Spatial Pattern Analysis of Deep Brain Stimulation in Parkinson's disease

Asim M. Mubeen[1], Babak Ardekani[2], John J Sidtis[1]

[1.] Brain and Behavior Laboratory, Geriatrics Division, NKI

[2.] Center for Biomedical Imaging and Neuromodulation, NKI

Abstract

A high frequency electrical stimulation i.e. Deep Brain Stimulus (DBS) of subthalamic nuclei (STN) is a widely used and successful therapy in Parkinson's disease (PD). However, the mechanism of this phenomenon is not very well understood. It is believed that stimulation of the STN adjusts the neurophysiological activity in basal ganglia resulting in more widespread effects in the brain. In studying the effects of STN-DBS on speech and brain function, Sidtis et al., 2012 observed a significant increase in whole-brain blood flow. That study used whole-brain regions-of-interest to obtain global values for the purpose of normalizing regional blood flow values. We have pursued the changes in global cerebral blood flow (gCBF) as a function of DBS-ON versus DBS-OFF conditions. We utilized pattern recognition methods to classify DBS-ON vs. DBS-OFF using PET (Positron Emission Tomography) images. After aligning and spatially normalizing PET images, Principal Component Analysis (PCA) was used to reduce the dimensionality of the data. Fisher's linear discriminant analysis (FDLA) was applied to the top principal components to differentiate DBS-ON from DBS-OFF. Using this method, we were able to discriminate between DBS-ON and DBS-OFF with 87% accuracy. The results indicated broad involvement of the cerebellum with increases in blood flow at a low magnitude, and more intense areas of increase and decrease across the cerebral hemispheres. The results provide additional evidence that stimulation in the region of the STN can produce widespread changes in cerebral blood flow.