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The basal ganglia: Motor and cognitive relationships in a clinical neurobehavioral context

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New information about the basal ganglia and cerebellar connections with the cerebral cortex has prompted a re-evaluation of the role of the basal ganglia in cognition. We know that the relation between the basal ganglia and the cerebral cortical region allows for connections organized into discrete circuits. Rather than serving as a means for widespread cortical areas to gain access to the motor system, these loops reciprocally interconnect a large and diverse set of cerebral cortical areas with the basal ganglia. The properties of neurons within the basal ganglia or cerebellar components of these circuits resemble the properties of neurons within the cortical areas subserved by these loops. For example, neuronal activity within the basal ganglia and cerebellar loops with motor areas of the cerebral cortex is highly correlated with parameters of movement, whereas neuronal activity within the basal ganglia and cerebellar loops with areas of the prefrontal cortex is more related to the aspects of cognitive function. Thus, individual loops appear to be involved in distinct behavioral functions. Studies of the basal ganglia and cerebellar pathology support this conclusion. Damage to the basal ganglia or cerebellar components of circuits with motor areas of the cortex leads to motor symptoms, whereas damage to the subcortical components of circuits with non-motor areas of the cortex causes higher-order deficits. In this report, we review some of the new anatomic, physiologic, and behavioral findings that have contributed to a reappraisal of function concerning the basal ganglia and cerebellar loops with the cerebral cortex and apply it in clinical applications to obsessive-compulsive disorder, Tourette's syndrome, and attention-deficit/hyperactivity disorder as examples of how compromise at different points in the system may yield similar but different clinical results.

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