

Bone conduction



Physics

Acoustics

Sound generation & propagation

Biology

Human Physiology

Other Senses



Difficulty level

easy



Group size

1



Preparation time

10 minutes



Execution time

10 minutes



General information

Application



Experiment setup

In this experiment, students will observe that sound can travel not only through the outer and middle ear to the sensation in the inner ear, but also through the human bone apparatus.

Bone conduction is used in medicine as a tool in diagnostics.

Using the Rinne and Weber experiments from the field of medical diagnostics as examples, students should understand that bone conduction bypasses the sound conduction of the outer and middle ear and that one can therefore use these experiments to distinguish between disturbances in sound conduction (outer ear, middle ear) and sound perception (inner ear, auditory nerve).

Other teacher information (1/3)

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Previous knowledge



Before performing the experiment, students should be familiar with the structure of the human ear.

You should also know that sound propagates not only in air, but basically in all media, including solids.

Scientific principle



In this experiment, students will perform various experiments in which sound waves propagate through human bones and observe how the sound waves behave.

Other teacher information (2/3)

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Learning objective



In this experiment, students learn about the behavior of sound waves in bones.

Tasks



This experiment is concerned with whether sound can be perceived by means other than the outer ear.

1. Students investigate bone conduction of sound in the human body.
2. They find out what an ear, nose and throat specialist means by Rinne test and Weber test and what they can provide information about.

Other teacher information (3/3)

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Note on evaluation

The experiments performed are not intended to provide instructions for self-diagnosis. They are only intended to demonstrate how a physician can isolate the cause of hearing problems with the help of, for example, the Rinne and Weber experiments.

Meaningful diagnosis is, of course, reserved for a specialist, which is why your own experimental results should not be used to diagnose any disorders. If necessary, point this out to the students before starting the experiments.

Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.



Student Information

Motivation



The human ear

The human ear generally perceives sound from its environment through the air. The processing of sound signals passes through three parts of the ear: the outer ear (pinna, external auditory canal), the middle ear (eardrum, ossicles, eustachian tube) and the inner ear (cochlea, organ of balance).

The actual auditory information is transmitted from the inner ear to the brain via the auditory nerve. Under normal circumstances, we would perceive sounds via the outer ear, but other pathways exist and will be looked at in more detail in this experiment.

Tasks

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The experimental setup

This experiment is concerned with whether sound can be perceived by means other than the outer ear.

1. Investigate the bone conduction of sound in the human body.
2. Find out what an ear, nose and throat specialist means by Rinne test and Weber test and what they can tell you.

Equipment

Position	Material	Item No.	Quantity
1	Tuning fork 440 Hz	03424-00	1
2	Impact hammer, rubber	03429-00	1

Set-up

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- Get the tuning fork and the striking hammer at your workplace.
- Write down your observations in an experimental protocol.
- Before starting the experiment, carefully read the entire procedure.

Procedure (1/4)

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Figure 1

Sub-experiment 1: Bone conduction

1. Strike the tuning fork with the striking hammer and hold it against various bones of the body: forehead, skull, jaw, sternum, elbow, etc.
2. Write down your observations.

Procedure (2/4)

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Figure 2

Subtest 2: Gutter test

1. Strike the tuning fork and place it with its foot on the bone behind the auricle (process of the temporal bone).
2. Wait until you can no longer hear the sound of the tuning fork over this bone.

Procedure (3/4)

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Figure 2

3. Then place the tuning fork in front of the auricle and observe whether a tone can still be heard in this way.
4. Write down your observations.

Procedure (4/4)

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Figure 4

Subtest 3: Weber test

1. Strike the tuning fork and place it centrally on the skull. Observe how the sound is heard in both ears.
2. Then cover one ear with a finger and repeat your procedure.
3. Write down your observations.

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Report

Task 1

Why do you hear the tuning fork when it touches a bone in the chest and skull area?

By placing it against the bone, the vibration of the tuning fork is amplified, making it easier for the sound wave to reach our eardrum.

Sound waves propagate better through solids than through air, which means that the sound wave from the tuning fork travels to the eardrum, where it is perceived as a normal sound.

Our brain can interpret vibrations of bones through the nervous system in a similar way to the vibration of an eardrum.

Task 2

Why does the sound wave propagate better through bones than through the air?

(Note: Because of the way our eardrums work, better propagation does not translate to better perception).

Bones have a lot of room to vibrate because of the joints, which is why sound waves can travel through bone without losing much energy.

Bones are often hollow on the inside, which means that sound propagated through them is very often reflected, significantly amplifying the overall signal.

Bone is a solid, which is denser than air. Sound waves propagate better through dense media than through less dense media such as gases.

Task 3

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Medically, a distinction is made between hearing problems in sound perception and sound conduction.

Sound perception takes place in the inner ear via nerve pathways to the brain. Sound conduction, on the other hand, is the transport of sound via the outer ear to the inner ear.

If the tuning fork can be heard longer via the bone conduction than via the sound conduction of the ear, this suggests a disturbance in the sound perception.

 True False Check

Task 4

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The Weber test is also used for diagnostics.

What observation would you expect (both ears open) for a healthy person with sound perception and conduction intact?


In the Weber experiment, the sound is not expected to be heard at all.

The sound is expected to be perceived equally in both ears.

Since humans have a dominant ear, the sound would be heard better in one of the two ears.

Slide	Score/Total
Slide 17: Tuning fork on the bone	0/1
Slide 18: Solids	0/1
Slide 19: Hearing problems	0/1
Slide 20: Weber	0/1

Total  0/4

 Solutions

 Repeat