COGNITIVE ERGONOMICS

DR. ANKUR GUPTA
IIT BHUBANESWAR

SUMMARY OF PREVIOUS LECTURE

- **Introduction to cognitive ergonomics**
- **The Human Sensory System:**
  - **Vision**

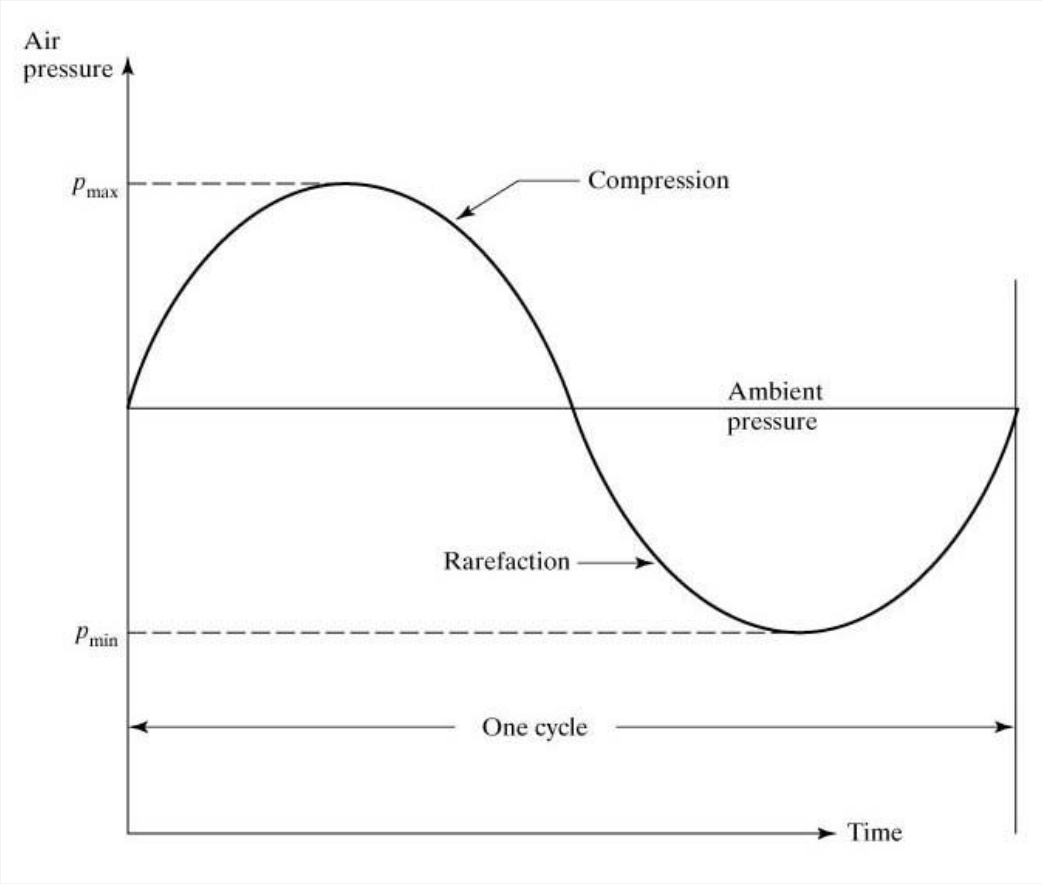
HEARING

HEARING

- Process of perceiving sound
  - The sensation is stimulated by acoustic waves - air pressure oscillations
- A simple sound-generating source produces a *pure tone*, which is characterized by two physical attributes:
  1. Frequency (Hz) - perceived as pitch
  2. Intensity (dB) - perceived as loudness

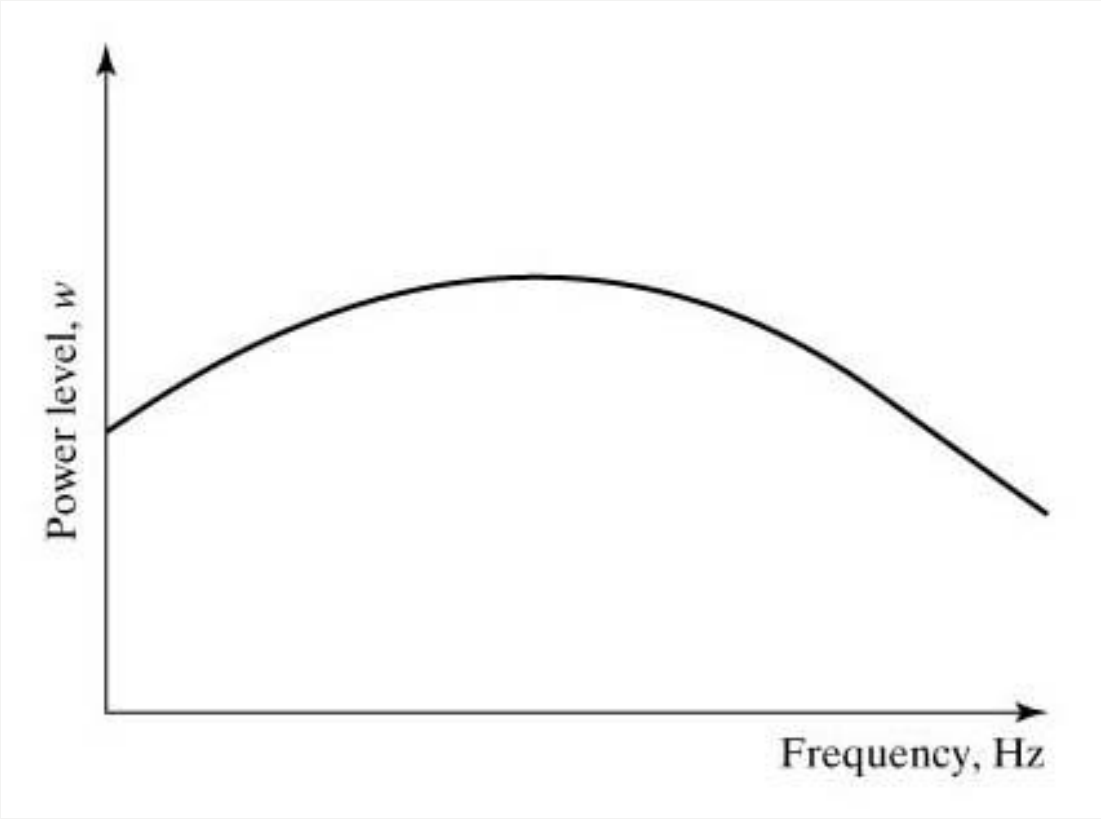
SOUND: A PURE TONE

Sinusoidal pressure oscillations of a simple sound-generating source



POWER SPECTRUM OF A SOUND

Continuous power spectrum of a sound consisting of multiple frequencies



SOUND INTENSITY

- Measured as pressure, e.g., N/m^2 or Pa
- However, range of sound pressures is very large (0.00002 N/m^2 to 20 N/m^2)
- Thus, intensity is converted to logarithmic scale, called sound pressure level (*SPL*) with units of decibel (dB):

$$SPL = 20 \log_{10}(p_s / p_r)$$

where p_s = sound pressure from source, N/m^2 , and p_r = reference sound pressure, N/m^2 (the usual reference pressure is 0.00002 N/m^2)

SOUND INTENSITY

- Sound intensity is measured from the listener's perspective
  - It is not a power measurement of the sound source
- Intensity of a sound wave varies inversely as the square of the distance from the source
  - Example: a person listening to someone talk at a distance of 15 cm (6 in) hears an intensity level of ~ 80 dB, while the same listener hears only ~ 65 dB at a distance of 100 cm (40 in)

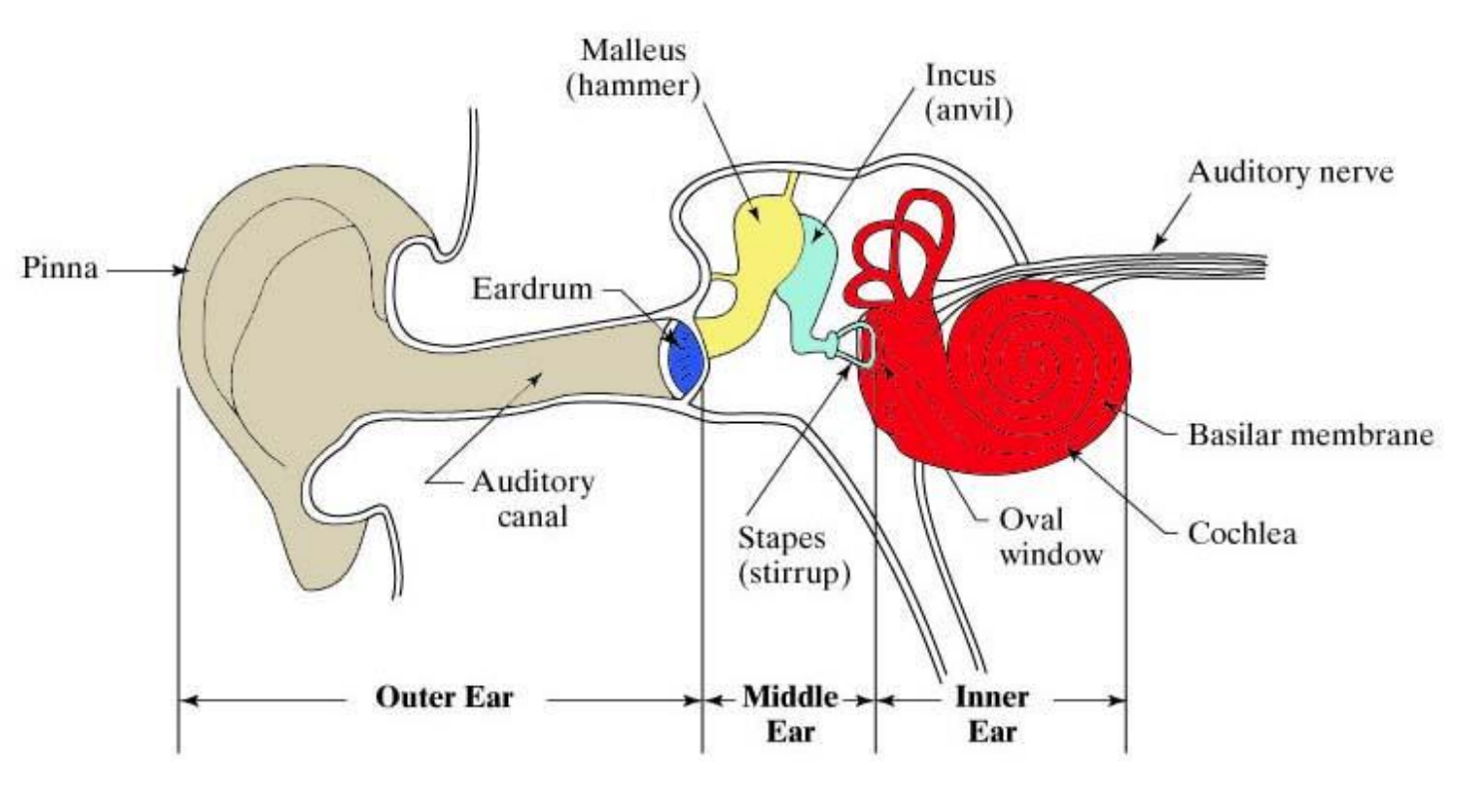
DB LEVEL OF VARIOUS SOUNDS

Threshold of hearing	0 dB
Soft whispering at 1 m (3 ft)	20 dB
Library environment	40 dB
Room air conditioner at 3 m (10 ft) 60 dB	
Talking at 15 cm (6 in)	80 dB
Powered lawnmower at 1 m (3 ft)	100 dB
Jet engine at 60 m (200 ft)	120 dB
Jet engine at 30 m (100 ft)	140 dB

THE EAR

- It's a transducer - it transforms mechanical energy of sound waves into electrical nerve signals that are transmitted to the brain for interpretation
- The ear consists of:
  - Outer ear - eardrum mechanically transmits sound vibration to middle ear
  - Middle ear - transmits and amplifies (20 times) vibrations to the inner ear
  - Inner ear - converts vibrations to neural impulses that are transmitted to brain

ANATOMY OF THE HUMAN EAR



AUDITORY PERFORMANCE

- Humans with normal hearing can perceive sound frequencies in the approximate range 20 Hz to 20,000 Hz when young
- Low frequencies (below ~ 300 Hz) are not heard as well as high frequencies (in the range 1000 Hz to 5000 Hz)
- The aging process takes its toll
  - Perception of high frequencies decreases with age
  - Normal hearing loss due to aging is called *presbycusis*

OTHER SENSERS

OTHER SENSORY RECEPTORS

- Tactile sense - sense of touch excited by receptors in the skin
  - More general term is *cutaneous sense*, which is stimulated by
    - Pressure
    - Temperature
    - Pain
- Olfactory sense - sense of smell due to receptors in each nostril that are stimulated by vapor molecules in the air
- Sense of taste

LECTURE CLOSING

A BRIEF HISTORY OF COGNITIVE PSYCHOLOGY & ERGONOMICS

18th CENTURY: THE BRITISH EMPIRICISTS

James Mill (1773-1836)

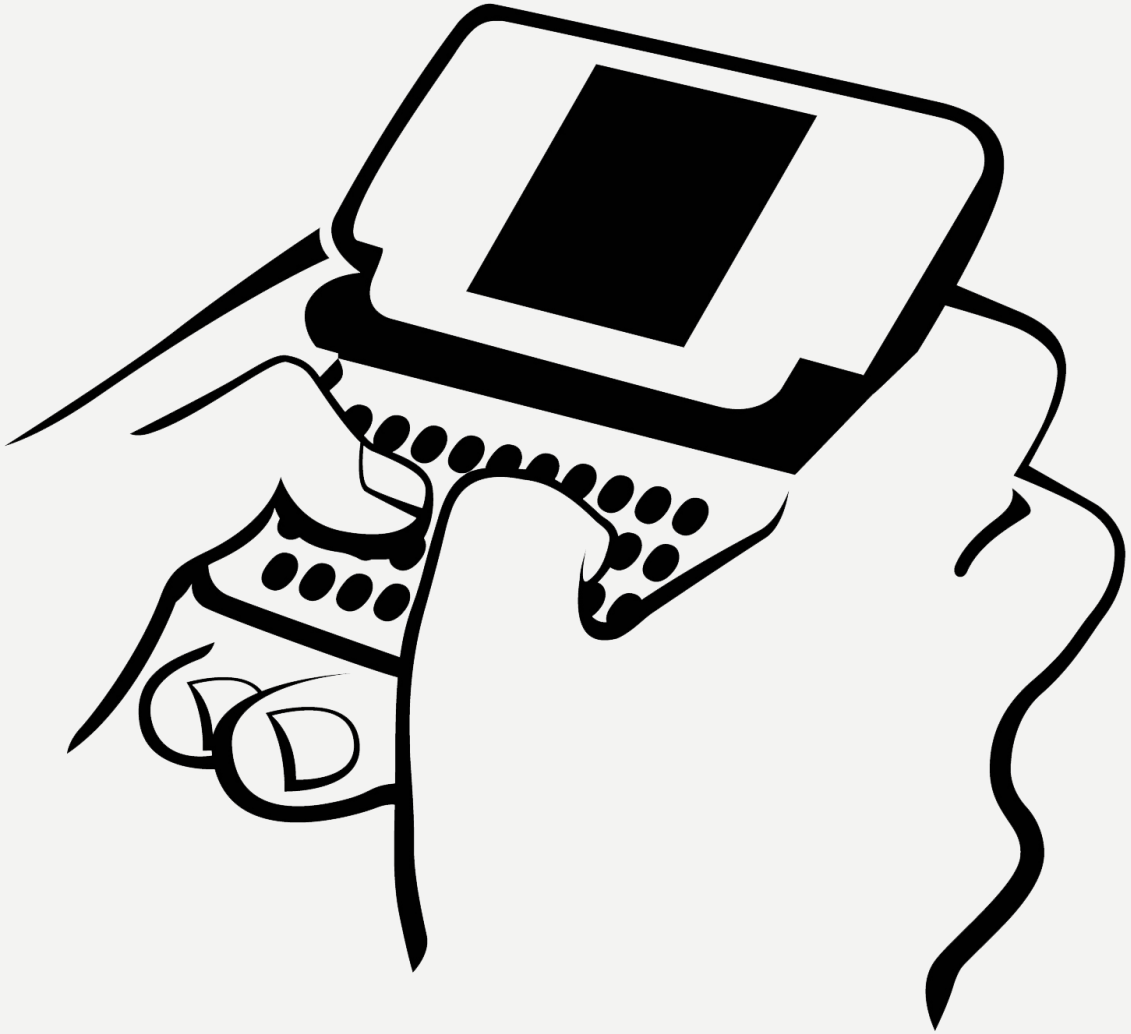
- James Mill believed that the human mind was totally passive. He felt that the mind was a machine functioning in the same way as a clock, acting upon external stimuli. His most important work and contribution to psychology is his book, "Analysis of the Phenomena of the Human Mind", written in 1829. Mill states that the mind must be studied through its reduction or analysis into elementary components. Mill believed that ideas and sensations are only certain kinds of mental processes. He felt that ideas result as a process of sensations that have occurred at the same time in a certain order. Thus, James Mill was considered a British empiricist, focusing on the primary role of sensation processes and the relationship between conscious processes and association. John Stuart Mill, who believed in Mental Chemistry, was the son of James Mill.

John Stuart Mill (1806-1873)

- John Stuart Mill was a British empiricist who was concerned with Associationism. Associationism studies how ideas can be hooked together and how many laws of association there should be. Mill believed the mind to be active, which is opposition to his father's belief that the mind was passive. He developed the idea of mental chemistry in which he believed the sum of two ideas compounded together is greater than the sum of the individual ideas. Along with Mill's research, he wrote several books which also influenced the work of James, Gestalt, and Wundt.

DID YOU KNOW……????

- human behavioral studies suggested that a person who loses their cell phone experiences a panic similar to a near death experience



GRAFFITI


© Randy Glasbergen
www.glasbergen.com
GLASBERGEN
"I bang my head against the wall several times a day. That's why I need ergonomic hair."

THANK YOU ….

PLEASE READ COGNITIVE ERGONOMICS FROM RECOMMENDED REFERENCE BOOKS FOR A BETTER UNDERSTANDING OF NEXT LECTURE