Recognition of Non-Japanese Custom Color Names: Relation among Distance in Color Space, Familiarity of Color Names, and Imaginableness of Color Names

Yosuke Yoshizawa*, Haruo Hibino**, Shinichi Koyama***

** Chiba University, Department of Science & Engineering , and Design Unit "Evolutional Blue", Japan, yosuke.yoshizawa@gmail.com*
*** Chiba University, Department of Science & Engineering, Japan, hibino@faculty.chiba-u.jp*
**** Chiba University, Department of Science & Engineering, Japan, skoyama@faculty.chiba-u.jp*

Abstract: We examined how custom color names are recognized, using three indices (i.e., the distance in color space between a given standard color of Japanese Industrial Standards (JIS). Furthermore, a principal component analysis revealed that two components, namely, "recognition" and "distance in color space" have 95.3% explainability with respect to the familiarity of color names. This indicates that a color name that consists of one basic color word is more recognizable than any other color and that the color names that consist of two basic color words are more recognizable than those that do not consist of basic color words. We found the distance in color space for color names that contain a basic color word (or words) to be significantly shorter than other color names. This suggests that subjects were able to infer the position of a color in color space using its basic color name(s) even if they did not know the color name.

.

Key words: basic color, CIE L*a*b* color system, familiarity of color names, imaginableness of color names, contain basic color or not, degree of recognition, degree of distance in color space

1. Introduction

In daily life, various colors are used in various situations. In Japan, "color strategies" used for industrial products such as automobiles and mobile phones, and learning for getting licenses of the color for teaching or job increases the value of color.

A color name is used in the communication of color through language. The JIS Z 8102 "Names of non-luminous object colors" provides two methods of such communication through language.

Systematic color names comprise basic colors (e.g., red, yellow, green, blue, purple, etc.) and adjectives (e.g., light, vivid, etc.). Although this method is easy to use, there exists a specific color range and such colors are difficult to reproduce more accurately.

On the other hand, custom color names originate from plants, minerals, regions, etc. If the origin of a color is known, it can be reproduced more accurately than a systematic color. However, if the origin is not known, the color cannot be reproduced accurately.

There also exist cases in which even if a color name and its origin are known, accurate reproduction may not be possible. For example, especially in plants, different petal colors, ripening conditions, or different types may lead to misrecognition against the Japanese Industrial Standards (JIS) as a baseline. Number of Custom color names were added to 269 in 2001. It is uncertain whether they are known well, used accurately, and communicated accurately by everyone. Research has been conducted on the recognition of custom color names (Morita et al. [3][4][5], Okamoto [6], Ishihara [8]).

However, different definitions were provided, and the color distance data was not used adequately. Based on past research, we will define "familiarity of color name," "imaginableness of color name," and "color distance in CIE L*a*b* Space" as indices for color recognition. Colors will be recognized by examining the interrelation among the three indices. This research is conducted to reveal the relation among these indices and to quantify each color recognition.

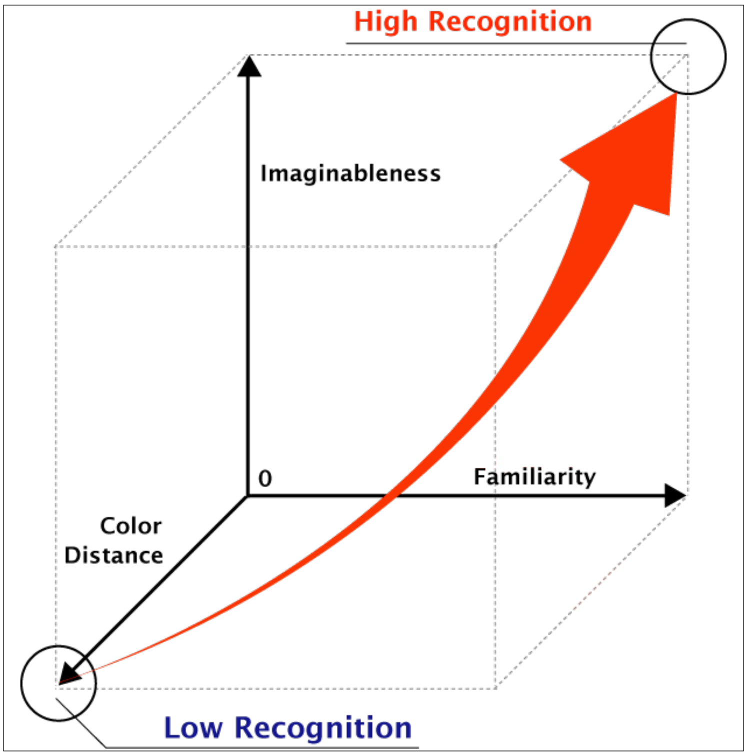

Figure 1 Model of Color Recognition

2. Method

2.1 Color Matching Task

Each subject was given the task of matching color names with the respective colors. Figure 2 shows a related tool. Subjects read a custom color name written on a card and chose a color from 468 color chips. In case they could not match a color with its name, they had to choose a color chip. The Kanyo-shoku chart [1] (Custom Color Chart) and PCCS 201-L [2] were used as color chips. Four hundred and sixty eight colors were attached on the board. White fluorescent lights (FLR 40-S-W/M-x36, by Panasonic, Japan) were used as the source of light and were adjusted at 500lx on the color chips.

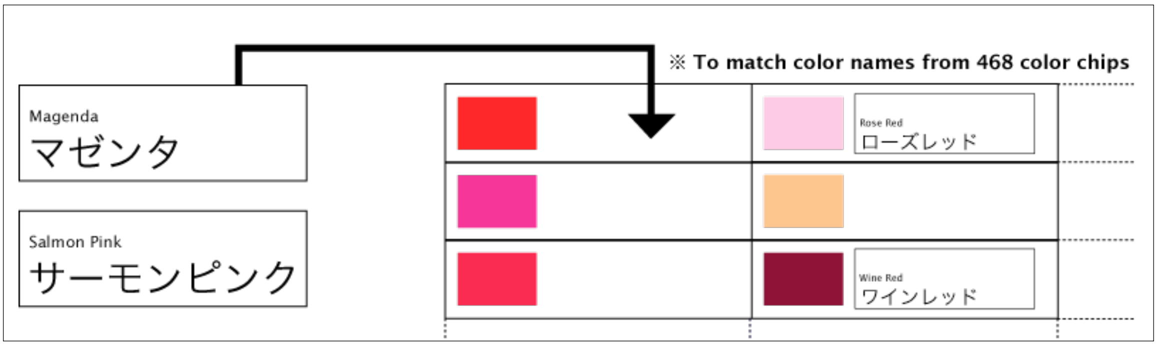

Figure 2 Image of the Color Matching Task

2.2 Questionnaire

In addition to the color matching task, subjects had to answer a questionnaire that tested their knowledge of color names. They had to answer two questions, namely, “Do you know this color name?” and “Can you imagine the color from its name?” If the subjects answered “yes” to the first question, they also had to answer the “Opportunity in Knowing color name.”

2.3 Subjects

Fifty-six Japanese college students participated in this test (30 men and 26 women in the age range of 19–28 years). Of all the subjects, 72.2% belonged to the design section; however, they had little opportunity to study color names in detail.

3. Result

Table 1 shows the results of the average distance in color space “ΔE,” ratio of “familiarity,” ratio of “imaginableness,” and the factorial score obtained from a principal component analysis for each color name. The ratio of “familiarity” represents the ratio of subjects who answered “yes” to the question “Do you know this color name?” and the ratio of “imaginableness” is the ratio of subjects who answered “yes” to the question “Can you imagine a color from its name?”

Table 1 Result of each color name

Custom Color Name	Munsell Notation	Classification	ΔE	Familiarity [%]	Imaginableness [%]	Score from Principle Component	
						z1	z2
Rose Pink	10RP 7/8	b	23.7	67.9	85.7	1.17	0.27
Cochineal Red	10RP 4/12	b	19.9	12.5	21.4	-1.02	-1.20
Ruby Red	10RP 4/14	b	13.6	33.9	78.6	0.75	-0.88
Wine Red	10RP 3/9	b	13.0	96.4	87.5	2.09	0.13
Burgundy	10RP 2/2.5	c	48.3	17.9	10.7	-2.09	0.42
Old Rose	1R 6/6.5	c	32.4	10.7	41.1	-1.07	-0.40
Rose	1R 5/14	c	17.3	76.8	89.3	1.62	0.07
Strawberry	1R 4/14	c	16.8	69.6	92.9	1.58	-0.05
Coral Red	2.5R 7/11	b	32.2	19.6	37.5	-0.97	-0.30
Pink	2.5R 7/7	a	23.0	100.0	98.2	2.04	0.81
Bordeaux	2.5R 2.5/3	c	38.8	44.6	28.6	-0.92	0.41
Baby Pink	4R 8.5/4	b	20.7	46.4	71.4	0.59	-0.32
Poppy Red	4R 5/14	b	12.7	12.5	35.7	-0.48	-1.52
Signal Red	4R 4.5/14	b	8.7	14.3	42.9	-0.17	-1.67
Carmine	4R 4/14	c	39.0	57.1	35.7	-0.56	0.66
Red	5R 5/14	a	11.9	100.0	98.2	2.41	0.19
Tomato Red	5R 5/14	b	10.4	17.9	87.5	0.75	-1.25
Maroon	5R 2.5/6	c	57.6	21.4	10.7	-2.34	0.99
Vermilion	6R 5.5/14	c	59.2	33.9	17.9	-2.02	1.32
Scarlet	7R 5/14	c	25.7	73.2	50.0	0.47	0.25
Terracotta	7.5R 4.5/8	c	41.5	30.4	23.2	-1.38	0.31
Salmon Pink	8R 7.5/7.5	b	22.4	87.5	85.7	1.57	0.50
Shell Pink	10R 8.5/3.5	b	26.3	23.2	48.2	-0.49	-0.51
Nail Pink	10R 8/4	b	27.9	12.5	53.6	-0.63	-0.55
Chinese Red	10R 6/15	b	33.6	25.0	60.7	-0.45	0.01
Carott Orange	10R 5/11	b	21.4	33.9	83.9	0.60	-0.40
Burnt Sienna	10R 4.5/7.5	c	46.3	14.3	7.1	-2.16	0.22
Chocolate	10R 2.5/2.5	c	12.9	73.2	96.4	1.85	-0.19
Cocoa Brown	2YR 3.5/4	b	12.5	44.6	85.7	1.13	-0.72
Peach	3YR 8/3.5	c	26.1	76.8	94.6	1.44	0.60
Raw Sienna	4YR 5/9	c	53.1	8.9	5.4	-2.53	0.51
Orange	5YR 6.5/13	a	16.8	100.0	100.0	2.28	0.47
Brown	5YR 3.5/4	a	15.7	100.0	92.9	2.17	0.36
Aprocpt	6YR 7/6	c	40.6	62.5	62.5	0.04	0.99
Tan	6YR 5/6	c	34.4	21.4	19.6	-1.38	-0.26
Mandarin Orange	7YR 7/11.5	b	22.5	44.6	73.2	0.54	-0.24
Cork	7YR 5.5/4	c	19.1	28.6	64.3	0.18	-0.73
Ecru Beige	7.5YR 8.5/4	c	26.3	7.1	19.6	-1.37	-0.94
Golden Yellow	7.5YR 7/10	b	33.2	37.5	80.4	0.20	0.30
Marigold	8YR 7.5/13	c	21.6	46.4	71.4	0.56	-0.27
Buff	8YR 6.5/5	c	38.4	3.6	3.6	-2.17	-0.41
Umber	8YR 5.5/6.5	c	40.3	26.8	12.5	-1.62	0.11
Bronze	8.5YR 4/5	c	26.1	85.7	87.5	1.45	0.70
Beige	10YR 7/2.5	c	20.0	98.2	91.1	1.96	0.57
Yellow Ocher	10YR 6/7.5	b	32.7	21.4	33.9	-1.03	-0.27
Burnt Umber	10YR 3/3	c	36.0	8.9	10.7	-1.84	-0.42
Sepia	10YR 2.5/2	c	31.6	94.6	85.7	1.39	1.14
Khaki	1Y 5/5.5	c	27.3	85.7	82.1	1.30	0.73
Blond(e)	2Y 7.5/7	c	30.4	91.1	85.7	1.37	1.01
Naples Yellow	2.5Y 8/7.5	b	30.3	10.7	16.1	-1.51	-0.67
Leghorn	2.5Y 8/4	c	40.7	1.8	3.6	-2.28	-0.31
Raw Umber	2.5Y 4/6	c	40.9	8.9	7.1	-2.08	-0.16
Cream Yellow	5Y 8.5/3.5	b	15.8	76.8	85.7	1.60	-0.03
Yellow	5Y 8.5/14	a	6.6	100.0	98.2	2.59	-0.11
Chrome Yellow	3Y 8/12	b	33.0	41.1	46.4	-0.43	0.14
Jaune Brilliant	5Y 8.5/14	c	105.2	8.9	5.4	-4.27	3.44
Canary	7Y 8.5/10	c	33.0	39.3	44.6	-0.50	0.09
Olivedrob	7.5Y 4/2	c	29.9	8.9	10.7	-1.64	-0.76
Olive	7.5Y 3.5/4	c	26.0	78.6	73.2	1.03	0.49
Lemon Yellow	8Y 8/12	b	15.8	92.9	92.9	2.04	0.26
Olive Green	2.5GY 3.5/3	b	31.4	30.4	58.9	-0.31	-0.04

Custom Color Name	Munsell Notation	Classification	ΔE	Familiarity [%]	Imaginableness [%]	Score from Principle Component	
						z1	z2
Chartreuse Green	4GY 8/10	b	64.9	3.6	16.1	-2.80	1.16
Leaf Green	5GY 6/7	b	32.6	44.6	75.0	0.24	0.34
Grass Green	5GY 5/5	b	34.2	23.2	60.7	-0.50	0.01
Sea Green	6GY 7/8	b	62.3	28.6	69.6	-1.16	1.73
Ivy Green	7.5GY 4/5	b	36.3	8.9	26.8	-1.52	-0.30
Apple Green	10GY 8.5	b	30.1	41.1	75.0	0.25	0.15
Mint Green	2.5G 7.5/8	b	21.3	55.4	80.4	0.92	-0.10
Green	2.5G 5.5/10	a	17.5	100.0	100.0	2.26	0.51
Cobalt Green	4G 7/9	b	38.6	53.6	62.5	-0.06	0.74
Emerald Green	4G 6/8	b	21.6	100.0	92.9	1.98	0.70
Malachite Green	4G 4.5/9	b	30.5	19.6	19.6	-1.28	-0.50
Bottle Green	5G 2.5/3	b	31.4	8.9	20.0	-1.50	-0.62
Forest Green	7.5G 4.5/5	b	17.5	26.8	69.6	0.31	-0.82
Viridian	8G 4/6	c	27.6	75.0	57.1	0.59	0.43
Billiard Green	10G 2.5/5	b	26.4	8.9	48.2	-0.75	-0.73
Peacock Green	7.5BG 4.5/9	b	32.3	21.4	21.4	-1.27	-0.36
Nile Blue	10BG 5.5/5	b	33.4	14.3	41.1	-1.04	-0.29
Peacock Blue	10BG 4/8.5	b	29.9	30.4	33.9	-0.77	-0.28
Turquoise Blue	5B 6/8	b	23.8	71.4	66.1	0.83	0.21
Marine Blue	5B 3/7	b	27.0	83.9	78.6	1.21	0.66
Horizon Blue	7.5B 7/4	b	35.8	8.9	19.6	-1.65	-0.38
Cyan	7.5B 6/10	c	31.7	87.5	78.6	1.12	0.99
Sky Blue	9B 7.5/5.5	b	24.2	91.1	89.3	1.65	0.68
Cerulean Blue	9B 4.5/9	b	19.4	48.2	28.6	-0.21	-0.63
Baby Blue	10B 7.5/3	b	20.4	23.2	39.3	-0.48	-0.89
Saxe Blue	1PB 5/4.5	b	24.9	33.9	26.8	-0.69	-0.55
Blue	2.5PB 4.5/10	a	13.0	100.0	98.2	2.37	0.25
Cobalt Blue	3PB 4/10	b	19.7	83.9	64.3	1.16	0.17
Iron Blue	5PB 3/4	b	20.4	10.7	32.1	-0.85	-1.13
Prussian Blue	5PB 3/4	b	28.5	10.7	8.9	-1.60	-0.82
Midnight Blue	5PB 1.5/2	b	24.4	48.2	62.5	0.32	-0.14
Hyacinth	5.5PB 5.5/6	c	39.2	41.1	46.4	-0.63	0.48
Navy Blue	6PB 2.5/4	b	20.3	62.5	64.3	0.75	-0.14
Ultramarine Blue	7.5PB 3.5/11	b	28.4	48.2	46.4	-0.14	-0.01
Oriental Blue	7.5PB 3/10	b	29.6	21.4	30.4	-1.00	-0.46
Wistaria	10PB 5/12	c	48.8	3.6	3.6	-2.52	0.18
Pansy	1P 2.5/10	c	69.7	46.4	58.9	-1.30	2.36
Heliotrope	2P 5/10.5	c	55.9	3.6	0.0	-2.83	0.56
Violet	2.5P 4/11	c	23.7	91.1	91.1	1.71	0.66
Lavender	5P 6/3	c	33.7	82.1	83.9	1.06	1.04
Mauve	5P 4.5/9	c	44.7	16.1	7.1	-2.08	0.16
Lilac	6P 7/6	c	50.4	30.4	12.5	-1.90	0.74
Orchid	7.5P 7/6	c	52.0	16.1	3.6	-2.40	0.55
Purple	7.5P 5/12	a	19.5	98.2	94.6	2.05	0.56
Magenta	5RP 5/14	c	31.0	91.1	80.4	1.24	1.01
Cherry Pink	6RP 5.5/11.5	b	21.6	42.9	73.2	0.54	-0.31
Rose Red	7.5RP 5/12	b	21.6	57.1	85.7	1.05	-0.02
White	N 9.5	a	0.7	100.0	98.2	2.78	-0.44
Snow White	N 9.5	b	2.5	71.4	85.7	1.95	-0.87
Ivory	2.5Y 8.5/1.5	c	29.5	85.7	66.1	0.90	0.76
Sky Gray	7.5B 7.5/0.5	b	18.0	30.4	69.6	0.36	-0.73
Pearl Gray	N 7	b	12.7	19.6	50.0	-0.06	-1.32
Silver Gray	N 6.5	b	10.2	26.8	58.9	0.34	-1.30
Asdh Gray	N 6	b	13.6	57.1	62.5	0.84	-0.61
Rose Gray	2.5R 5.5/1	b	23.7	5.4	39.3	-0.91	-0.99
Gray	N 5	a	9.4	100.0	98.2	2.49	0.05
Steel Gray	5P 4.5/1	b	13.5	14.3	51.8	-0.15	-1.35
Slate Gray	2.5PB 3.5/0.5	b	21.4	8.9	26.8	-1.02	-1.14
Charcoal Gray	5PP 3/1	b	19.2	60.7	50.0	0.46	-0.31
Lamp Black	N 1	b	7.8	10.7	28.6	-0.50	-1.87
Black	N 1.5	a	2.4	100.0	98.2	2.73	-0.35

Classification

a. Basic Color Name (Based on 11 basic colors by Berlin & Kay [9]) / b. Color Name included basic color word / c. Color Name non-included basic color word

3.1 Relation among the three indices

3.1.1 Relation between familiarity and imaginableness

Ishihara indicated the degree of "knowing" and "expressing" a color from its name in the questionnaire, but did not indicate the relation between the two [8]. If the relation was indicated, this will be revealed, and different tendency of the relation may be grasped by color name included basic color word of not. This relation was shown in Figure 3. In the result, a strong correlation was shown between these two indices ($r = 0.832$, $p < 0.0001$). This implies that if the color name is known, there will be a tendency to imagine a color from its name. Further, Figure 3 showed the difference in imaginableness when a basic color word is included and when it is not, in a low degree of familiarity. Therefore, ANCOVA was held in less than 50% familiarity of the color name. In the result, "color name that includes a basic color" was significantly lower than "color name that did not include a basic color word" in the degree of imaginableness (Parallel test: $F[1,71] = 0.026$, $p = 0.8735$; Comparison: $F[1,72] = 34.450$, $p < 0.0001$). This suggests that the existence of a basic color word in a color name is used as a cue by subjects.

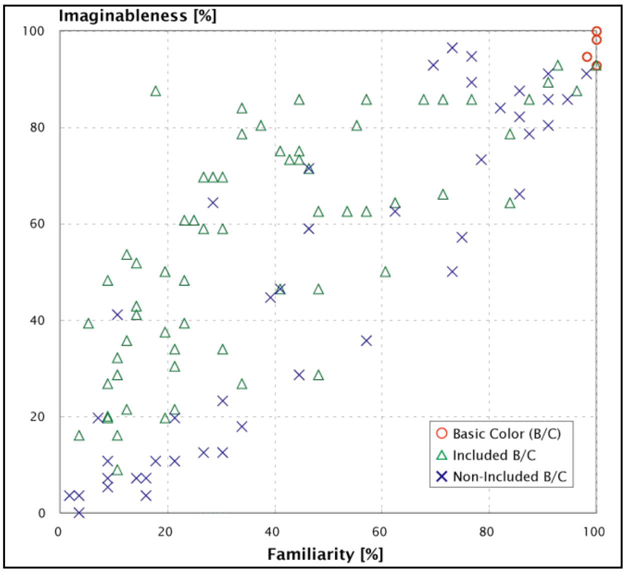

Figure 3 Relation between Familiarity & Imaginableness

3.1.2 Relation between familiarity and color distance

Past research has not clearly delved upon the relation between reproduction and familiarity. Therefore, we showed this relation objectivity. This relation is shown in Figure 4. From this, a middle negative correlation was shown ($r = -0.422$, $p < 0.0001$). Figure 4 showed the difference in familiarity when a basic color word was included and when it was not, in low color distance. Therefore, ANCOVA was held same as in 3.1.1. In the result, "color name that includes a basic color" was significantly lower than "color name that did not include a basic color" in the degree of color distance (Parallel test: $F[1,71] = 0.035$, $p = 0.8531$; Comparison: $F[1,72] = 30.628$, $p < 0.0001$). This suggests that the existence of a basic color name helps in deciding the color even if the color name is not known. As a result, color distance in a color name that included a basic color word was lower than that without a basic color word.

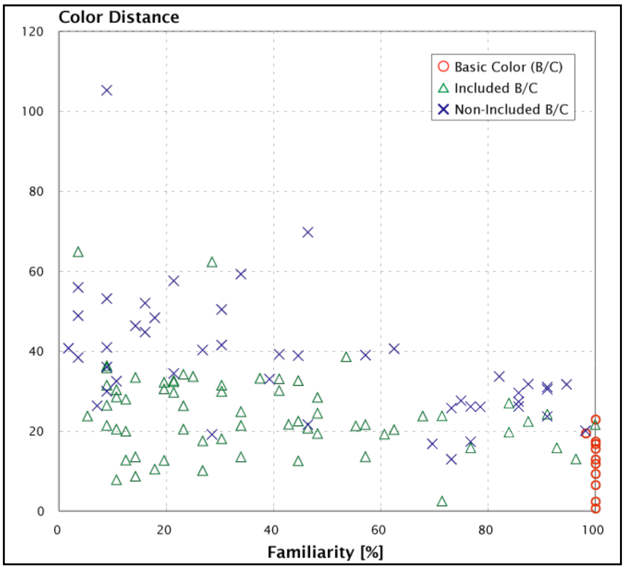

Figure 4 Relation between Familiarity & Color Distance

3.1.3 Relation between imaginableness and color distance

Similar to 3.1.2, the relation between the degree of imaginableness and color distance is shown in Figure 5. Figure 5 shows a somewhat strong correlation between these two indices ($r = -0.593$, $p < 0.0001$). Further, ANCOVA showed that the "color name that includes a basic color word" is lower than the "color name that did not include a basic color word" in color distance (Parallel test: $F[1,51] = 0.195$, $p = 0.6604$; Comparison: $F[1,52] = 9.241$, $p = 0.0037$). This suggests that the existence of a basic color word in a color name as a cue helps in deciding the color despite low imaginableness.

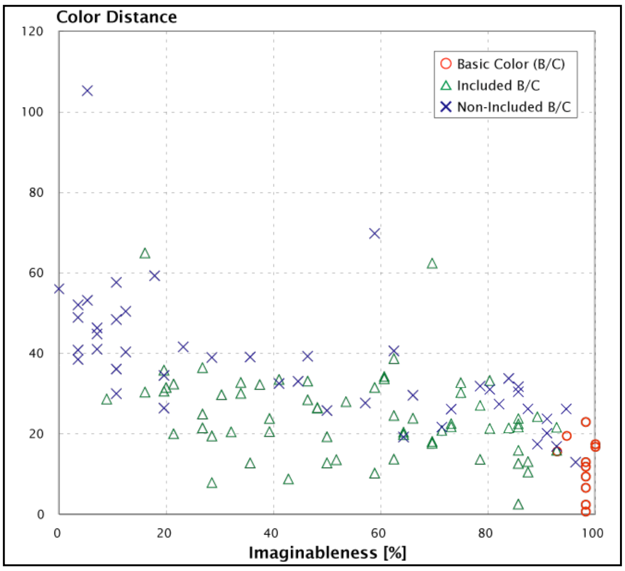

Figure 5 Relation between Imaginableness & Color Distance

3.2 Principle component analysis to acquire two new indices

Color recognition was delved upon in previous researches; however, each of them used only two indices, namely, familiarity and imaginableness or color reproduction data. In section 3.1 in this research, we evaluated the correlation among the three indices, and had a judgment of possibility in the quantitative evaluation of color recognition using the principle component analysis with three indices.

3.2.1 Comparison between the color name that included a basic color word and that which did not

The result of the principle component analysis with correlation matrix is shown in Table 2. As a result, three principle components were extracted. The first component had a 74.9% contribution value, and a combination of the first and the second component had a 95.3% value.

Table 2 Relation between imaginableness & color distance

Component Score		z1	z2	z3
Eigenvalue		2.246	0.611	0.142
Eigenvector	Color Distance	-0.501	0.839	0.212
	Familiarity	0.591	0.510	-0.624
	Imaginableness	0.632	0.187	0.752
Factrial load value	Color Distance	-0.750	0.656	0.080
	Familiarity	0.886	0.399	-0.235
	Imaginableness	0.948	0.146	0.283
Proportion		0.749	0.204	0.047
Cumulation Proportion		0.749	0.953	1.000

From eigenvectors in the first principle component, low color distance, knowing the color name, and imaginableness from it increased the z1 value, and this is interpreted as the recognition index. From the second principle component, all the three eigenvectors were positive, but resulted in the calculation of specific gravity in eigenvector, i.e., 54.6% in color distance, 33.2% in familiarity, and 12.2% in imaginableness. Although it must be considered that the specific gravity in familiarity was lower than that in color distance, the misrecognition tendency is observed in the case of knowing the color name and large color distance; otherwise, component score z2 tended to be negative in the case of not knowing the color name or not imagining from a color name, but little color distance. Therefore, the second principle component is interpreted as the degree of distance in color space. The principle component scores z1 and z2 calculated for each color name are placed on a coordinate (Figure 6). The scores for each color are listed in Table 1 on page 4.

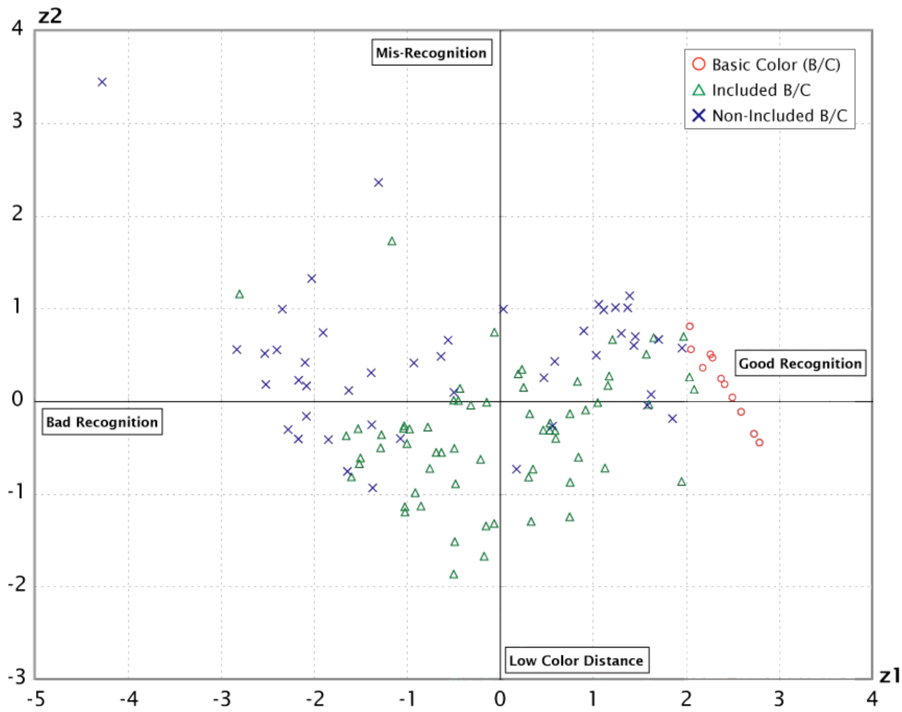

Figure 6 Relation between Imaginableness & Color Distance

3.2.2 Comparison of principle score among three groups

To ascertain the difference in the degree of recognition or distance in color space between color names that included a basic color word and those that did not, we conducted ANOVA. Figure 7 shows the result of z1 as the degree of recognition using ANOVA. The group of basic color name was significantly higher than that of names that included a basic color word and of names that did not ($F[2,119] = 23.047$, $p < 0.0001$). Further, Figure 8 shows the result of z2 as the degree of distance in color space using ANOVA. The group of color names that did not include a basic color word was significantly higher than that of names that included a basic color word. From this result, it is possible to interpret that imagining from color name can be accurate even if the color name is not known. Based on these results and Figure 6, since the basic color names were positive on z1 as recognition, they had a tendency to be better. Color names that include basic color names are negative on z2 with respect to the degree of distance in color space and wide range distribution on z1. Thus, there was a possibility that colors were chosen without the knowledge of their names. Color names that did not include a basic color word had a larger range on z1 than those that included a basic color word; however, this may depend on the existence of a basic color word.

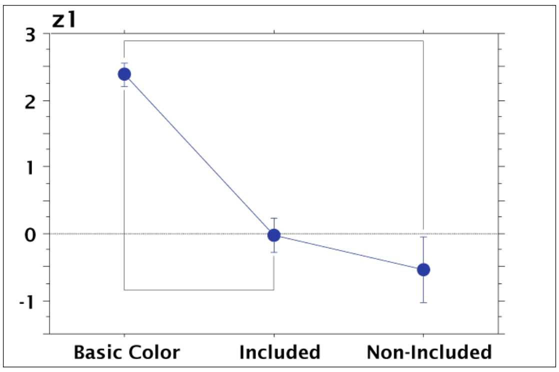

Figure 7 z1 Comparison among Three Groups

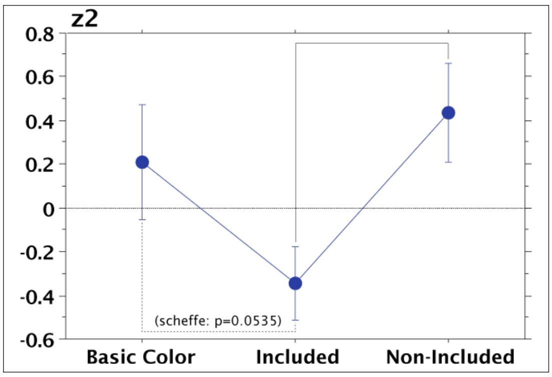

Figure 8 z2 Comparison among Three Groups

4. Summary

We conducted research on the relation among three indices, namely, familiarity, imaginableness, and color distance, in order to calculate color recognition objectively. The results obtained are as follows.

1. A strong positive correlation was observed between familiarity and imaginableness in color names. Imaginableness in color names that included a basic color was significantly higher than in those that did not include one.
2. A middle negative correlation was observed between familiarity and color distance in the color matching task.
3. A somewhat negative correlation was observed between imaginableness and color distance.
4. Color distance in color names that included a basic color word was significantly lower than in those that did not include in less than 50% familiarity or imaginableness.
5. From the principle component analysis, two principles were extracted (z1 as the degree of recognition; 74.9%, z2 as the degree of distance in color space; 20.4%; the total was 95.3%).
6. In the principle score of z1 as the degree of recognition, the group of basic colors was higher than that of color names that included and those that did not include a basic color word.
7. In the principle score of z2 as the degree of distance in color space, the group of color names that did not include a basic color word was significantly higher than those that included a basic color word (significant tendency from $p = 0.0535$ of Scheffe's p-value). This implies that color names that included a basic color word tended to be chosen from color names depending on the basic color word.

Since only college students participated in this research, there exists the possibility that the results will change depending on generation, sex, profession, nationality, etc. Therefore, we need to increase the attribution of subjects and compare them as well.

5. References

[1] JIS Hnadbook 2007 61. Color, p193

[2] Kunio Fukuda: Iro no Namae 507, Shufunotomo Sha Co. Ltd. (2007)

[3] Machiko Morita, Sachiko Kagawa: The Recognition of Color Names (Part 1): By Female University Students, Journal of the Color Science Association of Japan 13(3) pp.206–218 (1989)

[4] Sachiko Kagawa, Machiko Morita: The Recognition of Color Names (Part 2) Influence by Difference between Generations, Journal of the Color Science Association of Japan 14(3) pp.162–171 (1990)

[5] Machiko Morita, Sachiko Kagawa: The Recognition of Color Names (Part 3): Influence by Sex, Journal of the Color Science Association of Japan 17(1) pp.1–12 (1993)

[6] Ayako Okamoto: An Analysis of the sensible colors and the discernment about Japanese Traditional Accustomed Colors, Journal of Chikushi Jyogakuen Junior College 40 pp.17–38 (2005)

[7] Ayako Okamoto: An Analysis of the Discernment about Japanese Traditional Accustomed Colors and the Continuance, Journal of Chikushi Jogakuen University and Junior College 1 pp.285–304 (2006)

[8] Hisayo Ishihara: On Student's Concept of Conventional Names of Colors, Journal of Nagoya Women's University. Home Economics Natural Science 40 pp.23–31 (1994)

[9] Berlin & Kay: Basic Color Terms: Their Universality and Evolution. Univ. of California. Press (1969)

[10] Genro Kawakami, Akira Kodama, Naoshi Tomiie, Noboru Ota: Shikisai no Jiten, Asakura Publishing Co., Ltd., p127 (1999)

[11] Shikisai One-point 4. Iro no Arawashi-kata to Tsukai-kata (How to express & use colors), Japan Color Research Institute.

[12] Shikisai One-point 10. Iromei to Sono Episodo (Color Name and its Episode), Japan Color Research Institute.

1 Kanyo-Shoku (Custom Color) Chart (Japan Color Enterprise Co. Ltd.)

There are 269 custom color chips based on JIS Z 8102:2001 in this chart. In this test, 267 colors except "Kin (Gold)"and "Gin (Silver)" were used in the experiment.

2 PCCS 201-L (Japan Color Research Enterprise Co. Ltd.)

These charts are based on the Practical Color Co-ordinate System (PCCS) color system and consist of 201 colors. In this test, all the colors are shown to subjects.