Learning distributions of features in an uncertain environment

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The visual world is uncertain and heterogeneous. The same object might look differently from different viewpoints and under different conditions. Moreover, unlike artificial stimuli in laboratory experiments, objects in the real world do not have specific feature values. Rather, their features have probability distribution with certain values more probable than others. For example, while in the laboratory it is possible to show a white circle on a black background, “white” snow in a real world has a multitude of tints. How do human observers represent such stimuli? To answer this question, we developed a novel approach based on automatic learning of distractor features in visual search. When observers learn that distractors are likely to have certain features, they respond slower to a target with similar features. By analyzing the degree of slowing for different targets we were able to decode the observers’ probabilistic representations of distractors learned in previous trials. In my talk, I will present the results of several studies using this approach that show 1) how observers represent different distributions, 2) that they represent distributions rather than (or in addition to) specific feature values, and 3) that these distributions can be bound to specific locations and to other features. These findings suggest that encoding of uncertain and heterogeneous stimuli is more precise than it was thought before. In general, treating perception as a process of estimating probability distributions provides a different look at a number of visual phenomena ranging from perceptual learning to attentional guidance.