Low-pass filter properties of basal ganglia cortical muscle loops in the normal and {MPTP} primate model of parkinsonism

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Oscillatory bursting activity is commonly found in the basal ganglia (BG) and the thalamus of the parkinsonian brain. The frequency of these oscillations is often similar to or higher than that of the parkinsonian tremor, but their relationship to the tremor and other parkinsonian symptoms is still under debate. We studied the frequency dependency of information transmission in the cortex-BG and cortex-periphery loops by recording simultaneously from multiple electrodes located in the arm-related primary motor cortex (MI) and in the globus pallidus (GP) of two vervet monkeys before and after 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) treatment and induction of parkinsonian symptoms. We mimicked the parkinsonian bursting oscillations by stimulating with 35 ms bursts given at different frequencies through microelectrodes located in MI or GP while recording the evoked neuronal and motor responses. In the normal state, microstimulation of MI or GP does not modulate the discharge rate in the other structure. However, the functional-connectivity between MI and GP is greatly enhanced after MPTP treatment. In the frequency domain, GP neurons usually responded equally to 1-15 Hz stimulation bursts in both states. In contrast, MI neurons demonstrated low-pass filter properties, with a cutoff frequency above 5 Hz for the MI stimulations, and below 5 Hz for the GP stimulations. Finally, muscle activation evoked by MI microstimulation was markedly attenuated at frequencies higher than 5 Hz. The low-pass properties of the pathways connecting GP to MI to muscles suggest that parkinsonian tremor is not directly driven by the BG 5-10 Hz burst oscillations despite their similar frequencies.

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