We have initiated several studies designed to better understand and modulate the interactions between cortical and subcortical motor circuits. The first was a study in able-bodied volunteers, comparing the acute effects of three different types exercises targeted at different nervous system components: treadmill (spinal locomotor circuits), balance (brainstem and other pathways), and multimodal balance plus skilled hand exercise (simultaneous cortical and subcortical circuits). Transcranial magnetic stimulation (TMS)-mediated motor evoked potentials and TMS-mediated soleus H-reflex facilitation were measured immediately before and after each session. Across 20 subjects, short-interval H-reflex facilitation increased by 13.2±4.0%, 8.3±4.7%, or -1.9±4.4% for balance, multimodal, and treadmill exercise, respectively (p=0.042). Increases in long-interval H-reflex facilitation of 14.2±6.1%, 5.5±6.7%, and 5.7±7.2% for balance, multimodal, and treadmill exercise, respectively, were not significant. Both balance and multimodal exercise increased central motor conduction velocity significantly more than treadmill exercise (4.3±2.6%, 4.5±2.8%, versus -4.3±2.7%; p=0.045). All exercise types increased tibialis anterior evoked potential amplitude. These findings suggest that balance exercises (targeted mostly at subcortical pathways) may strengthen transmission between the motor cortex and spinal circuits in able-bodied volunteers. A clinical trial is now underway in individuals with chronic incomplete thoracic SCI to compare 48 sessions of two different exercise programs: body weight-supported treadmill training or multimodal training (balance exercises combined with skilled hand exercises). Both neurophysiological and functional outcomes are being assessed in that study.

Another project getting underway will apply clinical, radiological, and neurophysiological measurements in individuals with SCI to achieve two purposes: first, to quantify and categorize each person’s sparedome; and second, to establish surrogate neurophysiological endpoints for measuring short-term responses to different SCI treatments. This approach will optimize our ability to personalize SCI rehabilitation — each individual’s optimal intervention regimen will be rationally chosen based on short-term neurophysiological biomarker responses. This would replace the trial-and-error, one-size-fits-all approach currently used in rehabilitation.