

Cortico-basal ganglia networks and cognitive control of action

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The basal ganglia and the frontal cortex are interconnected by loop circuits. Each part of the circuits is considered to play a specific role in cognitive control of action. To gain deeper insight into specific functions played by each component of the loops, we recorded neurons from the globus pallidus (GP) and the frontal cortical areas while monkeys performed tasks designed to include separate processes for behavioral goal determination, action selection, and action execution. We then compared response properties of neurons in these areas. When a familiar visual signal instructed a behavioral goal, GP neurons started to reflect the visual features and the instructed goals no later than neurons in the frontal cortex, indicating that GP is involved in the early determination of behavioral goals based on visual information. When a forthcoming action was selected, the action specification occurred later in GP than in the frontal cortex, and GP was not as involved in the process by which a behavioral goal was transformed into an action. During execution of action, the movement-related activity in GP began later than that in the frontal cortex. Moreover, the length of time representing behavioral goal and action was shorter in GP than in the frontal cortex. Altogether, these results indicate that GP may be primarily involved in detecting individual behavioral events and results of information processing and in making a categorical decision, such as goals, while the frontal cortex uses them for subsequent processing stages to achieve cognitive control of action.