Thalamocortical basal ganglia loops versus local circuits: integration of sensorimotor processing from different levels

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Current computational models of the basal ganglia often focus either on the dynamics in specific subregions (e.g. striatum; Ponzi and Wickens, 2013) or on 'loops' including thalamocortical feedback (e.g. Leblois et al., 2006). Furthermore, models assume either reliable propagation of firing rates throughout the network (e.g. Guthrie et al., 2013), while others advocate temporal coding and active decorrelation (Morris et al., 2003; Wilson 2013). However, instead of fulfilling only one of these extremes, the basal ganglia might utilize various processing networks and coding principles depending on the circumstances. The goal of this project is to create novel basal ganglia models that bridge the local-circuit and basal ganglia loop levels and different coding dynamics (Kamali Sarvestani et al., 2011).

A key focus is on how cell responses to sensory stimuli are translated into motor activity. What are the dynamics that determine whether a sensory stimulus evokes a response pattern that leads to movement initiation or suppression? For example, sensory responses are processed locally within the striatal network including medium-spiny neurons and fast-spiking interneurons (e.g. Hjorth et al., 2009; Klaus et al. 2013), but are also affected by feedback loop dynamics. A coherent description of these different dynamics will help to understand the contribution of the basal ganglia to action selection and execution. Existing data sets of electrophysiological recordings (e.g. Leventhal et al., 2013; Schmidt el., 2013) will be used for comparison with model activity patterns and to test model predictions.

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