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Title: Deep brain electrical stimulation induced changes in the neuronal information encoding of the subthalamic nucleus in Parkinson's disease patients
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Background: A novel treatment for severe Parkinson's disease (PD) utilizes deep brain stimulation (DBS) delivered to the subthalamic nucleus (STN) resulting in a remarkable reduction in the clinical symptoms. While the clinical benefits of the surgery are proven, its mechanism is still enigmatic.

Research Hypothesis: We hypothesize that DBS has a complex current dependent influence on the neural activity affecting both firing rate and pattern. Our goal is to elucidate the effect of the DBS on the neuronal activity in the STN of human PD patients undergoing surgery.

Aims: The specific aims include characterizing the complex locking of the neuronal activity to the stimulus pulses, mapping the non-linear current dependent neural transition and finally mapping the neurophysiological changes to the amelioration of clinical symptoms.

Methods: Recordings of neuronal activity before and during electrical stimulation in the STN in patients undergoing DBS surgery in Hadassah Ein Karem. The research focused on parallel and complementary tracks: (1) Analysis of neuronal recordings in the STN of PD patients (2) Development of a computational framework for analyzing the data. (3) Development of a toolset for the removal of the stimulus artifact from the recordings. (4) Relating the human recordings to the results of a wider range of recordings in the primate model of PD following STN stimulation.

Results: Stimulation resulted in a combination of complex locking and inhibition of the neuronal activity. Results demonstrate a current amplitude dependant transition between locking and inhibition.

Discussion and conclusions: STN neurons undergo transition from locking to inhibition that manifest in the reduction in clinical symptoms. This leads to functional decoupling of the STN from the output nuclei of the basal ganglia.

Key words: Parkinson’s disease, Deep brain stimulation (DBS), Neurophysiology, Neurosurgery, Subthalamic nucleus
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