Revisiting Occupational Colour Vision Standards

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ABSTRACT

Colour vision standards are prescribed in fire-fighting, police work, railways, vocational driving and aviation. The Ishihara test is the commonest method used as it is the strictest screening test available. Only those with normal colour vision or very mild defects will pass.

Colour vision defects affects 8% of the male population and mild defectives have been shown to be able to carry out a wide variety of colour dependent activities.

A strict screening test which does not allow further identification of safe v/s unsafe colour defectives may unfairly discriminate against the mildly colour anomalous. In certain occupational groups, standards enable for secondary testing for applicants who fail the Ishihara.

In the railway sector, the Ishihara is used, with no secondary testing recommended. A new Colour Assessment and Diagnosis (CAD) test has been developed at the City University which enables the measurement of small changes in chromatic sensitivity. This test, together with an occupational assessment, has enabled the continuing employment of an employee who had earlier failed the Ishihara, in a depot on the London Underground. The extension of the approach throughout the railway sector and in other occupational settings is discussed.

TABLE 1: CLASSIFICATION OF COLOUR VISION DEFECTS [1]

	PROTAN defects	DEUTAN defects	TRITAN defects
DICHROMATISM	PROTANOPIA M=1% F=0.01%	DEUTERANOPIA M=1% F=0.01%	TRITANOPIA M=F=0.005%
ANOMALOUS TRICHOMATISM	PROTANOMALOUS TRICHOMATISM M=1% F=0.03%	DEUTERANOMALOUS TRICHOMATISM M=5% F=0.35%	TRITANOMALOUS TRICHOMATISM M=F=0.025%

Glossary:
Dichromatism = deficient in ONE of the THREE colour receptor mechanisms
Protanopia: deficiency in RED cone colour pigment
Deutanopia: deficiency in GREEN cone colour pigment
Tritanopia: deficiency in BLUE cone colour pigment

BOX A: ACQUIRED COLOUR VISION DEFECTS

Regular screening of occupational groups often includes colour vision testing, primarily to assess acquired colour vision defects. It is estimated that 5% of the population may have an acquired defect as severe as the 8% with an inherited defect, with this figure being probably higher over 50 [1].

Acquired colour vision defects may have the following properties[4]:
•often no clear-cut area of discrimination loss
•dependence of colour vision on target size and illumination
•conflicting or variable results on clinical colour vision tests
•some object colours are named incorrectly
•eyes are affected asymmetrically
•may have decreased acuity and visual loss
•defect fluctuates

Aetiology of acquired colour vision defects[1]:

Cataract
Glaucoma
Diabetic complication
Retinitis pigmentosa
Age related macular degeneration
Multiple sclerosis
Liver disease

Medication known to affect colour vision[4]:

Paracetamol
Chloroquine
Digoxin
Erythromycin
Ethambutol
Ibuprofen
Indomethacin
Oral contraceptives
Quinine
Salicylates
Sildenafil Citrate
Sulphonamides
Thiazides

Cannabis, alcohol and tobacco are also reported as potentially affecting colour vision[4].

Table 2: COLOUR VISION TESTING IN DIFFERENT OCCUPATIONAL GROUPS

SECTOR	SCREENING TEST	SECONDARY TEST
Aviation: Professional Flight Crew[2]	•Ishihara (if fails, move to secondary tests)	•Lantern Test: - Holmes Wright - Spectrolux - Beyne •Nagel Anomaloscope
Firefighters[3]	•Ishihara •City University •Hardy, Rand & Rittler (HRR)	•Farnsworth D15
Railways[4]	•Ishihara	Nil specified
Police[5]	"Any Colour Vision Test"	Nil specified

Colour vision deficiency affects 8% of the male population (Table 1) and up to 5% may develop acquired colour vision defects as a result of disease or intake of medication (see Box A). In many occupational settings, measurement of colour vision is done routinely at regular intervals throughout an employee's career (Table 2). The commonest screening test is the Ishihara plate test. However, it is very efficient at screening for red-green deficiency but it is not a diagnostic test. It is not suitable for screening for blue tritan defects and is also unsuitable for testing acquired defects.

Exclusive reliance on a screening test, such as the Ishihara, may be inaccurate at separating safe from unsafe defectives[5]. There may be unfair discrimination against the mildly colour anomalous in many occupational areas.

In the aviation sector, most countries have a primary screening test, usually the Ishihara. If the subject fails, a second test is used to decide on the type of licence a pilot can be granted, if any, and if any restrictions can be imposed. The second test is not standardised and depends in which country the pilot is being assessed.

With support from the Civil Aviation Authority, the Applied Vision Research Centre, Department of Optometry and Visual Science, City University, has developed a new computer based Colour Assessment and Diagnosis (CAD) test. The CAD test can accurately identify those subjects who have a chromatic sensitivity outside the normal range. It can provide a direct measure of chromatic sensitivity loss and a direct classification of the type of colour deficiency involved. This information should then make it possible to identify objectively the kind of visual tasks for which the applicant's colour vision may not be adequate[2].

Case presentation

Mr. M. is an existing employee of Metronet, with duties in a depot environment but not on the London Underground infrastructure. Existing medical standards are prescribed by London Underground Ltd (LUL) for all persons working in the environment of the London Underground and include strict vision and colour vision standards. On of the requirements of an employee working on track, who may be working on his own, is that he should have normal colour vision as tested by the Ishihara Test. These standards apply to Metronet and Mr. M. failed the Ishihara test.

He was then referred to the Applied Vision Research Centre at City University where he had a detailed colour vision assessment, including a CAD test. The test provided a detailed assessment of his colour vision status, showing that he had minimal deuteranomaly. The report stated that "Mr. M. relies on one normal L-cone pigment gene and also on a hybrid L-cone gene that are sufficiently separated spectrally (in terms of wavelength pigment sensitivity) to provide a reasonable amount of red-green discrimination. His yellow-blue colour discrimination is well within the normal range and he can also make good use of his slightly reduced red-green colour signal".

A site visit was carried out to assess Mr. M's colour vision performance in the working environment in the depot. The conclusion was that the visual tasks and other colour related tasks within the depot are well within Mr. M's visual abilities.

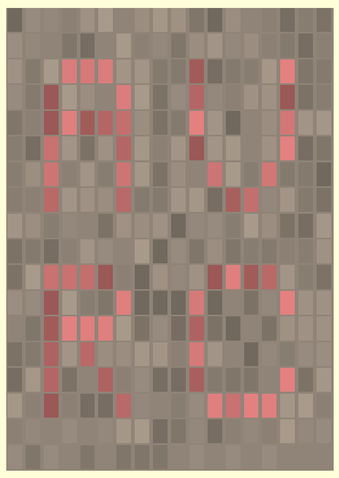
This case shows that it is possible for an employee with a degree of colour vision loss, having failed the Ishihara, can still function effectively in a depot environment. The issue now is whether the stringent colour vision standards applicable to track duties may be amended for depot work.

Recommendation: It is relevant to assess the applicability of the CAD test instead of, or in addition to, the well-established Ishihara test for employees in the London Underground and in the railway sector generally.

The CAD Test: A new web-based colour vision test developed by City University

To diagnose colour deficiency, it must be ensured that the subject can only make use of colour signals. Other parameters such as luminance contrast must be eliminated.

In the CAD test, a movie displays a moving "coloured" square that is buried in flickering luminance contrast noise. The square changes colour as the movie plays. The colour may be seen for some or all of the time. In case of colour deficiency, the person taking the test will have difficulty in seeing the "coloured" square moving all the time. The movie lasts for 90 seconds. The absence of the moving square may only last for 2 to 3 seconds, before it reappears in a different colour. This temporary disappearance of the pattern is diagnostic of colour vision deficiency. Illustrated below are some views of the CAD test, which is available at **http://www.city.ac.uk/avrc/colourtest.html**



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1. Health and Safety Executive. Colour vision examination, a guide for OH providers; Guidance Note MS7, 3rd Edition, 2005
2. Civil Aviation Authority. Minimal colour vision requirements for professional flight crew – Part 1; Paper 2006/4; August 2006
3. Office of the Deputy Prime Minister. Medical and occupational evidence for recruitment and retention in the Fire and Rescue Service; September 2004
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5. J. Volke. Colour vision defects – Occupational significance and testing requirements. J. Soc. Occup. Med 1978; Vol. 28, 51-56