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EVALUATION OF THE CITY UNIVERSITY COLOUR VISION TEST

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Abstract

The use of the City University Colour Vision Test for routine screening for colour vision abnormalities is evaluated. The results of screening for colour vision abnormalities using the City University Test are compared to results obtained when the patients are tested with the Ishihara test and Farnsworth Munsell Panel D 15 test. All patients in the study were also tested on the Farnsworth Munsell 100 Hue Test to confirm the presence and severity of the color vision defect. The City University Test was found to be the most reliable of the three screening tests used in this study for detecting congenital and acquired red green and/or blue yellow defects however it appears to be of limited value in testing patients with optic nerve disease.

Key words: *City University Test, colour vision, anomalous trichromat, congenital/acquired colour vision abnormality, Farnsworth Munsell 100 Hue/D-15, Ishihara.*

INTRODUCTION

The most common colour vision abnormality is congenital red green colour blindness (anomalous trichromatism).[1] As a result most simple colour vision tests have been designed to primarily test for this defect ignoring the other defects, especially the acquired colour vision anomalies. Common examples of tests designed to detect congenital red green anomalies only include the Ishihara, the Matsubara Children's Colour Vision Test and the Standard Pseudoisochromatic Test. The advantages of these tests are that they are very quick and easy to perform for both the patient and the examiner. The major disadvantage, which far outweighs the advantages, is the fact that patients with acquired colour vision abnormalities or congenital blue yellow defects pass these tests and thus appear to have no colour vision abnormality.

To date, in our department the Farnsworth-Munsell 100 Hue (FM 100 Hue) Test has been used to investigate patients with suspected colour vision abnormalities other than congenital red green defects. This test is one of the most thorough colour vision tests available as it will detect any congenital or acquired colour vision anomaly. The major disadvantage of the test is that it takes up to 45 minutes to test, score and print out the results from one patient.

As a result of the time involved in using the FM 100 Hue Test and the relative inaccuracy of the other vision tests mentioned, we decided to use the City University Colour Vision Test. The City University Test is quick and easy to perform and it is designed to test for all types of colour vision abnormalities. To date eighty patients have been tested in our department using the City University Test.

METHOD

City University Test

The test contains 11 plates including one control plate. Each plate consists of one central circle surrounded by four other circles — (see figure

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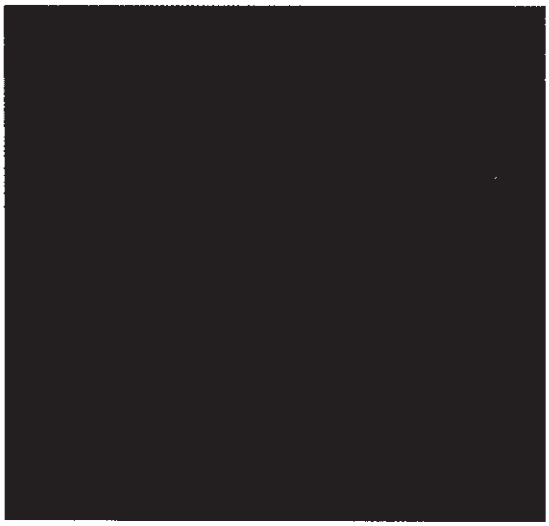

Figure 1: City University test plate 1. (Reproduced from the City University Colour Vision Test.)

1). Plates one to six have coloured circles 8 mm in diameter and plates seven to ten have 4 mm diameter coloured circles. On each plate one of the surrounding circles is very similar in colour to the central circle and the other three are different colours. The patient is simply asked to look at the central circle and then to tell the examiner which one of the four surrounding circles is MOST SIMILAR in colour to the central one (i.e. the circle to the top, bottom, right or left of the centre circle).

Initially the patient is tested with the control plate. This plate is designed so that achromatic (totally colour blind) observers can respond correctly. If, even after re-explanation, the patient responds incorrectly, there is nothing to be gained by continuing the test. Once the patient has responded to the control plate the examiner continues with plates one to ten. The patient's responses are recorded on the score sheet (see figure 2). To score the test the examiner simply circles the response the patient gives for each plate. For example, in figure 2 the patient gave a normal response. In figure 3 the results clearly indicate that the patient has the red green defect, protanomaly.

Plates one to six (called 'chroma four' plates) are not excessively difficult, hence patients with

CITY UNIVERSITY COLOUR VISION TEST (2nd Ed. 1980)

Address DESJ.1 Patient 9003675

Examiner AF Male/Female Date 17/7/1985

Spectacles worn? YES (NO) (RE)LE/BE

Illumination ("Daylight") Type Daylight Globe level

FORMULA: Here are 4 colour spots surrounding one in the centre. Tell me which spot looks most near in *colour* to the one in the centre. Use the words "TOP", "BOTTOM", "RIGHT" or "LEFT". Please do not touch the pages.

	PAGE (A is for demonstration)	SUBJECT'S CHOICE OF MATCH R	L	Both	NORMAL	DIAGNOSIS PROTAN	DEUTAN	TRITAN
"CHROMA FOUR"	1				(B) ◇	R	L	T
	2				(R) ▷	B	L	T
	3				(L) ◁	R	T	B
	4				(R) ▷	L	B	T
	5				(L) ◁	T	B	R
	6				(B) ◇	L	T	R
"CHROMA TWO"	7				(L) ◁	T	R	B
	8				(R) ▷	L	B	T
	9				(B) ◇	L	T	R
	10				(T) △	B	L	R
SCORE	AT CHROMA FOUR				6/6	/6	/6	/6
	AT CHROMA TWO				4/4	/4	/4	/4
	OVERALL				10/10	/10	/10	/10

Probable type of Daltonism P; PA, EPA MIXED D, DA, EDA TRITAN

Figure 2: Normal result from City University Test.

CITY UNIVERSITY COLOUR VISION TEST (2nd Ed. 1980)

Address SPR.G1 Patient 9003456

Examiner Male/Female Date 10/4/1985

Spectacles worn? YES (NO) (RE)LE/BE

Illumination ("Daylight") Type Daylight Globe level

FORMULA: Here are 4 colour spots surrounding one in the centre. Tell me which spot looks most near in *colour* to the one in the centre. Use the words "TOP", "BOTTOM", "RIGHT" or "LEFT". Please do not touch the pages.

	PAGE (A is for demonstration)	SUBJECT'S CHOICE OF MATCH R	L	Both	NORMAL	DIAGNOSIS PROTAN	DEUTAN	TRITAN
"CHROMA FOUR"	1				(B) ◇	R	L	T
	2				R ▷	(R)	L	T
	3				L ◁	(R)	T	B
	4				R ▷	(L)	B	T
	5				(L) ◁	T	B	R
	6				B ◇	(L)	T	R
"CHROMA TWO"	7				L ◁	(T)	R	B
	8				R ▷	(L)	B	T
	9				B ◇	(L)	T	R
	10				(T) △	B	L	R
SCORE	AT CHROMA FOUR				2/6	4/6	/6	/6
	AT CHROMA TWO				1/4	3/4	/4	/4
	OVERALL				3/10	7/10	/10	/10

Probable type of Daltonism P; PA, EPA MIXED D, DA, EDA TRITAN

Figure 3: Protan result from City University Test.

only mild colour vision defects may get most of these plates correct. In plates seven to ten ('chroma two' plates) it is more difficult to differentiate the colours thus it is more difficult to respond correctly. Hence, if a patient makes two or more errors on any of these 4 plates, they are said to have a colour vision abnormality.

This test may be performed monocularly or binocularly depending on the type of colour vision defect suspected (congenital defects are usually bilateral and symmetrical, hence the test may be performed binocularly). If possible the test should be performed under a daylight globe (6740° Kelvin). According to the instruction booklet patients should be given three seconds per plate, thus to perform the test monocularly, score the test and interpret the results takes approximately three to four minutes per patient.

Fifteen patients with colour vision defects included in the results of this paper were tested using the City University test together with the Ishihara test, the Farnsworth Munsell Panel D-15 Test (FM D-15) and the FM 100 Hue. Details of the testing procedures used in these three other tests have been outlined in a previous publication by the author.[2]

Patients reported in this study have defects including anomalous trichromatic colour vision (5 cases), cone and/or rod dystrophy (5 cases), optic nerve anomaly (4 cases), and macular dystrophy (1 case).

RESULTS

Anomalous trichromats: (cases 1, 2, 3, 4, 5)
Two cases of anomalous trichromatic colour vision (cases 1 and 5) demonstrated their abnormality on all four colour vision tests. Cases 2 and 4 showed anomalous trichromatic colour vision on all the colour vision tests except the FM D-15.

Case 3, a mild anomalous trichromatic patient appeared to have normal colour vision when tested on the Ishihara, and showed only one error on the FM D-15, a normal result. However, when tested with the City University Test, a red green anomaly (deuteranomaly) was apparent. (Responses to plates one to six were normal, however plates seven to ten all demonstrated deuteranomalous defect). The patient also demonstrated mild deuteranomaly on the FM 100 Hue Test (with a score of 320).

Retinal Dystrophies: (cases 6, 7, 8, 9 and 10)
Cases 8 and 10 showed achromatopsia (total colour blindness) on all tests. Cases 6 and 9 showed a blue yellow defect on all tests except the Ishihara. This was expected as the Ishihara does not test for blue yellow defects.

Case 7 passed the Ishihara Test, however showed a red green defect on the other tests.

Optic Nerve Abnormalities: (cases 11, 12, 13 and 14)
In all cases of optic nerve anomalies, the patients performed as normals on both the Ishihara and the City University tests. The colour vision abnormalities were apparent on both the FM D-15 and the FM 100 Hue in all cases. (It must be noted that this is only a small sample of patients with optic nerve dysfunction.)

Macular Dystrophy: (case 15)
In this case only the FM 100 Hue response was abnormal. The results of the other tests were normal.

DISCUSSION

The results of this paper have indicated that the FM 100 Hue was the only one of the four tests to demonstrate the colour vision abnormality in all cases. The reliability of the other three tests will now be compared.

As expected, most patients with acquired colour vision anomalies showed normal results when tested with the Ishihara Test. (The Ishihara is only designed to detect congenital red green colour vision anomalies).

Four of the five (80%) cases of congenital anomalous trichromatic colour vision showed a red green defect on the Ishihara Test. The defect was also apparent in all cases on the City University Test and the FM 100 Hue. It was interesting to note that three (60%) of the 5 cases (cases 2, 3 and 4) performed normally on the FM D-15. (These three cases were only mild anomalous trichromats when tested on the other tests). Thus the City University Test and the

TABLE 1: SUMMARY OF RESULTS (R/G = red green; B/Y = blue yellow)

CASE NO & DIAGNOSIS	COLOUR VISION TEST RESULTS			
	CITY UNI	ISHIHARA	FM D-15	FM 100 HUE
1 ANOMALOUS TRICHROMAT	R/G defect	R/G defect	R/G defect	R/G defect
2 ANOMALOUS TRICHROMAT	R/G defect	R/G defect	normal	R/G defect
3 ANOMALOUS TRICHROMAT	R/G defect	normal	normal	R/G defect
4 ANOMALOUS TRICHROMAT	R/G defect	R/G defect	normal	R/G defect
5 ANOMALOUS TRICHROMAT	R/G defect	R/G defect	R/G defect	R/G defect
6 ROD/CONE DYSTROPHY	B/Y defect	normal	B/Y defect	mild general loss
7 RETINITIS PIGMENTOSA	R/G defect	normal	R/G defect	R/G defect
8 CONE DYSTROPHY	achrom-atopsia	achrom-atopsia	achrom-atopsia	achrom-atopsia
9 RETINAL DYSTROPHY	B/Y defect	normal	B/Y defect	B/Y defect
10 ROD MONOCHROMAT	achrom-atopsia	achrom-atopsia	achrom-atopsia	achrom-atopsia
11 OPTIC NEURITIS	normal	normal	B/Y defect	B/Y defect
12 OPTIC N HYPOPLASIA	normal	normal	mild general loss	mild general loss
13 OPTIC ATROPHY	normal	normal	mild general loss	mild general loss
14 OPTIC ATROPHY	normal	normal	mild general loss	mild general loss
15 MACULAR	normal	normal	normal	mild general loss

Ishihara are more reliable than the FM D-15 for screening for congenital anomalous trichromatic colour vision.

In the cases of retinal dystrophy the results obtained on the City University, FM D-15 and FM 100 Hue Tests were all compatible. The abnormality was only demonstrated using the Ishihara in two of the five cases. Thus the City University Test and the FM D-15 are the more reliable tests for screening for colour vision anomalies in cases of retinal dystrophy.

The City University Test was not found to be reliable for screening for colour vision anomalies in cases of optic nerve anomaly. All patients with

optic nerve anomaly showed normal results on both the City University and the Ishihara Tests, however the abnormality was apparent on the FM D-15.

To date only one patient with macular dystrophy has been tested with the City University Test. The colour vision abnormality was only apparent on the FM 100 hue Test.

One main advantage of the City University Test is that it can be used on a greater range of age groups than the other colour vision tests. In our department the City University Test has been used on children as young as five years old. In the author's experience young children tend to respond more readily to this test than to the Matsubara Test and similarly a number of children who have not been able to do the Ishihara have managed the City University Test. A survey conducted in 1984 in our department (unpublished) demonstrated that children between the ages of six and ten years are able to perform the FM 100 Hue Test. However the children showed an abnormally high average score of 370 on the test. Rather than implying that all children between the ages of six and ten have colour vision deficiency, this high score suggests that these children lack the ability to perform the FM 100 Hue Test accurately.

CONCLUSIONS

Although this is only a small sample, the preliminary results indicate that the City University Test is very reliable for screening for colour vision anomalies in all cases with the exception of patients with optic nerve abnormalities. In such cases the FM D-15 proved to be the most reliable screening test. (It must be noted that colour vision anomaly is associated with subclinical optic nerve disease. This can be grossly detected at the bedside without formal colour vision testing. This is because the patients suffer from colour desaturation, i.e. colours appear duller in the affected eye. Once an anomaly has been detected the examiner can proceed to more formal colour vision testing. However detection of colour vision anomaly in subclinical macular or cone disease requires formal testing.)

The City University Test is a reliable test to detect congenital and acquired red green or blue yellow colour vision defects. The Ishihara Test is more limited than the City University Test as it does NOT detect acquired and/or blue yellow defects.[3] The results indicate that the FM D-15 is not always reliable in detecting anomalous trichromatic colour vision or acquired colour vision abnormalities associated with cone disease.

Thus when looking for a test to quickly and accurately SCREEN for colour vision defects in the clinic in patients over the age of five years the results of this study suggest that in all cases except those with optic nerve disease the City University Test is the most reliable.

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