Vision
Vision Basics

- Sensory receptors in our eyes transduce light into meaningful images

- Light = “packets” of waves

- **Measured in:**
  - *Brightness* – amplitude of wave (high=bright)
  - *Color* – length of wave
  - *Saturation* – purity of type of wave length
The Visible Spectrum of Electromagnetic Waves

• We can only see certain waves as light
  – Different wavelengths of visible light are seen as different colors

• Objects reflect certain wavelengths and absorb others
  – Objects that reflect all colors = white
  – Objects that absorb all colors = black
What is Light?
Anatomy of the Eye Worksheet

• Pg 105 of text
Figure 3.2 Structure of the Eye
Light enters the eye through the cornea and pupil. The iris controls the size of the pupil. From the pupil, light passes through the lens to the retina, where it is transformed into nerve impulses. The nerve impulses travel to the brain along the optic nerve.
Claire is pretty like fancy roses (red color)....but gets overrated.
Retina, Rods, and Cones

• **Retina**
  - Light sensitive area that houses our vision sensory receptors.....

• **Rods and Cones**
  - **Rods**: 100 million in each eye
    - Help with peripheral vision
    - Sensitive to brightness but not color – only see black and white
  - **Cones**: 6 million in each eye
    - All over retina but more at center
    - Work best in bright light
    - Responsible for color vision
Peripheral Vision and Color Demo

• **Rods** =
  – black/white
  – Peripheral

• **Cones** =
  – Color
  – Central focus
After Rods and Cones...

- Bipolar cells, Ganglion cells, Optic nerve, Thalamus
How the Eye Works
After the Eyeball...

• Neural Impulse goes from the optic nerve to the **occipital lobe** where feature detectors interpret the signals

• **Feature Detectors**
  – Groups of neurons in the occipital lobe that respond to different visual stimuli (like vertical lines, motion, curves, etc.)
  – Combination of these features helps us determine what it is we are seeing.
Parallel Processing

• Our brains process many features of what we are seeing at once (movement, form, depth, color, etc.)
Visual System, Simplified

Figure 18.10
A simplified summary of visual information processing

- **Scene**
- **Retinal processing:** Receptor rods and cones → bipolar cells → ganglion cells
- **Feature detection:** Brain's detector cells respond to specific features—edges, lines, and angles
- **Parallel processing:** Brain cell teams process combined information about motion, form, depth, color
- **Recognition:** Brain interprets the constructed image based on information from stored images
The Blind Spot

- Place where retina becomes optic nerve...no rods or cones here
Try this

- **Page 106** - Close your right eye and stare at the picture of the dog with your left eye. Slowly bring the book closer to your face. The picture of the cat will disappear at some point because the light from the picture of the cat is falling on your blind spot. If you cannot seem to find your blind spot, try moving the book more slowly.
Color Theories

- **Trichromatic Theory** *(Young-Helmholtz)*
  - Says we see color due to three types of cones
    - Blue, red, green (primary colors of light)
      - Cones are *optimally sensitive* to variations of those wavelengths
      - Activated in different combinations to produce all colors
Trichromatic Theory and T.V.
All color combos come from perception of combinations of RGB
**Color blindness** = lacking a chemical that produces specific color sensitivities in the cone. Most common is red-green color blindness (red or green cones aren’t “normal” so person confuses red and green...sex-linked recessive trait...males
Color Theories (cont.)

• **Opponent-Process Theory** *(Hering)*
  
  – *We never see certain colors together at the same time... (never a greenish red or yellowish-blue)... proposed that*

  – Sensory receptors are arranged in pairs:
    
    • Red/green
    • Yellow/blue
    • Black/white

  – When one color receptor is stimulated, its pair is inhibited from firing (happens in the ganglion cells behind the rods and cones)
Opponent Process Theory

Color Vision

response to wavelength

Young-Helmholtz
Trichromatic Theory

S  M  L
Blue  Green  Red

Opponent P
Why yellow if no yellow cone?

• Yellow is a primary color, meaning it is not composed of any other combined colors. So how can we see it if there is no cone for yellow?

• Yellow is the opposing pair of blue, so as long as the blue cone is active, the red and green cones cannot send signals to the brain that can be translated as yellow. However, when the blue cone is inactive, the red and green cones can receive yellow light (which has a medium-long wave length) and transmit that signal. But the minute blue comes back on, this is inhibited. You can only see blue or yellow in a single spot. They can be next to each other, but not overlapping or mixing. In a similar way, the balance of signals between all three cones produces the colors of black or white, but never both simultaneously. Thus, our three opposing pairs are red-green, blue-yellow, and black-white.
After Images

- Opponent-process theory proposes that as you stared at the red and blue shamrock, you were using the red and blue portions of the opponent-process cells. After a period of 60 to 90 seconds of continuous staring, you expended these cells' capacity to fire action potentials. In a sense, you temporarily "wore out" the red and blue portions of these cells. Then you looked at a blank sheet of white paper. Under normal conditions, the while light would excite all of the opponent-process cells. Recall that white light contains all colors of light. But, given the exhausted state of your opponent-process cells, only parts of them were capable of firing action potentials. In this example, the green and yellow parts of the cells were ready to fire. The light reflected off of the white paper could excite only the yellow and green parts of the cells, so you saw a green and yellow shamrock." (Ellen Pastorino & Susann Doyle-Portillo, *What Is Psychology? Essentials*, 2010)

- You can also see an example of negative afterimages at work in an interesting visual illusion in the negative photo illusion. In this illusion, your brain and visual system essentially create a negative of an already negative image, resulting in a realistic, full-color afterimage.
Figure 3.6 Color Afterimage
Stare at the white dot in the center of this oddly colored flag for about 30 seconds. Now look at a white piece of paper or a white wall. Notice that the colors are now the normal, expected colors of the American flag. They are also the primary colors that are opposites of the colors in the picture and provide evidence for the opponent-process theory of color vision.
Sensation in General... “Disorder”

- Synesthesia (video)
Synesthesia experience