Andrew Rosen

**The Origins of Knowledge:**

- **Empiricism** – Our senses are passive, founded by John Locke
  - At birth, human mind is a blank tablet (tabula rasa) on which experience leaves its mark

- **Distal stimulus** – An object or event in the outside world

- **Proximal stimulus** – The energies from the outside world that directly reach our sense organs

- George Berkeley stated that a large object that’s far away from us can cast the same image size as a small object closer
  - Retina is a 2d surface that cannot inform us directly about three dimensions

- Empiricists respond to Berkeley through the process of *learning*
  - Experience has taught us how to interpret 2d proximal stimuli
  - Eg: Distance cues in paintings can cause people to walk into them

- Other philosophers feel that the perceiver must categorize and interpret the incoming sensory information
  - Developed by Immanuel Kant
  - Mind organizes sensory information into certain preexisting categories
  - Innate grasp for certain spatial and temporal (time) relationships as well as cause-effect relationships
    - Known as “Forms of Apperception”

- **Psychophysics** – An approach to perception that relates the characteristics of physical stimuli to the sensory experiences they produce

- **Absolute Threshold** – The smallest quantity of a stimulus that an individual can detect

- **Difference Threshold** – The smallest amount that a given stimulus must be increased or decreased so that an individual can detect the difference

- **Just-Noticeable Difference (JND)** – The smallest difference that an organism can reliably detect between two stimuli

- Difference thresholds rely on proportionality differences and not absolute differences
  - Eg: You may notice a 2% weight difference. You’d feel the difference between 25 pounds and 25.5 pounds but not 50 pounds and 50.5 pounds

- **Weber’s Law** – The observation that the size of the difference threshold is proportional to the intensity of the standard stimulus
  - \[ \frac{\Delta I}{I} = c \]
    - \( I \) is the intensity of the standard stimulus
    - \( \Delta I \) is the amount that must be added to this intensity to produce a JND
    - \( c \) is a constant
    - \[ \frac{\Delta I}{I} = \text{Weber’s Function} \]

- **Fechner’s Law** – The observation that the strength of a sensation is proportional to the logarithm of physical stimulus intensity
  - \[ S = k \log l \]
    - \( S \) is the psychological magnitude (subjective)
    - \( l \) is the physical intensity of the stimulus
    - \( k \) is a constant whose value depends on the Weber fraction
    - Pain does not follow Fechner’s Law

**Vision:**

- Reflected light launches vision

- Light can vary in amplitude (brightness) or frequency/wavelength (color)

- We can only see light between 360 and 750 nanometers (visible spectrum)

- **Photoreceptors** – A light-sensitive cell located on the retina that converts light energy into neural impulses

- **Retina Image** – The image of an object that is projected on the retina. Its size increases with the size of that object and decreases with the object’s distance from the eye

- Iris - Smooth, circular muscle surrounding pupillary opening that dilate or contract to control how much light enters

- Cornea and lens focus incoming light
  - Cornea has a fixed shape that bends light
  - Lens fine-tunes light with ligaments that have an outward pull, causing the lens to flatten to focus far-away objects
  - To focus nearby objects, contractions in the ligaments allow the lens to be more spherical
Andrew Rosen

- **Rods** – Photoreceptors in the retina that respond to lower light intensities and give rise to achromatic (colorless) sensations
- **Cones** – Visual receptors that respond to greater light intensities and give rise to chromatic sensations
- **Fovea** – The area roughly at the retina’s center where cones are plentiful and visual acuity is greatest (no rods)
- **Rods and cones don’t report directly to the brain**
  - First step is receptors stimulating bipolar cells
  - Then ganglion cells are excited
    - Axons of ganglion cells converge to form optic nerve
- **Optic Nerve** – The bundle of fibers that proceeds from each retina to the brain
- **Optic nerve carries information to the lateral geniculate nucleus in the thalamus and then to the cortex**
- **Blind spot has no photoreceptors and is insensitive to light to enable the axons of the ganglion cells to exit the eye on their way to the thalamus**
- **Rods are receptors for night vision while cones serve day vision**
- **Acuity (ability to perceive detail) is much greater in the cones**
- **Sometimes it is best to see dim things with corner of the eye where there are the most rods and not straight on**
- **Photopigment** – A chemical in the photoreceptors that changes its form in response to light, producing an electrical change that signals to the nervous system that light is present
  - Rods contain rhodopsin
    - Breaks down more readily in response to light
  - Cones contain one of three types of photopigments
  - Rods contain one pigment and can distinguish between brightness but not hues
- **Vision is time sensitive and spatially sensitive**
- **Brightness contrast** – the effect that makes a stimulus look much brighter on a dark background than on a bright one
- **Edge enhancement** – amplification of brightness boundaries through the reliance on brightness contrast to allow us to see edges between objects more clearly
  - Mach bands – Gray strips arranged in ascending brightness from left to right that are uniform in brightness for each but the left edge looks brighter and the right edge looks darker
- **Lateral Inhibition** – The pattern of interaction among neurons in the visual system in which activity in one neuron inhibits adjacent neurons’ response to help distinguish edges since the outermost visual cells won’t be inhibited as much
- **Color** can be described with three dimensions: hue, brightness, and saturation
- **Hue** is the attribute that distinguishes one color from another and varies with wavelength
- **Brightness** is the dimension of color that differentiates black from white and shades of gray in between
- **Saturation** is the purity of color – the extent to which it is chromatic rather than achromatic
- **Trichromatic** – The principle underlying human color vision. Color vision occurs through the operation of three sets of cones, each maximally sensitive to a different wavelength of light
  - One cone is especially sensitive to blue, one to red, and one to green
  - The sum of the responses is what matters and not how the total was achieved
- **Simultaneous color contrast** – the chromatic counterpart of brightness contrast
  - Tendency of a chromatic region to induce a complementary color in adjoining areas (negative after-images of complementary hue)
  - Blue and yellow light makes white, same for red with green, purple with yellow-green, and orange with blue-green
  - Mixing paints is different than lights
    - Mixing light is an additive color mixture
    - Mixing paint is subtractive since the paint pigments absorb other wavelengths
- **Opponent-Process Theory** – A theory of color vision that proposes three pairs of color antagonists: red-green, blue-yellow, and white-black. Excitation of neurons sensitive to one member of a pair automatically inhibits neurons sensitive to the other member
  - All colors are combinations of yellow or blue PLUS red or green
    - Thus, unique colors need portions of other colors to cancel one another out
- **There might have been some reproductive advantage with color blindness since they might have been able to find prey that others could not**
- **Color blindness is more prominent in males because one cause is a defect on the x-chromosome**
- **Visual agnosics can’t distinguish shapes**
Receptive Field – For a particular cell in the visual system, the pattern of retinal stimulation that most effectively causes the cell to fire. For some cells, this pattern is defined simply in terms of retinal location; for others, the most effective input has a particular shape, color, or direction of motion
  o Cells differ in the types of detectors that they are
  o Feature Detectors – Neurons in the retina or brain that respond to specific attributes of the stimulus, such as movement, orientation, and so on

Auditory Transduction:

  • Cochlea – Coiled structure in the inner ear that contains the basilar membrane
  • Eardrum – The taut membrane that transmits the vibrations caused by sound waves from the auditory canal to the ossicles in the middle ear
  • Oval Window – The membrane separating the middle ear from the inner ear
  • Auditory Ossicles – The three bones of the middle ear that transmit the vibrations of the ear drum to the oval window
    o Composed of the malleus, incus, and stapes
    o Amplifies sound
    o Change in air pressure causes change in fluid pressure in air
  • Basilar Membrane – A membrane running the length of the cochlea; soundwaves cause a deformation of this membrane, bending the hair cells in the cochlea and thus stimulating the auditory receptors
  • Hair Cells – The auditory receptors in the cochlea, lodged between the basilar membrane and other membranes above
    o Specific regions react to certain frequencies
    o High frequency is not very far in the cochlea while low frequency is at the end
  • Place Theory – A proposal about pitch perception stating that regions of the basilar membrane respond to particular sound frequencies, and the nervous system interprets the excitation from different basilar regions as different pitches
    o Very low frequencies actually activate more than just the low frequency receptors
  • Frequency Theory – Frequency is encoded by the rate of neuronal firing (Hz)
    o Limited by refractory period
  • Both frequency and place coding are used for all frequencies
    o Place coding is relied on for high frequency and frequency theory is relied on for low frequencies