Sensitivity to gaze-contingent spatial distortions in freely-viewed movies

Abstract:
Sensitivity to luminance contrast is a prerequisite for all but the simplest visual systems. To examine contrast increment detection performance in a way that approximates the natural environmental input of the human visual system, we presented contrast increments gaze-contingently within naturalistic video freely viewed by observers. A band-limited contrast increment was applied to a local region of the video relative to the observer's current gaze point, and the observer made a forced-choice response to the location of the target (≈25,000 trials across five observers). We present exploratory analyses showing that performance improved as a function of the magnitude of the increment and depended on the direction of eye movements relative to the target location, the timing of eye movements relative to target presentation, and the spatiotemporal image structure at the target location. Contrast discrimination performance can be modeled by assuming that the underlying contrast response is an accelerating nonlinearity (arising from a nonlinear transducer or gain control). We implemented one such model and examined the posterior over model parameters, estimated using Markov-chain Monte Carlo methods. The parameters were poorly constrained by our data; parameters constrained using strong priors taken from previous research showed poor cross-validated prediction performance. Atheoretical logistic regression models were better constrained and provided similar prediction performance to the
nonlinear transducer model. Finally, we explored the properties of an extended logistic regression that incorporates both eye movement and image content features. Models of contrast transduction may be better constrained by incorporating data from both artificial and natural contrast perception settings.