Investigating Decision-Making and Confidence in the Human Basal Ganglia

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Introduction:
Modulation of the subthalamic nucleus has been remarkably successful in treating Parkinson's disease but has also shown the STN is more than a motor control center. The STN has been implicated in the control of impulsivity and action initiation. Different populations of STN neurons fire in correlation with action initiation and inhibition, and unplanned changes in movements result in decreased firing. Furthermore, beta oscillations in STN are associated with movement inhibition but not with changes in ongoing movements. Reconciling these findings with a theory of cognitive control requires a systematic investigation of the basal ganglia.

Objective:
We propose neural activity in the subthalamic nucleus encodes confidence in ongoing movements and conversely maintains activity necessary to stop such movements should the need arise. Furthermore, the STN may achieve this through interactions with downstream basal ganglia structures. We are investigating these hypotheses using intra-operative recordings during DBS implantation while patients perform a decision-making task.

Methods:
Patients are being trained on a perceptual decision-making task and simultaneously report their choice and their confidence. Patients respond using free hand movements in 3D space recorded by a stereoscopic camera. Patients then complete this task while awake during DBS surgery during microelectrode recordings. Recordings are targeted to STN, VA/VL and Vim thalamus, and globus pallidus.

Results:
Preliminary data shows that subjects can be rapidly trained on this task before DBS surgery (9 subjects have completed training thus far). Intra-operative recordings show multiple task-related changed in neural activity. Pilot data in STN show an increased firing rate around when patients are given feedback on whether their choices are correct though this needs replication in more patients. We will present updated findings at the time of the meeting.

Conclusion:
Task-based recordings in the basal ganglia in human subjects are essential to determining the role of this circuit in cognition.