Efficiency of the Ishihara Plates in Distinguishing Defects of Colour Vision

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Introduction

Defective Colour Vision has, apart from genetical interest, considerable importance in every-day life and industrial occupations. Consider automobile drivers who must distinguish the red "stop" traffic signal from the green "go" signal, or the inspectors in textile mills who must judge whether dyed cloth matches standards, or the lady selecting fabrics to decorate her home. In each of these cases, as in many others, defective colour vision may result in failure to make the correct decisions.

Although colour vision is important for successful performance of many jobs, minimum standards for colour vision have not been set for many occupations. Cavanagh (1) reports that, in England, the Metropolitan Police, British Railways, Merchant Navy, the Royal Navy and the Royal Air Force have set colour standards for jobs where colour discriminations are required. Selection of operatives in a linoleum factory in England, who were required to measure differences between products as manufactured and a standard sample, using a colour vision test, is discussed by Pickford (6). For any industry or service requiring colour discrimination, it will be necessary first to determine what types of defective colour vision are unacceptable, and second, to choose an appropriate device for screening out individuals possessing those types of defect.

Classically, the three receptor colour theory of Young and Helmholtz has served as the basis for defining types of defective colour vision (2). In terms of the number of primary colours required to match all colours of the visual spectrum, three main types have been isolated ; anomalous trichromats, dichromats, and monochromats. While anomalous trichromats require 3 primary colours, they use them in amounts different from normal persons, dichromats require two colours, and monochromats require only one colour. Anomalous trichromats are subdivided into three classes : deuteranomals or partial deuteranopes, who require more green than the normal to match a given yellow ; protanomals or partial protanopes, who require more red than the normal ; and tritanomals, a relatively rare group requiring more blue or violet than the normal. Similarly, dichromats are subdivided into classes ; the deuteranopes or green-blind ; protanopes or red-blind ; tritanopes, violet or blue-blind ; and tetratanopes, for whom the whole spectrum appears in terms of red or green (1). Pickford (6) has pointed out that not only are the dichromats a risk in certain occupations, but that anomalous trichromats are also. This is of course even more clear in the case of monochromats or totally colour blind individuals, After examining the occupations of a particular industry in terms of the defects of colour vision which are not acceptable, it is next appropriate to consider a test of colour vision to point out individuals with those defects.

A variety of colour vision tests have been developed. Their use and popularity have depended upon such factors as ease in administration, cost, and personnel required. The most widely used and popular type of test has used pseudo-isochromatic (apparently equal coloured) or poly-chromatic (many coloured) plates. In historical order, *Stilling's Pseudo-Isochromatic Plates for Testing the Colour Sense* were first developed, then Ishihara's *Tests for Colour Blindness* (based on Stilling's work), and later, the American Optical Company's *Pseudo-Isochromatic Plates for Testing Perception* (which is a selection of plates from the Stilling and Ishihara tests). Of these, the Ishihara test has been mostly widely used in industry, anthropological investigations, and psychological research (1).

The Ishihara test consists of a series of plates, each consisting of coloured dots in patterns, with the dots varying in colour and diameter. In the 11th edition (3), there are 38 plates : for the first twenty-five, designed for literates, the pattern includes 1 or 2 digit numbers ; and for the last thirteen, intended for illiterates, one or two winding lines, Canavagh (1) has pointed out that the plates belong to six series. Series 1 (plates 2–5 and 36–37) may be called a *transformation series* since the pattern as seen by normals is transformed to another one when seen by colour-defectives. Series 2 (plates 6–9 and 34–35) is also a *transformation* series, reversing background and pattern colours from those of series 1. Series 3 and 4 (plates 10–13, 32–33 and 14–17, 30–31 respectively) are of the *vanishing pattern* type, *i.e.*, the patterns seen by normals are rarely seen by colour defectives. Series 5 (plates 18–21 and 28–29) contains a *hidden pattern*, which is seen only by colour defectives, and not by normal or totally colour blind individuals. Series 6 (plates 22–25 and 26–27) consists of *differential patterns* in which protanopes should see only one pattern, deuteranopes another, while those with normal colour vision see both.

Although the Ishihara tests have been widely used due to their convenience, and apparent ease in administration, they are subject to a number of sources of error. Among these are careless administration, faulty interpretation of results, expecting too much of the tests and disregard of the critical importance of illumination during administration (1). To correct the first error, a standard procedure, such as that given by Cavanagh (1), should be set up and consistently used. Control of the second error can be introduced by the standardisation of a scoring procedure and definition of critical scores for classification. The third error arises due to lack of familiarity with existing literature on the test, and also, to insufficient quantitative studies on the efficacy of classification by the test. As the plates are designed for use in 'average daylight,' or illumination with a colour temperature of 6500–6750°K, that illumination should be approximated in so far as possible to control the fourth error. It may be noted that fluorescent or 'daylight lamps' are preferable to ordinary or tungsten filament lamps.

Expecting too much of the Ishihara test is an error which has been attributed in part to the lack of familiarity with existing literature on its efficacy. It may be of interest to point out some earlier studies in this context. Pickford (4) compared the results of normal and defective persons, as classified by the Ishihara test (8th edition), with their results on three other tests. He concluded that the Ishihara test was : (*a*) effective in distinguishing major defectives from normal, and minor defectives ; (*b*) useless for distinguishing different degrees of colour sensitivity among normal and minor defectives ; and (*c*) almost useless for distinguishing types or degrees of defect among major defectives. In a further study, Pickford examined responses to plates 2–25 of the test (5). He concluded that the first two series were unreliable, that the next 2 series were more reliable ; while plates in series 5 were rather easily read by normal persons, making them rather unreliable, and the last series of plates were unreliable. This evidence suggests that it is the overall classification provided by a large number of plates that is useful in screening colour defectives ; however, Pickford proposes that a shortened form of the test can be used to separate defectives from normals. The item analysis indicates that neither the shortened or complete test can be used satisfactorily to classify individuals according to type of defect. These results suggest that further quantitative studies on the efficacy of classification would assist investigators and others using the Ishihara test.

Before proceeding to the study undertaken along these lines, it will be desirable to consider the classification of colour defectives given by Ishihara (3). This is as follows :

- Congenital Colour Blindness
  - Total Colour Blindness
    - Complete
    - Incomplete
  - Red-green Colour Blindness
    - Red blindness
      - Complete
      - Incomplete
    - Green blindness
      - Complete
      - Incomplete

This system of classification has been criticised by Pickford (5). The test (3) claims to distinguish the following types : normal, red-green blind, total colour blind, red blind, green blind, and incomplete red-green blind ; these types do not appear to exactly fit Ishihara's system of classification. Thus, while red blind and green blind may correspond to protanopes and deuteranopes respectively, red-green blind may include both, and incomplete red-green blind may refer to anomalous trichromats. Difficulties in interpreting the test may occur partly because of the lack of agreement between systems of classification proposed and that customarily employed.

Assuming that plates in the Ishihara test should properly classify individuals into the types proposed by Ishihara, an empirical investigation may be undertaken to determine :

(*a*) degree of wrong classification by plates ; and

(*b*) average response pattern for the different classes of colour vision.

With these objectives in view, the present study was carried out.

Materials and methods

Plates 1–25 of the 11th edition of the Ishihara test (3) were used in this study. They were administered in serial order by trained technicians under standard conditions. The seating arrangements and fluorescent lighting were constant for all subjects.

A standard proforma was developed to record responses to the test. Reference to Table 1 will show that the column in which a response falls indicates whether it is a colour-blind or normal response, etc. In administering the test, the administrator simply encircled the response given by the subject to each plate. If the response was not among those specified by Ishihara, it was recorded in writing in the column provided for that purpose.

After the test was completed, the number of encircled responses in each column of the record form was counted and entered in the bottom row. On the basis of the column totals, the protocols were diagnosed by the following convention :

(*a*) If the total of columns 2, 6 and 9 was equal to or greater than 13, the subject was classified as normal ; if not, he was classified according to one of the succeeding steps.

(*b*) If the total of columns 3, 5 and 9 was equal to or greater than 13, the subject was classified as red-green blind.

(*c*) If the total of columns 4, 5 and 6 was equal to or greater than 13, the subject was classified as total colour blind.

(*d*) If the total of columns 3, 5 and 7 was equal to or greater than 13, the subject was classified as red blind.

(*e*) If the total of columns 3, 5 and 8 was equal to or greater than 13, the subject was classified as green blind.

(*f*) If the response pattern could not be classified according to any of the above conventions, the subject was classified as colour deficient with no further specification possible.

The test was administered to 194 male employees of a research institute (sample 1) and to 177 male employees of a factory (sample 2) in Calcutta. All subjects were able to read English ; their ability to read Arabic numbers was tested by Plate 1 of the test. (The results of Plate 1 were not analysed further.)

Results

According to Ishihara's notes, there are three possible responses to Plates 2 to 17 : normal red-green blind, or total colour blind. In order to determine the degree of wrong classification by the plates, subjects were placed into two groups according to test diagnosis : normal or colour blind. The latter group included red-green blind, total colour blind, red or green blind, or colour deficient subjects. Responses to the plates were similarly classified as normal or colour blind ; the latter class included red-green blind and total colour blind results. The resulting frequencies could be presented in fourfold tables, with 2 cells indicating " right " classification and the remaining two cells, " wrong " classification, as per the following model :

Test Diagnosis		Frequency of Item Response	
		Normal	Colour Blind
Normal	...	" Right "	" Wrong "
Colour Blind	...	" Wrong "	" Right "

To obtain the percentage of wrong responses, the following formula was used :

$$\% \text{ Wrong} = \frac{W}{W + R} \times 100$$

where W = total of frequencies in the " Wrong " cells

R = total of frequencies in the " Right " cells.

The results for Plates 2 to 17 are presented in Table 2. The data have been analysed separately for the two samples of subjects.

Responses to Plates 18 to 21 distinguish red-green blind from normal and total colour blind subjects, according to Ishihara's notes. Frequency tables were made up comparing red-green blind, normal or total colour blind, and other responses for three groups of subjects : red-green blind, normal or total colour-blind, or colour deficient. The first class included subjects diagnosed as red or green blind, while the latter included only those whose defect could not be classified. The frequencies were presented in the following format to determine the percentage of wrong classification :

Test Diagnosis		Frequency of Item Response		
		Red-Green Blind	Normal or Total Colour Blind	Other
Normal or Total Colour Blind		" Wrong "	" Right "	" Wrong "
Red-Green Blind	...	" Right "	" Wrong "	" Wrong "
Colour Deficient	...	" Wrong "	" Wrong "	" Wrong "

Percentage wrong was computed by the same formula as given above, and the results are given in Table 3 for the two samples separately.

Plates 22 to 25 are supposed to differentially classify the total colour blind, red blind, green blind, and normal or incomplete red-green blind subjects. For these plates, frequency tables were prepared for three sets of responses : first, total colour blind, second, red blind, green blind, and normal or incomplete red-green blind, and third, other responses. Similarly, subjects were classified into three groups : normal or red-green colour blind, including red or green blind ; total colour blind ; and colour deficient. The frequency table, with its " right " and wrong " cells, which was designed was as follows :

Test Diagnosis		Frequency of Item Response	
	Normal or Red-green Blind	Total Colour Blind	Other
Normal or Red-green Blind ...	" Right "	" Wrong "	" Wrong "
Total Colour Blind	" Wrong "	" Right "	" Wrong "
Colour Deficient	" Wrong "	" Wrong "	" Wrong "

Percentage wrong was computed in the same way as above. The data are summarised in Table 4 for the two samples separately.

For each subject, the total number of each type of response (in columns 2 to 10 of the record form) had been computed to make the original diagnosis. To obtain the average response pattern for the different classes of colour vision, frequency distributions were prepared, one for each column of the record form and each class of colour vision. The means of these frequency distributions were computed, which gave the average total on the nine columns for each of the classes of colour vision. Table 5 gives the means for the two samples of subjects separately.

Discussion

The practical necessity for a test of colour vision which accurately but economically screens colour defective from normal individuals and which classifies individuals according to the type of defect has led to the development of a wide variety of colour vision tests. Pseudo-isochromatic tests, consisting of plates of apparently equally-coloured dots, present patterns which are supposed to appear differently to persons with normal and defective colour vision. Probably the most widely used test of colour vision, the Ishihara test (3), is based on the pseudo-isochromatic principle. Research on the Ishihara test in the past has suggested that (i) the plates are individually unreliable (5) ; (ii) the test is effective for screening colour defectives, particularly dichromats and monochromats (4) ; and (iii) different types of colour defect cannot be distinguished by the test (4). As detailed data have not been presented for the separate plates of the Ishihara test, nor the response patterns typical of different classes of colour vision, the present study was undertaken.

Considering first the broad classification of individuals into two classes : normal and colour blind, the effectiveness of the individual plates may be examined. Table 2 presents the percentage of wrong classification for Plates 2 to 17. Rather than combine the data from the two samples of subjects the results have been separately computed and presented, In this way it is possible to see whether the two independent samples have given similar estimates. Table 2 shows that Plates 2, 3, 4, 5, 8, 10, 11, 15 and 16 are consistently superior to the remaining plates in the table. While they do not achieve perfect classification, in terms of the overall test diagnosis, they are clearly superior to Plates 6, 7, 9, 12, 13 and 14 which are wrong in more than 20% of the cases. Plate 9 is particularly unreliable, misclassifying 67% and 70% respectively in the two samples. Suggesting a short and more accurate version of the Ishihara test, Pickford (5) has selected Plates 10, 11, 14 and 15 from among the first seventeen. His work was carried out, however, on the 8th edition, and differences in results from those of this study may have been due to printing errors. From this study, it would appear that nine plates out of the first sixteen would be sufficient for purposes of broad classification.

The broad classification of individuals as red-green colour blind on the one hand, and normal or total colour blind on the other, is tested in Plates 18 to 21. Examination of Table 3 shows that in this study, none of these plates were satisfactory. Pickford (5) had recommended only Plate 13 of this series. Differential diagnosis is attempted by Plates 22 to 25. For the present analysis, the effectiveness of these plates in classifying individuals as normal or dichromatic, as opposed to monochromatic, was examined. Individuals classified as colour deficient were also treated separately, as they did not fall into these two classes of colour defect. Study of Table 4 reveals that, for this broader classification, Plates 22 to 25 are reasonably successful, and none need be rejected.

Empirical determination of the degree of wrong classification by individual Ishihara Plates has shown that, while none are perfect, for purposes of broad classification, thirteen (Plates 2, 3, 4, 5, 8, 10, 11, 15, 16, 22, 23, 24 and 25) were considerably more accurate than the remaining eleven. It is suggested that, in future studies, classification be made on the basis of these thirteen plates.

The response patterns typical of different categories of colour vision may also provide insight into the diagnostic efficiency of the test. Table 5 presents the mean number of responses of each type (*e.g.*, normal, red-green blind) for four different categories : normal, red-green blind, total colour blind, and colour deficient. Due to the small number of cases in the latter three categories, the results may not be as representative as those of the first category. There is a fair amount of similarity, however, between the patterns of all categories for the two independent samples. The patterns obtained for the normal, red-green blind, and total colour blind categories are in agreement with the diagnostic scoring key which was employed ; and suggest that the patterning of response does somehow provide accurate diagnosis despite the unrealiability of individual plates. The pattern for the colour deficient category has a high proportion of normal responses, though less than that of normals *per se*, and also of responses divergent from the scoring key, which suggests that these individuals may be anomalous trichromats. Studies of the colour matches made by such individuals might reveal whether, in fact, they are anomalous trichromats.

Concluding from these results, it may be said that, while individual test plates of the 11th edition of the Ishihara test are unreliable, the response patterns do possess diagnostic significance. Using a selection of the plates, more accurate classification may be possible for use by industry and other organisations for proper placement of colour defective individuals.

Summary

1. Responses were recorded to individual plates of the 11th edition of the Ishihara test from two samples of male adults, respectively 194 and 177 in size.

2. In terms of overall test diagnosis, responses to individual test plates were analysed to determine the percentage of wrong classification. Thirteen plates (2, 3, 4, 5, 8, 10, 11, 15, 16, 22, 23, 24 and 25) were found to be more reliable than the remaining eleven.

3. Average response patterns were obtained for the different categories of colour vision. The results confirmed the use of the test for broad screening into three categories : normal, red-green blind, and total colour blind.

Acknowledgments

The co-operation and assistance of the Biometry Research Unit, Machine Tabulation Section, Sri K. N. Sharma and Sri M. T. Baby, all of the Indian Statistical Institute, Calcutta, are acknowledged.

REFERENCES

1. CAVANAGH, P. The Ishihara test and defects of colour vision. *Occup. Psychol.*, 1955, 29, 43–57.
2. HELMHOLTZ, H. v. *Handbuch des Physiologischen Optik.* Hamburg Und Leipzig: L. Voss, 1896.
3. ISHIHARA, S. *Tests for Colour-Blindness.* 11th revised edition, Japan : Kanehara Suhppan Co. Ltd., 1954.
4. PICKFORD, R. W. A study of the Ishihara test for colour blindness. *Brit. J. Psychol.* (Gen.) 1949, 40, 71–80.
5. PICKFORD, R. W. An item-analysis of the Ishihara test. *Brit. J. Psychol.* (Gen.) 1950, 41, 52–62.
6. PICKFORD, R. W. Weak and anomalous colour vision in industry and the need for adequate tests. *Occup. Psychol.*, 1955, 29, 182–192.

TABLE 1

COLOUR VISION RECORD FORM

Examination : **Ishiharas' Tests for Colour Blindness, 11*th Revised Edition***
Japan : Kanehara Shuppan Co., Ltd., 1954 (*Plates* 1-25)

Sex = Male / Female

1.1 Name.................. ... .
1.2 Local address.........................
(Street and city).
District.................State.............

1.3 Examination Sl. No................
1.4 Date..................................
1.5 Signature of investigator...........

Plate number (1)	Normal response (2)	Red green blind response (3)	Total colour blind response (4)	Red-green or total colour blind (5)	Normal or total colour blind (6)	Red blind (7)	Green blind (8)	Normal or incomplete red-green build (9)	Other response (10)	Comments (11)
1	...	...	...	...	...	...	...	...	...	
2	8	3	C.R.	...	...	...	...	...	...	
3	6	5	C.R.	...	...	...	...	...	...	
4	29	70	C.R.	...	...	...	...	...	...	
5	57	35	C.R.	...	...	...	...	...	...	
6	5	2	C.R.	...	...	...	...	...	...	
7	3	5	C.R.	...	...	...	...	...	...	
8	15	17	C.R.	...	...	...	...	...	...	
9	74	21	C.R.	...	...	...	...	...	...	
10	2	...	...	C.R.	...	...	...	...	...	
11	6	...	...	C.R.	...	...	...	...	...	
12	97	...	...	C.R.	...	...	...	...	...	
13	45	...	...	C.R.	...	...	...	...	...	
14	5	...	...	C.R.	...	...	...	...	...	
15	7	...	...	C.R.	...	...	...	...	...	
16	16	...	...	C.R.	...	...	...	...	...	
17	73	...	...	C.R.	...	...	...	...	...	
18	...	5	...	...	C.R.	...	...	...	...	
19	...	2	...	...	C.R.	...	...	...	...	
20	...	45	...	...	C.R.	...	...	...	...	
21	...	73	...	...	C.R.	...	...	...	...	
22	...	...	C.R.	...	...	6	2	26	...	
23	...	...	C.R.	...	...	2	4	42	...	
24	...	...	C.R.	...	...	5	3	35	...	
25	...	...	C.R.	...	...	6	9	96	...	
Col. Total										

NOTE : C. R. Stands for " Can't Read "

TABLE 2

Normal *vs.* Colour Blind Classification for Plates 2 to 17 : Item Frequency Tables and Percentage of Wrong Classification

Plate Number.	Test Diagnosis	Sample 1: Frequency of Item Response: Normal	Sample 1: Frequency of Item Response: Colour blind	Sample 1: Percentage Wrong Normal	Sample 2: Frequency of Item Response	Sample 2: Frequency of Item Response: Colour blind	Sample 2: Percentage Wrong
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2	Normal ...	166	0	12.37	153	0	9.61
	Colour Blind ...	24	4		17	7	
3	Normal ...	166	0	11.86	152	1	11.30
	Colour Blind ...	23	5		19	5	
4	Normal ...	148	18	13.92	136	17	12.99
	Colour Blind ...	9	19		6	18	
5	Normal ...	165	1	10.31	50	3	7.91
	Colour Blind ...	19	9		11	13	
6	Normal ...	101	65	33.51	90	63	37.29
	Colour Blind ...	0	28		3	21	
7	Normal ...	140	26	19.07	103	50	32.77
	Colour Blind ...	11	17		8	16	
8	Normal ...	161	5	9.79	144	9	9.61
	Colour Blind ...	14	14		8	16	
9	Normal ...	31	135	70.10	35	118	67.23
	Colour Blind ...	1	27		1	23	
10	Normal ...	155	11	10.83	143	10	11.30
	Colour Blind ...	10	18		10	14	
11	Normal ...	157	9	9.79	146	7	9.04
	Colour Blind ...	10	18		9	15	
12	Normal ...	117	49	25.26	103	50	31.07
	Colour Blind ...	0	28		5	19	
13	Normal ...	138	28	18.56	122	31	19.77
	Colour Blind ...	8	20		4	20	
14	Normal ...	138	28	18.56	122	31	19.77
	Colour Blind ...	8	20		4	20	
15	Normal ...	166	0	10.31	151	2	9.04
	Colour Blind ...	20	8		14	10	
16	Normal ...	159	7	9.28	146	7	8.48
	Colour Blind ...	11	17		8	16	
17	Normal ...	132	34	21.65	122	31	19.21
	Colour Blind ...	8	20		3	21	

TABLE 3

Normal and Total Colour Blind *vs* Red-Green Blind Classification for Plates 18 to 21 : Item Frequency Tables and Percentage of Wrong Classification

		Sample 1				Sample 2			
		Frequency of item response				Frequency of item response			
Plate Number	Test diagnosis	Red-green Blind	Normal or Total Colour Blind	Other	Pcentage Wrong	Red-green Blind	Normal or Total Colour Blind	Other	Percentage Wrong
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
18	Normal or Total Colour Blind.	69	90	9	50.00	47	100	11	39.55
	Red-Green Blind.	7	0	0		7	0	0	
	Colour Deficient.	11	8	0		9	3	0	
19	Normal or Total Colour Blind.	56	83	29	55.67	30	107	21	37.29
	Red-Green Blind.	3	2	2		4	0	3	
	Colour Deficient.	8	6	5		4	3	5	
20	Normal or Total Colour Blind.	59	81	28	54.64	29	95	34	42.94
	Red-Green Blind.	7	0	0		6	2	0	
	Colour Deficient.	9	9	1		8	3	1	
21	Normal or Total Colour Blind.	18	114	36	39.69	4	122	32	28.81
	Red-Green Blind.	3	1	3		4	1	2	
	Colour Deficient.	4	7	8		2	4	6	

TABLE 4

Normal and Red-Green Blind *vs.* Total Colour Blind Classification for Plates 22 to 25 : Item Frequency Tables and Percentage of Wrong Classification

		Sample 1				Sample 2			
		Frequency of item response				Frequency of item response			
Plate number	Test diagnosis	Normal or Red-Green Blind	Total Colour Blind	Other	Percentage Wrong	Normal or Red-Green Blind	Total Colour Blind	Other	Percentage Wrong
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
22	Normal or Red-Green Blind.	164	3	6	14.95	154	1	5	12.43
	Total Colour Blind.	1	1	0		4	1	0	
	Colour Deficient.	13	0	6		10	0	2	
23	Normal or Red-Green Blind.	168	3	2	12.89	157	1	2	10.73
	Total Colour Blind.	1	1	0		4	1	0	
	Colour Deficient.	19	0	0		10	0	2	
24	Normal or Red-Green Blind.	167	2	4	13.40	155	2	3	12.43
	Total Colour Blind.	1	1	0		5	0	0	
	Colour Deficient.	16	0	3		11	1	0	
25	Normal or Red-Green Blind.	170	2	1	11.86	157	1	2	11.30
	Total Colour Blind.	0	1	1		4	0	1	
	Colour Deficient.	18	0	1		10	1	1	

TABLE 5

Average Response Pattern for Different Classes of Colour Vision

Col. number	Type of Response	Diagnosis: Normal Sample 1	Normal Sample 2	Red-Green Blind Sample 1	Red-Green Blind Sample 2	Total Colour Blind Sample 1	Total Colour Blind Sample 2	Colour Deficient Sample 1	Colour Deficient Sample 2
	n*	No. 166	No. 153	No. 7	No. 4	No. 2	No. 5	No. 19	No. 12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
2	Normal.	13.66	13.25	2.14	2.00	3.00	4.60	8.68	8.42
3	Red-Green Blind.	1.57	1.06	6.86	8.25	2.50	1.40	2.32	2.83
4	Total Colour Blind.	.22	.28	1.86	1.50	5.00	3.20	.84	1.33
5	Red-Green or Total Colour Blind.	.11	.18	7.14	7.00	7.50	6.40	1.37	1.33
6	Normal or Total Colour Blind.	2.20	2.67	.43	0	2.00	3.00	1.58	.58
7	Red Blind.	0	0	0	.50	0	0	0	0
8	Green Blind.	0	0	1.00	1.00	0	0	0	0
9	Normal or Incomplete Red-Green Blind.	3.96	3.96	1.14	0.50	1.50	2.60	3.53	3.42
10	Other Response.	2.28	2.35	3.29	2.25	2.50	1.40	3.79	4.50

n* = Number of subjects.