

Lecture 31 -- The Oculomotor System -- M. Goldberg

I. Six different kinds of eye movements:

1. **Fixation** holds the eye still.
2. **Pursuit** holds the fovea on a slowly moving target.
3. The **vestibulo-ocular reflex** (VOR) keeps the eye still in space when the head moves.
4. The **optokinetic** (ocular following) responses use visual information to compensate for inadequacies in the VOR.
5. **Saccades** move the eye rapidly from one object to another.
6. **Vergence** alters the depth of the plane of fixation.

II. Six muscles move the eyes

- A. Medial and lateral rectus muscles move the eyes horizontally
- B. Superior and inferior rectus muscles move the eyes vertically and extort them.
- C. Superior and inferior oblique muscles move the eyes vertically and intort them.

III. Three cranial nerves control the eye muscles

- A. Oculomotor nerve (III) innervates the medial, superior and inferior recti and the inferior oblique.
- B. Trochlear (IV) innervates the superior oblique.
- C. Abducens (VI) innervates the lateral rectus.

IV. Horizontal eye movements are organized in the pons and medulla.

V. Vertical eye movements are organized in the midbrain.

VI. Oculomotor neurons describe eye position and velocity.

- A. For horizontal saccades, the velocity signal comes from the paramedian pontine reticular formation. The position signal comes from the medial vestibular nucleus and the nucleus prepositus hypoglossi.
- B. For smooth pursuit and VOR, the velocity signal comes from the medial vestibular nucleus.
- C. Vertical gaze is organized in the midbrain.

VII. Horizontal gaze is coordinated by signals in the medial longitudinal fasciculus arising from the abducens interneurons and projecting to the oculomotor nucleus.

VIII. The supranuclear organization of saccadic eye movements:

- A. The superior colliculus drives the reticular formation to make contralateral saccades.
- B. The substantia nigra inhibits the colliculus; the frontal eye fields and lateral intraparietal area excite it.
- C. The frontal eye field provides a clear motor signal; the parietal cortex provides an attentional signal.

D. Parietal lesions result in neglect; frontal lesions result in an inability to perform antisaccades (looking away from a visual target).

IX. The supranuclear organization of smooth pursuit:

- A. Target velocity signals are provided by MT and MST, the motion-sensitive areas in the superior temporal sulcus.
- B. These areas project to the cerebellum via the dorsolateral pontine nuclei.
- C. The cerebellum sends an eye velocity signal to the medial vestibular nucleus.

Relevant reading: chapter 39 in “Principles”