Vision

Module 13

Vision

- The Stimulus Input: Light Energy
- The Eye
- Visual Information Processing
- Color Vision
Transduction

In sensation, transformation of stimulus energy into neural impulses.

*Phototransduction*: Conversion of light energy into neural impulses that brain can understand.

**OBJECTIVE 13-1**: Define transduction, and specify the form of energy our visual system converts into neural messages our brain can interpret.

The Stimulus Input: Light Energy

Light Characteristics

1. Wavelength (hue/color)
2. Intensity (brightness)
3. Saturation (purity)
Hue (color): dimension of color determined by wavelength of light.

Wavelength: the distance from the peak of one wave to the peak of the next.

Wavelength (Hue)

400 nm  700 nm
Short wavelengths  Long wavelengths

Different wavelengths of light result in different colors.

Intensity (Brightness)

Intensity: Amount of energy in a wave determined by amplitude; related to perceived brightness.
Intensity (Brightness)

Blue color with varying levels of intensity. As intensity increases or decreases, blue color looks more “washed out” or “darkened.”

Purity (Saturation)

Monochromatic light added to green and red make them less saturated.

Color Solid

Represents all three characteristics of light stimulus on this model.

http://www.colorconnection.org
OBJECTIVE 13-2: Describe the major structure of the eye, and explain how they guide the incoming ray of light toward the eye’s receptor cells.

**Parts of the eye**

1. **Cornea**: Transparent tissue where light enters the eye.
2. **Iris**: Muscle that expands and contracts to change the size of opening (pupil) for light.
3. **Lens**: Focuses the light rays on the retina.
4. **Retina**: Contains sensory receptors that process visual information and send it to the brain.

**The Lens**

- **Lens**: Transparent structure behind pupil that changes shape to focus images on the retina.
- **Accommodation**: The process by which the eye’s lens changes shape to help focus near or far objects on the retina.
The Lens

**Nearsightedness:** A condition in which nearby objects are seen more clearly than distant objects.

**Farsightedness:** A condition in which faraway objects are seen more clearly than near objects.

Retina

**Retina:** The light-sensitive inner surface of the eye, containing receptor rods and cones plus layers of other neurons (bipolar, ganglion cells) that process visual information.

Optic Nerve, Blind Spot & Fovea

**Optic nerve:** Carries neural impulses from the eye to the brain. **Blind Spot:** Point where optic nerve leaves the eye, because there are no receptor cells located here, it creates a blind spot. **Fovea:** Central point in the retina, around which the eye’s cones cluster.

OBJECTIVE 13-3 | Contrast the two types of receptor cells in the retina, and describe the retina’s reaction to light.
Test your Blind Spot

Use your textbook. Close your left eye, and with the right eye fixate on the black dot. Move the page towards and away from your eye. At some point the car on the right will disappear due to blind spot.

Photoreceptors

<table>
<thead>
<tr>
<th>Receptors in the Human Eye</th>
<th>Central</th>
<th>Peripheral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>6 million</td>
<td>200 million</td>
</tr>
<tr>
<td>Location in retina</td>
<td>Center</td>
<td>Periphery</td>
</tr>
<tr>
<td>Sensitivity in dim light</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Color sensitive?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pigment sensitive?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Bipolar & Ganglion Cells

Bipolar cells receive messages from photoreceptors and transmit them to ganglion cells, which form the optic nerve.
Visual Information Processing

Optic nerves connect to the thalamus in the middle of the brain, and the thalamus to the visual cortex.

---

Ganglion & Thalamic Cells

Retinal ganglion cells and thalamic neurons break down visual stimuli into small components and have receptive fields with center-surround organization.

---

Feature Detection

Nerve cells in the visual cortex respond to specific features, like edges, angle, and movement.

---

OBJECTIVE 13-4 | Discuss the different levels of processing that occur as information travels from the retina to the brain’s cortex.
Shape Detection

Specific combinations of temporal lobe activity occur as people look at shoes, faces, chairs and houses.

Perception in Brain

Our perceptions are a combination of sensory (bottom-up) and cognitive (top-down) processes.

Visual Information Processing

Processing of several aspects of the stimulus simultaneously is called parallel processing. The brain divides a visual scene into subdivisions such as color, depth, form and movement etc.

OBJECTIVE 13-5: Discuss parallel processing and discuss its role in visual processing.
Theories of Color Vision

**Trichromatic theory:** Based on behavioral experiments, Helmholtz suggested that retina should contain three receptors sensitive to red, blue and green colors.

If three primary colors (pigments) are mixed it results in subtraction of all wavelengths and the result is a black color.

**Subtractive color mixing**

OBJECTIVE 13-6! Explain how the Young-Helmholtz and opponent-process theories help us understand color vision.
Addition of Colors

If three primary colors (lights) are mixed the wavelengths are added and they result in white color.

Photoreceptors

MacNichol, Wald and Brown (1967) measured directly the absorption spectra of visual pigments of single cones obtained from the retinas of humans.

Color Blindness

Genetic disorder in which people are blind to green or red colors supports Trichromatic theory.
Opponent Colors

Gaze at the middle of the flag for about 30 seconds, when it disappears, stare at the dot and report if you see Britain’s flag.

Opponent Process Theory

Hering, proposed that we process four primary colors opposed in pairs of red-green, blue-yellow, and black-white.

Color Constancy

Color of an object remains the same under different illuminations. However, when context changes color of an object may look different.

OBJECTIVE 13-7 | Explain the importance of color constancy.