Introduction

Recently we observed a new powerful type of contrast and size illusion caused by apparent motion in depth, which we called the StarTrek illusion [1]. We found that an optic flow pattern consistent with objects moving in depth strongly modulates their apparent contrast and size. Disks which appeared to move away from the observer appeared to grow higher in contrast and larger, while their retinal size and contrast remained constant. We explain the illusion of contrast by contrast constancy*, which is largely analogous to the well-known size-constancy phenomenon. The size constancy, presumably, explains the size illusion. We discovered that the two phenomena are related in a non-trivial way. By adjusting the size of the disks during the optic flow motion, the illusory contrast increase could be easily cancelled or even reversed. On the other hand, the illusory size increase could not be reversed in the same way by contrast modulation. Our results suggest that brain may use the same scaling factor to account for the size and contrast change with distance and that the estimated object size further affects the contrast calculation. We hypothesize that, more generally, all object features are scaled by the same distance-factor - what we called the "general object constancy" hypothesis.

Experimental design

The target wall was a set of high-contrast randomly located disks moving on a gray background. Peripheral random disks formed a static stencil mask. The mask had a 10° circular aperture positioned in the center of the screen, through which the moving disks could be seen. Their motion created an optic flow consistent with the disks being positioned on a fronto-parallel plane moving back and forth. As the disks moved inward, new disks appeared along the boundary of the aperture from behind the occluding pattern of the stencil mask consistent with the pattern of the optic flow. We tested disks of various diameters from 0.05 to 0.3 degrees. Depending on the disks size 100 - 1000 dots were displayed in each trial, which included one back-forth motion cycle and lasted for 2 seconds. At a 0.5° disk size the disks appeared to grow brighter or dimmer as they "moved away". To measure the illusion's strength the contrast of the disks was gradually modulated by a Bayesian adaptive algorithm through the course of the optic flow (illusory nullying).

Results

- About the same relative amount of size change nulled the contrast illusion as the relative amount of contrast change for any given observer.
- The contrast modulation did not affect the size illusion.
- The strength of the size illusion was roughly half that of the contrast.

Discussion

We suggest that the StarTrek illusion is an illusion domain counterpart of the well-known Ponzo illusion. Ponzo illusion is a manifestation of the phenomenon of size constancy: objects appear to maintain their physical size even when their angular size (size on the retina) is changing. Analogously, the StarTrek illusion is the manifestation of contrast constancy.

Conclusions

The StarTrek illusion shows that size and contrast, apparently independent features, are directly linked. The contrast illusion nulled by a given amount of contrast change during the optic flow could also be nulled by the same amount of size change but not vice versa. This demonstrates that size calculation is done prior to the perceived contrast calculation and the resulting size is taken into account for the contrast calculation.


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