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Balanced excitation and inhibition shapes the dynamics of a neuronal network for movement and reward

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The neuronal circuit that relays information between the cortex, the basal ganglia nucleus of the striatum and the thalamus controls the execution of learnt motor tasks and stereotyped behaviors, anxiety and reward. This circuit, known as the cortico-striatal-thalamo-cortical (CSTC) pathway, is composed of a series of excitatory glutamatergic and inhibitory GABAergic synaptic connections. Hyperactivity in the CSTC pathway is implicated with the onset of neuropsychiatric disorders like OCD disorder and Tourette's syndrome. Here we use a mathematical modeling approach to determine how generalized and local changes in balanced excitation and inhibition control the network dynamics of the CSTC pathway. Our findings indicate that local changes in inhibition of distinct clusters of striatal neurons can powerfully control the activity of the CSTC pathway. In contrast, local changes in the excitation of these cells do not exert a similarly powerful control of the activity of this network. These findings provide new insights into the network mechanisms that control the activity of neuronal circuits implicated with the onset of neuropsychiatric disorders.