

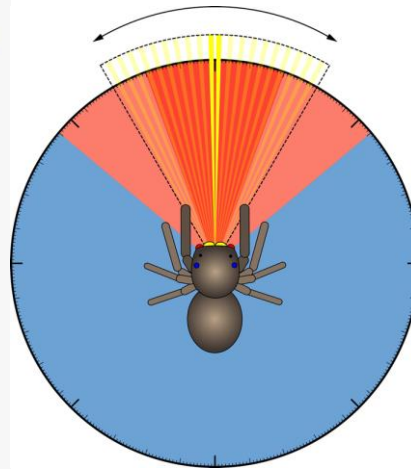
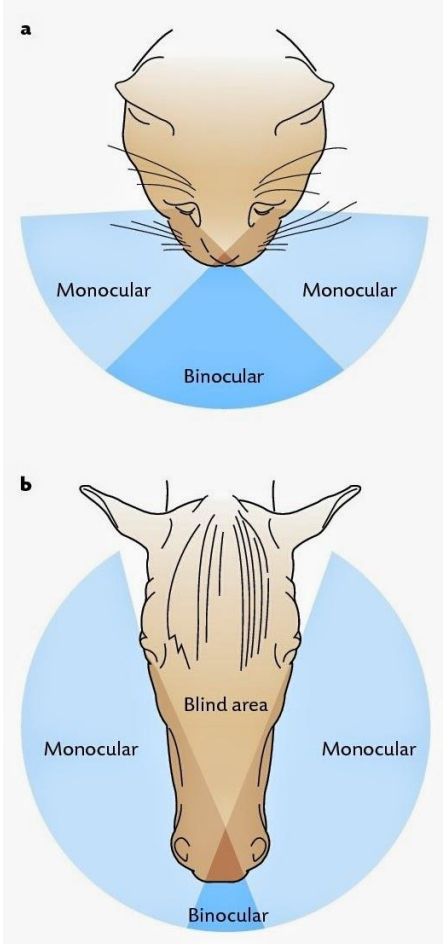
Human-Computer Interaction: HCI

Montri Phothisonothai

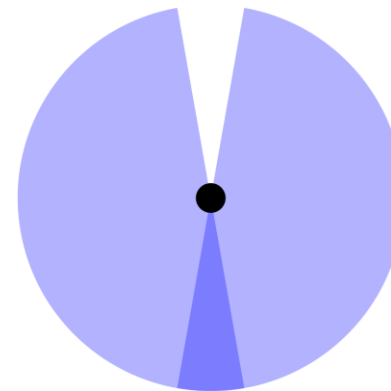
International College, KMITL

Sep 10, 2018

Visual Field of Animals (Cont.)

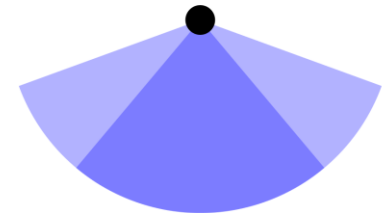


Pigeon



■ Binocular vision

Owl

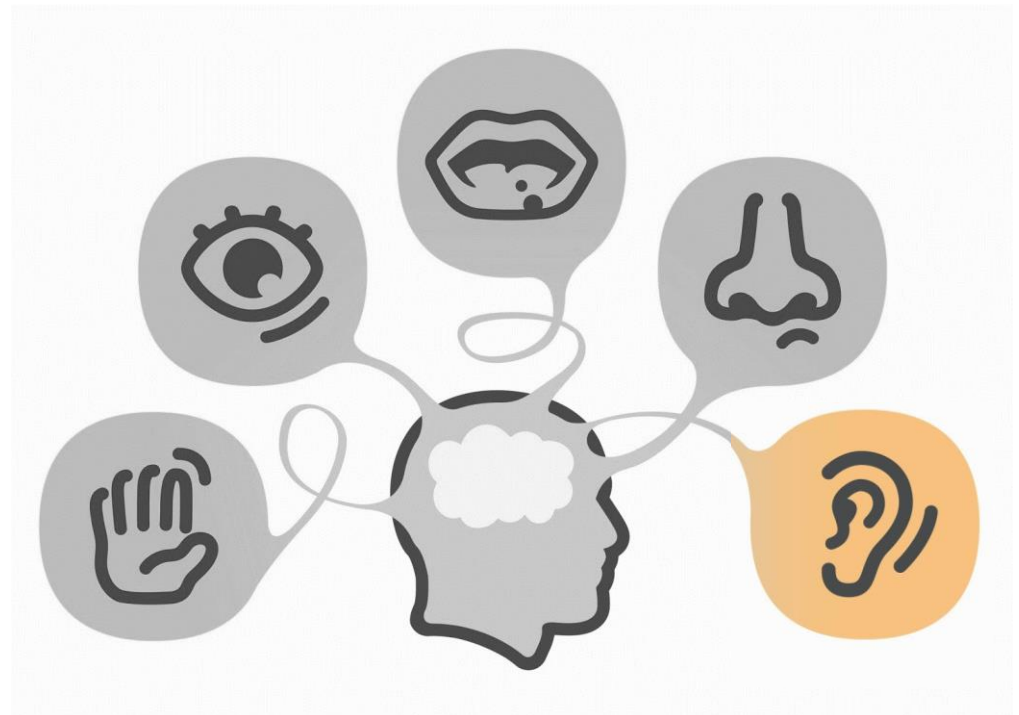


■ Monocular vision



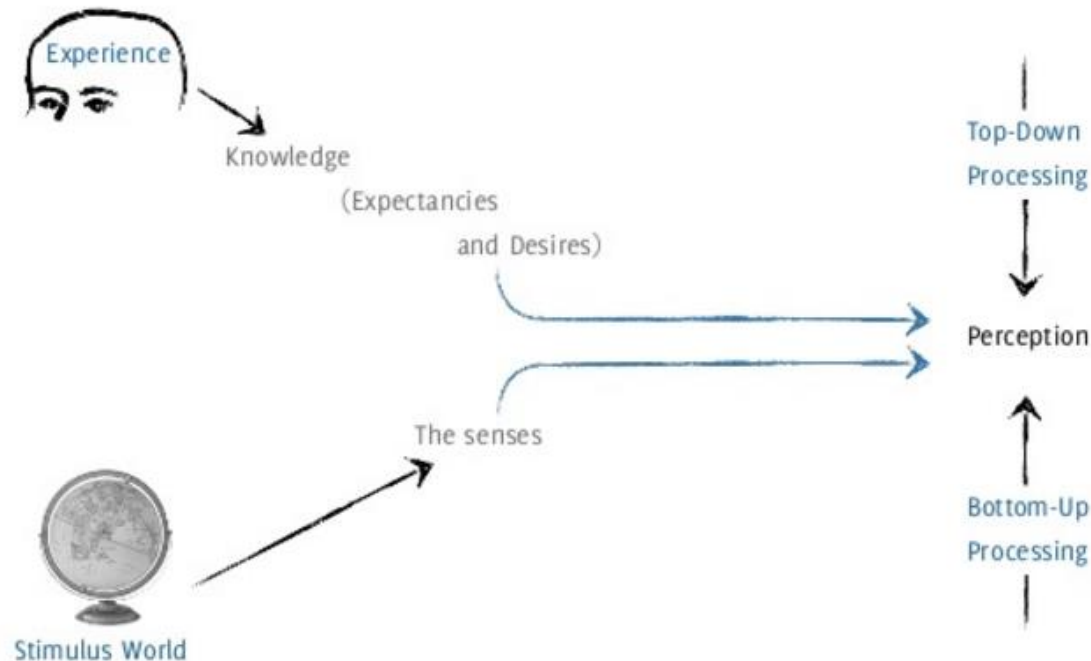
Sensory Information of **Auditory**

- ▣ Human I/O Units
- ▣ Processed by the Brain



Perception: top down vs bottom up

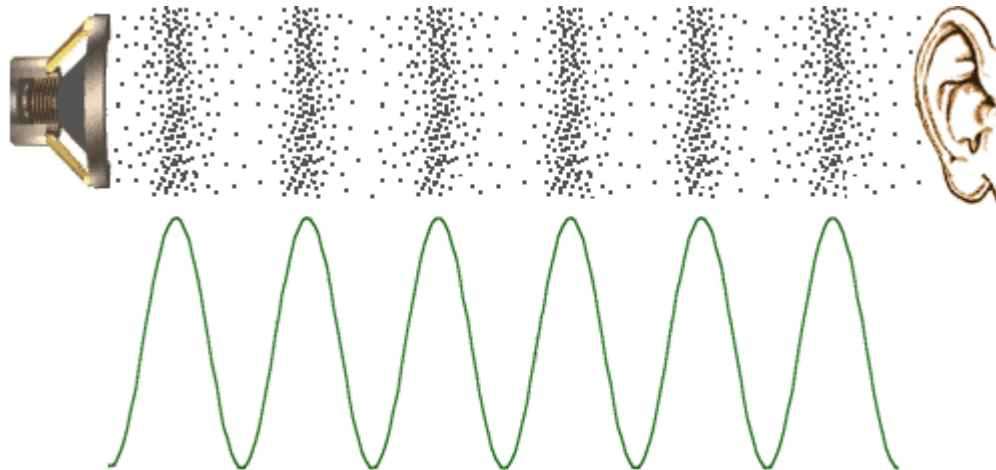
- Perceive the world using the combination of our physical senses and previous mental knowledge



*Relationship between top-down and bottom-up processing, when perceiving the world around us.
Image based on diagram in (AN_INTRODUCTION_TO_HUMAN_FACTORS_ENGINEERING, 2004).*

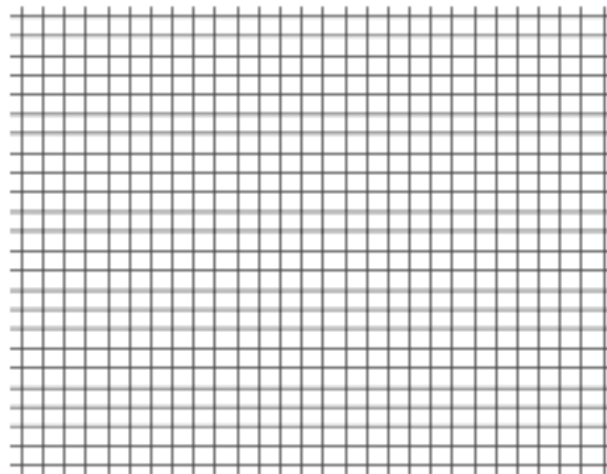
What is sound?

- The human ear measures **time dependent air pressure** and transforms these pressure variations into electrical signals that are fed into our brain and give us the sensation of what we call **sound**.



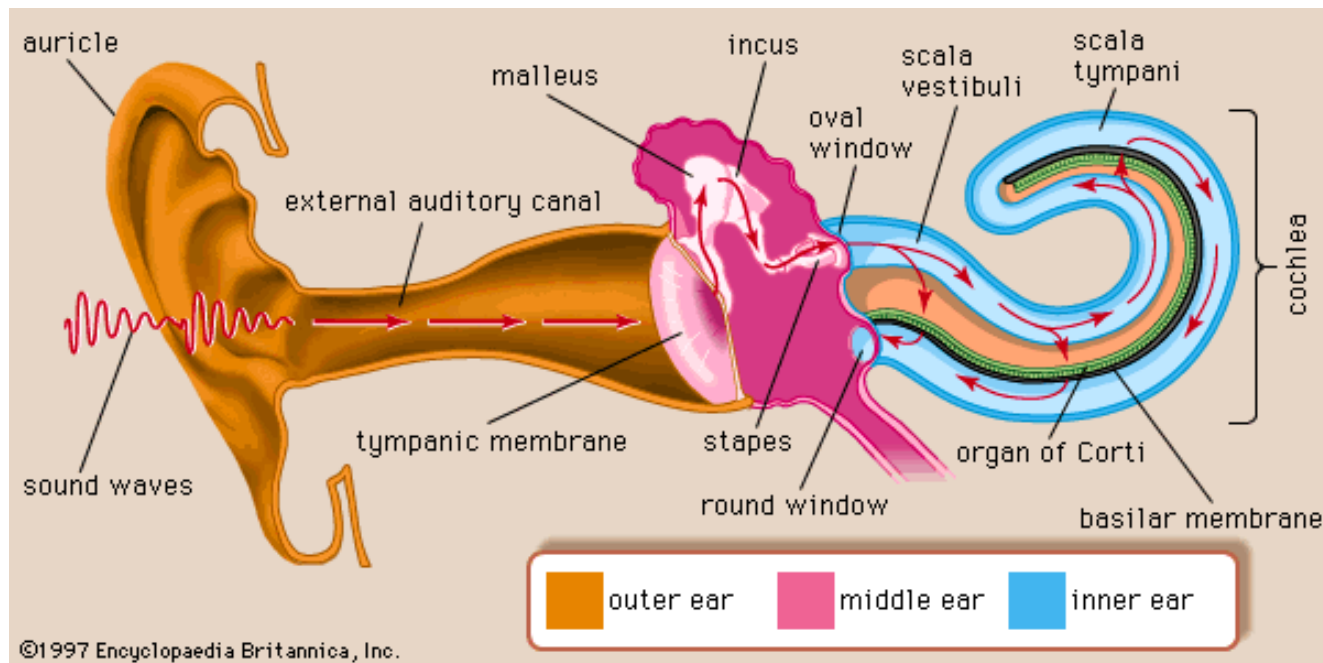
Sound Wave

- ▣ These pressure differences propagate in the air giving rise to a sound wave
- ▣ The air molecules close to the speaker are forced away from the speaker
- ▣ Characterized as a function of pressure against time



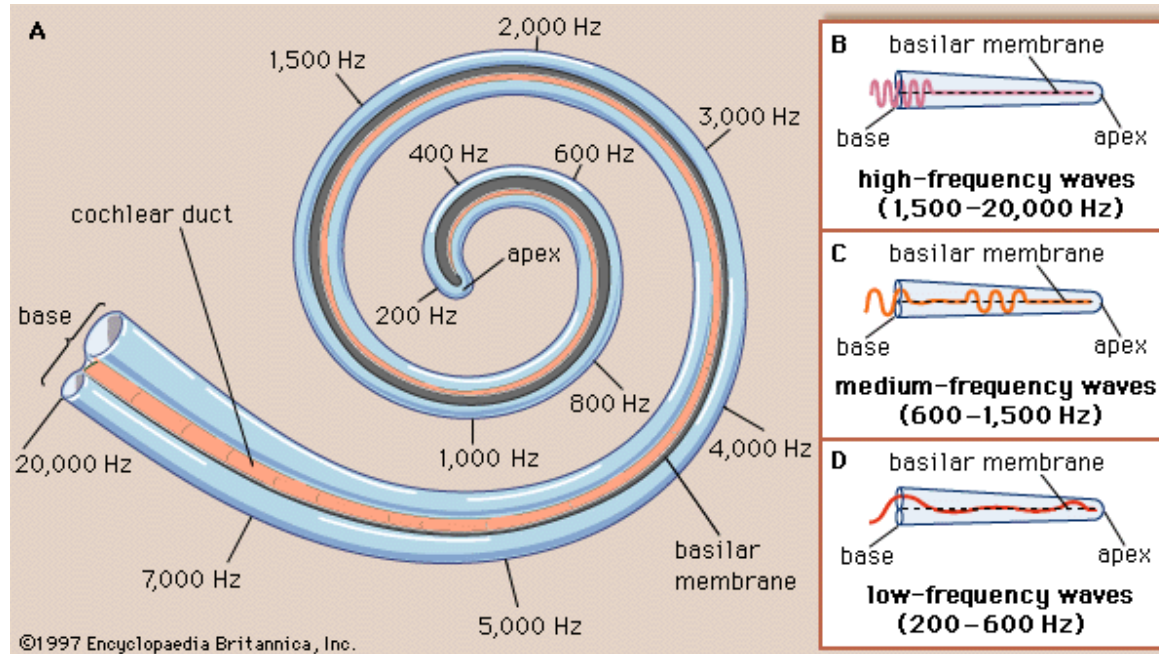
Human Perception of Sound

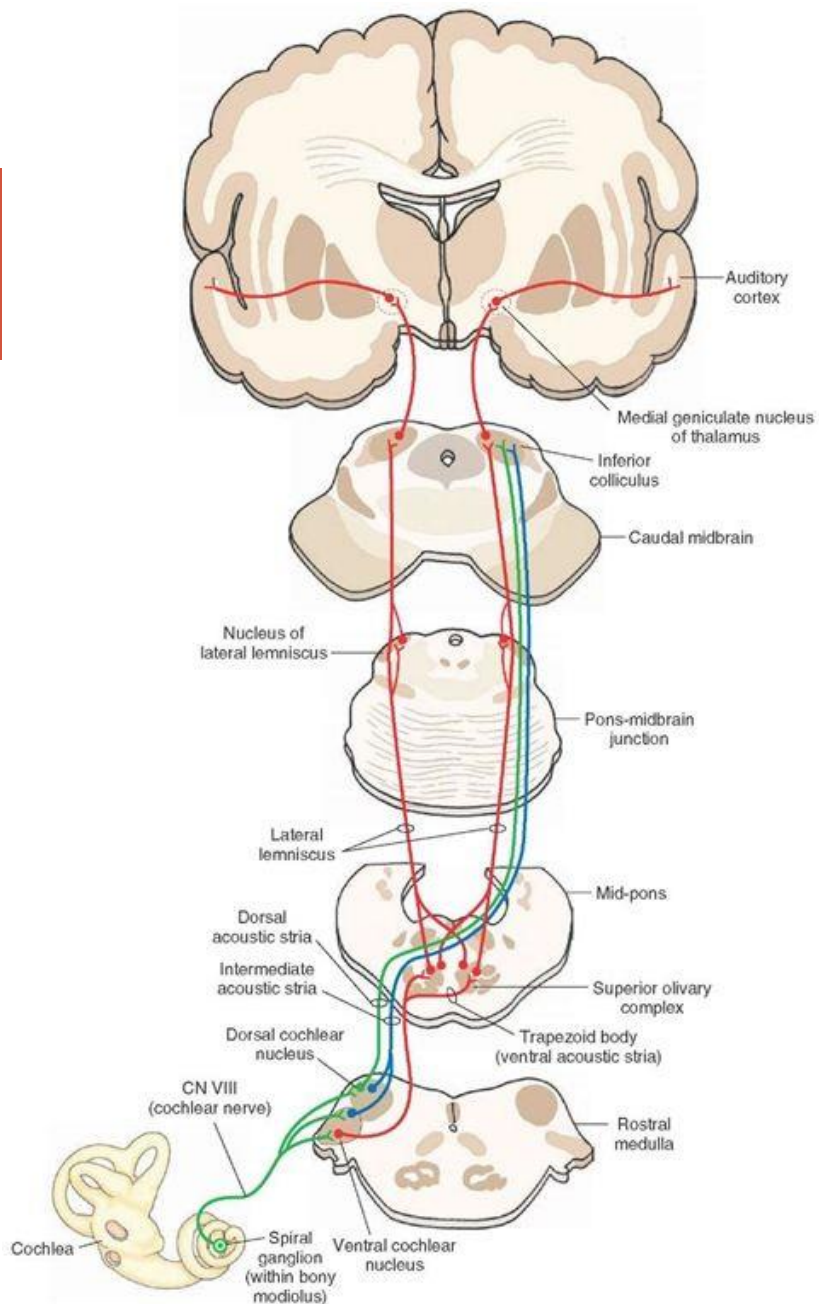
- The pressure differences travelling through the air 'hit' the tympanic membrane in the outer ear (the eardrum)



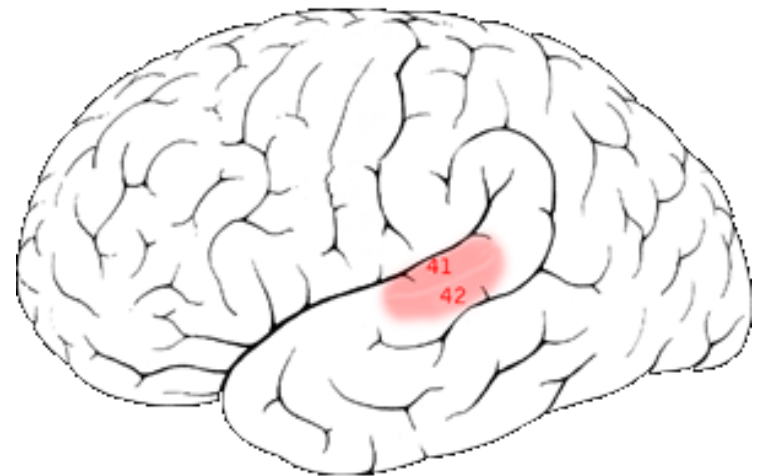
Human Perception of Sound

- The vibrating membrane at the oval window makes the fluid particles vibrate





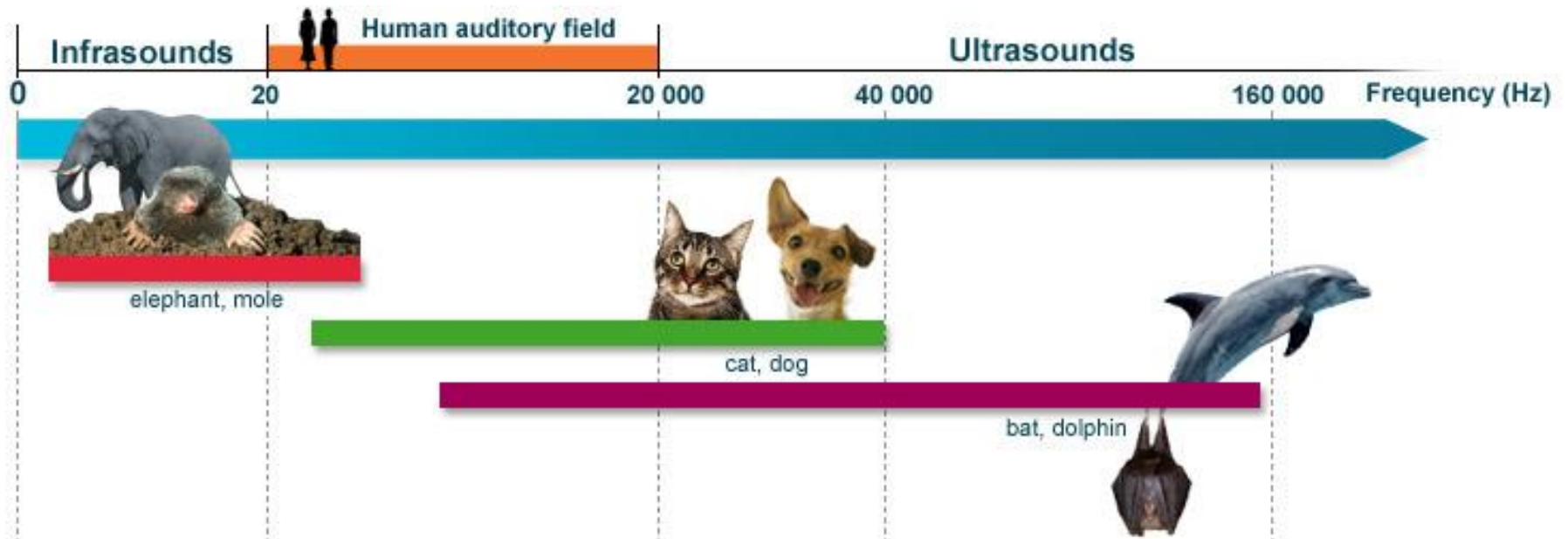
Primary auditory cortex



Audio Frequency

- ▣ Characterized as a periodic vibration whose frequency is audible to the average human
- ▣ The SI unit of audio frequency is the **Hertz** (Hz)
- ▣ The generally accepted standard range of audible frequencies is
 - ▣ 20 to 20,000 Hz
 - ▣ Really?

Auditory Field



Frequency Range of Human Hearing

Online Tone Generator

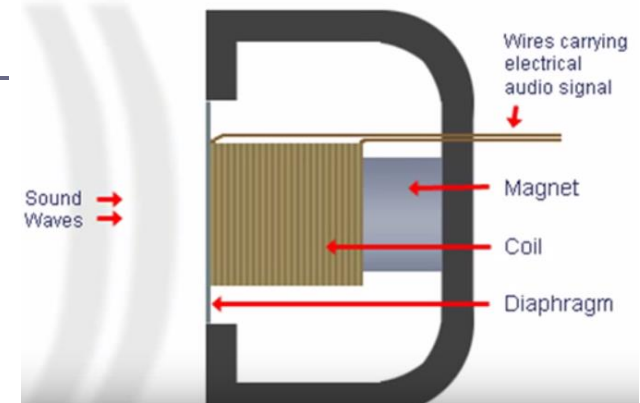
- <http://www.szynalski.com/tone-generator/>
- <http://onlinetonegenerator.com/>

Auditory vs. Microphone

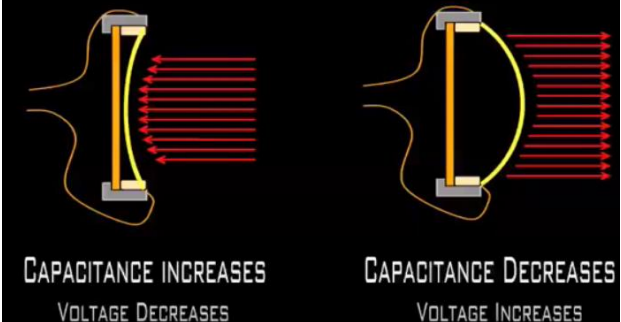
- Microphones are a type of **transducer** - energy from one form to another.
- Condenser and dynamic mic



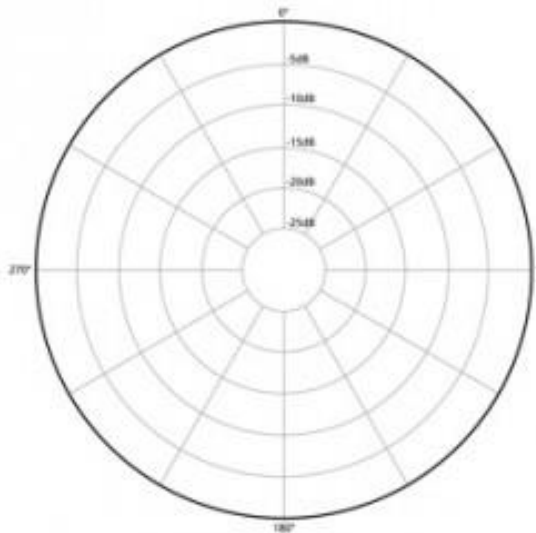
Cross-Section of Dynamic Microphone



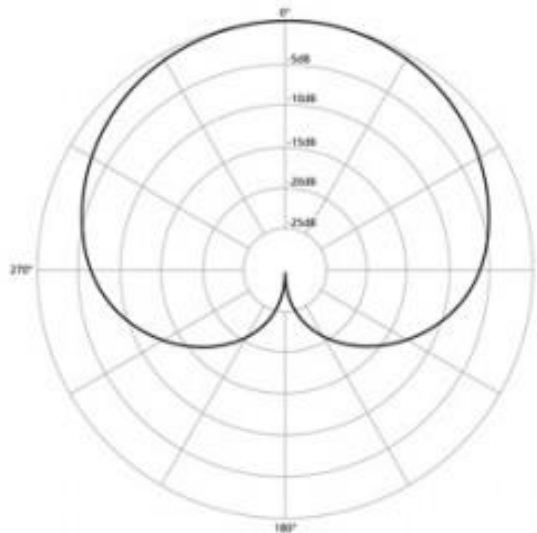
MICROPHONE THEORY CONDENSER



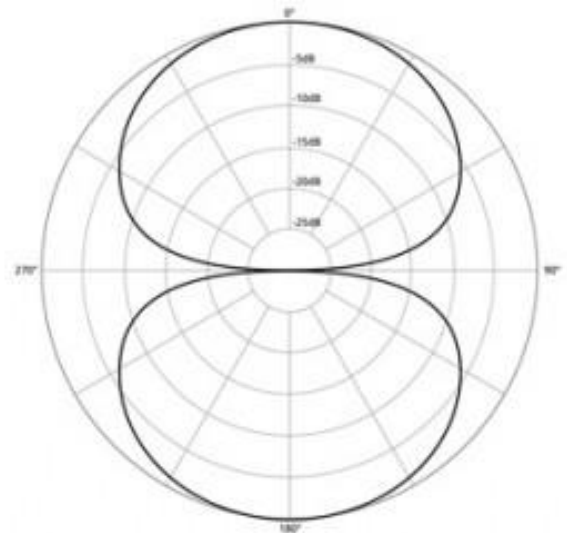
Types of Microphone



Omnidirectional



Unidirectional (Cardioid)

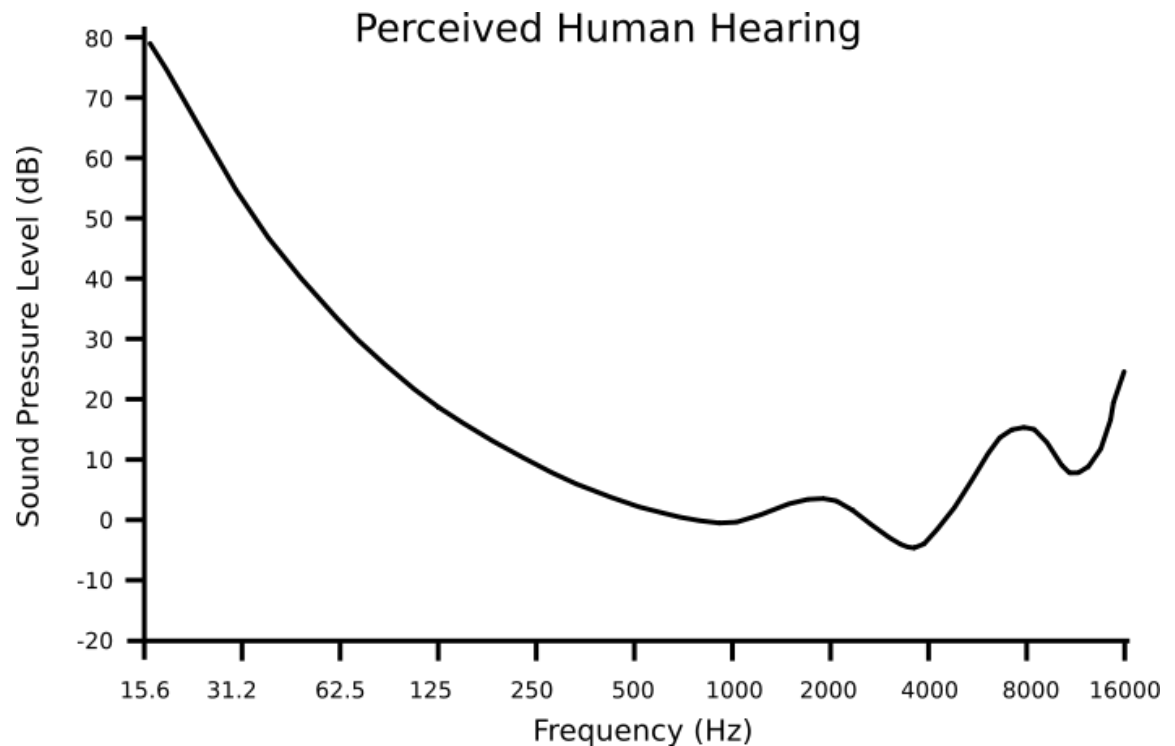


Bi-directional

The 3 main polar patterns

Absolute Threshold of Hearing (ATH)

- In fact the sound pressure level that is needed to hear sounds at equal loudness (a subjective measure) depends on the frequency of the sound



Sound Pressure Level Measurement

- The sound level was given in dB, short for decibel. This is a logarithmic scale that indicates the ratio between two audio power levels:

$$L = 20 \log_{10} \left(\frac{A_1}{A_2} \right) \text{ dB}$$

- actually **measured sound pressure level** of a given **sound**, A_1 , and A_2 is a reference value of $20 \mu\text{Pa}$, which corresponds to the lowest hearing threshold of the young, healthy ear.

Table of Sound Levels

Sound Levels	
Sound	AirSound Pressure Level (dB)
Jet engine at 30 m	150
Threshold of pain	130
Vuvuzela at 1 m	120
Hearing damage	120
Jet engine at 100 m	110-140
Busy traffic at 10 m	80-90
Hearing damage (long term exposure)	85
Passenger car at 10 m	60-80
TV at 1 m	60
Dishwasher	42-53
Normal conversation	40-60
Very calm room	20-30
Auditory threshold (at 1 kHz)	0

Sound Recording

- Sound is recorded using a microphone: a device that transforms the pressure variations in a medium into an electronic signal. This analog signal is digitized by quantization and sampling
- The number of samples per second for music is most often set at **44,000 Hz**.
- An audio CD sampling rate standard: **44.1 KHz**

Auditory-Based HCI Research

NAO Sound Tracker Demonstration

▣ https://www.youtube.com/watch?v=__wkJF4iHlbA

Human-Computer Interaction (HCI) Granular Synthesis and Localization of Sound

▣ <https://www.youtube.com/watch?v=ygDnvV7f7oA>