A Comparative Study Of Color Perception In Young Males And Females

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Abstract: Background: It is a well known fact that there is a significant difference in the color perception amongst the people. This study was done to compare color perception in males and females. Method: It is a cross-sectional, interventional study conducted at Civil Hospital, Ahmedabad. Total 100 healthy medical students (50 males and 50 females) were taken. Farnsworth-Munsell 100-hue test was used to assess color perception. Result: Mean age of males was19.16 with 1.085 SD and mean age of females was 19.86 with 1.83 SD. Favoritecolor in males was blue (40%) and in females was pink (33%).Mean result of FM 100 hue color perception test in males was 43.8 with SD of 28.524 and in females 28.38 with SD of 22.616 with P value 0.0035 indicating a better color perception in females. The mean and SD for myopes were 46.96, 29.309 respectively and for non myopes 25.2, 18.58 respectively with p value <0.0001. So a better color perception in non-myopes. Conclusion: The test value of FM 100 HUE COLOUR PERCEPTION test is more in the males and myopes. So females and non-myopic has better color perception.

Key words :Color Perception, FM 100 Hue color perception test, Gender, Myopia

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Introduction: Vision is the sensory modality of providing information to own and surrounding environment maximally than any other modality. The main mechanism concerned with vision is initiation, transmission and perception of vision. Color sense is type of color perception which means an ability of the eye to discriminate between different colors excited by light containing different wavelength of the cones. Cones perform this by different types of the pigments which absorb red, green, and blue wavelength of the light. This is done by protein called as opsin and the retinence. Color vision depends on three types of cones, some of which are more sensitive to the longer wavelengths of light (L-cones), some to the middle wavelengths (M-cones), and some to the shorter wavelengths (S-cones). The genes coding for two of these cone photoreceptors (L- and M-cones) are carried on the X-chromosome[1].

Color is a perceptual phenomenon, not just a physical property of an object[1]. There are different factors which affect the color perception like gender[2], age[3], illumination of light3, hormonal factors[2] and eye diseases[4]. So to find difference in the color perception various color metric systems are used in industry, in printings and in the graphic arts. There are two color metric systems. One is Ciecolor space system and second one munsellcolor system. The Ciecolor space system is based on amounts of three primary colors to match a specified color. While in munsellcolor metric system; all the colors are represented in a cylinder in terms of hue, value and Chroma. This munsell system covers a wide range of colors.5This is also reliable and valid. Many studies are done based on this munsell system for comparing the other Method, has three attributes; hue, lightness and saturation.[6]

There are many Method to test and compare the color perception of different individuals like strips and chart method2, Farnsworth munsell 100 hue color perception test[,3,7,8] electro-retinography.[9] In the strips and chart method, strips of different colors have to be matched with different shades of color in which time and error are recorded and then compare between two different groups.[2] This method does not seem to be accurate because of the less color member which has to compare. Another method is to check the sensitivity of the cones by the Electro Retinogrphy.9 The most common and valuable method for testing the color perception is Farnsworth munsell 100 hue color perception test which was very time consuming method when started earlier. The FM 100-hue test consists of 85 removable colored caps, each of a different hue. The caps are separated into four boxes, each containing 21 or 22 caps each. In addition to the 21 or 22 caps in each box, at each

end of the box there is a fixed cap of a particular hue. patient has to arrange the 21 or 22 removable caps in the box so that they progressively change in hue, starting from the hue of the fixed cap on the left of the box and ending with the hue of the fixed cap on the right of the box, a report is generated based on how correctly they arrange the caps.[8]

There were previous studies done on the color perception based on gender[2], age[3], study on illuminance of light[3], study of color vision based on the hormonal factors[2], study on high myopia associated with color vision defects[10]. We know that there is difference in the sensory modality of sex linked color perception. The genes coding for two of these cone photoreceptors (L- and M-cones) are carried on the X-chromosome.

Refraction generally depends on the developmental changes in different parts of the eye including the axial length, corneal curvature, lens power and anterior chamber depth. Genetic and environmental factors both play role in the pathogenesis of myopia. Inheritance of mild to moderate degree of myopia can be polygenic. Whereas severe degree of myopia can be monogenic in the most of the cases in the form of autosomal dominant, autosomal recessive or X linked inherited pattern.[9] From many studies[10,11], the role of genetic factors in pathogenesis of high myopia and asociatedcolor vision defects can be understood.

This study has been conducted to know whether there is any difference in color perception in males and females with normal color vision. Among males and females also the myopes and non myopes of the both group were included to compare the color perception amongst myopes and non myopes also. In this study we had used the Farnsworth munsell 100 hue color perception test which is a software based test. This method is less time consuming and had given an accurate result than other manual Method.

Material and Method: Study population and sampling: The present work was a cross-sectional, interventional, single center study conducted at Civil Hospital, Ahmedabad over the period of eight months after prior permission of Institutional review board and head of department of physiology.

Total 100 healthy medical students (50 males and 50 females) were enrolled in this study. Before study, we had done the pilot study on 10% of students, and validity of the Farnsworth munsell test was checked which was seen to be significant for study of color perception in different groups.

Based on the pilot study, we enrolled 100 healthy subjects as per inclusion criteria. Among these 100 medical students we had selected, 50 were myopes and 50 non myopes (means 25 females and males having myopia and 25 each having no refractive errors . Also the 25 males having the myopia and 25 males have no refractive errors.)

In our study, 96% subjects from the myopic group have mild to moderate degree of myopia. Only 2 students have high degree of myopia (myopia < -6)12. Those who had history of any abnormality in vision other than myopia, past history and family history of eye diseases were excluded.

Data regarding general examination and eye examination were recorded in case record form. Snellen's chart and Ishihara chart were used for visual equity and color vision respectively. Farnsworth-Munsell 100-hue test[7] (software based) was used to assess color perception. Data was entered in Microsoft excel sheet 2007 and analyzed using appropriate software. This study was done in computer lab between 1:00 pm to 4:00 pm, during bright daylight[2].

Ophthalmological examination: The Students were asked about any significant history of the eye diseases and the systemic diseases which can affect the vision like diabetes and hypertension. Visual equity 6/6 measured by Snellen's chart with correction of the refractive errors. Color vision was measured by Ishihara's chart because we had to exclude the subjects having color deficiency or anomalies. All the students had gone through the ophthalmological examination by the torch to see any abnormalities in the cornea or lens and the subjects having the abnormalities were excluded. 50 Subjects having myopia (25 each from males and females) with correction of their refractive errors were included.

The subjects having myopia without correction, having history of color blindness, eye disease like conjunctivitis, iritic, retinitis, migraine, eye surgery, glaucoma, cataract ,history of tobacco and/ or alcohol, diabetes, hypertension, ischemic heart diseases were excluded.

Fig 1: Farnsworth munsell 100 hue test Manual apparatus (above) and software based system on (below)

Farnsworth-munsell 100 hue color perception test[7] was used for comparing the color perception which is software based computer scanning system. The result of the test can be produced within the 15 seconds. Here one advantage of our study is that we have used the software based system which is easy to perform and results are easily reproducible, very accurate and takes very less time as compared to the manual method or the DOS based system. We tested the students' color perception with FM 100 hue color perception test online from the website www.xrite.com which is free to use for checking the color vision. As shown in the figure.1 this contains the 4 rows of the different shades of the color combinations. Each of the rows the last box of the color is fixed on both sides. The subject has to arrange this in the one row according to their hue, saturation and lightness. After completion of the test this system automatically develops a total error score. Stastical analysis was done based on the unpaired't' test applied for two groups: gender based group (males and females), refraction error based group (myopes and non-myopes).

Result: The mean age of male subjects was 19.16 ± 1.085 and the female subjects were 19.86 ± 1.83.

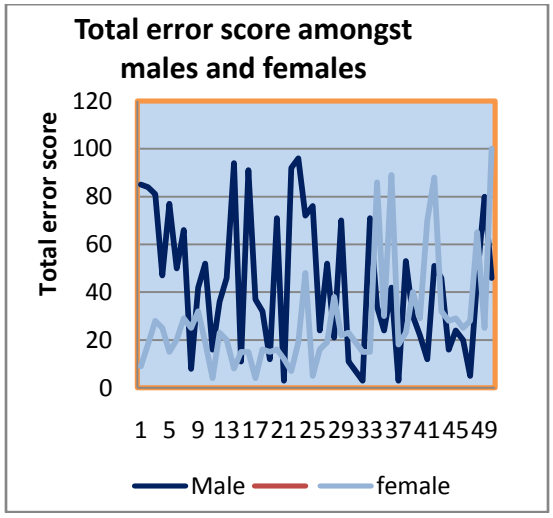
The result of the total error scores amongst the males and females were compared and can be seen in the graph.1. The total error score for the male group is 43.8±28.52 and for the female group is 28.38±22.62.Then the P value has derived 0.0035 after application of the unpaired't' test. The two-tailed p value equals 0.0035 which is considered statically significant.This shows that the males had the high total error score than the females (table 1).

The result of the total error score amongst myopes and non-myopes were also compared and can be seen in the graph 2. The total error score for the non-myopic group is 25.2±18.58 and the total error score for the myopic group is 46.96±29.31. The p value derived by the unpaired't' test is <0.0001. This value is extremely significant which shows that the non-myopic individuals give the more correct response. The mean and SD of total error score for the myopes having the spectacle number>= (-3) was 40.33, 29.78 respectively. The mean and SD for myopic group having spectacle number < (-3) was 49.64, 29.05 respectively (table 2).

The comparison was also done for the favoritecolor amongst males and females, which shows that 33.3% females prefer pink color and that of 13.33%, shades of red color. 40% males prefer blue and 23.33% males having the favoritecolor was black which is shown in the graph 3 and 4.

Discussion: This study shows that the total error score is high in the male group and low in the female group that means the females can identify more color range as compared to males. This difference may be due to sexual dimorphism. The genes that encode the photo pigment of long wavelength sensitive cones in the retina are more in females.[13]

Graph 1: Total error scores amongst males and female



Graph 2: Total error scores amongst myopes and nonmyopes

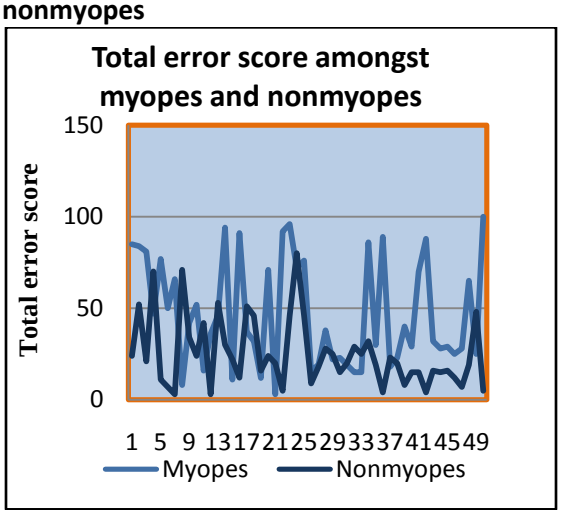


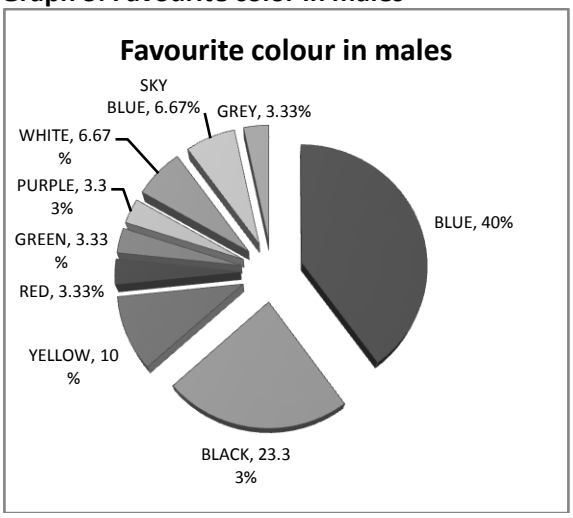
Table 1: Total error score amongst males and females

	MALES	FEMALES	p VALUE
Age (mean ± sd)	19.16 ± 1.085	19.86 ± 1.83	-
Total error score (mean ±SD)	43.8 ± 28.52	28.38 ± 22.6	0.0035
* pvalue<0.0035 significant.			

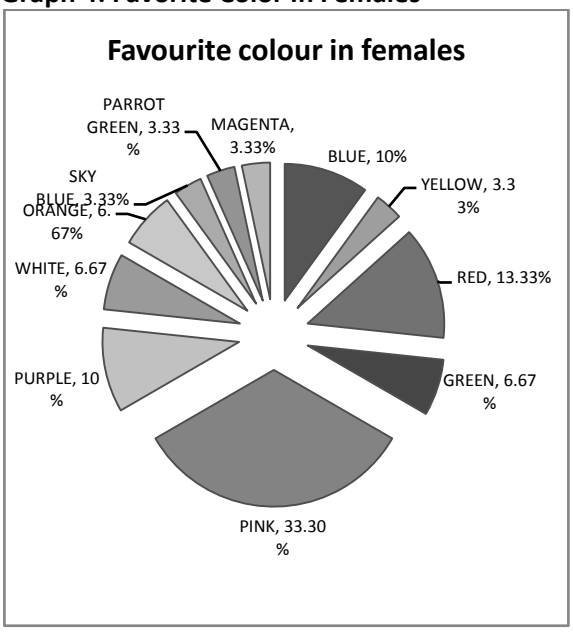
Table 2 : Total error score amongst myopics and nonmyopics

	Total error score (mean± SD)		Total error score (mean ± SD)
Myopes	46.96± 29.31	>3	40.33 ± 29.78
		<3	49.64 ± 29.05**
Nonmyopes	25.2± 18.58*	-	
* P value < 0.0001 significant ** p value 0.3228 Not significant			

Graph 3: Favourite color in males



Graph 4: Favorite Color In Females



Females have the two X chromosomes. These chromosomes have the genes for the different types of the red pigment on the 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 (but less for the green pigment containing cones) pigment activated on the other X chromosome. So there is certain type of different red and green cones on the two X chromosomes. 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.[14]

A study done by St. George found that blue for men stands out far more than for women15. Another study by Jastrow et al also found that men preferred blue to red and women red to blue.[15]This may be due to less development of red and green cones in the males and more development of red and green cones in the females.[1]

Color perception represents a major adaptive advantage which has been given by evolutionary pathways. It is such an important mechanism of biological signaling, a source of information from the environment. There are factors other than those related with physiological visual processes influencing such perception, which may be linked to the presence of estrogen receptors the retina.[16]

Color vision capabilities are believed to be developed and functioning equally in males and females by 1 year of age, but at the age of 5 to 6 years the ability to identify primary colors by name is significantly greater in girls than in boys.[17] The explanation offered is that various constitutional and environmental factors undoubtedly influence the acquisition of color-naming ability by children, and verbal skill and interest in colors may vary between boys and girls[17]. In adults, a number of studies suggest that color lexicons differ in fundamental ways across gender. Comparative cross-cultural studies of some Asian cultures found that females prefer reddish, pink, and purplish colors.[17]

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]

A study conducted by Bimler suggested that 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. They are also less reliable in identifying the colors. This may be due to existence of photo pigment heterozygosity among females while males are hemizygous, and gender differences in overall color awareness. Wald suggested that the genes for red and green receptors were altered in men and these genes must lie near each other on the X-chromosome.[9, 19, 20]

A study by Guilford and Smith found that men were generally more tolerant toward achromatic colors than women. Thus, women might be more color-conscious and their color tastes more flexible and diverse.15 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.[15]

An interview based study by Thomas et al in Nepalese found that there was a significant difference between men and women for naming of color. Although, the women consistently listed more color names than men did.[15]

Moreover in our study 96% of the subjects have myopia of mild to moderate degree. Only the 4% of the subjects having high degree of myopia did not give the significant family history of high myopia or the color deficiencies running in the family members. So the poor color perception amongst myopes probably not due to the color vision defects resulting from the congenital autosomal dominant, autosomal recessive or x linked disorders. In our study in the myopic individuals the color vision is normal when checked by the ishihara's chart but the total error score is significantly higher which is correlated with the study by M Mäntyjärvi and K Typpurainen.[13] They explained in their study that the high myopic

individuals without degenerative changes in their retina and with normal color vision shows high total error score in the spectrum of blue color. This occurs due to stretching of the posterior pole of the retina in the myopic individuals and this posterior pole of the retina contains s-cones (short wavelength cones) in the human beings which comprises only 10% of total cones. These s-cones are also known as the blue cones which are related with the discrimination of the blue color. In the myopes the degenerative changes are stopped at the inner nuclear layer.[13]In the study of Gündogan NU et al[10], showed that the high myopia responsible for the changes in the fundus. It also causes diminished response in the rods and cones which is resulting from the congenital myopia which is of the high degree.[10]

Conclusion: This study concludes that the females can see more range of colors as compared to males. In other words, the beautiful world is more colorful to the females. The high refractive error in the form of myopia can also affect the color vision.

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