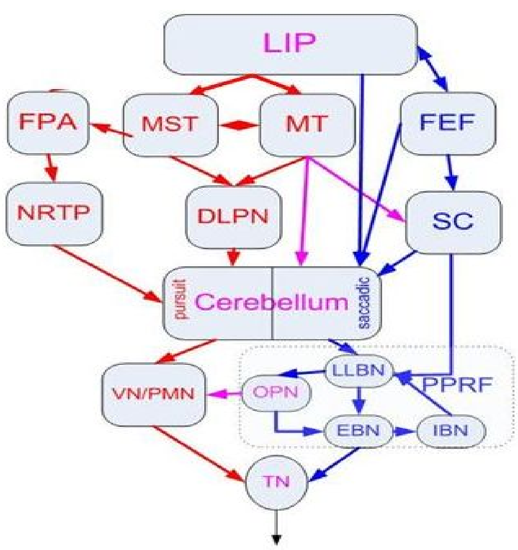
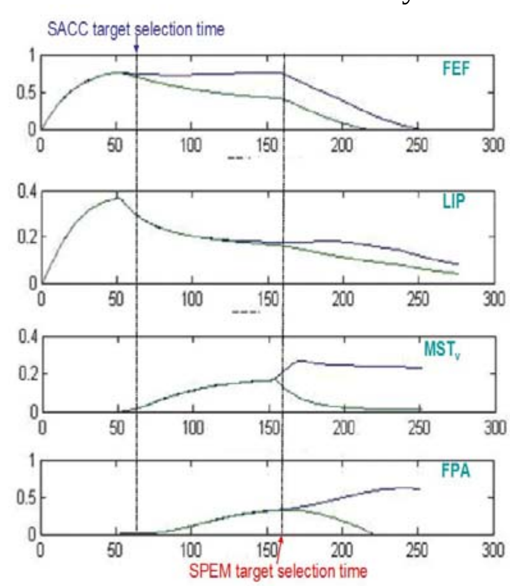
VISUAL TRACKING AND PERCEPTION OF UNPREDICTABLY MOVING TARGETS

How does the brain use eye movements to track objects that can move with variable speeds and in unpredictable directions? What mechanisms help brain decide which target to track among competing stimuli? How does the brain do this in a way that maximizes the time that the eye foveates a moving target, and thus can see it clearly? This project, with Daniel Bullock, Stephen Grossberg, and Krishna Srihasam, develops a neural model that answers these questions, and thereby contributes to two CELEST Thrusts (1, Learning in Visual Perception and Recognition; 3, Learning in Cognitive-Emotional Interactions and Planned Sequential Behaviors). The model describes the brain's design for a hybrid controller of ballistic and continuous movements to achieve this task. In particular, saccadic (or ballistic) eye movements (SAC) foveate rapidly on peripheral visual or auditory targets, while smooth pursuit eye movements (SPEM) keep an attended moving target near the fovea. When several potential targets are present in the environment, sharing of target selection information, between the SAC and SPEM, is critical for effective foveation. During natural eye movements, SAC and SPEM are effectively coordinated. So, what interactions decide the choice of a target among several competing moving stimuli? How do the systems interact so that the saccade is correctly calibrated to re-foveate a target while it is moving with variable speeds? A neural model of the interaction between the SAC and SPEM systems proposes answers to these questions. The model includes interactions of the following brain regions: motion processing areas MT, MST, FPA, DLPN; saccade planning and execution areas LIP, FEF, SC; the saccadic generator in the brain stem; and the cerebellum. Model simulations illustrate its ability to quantitatively simulate behavioral deviations from predictions of the simplest parallel model, as well as its ability to functionally explain the anatomical, neurophysiological and behavioral data that describe how such movements actually occur.



(a) Model Diagram



(b) Saccadic system biases SPEM target choice