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Oral presentation

Supervision of motor cortex by basal ganglia

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Each somatic motor cortical area receives input from non-motor cortical areas and from the basal ganglia. Each area projects to all of the other areas, and each area also projects directly to the spinal cord. There is a limited understanding of how these different motor areas interact, and how mappings from cognitive goals to coordinated motor behaviour are established. The role of the basal ganglia afferents is also enigmatic. While the basal ganglia sometimes have a profound influence on movement, the ablation of their output nuclei does not cause striking motor symptoms. We present the hypothesis that the basal ganglia obtain rough sketches of effective motor patterns via reinforcement learning, and that they subsequently drive the cortex in these patterns, such that the patterns are gradually transferred to the cortex via supervised learning. Such a transfer mechanism may account for a number of phenomena including: 1) the way in which activity migrates between structures as expertise develops in some motor tasks; 2) the subtlety of motor symptoms following ablation of basal ganglia output nuclei (as opposed to the striking motor symptoms of basal ganglia diseases); and 3) changes in motor cortical maps in Parkinson's disease. The feasibility of this mechanism is tested with a cortico-basal ganglia model. The model produces appropriate motor patterns given sensory and goal-related inputs, and produces progressively more sophisticated patterns of movement as it matures. On the basis of this model, we predict that patients should have difficulty learning novel, complex movement patterns following ablation of basal ganglia output nuclei.