ESTHETICS OF SIMPLE COLOR ARRANGEMENTS

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The experiments reported below in part I. of this paper were performed in the psychological laboratory of Mount Holyoke College during the year 1905–6. Those reported in part II. were performed in the psychological laboratory of Columbia University during the year 1906–7. Since the further tests which I wished to make must be indefinitely postponed there seems no reason for delaying any longer the publication of these little studies.

I

The question which suggested these tests might be phrased as follows. "In massing colors on a canvas is there any general reason for placing certain colors near the center and others near the outside. For example, in combining red with blue may we consider that it is better usually to put the blue in the center and the red in the peripheral parts of the field, or the red in the center and the blue in the periphery?"

Preliminary tests were made with colors arranged as in Fig. 1. A central square of one color was surrounded by four

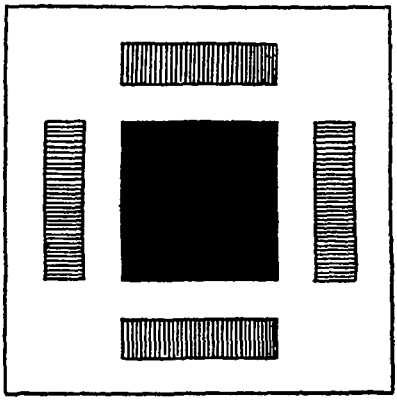


FIG. 1.

strips of another color, the spatial extent of the two colors being equal. This proved unsatisfactory for two reasons: (1) The figure as a whole was ungraceful and uninteresting to the subjects, and (2) the central color was disliked on account of its unbroken mass. The subjects found their attention repelled by the undifferentiated center, and it was evident that more complexity must be introduced into the figure to get an unquestioned esthetic reaction. The researches of Pierce[1] and Puffer[2] suggested that, since colors of different brightness were

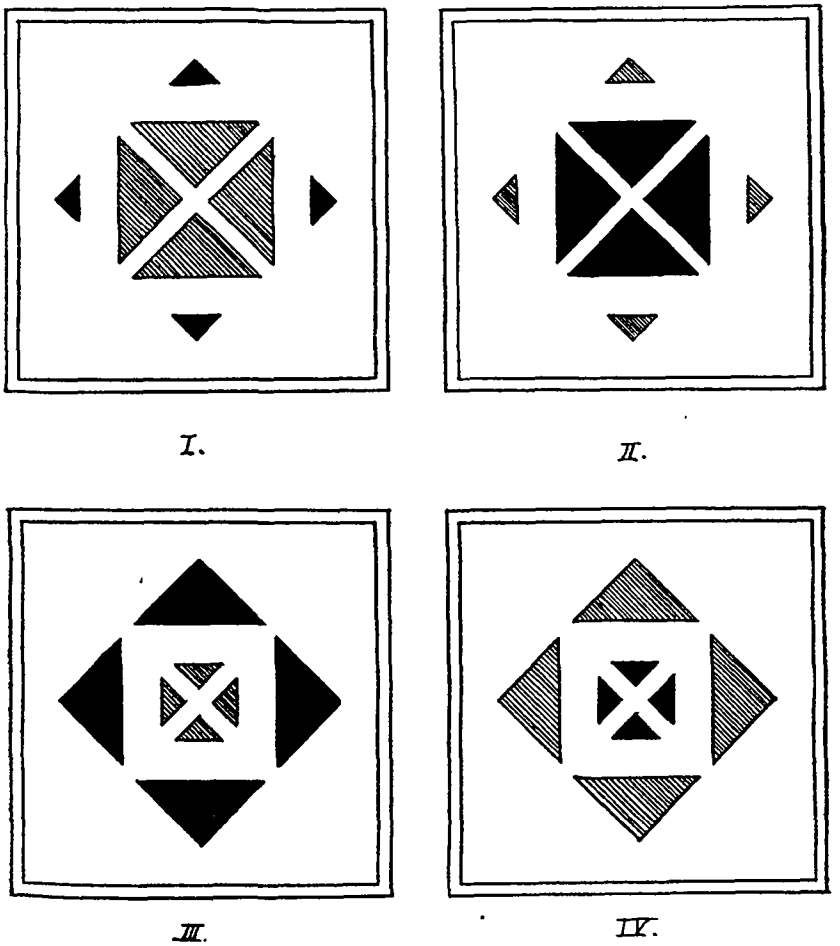


FIG. 2, I., II., III., IV.

[1] 'Æsthetics of Simple Forms,' PSY. REV., Vol. I.

[2] 'Studies in Symmetry,' Harvard Studies, Vol. I.

to be used, a contrast of large and small masses would be desirable. The figures finally chosen, Fig. 2, I., II., III. and IV., seemed the simplest ones which would meet the requirements. These four designs when filled out with a given color combination, *e. g.*, blue and red, represent the following possibilities of arrangement:

I. Small masses of blue in the periphery with large masses of red in the center.

II. Small masses of red in the periphery with large masses of blue in the center.

III. Large masses of blue in the periphery with small masses of red in the center.

IV. Large masses of red in the periphery with small masses of blue in the center.

The experiments were carried on in daylight illumination, and the colors used were the saturated hues of the yellow, green and blue of the Milton Bradley papers and the red of the Hering laid-on discs. The relative brightness of these colors may be stated in terms of the Hering gray paper series. The colors were matched with gray by indirect vision, and it appeared by this method that the

yellow equals in brightness Hering gray No. 2,
green equals in brightness Hering gray No. 8,
red equals in brightness Hering gray No. 13,
blue equals in brightness Hering gray No. 24.

The color combinations in these tests never included more than two colors at a time. This made only the following six combinations possible: blue-yellow; red-green; blue-red; green-yellow; blue-green; and red-yellow. All of these were used.

The method of presenting the combinations by paired comparisons was rejected after some trials. Anyone who has tried it with esthetic tests will recognize, I think, the serious objection against it, that it so quickly exhausts the esthetic reaction.

The figures were shown first upon a background nearly black, made of No. 45 Hering gray paper. This background paper, mounted on cardboard, was surrounded by a black frame 30 cm. square. The subject sat two meters away in

front of a shelf which was draped in gray. Upon the shelf were set, with interspaces of about 6 cm. the four frames containing the different figures. The subjects closed their eyes until the figures were all in place; they were then told to open their eyes and choose the most agreeable of the four designs. No restriction was made on the method of observing the figures, no fixation point was maintained and no time limit set. The subject was also asked to make a second and a third choice. Thus the task was to name the four designs in the order of preference. The frames were then taken down and the four figures filled out with another color combination. These tests were all repeated at a later sitting with this variation, that the figures were shown in reverse order on the shelf, namely 4, 3, 2, 1. Professor Martin[1] has pointed out the importance of relative position in the choice of simple figures, but since these figures were somewhat complicated and had individuality it was thought unnecessary to present them in each possible order, as 2 1, 4, 3; 3, 1, 2, 4, etc.

The subjects were twenty-nine young women in the junior and senior classes of Mount Holyoke College. All had had elementary work in psychology and several had served before as subjects of psychological experiments. They did not know the purpose of the tests and were told not to discuss their preferences with one another.

The method of tabulating the judgments was this: If a subject said that in the series, I., II., III., IV., No. III. was most agreeable, then that figure was credited with three points, because it was preferred to the three other figures. The second choice was marked two points because it was preferred to two others. The third choice was marked one because it was preferred to one other, and the fourth figure was marked zero. When the tests were repeated the figures were marked a second time, and the two sets of marks added. In cases where the subject was unable to choose the count was divided between the figures. Thus if the subject said that I. and II. were the best, two but she could not choose between them, each of these figures was given two and one half points, because first choice

[1] Psy. Rev., 1906, Fechner number.

counted three and second choice two. Counting up the preferences of all subjects in this way it appeared that with the dark background the preferences were distributed as in Table I.

TABLE I

Color Combination	Fig. I	Fig. II	Fig. III	Fig. IV
Blue-yellow:				
No. of prefs.	65.5	72	138	72.5
Percentage	18.8+	20.6+	39.6+	20.8+
Red-green:				
No. of prefs.	67	91	106	84
Percentage	19.2+	26.1+	30.4+	24.1+
Blue-red:				
No. of prefs.	72.5	77.5	118.5	79.5
Percentage	20.8+	22.2+	34.0+	22.8+
Green-yellow:				
No. of prefs.	75	72	126	75
Percentage	21.5+	20.6+	36.2+	21.5+
Blue-green:				
No. of prefs.	77.5	78	120.5	72
Percentage	22.2+	22.4+	34.6+	20.6+
Red-yellow:				
No. of prefs.	58	86	137	67
Percentage	16.6+	24.7+	39.3+	19.2+

In every color combination, then, the same figure received the greatest number of preferences, namely, the one in which small masses of bright color in the center are surrounded by large masses of darker color in the periphery. Moreover the combination which shows greatest disparity of brightness, the blue-yellow, shows greatest excess of preference for Fig. III. while the combination which shows least disparity of brightness, the red-green, shows least excess of preference for Fig. III.

In order to see whether these results would be modified by the brightness of the background against which the colors were shown all the above tests were repeated, substituting for the dark background a light one made of Hering gray No. I. The whole designs were then framed in light gray frames. The results are as given in Table II.

TABLE II

Color Combination	Fig. I	Fig. II	Fig. III	Fig. IV
Blue-yellow:				
No. of prefs.	40.5	100.5	132	75
Percentage	11.6+	28.8+	37.9+	21.5+
Red-green:				
No. of prefs.	65.5	87.5	110	85
Percentages	18.8+	25.1+	31.6+	24.4+
Blue-red:				
No. of prefs.	63	75.5	114	95.5
Percentage	18.1+	21.6+	32.7+	27.4+
Green-yellow:				
No. of prefs.	62.5	91.5	123.5	70.5
Percentage	17.9+	26.2+	35.4+	20.2+
Blue-green:				
No. of prefs.	57.5	86	126	78.5
Percentage	16.5+	24.7+	36.2+	22.5+
Red-yellow:				
No. of prefs.	48.5	95	138	66.5
Percentage	13.9+	27.2+	39.6+	19.1+

Adding together the whole number of preferences for each figure irrespective of color combinations there are

	Fig. I	Fig. II	Fig. III	Fig. IV
With dark ground	415.5	476.5	746.0	450.0
With light ground	337.5	536.0	743.5	471.0

The most noticeable difference lies in the relative increase of preference for II. over I. on the light ground.

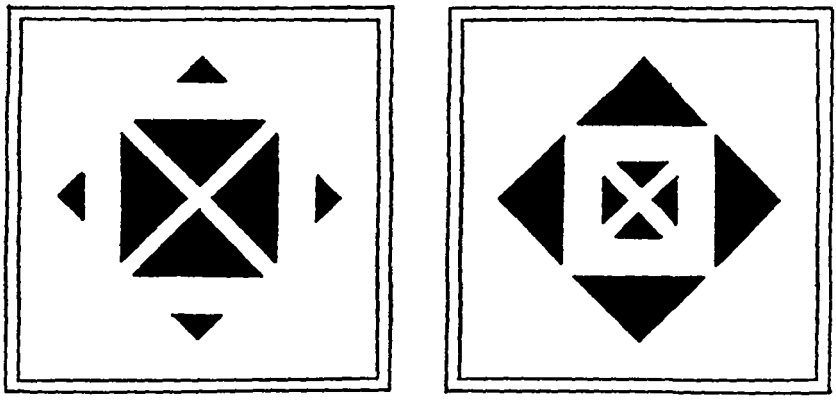
For the sake of isolating the several factors which contributed to the pleasantness of Fig. III. tests were next made to find out whether there was any preference for Figs. III. and IV. over I. and II. apart from the color combinations involved. The two figures were therefore shown side by side each filled out with a single color as in Fig. 3, I. and II. Here the color being constant the choice lay solely with the figure. It is conceivable, however, that the color chosen to fill them out with might affect the choice of the figure. Hence the two figures were filled out with each of the four colors in turn. These tests

were all repeated with the position of the figures reversed. Twenty-seven subjects took part.

TABLE III

Total No. of Prefs.	Fig. 3, I	Fig. 3, II
Filled out with blue	23	31
Filled out with yellow	20	34
Filled out with red	19	35
Filled out with green	21.5	32.5
Total of Prefs. on Light Ground	**Fig. 3, I**	**Fig. 3, II**
Filled out with blue	24	32
Filled out with yellow	21	35
Filled out with red	20.5	35.5
Filled out with green	26.5	29.5

There was therefore a constant preference for 3, II., as a figure, but, as Tables I. and II. show, this preference could be neutralized by other factors. The subjects who preferred 3, I.,



I. II.

FIG. 3.

said that it seemed more free and graceful than 3, II. Those who preferred 3, II., said that this one seemed more compact and unified.

The next step in the analysis of Fig. 3, III., was to abstract from the relative size of the peripheral and central masses, and to see whether the bright color is preferred in the center apart from any effect of large and small masses. Two designs were made in which the central and peripheral masses were equal in

extent. Fig. 4, I., shows the lighter color inside and 4, II., the darker inside. The results were, for twenty-nine subjects:

TABLE IV

With Dark Ground	Fig. 4, I	Fig. 4, II
Blue-yellow	38.5	19.5
Red-green	23	35
Blue-red	36	22
Green-yellow	38	20
Blue-green	39.5	18.5
Red-yellow	33	25
With Light Ground (15 Subjects)	**Fig. 4, I**	**Fig. 4, II**
Blue-yellow	20.5	9.5
Red-green	19.5	10.5
Blue-red	20.5	9.5
Green-yellow	20	10
Blue-green	19.5	10.5
Red-yellow	20	10

It appears, then, that with one exception (the case of the red-green combination on the dark background) the majority of preferences falls to the figure with the brighter color in the center. The reversal in the case of the red-green may be better understood in view of the results to be reported in part II. below.

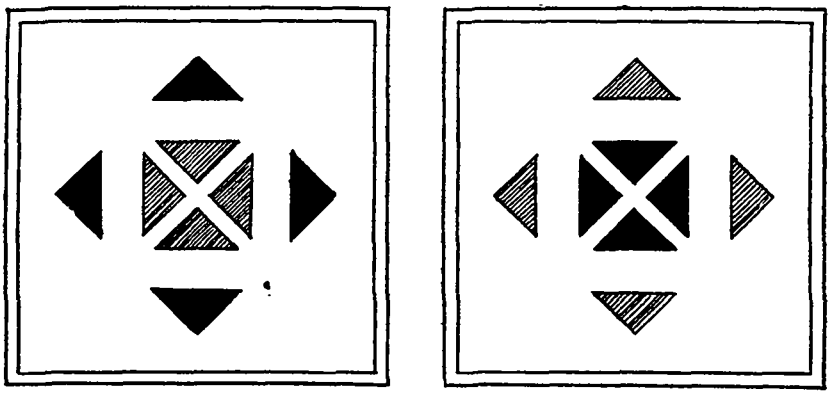
For the sake of trying what effect a contrasting frame might exercise on these choices a series of tests was made in which the colors were shown on the light ground but surrounded by the black frames. Fourteen subjects took part, and the tests were repeated in reverse order.

TABLE V

Light Ground with Dark Frames	Fig. 4, I	Fig 4, II
Blue-yellow	14	14
Red-green	12	16
Blue-red	14	14
Green-yellow	12.5	15.5
Blue-green	9.5	18.5
Red-yellow	9.5	18.5

The results show a striking reversal of judgments for the most part, *i. e.*, in every combination the figures with the dark color in the center are liked as well or better than those with the bright centers. The explanation I believe to be this: the rim

of black around the edge of the whole design makes a rhythm with the central color when this is a dark one. Only one subject, however, seemed consciously to realize the presence of



I II.

FIG. 4.

any such rhythms in the figures. No tests were made in which the dark ground was surrounded by a light frame. We must conclude that the brightness of the frame may have a very striking influence on the preferred color arrangement.

One further factor to be noticed is the preference for individual colors. One subject thought that she tended to prefer figures which had in them large masses of the favorite color irrespective of the arrangement. Each subject was asked to name the four colors used in order of their pleasantness (*A*) as seen on the dark ground, (*B*) as seen on the light ground. The color chosen first was counted three, the second two, etc.

RESULTS FOR 28 SUBJECTS

Dark ground	Red	Yellow	Green	Blue
	54	49	38.5	26.5
Light ground	Blue	Red	Green	Yellow
	60	47.5	44.5	16

Thus the most agreeable impression was made by the blue on the light ground, and the most disagreeable by the yellow on the light ground. Adding together the total choices, however, we get Red, 101.5; Blue, 86.5; Green, 83; Yellow, 65. Yellow

called out the widest extremes of choice. By some it was very much disliked, to others it was slightly disagreeable or indifferent, whereas a few said it was by far the most agreeable. It appears from these tests that the tendency to choose large masses of a favorite color is not a dominant tendency; for on the dark ground red was the best color, yet, in combination, small masses of red are chosen with large masses of blue and of green.

II

Seeing that the choice of colors as central seemed to be a function of their brightness, the next step was to equate the colors in brightness and to see what would then determine the choice. This part of the experiment was performed in a dark room. A light-proof box was made, inclosing an electric light. In front of the light was a ground glass plate which diffused the light over the designs which were fitted into the front of the box. The front of the box, which was 60 cm. wide and 30 cm. high, had grooves into which the cardboards carrying the designs in colored gelatines could be slid. The figures used were the same as Fig. 4, I. and II. above.

The colors used were the gelatine sheets furnished by the Stoelting Co. To match the colors in brightness two thicknesses of the blue gelatine were chosen as a starting point. The electric light was thrown through the glass plate and through the blue gelatines on to a screen at right angles to the light. At right angles to the screen a half-disc was set up which caught the direct light from a standard candle, the wick of which was kept as constant as possible. The candle could be moved until a point was reached at which, by the flicker method, the light from the candle was judged equal to the blue light. As a matter of fact the flicker never wholly disappeared with the blue light, but the minimum flicker, according to the middle judgment of three observers, occurred when the candle was 425 cm. distant from the half-disc. This, then, was taken as a standard, and the other colors were reduced to this brightness by the addition of sheets of gelatine. The judgments of two observers were taken for these equations and they coincided exactly. For the red, six sheets of gelatine

were necessary, for green, seven sheets, and for yellow ten sheets of gelatine and four sheets of yellow japanned paper. Of course the reduction of brightness by adding sheets of gelatine is not an ideally perfect system, because it does not give a continuous process, but it is only fair to say the the blending of the red, green and yellow with the candle light was very smooth and satisfactory, and if there was any objective difference in the brightness of the four colors it was very small, and, I think, negligible for the purpose of this experiment. The colors differed in saturation. Subjectively they all seemed pretty well saturated, but the spectroscope showed that, although red and green were good, the red lying between 640 and 620 on the spectrum scale, and the green between about 525 and 500, the blue transmitted violet, green and red, and the yellow transmitted green and red.

The experiment was conducted as above except that the subject sat in the dark until a signal was given and the electric light turned on which illuminated the colors from behind. As soon as the judgment of preference was given the light was turned off, and an interval of five minutes was allowed before the next pair of figures was presented. The subjects were all, with one exception, students in psychology at Teachers College. There were sixteen women and one man. The tests were repeated at a second sitting with the left and right position of the figures reversed. The results are shown in Table VI.

TABLE VI

Combination		No. of Prefs.
Blue-yellow:	Blue preferred as center	8
	Yellow preferred as center	26
Red-green:	Red preferred as center	24
	Green preferred as center	10
Blue-red:	Blue preferred as center	9
	Red preferred as center	25
Green-yellow:	Green preferred as center	12
	Yellow preferred as center	22
Blue-green:	Blue preferred as center	11
	Green preferred as center	23
Red-yellow:	Red preferred as center	23
	Yellow preferred as center	11

An examination of this table shows that in every color combination the color which is chosen as the center is the one which stands first in the order of the spectrum. Thus if we add together the total number of preferences for designs having red as a center we get 72, with yellow as a center 59, with green as a center 45, and with blue as a center 28.

I have no explanation to suggest for these preferences, but it seems probable that whatever factor was operative to determine choice in these last tests will serve to account for the case noted above in Table IV., where red was preferred over green as a center, though there the green was brighter.

Summary

1. When large and small masses of color appear together, it is more agreeable to find the large ones in the periphery of the visual field.

2. Brighter colors are preferred near the center of such figures, darker colors near the periphery, whether the background of the colors is light or dark.

3. In figures where the central and peripheral masses are equal in size, and where a light background is surrounded by a black frame, a dark color is preferred in the center.

4. There is probably some tendency to prefer large masses of a favorite color, but this tendency does not prevail over other considerations.

5. When colors are equated in brightness the color which stands nearer the red end of the spectrum is preferred in the center.