Research Statement

Sex bias refers to unintentional, but systematic neglect of a given sex. In medicine, this bias exists as stereotyped preconceptions about the health, behaviours, experiences, and choices of an individual based on their sex, and can have fatal consequences. Sex differences exist in risk factors, prevalence, diagnosis, symptomatology, trajectory, and treatment of many neurological diseases. Although clinicians are aware of sex bias, many healthcare decisions continue to be based on studies with predominantly male subjects.

In recent years, the use of machine learning in medicine has shown extraordinary promise but we must address ethical challenges when implementing these predictive models. Models trained on biased data capture patterns of pre-existing healthcare disparities. To avoid this, sex-dependent models must be explored. My research integrates my expertise in neuroimaging, connectomics (study of brain networks), neuroendocrinology, and machine learning to explore multimodal brain connectivity patterns underlying 1) sex differences in the brain, 2) cognitive abilities, and 3) sex-specific models of cognition.

Although males and females are similar across many domains, there are key differences in brain functional and structural properties that must be acknowledged. In my recent work, I quantified sex differences in temporal dependence of regional activation patterns and regional brain volumes. I also demonstrated that predictive models can classify subjects based on sex using regional temporal dependence or brain volume. This has major implications on the application of these measures as diagnostic markers for diseases exhibiting sex differences. To further advance this field, I am now identifying how brain activation patterns relate to hormone levels throughout the menstrual cycle and gene expression patterns.

Tens of billions of neurons interconnect in the human brain. Direct and indirect structural white matter connections between these neurons facilitate the flow of functional activation between brain regions. Together, these connections give rise to human cognition. In a recent study, I demonstrated that 1) machine learning models can successfully predict individuals' cognitive abilities based on functional and structural connections, and 2) distinct functional and structural connections are important to make these predictions.

An understanding of sex differences and neural correlates of cognition in the healthy brain provides an important foundation with which to delineate sex-specific mechanisms in age-, injury-, and disease- related changes in cognitive functioning. Building on my previous work, I am developing sex-specific models to predict cognitive function. These models will allow us to quantify sex-specific functional and structural connections underlying cognitive function.

In my current research, I address sex bias in medicine. In the future, I hope to expand my work to address gender biases as well. My long-term goals are to build sex- and gender- specific predictive models for cognitive dysfunction: a thorough understanding of sex- and gender-specific brain connectivity patterns underlying cognitive abilities will serve as a foundation for these models. These sex- and gender- specific models can inform decisions about disease diagnoses and help uncover treatment targets.