In everyday life we feel a direct and undeniable connection between attending to something and our clear awareness of it. In my own experience rock climbing I have had moments of tunnel vision: an intense focus on just the act of climbing while the rest of my awareness faded temporarily. I became interested in studying this phenomenon during a class taught by Professor Shimon Edelman at Cornell University. Professor Edelman discussed how brains can be looked at through the lens of programming and put forth a view that stood out for me: what brains do is use neurons to compute minds. Understanding what computations are necessary to generate perception remains an unsolved problem. For tunnel vision in climbing we would ask: what computations are the neurons involved in representing our awareness performing and how are these modulated by attention? This is a critical issue for our understanding of the mind but it also extends into other domains. If neurons are only a substrate for computation, then we may be able to take the same computations and use them to inform the engineering of new technologies. Several recent efforts have tried to mimic the design of neurons using silicon chips (cell bodies, axons, etc), but another direction is to translate the computations themselves into a design.

During the past four years I have taken advantage of several key opportunities to gain an understanding of how computational modeling can be used to understand neural activity. As an undergraduate at Cornell I worked with Professor Thomas Cleland on modeling rat behavior in a complex olfactory environment, specifically using Bayesian modeling to understand what the rat brain needed to compute and represent for success in their task. With Professor John-Dylan Haynes in Berlin I applied a brain-computer interfacing methodology to predicting human behavior in real time from scalp electrode recordings (EEG). This project helped me understand that at a neural level behavior is complex, but can often be captured by simple computational models. Our real-time protocol was able to predict behavior hundreds of milliseconds before the final movement using only brain activity, and the manuscript is now submitted to PNAS and in revisions. I also pursued functional MRI experiments as a part of Professor Haynes’ group, investigating how the brain represents information about “rules” held in memory.

These research opportunities have allowed me to develop an extensive set of skills encompassing fMRI, EEG, decoding, computational modeling, and animal behavior research. My collaboration with Professor Gardner at Stanford University will take full advantage of this knowledge as we explore how the brain instantiates computations. Our specific goal is to understand the role of attention on awareness and perception. Professor Gardner has already investigated the role of attention on behavior and we plan to extend this work to include