
- c) even more severe exposure can cause **pathological fatigue**, requiring up to 3 weeks for complete recoverytemporary deafness can result

d) little is known about temp. hearing loss physiologically

Permanent Hearing Loss (Deafness)

a) Prolonged exposure to loud noises (concerts, bands, factories, construction) can lead to permanent hearing loss

b) There is a dependence on the frequency, or pitch, of the noise

1) greatest when exposed to frequencies above 4000Hz

c) different generations hear different ranges of frequencies

1) children typically hear up to 20000Hz

2) Adults hear up to 10000-14000Hz, depending on age

3) By age 70, most don't hear above 8000Hz

i) the deterioration of perception of high frequencies is called "presbycusis"

d) If you lose below about 5KHz begins to severely affect understandability of speech → especially

1) plosives (p b)

2) fricatives (eg s, f)

EXPERIMENT

speaker with function generator to "test hearing"

- slowly sweep down from 20KHz and have students see where they can start hearing. If below 10KHz suggest they see an audiologist (sweep down counting out the frequencies and state that those below 10KHz maybe should see a hearing doctor).

Locations of deafness:

Anywhere along the track.

i) **Eardrum** : Thin layer of skin-

- the pressure of the air must be able to move it easily.
- thus the layer of skin which makes up the eardrum must remain thin.
- **Scarring thickens the eardrum**

a) **abrasions**

- caused by such aggravations that may be caused by using Qtips to clean the ear.
- Not only thickens the eardrum, but it also reduces its sensitivity.

b) **Damage**

- holes can be caused by pressure differences between outer and middle ear that move the drum, causing temporary hearing loss
- due to Explosions, diving - although this is not typically how it is damaged

c) **repeated infection**

d) **Infection of the middle ear**

- causing high pressure bursting the ear drum
- Can sometimes repair itself , but often needs surgery. Will always leave some scarring.

ii) Middle ear- damage to ossicles (hammer, anvil, and stirrups bones)

a) **Disease**-- middle ear infections.

1) Calcification due to age

- can be corrected by "breaking" the calcification.

2) can be caused by an explosive noise that causes an eardrum rupture

b) **Physical** damage to bones (rare due to protected position.)

c) **Congenital**-- the bones did not develop during embryo growth.

iii) Inner ear- damage is largely uncorrectable. Some experiments with "artificial" ears-- direct stimulation of nerve cells with electrical probes. Tends to be poor quality.

a) Hair cell damage

- main cause of hearing damage is due to excessive exposure to noise destroys the hair cells in the "organ of Corti" in the inner ear

- overexposure to noise can cause the destruction of the outer hair cells, which can result in a loss of 40db of noise amplification they provide (reduced sensitivity)

- especially to hair cells nearest the entrance (high frequency)

- Not fully understood, prevalent theory is that overexposure to sound forces the hair cells to work at too high a rate for too long

- Age related deafness problem due to such damage by excessive sound

Hair cell damage due to

i) **antibiotics**

- eg tetracyclines-- for some unknown reason damage the hair cells

ii) **loud noises**

- seem to "break off" hair cells . Also inflame and scar the basilar membrane.
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