Visual discrimination of natural-scene stimuli by amblyopic people

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In amblyopes, one of the eyes has poor vision compared to the other, usually resulting from neglect of that eye (perhaps due to squint) in early childhood. It is not clear whether the poor vision in complex visual tasks can be explained simply by lack of sensitivity to simple stimuli, or whether information from the amblyopic eye is processed differently in the brain (Levi et al, 2002). We performed experiments on 5 amblyopic women (aged 18-30) with Ethical Committee approval. We measured thresholds in the good and amblyopic eyes of each observer for 2 or 4 sets of natural scene stimuli: series of slightly different pictures made by morphing one picture into another (Parraga et al, 2000). For instance, observers could be asked to detect slight changes in facial expression. A total of 14 such experiments was performed. For comparison with the measures of discrimination of complex stimuli, we also measured the observersation contrast detection thresholds for sinusoidal gratings of different spatial frequencies. Thresholds were measured by presenting pictures or gratings (2 deg. square) on a high-performance CRT monitor, following a modified two-alternative forced-choice protocol (Parraga & Tolhurst, 2000). In all 14 experiments with complex natural-scene stimuli, the thresholds in the amblyopic eye were higher than those in the fellow eye; on average, thresholds were 1.83 times higher in the amblyopic eye (n=14, S.D.=0.44). In many cases, the contrast thresholds for the gratings were also higher in the amblyopic eye than the fellow, raising the question whether poor performance in complex discriminations results just from a failure to see the Fourier components of the complex scenes as well. We have previously developed a simplistic model of discrimination for normal observers (Parraga et al, 2000), in which we presume that the visual system breaks complex pictures down into separate spatial frequency bands, and discrimination depends on detecting differences in contrast in those bands. The parameters of the model include the oberverations thresholds for sinusoidal gratings. When we ran such models on the amblyopic eyes, we found that the poor sensitivity to gratings did predict poor performance on the complex discrimination task. However, in 4 of the 5 observers, the actual performance in the complex task was even worse than predicted by the model (on average, 1.40 times worse than predicted; s.d. 0.41). There are many assumptions in such a simplistic model, so it is interesting to note that our 2 best-studied observers (4 experiments each) actually had similar grating thresholds in their two eyes but performed the complex discrimination 1.57 times (n=8; S.D. 0.27) worse in their amblyopic eye than their fellow eye.

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