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The description of physical signs of illness in photographs by physicians with abnormal colour vision

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Background: Physicians with congenital colour vision deficiency (CCVD) have reported difficulties recognising certain physical signs of illness, for example, jaundice, red rashes and pallor, and interpreting coloured charts, diagrams and slide projections. However, there has been little study of the effects of CCVD on the performance of medical practitioners.
Aim: The aim of this study was to look for evidence of the effect of CCVD on the ability of physicians to recognise and describe physical signs of illness that have colour as either the main or an important feature.
Method: Twenty-three general practitioners with CCVD were shown 11 colour photographs depicting colour signs of illness and were asked to describe the signs they saw and rate their confidence in making their descriptions. Their responses were compared to those of 23 age-matched general practitioners with normal colour vision.
Result: General practitioners with CCVD compared to those with normal colour vision had less ability and confidence in detecting physical signs in the photographs and naming the colours.
Conclusions: The results of this study support other evidence that physicians with CCVD have difficulties detecting some colour signs of illness and naming the colours. Because of the use of photographs the extent of the problem in clinical practice is unknown but medical practitioners with CCVD should be aware of the possibility of failing to detect or correctly assess physical signs that are characterised by colour.

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The colours of the human body and its products are commonly used as signs of health and disease in the practice of medicine. Physicians with congenital colour vision deficiency (CCVD) may have difficulties observing these signs because the colours in question are often those that they can confuse or fail to discriminate. Medical practitioners with CCVD have reported such difficulties, the most common being the detection of total body colour changes, for example jaundice and pallor, and detecting blood in body products.[1-3] These reports of difficulty have been based on questionnaires and interviews of CCVD physicians: there have been no studies of the extent to which these difficulties affect their actual performance in medical practice.

The prevalence of CCVD among physicians in the UK is close to that in the total population, that is, one in 12 for men and one in 200 for women.[1] Medical practitioners often lack awareness of the severity of their own deficiency.[1] This may be of importance to their clinical practice as people with CCVD, especially those with the more severe forms, report difficulties with colour in everyday tasks.[4] Histopathologists are likely to make more errors interpreting stained slides,[5] general practitioners make more errors with a colorimetric test for blood glucose[6] and physicians and other medical workers more often fail to detect blood in photographs of body products.[7] When this

information is added to the fact that individuals with CCDV are often unaware of their failures of observation,[1] it can be seen that there is a need for research into the effects of CCVD on the observational skills of medical practitioners.

This report is part of a wider study on CCVD in medical practice[3,6] and compares general practitioners with CCVD with general practitioners with normal colour vision for their ability and confidence in observing and reporting on photographs of common physical signs, where colour is considered to be a significant factor. While we have reported previously on the ability and confidence of medical practitioners in the detection of normality and abnormality in clinical photographs,[3] this paper reports for the first time on their naming of the observed colours.

METHOD

Forty-six medical practitioners took part in the study: 23 (22 men and one woman) with CCVD and 23 (all men) with normal colour vision. All were full-time general practitioners under the age of 60 and members of the Royal College of General Practitioners. The general practitioners with CCVD (subjects) had responded to letters of invitation in the medical press to participate in the study, while those with normal colour vision (controls) were obtained from two Health Authority lists of general practitioners in locations readily accessible to the investigators. They were selected to match the ages of the subjects to within one year.

Controls were tested with the Ishihara Plates (1995, 24-plate edition) to exclude CCVD. All controls passed making no more than one error. Subjects were given two or more of the following tests: Ishihara (23 subjects), City University (17), Farnsworth D-15 (15), Farnsworth Mansell 100 hue (11), Nagel Anomaloscope (8), Pickford Anomaloscope (1), American Optical Co. HRR (2). Tests were administered throughout the UK either in the subject's own home or surgery or in the nearest university department of optometry. The departments of optometry used the tests they had available, which is the reason for the same tests not being used on all subjects. The colour deficiency of the subjects was classified by type and severity according to the methods described in Birch's book *Diagnosis of Defective Colour Vision*.[10]

There were 16 deutans (middle wavelength deficiency), of whom three had a slight deficiency, four were moderate and nine were severe. There were seven protans (long wavelength deficiency) of whom two were slight, one moderate and four severe.

There were 24 colour print photographs, each 110 mm to 140 mm by 100 mm. The photographs were taken from several sources (see Acknowledgements) and viewed with other photographs at the time of the original study.[3] The results for only 11 of the 24 photographs are reported here. The responses to the other photographs were excluded either because they depicted a normal state or because the responses of the colour normal controls varied widely so that a conforming (correct) response could not be established. The conditions depicted in the 11 photographs are listed in Table 1.

The photographs were viewed at reading distance under white fluorescent tubes with a colour rendering index of 86 or in a north-facing window (UK) at about midday (11 am to 1 pm). Colour vision tests were performed either under similar illumination or using a CIE Standard Source C.

Subjects and controls were visited by either AS or FM for the purpose of the study. Both groups were given written questions about the same clinical photographs. They were asked to decide on their normality or abnormality and to describe abnormalities. They were asked to use appropriate terms of colour, wherever possible, but were not required to give a diagnosis. Subjects and controls were asked to rate their confidence in their descriptions of abnormalities on a four-point scale (very low confidence, low confidence, confident, very confident).

Subjects' descriptions were judged as either conforming or not conforming to the descriptions given by the majority of controls. Names of colours were accepted as conforming if they were among the 11 basic colour names (black, white, red, yellow, green, brown, blue, purple, pink, orange and grey) defined by Berlin and Kay[8] with Crawford's qualifications.[9] For this study pink and red were accepted as one basic colour and some medical terms for colours were accepted if widely and uniformly used by the medical profession (for example, jaundice for yellow, erythema for red or pink, and pale for white or pale pink when describing the conjunctiva). Uncertainty expressed about the name of a colour and the answer 'normal' were classified as not conforming. No photographs of normal conditions were selected for analysis.

The North West Surrey Local Research Ethics Committee approved the project and informed consent was obtained from all participants.

RESULTS

From 11 of the 24 photographs presented, the majority of controls agreed on the presence of an abnormality and on the naming of the colour. Table 1 and Figures 1 and 2 show the responses of the subjects and the controls to the 11 photographs. The CCVD GPs made significantly fewer conforming responses for the photographs depicting rashes and three of the four photographs of jaundice. The responses of the CCVD GPs were not significantly different from those of the controls for the photographs depicting conjunctival pallor, retinal haemorrhages, tympanic inflammation and blood in urine.

Figure 2 shows the confidence ratings given by the subjects and controls for conforming responses. The confidence ratings of the CCVD GPs showed significant differences from those of the controls for conforming responses (X^2, 54.3; $p < 0.001$, 3 df). Non-conforming responses, which were in smaller numbers, showed no significant differences between the two groups.

DISCUSSION

When compared with controls, general practitioners with CCVD significantly more often adopted non-conforming names (that is, different from the terms used by

	No	Photograph condition	Conforming responses	Non-conforming responses given by CCVD subjects	Number of CCVD GPs giving each non-conforming response (n = 23)	Number of control GPs giving each non-conforming response (n = 23)	χ^2, p
Red rashes	1	Cholinergic urticaria (trunk)	Red Pink Erythema	Brown Pink/Brown Vitiligo Depigmentation No name or uncertain	2 1 1 1 2	0 0 0 0 0	8.3 0.004
	2	Early erythema nodosum (lower leg)	Red Pink Erythema	Normal Bruising Dark Non-reflective Pigmentation Pink/Brown	4 3 2 1 1 1	0 0 0 0 0 0	16.2 <0.001
	3	Rubella (back)	Red Pink Erythema	Normal Depigmentation Pale No name or uncertain	8 1 1 5	1 1 0 2	22.3 <0.001
Jaundice	4	Jaundice (face of man)	Jaundice Yellow Icteric	Normal Yellow-green Green Pallor No name or uncertain	5 2 2 0 2	0 0 0 1 1	8.7 0.003
	5	Right eye of man	Jaundice Yellow	Normal Yellow-green Green Pallor No name or uncertain	7 1 1 1 10	4 0 0 0 6	9.6 0.002
	6	Severe jaundice (chest and face of man)	Jaundice Yellow Icteric	Erythema	1	0	1.0 0.3
	7	Sclera shows jaundice (face of baby)	Jaundice Yellow Icteric	Normal Dark Red No name or uncertain	6 1 1 7	3 0 0 6	6.7 0.01
Pallor	8	Conjunctiva	Pale Anaemic	Normal Erythema Yellow No name or uncertain	7 1 0 7	4 0 1 6	2.3 5.2
Optic fundus	9	Diabetic retinopathy, dot and spot haemorrhages	Red Pink	Reddish-brown Orangey-red Brown	1 1 1	0 0 0	3.2 0.07
Tympanic membrane	10	Acute otitis media	Red Fresh blood	Almost orange	1	0 0	1.0 0.31
Urine	11	Heavily bloodstained urine	Red Pink Erythema	No name or uncertain	1	0	1.0 0.31

Table 1. Colour naming by subjects and controls of signs of illness in 11 photographs

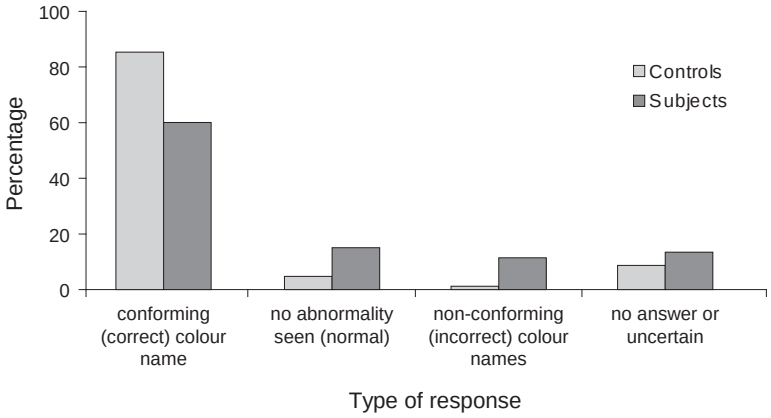

Figure 1. Percentage of correct and incorrect colour naming responses given by colour vision normal and colour vision deficient general medical practitioners to 11 colour photographs of clinical conditions in which colour is an important sign

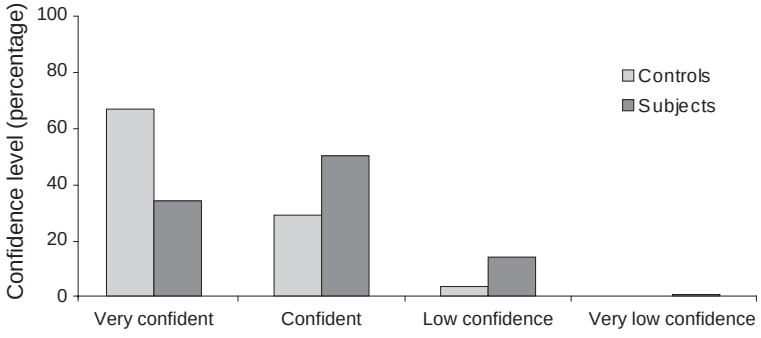

Figure 2. Confidence ratings given by colour vision normal and colour vision deficient general medical practitioners to their responses to 11 colour photographs of clinical conditions, in which colour is an important sign. Note: A confidence rating was not requested for the answer 'normal' given on 31 occasions by GPs with CCVD and on 11 occasions by GPs with normal colour vision. Nine GPs with CCVD and seven GPs with normal colour vision failed to answer confidence levels for single photographs.

the majority of controls) to describe the clinical photographs of red rashes (three out of three photographs) and jaundice (three out of four photographs). Some of these subjects failed to conform by describing photographs as normal; others by expressing uncertainty about a name they had used or by failing to use any name; others used a range of non-conforming names for the colours, sometimes alluding to dark/light differences rather than colour, for example pallor or dark rather than a term for a hue and on other occasions using a wrong colour name, such as brown, pink-brown or red-brown for the red used by controls or green or yellow-green for the yellow reported by controls.

No relationship was found between the type or severity of the deficiency and the performance of subjects with the photographs.

The general practitioners with CCVD showed less ability and less confidence compared to the general practitioners with normal colour vision when reporting on colour signs in clinical photographs.

Red rashes and mild and moderate jaundice were the signs that presented difficulty. It may have been the bright colour of the jaundice that prevented error in photograph 6 and the fact that it was the conjunctiva may have cued the correct response of pallor in photograph 8. The errors in naming colours were typical of those made by individuals with CCVD in an earlier study.[11]

The limitations of the method used in this study were the self-selection of general practitioners with CCVD, the small number of cases and the use of photographs of signs rather than the patients. The small numbers may account for the failure to demonstrate a relationship between severity of the deficiencies and the number of errors.

It cannot be concluded from this study that the same errors in detecting and describing colours would be made in the surgery or at the bedside, or at least with the same frequency. More cues for identifying colours would be available in these settings and the value of cues when used in this way is well recognised.[1] It should be noted that no history was given with the photographs, the history being a valuable lead to diagnosis and therefore a source of cues to colours.[12]

Even if errors of the kind demonstrated were made in clinical practice, it cannot be concluded that diagnosis and management would necessarily be affected: diagnosis is often a complex process and the part played by the various factors involved can be difficult to analyse. In certain situations, the part played in clinical practice by observation of colour is evident and may be a pivotal observation. Bradley[13] gives the example of red urine due to blood as an isolated sign of this kind while blood in other locations could also qualify. He points out that if there is a failure to observe this sign, the management of the case can be

radically and unfavourably altered.

Charts, diagrams and slide projections have been reported as difficult to read by medical practitioners with CCVD[1] and the photographs of this study clearly presented them with similar difficulties. Help in viewing coloured clinical images is likely to become available through digital imaging technology that allows simulation of the vision of dichromats and the modification of coloured images so that they become more easily seen by those with CCVD.[14]

To avoid difficulties in practice, physicians with CCVD should attempt to gain greater awareness of its effects and if they do not know the type and severity of their deficiency, they should arrange to have their colour vision fully diagnosed.

Additional work is required that should involve replacing the use of photographs with the direct observation of patients.

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