

# The Impact of Deep Brain Stimulation on the Cognitive Ability of Patients with Parkinson Disease

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**Abstract:** Deep Brain Stimulation, especially STN-DBS, is one of the most prevalent treatments for the Parkinson's Disease. Previous researches already showed its positive effects on the general conditions of the patients but lack evaluation of its influence on the cognitive ability of the patients. A comparison in the effect of DBS and surgical lesioning procedures can determine DBS's influence on the quality of life and confirm whether it is the most optimal treatment. This proposal reviewed previous researches about the influence of STN-DBS and proposed a study on its influence of patients' cognitive ability.

**Keywords:** Memory Ability; Verbal Ability

## 1. Introduction

As Marras *et al*'s estimation predicted in 2018, the number of patients with the Parkinson's Disease (PD) would be approximately 0.93 million in 2020 and would grow to 1.23 million in 2030. This is more than the combined number of people diagnosed with multiple sclerosis, muscular dystrophy and amyotrophic lateral sclerosis. The prevalence of the Parkinson's Disease not only adds great obstacles to the patients' life, but also poses intense financial burden on the families and the taxpayers. Lewin Group Inc's research in 2019 concluded that the direct medical cost of Parkinson's Disease in America is \$25.4 million, while the non-medical cost is \$26.5 million dollar. Deep Brain Stimulation (DBS) surgery was first approved in 1997 to treat Parkinson's Disease (PD) tremor, then in 2002 for the treatment of advanced Parkinson's. Although numerous studies showed the alleviation of dyskinesias, studying Deep Brain Stimulation's influence on the patients' cognitive abilities is helpful for deter-

mining whether DBS can sustain the quality of life of the patients.

## 2. Literature review & rationale

The author has been interested in exploring the causes and treatments of Parkinson's Disease ever since I watched a video one year ago on an animal demonstration of the disease. The experimental mouse shaking its head relentlessly but painfully struck me and got my attention into this not-often-mentioned but truly striking disease<sup>[1]</sup>. Currently, deep brain stimulation is one of the most common treatments for patients with Parkinson Disease. The most prevalent type of DBS is subthalamic nucleus (STN) DBS<sup>[4]</sup>. Evaluating the effectiveness and the potential risk of the treatment is crucial. However, most of the studies focused on the effects of different treatments on their decision-making or physical abilities while ignoring their cognitive domain<sup>[2]</sup>.

Globus pallidal deep brain stimulation for Tourette

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syndrome: Effects on cognitive function by Cappon, *et al.* examined the influence of bilateral deep brain stimulation of the anteromedial globus pallidus internus (GPi-DBS) on the cognitive ability of patients with Tourette syndrome. They found a positive influence on the severity of the syndrome, but an insignificant influence on the cognitive ability of the patients<sup>[2]</sup>. Decline in drawing ability and cerebral perfusion in Parkinson's Disease patients after subthalamic nucleus deep brain stimulation surgery by Furukawa, *et al.*, examined 21 patients with PD and utilized perfusion SPECT to find a decrease of cerebral blood flow in the prefrontal and cingulate cortex after surgery. This is also reflected by a decline in the drawing abilities of the participants. This study shows that there may be a side effect of the DBS on the cognitive ability, despite its positive influence on the general conditions<sup>[3]</sup>.

Furthermore, multiple studies focused on a comparison between the surgical lesioning procedures' and the DBS's damage to the brain tissues concluded that Deep Brain Stimulation has a lower damage<sup>[1,5-7]</sup>. These studies show the importance of comparison between different treatments: even if DBS may negatively influence the cognitive ability of the patients, it may still be a better choice than surgical lesioning procedures<sup>[4]</sup>.

These studies inspired me to evaluate whether the same relationship exists in that of Parkinson patients. Therefore, this study will examine the effect of Deep Brain Stimulation on Parkinson patients and its relationship<sup>[5]</sup>.

## 3. Methodology

### 3.1 Sampling

All the participants of the experiment are PD patients. To ensure that the severity of PD of each participant is roughly the same, Multiple Sclerosis Functional Composite (MSFC) would be used. The patients will be assigned in to two groups based on the treatment they take, either DBS or surgical lesioning procedures<sup>[6]</sup>.

### 3.2 Method

All the participants should take the cognitive test before and 3-6 months after using deep brain stimulation. The patients were evaluated on tests of memory (Short Recognition Memory for Faces), executive func-

tion (verbal fluency, Hayling Sentence Completion Test), and attention (Numbers and Letters Test)<sup>[7]</sup>. Single-Photon Emission Computed Tomography (SPECT) will be used to examine the blood flow in different areas of the cerebrum to reflect the brain activity, providing explanations to DBS's influence on the cognitive ability of the patients<sup>[8]</sup>.

## 4. Conclusion

Deep Brain Stimulation, especially STN-DBS, is one of the most prevalent treatments for the Parkinson's Disease. Previous researches already showed its positive effects on the general conditions of the patients but didn't evaluate its influence on the cognitive ability of the patients. A comparison in the effect of DBS and surgical lesioning procedures can determine DBS's influence on the quality of life and confirm whether it is the most optimal treatment. Evaluating its influence on cognitive abilities can enable the patients to make better informed decisions on their treatment choices.

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