CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
J0334

Project Title
The Fantasy of Visual Fusion

Abstract

Objectives/Goals
My objective is to develop a better understanding of the contrast enhancement mechanisms of the human eye and brain, and in particular to understand the similarity in behavior that occurs in the color and grey-scale vision systems with respect to the size of the perceived objects within the field of view. Furthermore, I wish to find out where these effects are generated along the path of information flowing from the eyes through the various levels of the brain.

Methods/Materials
Several sets of visual test targets, generated in Matlab and PowerPoint, were presented to human subjects in both grey-scale and color on a large 17" color-corrected computer flat-panel display, using an Apple Macintosh G4 desktop computer. A cardboard divider was used to separate right and left eye images for the image fusion experiments.

Results
The grey-scale lateral brightness adaptation effect was observed over the entire range of object sizes and distances tested, right to the limit of human visual acuity. The chromatic adaptation (color) effect was observed over a nearly identical range of object sizes and distances tested. The variance in observations reported was strikingly reduced by the use of a calibrated computer-driven display, as compared with our previous results using printed targets in outdoor lighting. Most observers were able to satisfactorily fuse the dichoptic image fusion target pairs, and reported the same brightness and color of the two superimposed center squares in almost all cases, demonstrating the elimination of the lateral adaptation mechanism when the central squares and differing backgrounds were not presented to either eye.

Conclusions/Discussion
The minimum fields-of-view for grey-scale and color lateral adaptation are more similar than different, with both grey-scale and color adaptation working essentially all the way to the limits of human vision. This result is unexpected due to the traditional view of the specific mechanisms by which the brain processes grey-scale and color information, and where in the eye and the brain grey-scale and color information are extracted. Furthermore, the mechanisms for lateral brightness adaptation and chromatic adaptation appear to be localized early in the eye-brain information flow, perhaps in the retina itself, in the lateral geniculate nucleus (LGN), or in the first few layers of the lowest level of the visual cortex (V1).

Summary Statement
The effects of lateral brightness adaptation and chromatic adaptation in the human visual system were explored as a function of scale; we have determined for the first time that these effects likely occur early in the human visual system.

Help Received
Father guided student through project, offered suggestions, and helped with the Matlab and PowerPoint programs. Mother solicited volunteers from work to be experimental subjects. Both parents helped with organization and editing of written materials.