Vision is the sense most central to people’s experience of the world. While a lot is experimentally known about the early visual system, we are still lacking an integrative theory of how vision works and why. For my PhD, I want to tackle this problem and build coherent, testable theories that can explain and unify experimental findings in visual neuroscience.

To do so, I will draw upon my previous research experience in both visual and computational neuroscience. My first real research experience was in the last year of my undergraduate degree in honors psychology at McGill University, where I was able to work on my own research. In my project entitled “**Modulating episodic memory alters risk preference during decision-making,**” we found that probing episodic memory in human participants reduced their aversion towards risky decisions. I’ve published this work as a first-author in the Journal of Cognitive Neuroscience. This project really helped me build autonomy and further sparked my interest in research.

Because I wanted to better understand the brain at the circuitry level, I then pursued my Master’s degree in visual neuroscience under the supervision of Dr. Curtis Baker at McGill University. In my research, entitled “**Model-Based Approach Shows ON Pathway Afferents Elicit a Transient Decrease of V1 Responses,**” I built a custom machine learning algorithm to analyze how recorded primary visual cortex (V1) neurons respond differently to light and dark patches within natural images. Using these methods, we showed that V1 neurons have weaker inhibition to dark than light stimuli in their early, but not late, responses. I’ve published this work as the first-author in the Journal of Neuroscience.

I am excited to now take my academic career to the next level by pursuing my PhD at Duke University under the supervision of Dr. John Pearson. I want to better understand the visual system by studying how it relates to information coding principles. Barlow (1961) suggested that sensory systems should be organized to optimize the information they process within some biological constraints (such as energy costs and a limited number of neurons). This *efficient coding* hypothesis makes testable predictions that have been verified experimentally, such as center-surround receptive fields (Karklin & Simoncelli, 2011) and color-opponency (Lee, Wachtler & Sejnowski, 2002) in the retina. Another interesting characteristic of the retina is that its neurons are organized into functional types, with each neuron type forming a mosaic and being distributed evenly across the entire retina. There are over 40 functional types in the retina, each of which processing visual stimuli in a different way. Recently, Jun, Field and Pearson (2021) used an efficient coding model to explain characteristics of these retinal mosaics. However, these models are limited to black and white information and cannot yet make predictions about how colors are processed. It is well-known that most retinal neurons form a mosaic that encodes the difference between shades of red and green, while another subset of neurons forms a mosaic that encodes differences between shades of blue and yellow. In my research, I aim to explain why it is efficient to encode colors this way by expanding the efficient coding model by Jun, Field and Pearson (2021).