Impacts of cortical lesions on cognition in multiple sclerosis
Geoffrey Ngo
Supervisor: Dr. Ravi Menon

Introduction: Multiple Sclerosis (MS) is the most common CNS disease in young adults affecting approximately 2.3 million people worldwide with prevalence rates in Canada being the highest [1]. The accumulation of lesions in the brain due to MS can lead to varying degrees of sensorimotor and cognitive impairment in patients [2]. While the sensorimotor symptoms are relatively well understood, the heterogeneity of MS pathology suggests that a lesion’s location may be a driving factor in domain specific cognitive decline. Resting-state functional magnetic resonance imaging (rs-fMRI) can be used to quantify connectivity between regions in the brain [3]. The synchrony of BOLD signals observed in resting-state network (RSN) analysis suggests there is an underlying white matter topology connecting cortical gray matter regions to one another, and damage to these structures likely affects their functional connectivity [4]. To better understand the correlations between lesion patterns and functional connectivity, a seed-based rs-fMRI approach could be employed as a sensitive method to delineate RSNs that are implicated with lesions. Diffusion tensor imaging (DTI) could then be used as a complimentary tool to provide quantitative measures that define the structural integrity connecting these regions of interest together.

Objectives: The study aims to determine for the first time if a lesion’s location has a negative impact on a specific cognitive domain, thus leading to impairment. To that end, I hypothesize that (1) the incidence of a cortical lesion may decrease the functional connectivity within the RSN that it resides in, and (2) the potential changes in the RSN may explain for the varying degrees of cognitive impairments we see in MS patient populations.

Methods: MS patients will be recruited to take part in a longitudinal study where patients will undergo specific MRI scans and participate in an array of cognitive batteries every 6 months for 7 years. The MRI protocols will all be employed using a 7T MRI scanner and will include a T1-weighted scan for anatomical information, a T2-weighted scan for structural damage, a DTI scan for tractography, and a spin-echo echo-planar scan for resting-state data performed twice for statistical power. A 7T MRI is necessary because cortical lesions are essentially invisible at lower magnetic field strengths. A seed-based resting state analyses will be performed on a patient by patient basis across all time points using regions of interest that exhibit newly formed cortical lesions. Changes in functional connectivity will be investigated further by examining potential correlations with DTI and cognitive measures.

Significance: My proposed study will provide a direct investigation into understanding the variations of cognitive impairment in MS populations. Structural damage residing in these resting state networks will be investigated on a patient by patient basis, thereby helping better understand specific neural mechanisms. This information can be used to further guide the direction of future rehabilitations and drug therapies.

References