A NEURAL MODEL OF PROBABILISTIC DECISION-MAKING DURING MOTION PERCEPTION

How does the brain make decisions? Speed and accuracy of perceptual decisions covary with certainty in the input, and correlate with the rate of evidence accumulation in parietal and frontal cortical "decision neurons." Stephen Grossberg and Praveen Pilly in CELEST Thrust 1 (Learning in Visual Perception and Recognition) have proposed how a biophysically realistic model of interactions within and between Retina/LGN and cortical areas V1, MT, MST, and LIP, gated by basal ganglia, can quantitatively simulate dynamic properties of decision-making (see Figs. 1*A*,*C*,*E*,*F* below) in response to ambiguous visual motion stimuli used by Newsome, Shadlen, and colleagues in their neurophysiological experiments. The model clarifies how brain circuits that solve the aperture problem and recurrent competitive networks that exhibit self-normalizing choice properties interact to carry out probabilistic decisions in real time. Some scientists have claimed that the above data regarding the neural correlates of perceptual decision-making exemplify Bayesian inference in the brain, which estimates an optimal interpretation of the stimulus given priors and likelihoods. However, Bayesian concepts do not explain the neocortical mechanisms that make decisions, and may not even be defined when environments unexpectedly change. The present model explains the data that Bayesian models have heretofore failed to explain without an appeal to Bayesian concepts and, unlike such models, performs its simulations directly in response to actual experimental stimuli. Model simulations include LIP neuronal dynamics and reaction time data during both correct and error trials (see Figs. 1*B*,*D*,*F*,*H* below), and clarify that LIP is not necessary to compute the global direction of random dot motion stimuli.

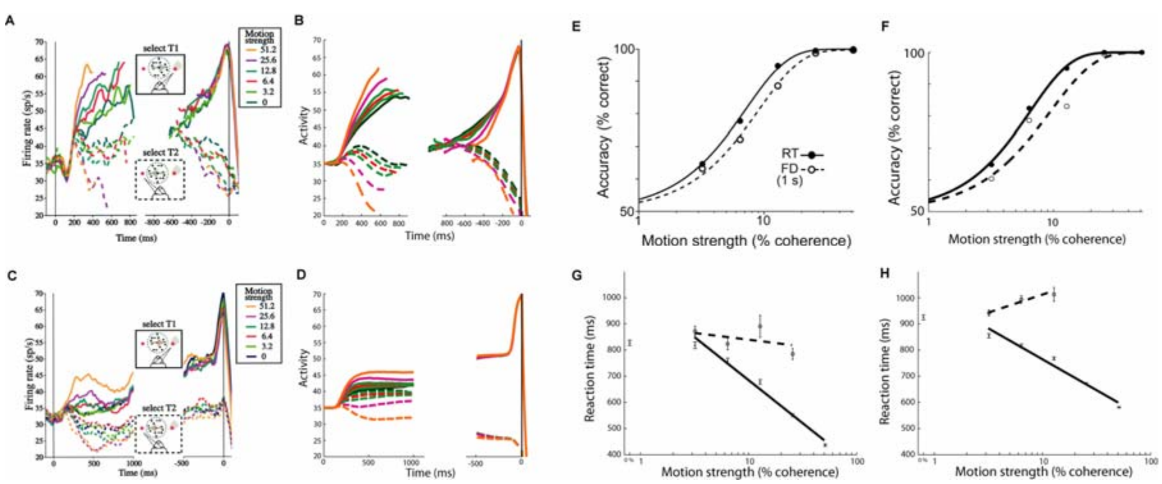

Figure 1. ***A***, Average LIP neuronal dynamics on correct trials of the Reaction Time (RT) task at various levels of motion coherence and for both opponent motion directions. ***B***, Model simulations. ***C***, LIP dynamics during the Fixed Duration (FD) task. ***D***, Model simulations. ***E***, Accuracy data as a function of motion coherence during both the FD and the RT tasks. ***F***, Model simulations. ***G***, Reaction time data as a function of motion coherence during the RT task on correct and error trials. ***H***, Model simulations. All data is from Roitman and Shadlen, 2002.