9.01 Introduction to Neuroscience
Fall 2007

9.01 Monday Recitation
October 22, 2007

**Vision**

http://www.brown.edu/Courses/BN01/images/review/vision1.pdf
http://www.brown.edu/Courses/BN01/images/review/vision2.pdf
http://www.brown.edu/Courses/BN01/images/review/vision3.pdf

Eye

- Photoreceptors – hyperpolarize in response to light; depolarize (release glutamate) when dark
- Bipolar cells (retinal processing)
    - OFF bipolar cells (respond to glutamate by depolarizing; glutamate-gated cation channels)
    - ON bipolar cells (respond to glutamate by hyperpolarizing; G-protein-coupled receptors)
    - **Center-surround receptive fields**
- Ganglion cells (retinal output)
    - Also center-surround; receive input from corresponding type of bipolar cell
    - Mainly responsive to differences in illumination
    - Types: P-type (small, 90%), M-type (large, 5%), nonM-nonP (5%)
    - Color opponency

Optic Nerve, Chiasm, Tract

- At chiasm, axons from nasal retinas **decussate**; result: left visual field information carried by right optic tract; right visual field information carried by left optic tract
- What parts of your vision is lost when
    - Left optic nerve is cut? **Input from right eye**
    - Chiasm is cut down the middle? **Peripheral vision**
    - Left optic tract is cut? **Right visual field**
- Targets of projection: LGN (thalamus) to striate cortex, hypothalamus, superior colliculus.

Lateral Geniculate Nucleus

- Six layers labeled 1 through 6; most ventral layer is 1
- Retinal information separated by eye and ganglion cell type
    - Ipsilateral axons synapse on LGN layers 2, 3, 5; contralateral axons on 1, 4, 6
    - Magnocellular LGN layers (1 and 2) receive input from M-type ganglion cells; parvocellular LGN layers (3-6) receive input from P-type; and koniocellular layers (lie just ventral to each numbered layer) receive input from non-M-non-P
- Receptive fields on LGH neurons almost identical to those of the ganglion cells that innervate them

Striate Cortex (V1, Area 17, primary visual cortex)

- Retinotopy (2D surface of retina is mapped onto 2D surface of LGN, striate)
    - Mapping of visual field often distorted (greater representation of fovea)
    - Discrete point of light can activate many cells in the retina, more in target structures, because of overlapping receptive fields; activity in cortex is broad distribution with peak at specific retinotopic location
    - Not literal map; no pictures in the brain
- Six layers (I through VI – IV divided into A, B, and C – IVC into α and β)

    - Most axons from LGN terminate in IVC – cell type and eye separation maintained in IVC
        - Magnocellular LGN neurons project to IVCα; parvocellular to IVCβ
        - Right, left eye inputs separated via **ocular dominance columns** (autoradiography)
        - IVC neurons project to II, III, IVB → some information integrated, processed; II and III receive binocular input
    - Koniocellular LGN axons project to II and III
    - Radial connections (perpendicularly across all layers) vs. horizontal (within one layer)
    - Outputs (II, III, IVB → cortical areas; V → superior colliculus, pons; VI → back to LGN)
    - Blobs (seen with **cytochrome oxidase**) run along II, III, V, VI; interblobs (between blobs) receives input from koniocellular layers of LGN
- Receptive fields
    - Binocularity
    - Orientation selectivity
    - Direction selectivity
    - Simple and complex receptive fields
    - Blob receptive fields

Beyond Striate Cortex

- Dorsal stream ("where" pathway)
    - Motion processing
    - Area MT
- Ventral stream ("what" pathway)
    - Area V4
    - Area IT

**Practice Short Answer:** What is meant by parallel processing in the visual system? Give examples.

**Parallel processing is the ability of the brain to process incoming stimuli simultaneously in different ways. This is especially important in vision.**

**A few examples of parallel processing in vision:**

- **Two eyes**
- **ON and OFF bipolar cells**
- **M- and P-type ganglion cells**
- **Dorsal and ventral streams**
- **Etc.**