Department of Biomedical Engineering
UNIVERSITY OF WISCONSIN–MADISON

Fall 2018 Seminar Series

Electrochemical, optical, and computational techniques for studying the neural effects of deep brain stimulation

J. Luis Luján, Ph.D.; Associate Professor,
Department of Neurologic Surgery at Mayo Clinic

More than two decades of animal and clinical studies have increased our understanding of the mechanisms by which electrical stimulation interacts with the central nervous system. However, there remains a lack of consensus regarding how stimulation of both neuronal and non-neuronal elements can lead to the therapeutic effects of specific neuromodulation techniques such as deep brain stimulation (DBS). Invasive data recording techniques such as electrophysiological monitoring have provided insight into the effects of electrical stimulation on morphologically- and functionally-undefined neural tissue but only at discrete nodes in the brain. In contrast, non-invasive techniques such as functional imaging and mathematical modeling have shed light on system-level effects on neural activity but have failed to provide information at the cell level. These techniques have failed to bridge the gap between the cellular, system level, and behavioral effects, thus preventing complete understanding of the underlying therapeutic mechanisms of deep brain and other forms of electrical stimulation.

It is clear that elucidating the underlying mechanisms of neuromodulation therapies will require the application of new data acquisition and analysis methods that provide information on the effects of stimulation at both the cellular- and systems-levels in the context of behavior. This presentation will describe a multidisciplinary bioengineering approach that integrates DBS, electrochemical monitoring, fluorescent microscopy, and computational modeling to identify real-time changes in neural activity evoked by DBS in a freely moving animal model of PD across type-specific populations of neuronal and non-neuronal cells. In the near future, the use of experimental paradigms that can bridge the gap between behavior and cellular- / system-level activity will enable a deeper understanding of neural interactions that can be used to tailor DBS and other electrical stimulation therapies to specific pathologies and individuals.

ABOUT the SPEAKER

J. Luis Luján is an Associate Professor in the department of Neurologic Surgery at Mayo Clinic. Dr. Luján is also the Assistant Dean for Diversity and Inclusion at the Mayo Clinic Graduate School of Biomedical Sciences and one of the co-directors of the Mayo Clinic Initiative for Maximizing Student Development (IMSD) and Postbaccalaureate Research Education Program. Dr. Lujan serves as the faculty advisor for the Initiative for Medical Equipment Sustainability (IMES), Med Students Care, and the Scientific Innovations Through Diverse Perspectives (SITDP) Conference Steering Committee. Dr. Luján received the B.S. in Computer and Systems Engineering from the Universidad Autónoma de Chihuahua in Chihuahua, Mexico and the M.S. and Ph.D. degrees in Biomedical Engineering from Case Western Reserve University in Cleveland, Ohio. Dr. Luján completed a postdoctoral fellowship at the Cleveland Clinic in Cleveland, Ohio. Dr. Luján's research is aimed at studying and modulating brain activity following neural injury and disease by taking advantage of engineering, mathematical, and computational principles and techniques.

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