attenuation of which is related to the improvement in bradykinesia. We compared the efficacy of neural closed-loop deep brain stimulation (NCL-DBS) for bradykinesia using patient-specific beta sub-bands that were more or less attenuated by deep brain stimulation compared to the off DBS state. **Methods**: To determine the upper and lower voltages for NCL-DBS and the beta band control variables, 6 akinetic-rigid consenting PD subjects (10 STNs), off-medication performed a repetitive wrist flexion-extension task (rWFE) during randomized presentations of 140Hz contralateral STN open loop (OL-)DBS at 0%, 25%, 50%, 75% and 100% of their maximum tolerable voltages. Synchronized wrist angular velocity and STN local field potentials (LFPs) were recorded during the task. Angular velocity was recorded using wearable gyroscopic sensors and LFPs were recorded from electrodes 0 -2 or 1 -3 of the DBS lead (model 3389, Medtronic, Inc) on to a sensing implanted neurostimulator (Activa®PC+S, FDA-, IDE-, IRB-, and CA Medicare-approved). LFP power spectral density identified two LFP bands between 8-30 Hz in each STN that were more or less attenuated during the voltage range used for NCL-DBS; these were used independently to drive NCL-DBS (Activa®PC+S and Nexus-D3/E system; Medtronic, Inc). **Results**: 6 PD subjects have completed WFE during randomized presentations of contralateral OL-DBS, 2 of whom have also completed a trial of 60 minutes of NCL-DBS driven by the beta sub-band that was maximally attenuated during OL-DBS. Preliminary results demonstrated that for each subject compared to off DBS, the root mean square angular velocity (V_{rms}) increased by 631% and 1692%; the coefficient of variation (CV) of V_{rms} decreased (more regular) by 66% and 86%; the mean frequency of movement increased by 362% and 442%; and the CV of frequency decreased by 79% and 83% during NCL-DBS. V_{rms} and frequency were greater on NCL-DBS compared to OL-DBS in both subjects. The total electrical energy delivered decreased by 43% and 63% during NCL-DBS as compared to their clinical OL-DBS.**Conclusions**: Neural closed loop STN DBS using LFP power in a patient specific, functionally relevant beta sub-band improved the velocity, frequency and regularity of progressive bradykinesia in akinetic rigid PD subjects and was more efficacious and efficient than their clinical open loop DBS. Further comparison of efficacy, side effect profile, and efficiency of patient specific NCL-DBS will be made with functionally irrelevant beta bands and with OL-DBS.

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Poster

498. Neurophysiology: Implanted Electrodes and Direct Interactions With Neurons - Stimulation and Closed-Loop

Location: Halls A-C

Time: Tuesday, November 14, 2017, 8:00 AM - 12:00 PM

Program#/Poster#: 498.21/HH35

Topic: E.05. Brain-Machine Interface

Support: NSF Grant DGE 1106400

Title: OMNI: A wireless,128-channel closed-loop neuromodulation device

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Abstract: Closed-loop neuromodulation systems, which deliver therapeutic microstimulation based on the real-time neural state of the patient, aim to provide on-demand therapy and reduce side effects, while also extending battery life. These technologies must be able to simultaneously record neural signals, remove stimulus artifact from recorded data, and extract neural biomarkers and behavioral states to optimally and automatically deliver microstimulation. To address these needs we have developed OMNI, a wireless and autonomous neurotechnology for closed-loop neuromodulation and continuous, high-throughput streaming of neural data.
OMNI utilizes two custom 64-channel ASICs for recording and stimulation, whose outputs can be dynamically assigned to any of 128 electrode channels. The ASICs provide highly reconfigurable stimulation parameters and nearly artifact-free recording during stimulation, resulting in real-time closed-loop computation on local neural activity during stimulation. On-board computational components enable neural signal processing and closed-loop control algorithms, and wireless data communications allow for operation during natural behavior with 11+ hours of battery life.
OMNI has been deployed in a nonhuman primate (NHP) subject for closed-loop microstimulation during a manual-control delayed reach task. The device records local field potential (LFP) activity and determines when the NHP is performing different sub-stages of the task by thresholding the power in different frequency bands, with all computation done on-board. The reaction time is increased by delivering targeted microstimulation in dorsal premotor cortex (PMd) during the delay-hold periods of the task, prior to the onset of movement. The OMNI device was also used for overnight cortical and subcortical recording during free, natural behavior. The pilot NHP study demonstrates the comprehensive recording and closed-loop functionality of the OMNI device.

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