Sensory and Perceptual Processes

1. **Sensation**: The process of receiving stimuli or information.
   
   1. We receive these stimuli through our sense organs, the five senses.
   2. **Sensory Receptor Cells** - receive the stimuli from the environment and through transduction transfer it to nerve impulses to be processed in the brain.

2. **Perception**: The process of evaluating information and giving it meaning.

   1. We perceive using our cerebral cortex organizing information received from our 5 senses (Sensory Receptors)
   2. They are not always accurate - as in the example of an optical illusion

3. Perception and Sensation work together – sensory receptors and our brain to help us understand our world

   1. **Bottom-up processing** - starts at the sensory receptors and works up to higher levels of processing.
   2. **Top-down processing** - constructs perceptions from the sensory input by drawing on our experience and expectations.
4. Concepts that explain experience of Perception

1. **Transduction** - the process of converting one form of energy into another that your brain can use. Changing energy that is input from the five senses into neurological impulses, or action potentials that trigger other brain neurons in regions of the brain that ultimately result in perception and our understanding of that input.

2. **Threshold** - how much of a stimulus is necessary for a person to sense a stimuli at all is present.
   1. **Absolute Threshold** - the smallest amount of energy that will produce a sensation half (50%) of the time.
   2. **Difference Threshold or Just Noticeable Difference (JND)** - is the smallest change in sensation that will produce a noticeable change in sensation, it is defined as the difference between 2 stimuli that can be detected half the time in trials with subjects.
   3. **Weber's Law** - the larger or stronger the original stimulus, the larger the change required to notice that any thing has changed. Usually follows a proportional change of about 5% for the stimulus.

3. **Signal Detection Theory** - Detecting a weak stimulus, or signal, depends not only on the signal’s strength (such as a hearing-test tone) but also on our psychological state—our experience, expectations, motivation, and alertness. Signal detection theory predicts when we will detect weak signals (measured as our ratio of “hits” to “false alarms”).

4. **Subliminal Stimuli** - Stimuli you cannot detect 50 percent of the time are subliminal below your absolute threshold. Under certain conditions, you can be affected by stimuli so weak that you don’t consciously notice them.
5. **Priming** – Initial stimuli can “prime” your response and perception of that stimuli.

6. **Perceptual Set** - a set of mental tendencies and assumptions that affects (top -down) what we hear, taste, feel, and see. Priming creates a perceptual set that influences what we perceive a stimuli to be, especially effective if that stimuli is ambiguous.

7. **Sensory Adaptation** - diminished sensitivity as a consequence of constant stimulation.

5. **Electromagnetic Radiation**

1. **Light** - Enables vision, light is in the form of a wave of energy
2. Light has 2 characteristics - wavelength (frequency) and amplitude (intensity).
   1. **Wavelength** (Hue or Color) is measured in nanometers \(1/1,000,000,000\) of mm (one billionth)
   2. We see only 1/64 of all available frequencies or colors.
   3. Light containing all wavelengths detectable by the eye we call **white light**.

6. **The Spectrum of all wavelengths of electromagnetic energy:**

<table>
<thead>
<tr>
<th>Gamma</th>
<th>X Ray</th>
<th>UV</th>
<th>Visible Light</th>
<th>Infrared</th>
<th>Microwaves</th>
<th>Radar</th>
<th>Radio</th>
<th>UHF</th>
<th>Broadcasts</th>
</tr>
</thead>
</table>

1. **The Eye**

1. **Cornea** - clear covering, (close eye & feel as move eye, look at a neighbors from the side)
2. **Sclera** - the whites of their eyes
3. **Iris** - A sphincter muscle
   1. Controls pupil size
   2. Colored by melanin (a pigment) it is influenced by heredity and tends to respond to emotions.
4. **Pupil** - the opening, not really a structure or tissue but the opening in the Iris. You may see changes in the Iris with a beam of light that constricts the pupil
5. **Lens and Ciliary Muscle** - provides focus of the image on the retina
   1. The Lens changes shape to focus light, a convex bulge to focus close
   2. The Lens flattens concavely to focus on distant objects
6. **Nearsighted (Myopic)** - Due to shape of eyeball, it is a longer distance between lens and retina than in a normal eye, light converges in front of retina
7. **Farsighted (Amblyopia)** - Due to a shorter eyeball than normal, light lacks space to coverage properly
8. **Accommodation** - process used to focus, becomes more difficult and takes longer with age as we lose elasticity of the lens
9. **Vitreous Humor** - fluid in the eye, its in this that we see "floaters" - those dots we see sometimes in our field a vision if we look at area of single color, like perhaps a sky while resting on the grass..
10. **Retina** (Latin for net) - the film of the eye so to speak, where vision begins, it contains rods and cones that respond to a small amount of energy, the smallest cell is about 1 micron
   1. **Rods** (125 million) & **Cones** (8 million)
   2. **Fovea** - the point where there is a concentration of only cones, the point of best vision (100,000) cones are packed into fovea
   3. **Blind Spot** - actually it is only the optic nerve or where the nerves leave the retina, there are no rods or cones only the nerve cells so there is no vision at this point in the field of vision

2. **Rods & Cones**
   1. **Rhodopsin** and **Iodopsin**, are chemicals in the rods and cones that react to light, the chemical is bleached by light striking the cell. This starts a chemical reaction that is converted to an electrical impulse that is sent via the optic nerve to the occipital area of brain to be processed.
   2. **Rods** - contain rhodopsin, breaks down in light, if it happens at a rate faster than it can be created and replaced, the result is what we experience as night blindness
      1. Rods contain Visual purple that is sensitive to Vitamin A
      2. Rods are connected to bipolar neurons, these reduce the needed threshold level to fire making them more sensitive to lower levels of light
      3. **Night vision** - or sensitivity to blue, black & white hues, is located on the peripheral of the retina (high concentration of rods) it allows us to see better at night (100 times more sensitive than cone vision)
      4. Although better at noticing objects at night, this vision has less acuity (sharpness) than vision using the cones.
   3. **Cones** - Contain the chemical iodopsin
      1. Connected usually only to one bipolar neuron, provides for maximum acuity (sharpness)
      2. **Day vision** - We experience greater acuity and better color perception when using the cones. We call it day vision because the cones require higher levels of light than rods. Cones tend to be located toward the center of the retina
4. **Feature Detectors.** These specialized neurons in the occipital lobe’s visual cortex receive information from individual ganglion cells in the retina. They respond to very specific properties of visual stimuli.

3. **Adaptation** of the Eye to light levels

1. **Dark adaptation** - The chemicals in the rods and cones adapt or change concentration to allow them to increase sensitivity to reduced amounts of environmental light
   1. The Cones react in about 10 minutes by increasing the amount of Iodopsin
   2. Rods take about 30 minutes to fully adjust, increasing one's low light vision even more.
   3. The effects of adaptation are because of the original decrease in chemical storage in the cells from the bright environment we were in before we entered a darker area, time is needed to increase the amount of the chemical in the rods and cones, this is the process of dark adaptation

2. **Light Adaptation** - Is the opposite reaction, excess amounts of the chemical make our rods and cones oversensitive to normal levels of light until they re-adjust, reducing concentrations to normal amounts

3. **Afterimages** - Those little illusions we see when we look at the intersection of black squares. The illusions are our attempt to balance the changes in stimulus. It is a function of constant dark or light adaptation

4. **How light become "sight":** Not automatic but a complex higher order process.

   1. Light hits the receptor cells that are linked together with **interneurons.** They also connect the bipolar neurons. The bipolar cells connect with the axons of **ganglion Cells and form the optic nerve,** and through chemical and electrical processes is carried to part of the thalamus.
      1. Magnocelluar Cells (M)-large, 100,000 cells or so. Code information about motion, shadow, distance and depth. Work in dim light.
      2. Parvocellular Cells (P) - smaller, code information about color, fine lines, texture, shape and form, work in bright light.

   2. The impulse is processed further by others parts of the brain and is relayed to the Primary Visual Area of the Occipital lobe. It is here where seeing begins, later it is interpreted by the association areas of the brain giving us the rich experience of vision.

   3. The brain organizes these spots, lines, motions and contours into more complex images in these association areas. One area is the Temporal Lobe:
      1. Temporal Lobe- Visual information is interpreted as recognizable objects.
      2. "Visual Agnosia" is a condition where this area is damaged and you cannot say what you see even though you recognize what you see.

5. **Eye Movement**
1. Due to 3 pairs of muscles
   1. Up and down motion
   2. Left and right motion
   3. And rotation.
2. Fixation movements
   1. Eyes are stopping to focus otherwise we would soon see a blur if they did not move. REM sleep (dreaming) demonstrates this movement even though the eyelids are closed
3. **Saccadic** eye movement
   1. Movement of image across the fovea, it allows replenishment of images, use X & Y cells in the brain, the Y cells being much quicker aiding in the recognition of objects. Anytime we stare at an image our cells fatigue and cannot fire, we lose the definition of that stimuli and our vision blurs or fades. The eye always scans a scene to refresh these receptor cells keeping vision sharp.

6. **Color Vision**

1. **Young-Helmhotz Tri-Chromatic Theory**
   1. Thomas Young discovered that 3 primary colors when mixed create all colors of spectrum.-- red, green and blue. (B & W vision comes from the rods).
   2. Helmholtz suggested the eye contains cones which are also sensitive to these colors, and thus might mix impulses to give us color vision. He hypothesized that if cones had these pigments, red, green, blue, we could see all shades of colors, recently scientists have found three such cones.

2. **Herings Opponent Process Theory**
   1. Hering suggested that cones were actually a pairing of yellow-blue, red-green and black-white sensitive cells
   2. Suggests 2 pairs of colors, red/green and yellow/blue are linked in the brain to form "**opponent systems.**" The response takes place in the Thalamus
   3. For example, some of the cells are excited by red and inhibited by green, others excited by green and inhibited by red.
   4. Other cells are excited by yellow and inhibited by blue, others are excited by blue and inhibited by yellow.
   5. Each pair requires an opposite kind of response in the neurons that produce the color. For example increased activity in the certain neurons of the pair (red/green) produce the experience or red, while a decrease in the activity of the **same** neuron produces the experience of green.

7. **Color Blindness**

1. **Monochromatic**- no color vision at all, only have rods and lack cones for color vision
2. **Dichromatic**- have deficiency in one of the cone pairs, unable to distinguish R from G, or Y from B
8. **Mechanisms of Perception**

1. **Gestalt Principles** - people tend to organize stimuli or sensations into what we call a Gestalt, a German word meaning a “form” or a “whole.” We use different Gestals or principles to assign meaning to the stimuli.

2. **Figure/Ground**
   1. What we see is the results of the eye and the mind working together
   2. Visual perception is based on a hierarchy; it includes elements of personal meaning, intensity, our habits, symbolic content, and assumptions we make

Some applications:
3. **Depth Perception**
   1. Cues that work with only **1 eye**:
      1. **Texture Gradient**
      2. **Linear Perspective**
      3. **Shadowing**
      4. Superposition or **Interposition**- placement of objects in front or behind others to give clues of depth
      5. **Aerial Perspective**
      6. Motion Parallax, or Speed- relationship of speed to distance
      7. **Accommodation**
   2. Cues that work with **2 eyes**:
      1. **Convergence** - As objects become closer the eyes must bend inward. This causes accommodation and changes in the lens to change focal length and give the brain a clue about distance
      2. **Binocular Disparity** or Stereoscopic Vision- Two perspectives from two eyes (viewmaster or stereopticon)
4. **Illusions**- REMEMBER ILLUSIONS ARE MISPERCEPTIONS, we are fooled by the cues. Here are some additional principles that affect us in everyday life

1. **Critical Fusion Frequency** - We need a minimum frequency to perceive motion as continuous. A movie is really a series of independent slides presented continuously. If the frequency drops below the minimal threshold level we no long perceive the motion as continuous, for example, notice the flicker of old films or burned out fluorescent lights

2. **Phi Phenomenon** - Is the name for the illusion of continuous motions we see in animations, the motion is actually from a series of still frames (cartoons, movies)

3. **Persistence of Vision** - the reason we can see through fan blades when turning, we fill in the field of vision from what we do see in little bits and form a complete field of view even though the field of vision is disrupted.
5. Autokinetic movement - illusion of movement of a stationary spot in a dark room after trying focus on it for a period of time

9. **Gestalt Principles** - Gestaltists believe the whole is greater than the sum of the parts. In other words we really perceive more that what our eyes actually are seeing. Our brains fill in the rest of the meaning for us.

1. **Figure Ground** - In order to perceive an object correctly our brains must distinguish between an object and its background. Our perception is based on this decision. If however, as with reversing figures, the chalice and profiles example in the text, we cannot really determine what we see and perceive that it could be understood as both. Once you can see that either could be the background or foreground your perception keeps changing.

2. **Similarity** - we group things that are similar by color, shape, etc. into a single unit and see them as belonging together or similar.

3. **Proximity** - we perceive things as a unit depending on the relative distance between them.

4. **Continuity** - We group things into a single unit if they appear to form a continuous pattern.

5. **Closure** - We tend to complete the missing elements of an object as we perceive it filling in what we expect to be there.

6. **Simplicity** - We choose the simplest explanation for any object or stimulus that we observe.
10. **Perceptual Constancy**

1. **Color Constancy** - color doesn't change under differing lighting conditions or brightness
   1. Retinex theory - From Land (same as the camera), states that the cones and cortex work together to give us the perception of the constancy of color, red is red regardless of where we eat the apple.
   2. You and I see color thanks to our brain’s computations of the light reflected by an object relative to the objects surrounding it.

2. **Size Constancy**
   1. A change in the size of the retinal image is not perceived as a change in size of the object, only its distance from us or another object
   2. Depends on perceptual cues
   3. Illusions trick the brain to make errors (as in the Ames room illusion)
   4. Context effects illusions
   5. Form or Shape Constancy - we expect objects to look some way, i.e. a cube, a rectangle for a door, etc. So we see it that way, always

3. **Shape Constancy** - we perceive the form of familiar objects, such as the door as constant even while our retina receive changing images of them.
4. **Brightness Constancy**
   1. Apparent brightness stays the same under changing illumination
      1. Coal in basement or in sun
      2. Same for white and for other colors

---

**Key Study Terms**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensation</td>
<td>Sensation is the process by which our sense receptors and nervous system receive stimulus energies from our environment.</td>
</tr>
<tr>
<td>Perception</td>
<td>Perception is the process by which the brain selects, organizes, and interprets sensory information.</td>
</tr>
<tr>
<td>Absolute Threshold</td>
<td>The absolute threshold is the minimum stimulation needed to detect a particular stimulus 50 percent of the time.</td>
</tr>
<tr>
<td>Subliminal</td>
<td>A stimulus that is subliminal is one that is below the threshold for conscious awareness. Limen is the Latin word for &quot;threshold.&quot; A stimulus that is subliminal is one that is sub- (&quot;below&quot;) the limen, or threshold.</td>
</tr>
<tr>
<td>Difference Threshold (JND)</td>
<td>The difference threshold, or just noticeable difference (JND), is the minimum difference in two stimuli that a subject can detect 50 percent of the time. For example; how many degrees of a rise in temperature is needed before a person notices the temperature has changed?</td>
</tr>
<tr>
<td>Weber's Law</td>
<td>Weber's law states that the just noticeable difference between two stimuli is a constant minimum proportion. (At least 5% of the original stimulus, less and you wouldn't notice)</td>
</tr>
<tr>
<td>Sensory Adaptation</td>
<td>Sensory adaptation refers to the decreased sensitivity that occurs with continued exposure to an unchanging stimulus. Example: When she entered the movie theater she could barely see well enough to find an open seat. If few moments she was able to see everyone in the theater -</td>
</tr>
<tr>
<td><strong>Sensory Adaptation</strong></td>
<td>Sensory adaptation had taken place.</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td><strong>Wavelength (Hue)</strong></td>
<td>In vision, the wavelength of light refers to the distance from the peak of one light wave to the next. It gives one the perceptual experience of hue, or color. Example: The visible spectrum consists of electromagnetic radiation ranging between wavelengths of about 350 and 750 nanometers.</td>
</tr>
<tr>
<td><strong>Pupil</strong></td>
<td>The pupil is the adjustable opening in the center of the eye through which light enters.</td>
</tr>
<tr>
<td><strong>Iris</strong></td>
<td>The iris is the ring of muscle tissue that forms the colored part of the eye and controls the size of the pupil.</td>
</tr>
<tr>
<td><strong>Lens</strong></td>
<td>The lens is the transparent structure of the eye behind the pupil that changes shape to focus images on the retina.</td>
</tr>
<tr>
<td><strong>Accommodation</strong></td>
<td>Accommodation is the process by which the lens of the eye changes shape to focus near objects on the retina. To accommodate is to change in order to adapt to a new experience. The lens of the eye accommodates its shape in order to focus objects at varying distances. As we age we loose lens flexibility and we cannot squeeze the lens as we once did while reading, we then require reading glasses to help us focus at close distances.</td>
</tr>
<tr>
<td><strong>Retina</strong></td>
<td>The retina is the light-sensitive, multilayered inner surface of the eye that contains the rods and cones, as well as neurons that form the beginning of the optic nerve.</td>
</tr>
<tr>
<td><strong>Rods and Cones</strong></td>
<td>The rods and cones are visual receptors that transform light into neural impulses. The rods have poor sensitivity; detect black, white, and gray; and function well in dim light. The cones have excellent sensitivity; enable color vision; and function best in daylight or bright light. Interestingly we have learned much from animal studies as nocturnal animals possess only rods, and diurnal animals possess only cones.</td>
</tr>
<tr>
<td><strong>Optic Nerve</strong></td>
<td>Comprised of the axons of retinal ganglion cells, the optic nerve carries neural impulses from the eye to the brain. At the optic chiasm, half of the optic nerve fibers from each eye cross over to the opposite side, so information from the left and right visual fields projects directly to the right and left sides of the brain, respectively. (Sound familiar? Split brain research chapter 2)</td>
</tr>
<tr>
<td><strong>Blind Spot</strong></td>
<td>The blind spot is the region of the retina where the optic nerve leaves the eye. Because there are no rods or cones in this area, this is a spot where the eye is visually insensitive. The fact that we are unaware of our blind spots indicates that the brain must perceptually &quot;fill in&quot; the missing visual detail.</td>
</tr>
<tr>
<td><strong>Young-Helmholtz</strong></td>
<td>The Young-Helmholtz <strong>trichromatic</strong> (three-color) theory maintains that the retina contains red, green, and blue sensitive color receptors that in combination can produce the perception of any color. This theory explains the first stage of color processing.</td>
</tr>
<tr>
<td><strong>Opponent-process</strong></td>
<td>The <strong>opponent-process</strong> theory maintains that color vision depends on pairs of <strong>opposing</strong> retinal processes (red-green, yellow-blue, and white-black). This theory explains the second stage of color processing.</td>
</tr>
</tbody>
</table>
| **Color Constancy**    | Color constancy is the perception that **familiar objects** have **consistent**
<table>
<thead>
<tr>
<th><strong>color</strong> despite changes in illumination that shift the wavelengths they reflect. (Remember our red apple discussion?)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audition</strong></td>
</tr>
<tr>
<td><strong>Gestalt</strong></td>
</tr>
<tr>
<td><strong>Figure-ground Relationship</strong></td>
</tr>
<tr>
<td><strong>Grouping</strong></td>
</tr>
<tr>
<td><strong>Proximity</strong></td>
</tr>
<tr>
<td><strong>Similarity</strong></td>
</tr>
<tr>
<td><strong>Continuity</strong></td>
</tr>
<tr>
<td><strong>Closure</strong></td>
</tr>
<tr>
<td><strong>Depth Perception</strong></td>
</tr>
<tr>
<td><strong>Binocular Cues</strong></td>
</tr>
<tr>
<td><strong>Monocular Cues</strong></td>
</tr>
<tr>
<td><strong>Retinal Disparity</strong></td>
</tr>
<tr>
<td><strong>Convergence</strong></td>
</tr>
<tr>
<td><strong>Relative Size</strong></td>
</tr>
<tr>
<td>Term</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td><strong>Interposition</strong></td>
</tr>
<tr>
<td><strong>Linear Perspective</strong></td>
</tr>
<tr>
<td><strong>Perceptual Constancy</strong></td>
</tr>
<tr>
<td><strong>Extrasensory Perception (Esp)</strong></td>
</tr>
<tr>
<td><strong>Parapsychology</strong></td>
</tr>
</tbody>
</table>