Color Preferences of People with Normal and Anomalous Color Vision

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Abstract: *Color preference refers to our tendency to prefer certain colors over others. Some colors are perceived by us as pleasant and attractive while others appear less pleasant or neutral, sometimes even repellent. Color preference has significance in industry and commerce as cars, furniture, dishes or fabrics in preferred colors sell better than those on neutral or unpleasant colors. The first color preference tests were performed in the 1890s. These tests proved that color preference differed between males and females, the young and the old or the healthy and the sick. But we have not found references on the color preference of those with normal and impaired color vision or the potential differences between these two groups. As color vision deficiency is one of the main topics researched at the Department of Mechatronics, Optics and Information of the Budapest University of Technology and Economics, we decided to investigate this particular issue. To test our hypotheses, we initiated color preference tests involving people with normal and impaired color vision.* Our initial results are presented below.

Keywords: *Color preference, color vision deficiency, normal color vision, color, pattern, harmony*

1 What is Color Preference?

Color preference refers to our tendency to prefer certain colors over others. Some colors are perceived by us as pleasant and attractive while others appear less pleasant or neutral, sometimes even repellent. If we are surrounded by colors perceived as pleasant, we will feel better or we may even perform better than in an environment with unpleasant colors.

2 Significance of Color Preference

Color preference has significance in industry and commerce as cars, furniture, dishes or fabrics in preferred colors sell better than those on neutral or unpleasant colors.

Color preference is also an important consideration in architecture and interior decoration as people prefer to stay in an environment with an adequate color design, where they feel pleasant.

If working places, offices and shops have a preferred color design, the performance and accuracy of employees will improve and they will tire later than in an unfavorable environment with repellent colors.

Wearing clothes of pleasant colors is particularly important for women as it improves their chances of finding a partner, thus they will have an advantage over those wearing plain or unattractive hues.

3 Earlier Tests on Color Preference

The first color preference tests were performed in the 1890s. These tests proved that color preference differed between males and females, the young and the old or the healthy and the sick. A wide range of references is available in the topic.

In Hungary, major color preference tests were performed by Nemcsics in the middle of the 20th century [1]. According to the results of his color preference and color harmony tests, he developed the COLOROID color system, approved and acknowledged worldwide [2].

Recently, Anya Hurlbert and Yazhu Ling have presented some rather interesting results on gender differences in color preference [3] and color preference in babies [4]. Michaels [5] and Read [6] also focused their work on the influence of aging on color preference. Sohn [7] published a study on the effect of pleasant and unpleasant impressions on color preference while Paul [8] investigated the influence of the cultural environment.

4 Research Objective

We have not found references on the color preference of those with normal and impaired color vision or the potential differences between these two groups. As color vision deficiency is one of the main topics researched at the Department of Mechatronics, Optics and Information of the Budapest University of Technology and Economics, we decided to investigate this particular issue. To test our hypotheses, we initiated color preference tests involving people with normal and impaired color vision.

5 Subjects

Our tests involved 57 persons with normal color vision and 24 ones suffering from color vision deficiency. Those with normal color vision were selected randomly from our friends and their friends, using snowball sampling. Their vision was checked with the Ishihara test. Their age varied between 19 and 80 years; each tested subject with a different age. Of the female subjects, 19 persons were ’young’ (below 45 years old) while 10 of them were ’older’ (over 45 years old). In the male group, 17 persons were considered ’young’ and 11 ones ’older’.

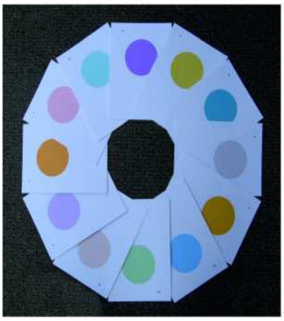
The group with color vision deficiency included 1 female and 23 male subjects. Their age varied between 12 and 55 years. They were selected from those volunteering for our color vision examination. Their color vision was tested by anomaloscopy in addition to the Ishihara test. In this group, 6 subjects were protanomalous and 18 ones deuteranomalous.

6 Color Samples

For the tests, color samples printed with color printer were used. The 25 color samples described in the Color Theory Testbook [9]; each color sample was printed separately, on white sheets of paper. The dimensions of the sheets were 150x210 mm, the color sample was given as a circle with a 80 mm radius (Fig. 1 and 2). Half of the samples had a light, pale hues while colors in the other half were darker, more vivid. Table 1 gives the names of the colors, their X, Y and Z tristimulus values and x, y color coordinates. In Fig. 3, the color points of the samples are given in the CIE color diagram.

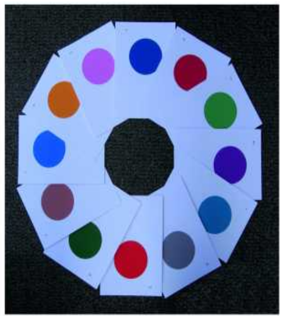
Table 1. Color samples

N	X	Y	Z	x	y	Name of colors
1	14,67	18,75	53,77	0,17	0,22	Blue
2	57,60	58,22	13,14	0,45	0,45	Citrine
3	52,48	49,79	18,63	0,43	0,41	Yellow-orange
4	62,68	58,53	92,65	0,29	0,27	Light purple
5	25,43	23,81	19,87	0,37	0,34	Brown
6	62,75	64,70	81,35	0,30	0,31	Light-grey
7	13,69	21,64	40,10	0,18	0,29	Dark-turquoise
8	57,45	62,52	24,90	0,40	0,43	Yellow-green
9	62,94	58,94	67,99	0,33	0,31	Light-pink
10	6,77	12,71	8,30	0,24	0,46	Dark-green
11	9,41	10,79	28,30	0,19	0,22	Dark-blue
12	28,24	32,48	60,60	0,23	0,27	Purple
13	45,70	36,13	49,88	0,35	0,27	Pink
14	25,98	27,32	33,22	0,30	0,32	Dark-grey
15	18,63	11,05	6,46	0,52	0,31	Dark-red
16	26,93	37,48	63,01	0,21	0,29	Turquoise
17	15,52	26,80	16,98	0,26	0,45	Green
18	66,83	67,26	76,96	0,32	0,32	Beige
19	24,97	15,60	6,35	0,53	0,33	Red
20	18,02	13,51	29,08	0,30	0,22	Dark-purple
21	13,39	13,08	11,75	0,35	0,34	Dark-brown
22	52,81	61,28	88,74	0,26	0,30	Light-turquoise
23	44,65	38,39	9,50	0,48	0,41	Orange
24	50,41	60,63	61,88	0,29	0,35	Light-green
25	46,20	52,24	91,74	0,24	0.48	Light-blue



Pale colours

Fig. 1. Light, pale color samples.



Strong colours

Fig. 2. Darker, vivid color samples

7 Conduction of Tests

Color samples were arranged in a random order by each other on a table covered by white paper. Illumination was provided by diffuse daylight. Test subjects were asked to select and take the color simple he or she liked most. Then the subject was asked to select another sample whose color best matches the previous one. We wish to use these color pairs in color harmony tests in the future. In the present tests, both color samples were considered as „preferred”.

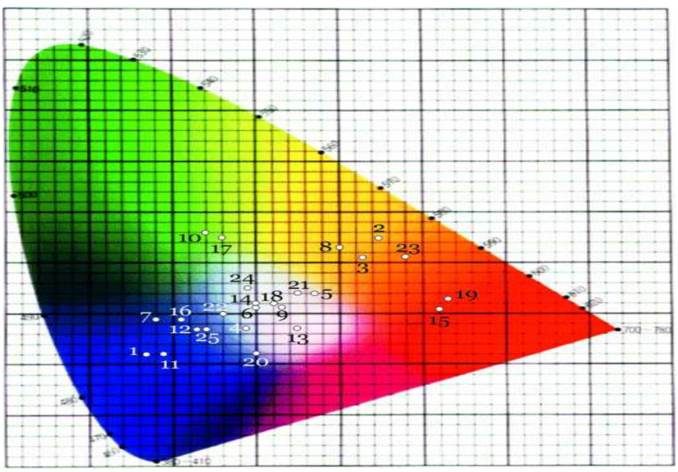


Fig. 3.Colours in the CIE colour diagram

8 Analysis

Results were indicated in a graphic form as frequency diagrams, following the methodology of Nemcsics [1]. For this, groups of equal numbers were selected from the test results. The selection was random; Table 2. gives the random numbers [10].

Table 2. Random numbers

25, 03, 07, 26, 28, 13, 15, 14, 30, 11, 16, 10, 17, 29, 22,

04, 24, 23, 21, 27, 18, 19, 09, 05, 12, 20, 06, 08, 02, 01,

In the first step, we analyzed whether the results of our test subjects with normal color vision confirm the trends proposed by the references. To test the hypothesis, 10 young and 10 older subjects, from the male and the female group each, were selected (Table 3.) . Their frequency diagrams are given in Fig. 4.

Table 3. Classification of people with normal color vision

	Name	Age	Color 1.	Color 2.
Young women	A. E.	19	7	6
	B. D.	22	7	8
	K. V.	21	10	9
	M. V.	20	15	7
	P. O.	20	11	7
	P. T.	39	15	23
	S. V.	19	7	23
	Sz. J.	21	16	9
	T. N.	21	13	6
	V. E.	20	8	9
Elderly women	D. G.	46	15	9
	H. M.	79	9	14
	K. M.	73	11	25
	P.D.	64	9	18
	M. I.	61	17	6
	M. M.	49	1	15
	P. A.	73	4	6
	S. C.	65	1	14
	V. I.	48	18	5

	W. K.	**73**	**25**	**18**
Young men	**A. P.**	**22**	**24**	**25**
	B. S.	**22**	**2**	**10**
	B. Z.	**28**	**23**	**10**
	D. J.	**21**	**15**	**17**
	J. B.	**21**	**7**	**8**
	K. P.	**21**	**15**	**11**
	N. B.	**24**	**19**	**16**
	N. V.	**21**	**17**	**23**
	R. I.	**21**	**1**	**10**
	S. K.	**36**	**1**	**7**
Elderly men	**A. A.**	**48**	**7**	**19**
	G. P.	**66**	**1**	**19**
	H. M.	**80**	**4**	**23**
	H. A.	**72**	**20**	**6**
	K. R.	**80**	**23**	**17**
	K. J.	**48**	**1**	**2**
	P. A.	**80**	**3**	**11**
	S. G.	**72**	**2**	**12**
	T. P.	**58**	**11**	**6**
	W. G.	**79**	**10**	**13**

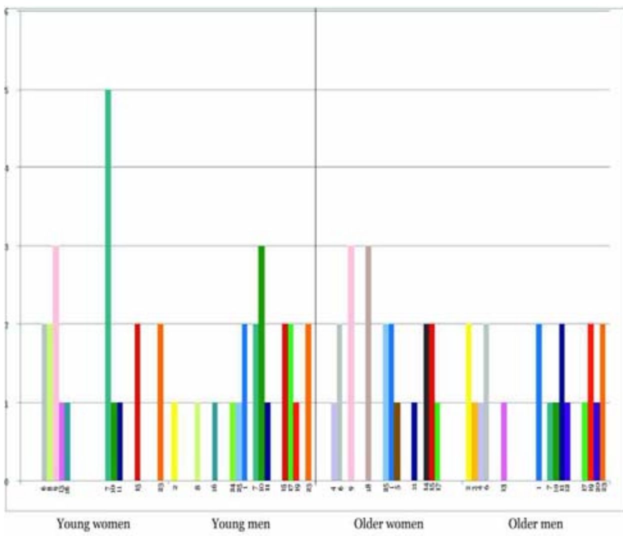


Fig. 4. Frequency diagram for people with normal color vision

Then we analyzed the results for differences between those with normal and impaired color vision. We selected 24 subjects with normal color vision for the 24 color deficient subjects (Table 4.). The selection again was based on random numbers. Their frequency diagrams are given in Fig. 5.

Potential differences between protanomalous and deuteranomalous subjects were not analyzed as we had only 6 protanomalous subjects, providing insufficient data for analysis.

Table 4. Classification of people with normal color vision and with impaired color vision

Normal trichromats			**Anomalous trichromats**		
Name	**Color 1.**	**Color 2.**	**Name**	**Color 1.**	**Color 2.**
K.D.	**1**	**2**	**PR.**	**1**	**2**
T.P.	**11**	**6**	**V.Z.**	**1**	**12**
S.K.	**1**	**7**	**P.T.**	**20**	**20**
S.G.	**2**	**12**	**Sz.P.**	**2**	**1**
W.G.	**10**	**13**	**B.A.**	**20**	**15**
K.R.	**23**	**17**	**S.R.**	**15**	**11**
P.A.	**3**	**11**	**S.G.**	**1**	**2**
H.M.	**4**	**23**	**H.T.**	**2**	**1**
H.A.	**20**	**6**	**D.G.**	**2**	**24**
A.A.	**7**	**19**	**D.K.**	**1**	**16**
D.G.	**2**	**24**	**P.D.**	**25**	**18**
Ö.M.	**15**	**1**	**K.E.**	**25**	**2**
D.J.	**15**	**17**	**B.A.**	**15**	**11**
R.I.	**1**	**10**	**Sz.Z.**	**4**	**8**
N.Cs.	**19**	**23**	**G.A.**	**25**	**7**
A.P.	**24**	**25**	**H.G.**	**1**	**11**
P.D.	**1**	**19**	**J.A.**	**15**	**19**
B.Z.	**23**	**10**	**A.G.**	**10**	**3**
B.S.	**2**	**10**	**Ö.K.**	**17**	**2**
M.D.	**17**	**16**	**J.G.**	**17**	**1**
K.P.	**15**	**11**	**PR.**	**1**	**2**
R.P.	**10**	**11**	**V.Z.**	**1**	**12**
R.G.	**10**	**6**	**P.T.**	**20**	**20**
E.A.	**17**	**6**	**Sz.P.**	**2**	**1**

9 Results and Discussion

Analyzing the results of subjects with normal color vision, a difference between young and older subjects could be detected (Fig. 4). Young subjects (both male and female) preferred vivid green, red and orange colors while older ones (both male and female) more often selected pale hues.

Another difference could be shown for male and females. Male subjects (both young and older) preferred vivid red, orange and blue colors while female ones (both young and older) often selected pink. These observations agree with those by Nemcsics [1].

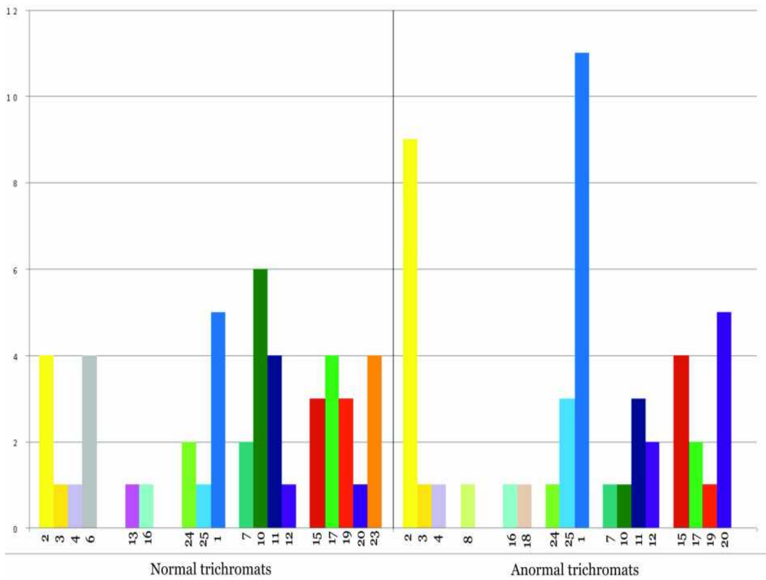


Fig. 5. Frequency diagram for people with normal color vision and with impaired color vision

Data for subjects with normal and impaired color vision are compared in Fig. 5. As we can see, subjects with color vision deficiency showed a marked preference for blue and yellow while those with normal color vision more often selected green and red. The assumed reason for this is the significantly poorer ability of the color blind to discriminate green and red compared to people with normal color vision while their yellow-blue color discrimination does not differ.

10 Future Research Plans

We were able to perform relatively few tests, nevertheless we were able to distinguish certain trends already. These tests are only the first ones in a series of planned experiments. We wish to increase the number of subjects and we expect interesting results from testing the color preference of children with color vision deficiency. We presume their color vision deficiency might be recognized already at an early age, from their unusual color preferences. We look forward to analyze the potential differences between protanomalous and deuteranomalous subjects.

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