A New Computerized Test for Colour Deficiency

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Abstract: 10% percent of today's population suffers from colour vision deficiency. There are many tests to diagnose colour blindness in related literature. Ishihara pseudoisochromatic plates which have almost one-century background are being used widespread to diagnose if a subject is colour blind. In this study, a novel computerized test based on Ishihara tests has been designed. The new test has been applied on 12 individuals having colour deficiency and 50 individuals having normal colour vision. We have achieved 100% sensitivity and 100% specificity from the new test though Ishihara test results.

Keywords: Colour blindness, Colour deficiency, New Computerized test, Diagnosing Colour deficiency.

1. Introduction

The colours emerged by perceiving reflected light from objects around us. Wavelength of these reflected light beams allow us to determine, discriminate and name the subsequent colours.

When light enters the eye, it is focused onto the retina, where it is absorbed by photoreceptors [1]. There are two kinds of photoreceptors named Rod and Cone in human retina. The Cones are less delicate to light then rods but they are responsible to see colours. The cones are of three kinds (Red, Green and Blue), depending on the pigments they contain [2]. Perception process of the colours will be impaired if any deficiency or absence at one or more of the three cone types occurs [3]. A person who has these kinds of defects of perception of the colours called as a colour blind.

There are many tests to diagnose colour deficiency in related literature. Ishihara colour blindness tests which is first published in 1917 [5] are most widely used [6]. However, the rest of the methods related to colour blindness in the related literature have not been popular since they infer some drawbacks such as invalid test equipment, time-consuming features, costs and inadequate accuracy.

2. Ishihara Pseudoisochromatic Plates

The Ishihara plates consist of dots of different size and colours. In the plates, there is a hidden number or line that is only can be seen by individuals who have normal colour vision. However, there is a hidden number that can be only seen by individuals who are colour blind in some plates. Fig. 1 shows some Ishihara plates.
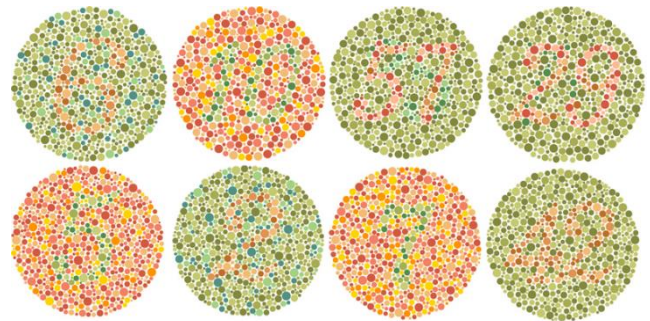

Figure 1. Ishihara Test Plates.

The full test includes 38 Ishihara plates [7]. It is not necessary to use the complete series of plates in all cases. According to the Ishihara test instructions, the full Ishihara plates can be simplified to a short test only consists of six plates just to determine whether the individual is colour blind or not.

Some weakness of Ishihara test:

- The validity of the test is reduced because of using colour plates over and over again causes wear and tear, an occurrence of fingerprints, and dust on the plates [5], [8].
- The test is being used without measuring quality of the colours on Ishihara plates [9].
- It is possible to get various results from same individuals because of Sunshine comes in the test room with various angle at different time of the day [8].
- The individuals can memorize the answers because of the Ishihara plates are in same order.

3. Aim and Objectives

In this study, a new computerized test has been developed to diagnose colour blindness based on Ishihara plates. The new test has been applied to 12 individuals who have colour deficiency and 50 individuals having normal colour vision. The new test eliminates the weakness of Ishihara plates listed above. The results from new test will be compared with Ishihara results to calculate sensitivity and specificity of the new test.

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4. Literature Survey

Marey at el. have scanned ishihara test with a scanner which has 600 dpi resolution. Then they have introduced a new colour blind test created from the scanned images. They applied their test on 23 individuals and their test has achieved 100% sensitivity and 98.78% specificity [11]. In addition to that, Isik at el. have introduced similar studies. They have scanned ishihara test with two different scanners that has 600 dpi and 1200 dpi resolution. They have applied their obtained images on two different groups. Their studies have achieved 100% sensitivity and 100% specificity [12,13]. As a result, it can be assumed that Computers and Monitors have enough capacity to diagnose colour deficiency.

5. Method

In our test setup, we have used, a 15" retina screen with a resolution of 2880x1800 pixels, a pixel density of 220 ppi and a maximum level of illumination for the screen. An object-oriented programming language has been used while developing the new test.
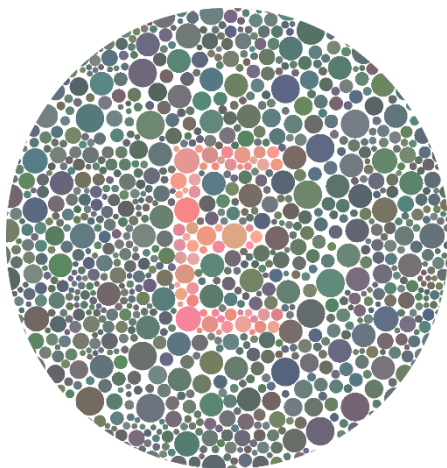

Figure 2. A Screen shot from the new test.

Fig. 2 shows an example test plates from the new test. The new test has been designed based on Ishihara plates. The new test screens also have a hidden number or letter like Ishihara tests. There is also a couple of geometric shape for individuals who are illiterate. The test value randomly changes in every screen.

6. Implementation of The New Test

Two test groups have been constituted for experiment. The first group consists of 12 individuals who tested clinically and aware of their situation before they volunteer to our experiment. The second group consists of 50 individuals who have normal colour vision. The colour-blind individuals have been numerated between 1 and 12. The new test and the first 21 plates of Ishihara full 38 version test applied to the groups.

In Ishihara test, If the individual read 13 or more less normally over first 21 plates, he or she accepted as a colour blind as Ishihara instruction suggest. However, if it takes more than 3 seconds to answer a plate, the answer accepted as a wrong [10].

In the new test, all individuals have been informed about usage of the new test. The individuals who were seated with right angle have been positioned 75cm ahead from the test screen. There are 10 screens in the new test and the individuals who has two or more wrong answer deemed to colour blind. However, if it takes more than 4 seconds to answer a screen plate in the new test, the answer accepted as a wrong.

The illumination of the test room which is lit adequately by daylight and fluorescence lamb are measured with a lux meter during the test.

7. Results

The ambiance light level of the table where Ishihara plates on is measured around 400 lumens during the test. On the other hand, the ambiance light level near the screen is measured around 700 lumens.

Table 1 and table 2 shows the answers that is gathered from the individuals having colour deficiency and letter 'x' stands for wrong answer.

Table 1. Results from ishihara plates.

Plate No	Individuals Number											
	1	2	3	4	5	6	7	8	9	10	11	12
1												
2	x	x	x	x	x	x	x	x	x	x	x	x
3	x	x	x	x	x	x	x	x	x	x	x	x
4	x		x	x	x	x			x		x	x
5	x	x	x	x	x		x	x		x		x
6		x		x	x		x	x	x	x	x	x
7	x		x	x	x	x	x		x			
8				x	x	x		x				
9		x	x	x	x		x		x	x		x
10	x	x	x	x	x	x	x		x	x		x
11	x	x	x	x	x	x	x	x	x	x	x	x
12	x	x	x	x	x	x	x	x	x	x	x	x
13	x	x	x	x	x	x		x	x	x		x
14	x	x	x	x	x		x	x		x		x
15		x			x		x		x	x	x	x
16		x		x	x	x		x	x			x
17	x	x	x	x				x				x
18							x				x	
19	x						x	x				x
20		x				x			x			
21				x								x

Table 2. Results from the new test.

Plate No	Individuals Number											
	1	2	3	4	5	6	7	8	9	10	11	12
1												
2	x	x	x	x	x	x	x	x	x	x	x	x
3	x	x	x	x	x	x	x		x	x	x	x
4	x	x	x	x	x	x		x	x		x	x
5	x	x		x	x		x	x	x	x	x	x
6				x	x	x	x			x		x
7			x				x	x	x			
8				x	x					x		x
9	x	x	x	x	x		x	x	x	x	x	x
10	x	x	x	x	x		x	x	x		x	x

If an individual is colour blind according to Ishihara test, then he or she is colour blind according to the new test. In addition to that, all results gathered from second group having normal colour vision after appliance of the new test and Ishihara test.

It can be assumed that all the results are the same. Consequently, the new test has 100% sensitivity and 100% specificity based on Ishihara and it can be used instead of Ishihara tests. However, the new test is most suitable for information technologies.

The new test's advantages over Ishihara:
- Because of the new test is in digital platform, using it over and over again will not cause any deficiency like Ishihara.
- The computer screen has more less effected from ambiance than Ishihara plates.
- The test value randomly changes in every screen so it is not

possible to memorize the order.
The new test eliminates the disadvantages of Ishihara plates that is in the matter of this study.

Discussion

The new test should be applied on more individuals for more reliable results. The new test should be also compared with Anomaloscope which is the golden test for colour blindness [4]

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