Pathways of sound conduction

[Purpose]
1. To learn how to use a tuning fork to generate sound;
2. To understand the function of the auditory organ;
3. To understand the pathways of sound conduction.

[Principle]

Hearing loss occurs when there is loss of sound sensitivity produced by an abnormality anywhere in the auditory system. A wide variety of conditions can cause hearing loss. While physicians can sometimes identify its causes, in some cases the causes are unknown.

Air conduction tests, which stimulate the ear through the air, test the functions of the external auditory canal and the middle ear, and the integrity of the inner ear, eighth cranial nerve, and central auditory pathways. Bone conduction tests use vibrating tuning forks placed in contact with the head. By bypassing the external auditory canal and middle ear, bone conduction tests can help distinguish problems in the inner ear, eighth cranial nerve, and central auditory pathways.

The Weber and Rinne tuning fork tests distinguish between conductive and sensorineural hearing losses. In the Rinne test, air and bone conduction tests are compared. In normal hearing, tones sound louder by air conduction than by bone conduction. In conductive hearing loss, however, the bone-conduction stimulus is perceived as louder. In sensorineural hearing loss both air and bone conduction sounds are diminished, but the air conduction sound is perceived as louder. The Rinne test is most sensitive in detecting mild conductive hearing losses if a 256 Hz tuning fork is used. The Weber test may be performed using a 256 or a 512 Hz tuning fork. During this test, the stem of a vibrating tuning fork is placed on the head in the midline. If the tone is perceived in the affected ear, this indicates a unilateral conductive hearing loss. In the case of unilateral sensorineural hearing loss, the tone is heard in the unaffected ear instead.
[Experimental object]
Human beings

[Experimental apparatus]
Tuning forks (256 and 512 Hz); cotton ball; rubber hammer.

[Experimental method & procedure]
1. For the tuning-fork tests, the examiner, using a rubber reflex hammer or his or her elbow, strikes one tine strongly enough to produce a sound clearly perceived by the examiner at 30 cm.
2. The Rinne test: In the Rinne test (Figure 1), the fork is held 2.5 cm from the external ear with the tines vibrating toward the ear. The stem of the tuning fork is placed on the mastoid and the subject is asked to indicate when she or he stops hearing the sound. The fork is then held 2.5 cm from the pinna, and the patient is asked if she or he still hears the sound. If the sound is still audible, air conduction is greater than bone conduction (AC > BC in normal ear); if not, BC > AC.
3. Use a cotton ball to block the external auditory canal (to mimic conductive hearing loss); repeat the Rinne test.
4. The Weber test (Figure 2) may be performed using a 256 or a 512 Hz tuning fork. During this test, the stem of a vibrating tuning fork is placed on the head in the midline. The thickness of the scalp or hair sometimes prevents an accurate response. Ask the patient, "Do you hear this better in the right or the left ear?" If the patient hesitates, then the Weber test shows that sound is not being referred to one ear. If the tone is perceived in the affected ear, this indicates a unilateral conductive hearing loss. In the case of unilateral sensorineural hearing loss, the tone is heard in the unaffected ear instead.
5. Proper recording of the Rinne test should be "AC > BC" or "BC > AC" for each ear; for the Weber test, "Weber → R" or "Weber → L" or "Weber not referred."
Figure 1. Proper positioning of tuning fork tines for air conduction testing.

Figure 2. Midline positioning of the tuning fork for the Weber test.

[Discussion]

1. Compare air conduction with bone conduction.

2. Why does an accurate recording of your voice sound different from what you hear when you are actually speaking?

3. What are the mechanisms of conductive hearing loss and sensorineural hearing loss?
Measurement of visual acuity

[Purpose]
1. To learn how to measure visual acuity;
2. To understand the function of the refractive system of the eye.

[Principle]
Visual Acuity (VA) is a test of macular function and optic nerve function. Normal VA can discriminate one minute of visual arc. A standard eye chart is necessary to make comparisons and to record VA. When viewed from a distance of 5 metres, the letter E on the 20/20 line occupies 5 minutes of visual arc in the observer's eye. Snellen letters are created such that the critical details that need to be resolved by the patient (for example the horizontal black lines and white gaps of the letter E) are 1/5th the size of the letter (Figure 1).

![Figure 1. The letter E on the 20/20 line occupies 5 minutes of visual arc. Each of the 3 black horizontal lines and 2 white gaps is the same size and comprises 1 minute of visual arc (for a total of 5 minutes.) A person with 20/20 vision should be able to resolve this angle.](image)

[Experimental object]
Human Beings

[Experimental apparatus]
Standard eye chart; pointer; occluder

[Experimental method & procedure]
The test should be given in good light. The eye chart should be placed upright on a wall, and the
testing distance should be measured exactly (5 metres). The person taking the test should stand at the testing distance. An occluder is used to cover one of the patient's eyes for monocular testing, ie: to facilitate testing one eye at a time. Do not allow subjects to use their own hand (they may peek through their fingers.) One may slide a tissue between the eye to be occluded and the patient's glasses as well. The lowest line that can be read correctly is the VA for that eye (Figure 2).

**Distance Visual Acuity Test (E Game)**

*(Read in good light at 10 feet.)*

![Eye Chart](image)

**Figure 2. The eye chart (E-Game)**

**[Discussion]**

1. Explain the difference between emmetropia and ametropia and their causes.

2. Outline the principle of measurement of visual acuity.
Measurement of visual field

[Purpose]
1. To learn how to measure visual field;
2. To understand the function of the refractive system of the eye and the retina.

[Principle]
The area in space that may be visualized by the eye is known as the visual field. The size of your visual field is the furthest you can see to the side when looking straight ahead. A visual field test is a method of measuring an individual’s entire scope of vision. Visual field testing actually maps the visual field of each eye separately. Plotting the visual field is important for many disorders, particularly disorders of the optic nerve and brain.

[Experimental object]
Human beings

[Experimental apparatus]
Arc perimeter; occluder; visual field paper; pen; colored visual pointer

[Experimental method & procedure]
1. Familiar yourself with the structure of the arc perimeter and the working principle of the instrument (Figure 1).

2. While the subject is seated comfortably, ask him/her to look straight ahead at a central target directly in front. Instruct him/her to tell you (or press a buzzer) when he/she becomes aware of a small light to one side, within his peripheral field. One eye is covered and the chin is placed in the chin-rest. Then, when the subject sees lights of various intensities at different locations, he/she tells you. This process produces a map of the visual field.

3. It is important to keep the eye focused on the central target throughout this examination so you can get an accurate measurement of the complete visual field. To get the best results, the subject must be alert and concentrate on the central target.
4. Change to different colors, such as red, green and blue; repeat the visual field test.

5. Record and draw the maps of the visual fields for different colors (Figure 2).

![Figure 1. An arc perimeter](image1)

![Figure 2. Measurement of visual field](image2)

[Discussion]

1. How does the visual field change with glaucoma?
2. Explain any differences when you use different colors for the visual field test.