Physiological Basis of Hearing Tests

By

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Def: Hearing is the ability to perceive certain pressure vibrations in the air and interpret them as sound.
Introduction

**Sound:**

Sound is a longitudinal pressure waves that consists of alternate phases of condensation and rarefaction.
Physics of Sound:

The waves travel through air at a speed of approximately 344 m/s at 20 °C at sea level

1) Pitch or Frequency:
   - Number of waves per unit of time
   - It is measured in cycle/sec or Hertz or Hz.
   - Normally the human ear can hear sounds from 20-20.0000Hz
   - In other animals, notably bats and dogs, much higher frequencies are audible.
   - The maximal sensitivity of the ear is between 1000-3000 Hz.
   - The human voice ranges from 65 to 1000 Hz → male voice in conversation is about 120 Hz and that of the average female voice about 250 Hz.
Introduction

1) Pitch or Frequency:
2) **Amplitude:**

- The amplitude of a sound wave is a measure of intensity or energy of pressure fluctuations.
- Amplitude can be measured as the absolute energy passing through an area of one cm² (dyne/cm²).
- It can be measured as Bells.

\[
\text{Intesity of given sound} = \log \left( \frac{\text{Intesity of standard sound}}{\text{Intesity of given sound}} \right)
\]

\[
\text{Sound Intensity in Bells} = \log \left( \frac{0.000204 \times \text{dyne/cm²}}{\text{Intesity of standard sound}} \right)
\]

- The standard sound equals 0.000204 × dyne/cm².
- A value of 0 decibels does not mean the absence of sound but a sound level of an intensity equal to that of the standard.
- A decibel (dB) is 0.1 bel.
Introduction

2) Amplitude:

<table>
<thead>
<tr>
<th>Decibels</th>
<th>Sound Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>Jet plane with afterburner</td>
</tr>
<tr>
<td>120</td>
<td>Pain</td>
</tr>
<tr>
<td>80</td>
<td>Discomfort</td>
</tr>
<tr>
<td>40</td>
<td>Heavy traffic</td>
</tr>
<tr>
<td>0</td>
<td>Normal conversation</td>
</tr>
<tr>
<td></td>
<td>Whisper</td>
</tr>
<tr>
<td></td>
<td>Threshold of hearing (0.0002 dyne/cm²)</td>
</tr>
</tbody>
</table>

N.B
The loudness of a sound is correlated with the amplitude of a sound wave and its pitch with the frequency. The greater the amplitude, the louder the sound; and the greater the frequency, the higher the pitch.
3) **Wave form or Timbre** (quality)

- Pure tone
- Noisy sound
- Musical sounds; repeated characteristic pattern of vibration
Introduction

Mechanism of Hearing:
The organ of hearing is the ear that consists of:

- External ear
- Middle ear
- Cochlea of the inner ear.
Introduction

Mechanism of Hearing:
The organ of Corti (receptor for hearing)
Introduction

Auditory Pathway:
Deafness

Def.

- Deafness means a lack or loss of the sense of hearing, which may be partial or complete.
- Partial loss of hearing is often called hearing loss rather than deafness.
- Deafness can occur in one or both ears.
Deafness

Types:

Conductive Hearing Loss
- Occurs in Ear Canal and Middle Ear
- Only 5% of Hearing Loss Cases
- Caused by trauma or disease

Sensorineural Hearing Loss
- Occurs in Inner Ear (Cochlea)
- Often called “Nerve Loss”
- Most common: 95% of hearing loss cases
- Caused by aging, noise exposure, disease, heredity
# Deafness

<table>
<thead>
<tr>
<th>Types:</th>
<th></th>
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<td><strong>Conductive Deafness</strong></td>
<td><strong>Sensorineural Deafness</strong></td>
</tr>
</tbody>
</table>

| Def. | caused by the inability of the sound to reach the inner ear | Caused by disorders of the inner ear or auditory nerve. |

| Causes | 1. Otitis media and externa  
2. Earwax  
3. Tympanic membrane perforation  
4. Otosclerosis of bony ossicles | 1. Tumors of Brain e.g. acoustic neuroma  
2. Neurological disorders e.g. meningitis, and stroke  
3. Ototoxic drugs such as:  
   • Aspirin  
   • Antibiotics: streptomycin, and neomycin.  
4. Mniere's disease  
5. Labyrinthitis |

| Character | - Air conduction is more affected than bone conduction  
- All frequencies are affected equally. | - Both air conduction and bone conduction are affected equally  
- Some frequencies are affected more. |
Hearing Tests

Types:

1. **Speech tests**: → detect the presence of hearing loss

2. **Tuning Fork tests** → differentiate between types of deafness

3. **Pure Tone Audiometry (PTA)** →
   - Detect the presence of deafness
   - Differentiate between types
   - Determine the degree of hearing loss and speech discrimination
Speech tests

- The normal person can hear whisper voice at 6 meters and sound of normal conversation up to 12 meters.

- When the person needs shorter distances to hear these sounds → presence of hearing loss or deafness.
Hearing Tests

Tunning Fork tests

- The frequency of fork may be 128, 256, 512, 1024, 2048. The most common frequency used is 512 Hz.
Hearing Tests

Tuning Fork tests

- The frequency of fork may be 128, 256, 512, 1024, 2048. The most common frequency used is 512 Hz.
Hearing Tests

**Tunning Fork tests**

**Principle:** test bone conduction on both ears at the same time

**Equipment:** Tunning Fork 512 Hz

**Procedure:** Strike the fork against a hard object and place it on the middle of the forehead

**Results:**

a. **Normal person** → he hears equally on both sides.

b. **Conduction deafness (one ear)** → Sound louder in diseased ear because the masking effect of environmental noise is absent on the diseased side.

c. **Nerve deafness (one ear)** → Sound louder in the normal ear.
Hearing Tests

Tunning Fork tests

Rinne Test

**Principle:** test bone and air conduction on the same ear

**Equipment:** Tunning Fork 512 Hz

**Procedure:** Strike the fork against hard object and place it on mastoid process (bone conduction) until subject no longer hears it, then held in air next to ear (air conduction).
Hearing Tests

Tunning Fork tests

Rinne Test

Results:

a. **Normal person** → hears vibration in air after bone conduction is over i.e. air is better than bone conduction = +ve Rinne

b. **Conduction deafness** → vibrations in air not heard after bone conduction is over i.e. bone is better than air conduction = -ve Rinne

c. **Nerve deafness** → vibration heard in air after bone conduction is over but for shorter time i.e. air is better than bone conduction but shorter than normal = reduced +ve Rinne
Hearing Tests

Tunning Fork tests

Schwabach Test

**Principle:** compare bone conduction of patient with that of physician.

**Equipment:** Tunning Fork 512 Hz

**Procedure:** Strike the fork against hard object and place it on the mastoid of patient the place it on mastoid process of physician.

**Results:**

a. **Normal person** → patient = physician.

b. **Conduction deafness (one ear)** → patient > physician.

c. **Nerve deafness (one ear)** → patient < physician.
Hearing Tests

**Pure Tone Audiogram (PTA)**

- Auditory acuity is commonly measured with an audiometer.
- This device presents the subject with pure tones of various frequencies through earphones.
- At each frequency, the threshold intensity is determined and plotted on a graph as a percentage of normal hearing.
- This provides an objective measurement of the degree of deafness and a picture of the tonal range most affected.
Hearing Tests

Pure Tone Audiogram (PTA) Of Normal person
Hearing Tests

Pure Tone Audiogram (PTA) Of Deaf person

Conductive Deafness

Sensorineural Deafness
Thank You
For
Not Listening