

# Impairment of colour vision in patients with ocular hypertension and glaucoma

With special reference to the 'D and H Color-Rule'

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Disturbances of colour perception, often of a tritanopic nature, have been described in glaucomatous patients (Fishman, 1973; Grützner and Schleicher, 1971; Lakowski, Bryett, and Drance, 1972; Verriest, 1964). The present paper describes a new method of assessing such deficiencies using the D and H Color-Rule (Hemmeldinger and Davidson, 1967).

The diagnostic uses of this simple device have been shown to have considerable value in assessing the various forms of hereditary colour deficiency, including autosomal dominant tritanopia (Kalmus, 1972; Kalmus, Neuhann, and Seedburgh, 1974). It seemed reasonable to investigate patients with ocular hypertension and glaucoma for evidence of tritanopic deficiency using the D and H Color-Rule.

## Subjects

The patients studied were selected from those attending the Glaucoma Clinic, Moorfields Eye Hospital, High Holborn, and the Eye Department, University College Hospital, London. Controls were obtained from staff at University College, London, Moorfields Eye Hospital, and other volunteers within the age-span of the patients.

## Methods

The investigator (D.S.) was unaware of the diagnosis at the time of assessment. All subjects were screened with the Ishihara charts for red-green deficiencies. A few patients were tested with the Farnsworth-Munsell 100-hue test. In addition, all subjects were shown the Dean-Farnsworth tritanopia chart (Kalmus, 1965) and similar charts produced by Dr. W. O. G. Taylor. After completing the preliminary tests, the D and H Color-Rule was used. All observations were made under a fluorescent lamp of 6500°K which illuminated the interior of a box painted white. The principle of colour-matching with the Rule was explained to the subjects, who were shown the colour range of the two slides. In some cases, the subjects were asked to name the colours. Each eye was tested separately.

The lettered slide of the D and H Rule (see Fig. 1) (graded from purple through grey to green) was set on A and the numbered slide (graded from blue through grey to brown) was set on 1. The subject was asked whether the upper and lower slides in the viewing area appeared to be the same colour, and if so, the numbered slide was moved by stages until

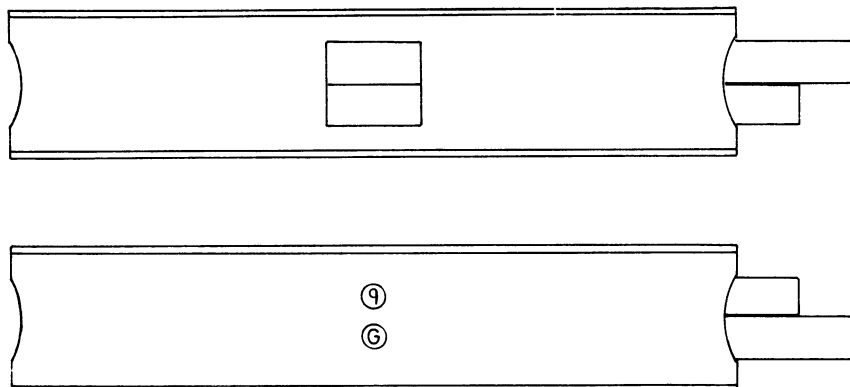


FIG. 1 *D and H Color-Rule. Front view (top) and back. About one-quarter actual size*

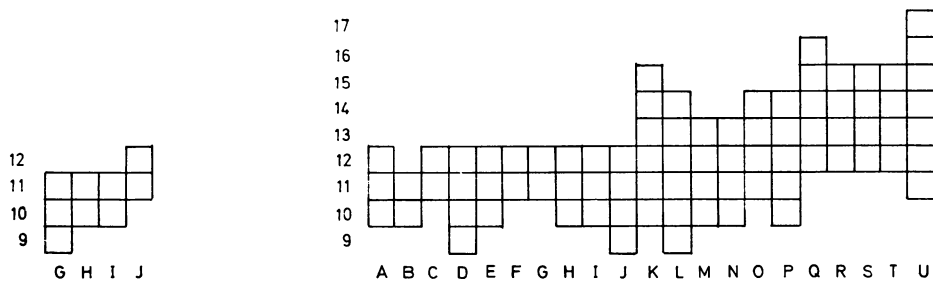
a difference became apparent. If at the commencement of the test they differed, the numbered slide was moved until both appeared the same. From this position, the slide was then moved again until a noticeable difference was evident. If no match was found, the lettered slide was set at the next position. The procedure was repeated with the lettered slide set at positions from B to U or, until having obtained a match, the observer recorded two adjacent letter positions with no acceptable match. In this way the matching and non-matching areas were fully recorded. To prevent any misunderstanding, the instructions were repeated at each setting of the lettered slide.

## Results

Screening with the Ishihara charts revealed four patients with a typical red-green deficiency response, and they were excluded from further studies. Many more gave atypical responses. The patients tested with the Farnsworth-Munsell 100-hue test produced general low discrimination patterns without any clear axis. Results with the tritan charts did not produce readings typical for tritanopia. On the contrary, with these charts, 11 per cent. of patients with ocular hypertension, 30 per cent. of patients with narrow-angle glaucoma, and 54 per cent. of patients with open-angle glaucoma gave readings indicative of red-green blindness.

23 patients with ocular hypertension and glaucoma were asked to name the colour of both slides of the Rule. Their reduction in matching ability was paralleled by difficulties in colour description. In general, colours were often described as muddy or dull. The description of the colours on the numbered slide was approximately correct, but the description of the colours of the lettered slide differed considerably from the normal. In particular, the green area between I and N was rarely described accurately.

Compared with the controls, a high percentage of the patients' eyes assessed with the Rule showed a marked increase in the number of positions accepted as colour matches. Fig. 2 shows the acceptance patterns for the normal and glaucomatous eye of a patient. It will be seen that the acceptance area of the affected eye is increased greatly, particularly in the horizontal direction. Such patterns are quite common for ocular hypertensive and glaucomatous eyes, although the difference between the eyes is sometimes less extreme than in the Figure. It must, however, be noted that a tendency towards a similar pattern was found in a few controls. Fig. 3 shows that the acceptance area of 38 ocular hypertensive and



NON-GLAUCOMATOUS EYE      CHRONIC SIMPLE GLAUCOMATOUS EYE

FIG. 2 Matching areas of normal and glaucomatous eyes of a patient, using the D and H Color-Rule

53 glaucomatous eyes is much greater than that of 66 controls, so that while three controls (4 per cent.) accepted more than twelve settings, thirteen ocular hypertensives (34 per cent.), eight narrow-angle glaucomatous eyes (57 per cent.), and 26 open-angle glaucomatous eyes (67 per cent.) gave readings greater than this value.

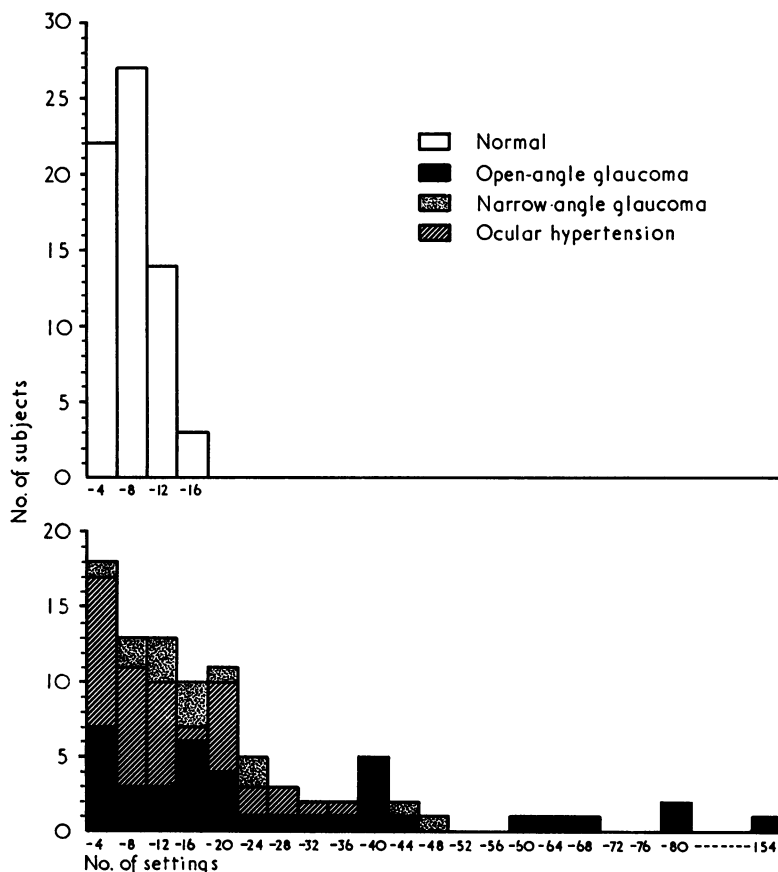


FIG. 3 Distribution of size of matching area (no. of squares) of ocular hypertensive, glaucomatous, and control eyes

## Discussion

Although tests on patients using the D and H Color-Rule demonstrated matching ranges and patterns similar to those found in congenital tritanopia (Kalmus and others, 1974), none of our patients gave typical tritan readings with Dean-Farnsworth's or Taylor's charts, as would be expected in the latter condition. As already indicated, we were also unable to demonstrate a typical tritan axis using the Farnsworth-Munsell 100-hue test, which produced only a generalized low discrimination pattern on patients tested. It appears therefore that the colour perception of patients with hereditary tritanopia and those with glaucoma (acquired tritan defects) differ. This observation is in keeping with that obtained in some of our patients using the tritanopia charts when, like red-green defectives, they could not see the blue square, yet gave atypical readings on the Ishihara charts. Whether this finding is caused by raised intraocular pressure or perhaps by changes in the ageing lens (Said and Weale, 1959) is not clear.

The results indicate that the D and H Color-Rule is of value in demonstrating that a proportion of patients with ocular hypertension and glaucoma show increased matching areas of a typical horizontal shape and position, indicative of a tritanopic disorder.

The elongated acceptance area, characteristic for glaucoma, usually lies along the ten to thirteen positions on the lettered slide, sometimes extending from A to U as in Fig. 2. Readings beyond N are particularly significant. With the progression of glaucoma a more generalized colour vision deficiency develops. However, a proportion of such patients do not exhibit the above feature. During an unrelated research project, characteristic readings such as those described were given by a supposedly normal subject who was however later diagnosed as suffering from glaucoma.

## Summary

The colour vision of 91 eyes of patients suffering from ocular hypertension and glaucoma was tested with regard to observations with the D and H Color-Rule. The majority of eyes were found to exhibit a typical loss in colour discrimination. This was evident by their greatly enlarged acceptance areas using the Rule compared with normal eyes. These areas showed a horizontal orientation typical for tritanopic vision. However, the Dean-Farnsworth charts for tritanopia and the Farnsworth-Munsell 100-hue test failed to produce results characteristic for tritanopia.

Although the findings with the D and H Color-Rule are significant, its clinical value in the assessment of ocular hypertensive and glaucomatous patients is limited not only by the negative observations in some affected patients but also by the length of time required if used as a routine test.

It remains to be seen in the future if those ocular hypertensive patients who performed poorly with the D and H Rule are more likely to develop the field changes of glaucoma.

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