

How the brain can achieve extraordinary computations on a routine basis has sparked my curiosity for the longest time. This curiosity motivated me to pursue a career in research to understand how the human brain works. I first chose to do an undergraduate psychology in McGill for the university's strong empirical research background in psychology and neuroscience. I then wanted to get a better grasp of how the brain computes information, which is why I pursued my graduate education in neuroscience at McGill to study the primary visual cortex. Next, I would like to further my understanding of brain computations even further by doing simulations of how unsupervised plasticity rules shape cortical networks. Stanford would be the perfect university for me to pursue such a project due to its strong laboratories in theoretical and visual neuroscience.

I've had the chance to develop a strong systems neuroscience background thanks to neuroscience courses at McGill such as "Human cognition and the brain", "Behavioral neuroscience 2", and "Topics in systems neuroscience". These classes taught me about a variety of cortical systems and allowed me to get an overview of what neuroscience is like across different fields. My neuroscience experience was further strengthened by studying the primary visual cortex in my graduate studies. I've also developed a solid statistical background from classes such as "Statistics" and "Multivariate linear regression and ANOVA". These classes taught me statistics from a mathematical perspective, which now grants me a deep understanding of how statistical tests work and help me greatly in analyzing data. Finally, I've challenged myself in my last semester of undergraduate studies by taking a graduate-level "Applied machine

learning” course from which I’ve learned a variety of machine learning skills and techniques.

My undergraduate studies granted me solid research experience through research projects in three different laboratories. My first lab in social psychology taught me how to design rigorous experiments. My second lab was in motor neuroscience and taught me how to do research using about computational approaches and how to program in R. My third lab was in decision-making and taught me the autonomy required to go from the start of a project to its publishable state. I’ve gained a variety of research skills through these different labs, which in my last year of undergraduate studies allowed me to publish my first-author paper entitled “Modulating episodic memory alters risk preference during decision-making” in the *Journal of Cognitive Neuroscience*. This research experience has also been greatly helpful to help me succeed in my master’s degree.

I am currently doing graduate research with Curtis Baker at McGill university on a project entitled “ON inhibition underlies stronger V1 responses to darkness”. My project combines electrophysiology with machine learning to better understand how different inputs drive V1 responses. We predict recorded responses of V1 neurons to natural images with a biologically-inspired convolutional neural network which, like the early visual system, separately processes light (ON) and dark (OFF) information in two parallel pathways. This fitting procedure allows us to infer the amount of excitation and inhibition each neuron receives from both pathways. Using this approach, we show V1 neurons to receive much more ON inhibition than the three other types of inputs,

especially at earlier time lags. These results explain why most V1 neurons are more driven by dark than by light stimuli (Yeh et al., 2009), and why V1 responses to dark are faster than to light stimuli (Komban et al., 2014). I have presented my research at the Society for Neuroscience (SFN) conference this year and intend to publish this work in an esteemed journal (such as Neuron, Journal of Neuroscience, or PLOS computational biology) soon. My graduate research taught me how to search the literature to ask the right research questions, and how to design experiments and analyze data to answer these questions. This research also improved my computational skills and taught me how to apply machine learning approaches to answer neuroscience problems.

I have also applied the statistical skills I have learned in my undergraduate studies to help others and gain teaching experience. I have tutored statistics to a variety of McGill undergraduate students for a year. I have also helped my fellow graduate students by teaching two workshops on how to use R for statistical analyses. These teaching experiences have improved my ability to explain complex ideas and techniques.

For my PhD, I want to better understand how neurons' receptive fields are built from spike-time-dependent plasticity (STDP) learning rules. We have a good grasp of how connections between different types of neurons can be strengthened or weakened. However, our understanding of how such learning rules shape and improve cortical networks is still relatively poor. I would like to combine biologically inspired unsupervised learning algorithms with natural images to replicate the center-surround receptive fields of retinal ganglion cells and the orientation selectivity of V1 cortical

neurons. I would also be interested to simulate STDP in hippocampal structures to better understand how this system encodes space and memory. I believe such simulations would help us understand how neurons become efficiently wired to process information.

Stanford university would be a great fit for me because of its strong laboratories in theoretical neuroscience. I am especially interested in working under the supervision of either Daniel Yamins or Surya Ganguli, due to their experience in applying computational models to visual neuroscience questions. I look forward to overcoming the challenges necessary to complete a PhD and hope what I learn will make me prepared to pursue a career in research.