Best and worse color sense discrimination in males and females by different age groups

D. Čebatorienė[1], R. Liutkevičienė[1,2]

[1]*Department of Ophthalmology, Medicine Academy, Lithuanian University of Health Sciences, Lithuania*

[2]*Neuroscience Institute, Medicine Academy, Lithuanian University of Health Sciences, Lithuania*

[1]*E-mail: dzastina.sarkunaite@gmail.com*

Introduction. Previous our research confirmed, that color vision does not depend on gender in ophthalmologically healthy persons in Lithuanian population, but we have not examine which colors' discrimination in males and females are seen worse, and which are seen as the best. Generally women are believed to be more discriminating than men in the use of color names and this is often taken to imply superior color vision. However, if both X-chromosomes linked color deficient males (~8%) and females (< 1%) as well as heterozygote female carriers (~15%) are excluded from comparisons, then differences between men and women in red-green (RG) color discrimination have been reported as not being significant [2, 3]. Simultaneous color contrast and color constancy are memory processes associated with color vision, however the gender-related differences of 'physiologic color space' remain unknown [4 - 11].

So we are going to check hypotheses separation of the best and worse color in males and females by different age groups.

Methods. Persons were divided into 3 age groups**:** 58 - 65 years group, 66 - 75 years group and 76 - 85 years group. Non-corrected and the best-corrected visual acuity (measured in decimals from 0.1 to 1.0) was evaluated using Landolt's rings (C optotypes) by Snellen test types at a 5 meter distance from the chart for all healthy controls. In the investigation of patients, the following computer test of the color sensitivity was used: the Farnsworth-Munsell 100 hue test (F-M 100 hue test). The F-M 100 hue test requires arrangement of color samples by tone. Majority of samples are of the same brightness and intensity in color. Four boxes containing 85 plastic color samples are provided. Two color samples in each box are repeated and used as supportive colors, between which other color samples have to be arranged so that a consistent transition of tones between the two supportive colors is achieved. The color samples are chosen in such manner as to cover the entire range of tones. The samples differ in tone but their colors are of approximately the same brightness and intensity. Two minutes are given for each box, though the speed of accomplishment of the test is not highly accentuated. A sequence number is assigned to each color sample. The result is evaluated as the total amount of differences between the number of a color sample chosen by a subject and the number of the color sample actually belonging to the position.

The degree of distinction of colors is assessed. The sensitivity of colors may be very high, i.e. the number of mistakes is up to 20; or normal average, i.e. the number of mistakes is up to 100; or disturbed, i.e. the number of mistakes is more than 100.

Statistical analysis was performed using the computer program SPSS / W 13.0 (Social sciences statistical package program for Windows, Inc., Chicago, Illinois, USA). The data are presented as real numbers (percent), the average values and standard deviations (SD). T test and the Mann-whitney U test were used for the comparison of two groups. Statistically significant difference was considered if $P < 0.05$.

Results. Sixty six females (132 eyes) and thirty four males (67 eyes) were evaluated. There were no difference between males and females color sense discrimination, only males in 76 - 85 years age group comparing to females can separate better green color (37.5% v. 3.3%, p = 0.003). The best and worse color sense using F-M 100 hue test (Table 1) in males and females was absolutely the same.

Table 1. The best and worse color sense using F-M 100 hue test

Para-meter	**Age groups, Years**								
A	**(58-65 years)**			**(66-75 years)**			**(76-85 years)**		
	M N=22	F N=50	*P-value*	M N=22	F N=46	*P-value*	M N=24	F N=30	*P-value*
Red color	13 (59.1)	40 (80)	0.08	14 (63.6)	40 (86.9)	0.051	15 (62.5)	26 (86.7)	0.56
Blue color	4 (18.2)	5 (10)	0.44	0 (0)	4 (8.7)	0.11	0 (0)	3 (10)	0.24
Green color	5 (22.7)	5 (10)	1.0	8 (36.4)	2 (4.4)	0.12	**9 (37.5)**	**1 (3.3)**	**0.003**
B	**(58-65 years)**			**(66-75 years)**			**(76-85 years)**		
	M N=22	F N=50	*P-value*	M N=22	F N=46	*P-value*	M N=24	F N=32	*P-value*
Red color	2 (9.1)	7 (14)	0.71	0 (0)	3 (6.52)	0.55	0 (0)	2 (6.7)	1.0
Blue color	11 (50)	32 (64)	0.3	14 (63.6)	35 (76.1)	0.59	18 (75)	24 (80)	1.0
Green color	9 (40.9)	11 (22)	0.15	8 (36.4)	8 (17.4)	0.07	6 (25)	4 (13.3)	0.07

A - Best color sense discrimination
B - Worse color sense discrimination
M – Males
F – Femailes

Discussion. Our research revealed that males and females were separating colors totally equal, except green color in older age group. Study done by Jain et al. investigated separate 60 ocular healthy subjects of 17 - 22 years of age group [18]. The task was to match 22 test color strips with 2 shade charts of different colors. Total number of correct answers and total time taken in

matching all the test color strips with the shade charts was recorded in both the sexes and analyzed. The results of this study showed that overall, females gave more correct responses ($P < 0.001$) and also took less time ($P < 0.01$) than males. Color wise also, females gave more correct responses especially for red ($P < 0.001$) and green color ($P < 0.01$). So we are in disagreement with study done by Jain et al, but we can give explanation, that **s**ome studies proved that demographic factors such as sex, age and even ethnicity also should be considered in explaining the communication values of various colors [16, 17].
However, recently, it was suggested that, simultaneous color contrast involved wavelength-differencing in men while in women, implicated frequency-differencing [12, 13].

It is thought that the females can see more shades of colors than males, but the sense of main colors, as red, blue and green does not depend on gender in healthy persons as our research proved, only males can separate better green color in older age group comparing to females.

References

1. Rodríguez-Carmona M, Sharpe LT, Harlow JA, Barbur JL. Sex-related differences in chromatic sensitivity. Vis Neurosci. 2008 May-Jun;25(3):433-40.
2. Pickford RW. Women with colour-blind relatives. Nature, 1944; 153, 409.
3. Pickford R. Individual diVerences in colour vision. 1951; London: Routledge and Kegan Paul.
4. Albers J. Interaction of color. New Haven: Yale University Press; 1963. pp. 20–21.
5. Daw N. Goldfish retina: organization for simultaneous color contrast. Science. 1968;158:942–944.
6. Land EH, McCann JJ. Lightness and retinex theory. J Opto Soc Am. 1971;61:1–11.
7. Livingstone MS, Hubel DH. Anatomy and physiology of color system in the primate visual cortex. J Neurosci. 1984;4:309–356.
8. Dufort PA, Lumsden CJ. Color categorization and color constancy in a neural network model of V4. Biol Cybern. 1991;65:293–303.
9. Foster DH, Nascimento SMC. Relational color constancy from invariant cone-excitation ratios. Proc R Soc Lond B Biol Sci. 1994;257:115–121
10. Kraft JM, Brainard DH. Mechanisms of color constancy under nearly natural viewing. Proc Natl Acad Sci USA. 1999;96:307–312.
11. Conway BR. Spatial structure of cone inputs to color cells in alert Macaque primary visual cortex (V-1) J Neurosci. 2001;21:2768–2783.
12. Njemanze PC. Asymmetric neuroplasticity of color processing during head down rest: a functional transcranial Doppler spectroscopy study. J Grav Physiol. 2008;15:49–59.
13. Njemanze PC. Gender-related asymmetric brain vasomotor response to color stimulation: a functional transcranial Doppler spectroscopy study. Exp Transl Stroke Med. 2010;2:21–27. doi: 10.1186/2040-7378-2-21.
14. Jacobs GH, Neitz J. Color vision in squirrel monkeys: sex-related differences suggest the mode of inheritance. Vision Res. 1985;25:141–143.

15. Moreland JD, Dain S. Macular pigment contributes to variance in 100 hue test. Doc Opthalmol Proc 1995;57:517-22.

16. Woo GC, Lee M. Are ethnic differences in the F-M 100 scores related to macular pigmentation? Clin Exp Optom 2002;85:372-7.

17. Dain SJ, Cassimaty VT, Psarakis DT. Differences in FM-100 Hue test performance related to iris colour may be due to pupil size as well as presumed amounts of macular pigmentation. Clin Exp Optom 2004;87:322-5.

18. Jaint N, Verma P, Mittal S, Mittal S, Singh AK, Munjal S. Gender based alteration in color perception. Indian J Physiol Pharmacol 2010 Oct-Dec;54(4):366-70.

Best and worse color sense discrimination in males and females by different age groups

D. Čebatorienė[1], R. Liutkevičienė[1, 2]

[1]*Department of Ophthalmology, Medicine Academy, Lithuanian University of Health Sciences, Lithuania*

[2]*Neuroscience Institute, Medicine Academy, Lithuanian University of Health Sciences, Lithuania*

The purpose of the work. To determine the best and worse color sense discrimination in males and females.

Material and methods. 66 females (132) and 34 males (67) were evaluated. Age±SD of the females was 62.85±11.88, and males 62.15±9.93. For visual acuity testing, a typical Snellen chart (the direction of the gap in Landolt C) was used. A computerised Farnsworth–Munsell 100 hue test was used for color discrimination.

Results. There were no difference between males and females color sense discrimination, $p>0.05$.

Conclusion. The best and worse color sense using F-M 100 hue test in males and females was absolutely the same.