Dopamine D1 receptor modulates neurotransmission through the basal ganglia

Satomi Chiken[1], Chikara Ohta[1, 2], Asako Sato[3, 4], Toshikuni Sasaoka[3, 4], Motoya Katsuki[4], Makoto Kurokawa[2], Atsushi Nambu[1]

[1]Division of System Neurophysiology, National Institute for Physiological Sciences, Okazaki, Japan, [2]Department of Biological Sciences, Tokyo Metropolitan University, Tokyo, Japan, [3]Kitasato University School of Medicine, [4]National Institute for Basic Biology, Okazaki, Japan

Dopamine in the basal ganglia (BG) plays a crucial role in controlling voluntary movements. The striatum, a main input station of the BG, receives excitatory inputs from the cerebral cortex and project to the internal (GPi) and external (GPe) segments of the globus pallidus. The striatum also receives dopaminergic inputs, and is divided into two neuronal groups: direct pathway neurons with dopamine D1 receptors (D1Rs) projecting to the GPi and indirect pathway neurons with dopamine D2 receptors projecting to the GPe. To clarify the role of D1Rs in information processing through the BG, we recorded activity of GPi and GPe neurons in D1R knockout mice harboring doxycycline (Dox)-regulated D1R expression under awake state.

Before Dox administration, cortical stimulation evoked triphasic responses, composed of early excitation, inhibition and late excitation in GPi and GPe neurons, as observed in the wild-type mice. However, after suppression of D1R expression by Dox administration, the cortically evoked inhibition of GPi neurons, which is mediated by the cortico-striato-GPi direct pathway, was markedly attenuated. On the other hand, no significant changes were observed in GPe neurons. These results suggest that dopamine maintains the excitability of the striato-GPi neurons via D1Rs and information flow through the direct pathway.