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DIFFERENCES IN COLOR PREFERENCES

WITH CULTURAL BACKGROUND

by

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TO
MY FAMILY
and
NILU

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INTRODUCTION

Experimentation in the field of color preferences began comparatively early; Cohn's article in 1894, is generally regarded as the first definitely empirical study. Cohn denied the existence of any general order of preference for colors; he found that among equally saturated colors, preference depends exclusively on individual taste. Over sixty researchers have been reported since that time, but little agreement has been reached until recently even on the most fundamental points.

Helson and Lansford(1970) conducted a landmark study using 5 light sources X 125 colors X 25 backgrounds X 10 observers and the results obtained dispelled the above confusion. They found that lightness contrast was the single most important factor in determining color preferences. They established some concrete results by finding that there are definite color preferences.

The main drawback of this study was the limited number of subjects used in the experiment. For such an important study it is important to verify Helson and Lansford with more observers. Also, today, with trade and cultural exchanges among countries growing stronger, it is important to know if there are different color preferences of people in from various countries. Knowledge of such differences can be used in various products to

enhance their overall effect.

The present study is a step in this direction to determine the color preferences of people coming from three different countries.

Munsell Color Notation

Of the various geometrical color solids which have been evolved for the systematic description of surface colors, the Munsell appeared to be the most suitable for work on color preferences and it has been used throughout in recent studies and in the present research. It is based on three principal attributes of surface colors-hue, lightness, and saturation(called by Munsell hue, value, and chroma). Since its inception, a vast amount of research has been carried out, mainly by physicists, to improve the system.

Hue. Hue is the attribute of color perception by means of which an object is judged to be red, yellow, green, blue, purple, or intermediate between some adjacent pairs of these.

Munsell hue. It is the attribute of a specimen, in Munsell terms, which correlates with the perceived hue of the specimen. Two designation systems for Munsell hue are shown in Figure 1 a letter-number system, and an all-number system. The letter-number system is preferred.

Lightness. Lightness is the attribute of color wherein more or less light is reflected.

Munsell value. The daylight reflectance of a specimen

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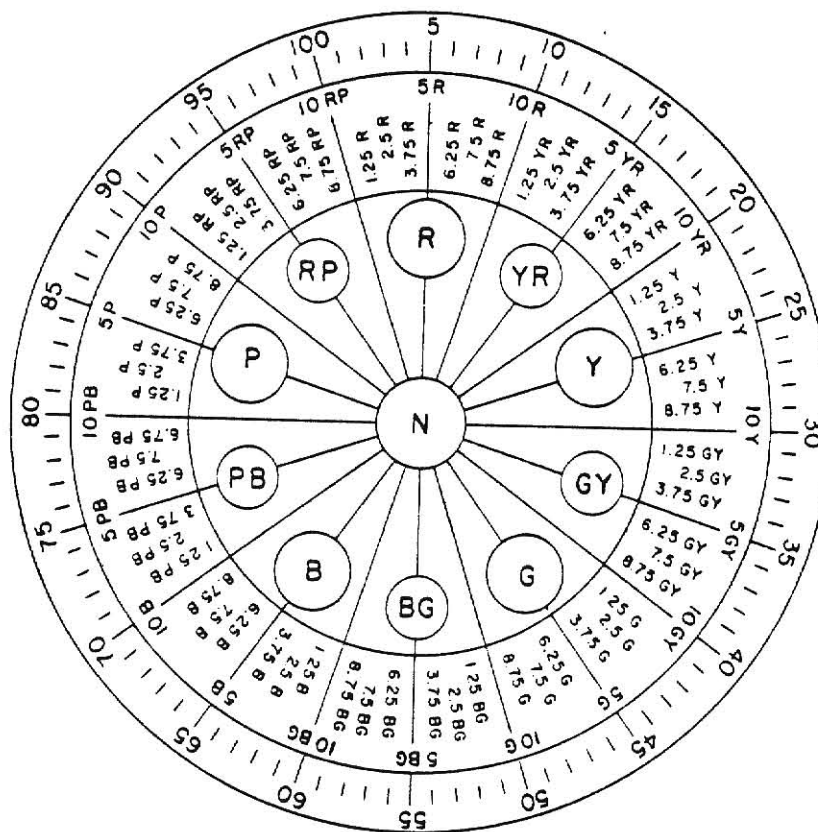


Figure 1. Designation systems for Munsell hue.

expressed on a scale extending from 0 for ideal black to 10 for ideal white by steps of approximately equal visual importance is value. Value notations are written V/. Achromatic or neutral colors are designated N followed by the value notation thus "N 5/". Technically, neutral N indicates colors with 0.0 chroma.

Saturation. Saturation is the attribute of color perception that expresses the degree of departure from the gray of the same lightness toward a "richer color". Grays, whites and blacks have zero saturation.

Munsell chroma. Chroma is the departure of a color from a gray having the same Munsell value, expressed on a scale extending from 0, by steps of approximately equal visual importance, to about 20 for the strongest colored specimens producible. Chroma notations are written "/C", thus chroma 5 is written, "/5".

Helson and Lansford Study

This is the most significant of recent studies which established some concrete results about the preference of colors. Pleasantness ratings of 125 colors on 25 differently colored backgrounds in five sources of illumination were made by five men and five women. Colors of low, medium, and high values and chromas were chosen. The colors were rated for pleasantness on a scale of nine categories ranging from one for very, very unpleasant, through five for neutral or indifferent, to nine for very, very pleasant. The

experiment was conducted in a light booth.

All main effects were found to be significant statistically. Differences between the sexes were highly significant in that men tended to prefer cool source, object and background colors(B, PB, P, and RP), women the warm colors(R, YR, and Y). The best colors for backgrounds had either low chroma and high value(8/, 9/, and 10/), or low chroma and low reflectance(2/ and 1/). The most important single factor determining the pleasantness of color combinations was lightness contrast. Hue and chroma contrasts, while of some importance, were not as decisive as lightness contrast. Tables 1 and 2 shows the pleasantness rankings of object colors obtained by Helson and Lansford.

The hues of the highest rated object colors in this study over all sources and backgrounds were B, PB, G, and BG. R ranked somewhat better than average. Y and P ranked low, as well as colors with strong Y components like GY and YR.

A preliminary research was conducted by this author in validation of Helson and Lansford and to find any differences in color preferences between two cultural groups Americans and (Asian)Indians. Eight subjects from each country rated eighty colors on two backgrounds.

The pleasantness ratings and hue preference were found to be the same as in Helson studies. Indians gave lower pleasantness rankings for all colors but the top rated hues were the same. Nationality differences with

Table 1. Pleasantness rankings and mean ratings of
125 object colors averaged across 25
backgrounds and five illuminants(Helson
and Lansford,1970).

Rank	Color	Mean	Rank	Color	Mean	Rank	Color	Mean	Rank	Color	Mean
1	10B 3/8	7.36	33	10GY 8/6	6.18	64	5P 2/6	5.76	95	5PB 2/2	5.46
2	5PB 3/12	7.33	33	5G 8/2	6.18	64	5P 5/10	5.76	96	10Y 8/2	5.45
3	5R 4/14	7.06	33	5RP 5/10	6.18	66	5PB 5/2	5.75	97	10BG 5/2	5.41
4	5PB 5/10	7.01	35	10RP 2/6	6.16	67	10GY 8/2	5.74	98	5R 5/2	5.40
5	5B 5/6	6.98	36	5B 8/4	6.14	68.5	5R 8/4	5.73	99	10GY 5/2	5.37
6	10BG 5/6	6.93	37	10R 4/10	6.08	68.5	5RP 8/2	5.73	100	10YR 2/2	5.36
7.5	5B 4/8	6.91	38	10R 5/10	6.05	70.5	5RP 8/6	5.70	102	5GY 7/10	5.35
7.5	10B 5/6	6.91	39	10GY 5/8	6.04	70.5	10R 8/2	5.70	102	10G 5/2	5.35
9	10G 5/6	6.87	40	5P 4/12	6.03	73.5	10R 8/4	5.67	102	10PB 5/2	5.35
10	5G 5/6	6.86	41.5	10B 8/2	6.01	73.5	5YR 8/2	5.67	104	5PB 8/2	5.33
11	5BG 5/6	6.70	41.5	10PB 8/2	6.01	73.5	5BG 2/2	5.67	105.5	5YR 5/2	5.32
12	5G 5/8	6.65	43	10G 8/2	6.00	73.5	5RP 2/2	5.67	105.5	5BG 5/2	5.32
13	10B 8/4	6.60	44.5	10RP 8/2	5.99	76.5	5YR 5/8	5.66	107	10RP 5/2	5.30
14	10BG 3/6	6.59	44.5	5BG 2/4	5.99	76.5	10YR 8/2	5.66	108	5P 5/2	5.26
15.5	5PB 2/6	6.52	46.5	10B 2/2	5.97	78	10YR 5/8	5.64	109	5G 5/2	5.21
15.5	5G 8/6	6.52	46.5	10R 2/2	5.97	79	10YR 8/6	5.63	110	5GY 8/2	5.20
17	10RP 3/10	6.49	48.5	10PB 2/6	5.92	80.5	10BG 2/2	5.62	111	10Y 6/6	5.15
18	10RP 5/10	6.45	48.5	5P 8/4	5.92	80.5	5RP 2/6	5.62	112	5GY 5/8	5.13
19.5	5R 5/8	6.43	50	5R 8/2	5.91	83	10PB 2/2	5.61	113.5	5Y 5/2	5.11
19.5	10PB 3/10	6.43	51	10P 3/10	5.90	83	10P 2/6	5.61	113.5	5Y 8/2	5.11
21	10Y 8/8	6.38	52	10P 8/4	5.89	83	10RP 2/2	5.61	115	5GY 2/2	5.10
22	10BG 8/2	6.35	53	5GY 8/8	5.88	85	N 8/	5.59	116	10P 5/2	5.03
23	5Y 8/12	6.34	54	5B 2/2	5.87	86	10GY 2/2	5.58	117	10Y 2/2	4.91
24	10B 2/4	6.29	55	5R 2/2	5.85	87	10YR 5/2	5.57	118	5RP 5/2	4.89
25	10PB 5/10	6.28	56	10G 2/2	5.81	88.5	5YR 6/12	5.53	119	5P 2/2	4.88
26	10GY 6/10	6.24	57	10R 5/2	5.80	88.5	5B 5/2	5.53	120	10P 2/2	4.85
27	5RP 2/12	6.22	59.5	10RP 8/6	5.79	90	N 2/	5.52	121	5Y 5/6	4.83
28	5BG 8/2	6.20	59.5	10P 8/2	5.79	91	10B 5/2	5.49	122	10Y 5/6	4.79
30	5BG 3/6	6.19	59.5	5G 2/2	5.79	93	5YR 8/4	5.47	123	10Y 5/2	4.64
30	5B 8/2	6.19	59.5	10YR 6/6	5.79	93	10P 5/10	5.47	124	5Y 2/2	4.56
30	5P 8/2	6.19	62	5R 2/6	5.77	93	N 5/	5.47	125	5GY 5/2	4.40
			64	5YR 2/2	5.76						

Table 2. Average pleasantness ratings of 21 color families across 25 backgrounds and five illuminants(Helson and Lansford,1970).

Family	Rating	Rank	Family	Rating	Rank
10B	6.39	1	5RP	5.65	13.5
5B	6.32	2	5P	5.65	13.5
5PB	6.25	3	10YR	5.61	15
10BG	6.17	4	5YR	5.58	16
5G	6.16	5	N	5.55	17
10G	6.03	6	10P	5.54	18
5BG	6.02	7.5	5GY	5.33	19
5R	6.02	7.5	10Y	5.24	20
10RP	5.88	9.5	5Y	5.20	21
10R	5.88	9.5			
10GY	5.85	11			
10PB	5.71	12			

lightness and chroma was found to be statistically significant. The most important result from this study was, Indians preferred colors with high value and low chroma which was the reverse in the case of Americans.

Factors Affecting Color Preference

Illumination. It is commonly recognized that objects have different colors in different sources of illumination due to changes in the spectral energies of the light leaving the objects and to changes in sensitivity of the eye arising from alteration in the quantity or quality of light affecting the visual mechanism. Helson and Judd(1952) studied the colors of Munsell samples under Macbeth daylight and incandescent filament light with a view toward formulating a quantitative theory for predicting the changes in passing from one to the other. The most important result of this study was, the establishment of the fact that people differ greatly with respect to chromatic adaption.

In earlier studies of colors of objects in strongly chromatic illuminants(Helson, 1938; Helson and Jeffers, 1940; Judd, 1940), and of object colors, incandescent(tungsten) illuminants(Helson, Judd, and Warren, 1952), it was shown that good first-order predictions of hue, lightness, and saturation could be made by taking into account the changed visual adaptation to the non-daylight viewing conditions as compared with daylight adaptation.

In attempting to determine whether or not any given luminous environment will be acceptable or

unacceptable to the majority of individuals, light sources cannot be considered apart from the objects they illuminate, for illuminants are usually evaluated, not by viewing them directly, but by colors of foods, complexions, ceilings, walls, floors, and all sorts of objects in interiors ranging from furniture and drapes to objects of art. Helson and Lansford(1970) conducted a landmark experiment using five light sources whose illuminant ratings are given in Table 3. Fluorescent cool white deluxe emerged as best and Macbeth filtered-incandescent as poorest, for large areas serving as background, Macbeth daylight emerged as the best and fluorescent standard warm white as poorest, for small backgrounds.

It is evident that the area of color and its background affect its pleasantness ratings, hence, the evaluation of the source in which it is seen. But there are larger and clearer effects attributable to differences among the sources having practical importance as shown by differences in: (1) the best background colors in the five illuminants; (2) ratings of individual colors which often vary as much as several category steps in different sources; (3) ratings of the color families in the five sources; (4) ratings of foods and complexions; and (5) differences between the sexes and their color preferences in the various sources.

Sources of illumination, therefore, may exert highly significant differential effects on color

Table 3. Average pleasantness ratings of object and background colors of five illuminants obtained by Helson and Lansford(1970).

Sources	Correlated Color Temps c.C.T	Color Rendering Indexes R_a	Illumina- nce Levels fc	Pleasantness Ratings	
				Object Colors	Large Areas
Incandescent Tungsten	2854 K	98-100	53	5.90	5.77
Fluorescent Standard Warm White	3000 K	51	38	5.78	5.61
Fluorescent Cool White (Deluxe Equivalent)	4500 K	85	40	5.94	6.01
Fluorescent Daylight	6500 K	91	32	5.85	5.95
Filtered Incandescent	6500 K	94	15	5.69	6.07

preferences for all cultural groups.

Sex. Many investigators have reported differences between the sexes in preferences for colors. Dorcus(1924) found that yellow has a lower affective value for females than with males. St. George maintains that blue for men "stands out" far more than for women, and Jastrow(1938) found that women preferred red to blue, men blue to red. Von Allesch(1934), on the other hand, did not observe any such differences, and Garth(1924), after examining several thousand cases, came to the conclusion that the color sequences between the two sexes are about the same. Eysenck(1940) found that there was a high agreement between the two sexes with regard to their color preferences. Apart from a slight preference for orange among the men and for yellow among the women, the average orders given by the two sexes are identical, the correlation between them being 0.95.

According to Helson and Lansford it was seen that women rated warm colors, red, yellow-red, and yellow, significantly higher than did the men, whereas the men rated the cool colors, blue, purple-blue, purple, and red-purple, significantly higher than the women did in the five sources of illumination. The significance of the sex differences is also borne out in the differential influence exerted by the backgrounds on the men and women, as shown in Table 4. The women rated R and YR colors higher than the men on almost all the twenty five backgrounds, while the men rated GY, P, and RP color families higher on 68%

Table 4. Differential background effects on ratings of eight color families by men and women(Helson and Lansford,1970).

Color Family	No. of backgrounds women ratings higher than men's	No. of backgrounds men ratings higher than women's
10R	23 (92%)	2 (8%)
5YR	25 (100%)	0
10YR	25 (100%)	0
5GY	8 (32%)	17 (68%)
5P	2 (8%)	23 (92%)
10P	4 (16%)	21 (84%)
5RP	3 (12%)	22 (88%)
10RP	8 (32%)	17 (68%)

to 2% of the twenty five backgrounds.

Thus, the preference for warm colors by women and for cool colors by men is borne out by the data for sources, backgrounds, and color families.

It has been found in past studies that age differences significantly alter the preferences in colors. Choungourian(1969) conducted a cross-cultural study on 308 American and Lebanese subjects at different age and education levels who expressed their preferences for eight Ostwald colors through the method of paired comparisons. The main findings indicate that green was significantly not preferred at earlier developmental stages while significantly preferred at a later adult stage. Garth and Moses(1938) found that East Indian color preference scales are rather different from those of American Whites. The effects of education and experience(age) seem to produce great changes in the scale values for many of the colors.

Background. Background exerts a greater effect on pleasantness of object colors than does the spectral energy of source, although the latter effect proved to be statistically significant in past studies. It is evident that proper choice of background may counteract to a greater or lesser extent a bad source and, on the other hand, that an improperly chosen background may hurt the effect of a good source. While these facts seem to complicate the problem of specifying sources for interior colors they also serve to alert the illuminating engineer to

background colors as an important factor in the viewing situation which affects aesthetic responses to illuminants.

Helson and Lansford(1970) found that the best background colors were white, light yellow, light red, light green, dark green, light purple-blue, and black as seen in Table 5. Six of the eight best background colors have lightness values of eight or higher and the other two are very dark. These backgrounds thus provide excellent background contrast. From this table one can generalize and say that the best dominant colors in an interior are those of high lightness and very low chroma. In other words, pastel colors, including the neutrals white and black, are the best background colors for enhancing the pleasantness of object colors.

General preference. Norman and Scott(1952) review findings regarding age, sex, race, and association as factors influencing color preferences. A cross-cultural study provides evidence for cultural differences in color preferences(Choungourian, 1968). Von Allesch(1934; Granger, 1955, 3-20) laying great stress on the chaotic diversity of preferences among colors, maintained that results obtained by him were too variable to justify his saying that any colors were, in general, pleasing or displeasing. On the other hand, Walton and Guiford(1933) found "a common basis of feeling for different colors among their observers, and they maintain that" there remains sufficient agreement upon color preferences to indicate a basic, biological

Table 5. Background colors ordered according to average pleasantness ratings of 125 Munsell samples over five sources of illumination (Helson and Lansford, 1970).

Rank	Hue	Value/ Chroma	Rating	Rank	Hue	Value/ Chroma	Rating
1	N	10/	6.24	14	5R	2/2	5.78
2	5Y	9/12	6.07	15	5G	5/4	5.78
3	5Y	8/2	6.04	16	5Y	2/2	5.77
4	5R	8/2	6.03	17	2.5PB	2/2	5.75
5	5G	8/2	5.99	18	5R	5/2	5.73
6	5G	2/2	5.97	19	5R	4/14	5.71
7	2.5PB	8/2	5.91	20	5R	5/4	5.71
8	N	1/	5.89	21	5Y	5/4	5.69
9	N	5/	5.86	22	10PB	3/10	5.69
10	2.5YR	5/14	5.84	23	2.5PB	5/4	5.68
11	5G	5/2	5.81	24	5Y	5/2	5.67
12	2.5PB	5/2	5.80	25	10RP	4/12	5.62
13	5GY	7/10	5.80				

cause of likes and dislikes for colors. St. George and Garth(1922) also argue in favor of native preference tendencies. Murray and Spencer(1939) noted that preferences remained constant even when backgrounds of varying colors was used.

Subsequent researches until recently, on the preference of colors provided many contradictory but some concrete results. Granger(1955) concluded that color appreciation is dependent on an aesthetic factor of a biological nature. Judd, Helson, and Warren(1952) established the fact that people differ greatly with respect to chromatic adaptation.

PROBLEM

The problem of this study is to examine the differences in color preferences of three adult national groups(America, India, and Nigeria), with hue, lightness, chroma, and background as the physical parameters.

The first hypothesis is that there will be a close correlation between the results obtained for Americans and Helson and Lansford findings with American judges.

The second hypothesis is, there will be a contrast between the three national groups regarding likings for lightness and saturation of colors.

The third hypothesis is both Indians and Nigerians will like high value colors and lighter backgrounds, and that Americans will tend to prefer high saturated colors.

METHOD

The method of this research is divided into the following five sections:

1. Subjects
2. Task
3. Procedure and Experimental design
4. Data analysis

Subjects

Thirty five subjects mostly college students, from three countries participated in the experiment. The subjects were eighteen from America(U.S.A), ten from India, and seven from Nigeria representing three different cultural groups. The subjects were recruited on a whoever-was-available basis and participated voluntarily. All the subjects were tested for color vision.

Task

In the Munsell system there are five principal hues, R, Y, G, B, and P, with five intermediates, YR, GY, BG, PB, and RP. Some Munsell 5B and 7.5B(blue) colors may appear greenish, and good unitary blues may not be seen until one reaches 2.5PB(bluish purple-blue) and 5PB(purple-blue). No trace of red may be seen by most observers before one reaches 7.5 or 10PB.

To represent all the main regions of the hue gamut ten Munsell hue colors were selected for this experiment which are shown in Table 6. Each of these

hues are represented with samples of low, medium, and high value(lightness) and chroma(saturation) as shown in Table 6. Three of the color chips 10Y, 5PB, and 5RP are represented by different lightness and chromas($3/4$, $2/8$, and $2/8$). Each hue has nine different samples of lightness and chroma.

Random sets of 12 of these colors were exposed on two different backgrounds N 8/ and N 2/ (white and black). The size of each color chip was 0.7 X 0.8 in. on a side, from the Munsell Book of Color. About 12 chips were displayed simultaneously, so as to afford some basis for comparison in judging the pleasantness of colors. The chips were placed so that the background could be seen clearly around the sample color. The observers rated the colors according to the method of absolute judgment. Each color was rated according to the following categories: very, very pleasant(9); very pleasant(8); pleasant(7); mildly pleasant(6); neutral or indifferent(5); mildly unpleasant(4); unpleasant(3); very unpleasant(2); very, very unpleasant(1); as shown in Figure 2.

The observations were conducted in a fluorescent light booth illuminated by four cool white deluxe lamps. Instead of considering a combination of many light sources and backgrounds only the one source of light and two backgrounds were used in the experiment. The walls and shelf in the booth was lined with a good non-selective white cardboard paper throughout. The light source was suspended in a fixture so that it could be adjusted

Table 6. Ninety object colors listed according to
Munsell notation.

	Low V Low C	Low V Med C	Low V High C	Med V Low C	Med V Med C	Med V High C	High V Low C	High V Med C	High V High C
True	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
5R	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
5YR	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
10Y	3/2	3/4	3/8	5/2	5/6	5/8	7/2	7/6	7/8
10GY	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
5G	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
10G	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
5B	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
5PB	3/2	3/6	2/8	5/2	5/6	5/8	7/2	7/6	7/8
10P	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8
5RP	3/2	3/6	2/8	5/2	5/6	5/8	7/2	7/6	7/8

V - Value

C - Chroma

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DOCUMENT(S) IS OF
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**THIS IS THE BEST
COPY AVAILABLE**

- (1). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (2). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (3). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (4). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (5). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (6). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (7). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (8). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (9). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (10). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (11). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.
 (12). -----9; -----8; -----7; -----6; -----5; -----4; -----3; -----2; -----1.

9 ----- Very, very pleasant

4 ----- Mildly unpleasant

8 ----- Very pleasant

3 ----- Unpleasant

7 ----- Pleasant

2 ----- Very unpleasant

6 ----- Mildly pleasant

1 ----- Very, very unpleasant

5 ----- Neutral or Indifferent

Figure 2. Pleasantness rating form.

to give the desired illumination on a shelf upon which the color chips were displayed. Fluorescent cool white deluxe is chosen because it emerged as the best source of light in Helson and Lansford findings. The booth was illuminated at 65fc. Each subject rated one hundred and eighty colors on the two backgrounds.

Procedure and Experimental Design

The subjects were adapted to the illumination in the booth for five minutes before the observations began. Thirty five sessions of approximately fifty minutes were necessary to complete the observations. Ninety standard Munsell samples were chosen to give the maximum range of lightness and saturation in various combinations for the ten major Munsell hues, as shown in Table 6. The ninety samples were randomized for each subject to minimize contrast effect. Twelve samples were exposed at one time. The experimental set-up is shown in Figure 3. Instructions to the subjects concerning preference judgments were, they should judge the colors according to their preference at the present moment.

Before the start of the experiment the subjects were tested for color vision with a Titmus vision tester. The subjects were given the instruction sheet as shown in Figure 4 after which they were asked to sign the consent form Figure 5. The subjects were adapted to the illumination in the booth for five minutes before the observations began. The first sample of twelve colors were

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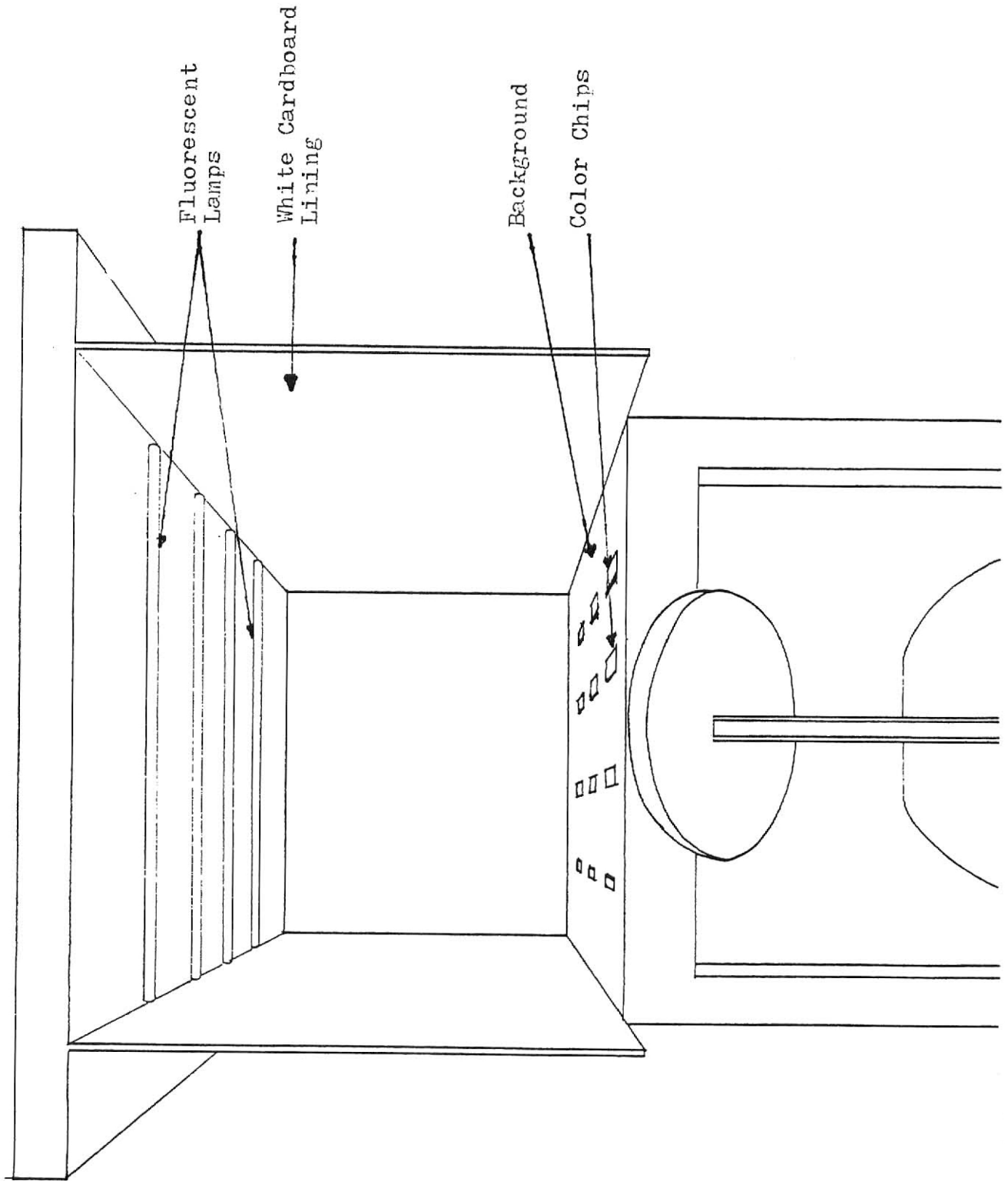


Figure 3. Experimental set-up.

INSTRUCTIONS

The purpose of this experiment is to determine peoples color preferences.

A random sample of 12 colors will be displayed simultaneously on the background. After you have rated the first 12 colors another random set of colors will be displayed on the same background. You will be rating 90 color chips on each of the two backgrounds (White and Black). You are asked to rate each color using the scale provided to you on the paper. Rate the colors from the first to the last row(left to right) as displayed on the background.

You will be recording a total of 180 observations on the two backgrounds. You are asked to avoid fixating individual colors during the experiment. You should judge the colors according to your preferences at the present moment.

The results of this experiment will depend on the quality of your judgment.

Figure 4. Subject instruction form.

SUBJECT CONSENT FORM

The experiment you are about to participate in, is to determine peoples color preferences. There will be no discomfort nor risk in this experiment. However, you are free to stop your participation any time you wish. Naturally I would prefer that you continue until the end so that I can get all of the needed data.

If you agree to participate as a subject in this experiment, please sign your name below. Thank You.

Reddy Thota Veernath

Figure 5. Subject consent form.

displayed on one of the two backgrounds placed in the booth just below the source of light. The subject was given the form to rate each of the colors against that particular background. After the subject rated the first twelve chips, another sample of twelve colors was displayed on the same background. The same procedure was repeated until all the chips were rated according to the above method. The same colors used above were rated with respect to the second background. The order of the backgrounds were randomized. At the end of his ratings the subject was given a questionnaire as shown in Figure 6 and was asked to comment on any factors which they thought were influencing their judgements; any incidental comments of interest were also noted.

The sets of colors for each set-up were presented to the subjects in a pre-arranged random order, and within sets the colors were also randomized.

Data Analysis

This is a repeated measure randomized design experiment with nationality as experimental factor. It is a split plot design with whole plot as subject and sub-plot treatment as hue, lightness-chroma factor and background. The analysis of variance was done using the general linear models procedure.

In your opinion the task you just completed was

1). Relaxing
1
2
3
4
5
6
7
8
9
10
 Strenuous

2). Boring
1
2
3
4
5
6
7
8
9
10
 Interesting

- 3). 1 --- Very, Very easy
 2 ---- Very easy
 3 --- easy
 4 --- Somewhat Hard
 5 --- Hard
 6 --- Very Hard
 7 --- Very, Very Hard

4). Was there any confusion in rating the colors?

5). Comments or suggestions.

Figure 6. Subject questionnaire form.

RESULTS

The primary data of this study consists of 6,300 pleasantness ratings. To assist in discovering what these data indicate, various averages of the pleasantness ratings were taken, and various statistical analysis were carried out.

The pleasantness rating was done on a scale of nine categories ranging from one for very, very unpleasant, through five for neutral or indifferent, to nine for very, very pleasant. The pleasantness ratings of object colors for nine combinations of lightness and chroma averaged across all the subjects for different hues and backgrounds for Americans, Indians, and Nigerians are shown in Tables 7 - 12. The tables also show the overall mean rating for a particular lightness-chroma combination for each of the two backgrounds and the three national groups.

The means of lightness(3/, 5/, and 7/) and chroma(/2, /6, and /8) for ten hues and the two backgrounds for Americans, Indians, and Nigerians are shown in Tables 13 - 15. Americans gave higher ratings to high chroma(saturation) colors whereas Indians and Nigerians to high value(lightness) colors. Tables 16 and 17 shows the pleasantness ratings for the means of six different lightness and chromas and ten hues for the three groups averaged across white and black backgrounds. The tables show that Nigerians gave higher ratings to all the hues

Table 7. Pleasantness ratings of Americans in nine
lightness-chroma combinations for the
white background.

Hue	Low V	Low V	Low V	Med V	Med V	Med V	High V	High V	High V	Average
	Low C	Med C	High C	Low C	Med C	High C	Low C	Med C	High C	
	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8	
5R	4.56	6.17	5.94	5.06	5.00	5.39	4.39	5.44	4.83	5.20
5YR	4.33	5.28	4.61	4.61	5.28	5.44	5.00	5.33	5.33	5.02
10Y	3.67	3.78	3.89	3.61	4.11	3.89	4.33	4.44	4.44	4.02
10GY	3.78	4.00	4.33	4.33	5.22	5.56	4.39	4.78	5.11	4.61
5G	3.72	5.39	5.00	4.39	5.39	5.56	5.39	5.22	4.56	4.96
10G	3.33	5.06	5.11	4.39	5.61	5.50	5.06	4.72	4.94	4.86
5B	3.83	5.56	5.33	4.83	5.94	6.39	5.67	6.62	6.61	5.60
5PB	4.28	6.39	6.44	5.56	6.39	6.78	5.33	6.33	6.50	6.00
10P	4.83	5.61	5.67	5.33	5.83	5.50	5.11	5.39	4.61	5.32
5RP	4.50	5.72	5.67	5.44	5.39	5.44	4.78	5.56	5.72	5.36
Average	4.08	5.30	5.20	4.76	5.42	5.55	4.95	5.34	5.27	5.10

Table 8. Pleasantness ratings of Americans in nine
lightness-chroma combinations for the
black background.

	Low V	Low V	Low V	Med V	Med V	Med V	High V	High V	High V	
	Low C	Med C	High C	Low C	Med C	High C	Low C	Med C	High C	
Hue	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8	Average
5R	4.00	5.72	5.67	5.17	5.00	5.44	4.61	5.22	4.94	5.09
5YR	3.61	4.78	5.11	4.67	5.50	5.50	5.28	5.28	5.44	5.02
10Y	3.61	3.83	3.78	4.33	4.06	3.78	5.28	4.22	3.94	4.09
10GY	3.17	4.28	4.67	5.28	5.50	5.28	5.28	4.89	5.22	4.84
5G	3.33	5.44	4.50	4.83	5.39	4.94	5.44	5.28	4.56	4.86
10G	3.22	4.89	4.78	4.33	5.22	5.22	5.33	4.78	4.94	4.75
5B	3.44	5.56	5.61	5.22	5.72	6.22	5.50	5.83	5.39	5.39
5PB	3.44	5.22	5.78	5.00	5.83	6.83	5.22	6.22	6.22	5.53
10P	3.61	5.28	5.50	4.72	5.50	5.17	5.00	5.39	5.33	5.06
5RP	3.89	5.11	5.06	4.56	5.28	5.56	5.00	5.44	5.56	5.05
Average	3.53	5.01	5.05	4.81	5.30	5.39	5.19	5.26	5.15	4.97

Table 9. Pleasantness ratings of Indians in nine
lightness-chroma combinations for the
white background.

Hue	Low V Low C	Low V Med C	Low V High C	Med V Low C	Med V Med C	Med V High C	High V Low C	High V Med C	High V High C	Average
	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8	
5R	4.8	5.2	4.8	6.6	5.3	4.8	6.7	5.2	5.8	5.47
5YR	4.9	5.0	4.8	6.2	5.0	5.2	6.7	6.2	5.5	5.50
10Y	4.5	4.3	4.7	5.1	4.9	5.1	6.4	4.9	4.8	4.97
10GY	4.1	4.2	4.7	4.6	5.4	5.2	5.8	6.4	5.6	5.11
5G	4.4	5.3	4.5	4.9	5.7	5.7	7.0	5.9	5.9	5.48
10G	3.3	4.5	4.7	5.4	5.9	5.6	6.5	6.5	6.0	5.38
5B	3.9	5.7	4.8	5.8	6.0	6.0	6.4	6.0	7.1	5.74
5PB	3.5	5.2	5.1	5.3	5.6	6.8	6.2	7.1	6.6	5.71
10P	4.5	5.0	5.0	5.3	5.2	5.2	6.9	6.9	6.1	5.57
5RP	4.7	4.6	4.5	5.3	5.5	5.9	5.3	6.3	5.6	5.30
Average	4.26	4.90	4.76	5.45	5.45	5.55	6.39	6.14	5.90	5.42

Table 10. Pleasantness ratings of Indians in nine
lightness-chroma combinations for the
black background.

Hue	Low V Low C	Low V Med C	Low V High C	Med V Low C	Med V Med C	Med V High C	High V Low C	High V Med C	High V High C	Average
	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8	
5R	4.2	3.8	4.6	5.5	4.7	5.6	6.2	5.5	6.3	5.16
5YR	4.4	5.0	4.3	5.1	4.8	5.0	6.4	5.8	5.6	5.16
10Y	3.6	4.1	3.9	5.5	5.4	4.7	7.1	5.0	5.4	4.97
10GY	3.8	4.4	4.5	5.3	5.3	5.2	5.9	5.9	6.0	5.14
5G	3.9	4.2	4.8	4.7	5.8	5.8	6.6	6.7	5.5	5.33
10G	3.3	4.2	3.9	5.1	5.2	5.5	5.4	6.3	5.6	4.94
5B	4.0	4.5	4.6	5.8	6.0	6.0	5.9	6.7	6.7	5.58
5PB	4.4	4.9	4.7	5.4	6.0	6.6	7.2	6.6	6.5	5.81
10P	4.3	4.5	4.8	5.0	5.1	5.7	7.0	6.7	6.7	5.53
5RP	4.2	4.0	4.0	4.6	5.3	5.9	5.9	6.1	6.3	5.14
Average	4.04	4.36	4.41	5.20	5.36	5.60	6.36	6.13	6.06	5.28

Table 11. Pleasantness ratings of Nigerians in nine
lightness-chroma combinations for the
white background.

Hue	Low V	Low V	Low V	Med V	Med V	Med V	High V	High V	High V	Average
	Low C	Med C	High C	Low C	Med C	High C	Low C	Med C	High C	
	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8	
5R	5.43	5.00	5.29	7.29	5.57	5.43	6.57	5.29	5.43	5.70
5YR	5.71	4.57	5.29	6.14	5.57	6.14	7.57	5.14	6.14	5.81
10Y	3.86	3.29	4.57	5.43	4.29	6.29	6.86	6.43	6.43	5.27
10GY	3.71	3.71	4.86	5.43	6.57	4.14	7.14	6.00	5.29	4.69
5G	4.57	5.86	3.57	5.29	5.57	5.43	6.71	5.57	5.86	5.38
10G	5.29	4.29	4.14	6.57	5.57	4.43	6.29	5.71	5.00	4.73
5B	4.71	4.86	5.14	5.43	6.71	6.29	6.43	5.86	6.57	5.78
5PB	5.29	4.29	4.86	5.86	7.00	7.29	7.43	7.71	7.57	6.37
10P	5.43	4.86	5.29	5.71	6.29	5.57	7.86	6.00	7.57	6.06
5RP	6.14	5.57	5.14	5.86	7.00	6.71	5.86	6.71	7.00	6.22
Average	5.01	4.63	4.82	5.90	6.01	5.77	6.87	6.04	6.29	5.60

Table 12. Pleasantness ratings of Nigerians in nine
lightness-chroma combinations for the
black background.

Hue	Low V	Low V	Low V	Med V	Med V	Med V	High V	High V	High V	Average
	Low C	Med C	High C	Low C	Med C	High C	Low C	Med C	High C	
	3/2	3/6	3/8	5/2	5/6	5/8	7/2	7/6	7/8	
5R	4.43	4.71	6.00	6.43	6.43	5.71	6.57	6.14	6.29	5.86
5YR	4.00	4.86	5.43	6.57	6.29	6.71	7.00	6.43	6.00	5.92
10Y	2.71	3.57	5.14	4.43	5.43	6.00	6.43	6.00	6.14	5.09
10GY	3.14	4.29	4.29	5.71	7.57	5.71	7.00	5.71	5.86	5.48
5G	2.29	5.14	4.86	6.14	6.14	6.29	6.57	6.71	5.14	5.48
10G	2.71	5.00	4.00	7.29	6.71	5.43	6.57	6.57	6.71	5.67
5B	3.00	5.86	4.57	4.86	6.71	6.29	6.86	6.14	5.86	5.57
5PB	3.29	4.00	4.29	5.29	6.43	6.71	7.14	6.86	6.43	5.60
10P	4.29	5.43	5.71	5.86	5.71	6.71	6.57	7.00	6.71	5.99
5RP	4.14	4.86	5.86	5.29	6.86	7.14	5.71	7.14	6.00	5.89
Average	3.39	4.77	5.02	5.79	6.43	6.27	6.64	6.47	6.11	5.66

Table 13. Pleasantness ratings of Americans in different lightness and chromas for white and black backgrounds.

Hue	Low V 3/		Med V 5/		High V 7/		Low C /2		Med C /6		High C /8		Average
	W	B	W	B	W	B	W	B	W	B	W	B	
5R	5.56	5.13	5.15	5.20	4.89	4.92	7.01	4.59	5.54	5.31	5.39	5.35	5.20
5YR	4.74	4.50	5.11	5.15	5.22	5.33	4.65	4.52	5.30	5.19	5.13	5.35	5.02
10Y	3.78	3.74	3.87	4.07	4.40	4.48	3.87	4.41	4.11	4.04	4.07	3.83	4.06
10GY	4.04	4.04	5.04	5.35	4.76	5.13	4.17	4.58	4.67	4.89	5.00	5.06	4.73
5G	4.70	4.42	5.11	5.05	5.06	5.09	4.50	4.53	5.33	5.37	5.04	4.67	4.91
10G	4.50	4.29	5.17	4.92	4.91	5.02	4.26	4.29	5.13	4.96	5.18	4.98	4.80
5B	4.91	4.87	5.72	5.72	6.17	5.57	4.78	4.72	5.91	5.70	6.11	5.74	5.49
5PB	5.70	4.81	6.24	5.89	6.05	5.89	5.06	4.55	6.37	5.76	6.57	6.28	5.76
10P	5.37	4.80	5.55	5.13	5.04	5.24	5.09	4.44	5.61	5.39	5.26	5.33	5.19
5RP	5.30	4.69	5.42	5.13	5.35	5.33	4.91	4.48	5.56	5.28	5.61	5.39	5.20
Average	4.86	4.53	5.24	5.16	5.19	5.20	4.83	4.51	5.35	5.19	5.34	5.20	5.04

Table 14. Pleasantness ratings of Indians in
different lightness and chromas for
white and black backgrounds.

Hue	Low V 3/		Med V 5/		High V 7/		Low C /2		Med C /6		High C /8		Average
	W	B	W	B	W	B	W	B	W	B	W	B	
5R	4.93	4.20	5.57	5.27	5.90	6.00	6.03	5.30	5.23	4.67	5.13	5.50	5.31
5YR	4.90	4.57	5.47	4.97	6.13	5.93	5.93	5.30	5.40	5.20	5.17	4.97	5.33
10Y	4.50	3.87	5.03	4.87	5.37	5.83	5.33	5.40	4.70	4.83	4.87	4.67	4.94
10GY	4.33	4.23	5.07	5.27	5.93	5.93	4.83	5.00	5.33	5.20	5.17	5.23	5.13
5G	4.73	4.30	5.43	5.43	6.27	6.27	5.43	5.07	5.63	5.57	5.37	5.37	5.41
10G	4.17	3.80	5.63	5.27	6.33	5.77	5.07	4.60	5.63	5.23	5.43	5.00	5.16
5B	4.80	4.70	5.93	5.93	6.50	6.43	5.37	5.23	5.90	5.73	5.97	5.77	5.69
5PB	4.60	4.67	5.90	6.00	6.63	6.77	5.00	5.67	5.97	5.83	6.17	5.93	5.76
10P	4.83	4.53	5.23	5.27	6.63	6.80	5.57	5.43	5.70	5.43	5.43	5.73	5.55
5RP	4.60	4.07	5.57	5.27	5.73	6.10	5.10	4.90	5.47	5.13	5.33	5.40	5.22
Average	4.64	4.29	5.48	5.34	6.14	6.10	5.37	5.19	5.50	5.28	5.40	5.36	5.34

Table 15. Pleasantness ratings of Nigerians in
different lightness and chromas for
white and black backgrounds.

Hue	Low V 3/		Med V 5/		High V 7/		Low C /2		Med C /6		High C /8		Average
	W	B	W	B	W	B	W	B	W	B	W	B	
5R	5.24	5.05	6.10	6.19	5.76	6.33	6.43	5.81	5.29	5.76	5.38	6.00	5.73
5YR	5.19	4.76	5.95	6.52	6.28	6.48	6.47	5.86	5.09	5.86	5.86	6.05	5.86
10Y	3.91	3.81	5.34	5.29	6.57	6.19	5.38	4.52	4.67	5.00	5.76	5.76	5.18
10GY	4.09	3.91	5.38	6.33	6.14	6.19	5.43	5.28	5.43	5.86	4.76	5.29	5.34
5G	4.67	4.10	5.43	6.19	6.05	6.14	5.52	5.00	5.67	6.00	4.95	5.43	5.43
10G	4.57	3.90	5.52	6.48	5.67	6.62	6.05	5.52	5.19	6.09	4.52	5.38	5.46
5B	4.90	4.48	6.14	5.95	6.29	6.29	5.52	4.91	5.81	6.24	6.00	5.57	5.68
5PB	4.81	3.86	6.72	6.76	7.57	6.81	6.19	5.24	6.33	5.76	6.57	5.81	6.04
10P	5.19	5.12	5.86	6.09	7.14	6.76	6.33	5.55	5.72	6.05	6.14	6.38	6.03
5RP	5.62	4.95	6.52	6.43	6.52	6.28	5.95	5.05	6.43	6.29	6.28	6.33	6.05
Average	4.82	4.39	5.90	6.22	6.40	6.41	5.93	5.27	5.56	5.89	5.62	5.80	5.68

Table 16. Pleasantness ratings of Americans, Indians,
and Nigerians for different lightness
averaged across white and black backgrounds.

Hue	Low Value			Medium Value			High Value			Average
	3/			5/			7/			
	Amr	Ind	Nig	Amr	Ind	Nig	Amr	Ind	Nig	
5R	5.35	4.57	5.15	5.18	5.42	6.15	4.91	5.95	6.05	5.41
5YR	4.62	4.74	4.98	5.13	5.22	6.24	5.28	6.03	6.38	5.40
10Y	3.76	4.19	3.86	3.97	4.95	5.32	4.44	5.60	6.38	4.72
10GY	4.04	4.28	4.00	5.20	5.17	5.86	4.95	5.93	6.17	5.07
5G	4.56	4.52	4.39	5.08	5.43	5.81	5.08	6.27	6.10	5.25
10G	4.40	3.99	4.24	5.05	5.45	6.00	4.97	6.05	6.15	4.46
5B	4.89	4.75	4.69	5.72	5.93	6.05	5.87	6.47	6.29	5.63
5PB	5.26	4.64	4.34	6.07	5.95	6.74	5.97	6.70	7.19	5.87
10P	5.09	4.68	5.16	5.34	5.25	5.98	5.14	6.72	6.95	5.59
5RP	5.00	4.34	5.29	5.28	5.42	6.48	5.34	5.92	6.40	5.50
Average	4.71	4.42	4.62	5.20	5.44	6.03	5.19	6.16	6.40	5.29

Table 17. Pleasantness ratings of Americans, Indians,
and Nigerians for different chromas
averaged across white and black backgrounds.

Hue	Low Chroma			Medium Chroma			High Chroma			Average
	/2			/6			/8			
	Amr	Ind	Nig	Amr	Ind	Nig	Amr	Ind	Nig	
5R	5.80	5.67	6.12	5.43	4.95	5.53	5.37	5.32	5.69	5.54
5YR	4.59	5.62	6.17	5.25	5.30	5.48	5.24	5.07	5.96	5.41
10Y	4.14	5.37	4.95	4.08	4.77	4.84	3.95	4.77	5.76	4.74
10GY	4.38	4.92	5.36	4.78	5.27	5.65	5.03	5.20	5.03	5.07
5G	4.52	5.25	5.26	5.35	5.60	5.84	4.86	5.37	5.19	5.25
10G	4.28	4.84	5.79	5.05	5.43	5.64	5.08	5.22	4.95	5.14
5B	4.75	5.30	5.22	5.81	5.82	6.03	5.93	5.87	5.79	5.61
5PB	5.48	5.34	5.72	6.07	5.90	6.05	6.43	6.05	6.19	5.91
10P	5.17	5.50	5.94	5.50	5.57	5.89	5.30	5.58	6.26	5.63
5RP	4.70	5.00	5.50	5.42	5.30	6.36	5.50	5.37	6.31	5.50
Average	4.55	5.26	5.60	5.27	5.39	5.73	5.28	5.38	5.73	5.38

under different conditions of lightness and chroma. Table 18 shows the means of lightness and chroma for ten hues obtained by Helson and Lansford. Table 19 shows the means of lightness and chroma averaged across all hues and the national groups. It can be seen that the combination of high lightness 7/ with all the other chromas has a higher rating than the other lightness-chroma combinations. The means of lightness averaged across all hues and backgrounds for Americans, Indians, and Nigerians as compared to Helson are shown in Table 20. Americans gave higher ratings to both medium and high value(lightness), 5/ and 7/ with means of 5.20 and 5.19 which closely compares with Helson means of 5.30 and 5.38. The average ratings of Indians and Nigerians for high lightness(7/) are 6.16 and 6.40.

The means of chromas averaged across all hues, backgrounds, and the national groups are shown in Table 21. The mean ratings for medium and high chromas (/6, /8) are 5.27 and 5.28 for Americans, 5.39 and 5.38 for Indians, 5.73 and 5.73 for Nigerians compared to Helson 5.41 and 5.35. There is almost no difference between these two chromas for all the groups.

Table 22 shows the overall ratings of the ten hues for the three groups compared to Helson averaged across all lightness, chromas, and backgrounds. The pleasantness ratings for white and black backgrounds averaged across all lightness, chromas, and hues are shown in Table 23. All the groups gave higher rating to the white background.

Table 18. Pleasantness ratings for different lightness
and chromas(Helson and Lansford,1970).

Hue	Low V 3/	Med V 5/	High V 7/	Low C /2	Med C /6	High C /8	Average
5R	5.26	5.33	4.78	4.69	5.35	5.33	5.12
5YR	4.67	5.21	5.40	4.71	5.29	5.28	5.09
10Y	3.79	4.07	5.15	4.30	4.48	4.21	4.33
10GY	4.16	5.03	5.25	4.45	4.87	5.12	4.81
5G	4.64	5.64	5.30	4.73	5.73	5.13	5.22
10G	4.51	5.16	4.88	4.54	5.05	4.96	4.86
5B	5.01	5.73	6.03	4.97	5.85	5.95	5.59
5PB	5.41	6.04	5.95	4.88	6.23	6.29	5.80
10P	5.26	5.42	5.50	5.03	5.59	5.56	5.39
5RP	5.09	5.46	5.54	4.84	5.54	5.71	5.36
Average	4.79	5.30	5.38	4.71	5.41	5.35	5.16

Table 19. Average pleasantness ratings of object
 colors in low, medium, and high lightness
 and chromas across all the national groups.

Chroma	Low Value 3/	Med. Value 5/	High Value 7/
Low Chroma /2	4.03	5.32	6.06
Med. Chroma /6	4.83	5.66	5.90
High Chroma /8	4.91	5.69	5.80

Table 20. Average pleasantness ratings of object colors in low, medium, and high lightness for the three national groups and Helson.

	Low Value	Med. Value	High Value
Nationality	3/	5/	7/
Americans	4.71	5.20	5.19
Indians	4.43	5.44	6.16
Nigerians	4.62	6.03	6.40
Helson	4.79	5.30	5.38

Table 21. Average pleasantness ratings of object colors in low, medium, and high chromas for the three national groups and Helson.

	Low Chroma	Med. Chroma	High Chroma
Nationality	/2	/6	/8
Americans	4.55	5.27	5.28
Indians	5.26	5.39	5.38
Nigerians	5.60	5.73	5.73
Helson	4.71	5.41	5.35

Table 22. Average pleasantness ratings of ten color families across the two backgrounds.

	Americans		Indians		Nigerians		Helson	
Hue	Rating	Rank	Rating	Rank	Rating	Rank	Rating	Rank
5R	5.20	4.5	5.24	6	5.76	5	5.12	6
5YR	5.02	6	5.33	5	5.86	4	5.09	7
10Y	4.06	10	4.97	10	5.18	10	4.33	10
10GY	4.73	9	5.13	9	5.34	9	4.81	9
5G	4.91	7	5.41	4	5.43	8	5.22	5
10G	4.80	8	5.16	8	5.52	7	4.86	8
5B	5.49	2	5.66	2	5.68	6	5.59	2
5PB	5.76	1	5.76	1	5.99	3	5.80	1
10P	5.19	5	5.55	3	6.03	2	5.39	3
5RP	5.20	4.5	5.22	7	6.06	1	5.36	4

Table 23. Average pleasantness ratings of white and black backgrounds for the three national groups and Helson.

Nationality	White Background	Black Background
	N 8/	N 2/
Americans	5.11	4.97
Indians	5.41	5.28
Nigerians	5.71	5.66
Helson	5.16	5.16

The analysis was done using the general linear models procedure with subj(nat) as an error term as shown in Table 24. All the main effects proved to be significant at the .05 level. Differences between the nationalities was found to be marginally significant. Table 25 shows the probability differences of the three lightness(values) with each of the three national groups. The effects are found to be significant at 0.05 level.

The probability of significant differences in chromas(saturation) between Americans, Indians, and Nigerians are shown in Table 26. The probabilities for the two backgrounds and the three groups can be seen in Table 27. Both the backgrounds are found to be significantly different.

The Duncan's test on the three national groups shows that they are significantly different from each other. They have overall mean ratings of 5.68 for Nigerians, 5.34 for Indians, 5.04 for Americans as compared to Helson 5.16. The Duncan's test for ten hues is shown in Table 29 with 5PB being the highest rated color(5.83) lowest being components of Y.

Lightness with 7/ has been rated highest with a mean of 5.92 followed by 5/ and 3/ and all the three are significantly different as shown in the Duncan's test of Table 30. Tables 31 and 32 show the Duncan's test for chroma and background. No differences were found between /6 and /8 chromas. Significant differences were found between the two backgrounds. The white background emerged as the best with mean of 5.41.

Table 24. Statistical General linear model for nationality, background, hue, lightness, and chroma with subj(nat) as an error term.

Alpha = 0.05

Source	df	Type IV SS	F	PR > F
Nationality*	2	403.34	2.71	0.0818
Hue	9	473.19	22.32	0.0001
Lightness	2	1720.92	365.33	0.0001
Chroma	2	123.18	26.15	0.0001
Background	1	14.22	6.04	0.0140
Nat*Hue	18	128.60	3.03	0.0001
Nat*L	4	445.81	47.32	0.0001
Nat*C	4	115.05	12.21	0.0001
Nat*Bgr	2	3.20	0.68	0.5069
Hue*L	18	154.52	3.64	0.0001
Hue*C	18	197.81	4.67	0.0001
Bgr*Hue	9	26.21	1.24	0.2667
Bgr*L	2	49.18	10.44	0.0001
Bgr*C	2	9.47	2.01	0.1341

** Subj(Nat) as an error term.

Table 25. Probability differences in low, medium, and high lightness(value) for Americans, Indians and Nigerians.

Alpha = 0.05

Nationality	Lightness	Americans			Indians			Nigerians		
		3/	5/	7/	3/	5/	7/	3/	5/	7/
Americans	3/				.0024			.234		
	5/					.0024			.0001	
	7/						.0001			.0001
Indians	3/	.0024						.1734		
	5/		.0024						.1534	
	7/			.0001						.0100
Nigerians	3/	.2343			.1734					
	5/		.0001			.0001				
	7/			.0001			.0100			

Table 26. Probability differences in low, medium, and high chromas for Americans, Indians, and Nigerians.

Nationality	Chroma	Americans			Indians			Nigerians		
		/2	/6	/8	/2	/6	/8	/2	/6	/8
Americans	/2				.0001			.0001		
	/6					.1155			.0001	
	/8						.0773			.0001
Indians	/2	.0001						.0017		
	/6		.1155						.0004	
	/8			.0773						.0012
Nigerians	/2	.0001			.0017					
	/6		.0001			.0004				
	/8			.0001			.0012			

Table 27. Probability differences in the white and black backgrounds for Americans, Indians, and Nigerians.

Nationality	Background	Americans		Indians		Nigerians	
		Black	White	Black	White	Black	White
Americans	Black			.0001		.0001	
	White				.0001		.0001
Indians	Black	.0001				.0001	
	White		.0001				.0008
Nigerians	Black	.0001		.0001			
	White		.0001		.0008		

Table 28. Duncan's test on Americans, Indians,
Nigerians, and Helson.

Means with the same letter are not significantly
different.

Alpha = 0.05

Grouping	Mean	N	Nationality
A	5.68	180	Nigerians
B	5.34	180	Indians
C	5.16	180	Helson
D	5.04	180	Americans

Table 29. Duncan's test on hue differences.

Grouping		Mean	N	Hue
	A	5.84	54	5PB
	B	5.61	54	5B
C	B	5.59	54	10P
C	B	5.49	54	5RP
C	D	5.40	54	5YR
C	D	5.40	54	5R
E	D	5.25	54	5G
E		5.16	54	10G
E		5.06	54	10GY
	F	4.74	54	10Y

Table 30. Duncan's test on lightness(value) of
object colors.

Grouping	Mean	N	Lightness
A	5.92	180	7/
B	5.56	180	5/
C	4.59	180	3/

Table 31. Duncan's test on chroma(saturation)
of object colors.

Grouping	Mean	N	Chroma
A	5.46	180	/8
B	5.46	180	/6
C	5.14	180	/2

Table 32. Duncan's test on white and black backgrounds.

Grouping	Mean	N	Background
A	5.41	270	White
B	5.30	270	Black

DISCUSSION

The chief single factor responsible for pleasant color harmonies was found to be lightness contrast between object and background colors. The greater the lightness contrast, the greater are the chances of good color combinations.

While the pleasantness of object colors depends not only upon their own particular dimensions(hue, chroma, and value), but also on illuminants and the backgrounds on which they are viewed, a color that receives a high average rating over a large variety of viewing conditions will more likely to be acceptable than one that has a low average rating. It should be noted that some of the average ratings are bunched rather closely, and the differences between them probably have little practical significance as such, although they are statistically significant owing to the large number of observations on which each average is based.

Hue

Consistently pleasant object colors have hues in the green to blue to purple range. Consistently unpleasant colors for objects have hues between yellow and yellowish green. The lowest rated hues in all the three groups were 10G, 10GY, and 10Y. The highest rated colors for all the three national groups are 5PB and 5B (Table 29). It is again proven that blue is a universal color and has a very wide preference.

In grouping colors into color families, differences in lightness(Munsell value), saturation(Munsell chroma), and colors of background are confounded as shown in Table 22. Taking the top three rankings, B, PB, and 10P emerged as the best for both Indians and Americans. The preference for Nigerians shows that the first three highest rated colors are components of P. They also tend to prefer red components in them because in the top five rankings three have components of red(5RP, 5R, and 5YR).

Nigerians gave highest rating to all the hues compared to the other two national groups. The overall rating for the groups are 5.68(Nigerians), 5.34(Indians), and 5.05(Americans). These are significantly different(Table 28). These values are means of seven, ten, and eighteen subjects with each subject recording a total of 180 observations.

The same hues between the three groups also proved to be significantly different. The Duncan's test (Table 29) shows that the lowest rated color components of G and Y are significantly different from other colors. 5PB and 5B are the highest rated colors with means of 5.84 and 5.61, when averaged across all the groups. Thus the hue preferences of Americans, Indians, and Nigerians agree with Helson and Lansford findings.

Chroma

Differences were not found between medium and high chromas(/6 and /8) for the three national groups. The mean

ratings are 5.27 and 5.23 for Americans, 5.39 and 5.38 for Indians, 5.73 and 5.73 for Nigerians, 5.41 and 5.35 for Helson (Table 21). Americans and Indians for all the three chromas preferred the white background, whereas Nigerians preferred the black background for medium and high chromas. Low chroma colors were least preferred by all the three groups. Americans preferred hues with high chroma giving these colors highest rating with a mean of 6.43 for 5PB.

There is a contrast for Americans preferring colors with high chroma (saturation) than low chroma with overall mean ratings of 5.5 and 5.14. Indians and Nigerians preferred high lightness colors over high chroma with overall mean ratings of 5.92, 6.48 and 5.5 and 5.14. The probability differences in low, medium, and high chromas for the three groups are significantly different except for /6 and /8 chromas for Nigerians X Americans and Americans X Indians (Table 26). Duncan's test shows that /6 and /8 chromas are not significantly different.

Thus Americans prefer high saturated colors, whereas Indians and Nigerians prefer low saturated (chroma) colors which is a significant contrast between the three national groups.

Value

Looking at Table 13 for Americans it appears that colors low in value (3/) are more acceptable on light (high

value, 7/) backgrounds, while colors high in value(7/) are more acceptable on dark backgrounds. According to this principle, colors of medium lightness should go well with either light or dark backgrounds and this is often the case since there is not much difference between the ratings of white and black backgrounds for medium value (lightness) for the three national groups(Tables 13 - 15). For high value colors the black background(2/) is preferred.

All the three national groups gave overall highest rating to high value colors. Low lightness and chroma colors were least preferred by all the groups with means of 4.59 and 5.14. A striking difference has been found for Indians and Nigerians over Americans as they preferred colors with high value(lightness) on both the backgrounds.

The probability differences in low, medium, and high lightness(value) for the three groups were found to be significant except for 3/ value between Americans X Nigerians and Nigerians X Indians(Table 25). Duncan's test shows that all the three values are significantly different(Table 30).

Thus lightness is a very important factor in determining the color preferences. Indians and Nigerians preferred colors with high value(lightness) over high chroma for Americans. The results obtained for Americans closely correlate with Helson for lightness (Table 20).

Background

The importance of background color in determining the pleasantness of object colors appears very clearly in differences between ratings in columns of Table 33. For high values and chromas Nigerians preferred the low-value (lightness) black background. Similarly Indians preferred the black background at higher values, though the difference is only marginal.

Americans and Indians rated white background higher for high chromas. All the three national groups preferred the white background with mean ratings of 5.11 (Americans), 5.41 (Indians), and 5.71 (Nigerians). The overall mean ratings for white and black backgrounds are 5.41 and 5.30, which are significantly different. From Table 24 it can be seen that Nationality X Background and Background X Hue effects were not found to be significant. Duncan's test shows that the two backgrounds are significantly different (Table 32).

Lightness Contrast

The most striking fact to emerge from the data in Tables 7 - 18 is the decisive role of lightness contrast between object and background colors in the pleasantness of object colors. From the above tables it is clear that the most pleasant combinations involve large lightness differences, and the least pleasant combinations involve little or no lightness differences between object and

Table 33. Pleasantness ratings of Americans
Indians, and Nigerians in different
lightness and chromas for white and black
backgrounds.

Nationality	3/ Low Value		5/ Med. Value		7/ High Value		/2 Low Chroma		/6 Med. Chroma		/8 High Chroma	
	W	B	W	B	W	B	W	B	W	B	W	B
Americans	4.86	4.53	5.24	5.16	5.19	5.20	4.83	4.51	5.35	5.19	5.34	5.20
Indians	4.64	4.29	5.48	5.34	6.14	6.18	5.37	5.19	5.50	5.28	5.40	5.36
Nigerians	4.82	4.39	5.90	6.22	6.40	6.41	5.93	5.27	5.56	5.89	5.62	5.80

background colors. This firmly establishes the results obtained by Helson and Lansford. It can be seen from Table 33 that colors low in value prefer white background (high value).

Thus lightness contrast is the single most important factor in determining the pleasantness of object colors for all the national groups which again correlates with Helson findings.

Sex

Only six (American) females participated in the experiment. It did not seem appropriate to determine the differences in hue, background, lightness, and chroma with data coming from such a small sample. No female subjects participated from India and Nigeria.

The overall rating of the subjects about the experiment by the subjects was relaxing, mildly interesting, and easy. Some of the subjects thought it was bit difficult to give the exact rating to each of the colors. Some of them commented that the rating scale should be narrowed down.

Practical Implications

The study of this experiment evolved one very significant difference. Indians and Nigerians preferred high lightness colors and lighter background. Americans preferred highly saturated colors.

The reason for preferring high lightness colors by Indians and Nigerians might be because they are

dark skinned and to provide contrast they prefer lighter colors. In India a majority of house interiors are white washed(white color). Both Indians and Nigerians come from hot climates. The only viable explanation that could be given for choosing high value colors, maybe because of their high reflectance in those climatic conditions. Highly saturated colors are preferred by Americans, maybe because of their fair skin color.

The new information supplied by this study should be useful to everyone who must choose color combinations - artists, industrial designers, architects, interior designers as well as illuminating engineers. Many industrial products and textiles are exported from one country to the other. Understanding the color preferences of people will go a long way in developing products which are eye pleasing and aesthetically suitable to the people of a particular country. Some products go well with a particular color.

The basic data in the tables can be used in a practical way by looking up the rating in the table most closely approximating the source, object color, and background color used in the viewing situation.

CONCLUSIONS

In general the pleasantness of object colors depends on the interaction of background color, hue, lightness, and chroma of the object color.

1. The results obtained for Americans in terms of hue preference, lightness, chroma, and background closely correlate with Helson and Lansford findings.
2. There was a contrast between the three national groups regarding likings for lightness and saturation of colors as Americans gave higher rating to chromas whereas Indians and Nigerians gave higher rating to lightness.
3. High lightness(values) are preferred to high chroma by Indians and Nigerians whereas Americans preferred highly saturated colors.
4. The hues of the highest rated object colors were the same for Americans and Indians(PB, B, and P components), but Nigerians preferred colors with purple and red components in them(RP, P, R, YR).
5. At high levels of lightness and chroma dark backgrounds are preferred by Americans and Indians, whereas, Nigerians had the same preference for both the backgrounds.
6. Preference is for colors where lightness and chroma have very high values.
7. The overall preference was for the light background.

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DIFFERENCES IN COLOR PREFERENCES

WITH CULTURAL BACKGROUND

by

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ABSTRACT

The objective of the study was to examine the differences in color preferences of three adult national groups(America, India, and Nigeria), with hue, lightness, chroma, and background as the physical parameters.

The experiment was conducted in a booth illuminated by four fluorescent cool white deluxe lamps. Ten hues from the Munsell Book of Color were selected and each hue was represented by nine combinations of lightness and chroma (low, medium, and high). Two neutral backgrounds with lightness of 8/ and 2/ were used. Random sets of 12 colors were exposed and the subjects were required to rate on a scale of nine categories ranging from one for very, very unpleasant, to nine for very, very pleasant. Eighteen subjects from America(U.S.A), ten from India, and seven from Nigeria participated in the experiment. It was found that the results obtained for Americans closely correlated with Helson and Lansford findings. Lightness contrast was the single most important factor in determining the pleasantness of object colors. The most important contrast was Indians and Nigerians preferred high lightness (values) to high chroma whereas Americans preferred highly saturated colors. Hue preference was the same for Americans and Indians(PB, B), but Nigerians preferred colors with purple and red components in them(RP, P, R, YR).