Statement of Purpose

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I want to pursue a Ph.D. to contribute to our understanding of the human mind and how it processes information to make decisions. Through my undergraduate research, I have come to appreciate the importance of mental models and how it relates to the decision making processes and the power of computational techniques in many aspects of research ranging from coding experiments to conducting statistical analysis. During my graduate training, I hope to continue my line of research while becoming more proficient with computational tools, that can involve Bayesian and machine learning elements, and in the use of brain imaging tools. As such, I believe continuing my training in this institution with its faculty members is invaluable to fulfilling my career goal of becoming a professor.

Currently, I am working on my undergraduate thesis project[1] under the supervision of Dr. Britt Anderson. This project explores the relationships between changes in an internal model, confidence and pupil diameter. My participants were tasked to infer whether the shape or the color of the visual stimuli was relevant when making a decision to go 'up' or 'down', and indicate how confident they feel that one or the other factor is at play. After making their choice, they received a stochastic audio feedback where there was a small chance to be wrong regardless of making the correct choice. I manipulated the participants belief by alternating the relevant factor while I looked at their pupil responses when they made prediction errors. Of interest was comparing pupil response after experiencing an informative or an uninformative prediction error. I hypothesized that informative errors will elicit a greater pupil response. A secondary hypothesis I explored was whether confidence positively correlated with greater pupil response and belief change. This was done by manipulating the stochasticity of the feedback where, during certain blocks, the chance of an unreliable feedback was increased.

By working on my thesis project, I became more familiar with the use of Python and the Psychopy library to code my experiment. I became more proficient with R programming to transform, visualize and analyze data. I applied parallelization to some of my Python codes to run tasks concurrently or to expedite a task. I learned to use an unfamiliar eye tracker (CRS LiveTrack), applying its code library and resolving bugs. And, I became more proficient working in the Unix environment and a variety of its tools to troubleshoot hardware issues and maintain a

[1] `https://github.com/sjp117/Undergrad_Projects/tree/master/mentalModelUpdatingPupil`

backup pipeline. I believe the skills I developed will be of value to both research and teaching assistantship. Although Im most familiar with Python and R, I am confident I can efficiently adapt to different programming languages, such as MATLAB.

In the lab, I assisted in two graduate student's projects, both involving eye-trackers (SR Eyelink) and probability learning (PL). The first project investigated whether the manipulation of involuntary spatial attention can influence voluntary spatial attention. This was done by biasing participants to a region of a display with a spatial PL task and analyzing their voluntary attention tendency using the Tse illusion. The second project investigated what eye movements can reveal about mental model updating. It involved participants learning the distribution shape of how stimuli dots appeared on the surface of an invisible circle. We monitored eye behaviors such as dwell duration (time spent fixated on a stimulus) and saccade latency (time between stimulus onset and saccade initiation) when stimuli appeared in 'low' vs 'high' probability locations and when the stimuli distribution shape was changed ('wide' $\leftrightarrow$ 'narrow').

Through a directed studies course[2], I strengthened my ability to work independently and I became more familiar with R programming through cleaning, mutating, visualizing and analyzing a diary data set. I used this data set to conduct my own exploratory analysis with my own post-hoc hypotheses. I learned to use packages to conduct quantitative discourse analysis, linear mixed effect modeling, and visualization.

It would be my pleasure to work with the likes of Dr. Wei Ji Ma and Dr. Todd Gureckis as their interests are most aligned with mine. I want to investigate how our mind is able to construct and use mental models to inform our decision making process. What are the mechanisms behind the model selection process? Out of all the possible models of the world, our mind seems to efficiently select the appropriate one. For example, while walking down a sidewalk and chatting with a friend, we adopt a mental model that is relevant to the conversation and we are sensitive inconsistencies in the narrative. However, when we realize we are coming to the end of the sidewalk, we rapidly switch our mental model to attend to the motion of the traffic and the state of the pedestrian light, while ignoring other traits, such as the color or the brand of the vehicles. Where in the brain does this happen and how could we model in the purview of reinforcement learning or other machine learning techniques?

[2] `https://github.com/sjp117/Undergrad_Projects/tree/master/mixedEffectModelDiary`