

TESTING THE BAYESIAN BRAIN HYPOTHESIS IN VISUAL PERCEPTION

April R. Swagman

Jeffrey N. Rouder, Dissertation Supervisor

ABSTRACT

Bayesian ideal observer theory describes perception as an ideal integration of sensory information with prior knowledge to produce optimal responses. Bayesian ideal perception models are popular in sensory domains; however, these models often prove unfalsifiable because of distributional assumptions and post-hoc estimation of participant beliefs.

Three visual perception tasks were designed to test Bayesian ideal observer theory under minimal assumptions using the Bayesian Decision Theory framework. Prior distributions of stimuli were specified, likelihoods were manipulated across four stimulus reliability levels, and loss functions were established so that participants could choose posterior point estimates that minimize loss.

In each experiment, a Bayesian ideal observer model was fit against a Bayesian posterior matching model (adapted from the probability matching phenomenon) and one or more non-Bayesian mixture models. Results from two experiments in which participants were making location-based judgments overwhelmingly supported the posterior matching models. Data from a third experiment in which participants made estimations about the number of items in an array were fit best by a non-Bayesian mixture model. Overall, Bayesian ideal observer theory was not supported in three experiments of visual perception.