Perception (PSY 4204) Christine L. Ruva, Ph.D.

INTRODUCTION TO VISION
Chapter 3

LIGHT: THE STIMULUS FOR VISION

- *Seeing involves a stimulus (**light**) and a mechanism (**visual system**).*
- *We see objects in the environment because light is reflected from these objects into the eye.*
- **Visible Light:** band of energy within the **electromagnetic spectrum** that humans can perceive.

LIGHT: THE STIMULUS FOR VISION

- **Electromagnetic Spectrum:** continuum of electromagnetic energy, which is energy produced by electric charges that are radiated as waves.
  - Visible spectrum for humans ranges from _____ nanometers
  - Most perceived light is _____
- **Wavelength:** the distance between the peaks of the electromagnetic waves and is associated with different _____ of the spectrum.

Visual Perception

- Although the sense of sight depends on light waves, for people to see, incoming visual input must be converted into neural impulses that are sent to the brain.

MAJOR DIVISIONS OF THE VISUAL SYSTEM

- **Visual receptors**: _____ which contain light sensitive chemicals called **_____.**
- The electrical signals flow through a network of neurons, which consist of 4 types of cells: **amacrine cells, bipolar cells, horizontal cells, and ganglion cells.**
- The **_____** of the **_____** form the **_____**, which conducts signals to the lateral geniculate nucleus (LGN).

MAJOR DIVISIONS OF THE VISUAL SYSTEM

- **Lateral Geniculate Nucleus (LGN) in the Thalamus**
- **Visual Receiving Area**: Also called the **Striate Cortex**.
- **Extrastriate Cortex**: includes areas in the temporal, parietal, and frontal lobes.

First Part of the Visual Process: Light is Reflected into the Eye and Focused on the Retina:

- **Cornea**: the transparent covering in the front of the eyes accounts for _____
- **Lens:** adjusts shape for object distance, accounts for the other _____
- **Accommodation:** results when ciliary muscles are tightened which causes the lens to thicken
  - Light rays pass through the lens more sharply and focus near objects on retina
- Near Point: is the distance at which your lens can _____ to bring close objects into focus.
- Presbyopia - _____
  - Distance of near point increases
  - Due to _____ and weakening of _____

TRANSFORMATIONS THAT OCCUR DURING THE FIRST PART OF THE VISUAL PROCESS

- **Distribution of Rods and Cones in the Retina:**
  - Fovea
  - Peripheral Retina
  - 120 million rods
  - 5 million cones
- **Paradox of the Visual System**: Rods and cones are located in the _____.
  They **face _____.**
  - receptors are in contact with a layer of cells called the pigment epithelium, which contains _____ that are vital to the receptors' functioning.

TRANSFORMATIONS THAT OCCUR DURING THE FIRST PART OF THE VISUAL PROCESS

- **Blind Spot**: area of the retina with _____
    - We are not usually aware of our blind spot because:
        - _____
        - _____
        - _____

- **Transduction of Light into Electricity:**
    - **Outer Segments**: The part of the receptors where light acts to create electricity. These contain the _____:
- **Opsin:** large protein
- **Retinal:** It reacts to light and is responsible for _____.
    - **Isomerization**: The visual pigment molecule changes _____ with this absorption of _____. Isomerizing one visual pigment molecule can cause a chemical effect that is large enough to activate the entire rod receptor.

Dark Adaptation of the Rods and Cones

- **Methods used to measure dark adaptation curve:**
    - **Light adapt the observer** by exposure to an _____.
    - **Measure the light-adapted sensitivity** by having the observer adjust the intensity of the test light so he/she can _____.
    - **Turn off the light**. This begins the process of dark adaptation.
    - **Measure the course of dark adaptation** by having the observer keep adjusting the intensity of the test light so it remains _____.
- **Dark-adaptation curve**: a plot of sensitivity versus the time in the dark, which shows the two-stage process of dark adaptation.

- **Dark adaptation occurs in 2 distinct stages**:
  - An initial rapid stage: Dark adaptation increases rapidly for the first _____ after the light is extinguished and then levels off.
  - A later slower stage: _____ after initiation of dark adaptation, sensitivity begins to increase further and continues to do so for another _____

Dark Adaptation of Cones

- **Method for Measuring Cone Adaptation**:
  - The observer looks directly at a test light so small that its entire image falls within the _____.

Dark Adaptation of the Rods

- **Method for Measuring Rod Adaptation**:
  - Use a _____
  - Both rods and cones begin gaining in sensitivity as soon as the lights are extinguished, but since the cones are more sensitive at the beginning of dark adaptation, they determine the early part of the dark-adaptation curve.
  - After about _____, the cones finish their adaptation
  - At about _____ after the beginning of dark adaptation the rods finally catch up to the cones and become more sensitive _____
  - Rods reach their maximum sensitivity by _____ minutes from the beginning of dark adaptation.

Dark Adaptation of the Rods and Cones

- **Visual Pigment Regeneration:**
  - **Pigment Bleaching**: The light sensitive _____ molecule separates from the larger _____ molecule during transduction and this separation cause the retina to become lighter in color.
  - **Pigment Regeneration**: Before the visual pigment can again change light energy into electrical energy, the _____.

Dark Adaptation of the Rods and Cones

- **Visual Pigment Regeneration:**
  - Cones pigment takes _____ to regenerate completely.
  - Rods take _____.
  - Relation between pigment regeneration and dark adaptation.

- **Spectral Sensitivity of the Rods and Cones:** an observer's sensitivity to light at each wavelength across the visible spectrum.

- **Rod and Cone Spectral Sensitivity Curves:**
  - **monochromatic light**: _____
  - **Cone Spectral Sensitivity**:
    - Measured by having people look directly at the test light, so that it stimulates only the _____.
    - Cones most sensitive at _____ wavelengths.
  - **Rod spectral sensitivity**:
    - Measured after the eye is dark adapted and presenting test flashes off to the side _____.
    - Short-wavelength light, that is, light nearer the blue and green end of the spectrum _____.

CONVERGENCE OF RODS AND CONES
NEURAL PROCESSING BY CONVERGENCE

- **Convergence:** more than one neuron synapses on another neuron. **126 million rods and cones** converge to **1 million ganglion cells**

- Because there are _____ rods in the retina and only _____ cones, rods must _____ more than cones.

- **foveal cone:** many have "_____" to ganglion cells – no convergence.

NEURAL PROCESSING BY CONVERGENCE

- The **greater convergence of the rods** compared to the cones translates into **2 differences:**
    - the rods are _____ in the dark than the cones.
    - the cones result in _____ than the rods.
- The rods are **more sensitive** in the dark than the cones. Why?
    - Greater _____ of the inputs of many rods into ganglion cells increasing the likelihood of response.
    - Rods take _____ to respond (2 vs. 10).
- The cones result in **better detail vision** than the rods. Why?
    - Direct lines = ability to _____
    - Trade-off is that cones need _____ to respond than rods.
    - Visual Acuity: Ability to detect that there are 2 spots of light.
- **The Cones Result in Better Visual Acuity than the Rods:**
- **Visual Acuity:** _____
    - Only all-cone _____ has good visual acuity.
    - The rod rich _____ can't see fineness of detail and that is why objects in the periphery appear blurry.
    - Rods **convergence** decreases their ability to resolve details.

LATERAL INHIBITION OF NEURONS

- **Lateral Inhibition:** is transmitted laterally, across the retina via the **horizontal** and **amacrine** cells.

Lateral Inhibition and Lightness Perception

- Three lightness perception phenomena explained by lateral inhibition
    - The **Hermann Grid**: Seeing spots at an intersection
    - **Mach Bands**: Seeing borders more sharply
    - **Simultaneous Contrast**: Seeing areas of different brightness due to adjacent areas

Hermann Grid

- People see an illusion of gray images in intersections of white areas.
- Signals from **bipolar cells** cause effect
  - Receptors stimulated by dark areas _____ the response of neighboring cells receiving input from white area.
  - The lateral inhibition causes a _____ which leads to the perception of gray images.

Simultaneous Contrast

- Our perception of the brightness or color of one area is affected by the presence of an adjacent or surrounding area.
- An area that is of the same physical intensity appears:
  - _____ when surrounded by a dark area
  - _____ when surrounded by a light area

Simultaneous Contrast & Lateral Inhibition Explanation

- Receptors stimulated by bright surrounding area send a large amount of inhibition to cells in center.
  - Resulting perception is of a darker area than when this stimulus is viewed alone.
- Receptors stimulated by dark surrounding area send a small amount of inhibition to cells in center.
  - Resulting perception is of a lighter area than when this stimulus viewed alone.
- Lateral inhibition cannot explain all of our perceptions of lightness and darkness.
- The biggest problem for lateral inhibition explanation of **simultaneous contrast** is posed by figures like the _____ and _____.
- **Benary Cross**
  - People see differing brightness of triangles even though lateral inhibition is equal
- **White's Illusion**
  - People see light and dark rectangle even though lateral inhibition would result in the opposite effect

- **Belongingness:** an area's appearance is influenced by which part of the surroundings to which it appears to belong.

- The mechanism behind many contrast effects appear **not** to be based in the retina, but _____ in processing, probably in the **_____.**

DISEASES THAT AFFECT THE RETINA

- **Macular degeneration**
  - Fovea and small surrounding area are destroyed
  - Creates a "blind spot" on retina
  - Most common in older individuals

- **Retinitis pigmentosa**
  - Genetic disease
  - Rods are destroyed first
  - Foveal cones can also be attacked
  - Severe cases result in complete blindness