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Presentation Title: Next Generation Smart DBS and Neuromodulation

Abstract:
Our team has pioneered real-time imaging of the response of the brain during DBS in both humans and animals. Using BOLD-fMRI imaging techniques, we are identifying brain regions and networks that are activated by DBS and are studying how patterns of DBS-invoked brain activation change after long periods of stimulation. Although its mechanism of action is poorly understood, we know that DBS causes the release of chemicals called "neurotransmitters" in specific brain regions, depending on the site of stimulation, and we believe that stimulation-induced neurotransmitter release plays a critical role in the therapeutic benefits of DBS. The success of DBS depends on the amplitude and frequency parameters of stimulation. Today's DBS systems deliver continuous stimulation at pre-set parameters in an open-loop mode without regard to potential changes in neural activity or patient behavior. We believe that tracking the dynamics (pattern and amount) of neurotransmitter release could serve as a feedback signal to develop a closed-loop smart system of DBS in which stimulation parameters are varied dynamically to optimize neurotransmitter release and maximize therapeutic effects for the patient. Our research and engineering team at Mayo has developed a neurotransmitter sensing system called WINCS (wireless instantaneous neurotransmitter concentration sensor), which is a device able to monitor stimulation-induced neurotransmitter release. We are now working to create and test WINCS MAVEN, the first integrated closed-loop DBS system for human use. Our clinical team was among the first to show neuromodulation therapy to be a viable treatment option for obsessive compulsive disorder and Tourette's syndrome. We are now working to expand the application of DBS to other neurologic and psychiatric disorders including addiction.

Brief Biosketch

Dr. Lee is a consultant in the Department of Neurologic Surgery with joint appointments in the Department of Physiology and Biomedical Engineering and the Department of Physical Medicine and Rehabilitation at Mayo Clinic in Rochester, Minnesota. He joined the staff of Mayo Clinic in 2006 and holds the academic rank of professor of neurosurgery and Biomedical Engineering.

Dr. Lee earned his B.A. in biology with a minor in philosophy (Summa Cum Laude) from the University of Colorado at Denver. He attended Yale University Graduate School, where he received his Master of Philosophy, M.D. (Cum Laude) and Ph.D. in neurobiology. He completed an internship in internal medicine at the Hospital of St. Raphael, Yale University School of Medicine and a residency in neurology at Harvard Medical School. He furthered trained at Dartmouth Hitchcock Medical Center, completing an internship in general surgery and a residency and chief residency in neurosurgery.

In his clinical practice, Dr. Lee is an expert on neurological disorders, seeing patients with Parkinson's disease, Tourette's syndrome, dystonia and other neurodegenerative diseases. His research focuses on developing deep brain stimulation for the treatment of Parkinson's disease, tremor, depression, obsessive-compulsive disorder and epilepsy. Dr. Lee is fascinated with the possibility of combining sophisticated electrophysiological and electrochemical recordings with miniaturized analytical elements (microprocessors) to augment or repair disrupted function of the brain.