Monitoring the effects of deep brain stimulation on sensorimotor cortex and peripheral muscles

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Background:

Deep brain stimulation (DBS) has been used for controlling motor symptoms of Parkinson's disease. Optimizing the DBS parameters using objective measures is desirable. Here we report the first result of mobile brain/body imaging using simultaneous high-density scalp EEG, neck and arm EMG, and body motion capture recordings from Parkinson's disease patients at onsets and offsets of bilateral subthalamic nucleus deep brain stimulation to observe resulting tremor modulation.

Materials and Methods:

Parkinson's disease patients with DBS treatment (n = 3) underwent EEG recording sessions. Here we report results on one subject. EEG was recorded from 192 electrodes placed on the scalp. Electromyographic (EMG) activity was recorded from 64 surface electrodes places on the right arm surface. The subject was seated comfortably. During recording, the experimenter switched the subject's DBS unit on or off at 1-minute intervals in a 108-minute session. EEG data were analyzed using EEGLAB (sccn.ucsd.edu/eeglab). Data were low-pass filtered below 50 Hz, and were linearly decomposed using adaptive mixture independent component analysis (AMICA) to obtain time-domain independent component activities, which were converted into the time/frequency domain using a wavelet transform. Equivalent dipole models were computed for stationary scalp topographies of independent component processes originating in brain source activity.

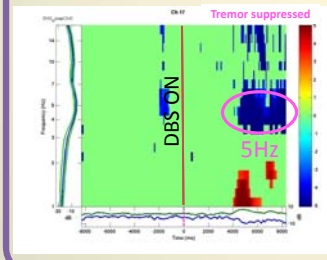
Mobile Brain Body Imaging (MoBI) Lab at SCCN

Motion capture (480Hz)

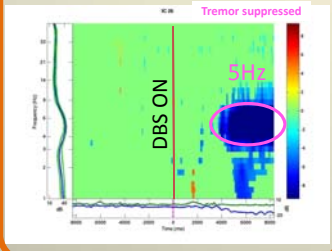
64ch arm EMG

192ch EEG

Motion capture

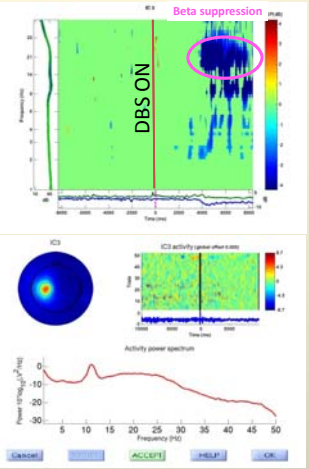


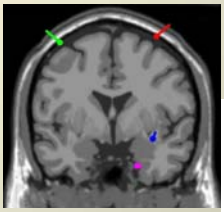
Tremor EMG



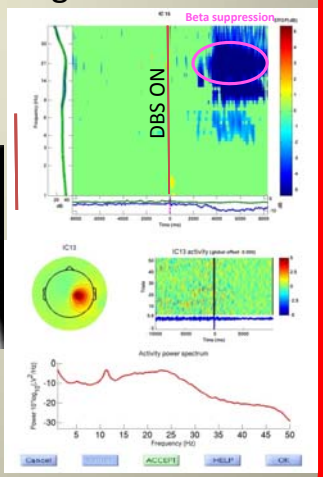
Event-related brain potentials

Left Motor Cotex





Right Motor Cortex



Results and Conclusion

Event-related potential (ERP) analysis revealed that turning on the DBS unit produced significant EEG power suppression in the beta band (15-30 Hz) activity in bilateral sensorimotor cortices about 4-sec after DBS onset. Importantly, DBS onset was also associated with strong attenuation of EMG power near 5 Hz and its harmonics in right neck muscle source activities and right arm EMG channels. Simultaneous motion-capture data from right arm markers also showed a near 5-Hz peak.

This result demonstrates that DBS suppresses beta-band activity in sensorimotor cortex, as well as suppressing tremor-associated EMG activity, and establishes the feasibility of using mobile brain/body imaging (MoBI) methods to monitor modulation of brain activity associated with movement disorders.