Three estimation types of color scheme preference

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ABSTRACT

The author conducted three experiments in which the impressions of color simulated models and images were evaluated by subjects to confirm the estimation types of color scheme preferences to be applied for each of them. In the first experiment, the streetscape models that consisted of five buildings were evaluated, and the results revealed that the impression of harmony correlates greatly with the impressions of similarity and order. The preference was explained by the impressions of harmony and brightness pertaining to the colors employed in these models. In the second experiment, a model representing the interior of a room, which was presented with variations in the wall and floor colors, was evaluated. The color preferences were explained by the weighted average of preferences for the walls and the floor. In the third experiment, a figure that consisted of characters placed in various backgrounds on an LCD screen was evaluated. The preference correlated largely with the brightness difference of colors pertaining to the characters and their background. These results show that we use different methods for color preference estimations. It implies that we should prepare several color harmony theories to apply to individual color designs.

1. INTRODUCTION

Numerous color harmony theories have been suggested in the past. Since they are a large number to introduce in this paper, the summary provided by D. B. Judd[1] will help us to conclude these theories. He extracted the following four principles from the past theories: (1) principle of order, (2) principle of familiarity, (3) principle of similarity, and (4) principle of unambiguity. The principle of order refers to the usage of colors having equivalent interval on a color system. The principle of familiarity refers to the frequency of colors seen in daily life and their gradation—popular images of reddish evenings and varied leaf greens of woods illuminated by sunshine are introduced as typical examples. The principle of similarity refers to the similarity or commonality of colors. The principle of unambiguity refers to the evident difference between colors, particularly the contrastive color combinations such as white and black or the complementary color combinations.

However, these simple principles are complex in terms of their application to color schemes. For example, it is difficult to prepare color schemes that are both similar and unambiguous because similarity is usually an idea contrary to unambiguity. If the application of these four principles is difficult yet possible, then we should define the conditions under which these principles are valid. This is the objective of this paper

The author conducted three experiments in which the subjects evaluated their impressions of color simulated models or images to confirm the validity of these principles under different conditions. The results show the existence of three estimation types of color combination preferences.

Figure 1: An example of the image shown in Experiment 1.

2. EXPERIMENT 1

The first experiment was already introduced at AIC1997 by the author[2]. The streetscape models consisted of a street with five buildings at 1/100 scale (see Figure 1) which had 84 color patterns to be evaluated. The 84 color patterns included variations in the form of gradation, alternation, certain/similar tone, certain/similar hue, uniformity, divisions of two and three, randomness, etc. A total of 28 subjects evaluated 18 semantic differential scales including order, familiarity, similarity, and unambiguity.

The result shows that the impression of color harmony is largely correlated with the impressions of unity, order, or similarity. A factor analysis of scale model impressions was performed and the result revealed the abovementioned relationship (see Table 1). This result indicates that the principle of similarity is dominant in this model, and it could be said that a similar color scheme should be recommended to obtain color harmony in streetscapes.

Another noteworthy point is that harmony is different from preferences. Preference has a middle-loading pattern of not only factor 1 but also factors 2 and 3. The regression analysis yielded the predicted preference value by using harmony and brightness as explanatory variables. This value correlates with the evaluated value at 0.815. In case unambiguity is added to this analysis, the value increases to 0.846 (although the influence direction of unambiguity to preference is diverse from Judd's principle).

The results of this analysis indicate that streetscapes with similar, bright, and ambiguous (less saturated) building facade colors were preferred.

Table 1: Factor loadings of SD scale ratings of Experiment 1

Scale	Factor 1	Factor 2	Factor 3	Commu-nality
Similarity	0.97	-0.01	-0.02	0.95
Order	0.97	-0.04	0.02	0.94
Unity	0.96	-0.09	0.21	0.96
Organized	0.95	-0.05	0.17	0.94
Regularity	0.94	-0.06	0.05	0.88
Harmony	0.93	0.15	0.26	0.95
Peacefulness	0.81	-0.30	0.38	0.89
Reality of colors	0.68	-0.32	0.46	0.77
Beauty	0.64	0.61	0.23	0.83
Familiarity	0.52	0.57	0.53	0.87
Preference	0.49	0.58	0.48	0.81
Cheerfulness	-0.06	0.97	-0.02	0.94
Brightness	-0.04	0.96	0.10	0.93
Excitement	-0.22	0.85	-0.18	0.80
Warmth	-0.03	0.83	0.10	0.70
Vividness	-0.25	0.79	-0.52	0.95
Unambiguity	-0.07	0.07	-0.95	0.91
Strength	-0.21	-0.08	-0.92	0.90
Factor Contribution(%)	**42.40**	**28.58**	**17.38**	**88.36**

3. EXPERIMENT 2

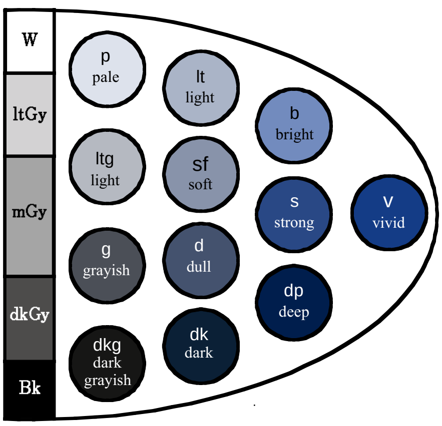
In the second experiment, a 1/10 scale model of an office interior with alterable wall and floor colors (see Figure 2) was built. A total of 27 subjects were shown 16 variations of identical wall and floor colors and 58 variations of different colors for the walls and the floor (all three walls had the same color) in order to evaluate their impressions on SD scales. The variations were based on 20 colors; 6 hues selected from pale, light, and dull tones, and 2 achromatic colors (see Figure 3 for information regarding tones in PCCS).

The preference for the interior with different wall and floor colors was estimated by using the evaluated values of the pattern that had identical wall and floor colors. The predicted preference value yielded by regression analysis using categorical explanatory variables correlates largely with the ratings at 0.93.

$$Proom(c1, c2)= a(wall)*P(c1) + a(floor)*P(c2) + const \quad (1)$$

Proom(): Preference ratings of the rooms which have different wall and floor colors

Figure 2: An example of the image shown in Experiment 2



The tones have been described in accordance with PCCS (Practical Color Coordinate System) proposed by the Japan Color Institute

Figure 3: The explanation of tone.

P(): Preference ratings of the rooms which have identical wall and floor colors
c1, c2: color
a(): coefficient.

This formula shows an estimation type that is different from the one in Experiment 1. Further, it shows the existence of a principle apart from the four principles provided by Judd. It implies the preference of color combinations that employ desirable colors (it roughly implies bright colors). Incidentally, the rating profile of harmony was similar to that of preference.

4. EXPERIMENT 3

In the third experiment, the goodness of color combination of a colored sentence consisted of 20 letters in various colored backgrounds on an LCD screen (see Figure 4) were evaluated. The evaluation sheet was prepared on Microsoft Excel and included 1600 samples selected from 40 character colors displayed by 40 background (cell) colors. The Y, x, y value of colors majored from approximately 0.6 meter from LCD, the subject's face position, are shown in Table 2. The cell measures 180 mm in width and 12 mm in height. The height of the letters (Japanese font "Osaka" written in boldface) was approximately 4 mm. The order of the samples was randomized and divided into four portions during evaluation. Each portion was evaluated by 9 to 12 subjects.

The goodness of color combination correlated with the difference of brightness (Y values in Table 2) primarily between character and background colors. The correlation coefficient between the preference values and Y values is 0.74. This implies that a combination of bright and dark colors is preferable. This is the third estimation type of color preference.

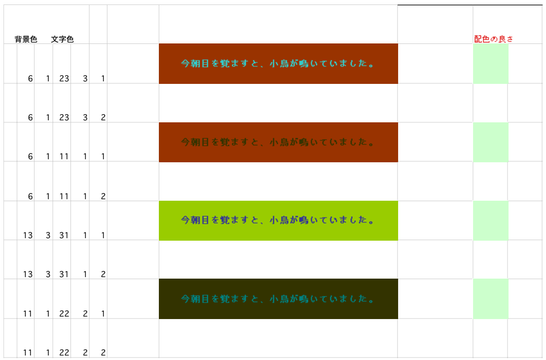


Figure 4: A part of the sample shown in Experiment 3.

Table 2: The 40 colors used in Experiment 3.

Number		Y	x	y	Number		Y	x	y
1		10.3	.333	.348	21		22.2	.237	.256
2		19.8	.473	.348	22		39.9	.238	.312
3		26.3	.499	.355	23		61.7	.244	.313
4		34.6	.364	.236	24		57.1	.217	.267
5		67.0	.314	.293	25		91.1	.280	.315
6		29.3	.439	.397	26		14.0	.207	.154
7		46.4	.454	.414	27		15.2	.191	.130
8		63.0	.426	.444	28		40.9	.218	.206
9		75.2	.406	.464	29		63.2	.219	.281
10		73.1	.332	.347	30		75.3	.262	.283
11		21.3	.363	.419	31		23.9	.240	.217
12		44.1	.348	.373	32		40.1	.270	.269
13		67.5	.367	.486	33		19.1	.240	.165
14		81.6	.394	.475	34		33.0	.335	.280
15		96.8	.324	.365	35		67.0	.277	.259
16		19.1	.317	.431	36		23.5	.307	.326
17		30.1	.293	.437	37		49.0	.295	.316
18		48.8	.275	.367	38		53.0	.297	.318
19		53.5	.302	.480	39		76.9	.293	.313
20		93.4	.293	.339	40		97.7	.294	.315

Although harmony was not evaluated during this experiment, it can be expected to have a tendency identical to the goodness.

5. DISCUSSION

To the best of the author's knowledge, color harmony theories such as those proposed by Moon and Spencer, Ostwald, and Chevreul did not contain any description regarding the applicable range covered by them. Such theories are normative, and hence, the description of harmony is limited to the relationship among colors in the color system. However, the results of the three experiments mentioned above suggest that we need to apply different principles to various settings or objects in the real world.

Two ideas can be supposed when considering what decides the range of a principle to be applied. The first idea associated with an applicable principle depends on the type of the estimated object such as streetscapes, room interiors, characters and their backgrounds. The second one depends on the feature of the object, such as the colors in a straight line, colors which envelop us, color combination of small figures and their background (See Figure 1, 2, 4 again). According to the author, it is likely that the latter idea associated with an applicable principle would be more available given that the variation of the estimation of impression is not dependent on the category of the object but on its features, which were observed in the experiments that have not been included herein. For example, the third experiment mentioned above included an additional experiment in which the characters were replaced with symbols. The result was similar to that of Experiment 3. The difference of brightness in colors is the most contributory variable, even though the coefficient between preference and the difference of brightness is 0.671, which is slightly smaller than that in Experiment 3.

Although it is now evident that the available principles vary in their application to preferences for color combinations, the condition that divides the process of estimation is not sufficiently evident. Furthermore, experiments would be required to clarify this condition.

References

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3. K. Fukuda, Color harmony theories (Asakurashoten, Tokyo, Japan, 1996). (in Japanese)