Sensing and Perceiving

- Physical stimulus --- sensory receptors --transduction--> receptor potentials--- sensory processing---perceiving
  - sensory
- Physical stimulus: Light
  - Photons and the electromagnetic spectrum
  - Light is a 'radiation' (a sine wave)
  - Light is characterized by 3 parameters
    - Hue (wave length)
      - Related to the 'frequency' of the sine wave
      - Wavelength = 1/frequency
    - Saturation (purity)
      - Decreasing saturation <-------'purity' of sine wave<--------> increasing saturation
    - Brightness (intensity)
      - Increasing brightness <------ 'amplitude of sine wave' <------ decreasing brightness

Vision: Sensing

- The eye
  - Not all eyes are the same
    - Species to species variations
  - Visual field = the 'visual space' that you sense
  - Monocular (seen by 1 eye) vs. Binocular (seen with both eyes)
  - The Human eye (figure 6.3)
    - Conjunctiva (merges with inside of eyelids)
    - Cornea
    - Iris
    - Pupil (opening in iris)
    - Accommodation ('focus')
    - Sclera
      - Muscles
        - Responsible for saccadic eye movements (~4 times/second)
        - Can be controlled during 'pursuit' movements
      - Oculomotor
      - Trochlear
      - Abducens
- Vitreous humor (upper half has been removed)
- Layers of retina
- Optic nerve (2)
- Blood vessels
  - Fovea vs. Blind Spot
    - Fovea: just behind the pupil--objects inverted
    - Blind spot: where all axons/blood vessels exit the eye
    - ***6.3 is incorrect: optic disk/blind spot is not the same as the fovea
- The retina
  - At least 5 types of cells organized in 3 layers
  - 1st layer: rods and cones
  - Visual acuity: central (fovea) vs. peripheral vision

<table>
<thead>
<tr>
<th>Rods</th>
<th>Cones</th>
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</thead>
<tbody>
<tr>
<td>120 millions</td>
<td>6 millions</td>
</tr>
<tr>
<td>Periphery</td>
<td>Fovea</td>
</tr>
<tr>
<td>Not color sensitive</td>
<td>Color sensitive</td>
</tr>
<tr>
<td>Poor spatial acuity</td>
<td>High spatial acuity</td>
</tr>
<tr>
<td>Good in dark</td>
<td>Poor in dark</td>
</tr>
<tr>
<td>Good for motion</td>
<td>Poor for motion</td>
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</tbody>
</table>

Central and peripheral acuity
- Cells have receptive fields that cover a small part of the visual field
- Ganglion cells in the fovea are more accurate than ganglion cells in the periphery
- First layer
  - Photoreceptors
- Second layer
  - Bipolar cells
- Third layer
  - Ganglion cells
- Fourth 'layer'
  - Optic nerve (to brain)
- Photoreceptors: rods and cones
  - Photo-pigment + light --> opsin (e.g. rhodopsin) + retinal (from Vitamin A)--> release neurotransmitter on bipolar neurons
- Transduction
- Ganglion Cell Responses
  - Receptive fields
  - ON/OFF or OFF/ON receptive fields
    - Sensitive to contrast
  - ON center, OFF surround cells are active when they are presented with bright light in the center, or dark spot on surround
○ Color perception
  • Trichromatic photoreceptors: 3 types of cones (R (red), G (green), B (blue))
    ▪ much less blue cones
  • Genetic disorders
    ▪ Protanopia (red cones filled with green opsin)
      • Confuse red and green
      • X chromosome (male prevalence 7%)
    ▪ Deuteranopia (green cones filled with red opsin)
      • Confuse red and green
      • X chromosome (male prevalence 7%)
    ▪ Tritanopia (no blue cones)
    ▪ All: intact visual acuity
    ▪ Ishihara color test
      • See a color # against contrast colors
○ Color sensitive ganglion cells
  • 3 types of photoreceptors but only 2 types of color sensitive ganglion cells
    ▪ RG an YB
  • Ganglion cells: opponent processing
    ▪ R <---> G
    ▪ Y<--->B
  • Yellow sensitivity is due to simultaneous red and green cones inputs
  • ON/OFF receptive fields are color specific
○ Visual pathway
  • Each eye receives information from the R and L visual fields (binocular area)
  • Lateralization
    ▪ Left visual field --> right hemisphere
    ▪ Right visual field --> left hemisphere
  • Mapping
    ▪ 2 near by cells in the visual cortex have 2 nearby receptive fields
  • Steps
    ▪ Region of overlap of 2 visual fields or visual field of right eye goes into optic nerve
    ▪ Optic chiasm
    ▪ Later geniculate nucleus (LGN)
    ▪ Information from left half of visual field; information from right half of visual field
    ▪ Primary visual cortex
  • Eyes --> LGN-->V1 (visual perception)
    • LGN
      ▪ Hypothalamus (circadian rhythms)
      ▪ Tectum- superior colliculus (e.g. eye movements accommodation)
  • Lateral Geniculate Nucleus
    • 6 layers of neurons in 3 layers
      ▪ Parvocellular (3, 4, 5, 6): red + green cones, high resolution, slow
      ▪ Magnocellular (1, 2): low spatial resolution, fast
- Koniocellular groups (in between): blue cones, low resolution