Project title: recurrent neural-computer interfaces for neuropathic pain

Project description: up to 80% of individuals with spinal cord injury (SCI) experience debilitating, medically refractory neuropathic pain. In part, this pain may be related to maladaptive over-activity in specific spinal pain-processing neurons. Recurrent neural-computer interfaces (rNCI) are an emerging technology that uses biophysical signals recorded from one area of the body/nervous system to trigger contingent stimulation (e.g., electrical, chemical) in another region of the central or peripheral nervous system. Such artificial neural connections can be used to facilitate and guide beneficial neural plasticity and/or to produce specific movements or sensations. In this project, we aim to use rNCI to selectively weaken over-active neural circuits by driving activity-dependent neural plasticity. The project draws primarily from the broad fields of basic neurophysiology, animal models of SCI, biophysical signal processing, data acquisition/instrumentation, and electrical engineering.

Project title: sensorimotor integration as a window into neurological impairments

Project description: injuries to the central nervous system such as stroke and spinal cord injury frequently result both in motor deficits and changes in sensation (ranging from muted pain perception to the presence of spontaneous neuropathic pain). Although a growing body of evidence suggests that an increased influence of specific neuromodulatory centers in the brainstem reticular formation may underlie both the sensory and the motor changes, the majority of investigations only consider one or the other. Thus, in this project we will investigate the pain-motor dynamic in humans by using a combination of mechatronic devices, psychophysical analyses, and biophysical signal processing. The goal of the project will be to quantify how changes in volitional motor output impact sensory acuity, and how painful and non-painful sensory stimuli impact volitional and reflexive motor output.