Project Title: Electrophysiological basis of cortical abnormality in children with encephalopathy of prematurity

Abstract: The incidence of premature birth is high and growing. The ability to save the lives of babies born prematurely is improving each year. However, diagnosis of resulting brain injury is lacking and large numbers of premature children have serious neurodevelopmental disabilities. Brain injury from premature birth consists primarily of periventricular leukomalacia (PVL), exhibiting cerebral white matter injury often accompanied by neuronal/axonal disease. We propose to integrate three cutting-edge neuroimaging technologies to develop a novel method to identify the electrophysiological basis of cortical abnormalities in children with PVL. We will focus on children who have developed cerebral palsy (CP) with sensorimotor deficits due to PVL. Magnetic resonance (MR) based high-angular resolution diffusion imaging (HARDI) of axonal structural connectivity will be used to quantify differences in thalamocortical and cortico-cortical fiber tracts to somatosensory cortex between CP patients and age-matched controls. Quantified differences in fiber tract number and conductance velocities will then be implemented into a biophysically principled mathematical neural modeling that simulates magnetoencephaolography (MEG) measured somatosensory evoked fields (SEFs), which depend explicitly on thalamocortical and cortico-cortical connectivities. Predictions on resulting abnormalities in SEFs will be made and then tested with a custom designed pediatric MEG system. Our goal is to see if we can predict the SEF responses in these patients on an individual basis. To the extent that this is possible, we will be able to identify the nature of the cortical abnormality in children with CP due to PVL and in the long-term premature infants while in the NICU.