**Interdisciplinary Neuroscience Program**
**Ph.D. Thesis Defense**

# BEHAVIORAL AND COMPUTATIONAL INVESTIGATION OF THE EFFECT OF PRIOR KNOWLEDGE ON VISUAL PERCEPTION

**by**

**Buse Merve Ürgen**

**Advisor: Prof. Dr. Hüseyin Boyacı**

## ABSTRACT

Visual perception results from the dynamic interaction of bottom-up and top-down processes. Top-down prior knowledge and expectations can guide us to predict upcoming events and even determine what we see in an ambiguous or noisy sensory stimulus. Despite the well-established facilitating effects of expectations on recognition or decision-making, whether and how early sensory processes are affected by expectations remain unclear. This dissertation attempts to investigate the effect of expectations on early visual processes. To this end, we used behavioral experiments to examine the effects of expectation on visual perception at the threshold level and implemented a recursive Bayesian model and a recurrent cortical model to unravel the computational mechanisms underlying those effects. In the behavioral experiments, we systematically manipulated expectation's validity in separate sessions and measured duration thresholds, which is the shortest presentation time sufficient to achieve a certain success level. Our behavioral findings showed that valid expectations do not reduce the thresholds, rather unmet expectations lead them to increase. Next, using a recursive Bayesian updating scheme, we modeled the empirical data obtained in the behavioral experiments. Model fitting showed that higher thresholds observed in the unmet expectations are not due to a change in the internal parameters of the system. Instead, additional computations are required by the system to complete the sensory process. Finally, within the predictive processing framework, we implemented a recurrent cortical model to explain the behavioral findings and discuss possible neural mechanisms underlying the observed effects. The cortical model findings were in agreement with the Bayesian model results, revealing that longer processing is needed when expectations are not met. Overall, the computational models that are proposed in this study provide a parsimonious explanation for the observed behavioral effects. The proposed experimental paradigm and the computational models offer a novel framework that can be extended and used in other stimuli, tasks, and sensory modalities.

**Keywords:** visual perception, perceptual inference, expectation, prior knowledge, predictive processing, computational modeling, Bayesian model, cortical model

**DATE:** 14.01.2021, Thursday
**TIME:** 14:00