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Original article:

An observational study to analyze difference in color perception amongst males and females

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Abstract:

Background: Color vision is defined as an ability to discriminate a light stimulus as a function of its wavelength. Human colour vision has been one of the most popular and productive yet elusive and controversial areas of enquiry over a century. It is still controversial whether there are sex-related differences in human color vision. Factors such as age and sex, other than those related to physiological mechanism could affect this perception, due to the presence of estrogen receptors in retina.

Aim: To analyze the gender based differences in color perception

Objectives:

1) To evaluate color vision among subjects.
2) To compare perception of color vision amongst males and females.
3) To evaluate responding times and correct responses for matching colors in males and females.

Methodology: Study includes 200 participants of age group 17-22 years. Test color strips and shade charts were given and subjects were asked to match all the test color strips one by one with shade charts and code numbers were noted down. Total number of correct answers was evaluated. Total time taken in matching all test color strips with shade charts was recorded by stop watch for each individual.

Observation and Results: It was found that females gave more correct responses as compared to males. Also, females took less time than males in matching all test color strips with shade charts.

Conclusion: From the results we can conclude that females can see more colors and hence differentiate between various ranges of colors as compared to males.

Keywords: Color vision, color perception, color strips, shade charts.

INTRODUCTION

Color vision is defined as the ability to discriminate a light stimulus as a function of its wavelength. Human colour vision has been one of the most popular and productive, yet elusive and controversial areas over a century [1]. It is one of the most fascinating areas of human research from a perspective of neurophysiology, psychology, philosophy, or the arts. It is also, notably, one of the few areas of research where no one viewpoint holds sway, and where the subjective and objective perspectives share much the same framework [2-5]. Color vision is the ability to distinguish objects based on the wavelengths (or frequencies) of the light they reflect, emit, or transmit. White light splits into its component colors when passed through a dispersive prism discovered by Isaac Newton. Perception of "white" is made by the whole spectrum of actinic radiation, or by mixture colors of simply many wavelengths, like red, green, and blue, or by mixing simply a combine of complementary colors like blue and yellow [6]. The perception of color is one of the advantages of adaptation provided by the evolutionary development. There are factors such as age and sex, other than those related to physiological mechanism that could affect this perception, due to the presence of estrogen receptors in the retina [7]. Men and women may experience appearance of color in different ways, perceptually and cognitively. Studies on the skills that might relate to the color perception have shown that women are quicker to name the colors than men, possibly due to greater ease of access and retrieval of the correct names for the colors or forms. Therefore, this study was designed to determine the influence of gender in color perception in individuals of same age.

AIM AND OBJECTIVES

Aim: To analyze the gender based differences in color perception

Objectives: To evaluate color vision among subjects and compare perception of color vision amongst males and females with evaluation of responding times and correct responses for matching colors in males and females.

MATERIAL AND METHODS

The study was an observational study. The study included 200 students of the age group between 17-22 years of a Tertiary Care Hospital. Written informed consent was obtained from the participants and institutional ethical committee approval was taken before starting the study. Individuals willing to participate were enrolled for the study. The subjects were divided into two groups – Group 1 had 100 male subjects and Group 2 had 100 female subjects. History of any disorder related to ocular diseases was ruled out. First of all testing of Visual Acuity by Snellen's chart was done. Color vision was tested by using Ishihara pseudo-isochromatic plates (Ishihara's Tests for Colour Deficiency, Concise Edition 1996, Kanehara & Co., LTD, Tokyo, Japan) to rule out the abnormalities in color vision. Subjects who had more than 4 errors in Ishihara plates were excluded from the study. Test was done in bright sunlight between 12.00–3.00 pm. There were 32 test color strips and 2 shade charts [(Figure 1 (a) and (b)] having various shades of different colors, and they were numbered with secret code numbers.

Figure 1 (a). Color Chart

Figure 1 (b). Color Matching Stripes with Secret Code numbers

The test color strips and color shade charts were given to participants. Then each subject was asked to match all the test color strips one by one with the shade charts and the code numbers were noted down. Total number of correct answers was also evaluated. Total time taken in the matching of all test color strips with shade charts was also recorded by stop watch for each individual.

Statistical Analysis: Statistical analysis was done by graph pad instat software, by applying unpaired students unpaired‘t’ test and Mann-Whitney Test.

The level of significance was –

P<0.05 – Significant

P<0.01 – Moderately significant

P<0.001 – Highly significant

OBSERVATIONS AND RESULTS

The mean age of male subjects was 19.16 ± 1.085 and the female subjects was 19.86 ± 1.83 (range between 17–22 years of age). Overall, out of 32 test color strips, the total number of correct responses was compared in both males and females.

a) It was found that females (31.04 ± 1.7) gave more correct responses as compared to males (29.76 ± 2) and this difference was calculated by Mann-Whitney Test, where P value was derived as (P<0.0001) and it was extremely significant (Table 1).

b) Other than this females (108.57 ± 21.9) also took less time than males (118.35 ± 20.52) in matching all the test color strips with the shade charts and this difference in duration was calculated by Unpaired ‘t” Test, where P value was derived as (P=0.0013) and it was also found to be statistically significant (Table 1).

The total number of Correct Responses and time taken to match the color stripes with the chart is labelled below in Table 1.

Subjects	Number of Color Strips (32)	Time taken (in Sec)
Male (n=100)	29.76 ± 2	118.35 ± 20.52
Female (n=100)	31.04 ± 1.7	108.57 ± 21.9
P value	<0.0001	0.0013

Comparison of Mean Values of total number of correct responses and Mean Values of time taken to respond by males and females are represented in Chart 1 and Chart 2 respectively (Error bars represent Standard Deviation).

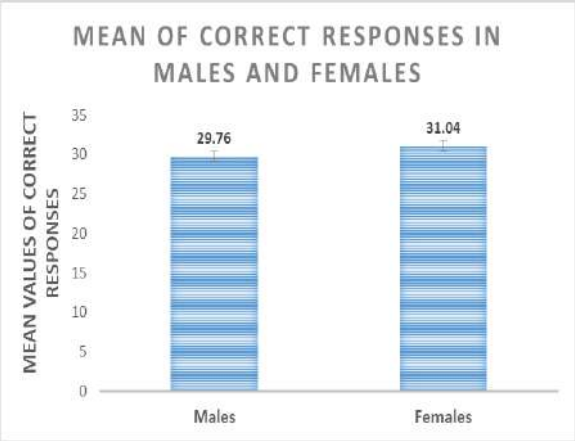

Chart 1. Comparison of Mean Values of Correct responses. Chart 2. Comparison of Mean Values of time taken

DISCUSSION

As per results of our study, females showed statistically significant better matching of colors in comparison to their male counter parts ; also females took less time to match the color strips than that of males. One of the possible physiological factors underlying these differences is a sexual dimorphism in the gene that encodes the photo pigment of the long wavelength sensitive cones in the retina [8, 9]. Females have two X chromosomes. In females, on one X chromosome some type of the red and green pigment containing cones are activated whereas the other type of cones for different red and green pigment activated on the other X chromosome. Also the red cones lie very nearer to each other on the X chromosome. This is called as the super color vision power of the female [10, 11]. Jain et al, in their study have assessed Gender variation with respect to total no. of correct responses ($p<0.0001$) and the time taken ($p<0.01$) [8]. Panchal et al, compared the total error score ($p<0.0035$) with Farnsworth-munsell 100 hue color perception test was used which is a software based computer scanning system [11]. In the present study it was observed that total no. of correct responses ($p<0.0001$) and for the time taken ($p=0.0013$) which has been

statistically significant. Wald suggested that the genes for red and green receptors were altered in males and these genes must lie near each other on the X-chromosome [12]. Anomalous color vision, which is usually a genetically determined normal state, is always a decrease in fineness of color perception. It is predominantly seen in males as it is carried on X-chromosome. [8,13] Bimler in his study suggested relative differences in the salience of color-space axes, with the males tending to attend more to a lightness axis and less to a red-green axis. This may be due to existence of photo pigment heterozygosity among females while males are hemizygous, and gender differences in overall color awareness. [14,8,9,15 and 16] Red and green cones may be more developed in females and this is proved by their liking towards shades of red and green colors. Red and green cones may be less developed in males therefore male subjects liked mostly shades of black and blue colors. These findings may also be related to the high incidence of red green color blindness in males. [17, 15] Human color vision is trichromatic depending upon the different cones. Especially females express more than one variant of the opsin which forms the L and M types of the cone photo pigments. Males required a slightly longer wavelength to experience the same hue as did females. This difference is because of the testosterone receptors lying on the cerebral cortex in males.[18] Explanations for differences in color experience could be sought at a number of levels, from retinal performance (e.g., photo pigment heterozygosity in a subgroup of females), influence of the wavelength absorption by the macular pigments. [17] Green (1995) examined the color identification and vocabulary skills of college students. The results showed that women recognized significantly more elaborate colors than did the men. [19]

Limitations:

1. Non- availability of FM Hue 100 Color Perception test software, if we had this software the study would have been more simplified and also it would have consumed less time.
2. Time allowed to complete study was comparatively less and hence we were unable to get more number of subjects.

CONCLUSION

The maximum number of correct responses (32/32) were given by 31 out of 100 males, and 71 out of 100 females. From this we concluded that females have better color perception than males. Also the minimum time taken with all correct responses was recorded in females was (73 sec) and in males it was (80 sec). Hence it is clear that females can match color better and faster than males.

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