Subthalamic nucleus connections

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The subthalamic nucleus receives direct excitatory inputs from the cerebral cortex and centromedianparafascicular nucleus of the thalamus and sends excitatory projections to the output nuclei of the basal ganglia, the internal (GPi) and external (GPe) segments of the globus pallidus, substantia nigra pars reticulata (SNr) and compacta (SNc), and the pedunculopontine nucleus. The subthalamic nucleus receives reciprocal inhibitory inputs from the GPe, and modulatory inputs from the SNc and pedunculopontine nucleus. The GPi, GPe, and SNr send inhibitory projections (black) to their targets. The pedunculopontine nucleus sends glutamatergic and cholinergic (green) projections to the STN.

A connection between the subthalamic nucleus (STN) and the cerebellum which has been shown to exist in non-human primates, was recently identified in humans. However, its anatomical features, network properties, and function have yet to be elucidated in humans.

Wang et al. guantified the STN-cerebellum pathway in humans and explored its function based on structural observations. Anatomical features and asymmetry index (AI) were explored using high definition fiber tractography data of 30 individuals from the Massachusetts General Hospital - Human Connectome Project adult diffusion database. Pearson's correlation analysis was performed to determine the interrelationship between the subdivisions of the STN-cerebellum and the global cortical-STN connections. The pathway was visualized bilaterally in all the subjects. Typically, after setting out from the STN, the STN-cerebellum projections incorporated into the nearby corticopontine tracts, passing through the cerebral peduncle, mediated by the pontine nuclei and then connecting in two opposite directions to join the bilateral middle cerebellar peduncle. On the group averaged level, 78.03% and 62.54% of fibers from the right and left STN respectively, distributed to Crus I in the cerebellum, part of the remaining fibers projected to Crus II, with most of the fibers crossing contralaterally. According to the AI evaluation, 60% of the participants were right STN dominant, 23% were left STN dominant, and 17% were relatively symmetric. Pearson's correlation analysis further indicated that the number of pathways from mesial Brodmann area 8 to the STN (hyperdirect pathway associated with decision making) was positively correlated with the number of fibers from the right STN to Crus I. The insertion and termination, the right-side dominance, and the positive correlation with the hyperdirect pathway all suggest that the STN-cerebellum pathway might be involved in decision-making processes ¹⁾.

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Wang ZM, Wei PH, Shan Y, Han M, Zhang M, Liu H, Gao JH, Lu J. Identifying and characterizing projections from the subthalamic nucleus to the cerebellum in humans. Neuroimage. 2020 Jan 19:116573. doi: 10.1016/j.neuroimage.2020.116573. [Epub ahead of print] PubMed PMID: 31968232.

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