Testing hypotheses about computation and coding in the visual system

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The subject of neural coding has generated much debate. A key issue is whether the nervous system uses coarse or fine coding. Each has different strengths and weaknesses and, therefore, different implications for how the brain computes. For example, the strength of coarse coding is that it's robust to fluctuations in spike arrival times. Downstream neurons don't have to keep track of spike train structure. The weakness, though, is that individual cells can't carry much information, so downstream neurons have to be able to pool signals across cells and/or time to obtain sufficient information. With fine coding, individual cells can carry a great deal of information, but downstream neurons have to be able to resolve spike train details to obtain it. Here we set up a strategy to determine what the neural code can and can't be and used it at the level of the retina. We recorded from essentially all the retinal output cells an animal uses to solve a task, evaluated the cells spike trains for as long as the animal evaluates them, and used optimal, i.e., Bayesian, decoding. This makes it possible to obtain an upper bound on the performance of codes and thus eliminate those that aren't viable. Our results show that standard coarse coding is insufficient; finer, more information-rich codes are necessary.