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Opinion Article

Implications of Deep Brain Stimulation on Thinking and Emotion in Parkinson's disease

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DESCRIPTION

Parkinson's Disease (PD) is a neurodegenerative disorder that affects the motor system, causing symptoms such as tremor, rigidity, and slowness of movement. PD also has non-motor manifestations, such as cognitive impairment, mood disorders, and behavioral changes. Deep Brain Stimulation (DBS) is a surgical treatment that involves implanting electrodes in specific brain regions and delivering electrical impulses to modulate their activity. DBS can improve the motor symptoms of PD by targeting the Subthalamic Nucleus (STN) or the Globus Pallidus Interna (GPi), two structures involved in the basal ganglia circuitry. However, DBS may also have an impact on the cognitive and emotional functions of PD patients, which can affect their quality of life and self-functioning. The aim of this article is to review the current evidence on the cognitive and emotional effects of DBS in PD patients, focusing on the STN and GPi targets.

Cognitive effects of DBS

Cognitive impairment is a common feature of PD, affecting up to 80% of patients over the course of the disease. The most affected domains are executive function, memory, attention, and processing speed. Cognitive impairment can interfere with daily activities, social interactions, and decision making.

DBS may have different effects on cognition depending on the target, the stimulation parameters, the baseline cognitive status, and the follow-up duration. The majority of studies have focused on STN-DBS, while fewer have investigated GPi-DBS or other targets such as the Pedunculopontine Nucleus (PPN) or the thalamic Ventral Intermediate Nucleus (VIM).

STN-DBS has been associated with a mild but significant decline in verbal fluency, a measure of executive function that involves generating words according to a given category or letter. This decline may be related to the interference of STN-DBS with the frontal lobe functions or the spread of stimulation to adjacent structures such as the internal capsule or the limbic STN. Other executive functions, such as working memory, planning, inhibition, and mental flexibility, may also be affected by STN-DBS, but the evidence is less consistent.

Memory function may also be impaired by STN-DBS, especially verbal memory. This may be due to the disruption of the hippocampal-STN loop or the modulation of dopamine levels by STN-DBS. However, some studies have reported improvement or no change in memory after STN-DBS, suggesting that other factors such as medication reduction, mood state, or learning effects may influence memory outcomes.

Attention and processing speed are also cognitive domains that may be affected by STN-DBS. Some studies have reported deterioration or no change in these domains after STN-DBS, while others have reported improvement. The variability of results may depend on the type of tasks used to assess these domains, as well as on individual differences in baseline performance and stimulation settings. Global cognition, as measured by global scales such as the Mini-Mental State Examination (MMSE) or the Montreal Cognitive Assessment (MoCA), does not seem to be significantly altered by STN-DBS.

The emotional effects of DBS are related to the mood and affective state of PD patients, which can be influenced by several factors, such as disease progression, medication side effects, social support, and coping strategies. DBS may have different effects on mood depending on the target, the stimulation parameters, the baseline mood state, and the follow-up duration. The majority of studies have focused on STN-DBS, while fewer have investigated GPi-DBS or other targets. STN-DBS has been reported to have no significant effect on depression, as measured by standardized scales such as the Beck Depression Inventory (BDI) or the Hamilton Depression Rating Scale (HDRS). However, some studies have reported improvement or worsening of depression after STN-DBS, suggesting that individual factors such as medication reduction, personality traits, expectations, or surgical complications may influence mood outcomes.

Anxiety is another mood dimension that may be affected by STN-DBS. Some studies have reported improvement of anxiety

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after STN-DBS, as measured by scales such as the State-Trait Anxiety Inventory (STAI) or the Hamilton Anxiety Rating Scale (HARS). This improvement may be related to the reduction of motor symptoms, the increase of dopamine levels, or the modulation of the limbic STN. However, other studies have reported no change or worsening of anxiety after STN-DBS, indicating that anxiety may also depend on other factors such as medication changes, social adjustment, or stimulation side effects.

GPi-DBS has been less studied in terms of mood effects, but some studies have suggested that it may have a more favorable impact on mood than STN-DBS. GPi-DBS may preserve or improve depression and anxiety scores, as well as quality of life and emotional well-being. This may be due to the lower risk of cognitive decline, the lower reduction of medication, or the different anatomical and functional role of the GPi compared to the STN. Other targets such as PPN or VIM have been explored for their potential mood effects in PD patients, but the evidence is still scarce and inconclusive. PPN-DBS may improve depression and anxiety in some patients with refractory gait and balance problems.