The Effects of Filters on Colour Vision

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Abstract

Colour vision is important in everyday life and colour vision deficiency generally lowers the quality of life. The objective of the study was to perform tests and measurements to investigate the effects of gelatine filters on colour vision. Colour vision measurements were carried out using the Ishihara and Dvorine colour test plates. The visual acuity measurements were obtained using the Snellen letters. A total number of 12 subjects were tested. The results of the measurements showed that colour vision improved significantly using the red and orange filters but worsened using the green and blue filters. Therefore the use of red and orange filters as spectacles is recommended for those individuals with red-green deficiency.

Keywords Colour Vision, Filters, Visual Acuity, Snellen Letters, Ishihara Dvorine Colour Test, Gelatine

Introduction

The importance of colour vision cannot be overemphasized and it is hypothesized that colour vision in the visual system evolved as a means of overcoming the extremely unfavourable lighting conditions in the natural environment of early vertebrates.[1] Colours are the basic information carriers of any natural scene.[2] Daily life depends on colour to an enormous extent in education, packaging, medicine, sport, horticulture, transport, and many industrial activities.[3] Minor frustrations for the colour abnormal individual include weather forecast (because of the colour coding on the legends), light emitting diodes, traffic lights, purchasing clothing, bank tellers (normally in triplicate, each for a specified box) e.t.c. According Lennie[4], colour vision has attracted scientific attention for at least 275 years, though it was not until the nineteenth century that we began to understand it properly. Since then, Scientists have provided very precise descriptions of the phenomena of colour vision and provided much new information on the mechanisms of colour vision. The loss of information due to inadequate colour decoding prevents or slows down comprehension, increases reaction time and generally lowers the quality of life. 8% of men and 0.5% of women have colour deficiency or colour blindness in the civilized world. It is more prevalent among the whites than other racial groups[5,6] and colour vision tests are necessary for different professions.[7] In order for colour to be seen, electromagnetic energy has to reach the eye. An object is seen when light is reflected from it. If it looks green in daylight, then this must imply that it is only reflecting the green part of the light back to our eyes. The remainder of the spectrum is absorbed.

Colour vision deficiency is a condition in which certain colours cannot be distinguished, and is mostly due to an inherited condition. Red-Green colour deficiency (blindness) is by far the most common form, about 99%, and causes problems in distinguishing reds and greens. Another colour deficiency, Blue-Green also exits, but is rare and there are no commonly available tests for it. Abnormal colour vision interests a wide range of people, including the millions who realize that their appreciation of colour is 'defective', their families and many more who are responsible for the dangers and other consequences of their condition, including industrial and professional implications. The objective of this study was to perform tests and measurements to investigate the effects of filters on colour vision.

Using Colour Filters

Interesting results are obtained when light filters, in the form of sheets of gelatine coloured with various dyes, are placed in front of white light. By this means, the light transmitted by the filter can be analyzed into its component colours. It is observed that certain colours depending on the colour of the filter, are now absent from the spectrum. The missing colours are those of light which have been absorbed by the filter, while remaining colours have been transmitted. Now one would expect red gelatine to transmit only red light, green gelatine only green light and so on. Indeed, this generally proves to be so when tested by experiment. But an unusual result is obtained with yellow gelatine. The spectrum of light passing through most types of yellow gelatine is found to consist of red and green as well as yellow. What is even more striking is that this particular yellow light looks just the same to the eye as that which comes from a filter passing only pure yellow. To distinguish between the two, the former kind of yellow is called compound yellow light. Filters modify the visual system[8] and are used to alter and cause a lot of effects in the performing arts. By additive mixing using multiple sources and by using multiple filters in units, a virtually unlimited palette can be achieved.

Materials and Method

The investigations were carried out in four parts: Visual Acuity Measurements [9,10] Ishihara Test[11], Dvorine Colour Test[12] and Colour Naming Test. All sessions were done under normal natural lighting room condition, which was good for near and distance acuity measurements. All subjects on glasses were tested without their glasses on to avoid any effect of such on the measurements. The colour plates were held at a distance of 75 cm and tilted so that the plane of the paper was at right angle to the line of vision. Each plate was to be read within a maximum of three seconds. In some sessions, the order of the plates was varied to avoid subjects reading from memory.[13] Since the focus of the work is on the effect of filters, details of the visual acuity and colour vision measurements are described in an earlier paper.[14]

Griffin gelatine -film colour filters were also used in the experiment to observe the effect of filters on colour vision. The filter was used for each eye separately placed on a spectacle frame.

Results

Table 1 shows the responses of the 12 subjects for no filter, red filter, orange filter, yellow filter, green filter and blue filter respectively for the Ishihara and Dvorine colour plates. The subjects were of different ages and visual acuities. The eye column indicates either the right eye R, or the left eye, L response.

Discussion and Conclusion

Figures 1 and 2 show graphically the comparison of the filters used. The results show a remarkable improvement using the red and orange filters but a poor response from the green and blue filters. The results indicated 3 persons with colour deficiencies that are acquired, rather than congenital shown clearly by failing to read four or more of the Ishihara colour plates and a 100% score in colour naming. Those with congenital colour deficiencies were 3.The Ishihara test had a total of 17 plates and a failure to read four or more plates indicated a colour vision deficiency. Using the red filter therefore enabled the subjects but one to read almost all the plates correctly. The subject with a poor visual acuity of 6/60 rather had a worse perception which was not necessarily a colour vision deficiency but of the acuity. A similar result was obtained the orange filter. The red and orange filters used on the Dvorine plates also showed some little improvement. Green and blue filters had a rather negative effect on the reading of the plates. This could be due to the fact that the red and orange filters compensated for the spectrum not distinguishable to the colour deficient subjects. Therefore the use of red and orange filters as spectacles is recommended for those individuals with red-green deficiency particularly in fields where colours are encountered daily as in the computer and its various applications.

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Appendix

Table 1: Results of the Filters Used.

S/No	Age (Yrs)	Acuity	% Colour Naming	Eye	Number of Ishihara Plates missed						Number of Dvorine Plates missed					
					None	R	O	Y	G	B	None	R	O	Y	G	B
1	25	6\6	37.5	R	14	0	0	16	17	14	13	1	3	14	14	14
	25	6\6	37.5	L	13	0	1	15	17	14	14	4	4	14	13	13
2	23	6\6	100.0	R	6	1	0	8	17	14	8	6	6	7	14	14
	23	6\6	100.0	L	6	1	1	10	16	14	8	5	5	7	14	14
3	19	6\6	100.0	R	14	0	3	16	17	16	13	6	6	13	14	14
	19	6\6	100.0	L	14	1	3	16	17	16	13	6	6	13	14	14
4	24	6\9	100.0	R	10	3	4	4	17	16	9	6	4	13	14	14
	24	6\9	100.0	L	10	3	6	7	17	16	9	8	5	13	14	14
5	41	6\5	62.5	R	16	0	4	16	17	16	13	7	8	14	13	13
	41	6\5	62.5	L	16	0	5	16	17	16	13	5	8	14	13	13
6	35	6\5	87.5	R	1	0	2	1	17	16	0	4	3	0	14	12
	35	6\5	87.5	L	1	0	1	0	16	16	0	4	4	1	14	11
7	50	6\9	100.0	R	1	1	0	2	16	16	1	6	6	2	14	13
	50	6\9	100.0	L	1	0	0	0	16	15	1	7	5	2	13	13
8	20	6\6	100.0	R	0	0	0	0	16	16	0	3	2	3	14	14
	20	6\6	100.0	L	0	1	0	0	16	16	0	3	2	0	12	13
9	23	6\5	62.5	R	0	3	3	3	15	16	2	4	5	3	12	14
	23	6\5	62.5	L	0	0	0	1	17	16	2	6	5	2	13	13
10	20	6\60	87.5	R	12	16	16	16	17	17	14	14	15	14	15	14
	20	6\60	87.5	L	12	15	16	14	17	17	14	15	15	14	15	15
11	45	6\6	100.0	R	2	1	4	0	15	11	0	3	3	1	13	13
	45	6\6	100.0	L	2	1	3	0	15	12	0	2	3	1	13	13
12	21	6\6	62.5	R	1	2	3	1	16	16	1	6	5	2	14	14
	21	6\6	62.5	L	1	2	1	1	16	16	1	6	7	3	14	14
TOTAL					153	51	76	163	394	368	149	137	135	170	327	323

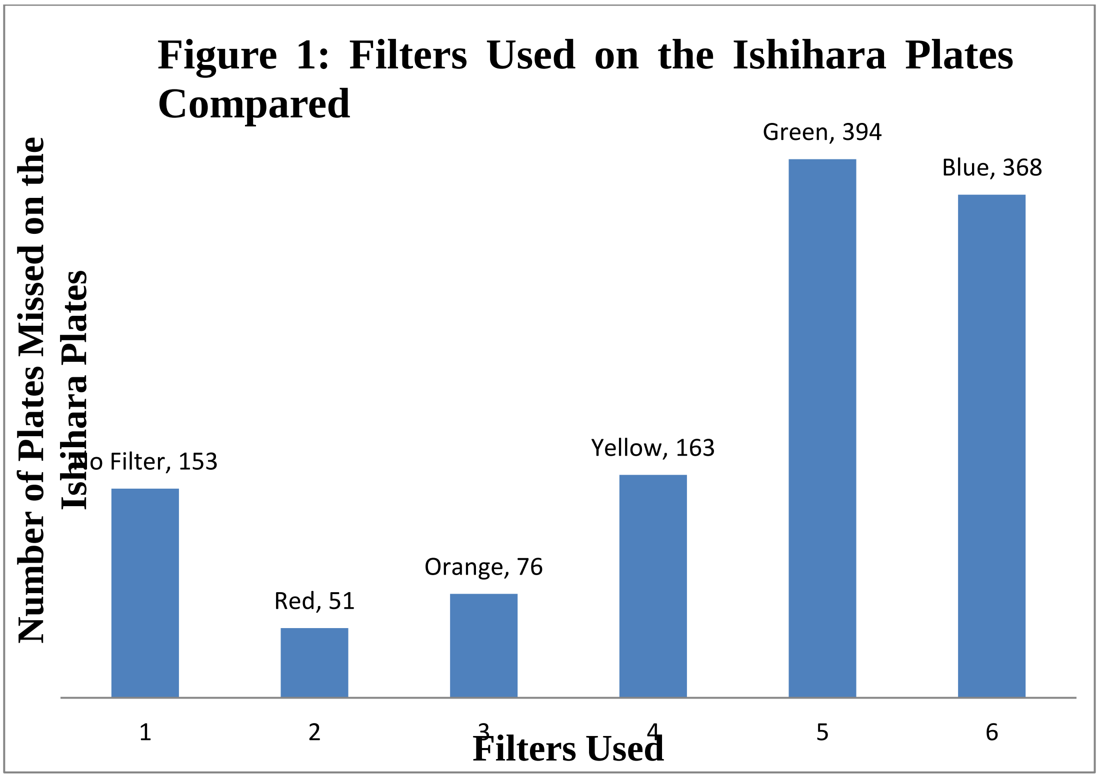
Figure 1: Filters Used on the Ishihara Plates Compared
Number of Plates Missed on the Ishihara Plates
No Filter, 153
Red, 51
Orange, 76
Yellow, 163
Green, 394
Blue, 368
1
2
3
4
5
6
Filters Used

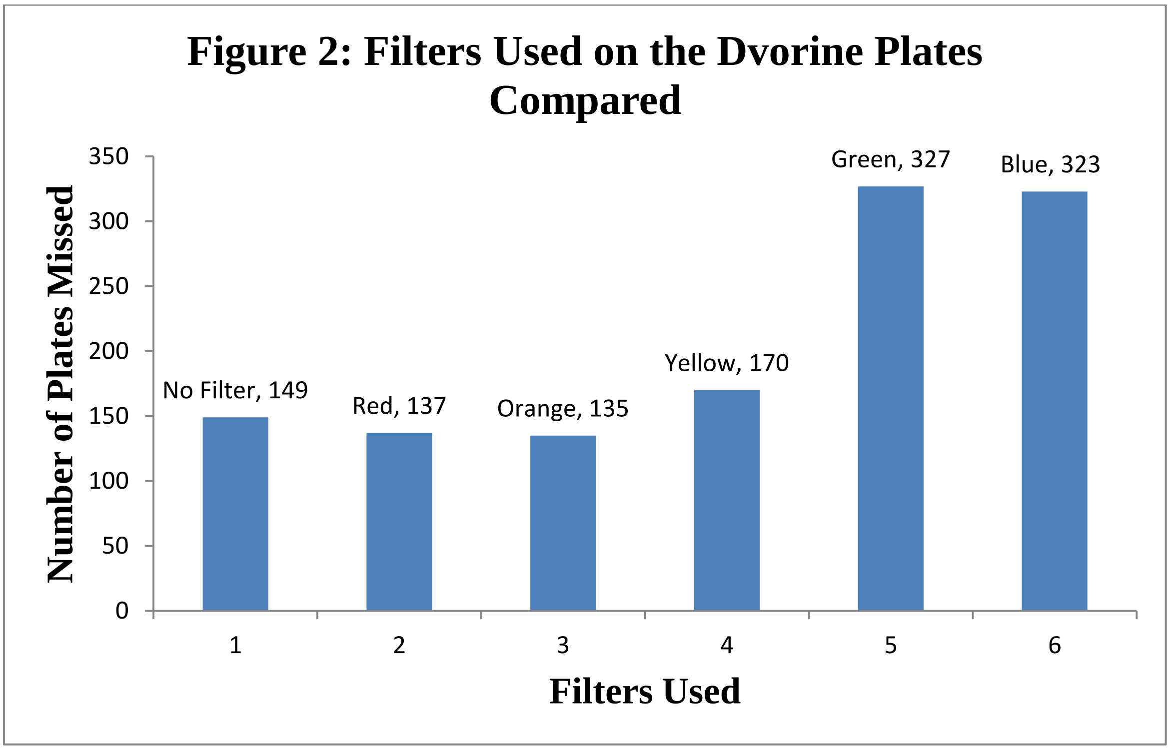
Figure 2: Filters Used on the Dvorine Plates Compared
Number of Plates Missed
350
300
250
200
150
100
50
0
No Filter, 149
Red, 137
Orange, 135
Yellow, 170
Green, 327
Blue, 323
1
2
3
4
5
6
Filters Used