Modeling Parkinsonian Freezing and Deep Brain Stimulation Effects in a Basal Ganglia Network

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Abstract

The precise mechanism through which Deep Brain Stimulation (DBS) mitigates freezing episodes in Parkinson's disease remains unknown. We modelled Parkinsonian freezing using a model of the basal ganglia that adopts a Dynamic Neural Field network for simultaneous action selection (selecting *which* action is executed) and specification (resolving the continuous parameters governing *how* that action is performed). Action selection success was based on whether activation surpassed a threshold. The model robustly differentiated healthy and dopamine-depleted (Parkinsonian) conditions, producing stable action selection under healthy dopamine and impaired, freeze-prone dynamics following depletion. We then modelled DBS as a scaled reduction in afferent drive to the subthalamic nucleus (STN) and globus pallidus internus (GPi). While this formulation has succeeded in previous computational work, it did not yield consistent restoration of action selection within our framework, motivating future investigation of alternative DBS formulations.

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