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# Changes in cognitive abilities after deep brain stimulation for Parkinson disease

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**WHY IS THIS STUDY IMPORTANT?** Persons with Parkinson disease (PD) who have difficulties from side effects or dosing of medications, or both, have the option of undergoing deep brain stimulation (DBS). DBS provides electrical stimulation via electrodes implanted into one or both sides of the brain. These electrodes are connected to a programmable (adjustable) pulse generator (like a pacemaker) placed under the skin of the chest. The 2 most common targets for the brain electrodes are the subthalamic nuclei (STN) or globi pallidi (GPi). One of each of these targets is found in the left and right halves of the brain. These brain structures contain circuits important for motor functions or movement. Nearby in the brain are circuits that regulate emotion, mood, and cognition. Cognition refers to mental abilities such as memory, abstract thinking, and word finding. There is concern that the benefits of DBS for movement might be offset by negative effects of DBS on thinking and emotion. Studies have shown that DBS is safe from cognitive and emotional standpoints. Still, a minority of patients have problems with cognition and emotion after DBS. It is unclear whether stimulating the STN or GPi is safer. A few studies examining a small number of patients (and often using a limited number of tests) suggest that stimulation of the GPi might be safer than the STN for cognition and emotion.<sup>1</sup> A large well-done study is needed to help physicians and patients make the best choices. This study by Odekerken and colleagues<sup>2</sup> is 1 of 2 recently published that seek to address the important question of whether STN or GPi DBS is safer.

**HOW WAS THIS STUDY DONE?** One hundred twenty-eight patients with PD were assigned in roughly equal numbers to undergo STN or GPi DBS. Of these, 114 completed a series of neuropsychological tests (tests of thinking ability, including, for example, memory) before and 12 months after DBS. This study compared changes in test scores before and after DBS for patients with implants at each brain location. The researchers also looked at how cognitive changes affected quality of life. They also tried to determine whether changes in thinking could have been predicted before DBS surgery.

**WHAT ARE THE STUDY'S MAIN FINDINGS?** Most tests of thinking were not different in the 2 groups. Scores on 2 tests of thinking were better in the GPi group than the STN group. Both tests involved response speed. This means that as groups, the GPi and STN DBS patients mostly showed similar changes in mental abilities. This main finding did not answer all questions about the effects of DBS. The researchers compared groups of people, but those tested may have had important changes that were hidden in the group results. Group findings do not express whether the changes have an important effect on quality of life. In additional analyses, the study found that those who experienced cognitive changes had a comparable quality of life to those who did not experience such cognitive changes. In fact, quality of life improved to a similar degree after DBS in both groups. Only one test score (ability to quickly say words belonging to a category) before surgery predicted whether a person would have a decline, but the study could not convincingly explain why those with better scores on the test got worse. When looking at person characteristics, the cognitive changes tended to occur in “older” persons. However, the average ages of those showing and not showing declines (62 years vs 58 years) were quite similar.

**NEXT STEPS, OR WHAT THE STUDY DOES NOT TELL US** PD is a progressive condition that involves eventual mental declines in most patients. Because of this, it is hard to identify which changes were a result of DBS, surgery, disease progression, or something else.

Another recent study helped answer this question. It compared cognitive outcomes after 6 months of DBS to outcomes after 6 months of more medical treatment.<sup>3</sup> That study also found very few differences in outcome between DBS stimulation of the 2 different brain sites (GPi and STN). However, it did find that patients treated with DBS had greater decline on cognitive tests than patients treated with medication. The higher number of persons who had declines on multiple tests in the study by Odekerken and colleagues might reflect how decline was defined. In addition, the participants were relatively young with healthy brain function. Future studies will hopefully show whether cognitive declines are more likely

to occur in those who are older or have noticeable cognitive problems already before surgery. We still need to find ways to reliably identify those patients at greatest risk for cognitive declines. For those at risk for cognitive decline, we need to understand when this decline affects quality of life to the extent that DBS might not be recommended.

#### REFERENCES

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## Section Editors

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# About deep brain stimulation

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**WHAT IS DEEP BRAIN STIMULATION?** Deep brain stimulation (DBS) is a surgery that is used to treat a number of disabling symptoms of neurologic diseases. These include symptoms of Parkinson disease (PD), essential tremor, dystonia, or obsessive-compulsive disorder. It has also been used in Tourette syndrome, neuropathic pain, and depression. A report of the first successful clinical use of DBS in PD was published in 1987 by Alim-Louis Benabid and his team from France.

Patients must be carefully studied and chosen for DBS. Patient selection for DBS is based on symptoms and medication response. The patient's major cognitive or emotional problems are also reviewed. DBS can be very beneficial for the treatment of symptoms that don't respond to standard medical treatments. Drugs should always be the first line of treatment, as they usually improve motor symptoms a lot, at least for some years. At some point, however, DBS could be the most effective therapy available for a number of persons with PD.

**HOW IS DBS SURGERY PERFORMED?** During DBS, the patient will have one or more (typically 2) wires, also called "leads" or "electrodes," placed into specific structures deep in the brain. An implantable pulse generator ("IPG" or "neurostimulator") is also placed beneath the skin in the chest or abdomen. The location in the brain where the leads will be placed is based on the person's symptoms. That surgical target is carefully identified using sophisticated computer software and brain imaging such as MRI and CT. A frame, which is used to precisely guide the leads into the desired location within the brain, is attached to the patient's head after the skin has been numbed. Skin and bone are carefully cut open, allowing further lead positioning in the brain. The extension cables are then passed under the skin into the chest (outside the rib cage), where the IPG is positioned. These wires will connect the IPG to the leads. The IPG delivers electrical pulses to the deep brain structures where the leads are implanted. These pulses change nerve cell function to relieve symptoms. Doctors and nurses

can regulate the IPG at any time using a special device that wirelessly "talks" to the IPG.

**WHAT ARE THE BENEFITS OF DBS IN PD?** DBS is usually offered to patients with PD when the so-called motor complications have set in despite best medication treatment. These motor complications include peak-dose dyskinesias. These are excessive involuntary writhing movements caused by the action of PD drugs. Another motor complication is called delayed "on," which is when there is an increasingly long interval between when a medicine is taken and when the symptom benefit is apparent. Sudden "off" periods, with rapid, sudden, and unpredictable loss of benefit from a given dose of medicine, may also be a problem.

In general, DBS can help symptoms that respond to medications such as levodopa, but it doesn't involve bothersome motor complications such as peak-dose dyskinesia. With DBS, patients will usually benefit from improved and more consistent mobility throughout the day, reduced tremor, and decreased motor fluctuations. There is growing evidence suggesting that DBS might also reduce a few nonmotor symptoms that improve with antiparkinsonian medication, such as anxiety and pain. In addition, after surgery many patients will be able to reduce the amount of medications taken.

**WHAT ARE THE RISKS?** DBS should be carried out by an experienced team. This reduces the risk of complications. Postoperative infection of skin wounds is one of the most common serious complications, occurring in about 5%–10% of cases. It is usually not life-threatening, but the stimulation system may have to be removed. A repeat surgery is possible in many such cases. The most serious surgical complication is bleeding in the brain caused by lead placement. This occurs in 1% or less of patients treated in experienced centers. A number of other complications might occur, many of them temporary, and this issue should be discussed with the treating team before surgery. Very few patients experience speech, cognitive, or emotional problems, some temporary and others more lasting.

**WHAT ELSE SHOULD PATIENTS KNOW?** The process of patient selection, surgical intervention, and postoperative DBS adjustment is difficult and takes time. Patients may need to be seen frequently in the clinic, especially in the first few months after surgery when stimulation and medication will be adjusted. Also, those considering the procedure should discuss expected benefits and risks with the treating team before deciding to have DBS so that expectations are clear.

#### **FOR MORE INFORMATION**

National Parkinson Foundation

<http://www.parkinson.org/parkinson-s-disease/treatment/surgical-treatment-options/deep-brain-stimulation>

Christensen, Jackie Hunt. *Life With a Battery-Operated Brain: A Patient's Guide to Deep Brain Stimulation Surgery for Parkinson's Disease*. Minneapolis, MN: Langdon Street Press; 2009.

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