15. Hearing range Report

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PROBLEM STATEMENT

15. Invent Yourself: Hearing range

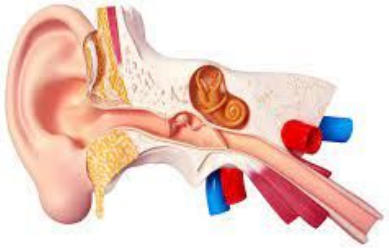
There is a considerable variation in the range of frequencies that can be heard by humans and other mammals. Suggest a problem to investigate the lowest and highest audible frequencies for specific species of societal groups.

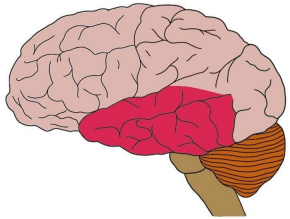
Problem proposed:

How does **age** affect the range of audible frequencies in **humans.**

CONTENTS

INTRODUCTION-HEARING





- **Hearing**, or **auditory perception**, is the ability to perceive sounds by **detecting vibrations** and changes in the pressure of the surrounding medium through time, through an **organ** such as the ear.

- In humans, hearing is performed primarily by the **auditory system**: vibrations, are detected by the **ear** and transduced into **nerve impulses** that are perceived by the **brain** (primarily in the temporal lobe).

- Audition requires **sensitivity** to the movement of molecules in the world **outside the organism**. Hearing is a type of **mechanosensation**.

INTRODUCTION-HUMANS

- Frequencies capable of being heard by humans are called audio or **sonic**. The range is typically considered to be between **20 Hz** and **20,000 Hz**.

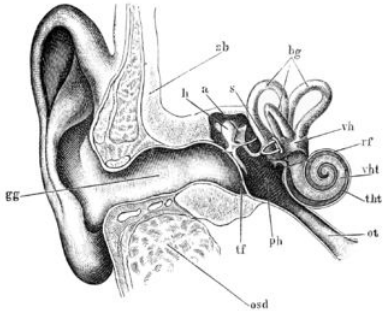
- Frequencies **higher** than audio are referred to as **ultrasonic**, while frequencies **below** audio are referred to as **infrasonic.**

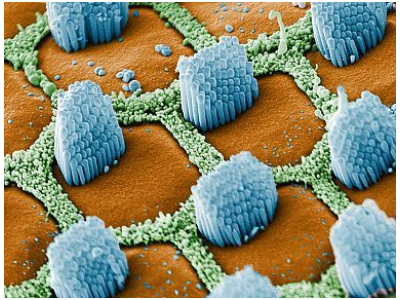
- There is considerable **variation** between individuals, especially at high frequencies, and a gradual **loss of sensitivity** to higher frequencies with **age** is considered normal.

- The absolute threshold of hearing (**ATH**) is the **minimum sound level** of a **pure tone** that an average human ear with normal hearing can hear with no other sound present.

THEORY-HOW DO WE HEAR?

- Sound waves enter the **outer ear** and travel through a narrow passageway called the **ear canal**, which leads to the **eardrum**.
- The eardrum **vibrates** from the incoming sound waves and sends these vibrations to three tiny **bones** in the middle ear.
- The **sensory cells** that detect these sounds are called **hair cells**, named for the hair-like strands that cluster on their tops.
- **Hair cells** are spread across a flat surface called the **basilar membrane**, which is rolled like a carpet and tucked into a snail shell-shaped structure in the inner ear called the **cochlea**.



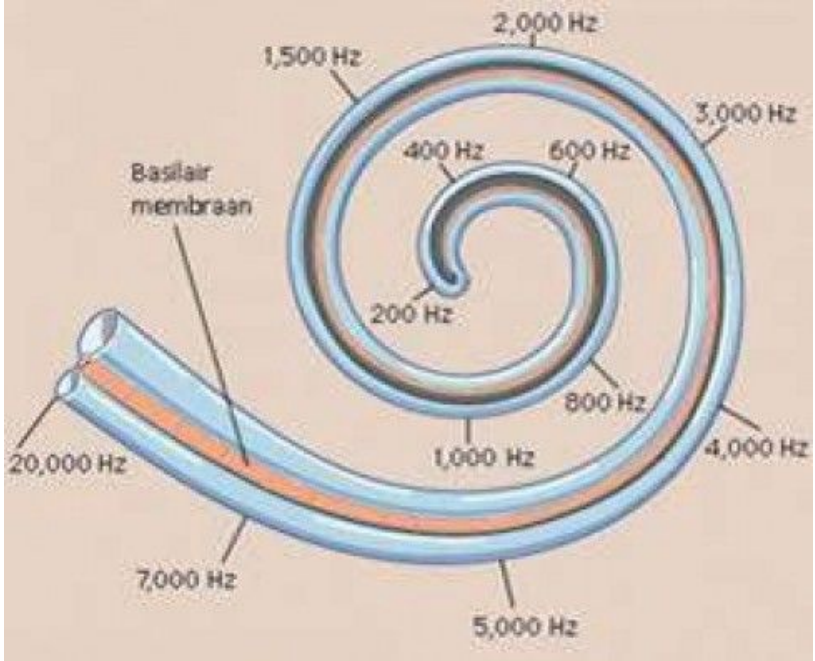


THEORY-HEARING DIFFERENT PITCHES

- Each of our (apx) **16,000 hair cells** is dedicated to a narrow frequency range.

- These cells are **ordered** along the basilar membrane according to the frequencies they detect.

- Those that sense **low pitches** are at one end and those that detect **high pitches** are at the other.



THEORY-PRESBYCUSIS

- Age-related hearing loss (**presbycusis**) is a **decrease in hearing ability** that happens with **age**. Usually, the hearing loss affects both ears. It can begin as early as a person's thirties or forties and **worsens** gradually over time.

- It first affects the ability to hear **high-frequency** sounds. As it worsens, it affects more frequencies.

- It is most commonly associated with **changes in the inner ear** where sound waves are converted to nerve impulses that are sent to the brain. However, it can also be associated with **nerve pathways** that carry sound information in the brain or changes in the eardrum or in the small bones in the middle ear.

HYPOTHESES

1

The older the age, the smaller the range of frequencies that the person will be able to hear

2

Only people younger than 40 will be able to hear very high pitched sounds. (higher than 19.000Hz)

3

People older than 65 will have difficulty hearing lower pitched sounds too. (lower than 50Hz)

EXPERIMENTAL SETUP AND PARAMETERS

- ➔ The participants heard an audio with frequencies ranging from **20-20.000Hz**
- ➔ They were asked to write down in which range they are able to hear.
- ➔ The experiment was conducted 10 times.

INDEPENDENT VARIABLES:

- Age

DEPENDENT VARIABLES:

- Range of frequencies

CONTROLLED VARIABLES:

- Environmental conditions

PARTICIPANTS

AGE	NUMBER
12-14	10
15-18	10
19-25	10
26-30	10
31-35	10
36-45	10
46-55	10
56-65	10
66+	10

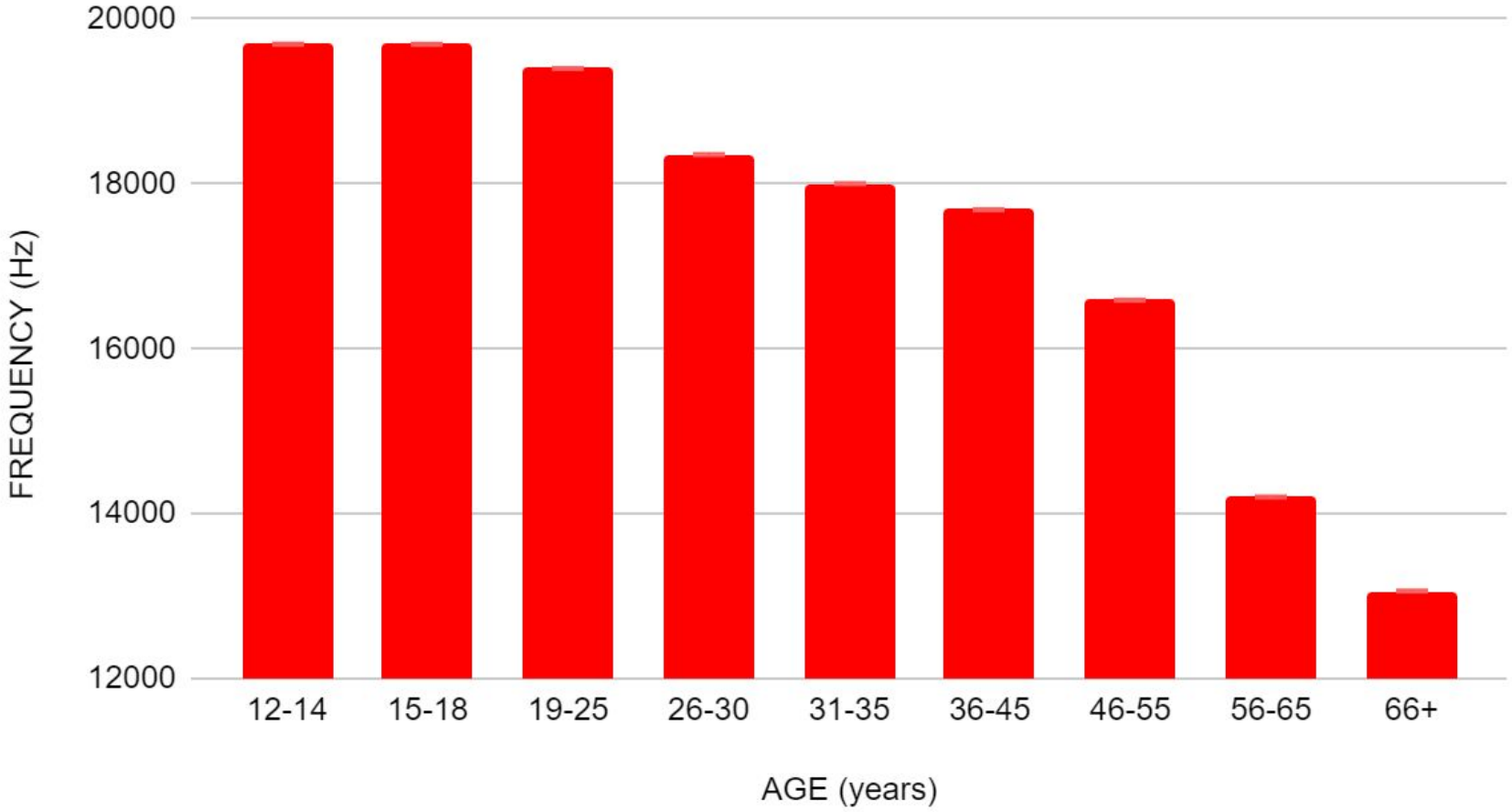
POSSIBLE ERRORS

- Inability of participants to precisely note when they started and stopped hearing.
- Auditory system ability.
- Hearing problems.

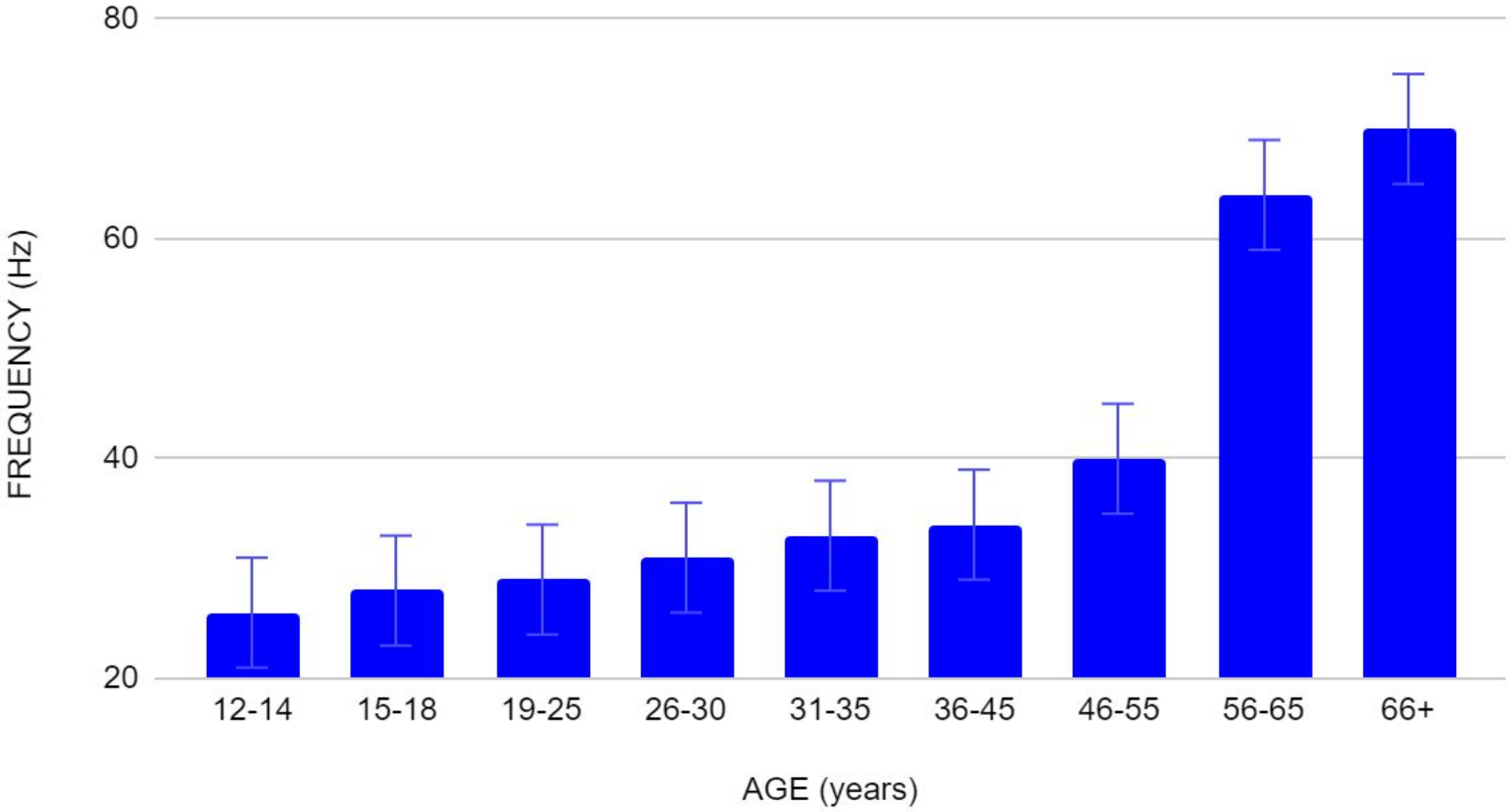
RESULTS

AGE	LOWEST	HIGHEST	RANGE
12-14	26	19695	19669
15-18	28	19693	19665
19-25	29	19400	19371
26-30	31	18356	18325
31-35	33	18003	17970
36-45	34	17687	17653
46-55	40	16590	16550
56-65	64	14203	14139
66+	70	13062	12992

HIGH FREQUENCY



LOW FREQUENCY



CONCLUSIONS

As **ages** got **higher**, the **high** frequencies are the **first** to be inaudible.

- People older than **55** stopped hearing **low** pitches
- People older than **45** stopped hearing **high** pitches.

CONCLUSION-HYPOTHESES

1

The older the age, the smaller the range of frequencies that the person will be able to hear

CONFIRMED

2

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CONFIRMED

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People older than 65 will have difficulty hearing lower pitched sounds too. (lower than 50Hz)

CONFIRMED

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Hearing by Whales and Dolphins. Springer

THANK YOU

APPENDIX

- Due to personal data and privacy rights we could not include photos of the experimental procedure.
- Distance between speaker and people was 1 meter
- The room was soundproof

ENVIRONMENTAL NOISE

- The related environmental factors were monitored with the use of DIY Ultra Sensitive EMF Arduino Detector and found to be stable during the experimental process.
- The laboratory that the experiment was conducted in is sound-proof.

INTRODUCTION-VERTEBRATES

Not all sounds are audible to all animals. Each species has a **range** of normal hearing for both amplitude and **frequency**.

- **Bats** use ultrasound for echolocation while in flight.
- **Dogs** are able to hear ultrasound, which is the principle of 'silent' dog whistles.
- **Snakes** sense infrasound through their jaws
- **Baleen whales**, **giraffes**, **dolphins** and **elephants** use infrasound for communication.
- Some **fish** have the ability to hear more sensitively due to a well-developed, bony connection between the ear and their swim bladder.

INTRODUCTION-INVERTEBRATES

Invertebrates don’t have ears so they have developed other **structures** and systems to **decode vibrations** traveling through the air.

- Many **insects** detect sound through the way **air vibrations deflect hairs** along their body. Some insects have even developed **specialized hairs** tuned to detecting particular frequencies
- Some other insects possess a **tympanal organ**. These are "eardrums", that cover air filled chambers on the **legs**. Similar to the hearing process with vertebrates, the eardrums react to **sonar waves**. **Receptors** that are placed on the inside translate the oscillation into **electric signals** and send them to the **brain**.