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Sensation and Perception

What is Sensation?

- **Sensation** = the process by which action potentials that originate from sensory neurons are delivered to the brain
- **Perception** = the process by which sense data is processed and interpretted by the brain
- **Bottom-Up** = term that describes how **sensation** occurs
  - Low-level processing occurs early on in the transmission
  - The more high-level, pattern-recognition processing is done in the brain
- **Top-Down** = term that describes how **perception** occurs
  - Tasks are centrally organized by the brain

Psychophysics

- **Psychophysics** = the study of physical stimuli and how it affects behavior and mental processes
- **Stimuli** = any information that can be detected and interpretted by the brain
  - Light
  - Sound waves
  - Temperature
  - Pressure
- Thresholds
  - **Absolute Threshold** = the amplitude a stimuli must exhibit to be detected **50%** of the time
  - **Difference Threshold** = the difference in amplitude two stimuli must exhibit for people to perceive a **just noticeable difference** between them
    - **Just Noticeable Difference(JND)** = the perception of a slight difference in magnitude of two stimuli

Signal Detection Theory

- **Signal Detection Theory** = a theory that attempts to explain how stimuli are reliably perceived in the presence of lots of background stimuli

  - People's likelihood of perceiving faint stimuli in noisy backgrounds depends on
    * Experience
    * Expectation
    * Motivation
    * Fatigue

- **Subliminal** = a term that describes stimuli that are lower in amplitude than the **absolute threshold** needed to reliably perceive them
- **Weber's Law** = a law that states that the **difference threshold** depends on which *type* of stimuli you test
  - Light intensity must vary by 8% to be noticeable
  - Weight must vary by 2% to be noticeable
  - Tone frequency must vary by 0.3%
- **Sensory Adaptation** = the increased threshold of perception that comes with repeated exposure to a certain stimuli
  - Rather similar to **habituation**
- **Transduction** = the transformation of one form of energy to another
  - *eg.* Electromagnetic waves turning into action potentials
  - **Sensation** is the process of transduction from various media to action potentials

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Vision

- **Accommodation** = the process of the lens contorting in order to focus the image on the **fovea**
- **Acuity** = the accuracy and sharpness of vision
  - Typically deteriorates with age
- **Nearsightedness** = a condition in which it is easier for objects near to the eyes to be seen
- **Farsightedness** = a condition in which it is easier for objects far from the eyes to be seen

Psychophysics of Vision

- **Hue** = basically the color that the light is
  - Determined by **frequency/wavelength**
- **Intensity** = amplitude of EM wave
  - Associated with how **bright** the color is
- **Wavelength** = distance between the crests of the wave
  - Larger wavelength is associated with lower frequency
- **Frequency** = the amount of oscillations the wave undergoes per second
  - Measured in Hertz(Hz)

Anatomy of the Eye

- **Cornea** = the outer protective layer that covers the eye
- **Pupil** opening of the eye that is adjustable in size when **iris** contracts or relaxes
  - Acts similar to camera shutter
    - If pupil is open, more light will make its way in
  - Pupil helps to adjust vision to changing light conditions
- **Iris** = a colored ring of muscle that contracts and relaxes to adjust the size of the pupil
- **Lens** = transparent structure that is behind the pupil that contorts to adjust the path of incoming light
  - Lens also inverts the image
    - We don't see the world as upside down because the brain flips the image
- **Retina** = a layer of light-sensitive cells that start an action potential if hit by certain kinds of light
  - **Rods** = detect the outline of shape
    - Cannot distinguish color
  - **Cones** = detect the color of objects
    - Cannot distinguish movement
  - **Transduction** = converting of electromagnetic energy into chemical potential energy
- **Fovea** = area of the **retina** that the lens focuses the image onto
  - Where all fine details are made out

- **Optic Nerve** = a bundle of nerve tissue that conveys action potentials from the retina to the brain
  - Causes a **blind spot**, because there are no **cones** or **rods** on the optic nerve
  - **Blind spot** = a area of the retina that cannot sense light
    * Caused by **optic nerve** and blood vessels

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Processing Visual Information

- **Ganglion Cells** = cells that connect to **bipolar cells**
  - Axon connects to **optic nerve**
- **Bipolar Cells** = neurons that connect **rods** and **cones** to the **ganglion cells**
- **Optic chiasm** = physical point when optic nerve splits into two distinct nerve tracks
  - Each track leads to one hemisphere
- Process
  1. Transduction occurs on the **cones** and **rods** and an action potential is generated
  2. **Bipolar cells** convey action potential to the **ganglion cells**
  3. **Optic nerve**, made of **ganglion axons**, conveys the action potential to the **optic chiasm**
  4. At the **optic chiasm**, information is segregated onto separate paths to each hemisphere
  5. Each path leads to the **thalmus**
  6. The thalmus directs the action potentials to **visual cortex**
- **Parallel processing** = the simultaneous processing of several different aspects of a problem congruently
  - The brain performs this on
    * Color
    * Motion
    * Form
    * Depth
- **Trichromatic Theory of Color Vision** = a theory that explains how humans see color

  - Researched by **Young** and **Helmholtz**
  - Relies on principle that there are *three* **primary colors**
    * They discovered that using red, green, and blue, they could generate all possible colors
    * They postulated that there are *three* corresponding photoreceptors
- **Opponent-Process Theory** = a theory that attempts to explain afterimage effects
  - Postulates *four* photorecptors
    * Red and green = opponents
    * Blue and yellow = opponents
  - Modern view of vision is a blend of **trichromatic theory** and **opponent-process theory**
- **Color constancy** = the phenomenon of the brain adjusting perception in different lighting conditions so that colors look the same
  - Color is fundamentally a psychological property, not a physical property

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Hearing

- **Audition** = the raw experience of hearing
- **Frequency** = number of oscillations of sound wave per second
  - Measured in **Hertz(Hz)**
  - Just like **frequency** in light
- **Pitch** = a tone's character of being high or low
  - Dependent upon frequency
- **Amplitude** = the magnitude of the sound wave
  - Described as the height of the wave crests
- **Decibel system** = a method of ranking sound amplitude
  - Is based on a *logarithmic* scale

Anatomy of the Ear

- **Outer Ear**
  - **Ear lobe**
  - **Auditory canal**
- **Middle Ear**
  - **Tympanic membrane**
    - Also called **eardrum**
  - Three bones
    - **Malleus(Hammer)**
    - **Incus(Anvil)**
    - **Stapes(Stirrup)**
  - **Semi-circular canals**
    - Also called **vestibular sacs**
- **Inner Ear**
  - **Cochlea**
    - Snail-shaped tube with ciliated **basilar membrane**
      - **Cilia** = cytoplasmic extensions that typically serve in motion but can also sense pressure changes
      - **Basilar membrane** = ciliated lining inside the **cochlea**
    - **Transduction** occurrs here
  - **Auditory nerve**
    - Attached to **cochlea**