(Journal of Cognitive Neuroscience. 2001;13:256-271.)

A Model of Saccade Initiation Based on the Competitive Integration of Exogenous and Endogenous Signals in the Superior Colliculus

Thomas P. Trappenberg1, Michael C. Dorris2, Douglas P. Munoz2 and Raymond M. Klein3

1 University of Oxford, UK
2 Queen's University, Canada
3 Dalhousie University, Canada

Significant advances in cognitive neuroscience can be achieved by combining techniques used to measure behavior and brain activity with neural modeling. Here we apply this approach to the initiation of rapid eye movements (saccades), which are used to redirect the visual axis to targets of interest. It is well known that the superior colliculus (SC) in the midbrain plays a major role in generating saccadic eye movements, and physiological studies have provided important knowledge of the activity pattern of neurons in this structure. Based on the observation that the SC receives localized sensory (exogenous) and voluntary (endogenous) inputs, our model assumes that this information is integrated by dynamic competition across local collicular interactions. The model accounts well for the effects upon saccadic reaction time (SRT) due to removal of fixation, the presence of distractors, execution of pro- versus antisaccades, and variation in target probability, and suggests a possible mechanism for the generation of express saccades. In each of these cases, the activity patterns of "neurons" within the model closely resemble actual cell behavior in the intermediate layer of the SC. The interaction structure we employ is instrumental for producing a physiologically faithful model and results in new insights and hypotheses regarding the neural mechanisms underlying saccade initiation.