Subjective contextual statistics

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Parallel to the substantial studies into the statistics of characteristics of natural scenes are recent attempts to use experimental methods to elicit the actual prior distributions over such characteristics that are employed by psychophysical subjects [1]. Iterated learning [2] is a powerful and general new method for doing just this, in which subjects act a little like a Markov-chain Monte Carlo stochastic process whose stationary distribution is the prior.

More particularly, subjects are asked to generate stimuli for themselves, ostensively based on feedback as to what these stimuli should have been. In doing this, the influence of the feedback is inevitably tempered by the influence of their prior distributions. Following a block of such trials, subjects repeat the same task, except the feedback signals in the new block are taken as their guesses from the previous block. Kalish et al [2] showed that after a number of iterations, this procedure is equivalent to producing samples from the prior distribution alone for a set of stimuli. Intuitively, the influence of the initial feedback (whatever it may be) becomes weaker on each iteration until the responses subjects produce only reflect the prior distribution.

To test and prove these ideas, we used the case of contextual effects associated with visual orientation. This is an attractive domain, because the actual natural scene statistics have been well studied, and much is known both neurophysiologically and psychophysically about contextual processing. In particular, phenomena such as the tilt illusion prove that the stimuli in the surround of a target oriented bar exert a critical influence on the perception that bar; further, the normative basis of this influence, and its relationship to input statistics or subjective priors, are all hotly debated.

We adapted iterated learning to this case by presenting subjects with surround stimuli at various orientations, positions, and contrasts, and providing them with a constrained ability to generate target stimuli. We present preliminary results from this procedure.

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References
