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Original Research Article

COMPARISON OF COLOR VISION DISCRIMINATION IN MALE AND FEMALE EYES AMONG YOUNG ADULTS- A CROSS SECTION OBSERVATIONAL STUDY

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ABSTRACT

Background: Color perception is an important aspect of our life. It is well established that there is a significant difference in color vision among different peoples. Male and female have a different perception of colors. Therefore this study was done to evaluate the color perception in two genders of the same intellectual and same age. **Material and Methods:** A cross-sectional observational type of study was carried out including 170 young adults with normal color vision. The Ishihara pseudo-isochromatic plate test for screening of CCVD, Gundogan test for detecting Dominant Eye, and FM100HUE TEST for color vision discrimination ability were performed. **Results:** Total of 101 males (59.42%) and 69 female (40.58%) participants were included in the study. The mean and standard deviation Age profile of the young adults is 18.6 ± 0.91 and Median is 18. Mean and Standard Deviation of Total Error Score of FM 100 Hue test between Right Eye (RE) and Left Eye (LE) among males and females for color vision discrimination ability was found significant. Mean (±SD) Total Error Score of FM100 HUE TEST for Two Eyes with Dominant Right Eye and two eyes with Dominant Left Eye in male and female was also found significant. **Conclusion:** From this study, it is concluded that the color vision discrimination performance ability was found superior for females than males. We hope that with more advanced studies in the context of developing imaging techniques could found more and more descriptive information.

Keywords: Dominant Eye (DE), Farnsworth Munsell 100 Hue Test (FM100 Hue Test), Ishihara Pseudo-isochromatic Plate Test (IPPT).

INTRODUCTION

Eye is a sensor of vision and is an extremely complex sensory organ. Color is a philosophy of human visual sense that gives ambiance to a varied aspect of life. The molecular neurophysiology of color directed the presence of molecular receptors well known as cones which are responsible for the transduction of spectral electromagnetic energy into a mean of communication that is comprehensible, intelligible and decipherable by customized system of neuronal pools sub serving the phenomenon and specter of Color Vision**(1)**.

The retina contains 3 layers of neural cells consisting of photo-receptor layer of rods and cones. The Human retina contains around 100 million rods (night vision, i.e., perception of light) and about 60 million cones (trichromatic color vision due to three types of cones giving flavor to light), located on outer nuclear layer of the retina **(2)**.

The process of color vision can be explained by Trichromatic Theory of Helmholtz **(3)** and Opponent Process Theory of Color of Ewald Herring **(4)**.

Color vision deficiency is an abnormal condition which is defined by the inability to clearly differentiate certain shades of color. Pseudo-isochromatic plate testing can be used to determine

if a color vision deficiency exists and also find out the type of color vision deficiency **(5, 11)**.

The Farnsworth-Munsell **(6)** (FM) 100 hue test is a widely used tool for measuring chromatic discrimination which consist of 85 colored caps arranged in 4 rows. The color of caps is changes gradually in hue and thus the whole box represent the entire color circle. Challenge for the subject is to arrange these given caps in the best order of hue and accuracy of this arrangement of caps to form a gradual transition in chroma in between 2- anchor caps is defined as Total Error Score (TES). If the number of misplacement is higher, TES value will be larger **(7)**.

Eye dominance of an individual was tested here through gundogan test **(8)** by means of the near-far alignment and the ability of dominant Eye to discriminate color as compared to that of non – dominant Eye was also compared.

Males are more expected to be color blind/ deficient than females, because the genes responsible for the most common forms of color blindness are present on the X chromosome **(9)**.

About 8% male population of world exhibit CVD while only 0.4% of females have CVD. In males mostly 1% are red blind (protanope), 1.1% are green blind (dueteranope), 1% are insensitive to red (protanomalous) and 4.9% are sensitive to green (deuteranomalous) trichomates **(9)**.

Mutations and rearrangements in the genes, Which encodes the long, middle and short wavelength of sensitive cone photo pigments are accountable for color vision defects and these mutations, also affect varied types of cone and absorption spectrum of cone photo pigments, functionality and viability of cones, and topography of mosaic cone **(10)**. This study has been conducted to know whether there is any difference in color perception in males and females with normal color vision.

MATERIAL AND METHODS

The present study was carried out in the Department of Physiology in association with the Department of Ophthalmology, SMS Medical College, Jaipur, Rajasthan India. Study design is cross- sectional comparative and analytic type of study. Total 170 young adults in the age group of 18-25 years with normal color vision, including males and females were involved in the study. Data was collected after approval from Ethical committee and Institutional Review Board. No risk involved to the young adults for the study. Ethical consideration, Verbal explanation, informed and written consent from each participant was taken. Identity of each participant during study period, during analysis and after publication of the study will be kept confidential in future. The data was entered and tabulated in Microsoft Excel Office 2010. Data were shown as number and percentage (n and %). Qualitative data was expressed in rates and proportions and quantitative data was expressed in terms of mean and standard deviation and median. Fisher's Exact test was used for statistical evaluation of categorical variables. Results were stated as the figure of observations and percentages (%). Statistical analysis was performed with the SPSS, version 21 for Windows statistical software package (SPSS inc. Chicago, IL, USA). If p values were recorded as less than 0.05 ($p<0.05$), Probability was considered to be significant.

The inclusion criteria for the participants were; Subjects with normal visual acuity, Age group 18-25 years of either sex, Subjects with normal ocular motility Voluntary participation and who gave informed written consent for study. The exclusion criteria in proposed research design were: Subjects with a history of ocular surgery, Subjects not able to communicate and not cooperative, Presence of ocular diseases such as strabismus, nystagmus, retinal pathology and any other co-morbidity like diabetes mellitus, hypertension etc.

Each participants undergo a complete ophthalmological examination including best corrected visual acuity. The color vision tested by using IPPT and normal color vision subjects were further tested by FM100 HUE TEST. The DE assessment was carried out to all participants by using Gundogan method.

Ishihara Pseudo-isochromatic Plate Test (IPPT) **(5,11)**

Each participants screened with 38 Ishihara plates under day light with best corrected visual acuity. The plates were held at 75 cm. distance from the subjects. Consuming of time for each plate should not more than three seconds. Plates should be shown to each participants only once time.

Dominant Eye Assessment **(8)**

All participants were assessed in the same conditions by near far alignment test. The two equal size black round shaped points were used as a near point and far point (two reference points). The subjects was asked to align these two points in the horizontal plane at the level of eye. Two reference points

should be align in the same line. Eye representing minimum shifting distance between two points was accepted to be dominant.

Farnsworth Munsell 100 Hue Test **(6)**

The test was done under best corrected visual acuity with using with a Farnsworth Munsell 100 Hue Test Kit (X RITE MUNSELL COLOR). It consists of four trays (Panels) includes a total of 85 removable color reference caps (incremental hue variations) spanning the visual spectrum. The caps 85-21 (red/yellow) are arranged in first panel and the caps 22-42 (yellow/blue-green), the caps 43-63 (blue/green-purple), and the caps 64-84 (purple- red) are arranged in this order in the remaining 3 panels. A TOTAL ERROR SCORE (TES) of 0-100 is considered normal for healthy individuals. In this study, the test was performed from a reading distance of approximately 40 cm without. Color vision aptitude is detected by the ability of the test subject to place the color caps in order of hue. The subjects were provided a reasonable time to arrange the plates and were permitted to alter the sequence prior to completion. The usual time given was about 2.5 minutes for each row. The aim of the test was to arrange the shown color tiles in the correct order and any misplacement could point to some sort of color vision deficiency. Subjects could find the detailed instructions in the test with in the Software CD that holds the Farnsworth- Munsell 100Hue Test installed on desktop of computer.

RESULTS

Table 1: Gender Distribution in Young Adults in Study Population

	Number of subjects	Percentage
Male	101	59.42
Female	69	40.58
Total	170	100.00

Table no.1 Shows 101 males (59.42%) and 69 (40.58%) female participants were enrolled in Study Population. A total number of 170 participants were recruited in study.

Table 2: Comparison of Mean Total Error Score of FM 100 HUE test Between the RE and LE in Gender Group.

	Male		Female		P value
	Mean	**SD**	**Mean**	**SD**	
RE	89.56	18.92	58.81	16.70	P<0.001 (S)
LE	95.92	22.27	64.35	16.52	P<0.001 (S)

Table 2: Exhibits mean and Standard Deviation of Total Error Score of FM 100 HUE test among male and females for color vision discrimination (Hues of color are sets in correct increasing order). In all RE and LE sites the comparison of mean Total Error Score among the young adults including males and females showed significant difference (p<0.05).

Table 3: Comparison of Mean Total Error Score of FM100 Hue Test Among Young Adults In Gender Group between two(both) Eyes

	Male		Female		P value
	Mean	**SD**	**Mean**	**SD**	
Two eyes with Dominant Rt Eye	76.00	10.61	48.85	13.02	p<0.001
Two eyes with Dominant Lt Eye	75.93	9.71	46.73	15.46	p<0.001

Table 3 Exhibits Mean Total Error Score of FM100 Hue Test Among Young Adults In Gender Group For Color Discrimination (Hues of color are sets in correct order according to reference points). The Mean Total Error Score (±SD) of FM100 Hue test has to be found Statistically Significant Difference Between Two Eyes of Males and Females.

Our study exhibits Mean age of young adults was 18.62±0.91. As on interpretation of table 2, The mean and Standard Deviation of Total Error Score In all RE and LE is found to be 89.56±18.92 and 95.92±22.27 for males respectively and the mean and standard deviation of Total Error Score In all RE and LE is found to be 58.81±16.70 and 64.35±16.52 in females respectively. p value is <0.001 is considered to be significant (p<0.05).

Table No. 3 Exhibits Mean Total Error Score of FM100 HUE TEST among young adults in gender group for color discrimination. Mean (±SD) Total Error Score of FM100 HUE TEST for Two Eyes with Dominant Right Eye was 76.00±10.61 for males and 48.85±13.02 for females. Mean (±SD) Total Error Score of FM 100 HUE TEST for Two Eyes with Dominant Right Eye in males and females showed statistically significant difference (p value <0.05). Mean (±SD) Total Error Score of FM100 HUE TEST for Two Eyes with Dominant Left Eye was 75.93±9.71 for males and 46.73±15.46 for females. There was statistically significant difference has to be found between the Mean (±SD) Total Error Score of Two Eyes with Dominant Left Eye in males and females (p value 0.05).

DISCUSSION

The present study was designed to evaluate the color perception in two genders of same intellectual and same age. Our study shows that the total error score is high for the male participants and low for the female participants that suggest the females are able to perceive color range better as compared to males.

It is also evident that there are differences in process of color information of male and female, and these differences may be at different levels from color perception to color cognition, and this difference can be explained by a range of so many factors like genetic, physiological and behavioral/social.

The encoding genes for cones responsible for photo pigment of long wavelength are abundant in retina of females. This may also be explained by sexual polymorphous and hormonal, developmental and environmental differences among the both sexes**(12)**.

A cross sectional study conducted by Woldeamanuel et al. (2018) among school children concluded a prevalence of colour vision deficiency of 4.1% among school children to with higher in males than females **(13)**. Study done by Jain et al.(2010) on difference in color vision perception was based on gender and hormonal factors **(14)**. It is also established by Fareed M et al. (2015) that color vision impairment in children is more in males (7.52%) than female (0.83%) and this is based on genes (X- chromosome) and their mutations**(15)**. Panchal, GS et al (2012) showed that females are better able to perceive colors than males **(16)**.

Our study shows that that is a clear and significant difference in color vision discrimination among males and female by means of single eye(either right or left), dominant eye and both (two) eyes.

CONCLUSION

From this study it is concluded that in young adults of similar educational background, the color vision discrimination performance ability was found superior for females than males.

It is an important topic for research in future, and it may become skilful and excellently an important model system for future research. Additionally a global standard that has been used by governments and industry, the FM100 Hue test evaluates as a diagnostic tool for future times and determine type and degree of color vision deficiency.

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