

Statement of Purpose

How does visual attention influence how we perceive our world? I am interested in this question, because attention has a significant influence on the way we represent visual information around us, while its details and mechanisms remain to be explored. I would like to approach this question using computational modeling, due to its power in uncovering the underlying neural mechanisms mediating the many effects of attention on visual perception. To achieve this goal, I want to pursue a Ph.D. degree in psychology with a strong focus on computational vision, to obtain systematic training on vision research. I am a well-prepared applicant with strong analytical skills, excellent learning ability, and a solid mathematical and programming background.

I actively searched for research opportunities while pursuing an M.A. degree in psychology at New York University (NYU). Since June 2018, I have been working under the supervision of Prof. Marisa Carrasco and Dr. Antoine Barbot to characterize asymmetries in visual performance across the visual field, known as *performance fields*. While previous studies showed performance asymmetries in contrast sensitivity and spatial resolution at the vertical and horizontal meridian, our study was the first to systematically probe the angular extent of asymmetries in spatial frequency (SF) sensitivity. We found that SF sensitivity was higher in the lower visual field than in the upper visual field, and these visual asymmetries became linearly less pronounced as approaching the horizontal meridian. I presented these findings at the Annual Meeting of the Vision Science Society (VSS) in May 2019 and received a lot of useful feedback from experts in the field. In the past few months I have been running additional analyses to compare binocular and monocular viewing conditions. We found the same pattern for binocular and monocular presentations, which allowed us to rule out binocular disparity as a contributing factor to visual performance fields in SF sensitivity. These findings have important implications in experiment design and model construction for vision study.

By joining this project, I gained invaluable experience in experimental design, data collection with eyetracking, data analysis, research collaboration, and scientific writing. Having limited knowledge in model fitting at the time, I learned extensively about basic psychophysical knowledge and taught myself model-fitting theories by reading publications, practicing with available codes and active discussions with my two supervisors and people in my lab. For instance, I managed to write a full repertoire of MATLAB scripts for efficient data analysis, and visualization. After data analysis, I wrote

the first draft to illustrate the findings, and we just submitted the manuscript titled “The angular extent of spatial frequency asymmetries across the visual field” to *Journal of Vision*.

Due to a strong motivation to adopt computational approach in my future research, I actively absorbed computational knowledge and skills by taking doctoral-level computational courses at NYU. In addition to working meticulously on the course material and assignments, I sought ways to apply the theories to my ongoing research once I had a solid command of them. For example, after learning bootstrapping from the course *Mathematical Tools for Neural and Cognitive Science* by Prof. Eero Simoncelli and Prof. Michael Landy, I applied this resampling method allowing model-free analysis to generating confidence intervals of SF sensitivity, and to verifying statistical tests in my projects (in preparation for a poster I will present at VSS in 2020). Moreover, when taking the course *Computational Cognitive Modeling* by Prof. Brendan Lake, I came across a deep exploration of Bayesian estimation. To obtain a better command of this widely applied computational approach, I built a Bayesian model using Python for my assignment project to predict human selection of numbers based on data generated from a rule-directed system. Taking these two courses not only strengthened my mathematic and programming skills, but also inspired me toward computational approaches for my future research.

Armed with growing computational knowledge and research experience, I took a major step forward in my current project in the second year of my master program. To further characterize visual performance fields for SF sensitivity, I am using *reverse correlation*, a powerful computational tool in characterizing perceptual sensory tuning functions. This approach will substantially advance our understanding of the mechanisms underlying visual performance fields. I am currently working on the experiment design of this project, which is the subject of my Master’s thesis. Furthermore, I am going to examine how covert spatial attention affects the asymmetric distribution of SF sensitivity.

I am applying to the *Ph.D. in Cognition and Perception* program at NYU because this is one of the best programs that could help me to pursue my research interest in computational visual attention. I would like to work with Prof. Marisa Carrasco to continue the study on performance field, to develop possible models accounting for the direction and magnitude of attentional effect, and to design experimental study to test the predictions of such models. I am also interested in collaborating with Prof. David Heeger and Prof. Michael Landy who adopted multiple computational approaches to study visual perception.