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The basal ganglia (BG) play a pivotal role in action selection, reinforcement learning, and working memory. Here, we present a connectionist model that explores the more general hypothesis that the BG implements a conditional information re-routing circuit, where cortical signals are gated and subsequently relayed onto different pathways projecting to the prefrontal cortex.

In the model, distributed representations in cortical areas are copied onto separate compartments in the striatum. Striatal interneurons with continuous activation functions match patterns across the cortical inputs, and eventually gate a selection of them to output matrisomes. Two branches of the direct pathway (projecting to the substantia nigra and to the ventral pallidus) transfer the gated representation and a topological representation of their destination, respectively. Projections from these nuclei to the thalamus determine how different patterns are switched to different loops. The indirect pathway through the lateral pallidus provides a transient memory of the previous action, and maintains tonic activity on the direct pathway.

The model accounts for the anatomy of the BG circuit and mimics signature disorders when appropriately damaged, as well as the subsequent effects of two common surgical interventions (pallidotomy and deep brain stimulation).

Hebbian learning among striatal units, fostered by dopamine projections, enables the model to develop internal representations of cortical inputs, eventually leading to the development of automatic procedures.

Finally, it is shown that the model's cycles correspond to variable binding and action execution within production systems, providing a biological basis for the robust execution of sequential behavior.