Physiology of DBS targets in the basal ganglia

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The basal ganglia (BG) use actor/critic architecture that enables multi-objective optimization of behavioural policy. The BG modulators (critics, e.g., dopamine) encode the mismatch between prediction and reality; whereas the BG main axis (actor) provides the connection between state and action.
The striatum and the subthalamic nucleus (STN) constitute the input stage of the BG main axis (actor) network and together innervate BG downstream structures. Our recent studies indicate that subthalamic rather than striatal activity shapes BG downstream activity. This STN modulation of BG downstream activity occurs both before (in health) and after intoxication by 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP) which leads to striatal dopamine depletion and parkinsonian clinical symptoms.
We conclude that the divergent excitatory STN projections have a critical role in shaping BG output activity. This explains why the STN (and not the striatum) is such an effective site for deep brain stimulation (DBS) in Parkinson's disease and other BG disorders.
Finally, today DBS systems are manually adjusted every 1-3 months. However, the abnormal beta synchronized oscillations in the STN are episodic, and long (> 4 seconds) episodes can be detected only after MPTP treatment. We therefore suggest that we can better treat BG disorders by closed-loop adaptive DBS that would inactivate the basal ganglia only when they "misbehave", i.e., following detection of STN long beta events.

The subthalamic nucleus - A small but so exciting structure

Jérôme Yelnik

A short history of the subthalamic nucleus will be summarized with a focus on what makes this structure so exciting. Its small size compared with the crucial role that it plays in the Basal Ganglia circuitry. Its unexpected reactivity to extraphysiologic conditions: subthalamic lesion results in production of movement, subthalamic hyperactivity results in decreased motor activity, subthalamic high frequency stimulation results in inactivation. Finally the role of the subthalamic nucleus in the control of non motor pathologies as obessesive compulsive disorder will be evoked.

Short Biography:

Jérôme YELNIK, né le 7 Juin 1949
Médecin, Directeur de Recherches émérite à l'Inserm
Président du Comité d'éthique en expérimentation animale depuis 2002
Chargé de Mission au Ministère de la Recherche pour l'expérimentation animale depuis 2014
1976 - Thesis on the anatomy of the subthalamic nucleus
1996 - Joins the group of Yves Agid. Development of a research program on Parkinsonian tremor in the primate and participation to the first implantations for deep brain stimulation (DBS)
2007 - Creation and publication with Eric Bardinet of a 3D atlas of the basal ganglia which includes three functional territories for DBS of motor and non motor diseases
2009 - Creation of the team « Behavior, Emotion and Basal Ganglia » (BEBG) with the psychiatrist Luc Mallet in the new Institut du Cerveau et de la Moelle épinière (ICM)
2014 - Re-creation of the BEBG team which focuses on the implication of the Basal Ganglia in the pathophysiology of OCD