Bioacoustics

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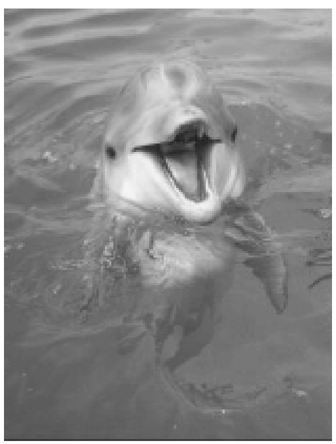
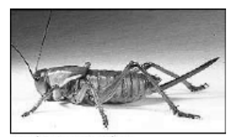
Bioacoustics

Bioacoustics is the study of the adaptive basis of animal sound signals: how, (when, where) and
why animals make sounds????





Female mormon cricket

Communication: the basic function of a signal (information exchange)

Bioacoustics

Mutualism: there is mutual benefit,

Eavesdropping: 'Overhearing' Sometimes only the receiver benefits

Deceit: Perhaps a sender benefits at the expense of a receiver.

Spite: In this under-represented category both sender and receiver experience a reduction in fitness.

Adaptive contexts of selection on sound signals

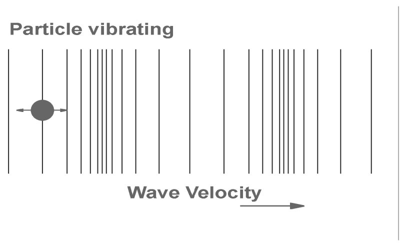
1. localization
2. aggregation
3. noise
4. species recognition
5. mate choice
6. rivalry
7. group recognition
8. individual recognition
9. eavesdropping
10. alarm
11. startle & distress
12. Deceit and acoustic mimicry.

Sound

Sound is any disturbance that travels through an elastic medium

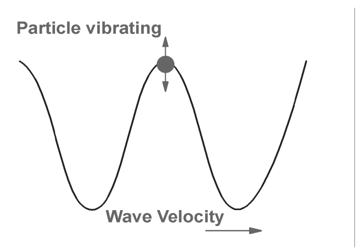
Sound wave motion

Longitudinal Waves:



Through medium

Transverse Waves:



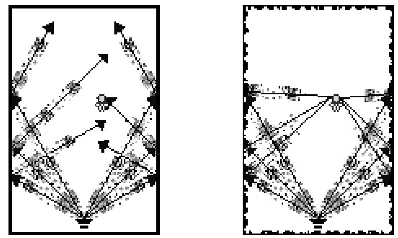
On the surface

Velocity of Sound Waves: at 20 C. it is approximately 1,130 ft (340 m) per second,

Behavior of Sound Waves

Reverberation:

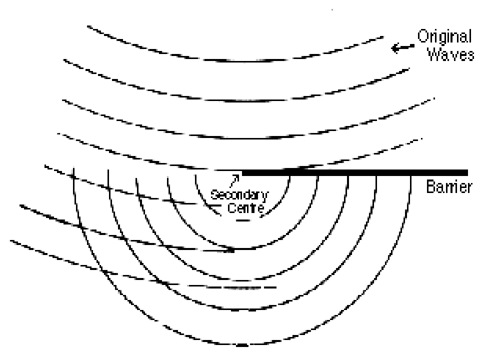
Echoes:



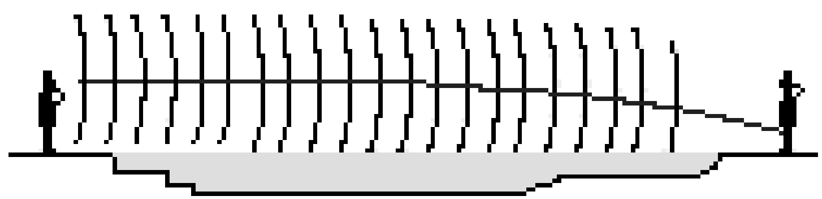
Smooth walls fail to give the room a feel of full sound.

Rough walls give a room a feel of full and lively sound.

Diffraction:



Refraction



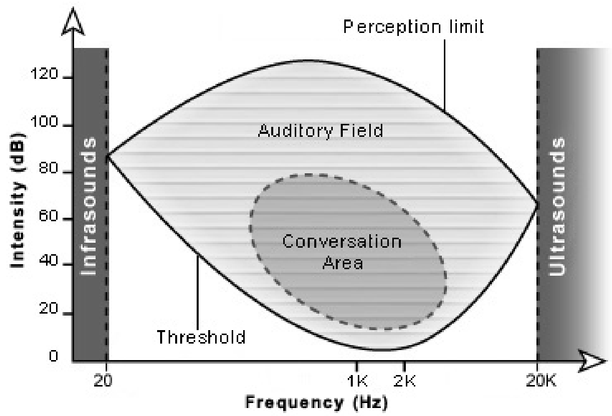
decibel scale

The decibel (abbreviated dB) is the unit used to measure the intensity of a sound.

•Near total silence - 0 dB
•A whisper - 15 dB
•Normal conversation - 60 dB
•A lawnmower - 90 dB
•A car horn - 110 dB
•A rock concert or a jet engine - 120 dB
•A gunshot or firecracker - 140 dB

Eight hours of 90-dB sound can cause damage
to your ears; any exposure to 140-dB sound causes immediate damage

Sound range



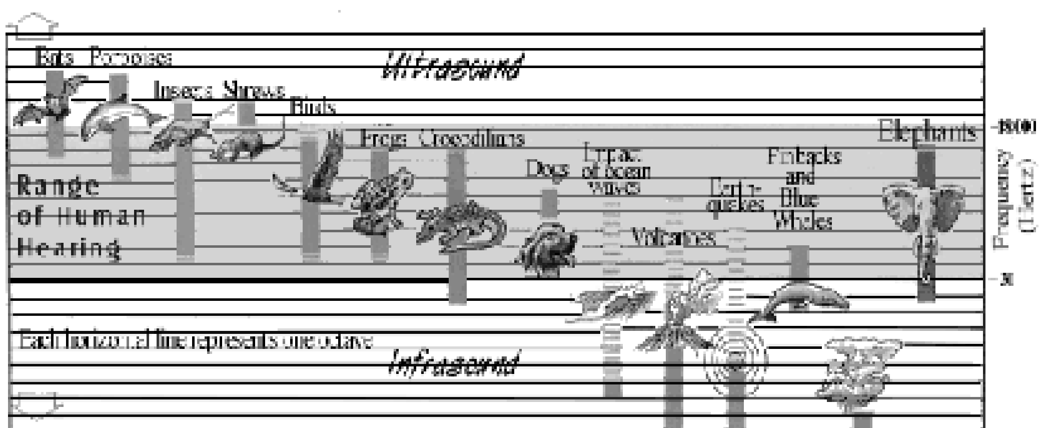
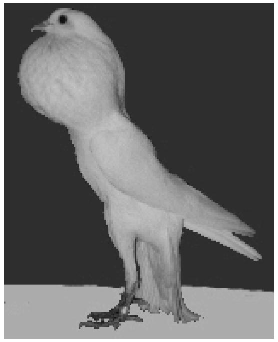


Diagram modified from original by Pierre Mion in National Geographic

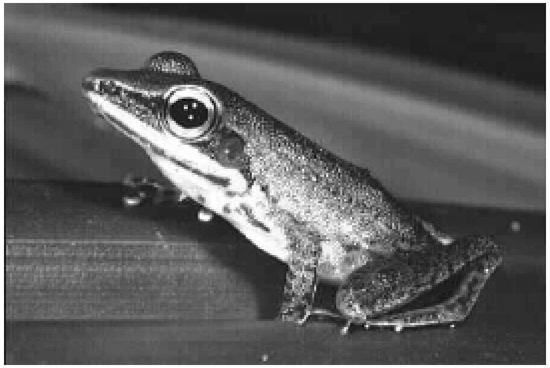
Infrasonic communication

(Seismic communication)

Domestic Pigeon



White-lipped Frog



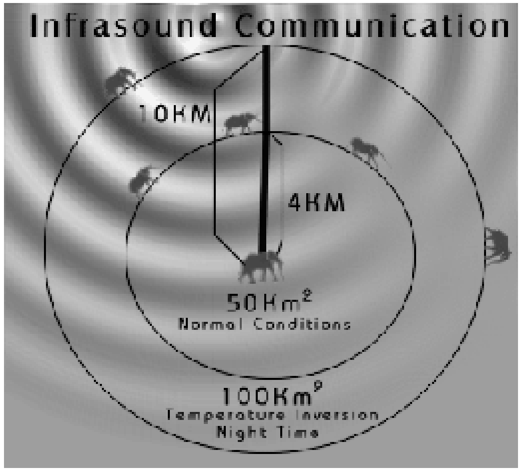

Discovery
CHANNEL

Infrasonic communication

(**Seismic communication**)

Elephants: hearing range between 1 and 20,000 Hz & communicate between 16.0 to 32.0 km

Vibrations generated through stomping of the foot and flapping of the ears



Infrasonic communication

Rhinoceros: Very similar to the elephant, not for as long of distances,

Hippopotamus: In the air, the calls travel for 6.4 km (4.0 miles)
In water up to 32.2 km (20.0 miles).

Infrasonic communication

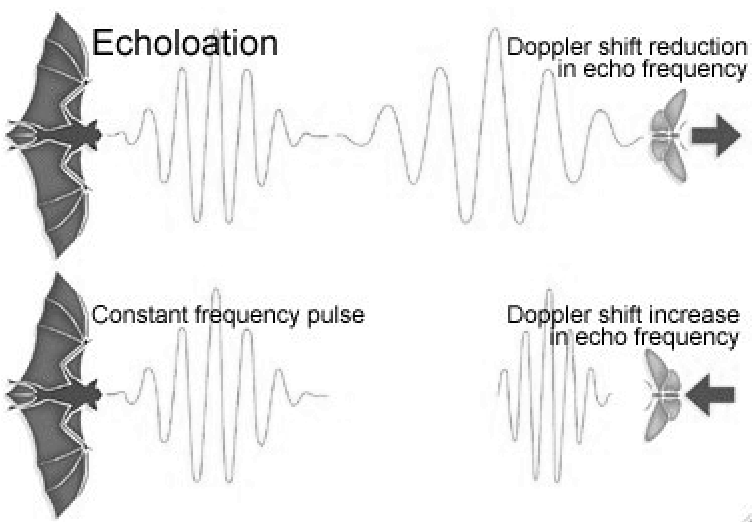
(**Seismic communication**)

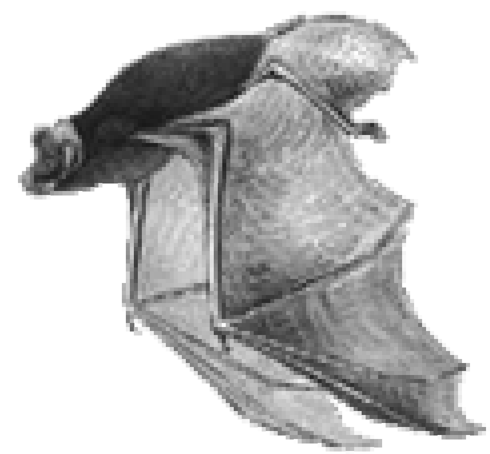
scorpions could locate minute disturbances
within the sand 10.0 to 15.0 cm

Blind Mole Rat:sense through the skin
and travel to the brain by bone conduction.

ultrasonic communication

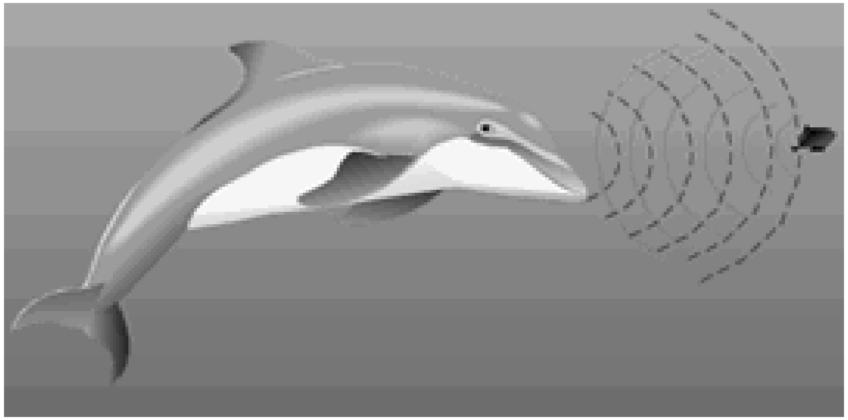
Bat: uses sound waves approximately 100.0 to 20.0 kHz,





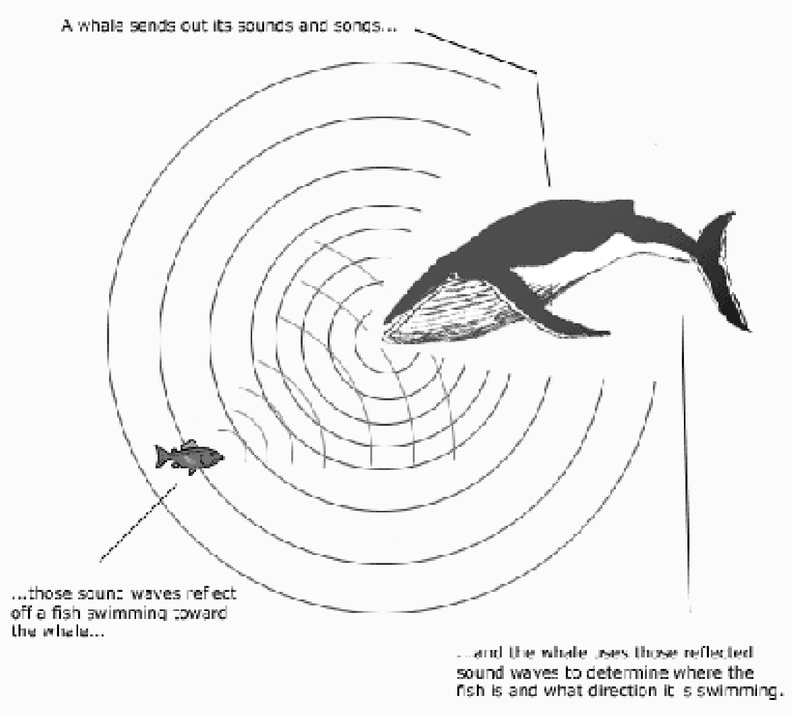
ultrasonic communication

Dolphins are capable of perceiving sounds of 200000 Hz by use of their ears.



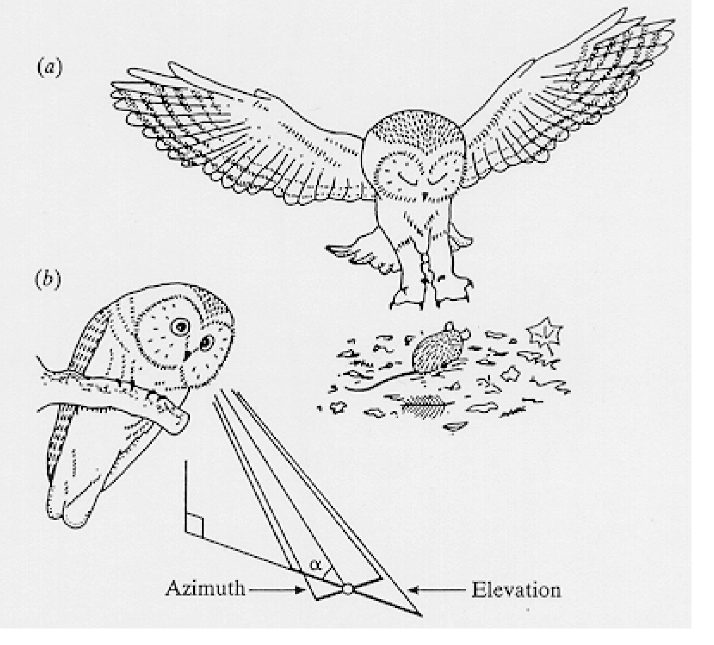
ultrasonic communication

Whales: Besides using infrasound to communicate,
 the blue whales (and all other whales)
also use ultrasound



Sonic communication

Owl: Prey detection
1. Intensity
2. Frequency
3. Direction
4. Object localization

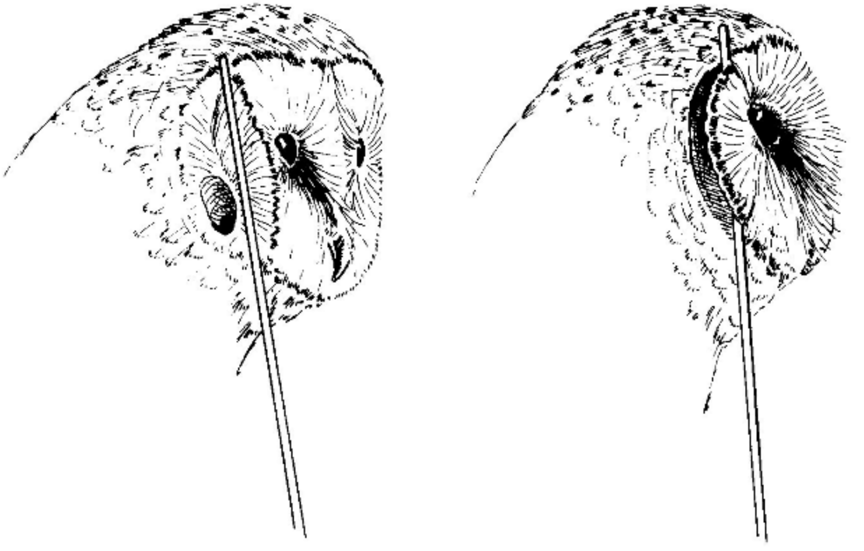


Sonic communication

2 Left ear above midpoint of eyes

3 Right ear below midpoint of eyes

4 Owls' ears also are asymmetrical;
they are in different sizes



The owl's large ear opening is hidden behind the facial disk.

Sound localization

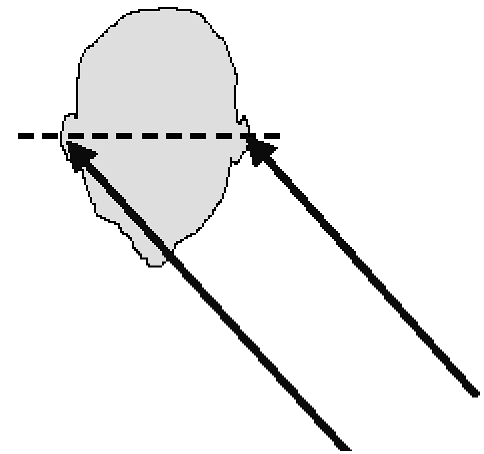
1. Delayed in time

Interaural Time Differences (ITDs)

Time delay is 690 μs

frequencies (< 1500 Hz)

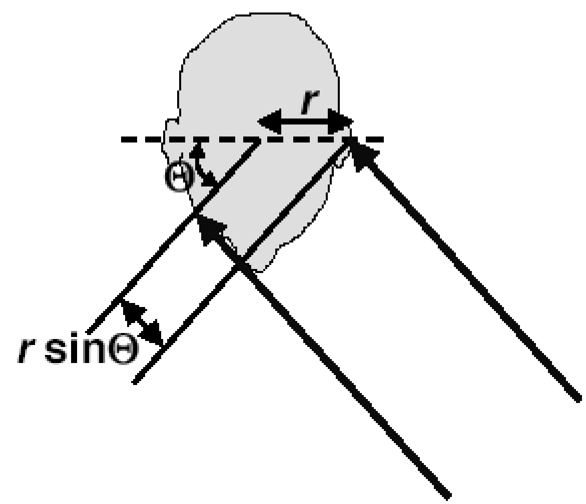
wavelength is long compared to the size of the head (1888 Hz)



2 less intense

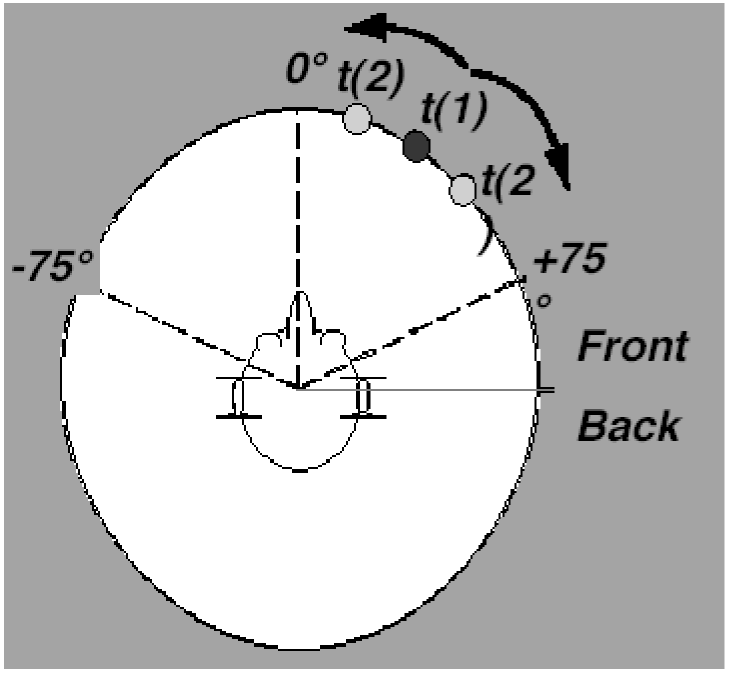
Interaural Intensity Differences (IIDs)

wavelength is short compared to the size of the head



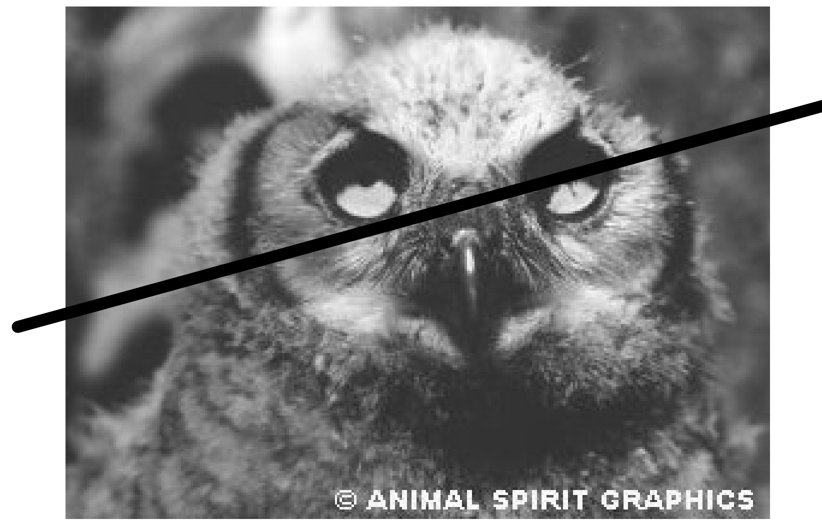
Minimum audible angle

For a 500 Hz tone the acuity at 0° is about 1° of arc and at ±75° it is about 8° of arc

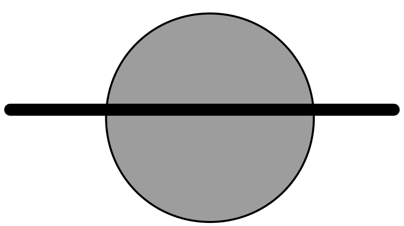


Ear angle of human & owl

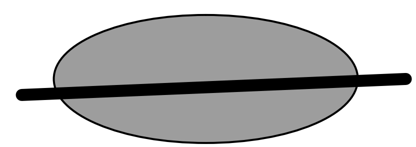
Front view



Front view



Top view (human)



Top view (owl)

Possible application of owl principle

- Military application
- Zoological study (finding animals)
- <u>Hearing aid in traffic</u>

Hearing problems without helmet

•Noises of other vehicles
•diffraction of wind sound in speed
•Doppler effect with moving vehicle

Noise pollution & related health problem

Hearing problems with helmet

- Reduces external sound
- Difficult to sense vehicle’s sound & horn coming from back side
- Difficult to communicate
- Change in sound frequencies

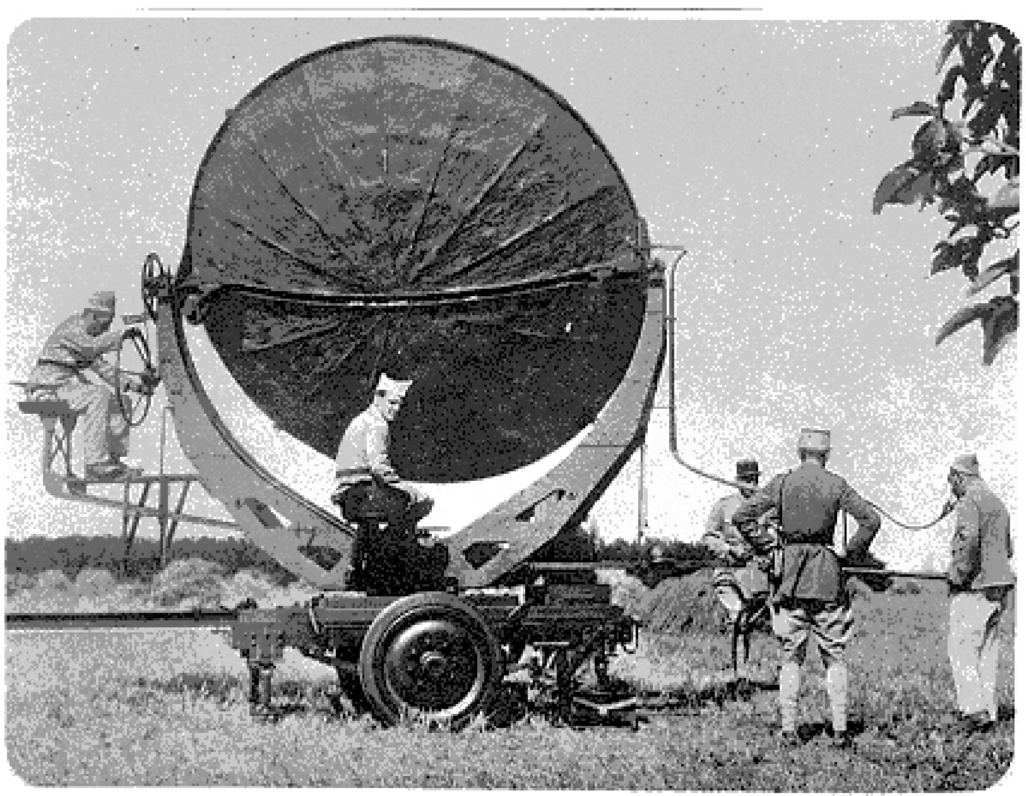
Project brief.

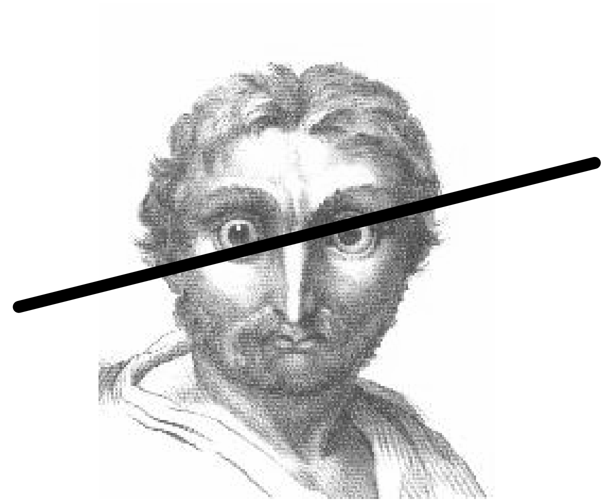
•The study is aimed to develop a hearing aid inside helmet for rider to judge the traffic around him by using bio acoustic principle of owl.

•It may also take care about noise pollution.

•The output of hearing aid may be audio or visual.

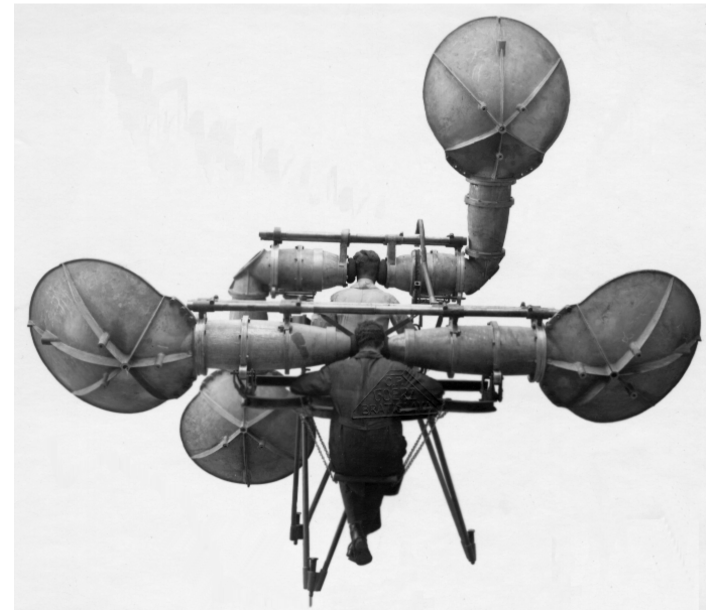
Experiments to improve sound localization





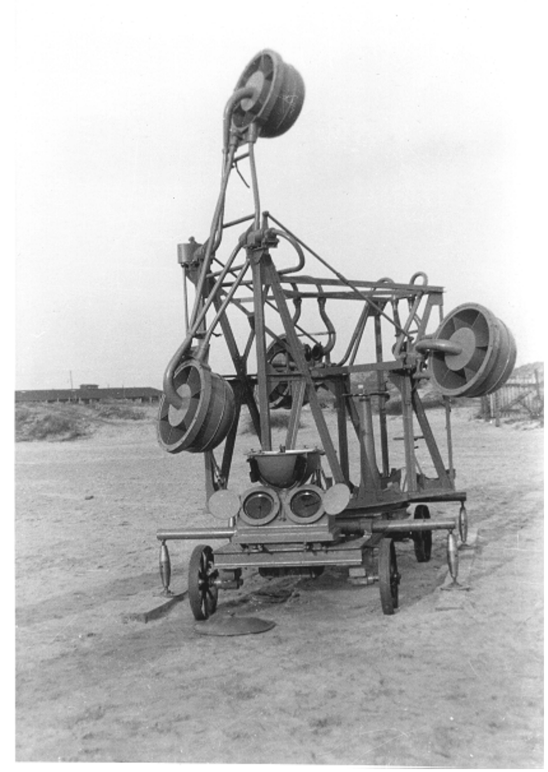
1920

Half of the equipment by
Goerz, Czechoslovakia

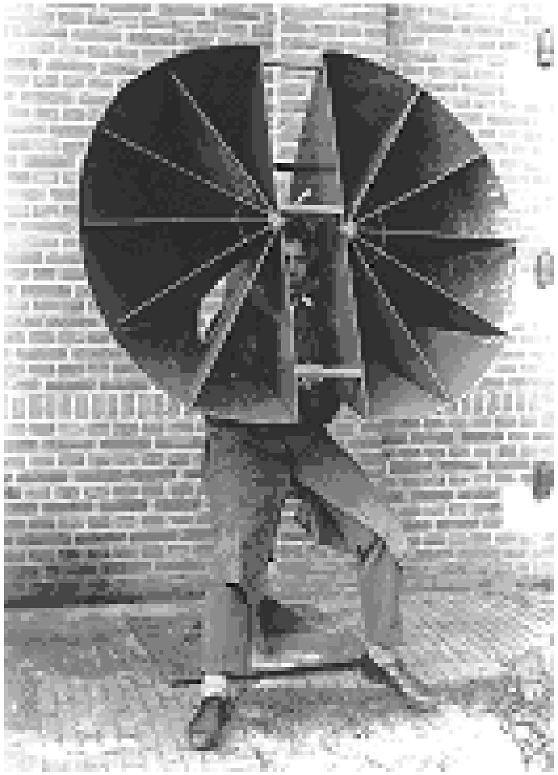


Listening equipment with receiving
shells (Czechoslovakia)

Doppelt Richtungshörer,
manufacturer Askania, Germany

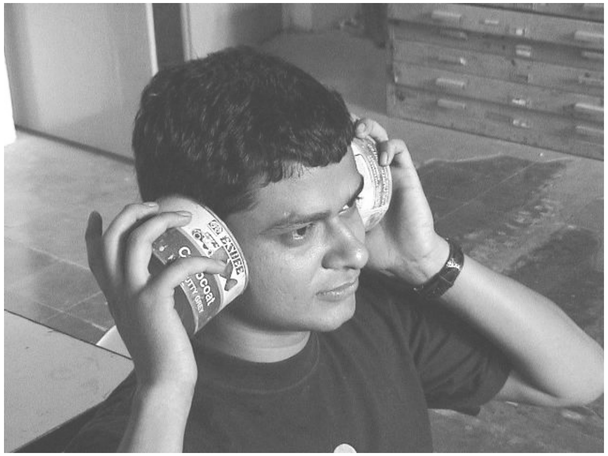


Equipment by Barbier, Bénard
and Turenne, France



Listening equipment "Waalsdorp",

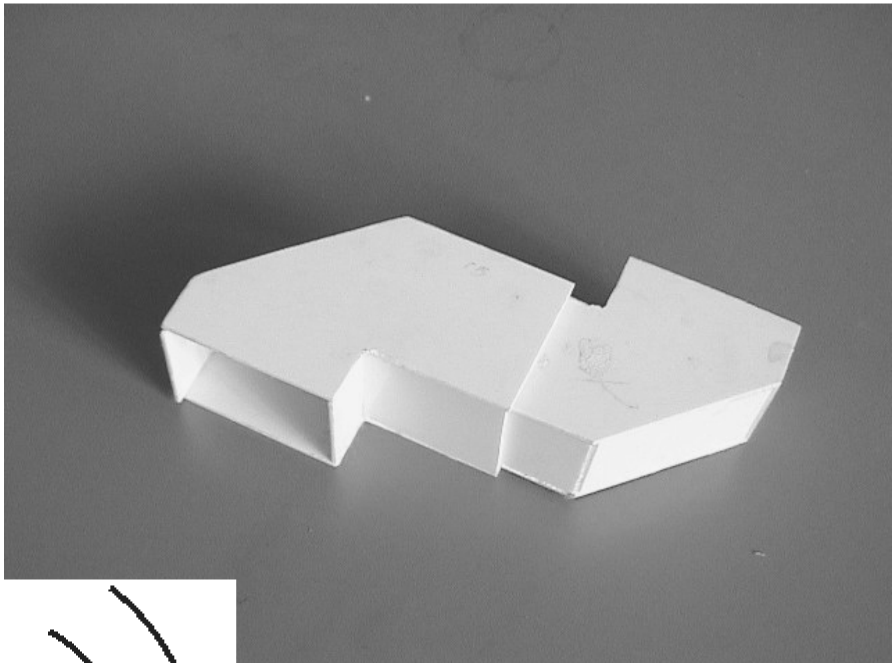
Experiments

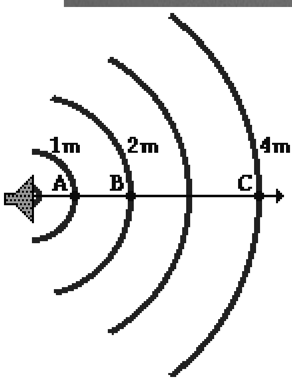


Tin cans

Only noise due to sound vibration from all around

Experiments

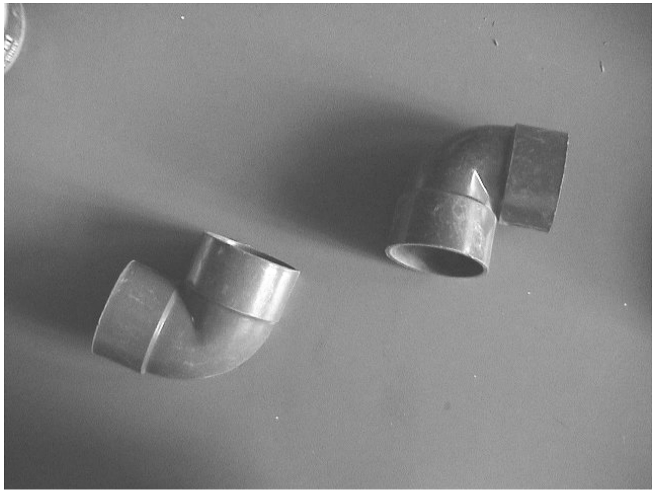




Variable length square channel

•More noise creation due to square cross section

Experiments



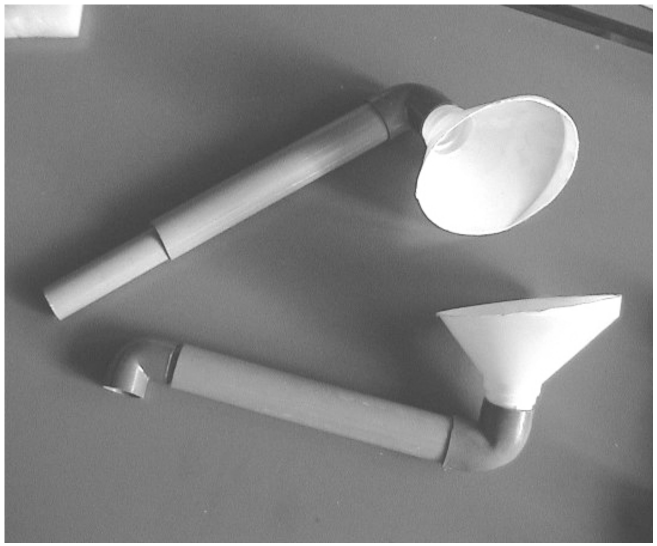
•Round pipes have less noise as compare to the square cross section

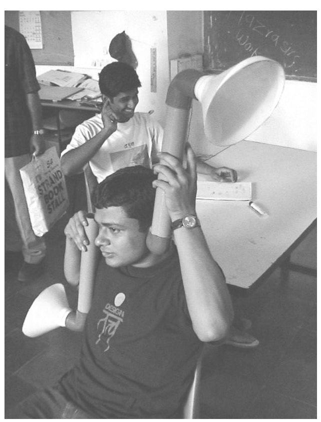
•No improvement in sound localization.

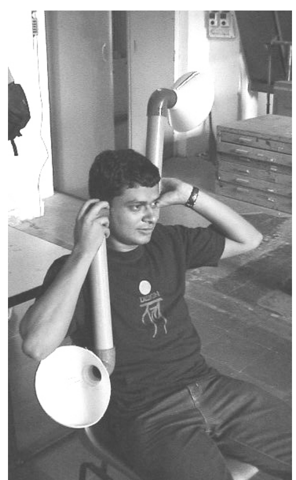
Experiments

•improvement in sound localization.
•Noise creation is more

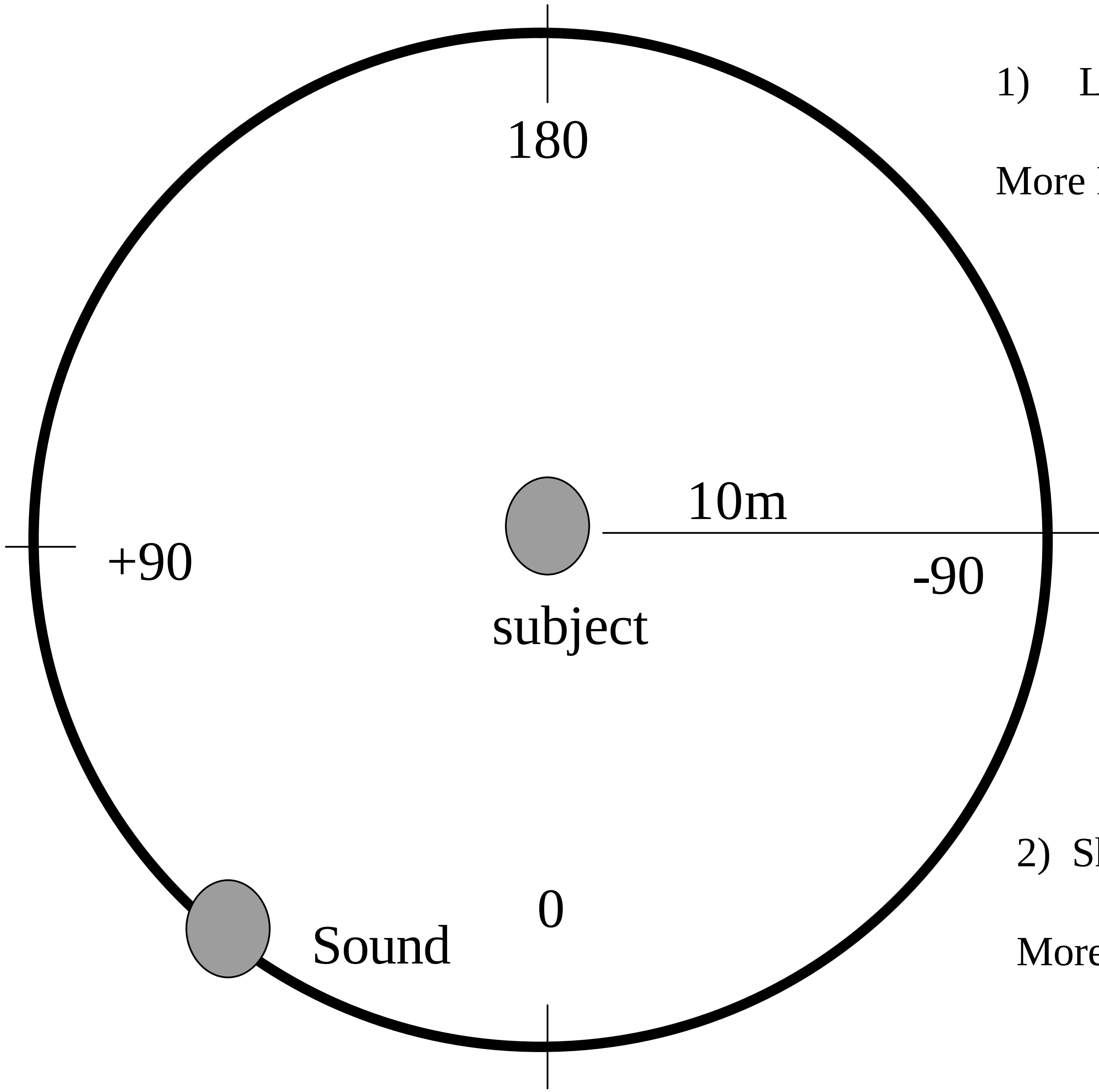
Experiments







Variable length sound collector



1) Long system 55% success

More Reverberation

2) Short system 70 % success

More noise

Problems

In mechanical system

- Generation of diffraction of sound
- Amplifies background noise
- Not useful for low frequencies
- Long length creates reverberation
- Difficult to mount on ears
- noise filters (mufflers) are too bulky

The alternative may be **Electronic system**

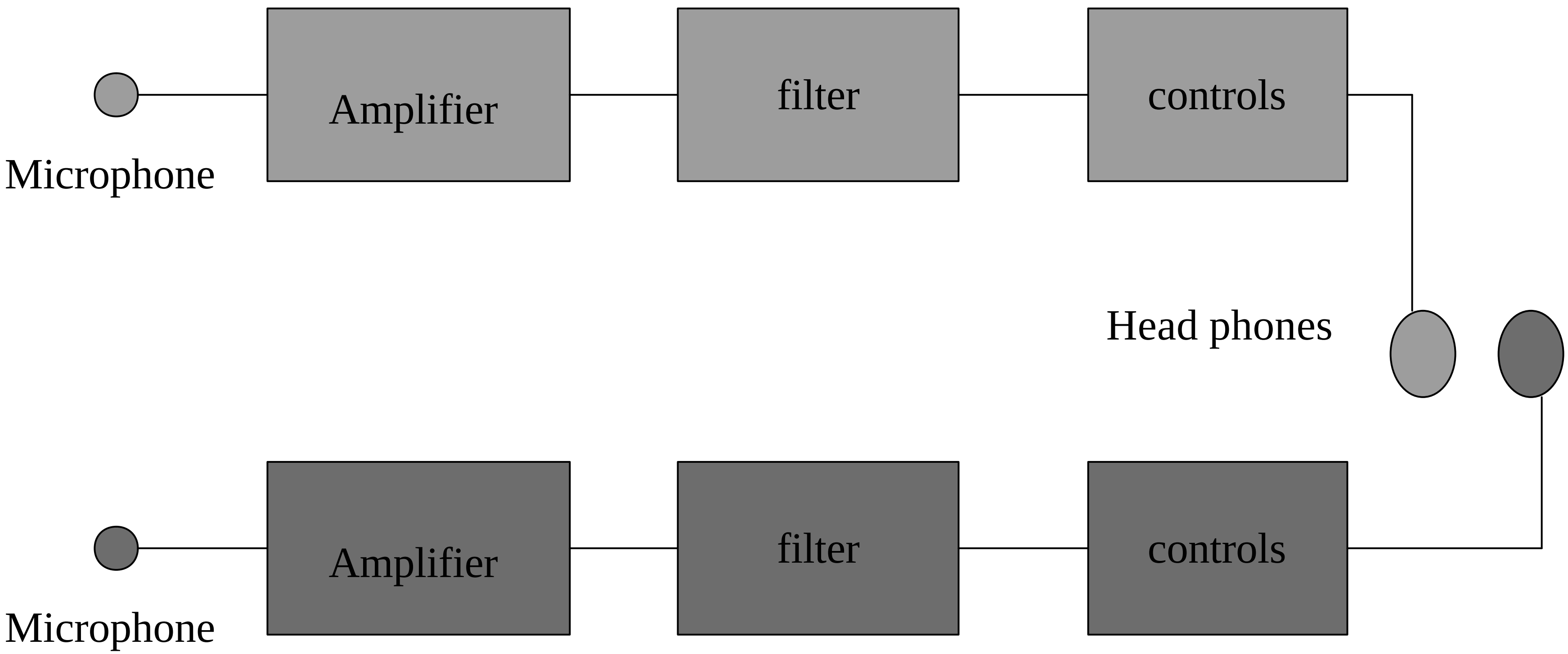
Advantages in electronic system

- microphone creates less diffraction
- The amplification can be control
- Unwanted frequencies & intensity can be control by electronic filters
- The electronic system is able to capture low frequencies too
- It is small & very compact

Disadvantage of electronic system

- It need constant electric supply.

Construction of electronic system



Mounting of hearing aid

Right side

Left side

Test

Stationary test

Rider test

Rider test in traffic

Rider test in traffic

Test results

•Able to get low frequencies created by big vehicles, picking up low frequency sound signals due to helmet diameter

total10 users tested,
6 on motor bike
4 stationary

•The success rate is **94%**

Thank you