

Caudate activity in a decision-making reaction time task

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Perceptual decision-making is a deliberative process that integrates sensory information with other factors like bias and reward expectation to generate a categorical choice. It is not known how and where in the brain these disparate kinds of information are integrated, but one intriguing candidate is the caudate nucleus in the basal ganglia. Caudate neurons are intimately related to behavioral planning and execution and also have been shown recently to reflect reward expectation.

To study how the caudate is involved in the decision process, we have trained one monkey on a reaction-time version of a random-dot motion direction discrimination task. This task has been used previously to study decision-making behavior and its neural correlates in the lateral intraparietal area (LIP). LIP activity measured during task performance represents an accumulation over time of noisy motion information that reaches a threshold level of activation just prior to response initiation. These LIP responses and the monkeys' behavioral choices and reaction times are consistent with a class of decision models related to mathematical descriptions of diffusion or random-walk processes that drift noisily to a fixed threshold. Here we use this well-established computational framework to examine how bias, reward expectation and sensory evidence are represented in the activity of individual caudate neurons and to relate the caudate activity to the speed and accuracy of the decision process.

We recorded single-unit activity of putative projection neurons in the caudate while the monkey performed the motion discrimination task. In our preliminary dataset, we have observed activity that reflects the strength of the motion evidence in a substantial portion of neurons. Unlike those observed in LIP, these neural responses did not reach a common threshold just prior to saccade onset and often persisted into the reward period, consistent with an internal online estimate of reward probability or choice value. We also observed bursts of firing at saccade onset that were independent of motion strength but selective to a particular saccade direction, suggesting that these responses might reflect detection of the threshold associated with a particular choice. Interestingly, the bursts in some neurons were preceded by elevated firing that began after trial onset and was independent of the strength of the motion stimulus. This elevated firing ended ~300 ms after onset of the motion stimulus only in trials in which monkey made a saccade to the null direction, regardless of the actual direction of motion. Such tonic activity might thus represent the monkey's initial bias. These results suggest that the caudate nucleus might provide signals related to reward expectation, threshold crossing and bias that contribute to the overall decision-making process.

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