

Merging frequency and upper hearing limit of humans



Biology

Human Physiology

Hearing & Seeing



Difficulty level

medium



Group size

2



Preparation time

10 minutes



Execution time

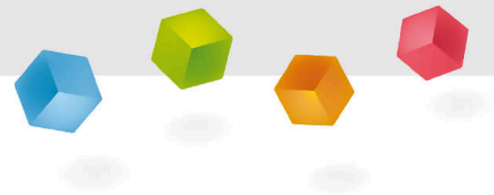
45+ minutes

This content can also be found online at:



<http://localhost:1337/c/6188c9a21aeb390003862a91>

PHYWE



Teacher information

Application

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Human ear

You have probably already experienced it first hand: with increasing age, hearing ability decreases. However, hearing does not only deteriorate in terms of volume, people also perceive fewer frequencies, especially fewer high frequencies, as they get older, which is less obvious.

The fact that our hearing fails at high frequencies and that hearing deteriorates over time will be explored in this experiment.

Other teacher information (1/2)

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Prior knowledge



The human ear perceives sounds only within a very specific frequency range. Animals also have a typical hearing range, and even vertebrates can hear very different from the human body. In humans, the upper acoustic threshold strongly depends on age. The mean values of the performed measurements should correspond approximately to the following values: up to 16 years: 20 kHz, up to 20 years: 18 kHz, up to 35 years: 15 kHz, up to 50 years: 12 kHz, up to 70 years: 9 kHz, up to 90 years: 5 kHz.

Scientific Principle



The experiment shows that the auditory range of the human ear is age-dependent: the older the person being examined, the lower the Auditory range. Tones above the upper hearing threshold with increasing age are not anymore perceived and individual tones below the unhearing threshold (the so-called merging frequency) are perceived as a continuous low tone.

Other teacher information (2/2)

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Learning objective



In this experiment, students will discover and explore the upper limit of human hearing by taking hearing measurements with individuals of different ages.

Tasks



- Determination of the merging frequency and the upper Hearing threshold of subjects of different ages
- Stimulation of the auditory system with frequencies in the range of the lower and upper hearing threshold by means of a Sine wave generator and headphones

Safety instructions

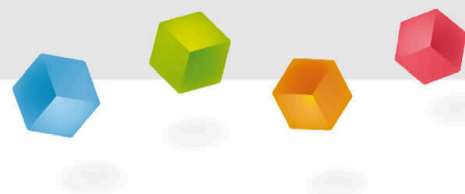
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The general instructions for safe experimentation in science lessons apply to this experiment.

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Student Information



Motivation

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Everybody knows, that their own dog hears a sound far before they perceive it themselves. It is widely known that dogs have better ears and hear not only quieter but also higher tones than we do. Even between people there are big differences. Young people still hear high tones that the same people years later no longer perceive.

The following experiment is about discovering human hearing at its upper limit and beyond.

Tasks

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Sine wave generator

- Determination of the merging frequency and the upper Hearing threshold of subjects of different ages
- Stimulation of the auditory system with frequencies in the range of the lower and upper hearing threshold by means of a Sine wave generator and headphones

Equipment

Position	Material	Item No.	Quantity
1	Headphone, stereo	65974-00	1
2	PHYWE Digital Function Generator, USB	13654-99	1

Set-up

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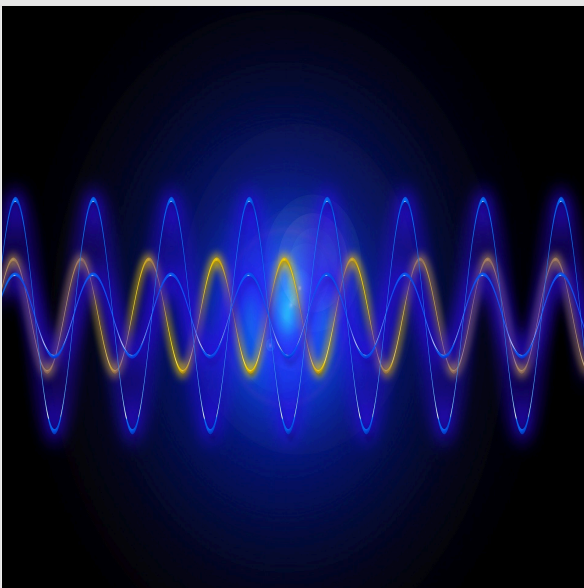
Test setup

The digital function generator is set up in a quiet room and switched on. Adjust the function to Sine and frequency to 20 kHz. Change the output to headphones, connect the cable and set the signal amplitude to maximum.

Place the headphones on the subject's head.

Procedure (1/2)

PHYWE



The investigator of the experiment gradually reduces the frequency until the subject hears only the sound. The measurement is recorded. To avoid personal influence, the subject must not see the digital display during the measurement process. The measurement should be repeated several times with the same subject.

The frequency is set to 10 Hz. The leader of the experiment gradually increases the frequency depending on the subject until the individual tones merge into one continuous tone. This merging frequency is recorded. The measurement is repeated several times with the same subject.

Procedure (2/2)

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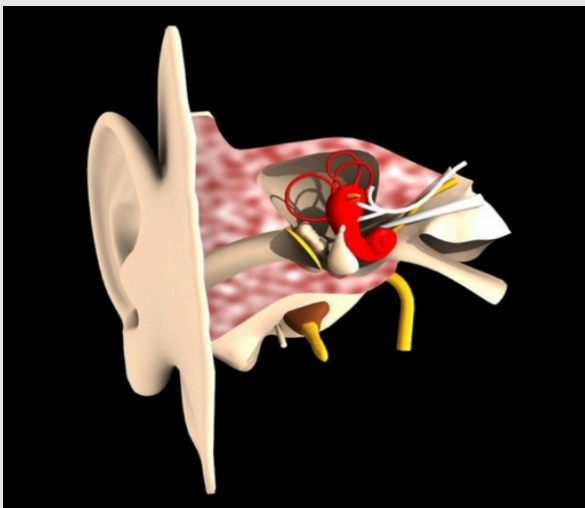
The upper acoustic threshold and the merging frequency should also be used for comparative purposes in the case of younger and older subjects according to the procedure described on the previous page.



It would be advantageous to use loudspeakers instead of a headset, since the measurement could be performed for many subjects simultaneously. However, it is not recommended, because standing waves spread out in the classroom. As a result, the sound is perceived at a constant frequency and amplitude in different degrees of loudness depending on whether the ear is close to a wave center or a wave node.

Explanation

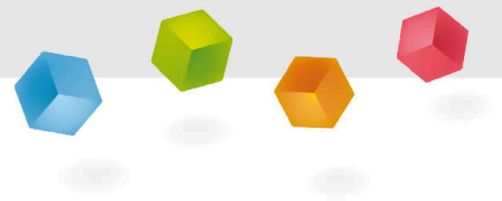
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Structure of the human ear

If the upper acoustic threshold is exceeded even at maximum sound intensity there is no stimulation of the sensory cells. If the lower limit is undershot the individual tones remain audible. Nevertheless, the lower acoustic threshold can be easily determined, since in this case the individual tones merge into a continuous low tone; it is thus best described as a merging frequency. This frequency is independent on age and is between 16 and 20 Hz.

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Report

Task 1

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Where are the hair cells located that make hearing possible?

In the arcades of the inner ear

In the eardrum

In the cochlea in the inner ear

In the bones of the middle ear

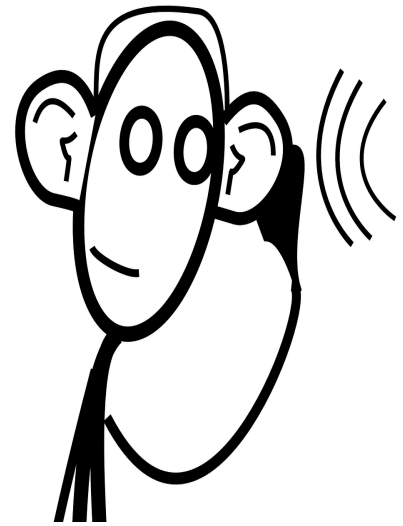


Task 2

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Are there differences between people in human hearing?

- ☐ No, people are all absolutely the same.
- ☐ Yes, not everyone can hear all frequencies.
- ☐ Yes, different volumes, are not heard by every person.

☒ Check

Task 3

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The upper hearing limit is the same for all people

☐ True☐ False☒ Check

The fusion frequency in humans is between 16 and 20 kHz.

☐ True☐ False☒ Check

Slide	Score / Total
Slide 15: The place of hearing	0/1
Slide 16: Differences in human hearing	0/2
Slide 17: Multiple tasks	0/2

Total  0/5



Solutions



Repeat