A note on stray light in the Tübingen perimeter

R. A. WEALE

From the Department of Visual Science, Institute of Ophthalmology, Judd Street, London, WC1

CAROL WHEELER

From Moorfields Eye Hospital, City Road, London, EC1

SUMMARY Measurements were made of the relative intensity of light scattered in the neighbourhood of the large and small targets on the Tübingen perimeter. Two target intensities were studied. The scattered light fraction ranged from 0.1 to 25%, and its effect was detected more readily by young than by older observers.

Most perimeters provide visual test stimuli by reflection at a painted surface. In these circumstances the definition of the stimulus, let alone of the retinal image, becomes a problem because of stray light. This is easily seen in bowl perimeters, such as those designed by Goldmann and by Harms, when, for example, a target of 10 asb intensity is projected on a background of zero intensity. A wide halo is seen to surround the target, and to become even more noticeable in non-foveal vision, once the eye begins to adapt to the dark.

Although stray light in the eye has understandably received much attention (Ranke, 1954; Wolf and Gardiner, 1965), we have not come across any study of the significance of the problem from the clinical point of view. As our attention to the question was attracted by a difficulty in interpreting the results of static perimetry in a series of clinical scotopic tests, we made the following measurements.

Methods

A Tübingen perimeter (Oculus) was used. Five observers with normal vision and ranging in age from 23 to 53 years were asked to make foveal matches between the luminances of the target and its immediate neighbourhood.

For this purpose they were provided with clean, calibrated neutral density filters. One edge of the filter or filter combination was made to overlie the target, the total density being adjusted till a match was obtained with a neighbouring area. Each measurement was made three times on three different days. The variables included stimulus intensity (100 and 1000 asb, as lower values yielded nothing of significance) and angular diameters of 10' and 104'.

Results

The averaged values and their standard deviations are shown in Fig. 1. Target luminance is plotted along the abscissa and the filter density needed to equate target and surround luminance along the ordinate. Expressed in arithmetical units, the apparent brightness ratio ranges from 0.1 to 25%—that is, from the barely to very significant. In general, this ratio varies only with the smaller of the two targets, being more important at the lower intensity.

Fig. 1 Abscissa: target luminance; ordinate: filter density needed for a visual match between target and surrounding area. The different symbols refer to different observers

Fig. 2 Filter density (cf. Fig. 1) as a function of the observer's age

The variation for the large target is statistically non-significant. Application of the χ^2 test to the 10' data shows them to be significant at a level of $P < 0.001$. Even if the data represented with squares are arbitrarily omitted in order that we may establish whether their small error decisively biases the whole result, a significance at $P < 0.01$ is still obtained. The various symbols represent the various observers, and Fig. 2 shows with data taken from Fig. 1, as shown in the inset, that there is some correlation with the age of the observer. The numbers are too small for too much emphasis to be put on this point.

Conclusion

The data show that stray light can cause an increase in the apparent size of a perimetric test target. The effect is more likely to play a role in younger eyes. At target intensities near the threshold the stray light may be below threshold and may be virtually undetected except after dark adaptation. At very high intensities intraocular scatter and glare may render it unnoticeable. However, at intermediate intensities it is clearly measureable and can act by reducing the apparent extent and depth of scotomata. It is easy to envisage situations wherein stray light may offer a more powerful stimulus than does the target owing to the integrative properties of the retinal periphery. Instrument design and observer and patient variability seem to exclude the possibility of applying any but the crudest correction to measurements obtained when extraneous stray light plays a role. It is evident that the problem can be circumvented with the use of self-luminous tests—e.g., in the shape of light-emitting diodes.

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References

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