

The role of generative knowledge in object perception and action selection

Dan Kersten, Peter Battaglia, and Paul Schrater

Department of Psychology, University of Minnesota,
Elliott Hall, 75 East River Road Minneapolis, MN, 55455, USA

Through vision, we estimate object properties useful for cognition and the planning and control of actions. The remarkable fact is that we do this so well. The human visual system provides highly reliable information for a prodigious range of tasks despite highly complex and locally ambiguous sensory input. Our ability to flexibly and competently handle ambiguity, both sensory and motor, is the result of built-in generative knowledge regarding both the scene causes of sensory input, as well as the consequences of our own actions. Computationally, generative knowledge can be implemented using structured probabilistic representations that characterize how internal "hypotheses" can combine to "explain" multiple sensory measurements, in a way that is sensitive to the degree of sensory and motor uncertainty. We describe results from studies of human object perception, object interception, and timed reaching which demonstrate built-in knowledge of generative structure consistent with the use of structured probabilistic representations. In particular, one study shows that humans can use haptic knowledge of an object's size to improve their ability to intercept an object with ambiguous visual depth information. Another study shows that humans can use generative knowledge about the rate of improvement of visual estimates and motor speed/accuracy trade-offs to optimize the amount of time spent planning and executing reaches to targets under time pressure.