Lecture 15. Saccades 1

Reading Assignments: TMB 6.2

The Modular Design of the Oculomotor System in Monkeys
Peter Dominey, Michael Arbib, and Amanda Alexander
Sections: Description, Architecture

Supplementary Reading:
Crowley-Arbib Saccade Model
M. Crowley, E. Oztop, and S. Marmol
From Schemas to Neural Networks - A Case Study: Modeling the Control of Saccades

Classical Model of Reflex Saccades

Expanding the Model to Bring in Cortical Functions
Develop hypotheses on **Neural Networks** that yield an equivalent functionality: mapping **schemas (functions)** to the cooperative cooperation of sets of brain regions (structures)
An experimental protocol defines a class of experiments based on:

- Preparation used
- External stimuli
- Experimental manipulations: electrical stimulation, drug application, etc.
- Measurements and observations

The protocol can be translated into a simulation interface for “stimulating” a simulation and displaying the results.
Experiment - Double Saccade
**Double Saccade -- Neural Array Activity Snapshot**
Brain Stem Saccade Burst Generator


In the present Chapter/Lecture, this is treated as an unanalyzed module (available from the NSL Library) so that attention may focus on the other brain regions, which are described next.
Bringing in SC and FEF

SC - Superior Colliculus: The midbrain’s path from vision (and other senses) to eye movement.

FEF - Frontal Eye Field: The cortex’s path from vision to eye movement.

Data point: A cat or monkey can still make saccades if one of SC or FEF is lesioned.
Simple Saccade Task
Experimental Setup
"visinP3M3" is the stimulus for the first target, "fixation" is the fixation timing, "verticalTheta" is the vertical eye movement response, and "horizontalTheta" is the horizontal eye movement response. Notice that the eyes do not move until the "posteriorParietalCenter", a specific neuron in the model of LIP, goes low.
Memory Saccade Experiment

Laurent Itti: CS564 - Brain Theory and Artificial Intelligence. Saccades 1
"visinM2P2" is the stimulus for the target, "fixation" is the fixation timing, "verticalTheta" is the vertical eye movement response, and "horizontalTheta" is the horizontal eye movement response.
Double Saccade Experiment

Laurent Itti: CS564 - Brain Theory and Artificial Intelligence. Saccades 1
"visinM3P0" is the stimulus for the first target and "visinM3P3" is the stimulus for the second target. "fixation" is the fixation timing, "verticalTheta" is the vertical eye movement response, and "horizontalTheta" is the horizontal eye movement response.
Output of SC is disabled.

"visinP3M3" is the stimulus for the first target, "fixation" is the fixation timing, "verticalTheta" is the vertical eye movement response, and "horizontalTheta" is the horizontal eye movement response.
**FEF Stimulation with SC Lesioned**

- **FEF Stimulation**
- **time**
Compensatory Saccade: Stimulation of FEF with Lesioning of SC

A visual target is briefly presented and removed before a saccade can begin. Before the visual saccade can begin, an electrical stimulus is applied to the FEF. The monkey will first saccade to the stimulated location and then to the real target even though timewise the real target appeared first. This is due to the fact that the visual signal takes time to get from the retina to the FEF.
The Full Dominey Model

DCEP-Damped Change in Eye Position
7a/LIP-Oculomotor Region of Posterior Parietal Cortex