The Efficacy and Optimization of Somatosensory Intracortical Microstimulation in Rats

Sean McDowell[1,2], Ryan Verner[1], and Kevin Otto[1,3]

[1]*NeuroProstheses Research Laboratory, Weldon School of Biomedical Engineering, Purdue University, West Lafayette, Indiana*
[2]*Summer Undergraduate Research Fellowships, Purdue University, West Lafayette, Indiana*
[3]*Department of Biological Sciences, Purdue University, West Lafayette, Indiana*
Email: smcdowe@purdue.edu

Demand exists for brain-machine interfaces that offer a wide range of sensory feedback along with volitional motor control to individuals with limited control of natural sensory or motor function. As these sensorimotor devices are developed, it is necessary to improve the interaction between the prostheses and higher-level cortical structures. Optimizing these somatosensory stimulation parameters will require the use of a high-throughput experimental design. To address this, one Sprague-Dawley rat was trained to respond to auditory stimuli during a conditioned-avoidance behavior task and then implanted with a penetrating microelectrode array in the part of the somatosensory cortex corresponding to the left forelimb. After implantation, the task was repeated using electrical stimuli instead of auditory signals. Detection threshold data was collected from each electrode site to prove stimulation efficacy. The pulse rate of electrical stimulation was varied to optimize power usage by the neuroprosthesis while still achieving the lowest possible thresholds. Electrical impedance spectroscopy and cyclic voltammetry data were collected to monitor the performance of the electrode. Testing shows that auditory learning can be translated to somatosensory stimulation. As an aggregate, somatosensory detection thresholds are significantly different from those in the auditory cortex (Student's t-test, $p < 0.0003$). With these results in mind, future research can further optimize somatosensory intracortical microstimulation to provide more sensory feedback in motor prostheses.