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Statement of purpose

I've always been obsessed about wanting to understand how the brain and mind work. As early as my teenage years, my dream has been to understand the neural circuitry behind our decisions, feelings and perceptions. To fulfill this curiosity, I pursued degrees in the fields of psychology and neuroscience. The more I learned about these topics, the more amazed I became at how complex and fascinating the brain is. However, I also learned how distant we are from understanding the computations performed by neural circuitry. While the brain is very intricate and this dream of mine might seem unrealistic today, the field of neuroscience is thriving and I believe how the brain solves complex tasks won't remain a mystery forever. There will be a day when we understand how the brain manages to transform simple photons on the back of the retina into the perception of a home, or even how our mind decided to buy that house in the first place. I'm curious to see what such theories will look like, and I want to study computational neuroscience so I can help us get there. I am especially interested in neuroplasticity since I believe it is thanks to neuroplasticity that neurons learn to work together to solve complex tasks. Obtaining my PhD at the University of California at Berkeley would be ideal, as many of the leading experts in computational and theoretical neuroscience are at the Redwood Center.

My first real taste of research was in my third year of undergraduate studies, where I was given the opportunity to be in charge of my own research project. My work afforded me a first-author publication in the Journal of Cognitive Neuroscience titled **"Modulating episodic memory alters risk preference during decision-making"**, where we found that engaging episodic memory processes increased preferences towards risky decisions. I built this project from scratch and did almost everything including writing the ethics proposal, programming the computer task, testing participants, analyzing data and writing the paper. I faced many challenges along the way, including learning Python so I could program the computer task and re-analyzing the data so I could better understand the results and interpret them into a coherent story. Solving these problems helped me develop more autonomy and made me realize how fulfilling it is to carry out my own research. This project prepared me to start my Master's degree and become a graduate student.

My master's thesis, **"Transient inhibition to light explains stronger V1 responses to dark stimuli"**, aimed to study the mechanisms behind stronger responses to dark than light stimuli in the primary visual cortex. We used machine learning to do system identification of recorded V1 neurons. We discover the stronger dark responses found by previous research (Jin et al., 2008; Shapley et al., 2009) to only occur at early

latencies, and to be due to slower intracortical inhibition to dark than light stimuli. During this research project, I greatly improved my machine learning skills, learning how to use Tensorflow to build my own custom, biologically-inspired convolutional neural network. I also developed a solid expertise in both visual neuroscience and electrophysiology, on top of learning how to review and understand the literature to relate my results to it. The preprint of this work is currently available as a BioRxiv, and we are working to get it published in a peer-reviewed journal.

During my master's, I published a paper entitled **"Visual perception of texture regularity: conjoint measurements and a wavelet response-distribution model"** where I created the extension to an advanced statistical method to analyze our experimental data. This psychophysics project studies the effect of jitter, texture size and texture spacing on the regularity perception of stimulus pairs using Maximum-Likelihood Conjoint Measurement (MLCM). While MLCM was previously used to study two variables when comparing stimulus pairs, our study was the first to simultaneously estimate the effect of three different variables. As the group's statistical expert, I designed a new statistical framework to extend MLCM to test for two and three-way interactions in an experiment with three variables. We found the effect of jitter on regularity perception to be strongest at small element spacing and large texture element size, suggesting the visual system uses the edge-to-edge distance between elements as the basis for regularity judgements. This work was published in PLOS Computational Biology, and received compliments from Kennett Knoblauch, who invented MLCM.

We are rich in knowledge about how neuroplasticity works at the cellular level, but there is still little we understand about how these rules allow neural circuitry to solve complex problems. To make a difference, I want the next step in my research career to be studying computational models of neuroplasticity. An example project I am interested in would be to use biologically-inspired neural networks with Spike-Timing-Dependent Plasticity (STDP) to replicate results of sparse coding models (Olshausen & Field, 1996) in primary visual cortex (V1). I dream of being given the opportunity to obtain my PhD at the University of California at Berkeley, as the Redwood Center has some of the best theoretical neuroscience researchers in the world. This includes Dr. Bruno Olshausen, who does outstanding research at replicating results from the primary visual cortex using sparse code models, and Dr. Friedrich Sommer who does amazing work at combining computational models with electrophysiology to study the primary visual cortex. I am certain doing research for such supervisors would be both fascinating and propel my research career to the next level.