Experimental Determination of Laws of Color Harmony. Part 1: Harmony Content of Different Scales with Similar Hue

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Abstract: In 1956 we came to the decision at the Budapest Technical University to start large scale experiments on color harmony. The experiments and the processing of the experimental results have been completed in 2006, after 50 years of research work. Within the frame of the experiments 95 000 participants have carried out more than 36 million elementary observations and made elementary decisions. Only certain parts of the experimental results have been published up to now. This article starts publishing the results not published yet. Research work on color harmony carried out during these 50 years can be categorized into seven main groups. The present article deals with the group of experiments testing how much the harmony content of the scales found in different locations in various positions of the axial sections of the Coloroid color system differ from each other. Our experiments were focused to three groups: we examined the variations in the extent of harmony content in the following cases (1) scales carried by lines with different angles to the gray axis, consisting of colors having the same number of harmony intervals between them, (2) scales consisting of colors being parallel to the gray axis, featuring various saturations, having different harmony intervals between them, and (3) scales perpendicular to the gray axis, with different luminosity, having different harmony intervals between each other. The examined color scales contained six colors in each experiment. Experiments were carried out for 24 different axial sections of the Coloroid color system. After 15-years interruption experiments were repeated; however, with compositions of different appearances. © 2007 Wiley Periodicals, Inc. Col Res Appl, 32, 477–488, 2007; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/col.20357

Key words: color harmony; color composition; color science; color theory; Coloroid Color System

INTRODUCTION

In the Greek mythology the beautifully shaped daughter of Ares and Aphrodite was named Harmony. The harmony of compositions, generating aesthetic experiences which can be characterized by the expression "beautiful" is defined since that time by the name of this mythological figure. The experimental determination of the harmony between the colors, the establishment of color harmony experience has been dealt with since the second half of the 17th century. On the basis of various ideas, often referring to experimental results, various color harmony theories were originated. Our color harmony experiments have taken into consideration numerous findings of them, among others that of Aars, Albers, Allen, Allesch, Birkhoff, Chandler, Chevreul, Daschiell, Dorcus, Eysenck, Goethe, Granger, Guilford, Hoelzel, Jastrow, Kandinsky, Klee, Moholy-Nagy, Moon-Spencer, Mori, Munsell, Ostwald, Pfeifer, Pope, Rabaté, Rosenthiel, Rumford, Schoppenhauer.[1–47]

We found that certain authors examined only single aspects of the establishment of harmony experience, others in turn based their statements on the opinions of rather small number of experimental participants or quite a few shared the opinion that the problem of color harmony is independent of human judgment and can be deducted from a color system by methods of logic, respectively the examination of numerous possible problems has not been dealt with. Therefore, we decided to start large scale experiments on color harmony at the Budapest Technical University in 1956. The experiments and the processing of the experimental

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results have been completed in 2006, after 50-years of research work. Within the frame of the experiments 95,000 participants have carried out more than 36 million elementary observations and made elementary decisions. In course of the research work the development of computer technology and computer aided technologies have been so rapid, that even questions could be examined, which had not been thought of earlier. The conclusions of the experiments provided support for more accurate formulation of color harmony laws. Up to now, we published only some individual results of the experiments as they were concluded. With this article we start the publication of the comprehensive results of our color harmony experiments, unpublished until now.

MAIN GROUPS OF THE COLOR HARMONY RESEARCH CARRIED OUT AT THE BUDAPEST TECHNICAL UNIVERSITY

The color harmony research carried out during 50-years can be classified into seven main groups. These are:

1. Experimental checking of statements found in the technical literature concerning the establishment of color harmony experience. Results belonging to this group have been partly published.[48–51] Further publications are not envisaged.
2. Experimental determination of color harmony laws built up on aesthetically even thresholds of color space allowing their exact description. The publishing of the Coloroid color system based on the results of experiments built up on the harmony thresholds has completed. Until today it became a part of the technical literature.[51–60]
3. Examination of the scale-like arrangement of saturation and luminosity of colors in color compositions generating the experience of harmony. Only a part of experiments carried out and the statements built up on their results have been published.[51,61–65] The publication of further parts starts by this article.
4. The role of hue in establishment of harmony experience. Only a part of experiments carried out and the statements built up on their results have been published.[51,66,67] Publication of further parts is being envisaged.
5. Role of human factors (age, gender, ethnic group, color preference, color association, etc.) in the establishment of the color harmony experience. Only a part of experiments carried out and the statements built up on their results have been published.[51,68–75] Publication of further parts is being envisaged.
6. Role of environmental factors (weather relations, landscape environment, three-dimensional position, expression of some function, etc.) in the establishment of color harmony. Part of experiments carried out and their results have been published.[76–79] Publication of further parts is being envisaged.
7. Systematization and computer modeling of color harmony laws. Publication has been started already,[80–82] and publication of further parts is being envisaged.

A considerable share of color harmony experiments belonging to different groups have been carried out by building on one another. Different experiments have often been carried out in parallel. Results of later experiments requested sometimes to repeat former experiments complemented with new aspects.

EXAMINATION OF THE EXTENT OF HARMONY CONTENT IN SCALES APPEARING ON LINES OF VARIOUS POSITIONS OF AXIAL SECTIONS CONTAINING COLORS WITH IDENTICAL HUES

As it is known the color space of the Coloroid color system has been elaborated by harmony threshold measurement experiments. In the Coloroid axial sections named Coloroid color planes, colors of identical hues and characteristic wavelengths are included. On each line that can be drawn on Coloroid color planes, the composition built up of colors arranged into arithmetical or geometrical series are felt to be harmonic.[51–60]

In the experiments detailed in this article belonging to the third group of studies on color harmony listed in the previous section how much the harmony content of the scales being in different positions at various points of the Coloroid color planes differ from one another has been studied. The experiments could be assigned to three groups. The variation in the extent of the harmony content has been investigated in case of (1) scales carried by lines with different angles to the gray axis, consisting of colors having the same number of harmony intervals between them, (2) scales consisting of colors parallel to the gray axis, featuring various saturations, having different harmony intervals between them, and (3) scales perpendicular to the gray axis, with different luminosity, having different harmony intervals between each other. The examined color scales contained six colors in each experiment. Experiments were carried out for 24 different axial sections of the Coloroid color system (Fig. 1).

Markings in Coloroid color system and characteristic wavelengths of hues participating in the experiments are as follows:

A10	λ570.83	A12	λ574.38	A14	λ577.50	A16	λ580.95
A21	λ584.46	A23	λ588.59	A25	λ594.00	A30	λ602.72
A32	λ625.00	A34	λ-495.28	A40	λ-502.69	A42	λ-520.40
A44	λ-548.11	A46	λ-564.18	A51	λ468.71	A53	λ479.29
A55	λ484.29	A60	λ490.40	A62	λ495.28	A64	λ502.69
A66	λ520.40	A71	λ548.11	A73	λ560.74	A75	λ566.78

FIG. 1. Color cycle of the Coloroid color system with the 48 Coloroid basic hues; - hues dealt with in the experiments are marked by ●.

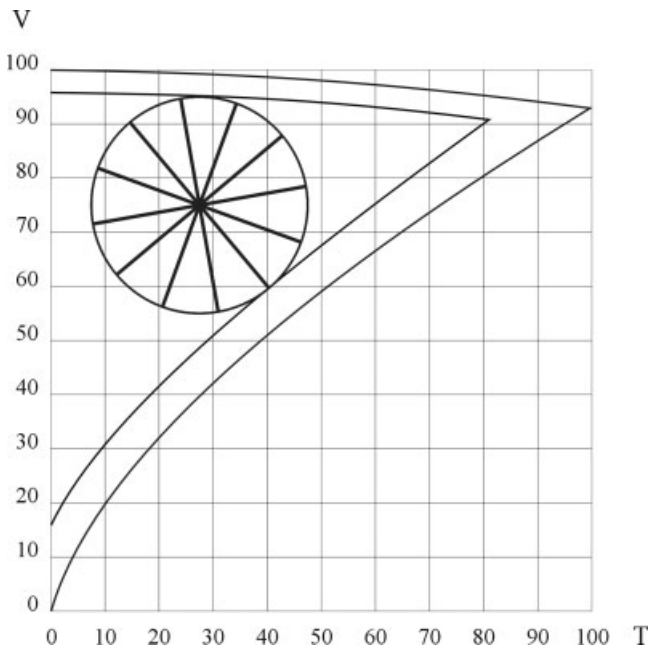

FIG. 2. An axial section of the Coloroid color system with the network formed by vertical lines carrying colors of the same saturation and by horizontal lines carrying colors of the same luminosity. The colors of scales investigated are sitting on lines passing through the center points of circles drawn into the axial section. The scales on the lines are marked by their β angles of inclination measured from the horizontal.

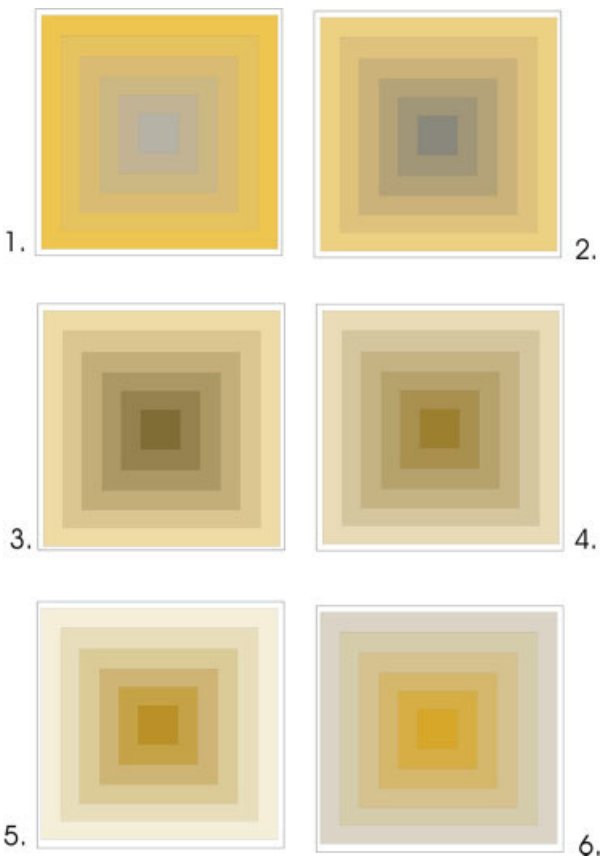

FIG. 3. A test sheet having been used between 1980 and 1985 in the series of experiments. The compositions of the test sheet are made of colors of scales on lines declining, from left to right, 10°, 40°, 70°, 100°, 130°, 160° from the horizontal of the axial section with Coloroid hue of A12.

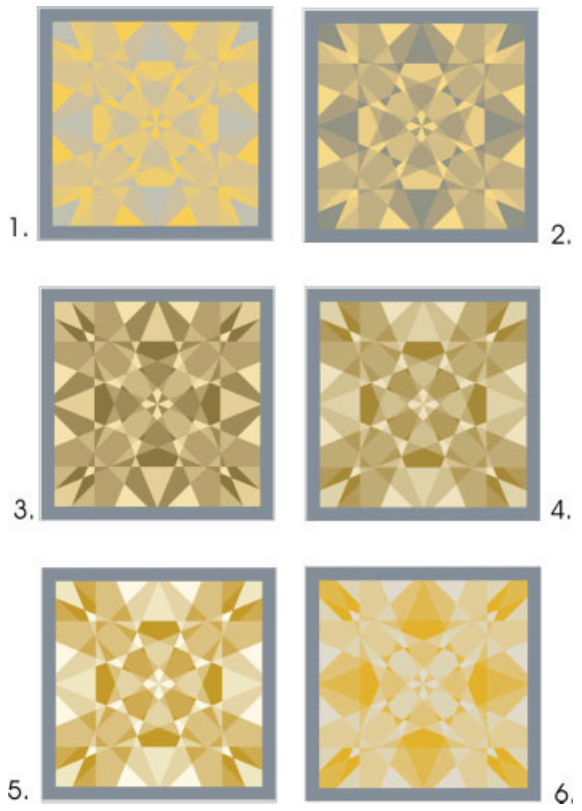

FIG. 4. A kaleido test sheet having been used between 1998 and 2001 in the series of experiments. The compositions of the test sheet are made of colors of scales on lines declining, from left to right, 10°, 40°, 70°, 100°, 130°, 160° from the horizontal of the axial section with Coloroid hue of A12, in agreement with the colors of scales of Fig. 4.

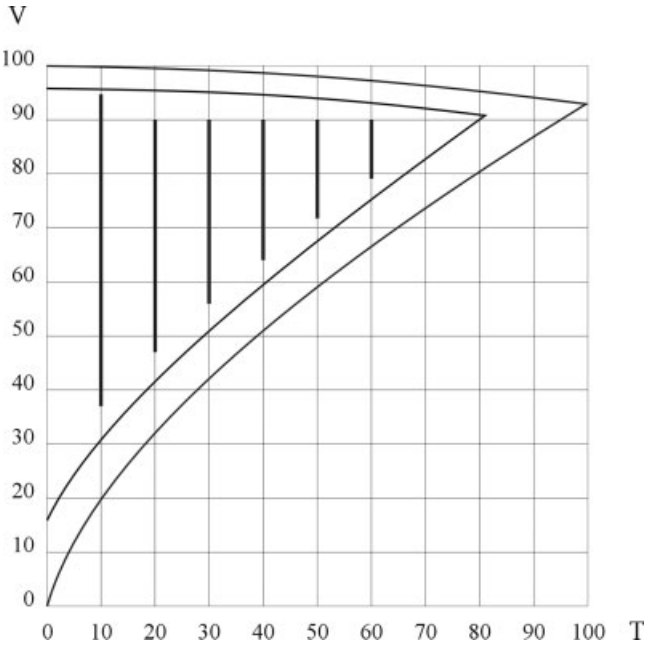

FIG. 6. An axial section of the Coloroid color system with the network formed by vertical lines carrying colors of the same saturation and by horizontal lines carrying colors of the same luminosity. The colors of scales investigated are sitting on lines drawn into the axial section parallel to the gray axis.

The subjects of the experiments were mostly 18–24-years-old students of the Budapest Technical University, however, from time to time, graduate and postgraduate

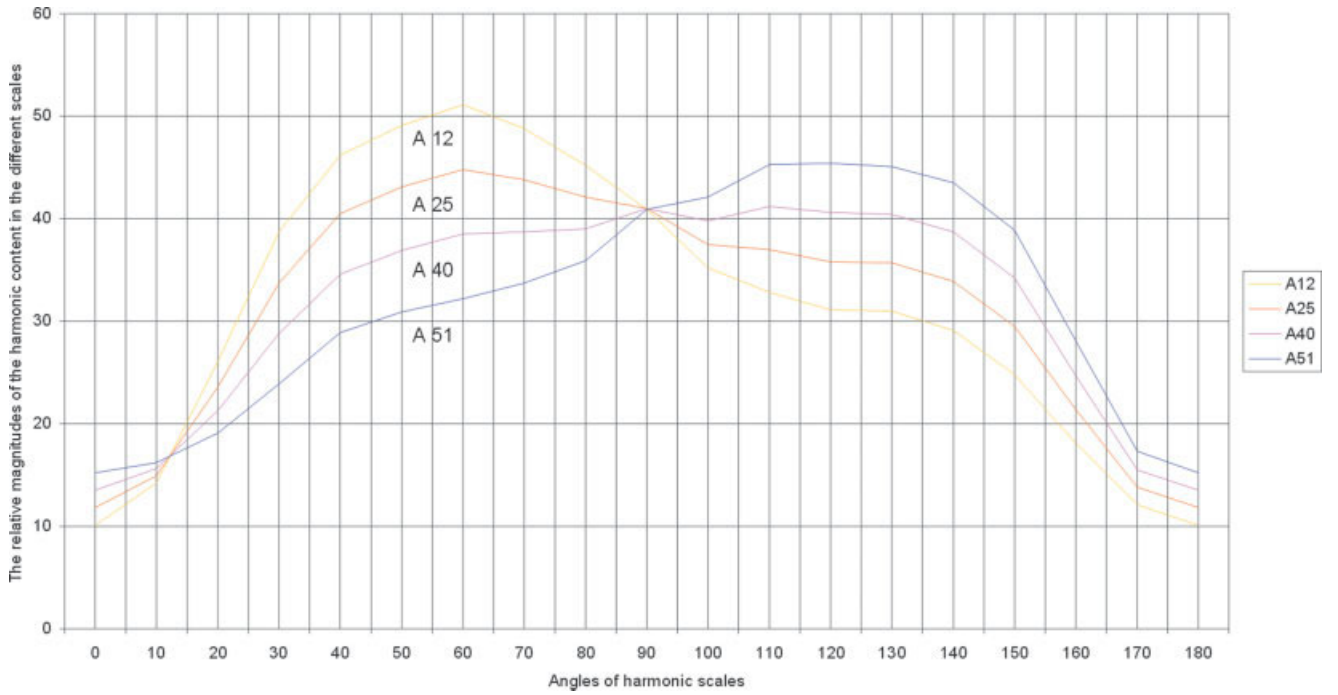

FIG. 5. Relative extent of harmony content of Coloroid axial sections marked as A12, A25, A40, A51. The horizontal axis shows the compositions consisting of colors of the scales inclining from the initial line at different angles, the vertical one shows the percent rate of votes for them are shown.

TABLE I. CIE (*X*,*Y*,*Z*) and COLOROID (*A*,*T*,*V*) data of colors of scales comprising compositions of Figs. 4 and 5.

	CIE			Coloroid		
	X	*Y*	*Z*	*A*	*T*	*V*
Composition 1 (A12,10°)						
Color 1	54.75	57.96	55.04	12.00	8.06	76.13
Color 2	56.49	60.14	49.54	12.00	15.94	77.55
Color 3	58.27	62.36	44.08	12.00	23.81	78.97
Color 4	60.09	64.62	38.67	12.00	31.68	80.39
Color 5	61.95	66.92	33.31	12.00	39.55	81.81
Color 6	63.84	69.26	27.98	12.00	47.42	83.23
Composition 2 (A12, 40°)						
Color 1	71.07	76.42	45.78	12.00	37.42	87.42
Color 2	63.00	67.66	42.37	12.00	31.29	82.26
Color 3	55.44	59.44	39.55	12.00	25.16	77.10
Color 4	48.39	51.75	37.31	12.00	19.03	71.94
Color 5	41.84	44.59	35.64	12.00	12.90	66.77
Color 6	35.80	37.96	34.56	12.00	6.77	61.61
Composition 3 (A12, 70°)						
Color 1	76.90	82.17	61.07	12.00	28.39	90.65
Color 2	64.55	69.05	49.50	12.00	25.68	83.10
Color 3	53.29	57.08	39.17	12.00	22.97	75.55
Color 4	43.10	46.24	30.08	12.00	20.26	68.00
Color 5	34.00	36.54	22.24	12.00	17.55	60.45
Color 6	25.98	27.99	15.63	12.00	14.84	52.90
Composition 4 (A12, 100°)						
Color 1	74.56	79.27	67.59	12.00	18.71	89.03
Color 2	64.80	69.05	55.44	12.00	19.74	83.10
Color 3	55.72	59.54	44.05	12.00	20.77	77.16
Color 4	47.30	50.73	33.43	12.00	21.81	71.23
Color 5	39.56	42.63	23.57	12.00	22.84	65.29
Color 6	32.48	35.23	14.48	12.00	23.87	59.36
Composition 5 (A12, 130°)						
Color 1	87.89	93.03	88.71	12.00	12.58	96.45
Color 2	76.80	81.58	71.08	12.00	17.74	90.32
Color 3	66.41	70.89	54.27	12.00	22.90	84.19
Color 4	56.75	60.94	38.28	12.00	28.06	78.06
Color 5	47.79	51.75	23.11	12.00	33.23	71.94
Color 6	39.55	43.31	8.75	12.00	38.39	65.81
Composition 6 (A12,160°)						
Color 1	71.71	75.86	73.24	12.00	9.35	87.10
Color 2	66.98	71.21	60.63	12.00	16.90	84.39
Color 3	62.38	66.71	48.18	12.00	24.45	81.68
Color 4	57.93	62.36	35.89	12.00	32.00	78.97
Color 5	53.61	58.15	23.76	12.00	39.55	76.26
Color 6	49.44	54.09	11.79	12.00	47.10	73.55

students of other professions, universities, colleges also participated. The experiments were done on the third floor of the Central Building of the Budapest Technical University, in an area illuminated by light reflected from the Northern firmament, near to the window, where the level of illumination was about 1600–1800 lx. The experimental tests were positioned on a vertical surface. The environment of the tests has been a gray surface of $Y = 30$ light density factor. Illumination of the tests was at 45°, observation was made with 90° viewing angle from a distance of 150 cm. Before starting the experiments, the leader of the experiments showed the tests to the subjects of the experiment, and then explained their tasks in detail, according to which they had to classify the six compositions of the tests by their own judgment, beginning by the most harmonic perception up to the least harmonic perception for them. Observers participated individually in the experiments. Their answers were recorded by the researcher onto the experiment form sheets. On the form sheets, the genders and ages were also recorded. (This article does not examine their answers from this aspect). During the series of experiments 432 compositions were shown on 72 test sheets, 500 observers per test forms, that means there were 36,000 elementary observations and elementary decisions. This section of the experiments has been carried out between 1980 and 1985. Later, between 1998 and 2001 the experiments were repeated. At that time the test compositions were produced by a suitably calibrated computer and printer. In the compositions all colors of the scales have appeared more times like a kaleidoscope, namely so, that each color was bordering on all the other colors.

The description, tests, documented results of the series of experiments comprise more extensive volumes, on electronic media requiring nearly 5 GB. The current article shows the experiment with an arbitrarily chosen

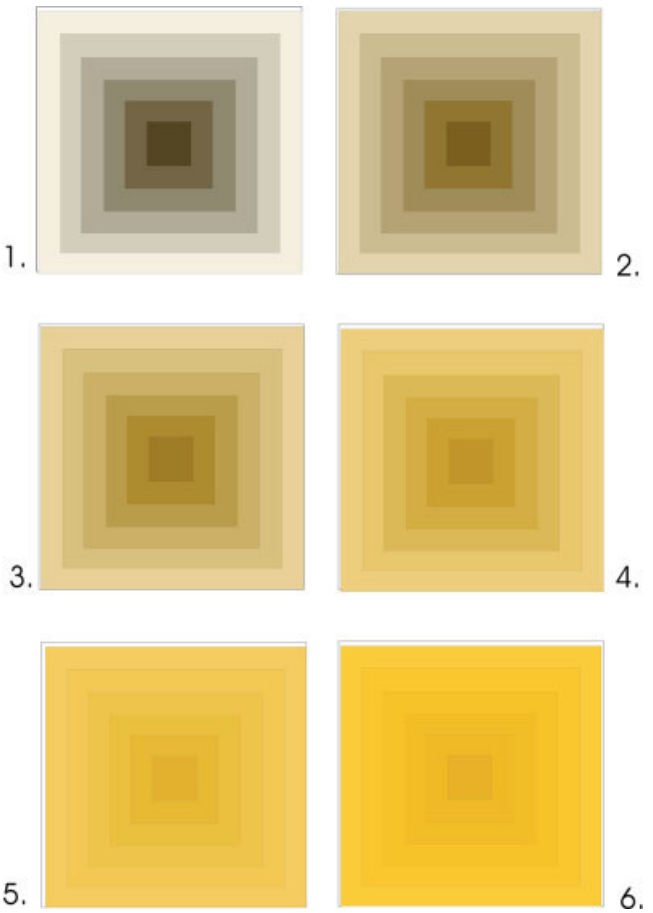

FIG. 7. A test sheet having been used between 1980 and 1985 in the series of experiments. The compositions of the test sheet are made of colors of scales of the axial section A12 Coloroid hue sitting on lines parallel to the gray axis, containing T10, T20, T30, T40, T50, T60 color saturations, respectively.

yellow hue denoted as A12 Coloroid color. The graphs presenting the results are related to four hues being also arbitrarily chosen (A12 Coloroid yellow, A25 Coloroid orange, A40 Coloroid purple, A51 Coloroid blue colors).

Experiments with Scales Carried by Lines with Different Angles to the Gray Axis, Consisting of Colors Having the Same Number of Harmony Intervals Between Them

The scales investigated in the experiment are crossing the central points of circles with the largest radius that can be drawn into the individual Coloroid color planes. The horizontal line perpendicular to the gray axis has been chosen to be starting line. The β-angle of scale inclination has been measured counterclockwise from this line (Fig. 2). We prepared test sheets with scale inclinations of 10° increments to be used in the experiments (Fig. 3). The test sheets contained square compositions of 30×30 cm^2 size. On the test sheets, the actual colors of the compositions became homocentric darker towards the center. The most luminous or most unsaturated colors of the scale were always seen on the outer part of the scale while the darkest or most saturated parts were seen towards the center. The experimental tests have been prepared by workgroups consisting of third- and fourth-year-students of Architecture led by painter-artist instructors of the drawing and design sciences Department of Budapest Technical University. The workgroups have been complemented in several cases by painter-artists as well. Several tests were produced even by myself. The tests have been prepared on mould-made paper, with light-resistant pulverized paint and polyvinyl acetate binding agents. The colors of the tests have been accurately fine tuned with spectrophotometer control measurements.

Each of the experimental participants had to classify six compositions according to the extent of the intensity of the harmony experience generated. (Fig. 4) For classification the tests were organized into groups as described on the next page:

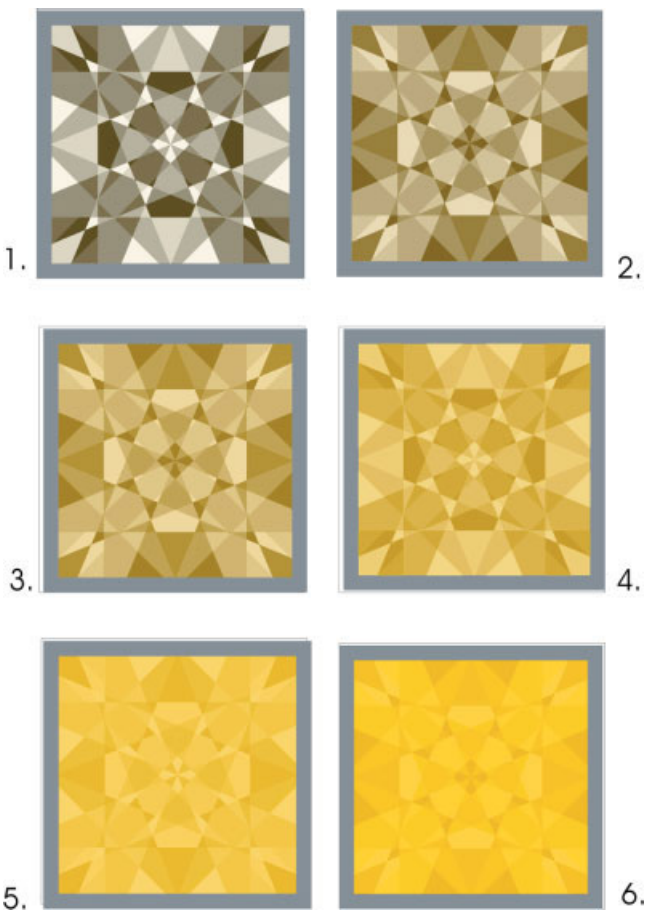

FIG. 8. A kaleido test sheet having been used between 1998 and 2001 in the series of experiments. The compositions of the test sheet are made of the colors of the scales with Coloroid hue A12, being on the lines parallel to the gray axis, featuring color saturations T10, T20, T30, T40, T50, T60 respectively.

TABLE II. CIE (*X*,*Y*,*Z*) and COLOROID (*A*,*T*,*V*) data of colors of scales comprising compositions of Figs. 7 and 8.

	CIE			Colorid		
	X	*Y*	*Z*	*A*	*T*	*V*
Composition 1 (A12, T10)						
Color 1	89.19	94.28	92.65	12.00	10.00	97.10
Color 2	68.41	72.41	68.84	12.00	10.00	85.10
Color 3	50.37	53.43	48.17	12.00	10.00	73.10
Color 4	35.06	37.33	30.64	12.00	10.00	61.10
Color 5	22.49	24.11	16.24	12.00	10.00	49.10
Color 6	12.66	13.76	4.98	12.00	10.00	37.10
Composition 2 (A12, T20)						
Color 1	71.26	75.86	62.59	12.00	20.00	87.10
Color 2	58.63	62.56	48.11	12.00	20.00	79.10
Color 3	47.21	50.55	35.03	12.00	20.00	71.10
Color 4	37.00	39.81	23.34	12.00	20.00	63.10
Color 5	28.01	30.36	13.05	12.00	20.00	55.10
Color 6	20.24	22.18	4.15	12.00	20.00	47.10
Composition 3 (A12, T30)						
Color 1	70.84	75.86	52.59	12.00	30.00	87.10
Color 2	61.25	65.77	41.60	12.00	30.00	81.10
Color 3	52.34	56.40	31.40	12.00	30.00	75.10
Color 4	44.12	47.74	21.98	12.00	30.00	69.10
Color 5	36.58	39.81	13.34	12.00	30.00	63.10
Color 6	29.73	32.60	5.49	12.00	30.00	57.10
Composition 4 (A12, T40)						
Color 1	70.42	75.86	42.58	12.00	40.00	87.10
Color 2	63.95	69.05	35.17	12.00	40.00	83.10
Color 3	57.79	62.56	28.11	12.00	40.00	79.10
Color 4	51.92	56.40	21.39	12.00	40.00	75.10
Color 5	46.37	50.55	15.03	12.00	40.00	71.10
Color 6	41.11	45.02	9.01	12.00	40.00	67.10
Composition 5 (A12, T50)						
Color 1	70.00	75.86	32.58	12.00	50.00	87.10
Color 2	66.73	72.41	28.83	12.00	50.00	85.10
Color 3	63.53	69.05	25.17	12.00	50.00	83.10
Color 4	60.41	65.77	21.59	12.00	50.00	81.10
Color 5	57.37	62.56	18.11	12.00	50.00	79.10
Color 6	54.40	59.44	14.70	12.00	50.00	77.10
Composition 6 (A12, T60)						
Color 1	69.58	75.86	22.58	12.00	60.00	87.10
Color 2	66.31	72.41	18.83	12.00	60.00	85.10
Color 3	63.11	69.05	15.17	12.00	60.00	83.10
Color 4	59.99	65.77	11.59	12.00	60.00	81.10
Color 5	56.95	62.56	8.10	12.00	60.00	79.10
Color 6	53.98	59.44	4.70	12.00	60.00	77.10

- Group 1: Scales inclining from the starting line by 10°, 40°, 70°, 100°, 130°, 160°.
- Group 2: Scales inclining from the starting line by 20°, 50°, 80°, 110°, 120°, 170°.
- Group 3: Scales inclining from the starting line by 30°, 60°, 90°, 120°, 150°, 180°.

In course of the processing the answers of experimental participants the extent of harmony content of each composition has been expressed in percents according to function below:

$$x_{\mathrm{h}} = 100 n_h / m,$$

where x_{h} is the rate of preference of the composition in percents, n_{h} is the number of the votes given to the composition in question, m is the number of all voting experimental persons. The harmony contents of four selected Coloroid axial sections are shown in Fig. 5.

Experiments Carried Out with Scales Made of Colors Carried by Lines Parallel to the Gray Axis Having the Same Number of Harmony Intervals Between Them

The scales participating in the experiments are appearing on lines (Fig. 6) parallel to the gray axis containing colors with 10, 20, 30, 40, 50, 60 Coloroid saturation, respectively. The dimensions, arrangements of the experimental tests, the realization of the experiment, number of the experimental persons participating in the experiment were fully identical with the experiments described earlier. In course of the experiment we used the tests of Figs. 7 and 8).

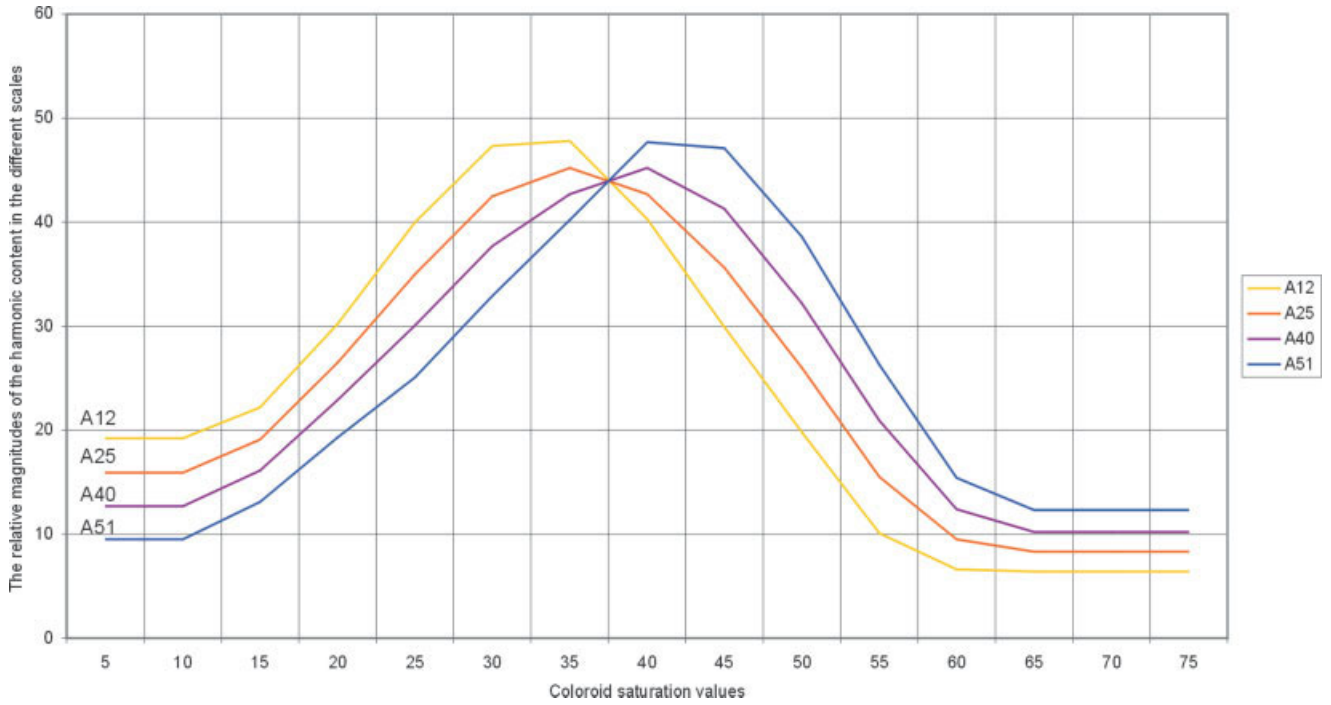

FIG. 9. The figure shows the relative extent of harmony contents of Coloroid axial sections marked A12, A25, A40, A51 respectively. The horizontal axis shows the compositions made of colors of scales representing different saturations, on the vertical one the percentage of the votes for them are shown.

The extent of harmony content of four selected Coloroid axial sections is shown by Fig. 9.

Experiments with Scales Consisting of Colors Having Equal Number of Harmony Intervals Between Them, Appearing on Lines Perpendicular to the Gray Axis

The scales participating in the experiments are appearing on lines (Fig. 10) being perpendicular to the gray axis containing colors of 87, 77, 67, 57, 47, 37 Coloroid luminosity. The dimensions, arrangements of the experimental tests, realization of the experiments, number of observers was the same as in the experiments described earlier. The experiments used the tests of Figs. 11 and 12.

The extent of harmony content of four selected Coloroid axial sections is shown in Fig. 13.

CONCLUSIONS

1. One condition of the creation of a color harmony experience says that a definite order be observable between the saturations and brightnesses of colors of the actual group or composition.
2. The order between saturations and brightnesses of colors of the color composition producing harmony experience cannot be determined by purely logical methods. This determination requires establishment of psychometric scales modeling that order, by suitable set up experiments.
3. By suitable set up experiments color compositions percept as harmonic compositions can be ranked according to the extent of their harmony content and the precedence can be registered numerically.

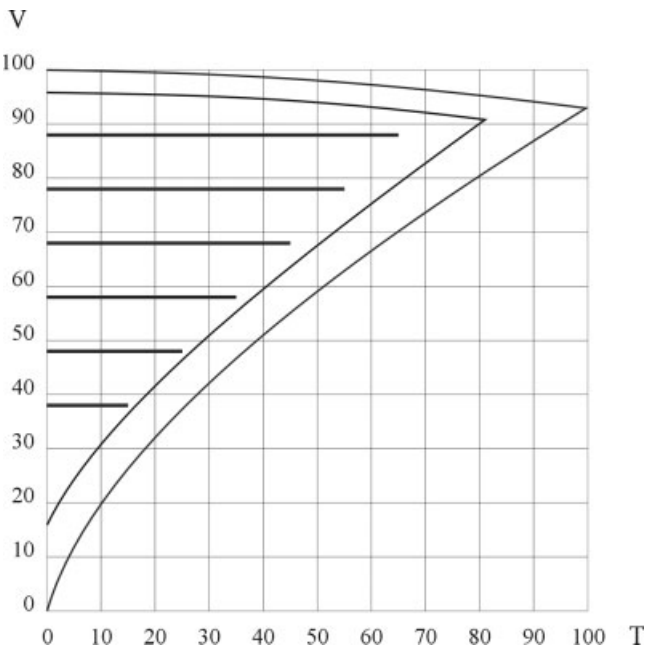

FIG. 10. An axial section of the Coloroid color system with the network formed by vertical lines carrying colors of the same saturation and by horizontal lines carrying colors of the same luminosity. The colors of scales investigated are appearing on lines drawn into the axis section perpendicular to the gray axis.

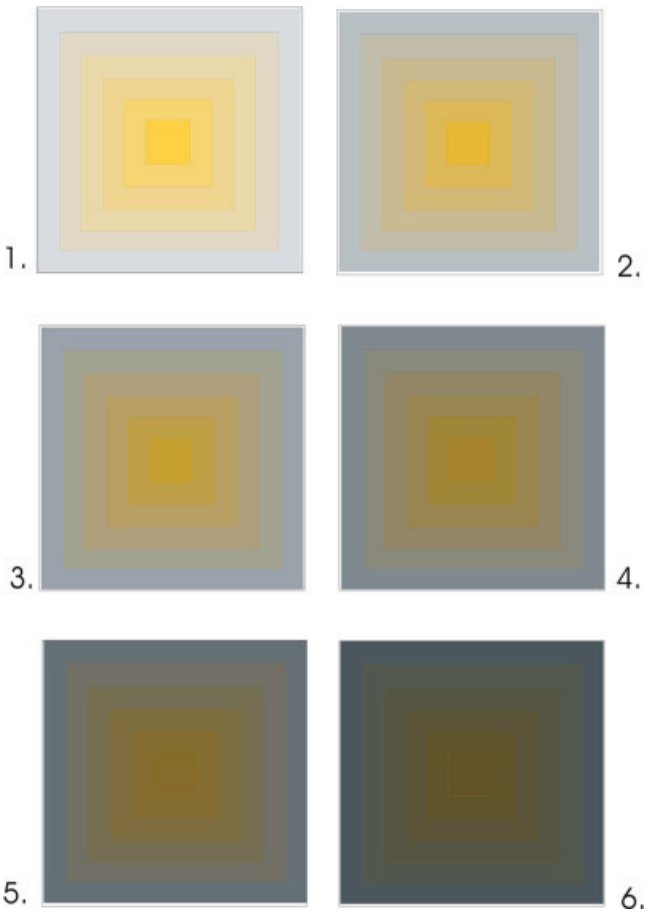

FIG. 11. A test sheet having been used between 1980 and 1985 in the series of experiments. The compositions of the test sheet, from left to right are made from the colors of scales appearing in axial section marked as A12 Coloroid hue, on lines perpendicular to the gray axis and having lightness V87, V77, V67, V57, V47, V37, respectively.

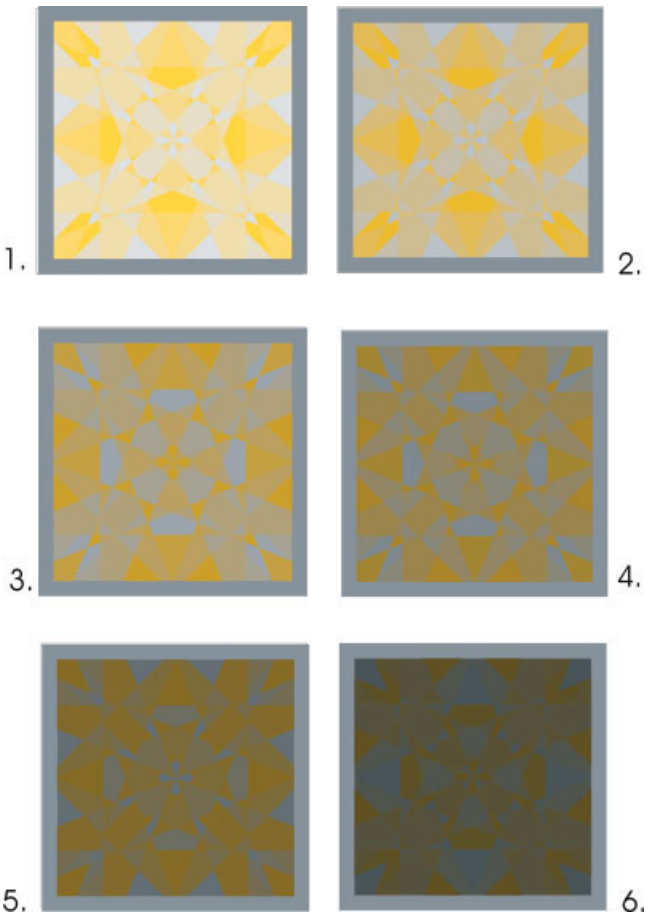

FIG. 12. A kaleido test sheet having been used between 1998 and 2001 in the series of experiments. The compositions of the test sheet, from left to right are made from the colors of scales appearing in axial section marked as A12 Coloroid hue, on lines perpendicular to the gray axis and having lightness V87.1, V77.1, V67.1, V57.1, V47.1, V37.1, respectively.

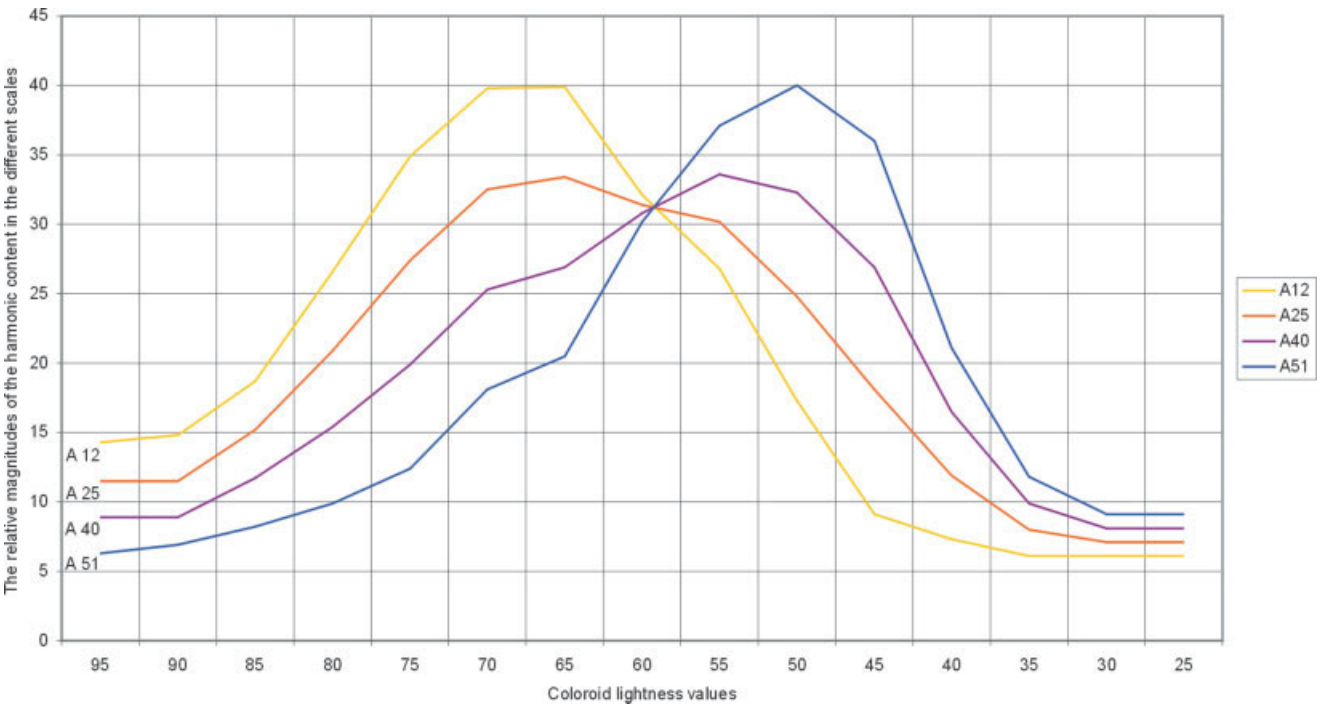

FIG. 13. The figure shows the relative extent of the harmony content of the various scales of Coloroid axial sections marked as A12, A25, A40, A51. The horizontal axis of the figure shows the compositions made of colors of scales representing different luminosities, on the vertical one the percentage of the votes for them are shown.

TABLE III. CIE (*X*,*Y*,*Z*) and COLOROID (*A*,*T*,*V*) data of colors of scales comprising compositions of Figs. 11 and 12.

	CIE			Coloroid		
	X	*Y*	*Z*	*A*	*T*	*V*
Composition 1 (A12, V87)						
Color 1	72.09	75.86	82.27	12.00	0.32	87.10
Color 2	71.58	75.86	70.27	12.00	12.32	87.10
Color 3	71.08	75.86	58.27	12.00	24.32	87.10
Color 4	70.58	75.86	46.26	12.00	36.32	87.10
Color 5	70.07	75.86	34.26	12.00	48.32	87.10
Color 6	69.57	75.86	22.26	12.00	60.32	87.10
Composition 2 (A12, V77)						
Color 1	56.48	59.44	64.40	12.00	0.32	77.10
Color 2	56.06	59.44	54.39	12.00	10.32	77.10
Color 3	55.64	59.44	44.39	12.00	20.32	77.10
Color 4	55.22	59.44	34.39	12.00	30.32	77.10
Color 5	54.80	59.44	24.38	12.00	40.32	77.10
Color 6	54.38	59.44	14.38	12.00	50.32	77.10
Composition 3 (A12, V67)						
Color 1	42.78	45.02	48.70	12.00	0.32	67.10
Color 2	42.44	45.02	40.69	12.00	8.32	67.10
Color 3	42.11	45.02	32.69	12.00	16.32	67.10
Color 4	41.77	45.02	24.69	12.00	24.32	67.10
Color 5	41.43	45.02	16.69	12.00	32.32	67.10
Color 6	41.10	45.02	8.68	12.00	40.32	67.10
Composition 4 (A12, V57)						
Color 1	30.97	32.60	35.17	12.00	0.32	57.10
Color 2	30.72	32.60	29.17	12.00	6.32	57.10
Color 3	30.47	32.60	23.17	12.00	12.32	57.10
Color 4	30.22	32.60	17.17	12.00	18.32	57.10
Color 5	29.97	32.60	11.17	12.00	24.32	57.10
Color 6	29.71	32.60	5.17	12.00	30.32	57.10
Composition 5 (A12, V47)						
Color 1	21.07	22.18	23.83	12.00	0.32	47.10
Color 2	20.90	22.18	19.83	12.00	4.32	47.10
Color 3	20.73	22.18	15.83	12.00	8.32	47.10
Color 4	20.57	22.18	11.83	12.00	12.32	47.10
Color 5	20.40	22.18	7.82	12.00	16.32	47.10
Color 6	20.23	22.18	3.82	12.00	20.32	47.10
Composition 6 (A12, V37)						
Color 1	13.07	13.76	14.66	12.00	0.32	37.10
Color 2	12.98	13.76	12.66	12.00	2.32	37.10
Color 3	12.90	13.76	10.66	12.00	4.32	37.10
Color 4	12.81	13.76	8.66	12.00	6.32	37.10
Color 5	12.73	13.76	6.66	12.00	8.32	37.10
Color 6	12.65	13.76	4.66	12.00	10.32	37.10

4. It is expedient to study the basic conditions of the order between saturations and brightnesses producing harmony experience with compositions of colors having identical Coloroid hues (identical characteristic wavelengths).
5. Between Coloroid saturations and brightness values of color compositions felt harmonic there are identical numbers or logarithmic varying numbers of harmony intervals. The extent of harmony interval being a function of hue and numerous other factors can be determined by measurements of harmony threshold.
6. Members of compositions consisting of colors with identical hue, being felt as harmonic, are located, in basic cases, on a straight line of the actual axis section (Coloroid color plane) of Coloroid color space. It means that even the order (arithmetical or geometrical series) between the numeric values of Coloroid coordinates describing the composition signals the harmonic feature of the composition.
7. The harmony content of color compositions located on identical harmony intervals on straight lines of Coloroid color planes is felt to be different, according to the angle between the straight line concerned and the initial straight line being perpendicular to the gray axis.
8. The most harmonic compositions are the following: in case of colors with characteristic wavelengths between 565 and 585 nm compositions containing scales declining with 55° to 75° from the initial straight line, in case of colors with characteristic wavelengths between 585 and 630 nm this declination proves to be between 55° and 135°, in case of colors with characteristic wavelengths between 450 and 565 nm this declination proves to be between 95° and 145°. The least harmonic felt compositions are for each hue those containing scales declining between 0° and 30° respectively between 155°and 180°.
9. Compositions containing scales of Coloroid saturations between 25 and 45 and colors with evenly

changing brightness are felt more harmonic than (1) compositions containing less saturated scales having more harmony intervals between their colors and (2) compositions containing more saturated scales having less harmony intervals between their colors.

10. Compositions containing scales of Coloroid brightness between 75 and 45 and colors with evenly changing saturation are felt more harmonic than (1) compositions made of more bright scales having more harmony intervals between their colors and (2) compositions made of less bright scales having less harmony intervals.
11. Most harmonic are scales where the number of harmony intervals between the members lies between 4 and 6.
12. The psychometric scales established during our experiments have facilitated description of generalized laws on color harmony. Description of these laws in the color space of Coloroid color system is relatively simple, proved even by the color harmony software based on above laws. Because Coloroid color space has a continuous and direct transformation relation to CIE XYZ system, this enables description of our color harmony laws in any color space nevertheless some more difficult.

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