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Korean Society of Color Studies
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Dear colleagues,

Color is the matter of science, engineering, psychology, art and design.
The conception of color has been changing along with the development of industrial society.

It is apparent that good sense of color plays important role to improve not only the quality of personal and social life but also the quality of art works and industrial products in this global environment.

The conference of '2000 AIC Meeting Seoul' convinced all of us that color has enormously contributed in every part of our life especially with the theme 'Color and Environment'.

I would like to express my deep appreciation to all of those who submitted their precious papers to this journal.

I am also grateful to Mr. Mitsuo Ikeda, president of AIC, the board members and three invited speakers, Mr. Yasuhiro Nagata, Dr. Romesh Kumar, Prof. Yves Charnay, for their support for successful conference in Seoul.

Sincerely yours.

Gi-chul Kim
Professor of Sejong University
Chairman of Organizing Committee

Committes of 2000 AIC Seoul Meeting

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A Color Choice for a Good Housing Environment; A Research on a Repainting Color over A Wall or Roof in Hokkaido

Sakahara Koya

Abstract

In this report, using the results of the research, we show the trends of a color choice when trying to repaint a color on a roof or wall. These are are a basic data for keeping a good housing environment. In '95. '96. '97, we had made a research on the sense of inhabitants at a townscape by owned house residents in Sapporo and the suburbs of 3 cities. 22.2% of families accepted the questionnaires. We got 6368 effective data and the recovery rate is 89.6%. we consider the question "If you repaint on a roof (a wall), which color do you choose? Please choose a color in the attached color chart."

Keywords : Wall, Roof, Repaint, Research, Sapporo

1. Introduction

In this report, using the results of the research, we show the trends of a color choice in repainting a color on a roof or wall. These are to be a basic data for keeping a good housing environment. A color decided by a personal taste and can not control by a law as a height on a building. Accordingly, in thinking to a good townscape, it is an important element to know an intention on a resident. Therefore, with such a point of view, I pick up a roof and wall, inside a various element on a housing.

In '95 through '97, we made a research in Sapporo and 3 Cities around Sapporo.

22.2% of families accepted the questionnaires. We got 6368 effective data and the recovery rate is 89.6%. we distributed a set of the questionnaires and color chart to residents who are more than 13 years old in a owned house and then collected it on a day behind.

It is roughly 5 question items which are "① An attribute on and answerer(②An age, sexuality, residence year number, etc.)", " a condition of housing", "③ A near adjoining relation", " architecture agreement" and " Color image". In the question regrading to "2", we consider the question "If you repaint on a roof (a wall), which color do you choose? Please choose a color in the attached color chart." By the way, except for a roof and wall, we make a same question about the color on a garage, a outer wall and a kerosene tank. And, a color to choose is one.

We made the color chart for this research including an achromatic color on the color chips in the reference 1. As we thought that there were some color difference among color charts, we sampled the 50 color charts in random. And we measured the chromaticity. In this time, we used "minolta CR-200". The color system wa CLEL*a*b*.

We calculated the color differences in each color chart and the median of the mutual color difference. The largest color difference is 7.45. Therefore, under the condition that the largest color difference is about 10.0, there is no-problem. These results are shown in Table 1. By the way, this color chart is made on the basis of the P.C.C.S color system. The color name is wrought in the reference 1. But, as there are some similar color names, each color is automatically given the number from the left upper part in order. There are the values of L*a*b* in Table 1. These are the average are the average in calculating the color difference.

Sakahara Koya
Dept. of Architecture, Hokkaido Institute of Technology
7-15-4-1 Maeda, Teine-ku, Sapporo, 006-8585, Japan
Phone : +81-01-681-21 Fax : +81-01-681-362261
E-mail : Sakahara@hit.ac.jp

2. A Color Choice on a Wall or Roof

The Fig. 1 is the high rate colors of the 10th through the top and these chromaticity.

And then, the lightness and the chroma by a

Table 1. The Color Differnce among the Color Charts and the Average Chromaticity by CIEL*a*b*

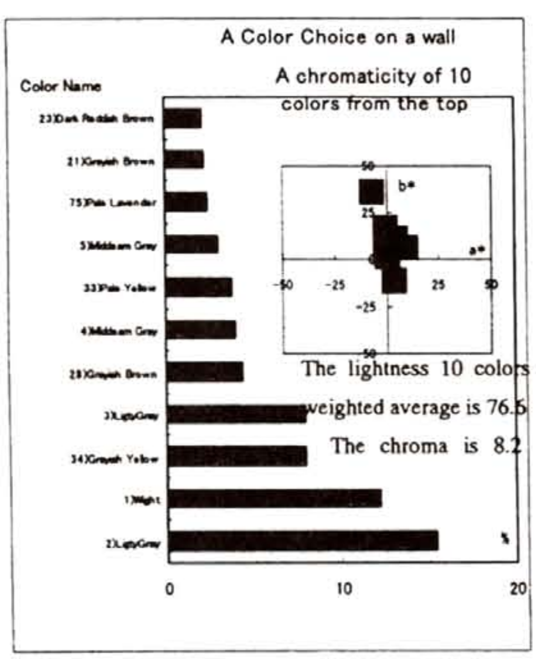
Achromt Color	Tone	Red(r)	Reddish Orange(Or	Yellowish Orange(yo)	Yellow (y)	Yellow Green(Yg	Green (g)	Blue Gree (bg)	Greenish Blue(gb)	Blue (b)	Pruple Blue(pb)	Purple (p)	Purple Red(pr)
1) W	Vivid(v)	10)v2	15)v4	24)v6	29)v8	38)v10	43)v12	52)v14	57)v16	66)v18	71)v20	80)v22	85)v24
91.35	L*	52.50	62.63	75.14	85.35	72.89	58.58	63.13	49.88	47.19	44.78	48.34	46.86
3.51	a*	24.10	41.12	58.17	81.78	37.80	20.19	-2.51	-22.27	-31.63	-28.69	-15.64	4.91
-0.40	b*	60.02	48.68	18.56	-4.44	-43.68	-46.43	-37.8	-13.34	6.49	20.01	25.92	47.36
1.72	C D *4	2.79	3.61	2.4	2.08	2.07	1.36	2.98	1.27	1.78	6.92	3.78	3.08
2)Lt.Gy	Bright(b	11)b2	16)b4	25)b6	30)b8	39)b10	44)b12	53)b14	58)b16	66)b18	72)b20	81)b22	86)b24
84.36	L*	65.53	69.31	79.41	86.09	78.92	71.07	65.85	60.33	60.41	57.53	61.12	62.99
3.76	a*	29.12	39.96	51.93	68.59	58.24	16.51	-0.36	-23.04	-26.47	-27.09	-14.87	4.29
-0.048	b*	44.63	34.73	13.32	-5.42	-28.09	-38.50	-36.67	-18.44	-1.72	16.79	29.05	37.66
0.72	C D *4	5.17	7.45	6.93	3.00	3.70	6.90	3.40	2.90	2.99	2.44	2.29	1.55
3)Lt..Gy	Light(lt)	12)lt2	17)lt4	26)lt6	31)lt8	40)lt10	45)lt12	54)lt14	59)lt16	67)lt18	73)lt20	82)lt22	87)lt24
74.17	L*	72.18	76.28	81.12	87.64	83.36	75.29	73.09	68.48	68.97	66.22	69.23	71.43
2.38	a*	21.17	29.14	41.25	51.76	50.41	18.91	-0.06	-12.14	-16.14	-20.12	-10.68	6.54
0.02	b*	33.46	22.12	10.23	-6.33	20.11	-42.07	-30.65	-21.29	-4.30	11.19	26.15	36.36
0.67	C D *4	3.51	2.68	3.92	2.01	6.50	1.97	1.33	3.94	1.22	2.97	4.72	2.65
4)M.Gy	Deep(dp	13)dp2	18)dp4	27)dp6	32)dp8	41)dp10	46)dp12	55)dp14	60)dp16	68)dp18	74)dp20	83)dp22	88)dp24
69.03	L*	46.36	55.27	62.76	64.62	64.31	54.80	47.53	41.75	41.44	41.82	47.74	46.06
1.68	a*	13.73	28.89	40.56	48.65	29.02	8.37	-5.78	-16.53	-21.49	-23.48	-14.35	1.03
0.04	b*	39.15	30.94	19.88	5.28	-16.26	-26.55	-22.36	-8.44	2.79	16.50	26.67	30.92
1.02	C D *4	2.61	1.38	1.76	2.75	1.98	1.86	1.76	3.74	2.62	3.55	2.26	1.42
5)M.Gy	Pale(p)		19)p4		33)p8		47)p12		61)p16		75)p20		89)p24
60.06	L*		81.16		89.12		83.53		79.81		77.12		79.24
1.68	a*		18.46		35.84		13.66		-6.11		-11.56		2.80
0.04	b*		13.15		-6.61		-20.25		-12.69		3.96		17.09
2.18	C D *4		1.84		4.25		1.26		3.25		1.74		2.97
6)M.Gy	Lt.Gy.(ltg)		20)ltg6		34)ltg8		48)ltg12		62)ltg16		76)ltg20		90)ltg24
50.02	L*		68.66		70.22		69.04		63.69		61.18		65.51
0.38	a*		7.49		17.01		2.92		-5.30		-9.36		0.58
-0.34	b*		11.42		-0.035		-7.97		-4.69		3.33		8.93
1.12	C D *4		2.43		1.39		2.07		1.76		1.52		1.66
7)Dk.Gy	Grayish(	14)g2	21)g6	28)g6	35)g8	42)g10	49)g12	56)g14	63)g16	64)g18	77)g20	84)g22	91)g24
45.47	L*	51.74	52.69	53.37	55.05	56.50	56.54	49.63	52.9	48.59	49.84	51.86	52.79
-0.50	a*	4.56	6.53	10.89	9.73	9.59	3.15	-1.01	-4.37	-9.61	-8.74	-6.29	0.95
-0.56	b*	11.69	7.84	4.86	-0.36	-6.51	-7.50	-8.96	-4.13	-1.96	4.51	6.34	9.47
1.49	C D *4	2.69	1.89	0.74	2.54	2.35	2.06	3.83	2.50	1.73	2.36	2.28	2.86
8)Dk.Gy	Dull(d)		22)d6		36)d8		50)d12		64)d16		78)d20		92)d24
37.90	L*		61.63		68.50		60.81		55.20		42.30		55.3
-1.15	a*		21.68		41.14		6.92		-11.23		-16.23		-0.63
0.68	b*		21.12		3.08		-18.22		-9.22		10.51		18.25
1.09	C D *4		2.32		2.13		3.29		1.89		3.01		1.66
9)Bk.	Dark(d)		23)dk4		37)dk8		51)dk12		65)dk16		79)dk20		93)dk24
31.52	L*		55.26		50.97		54.48		44.82		45.14		45.14
0.67	a*		6.91		19.03		3.47		-6.20		-7.90		-1.03
0.77	b*		9.44		1.70		-8.56		-2.77		4.31		10.30
1.30	C D *4		3.86		2.19		4.02		3.43		2.43		1.53

*1 Earch Box are The Color Number) THe abbreviation of P.C.C.S, The Lightness of CIEL*a*b*, a*, b* and The Color Difference from the top

2 "L","a* "and "b* " are the average value in 50 samples

*3 Earch Color Difference is the mediam among the 50 color chips by random sampling

*4 CD is Color Difference



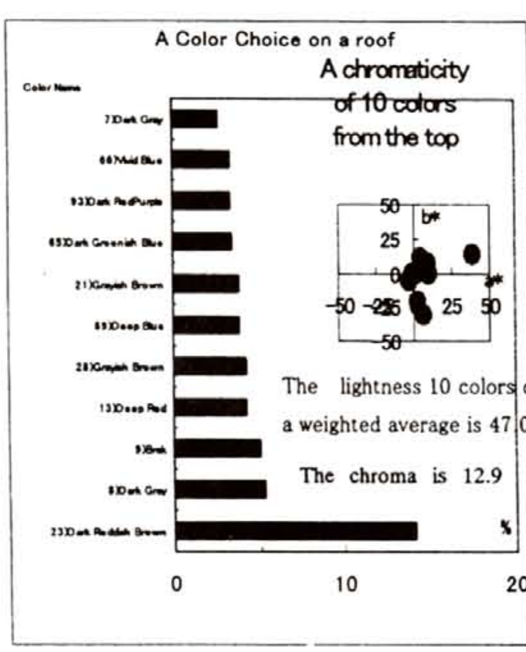


Figure 1. The selectivity of 10 colors from the top on a wall or roof

weighted average to consider the selectivity as a weight is shown in this figure. The left side is the case of a wall and the right side is a roof. The color names and numbers are shown in the Table 1.

In the case of color choice on a wall, there is a high rae of an achromatic color. And an achromatic color get a majority as 5 colors within 10 colors. These 5 achromatic colors are high lightness colors as White, etc. The highest rate of color choice is Light Gray, it is about 15% of the all, and the next is White, it is about 10% of the all.

The hue on chromatic color, Yellow is a majority.

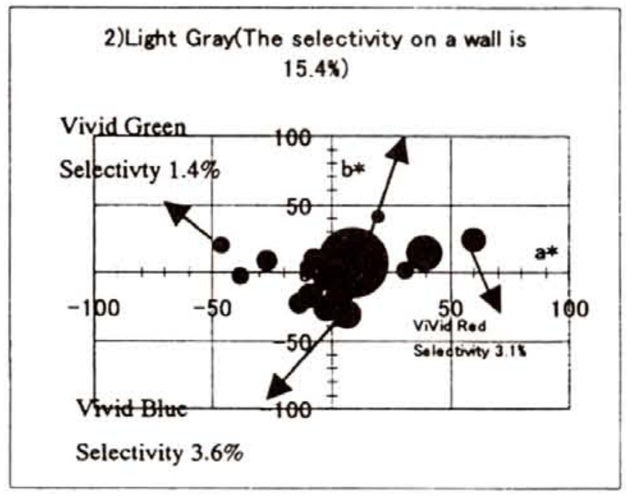
In the case of color choice on a roof, the rate of an achromatic color is low. An achromatic color are 3 colors within 10 colors. These are Black and Dark Gray, it is a low lightness. a hue Red and Blue get a majority. Dark Reddish Brown is the highest rate. It is 15% of the all. The another colors are about 5% of the all.

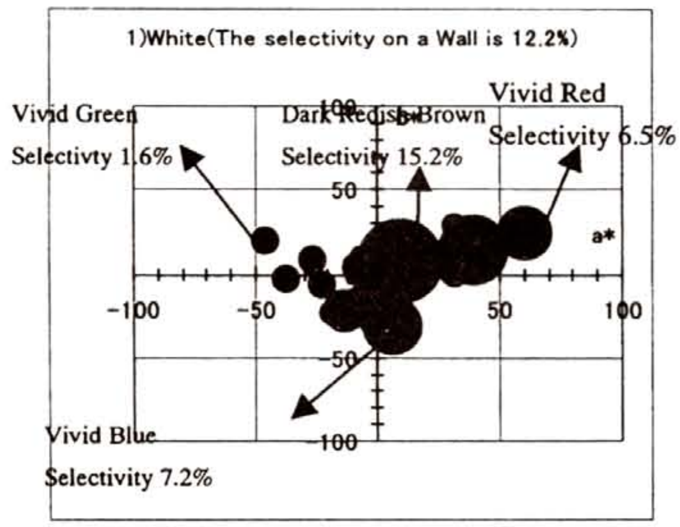
The lightness of a wall on a weighted average of the color choice as a weight is 76.6. A roof is 47.0 There is a clear difference from the both. A chroma on a wall is 8.2 and a roof is 12.9. In the case of chroma, there is not a big difference between a wall and roof. By the way, we calculated these values by using the values on the L* a* b* colorimetric system in the Table 1.

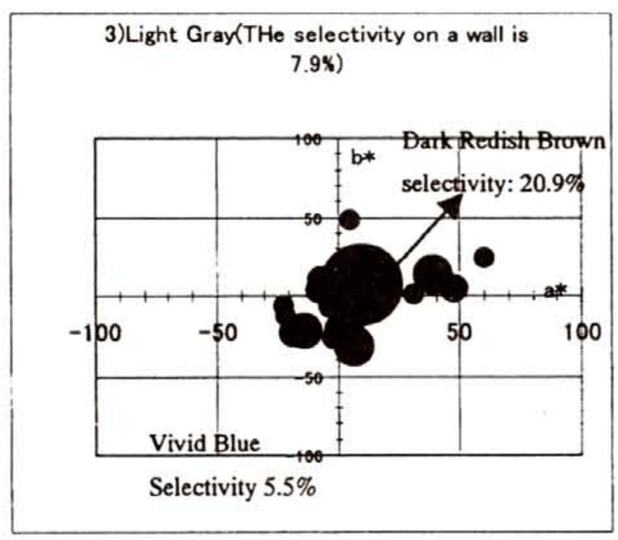
3. The Color Selection on a Roof at the Time to Choose a Color on a Wall

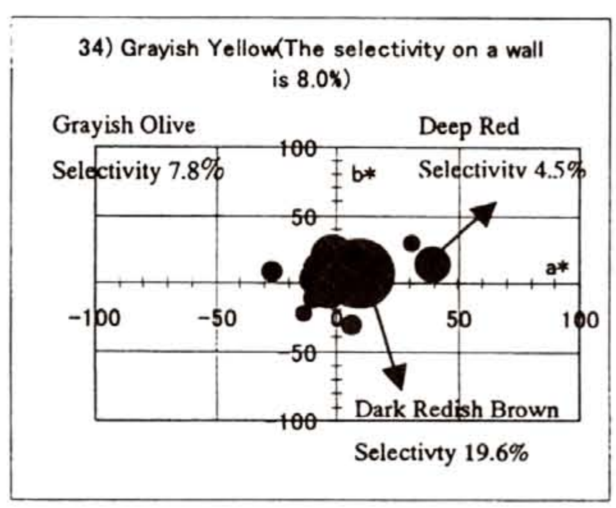
We consider a color on a roof when choosing a high rate color on a wall. In the Fig. 2, the left is the case of an achromatic color on a wall, the right is the case of a chromatic color. We show the 3 colors Which are the highest selectivity rate respectively. These are the chromaticity diagrams of the color on a roof when choosing the color on a wall. The colors on a roof are the case which is selected more than 1% of the all. The bubble size is the selectivity rate in each color. To a reference we show the characteristic color name and selectivity rate on a roof in the Fig. 2. For the upper part on a figure, the color name on a wall and selectivity rate. The number of color name is shown in the Table 1.

With a form on a chromaticity diagram, we show roughly two groups. The first group is "2) Light Gray", "1) White" and "33) Pale Yellow" in colors on a wall. The second group is "3)Light Gray", "34)Grayish Yellow" and "28)Grayish Brown. The hue of the color on a roof in the first group are Red, Green and Blue. The color of vivid tone is included in the first group respectively. The lightness of colors on a wall are 84.6, 91.3 and 89.2. These are a very high lightness. The other hand, the colors in the









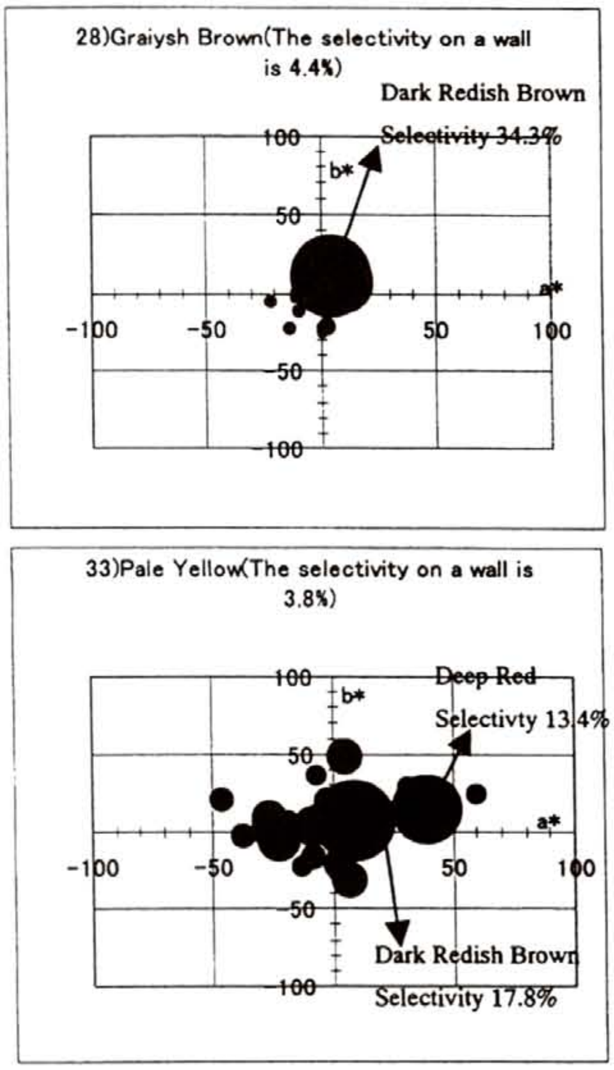


Figure 2. The color on a wall to show a high selection rate and the chromaticity of a color on a roof which is selected more than 1% when choosing a color on a wall

second group tend to be for the origin and the near. A vivid tone is not chosen. The lightness of colors on a wall are 74.7, 70.2 and 53.3 These are clearly lower than the first group.

4. A Color Difference between the Colors on a Wall and Roof. And the Selectivity Rate of a Color on a Roof

In the Fig. 3, We show the relation between the selectivity rate of the color on a roof and the color difference between the colors on a wall and roof. The color names in the figure are the color on a wall in the Fig. 2 and the color number in the Table 2. The regression line and R2(a coefficient of correlation square)are shown. The colors on a roof belong to the hue Red or Reddish Orange.

The upper two figures are Vivid tone(Vivid Red) and Deep tone(Deep Red). In the case of Vivid Red, R2 is small but the relation isn't clear. Both of all, as the color difference between a wall and roof increase, the selectivity of a color on a roof increase. These color differences are more than 50.\

The under two figures are Grayish tone(Grayish

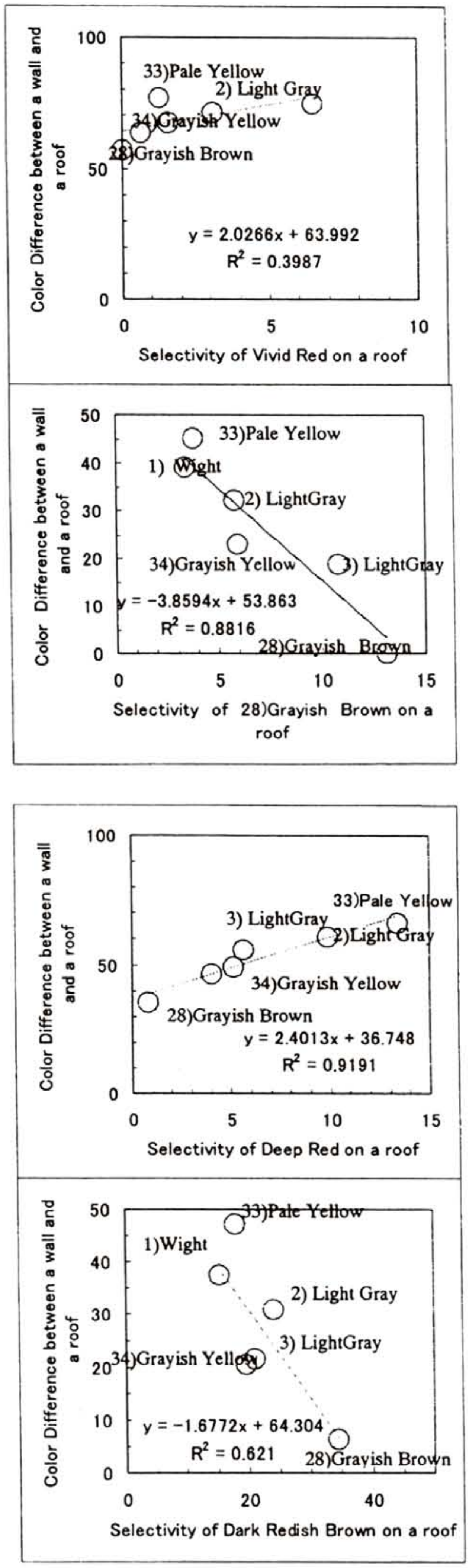


Figure 3. The relation between the selectivity of the color on a roof and the color difference between the colors on a wall and a roof : the case of a hue Red or Redish Orange

Brown) and Dark Redish Brown). These cases are shown a reverse tendency with front two. As The color difference increase, the selectivity of a color on a roof decrease. And the color differences are small, the largest color difference is less than 50. By the way, Dark Reddish Brown is the color on a roof to be selected most in all colors. Grayish Brown is selected the same color on a wall and roof. Though it isn't funny as a tendency in this figure, we think that the roof and wall are understood separately. Through we can't say a definite matter at least the hue Red and Reddish Orange, in the case of the high lightness and high chroma colors from Vivid tune to Deep tune, as the color difference increase, the selectivity rate of the color on a roof increase. In the case of the color from Graysih tune to Dark tune, as the color difference increase, the selectivity rate decrease.

5. Conclusion

The following is the conclusions of this report.

(1) In the case of a color on a wall, the high lightness achromatic color is selected in high rate. In the case of the color on a roof, there is a trend that a middle lightness color is selected.

(2) In the case of a color on a roof, Dark Reddish Brown is the highest selectivity rate.

(3) In the case of more-than-80, there is a dispersing tendency to hue Red, Green and blue in the chromaticity diagram. In the case of less-than-80, there is a centralizing tendency in a nearly achromaticity diagram. In the case of less-than-80, there is a centralizing tendency in a nearly achromatic color area which is low chroma.

(4) In the case of the color on a roof from Vivid tune to Deep tune, as the color difference between a wall and roof increase, the selectivity rate increase. In the case of the color on a roof from Grayish tune to Dark tune, as the color difference increase, the selectivity rate decrease.

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A Survey of Measures on Landscape Ordinance as to Color Element

-Analysis of Landscape Ordinance-

Shoji Iijima

Abstract

The aim of this paper is to provide with information on details of landscape ordinances in Japan,
and their classification by the scale of local authorities and regions concerning color environmental policy. This paper intends to describe a outline of the landscape ordinances aboutcolor control in Japan. About 130 landscape ordinances were analyzed concerning zoning mechanism, color guideline, residents' participation and so on.
As the result, detailed aspects of landscape ordinances were cleared under current legal system, and quality of Japanese landscape ordinances were identified as to color environmental policy. In expectation, landscape ordinances will play an important role in the near future to keep and create comfort color condition in Japan.

Keywords : landscape color, landscape ordinance, color control

1. Introduction

It is said that landscape color is formed not only by natural aspect ; climate condition, soil nature etc., but also by social environments ; district community and so on. And, it is stressed that as to color planing, historical and cultural survey are in need for reasonable color planing process. Moreover, formation of comfortable color environment for future should need the legal system such as landscape ordinance.

The aim of this paper is to provide with information on detail of landscape ordinances in Japan, and their classification by the scale of local authorities and regions concerning color environmental policy. This paper intends to describe a outline of the landscape ordinances about color control in Japan.

2. Method

About 130 landscape ordinances in Japan were analyzed concerning zoning mechanism, color guideline, citizens' participation and so on. And each text of landscape ordinance is defined as to color formation system and is certified existence of description for color.

Shoji Iijima
Okayama Shoka University
2-10-1 Tushima-kyoumachi Okayama 700-8601 JAPAN
Phone : 086-252-0642
F a x : 086-255-6947

3. Result

As the result, detailed aspects of landscape ordinances were cleared under current legal system, and quality of Japanese landscape ordinances were identified as to color environmental policy. This paper discussed the situation of color environmental aspect as to landscape ordinance under Japanese present landscape color condition.

In the table 1, the presence of description for color among authority scale are shown. In the purpose section of ordinance, the description for color is prominent in city ordinance than other authority scale.

In the column of establishment of standard for landscape formation, the description for color is prominent in city (72%) and town (46%) ordinance And, in the column of notification of performance, the description for color is prominent in city (70%) and town (58%) ordinance. But, in the column of residents' agreement for landscape formation, the description for color is prominent in town ordinance (33%) than city (16%) ordinance. So, making a comparison the policy for color condition of city and that of town, city ordinance carry weight with the standard for landscape formation and town ordinance

Table 1. Presence of description for color among authority scale

element of Landscape Ordinance / scale of authority	scale of authority				
	Prefecture 5 ordinance 5prefecture	City 115 ordinance 115city	Town 15 ordinance 15town	Village 1 ordinance 1village	total 136 ordinance
conservation of Histrical landscape (purpose)		2 10%			2 8%
aesthetic zone (purpose)		1 25%			1 25%
conservation district of Traditional Building (purpose)		3 30%			3 27%
conservation of natural Environment (purpose)		1 3%			1 3%
conservation of life Environment (purpose)		1 17%			1 13%
district of scenic beauty (purpose)		1 100%			1 33%
conservation of the route environment (purpose)		2 10%			2 8%
establishment of master plan for landscape formation (strategy)		2 3%			2 2%
establishment of district master plan for landscape formation (strategy)		1 1%			1 1%
establishment of standard for landscape formation (strategy)		69 72%	6 46%		75 66%
notification of performance (strategy)		74 70%	7 58%		81 66%
ragulation of large scale performance (strategy)		53 62%	200% 67%		55 59%
notification of performance and guidance (strategy)		18 24%			18 24%
residents' agreement (strategy)		10 16%	2 33%		12 17%
buildings contributing to landscape formation (strategy)		1 1%			1 1%

environment.

In the table 2, the presence of description for color among regions are shown. In the column of establishment of standard for landscape formation, the description for color is not prominent in kanto region (32%){ total : 66%}, And, in the column of notification of performance, the description for color is not prominent in Kanto region (55%) and Tohoku region (57%)

4. Discussion

It is said that Japanese landscape ordinance is unique and familiarized with Japanese. But, participation in color is not known and not interested in. But, forming comfortable color environment, we should concern with landscape formation legal system. It is presumed that Japanese landscape ordinance take a little interest in color aspect.

In expectation, landscape ordinances will play an important role in the near future to keep and create comfort color condition in Japanese landscape.

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Table 2. Presence of description for color among regions

element of Landscape Ordinance / region	region Hokkaido 9ordinance 6city,3town	Tohoku 7ordinance 6city,1town	Kanto 29ordinance 24city,5town	Chubu 23ordinance 21city,2town	Kinki 28ordinance 27city,1town	Chushikoku 15ordinance 13city,2town	Kyusyu 20ordinance 17city,2town,1village	Total 131ordinance
conservation of Histrical landscape (purpose)					1 33%	1 33%		2 9%
aesthetic zone (purpose)					1 55%			1 25%
conservation district of Traditional Building(purpose)	1 100%				2 100%			3 27%
conservation of natural Environment (purpose)					1 13%			1 3%
conservation of life Environment (purpose)					1 50%			1 13%
district of scenic beauty (purpose)							1 50%	1 50%
conservation of the route environment (purpose)					2 17%			2 8%
establishment of master plan for landscape formation (strategy)			2 11%					2 2%
establishment of district master plan for landscape formation (strategy)	1 20%							1 1%
establishment of standard for landscape formation (strategy)	8 100%	5 83%	7 32%	15 79%	19 73%	8 73%	13 76%	75 69%
notification of performance (strategy)	6 75%	4 57%	12 55%	15 68%	21 81%	9 64%	14 82%	81 69%
ragulation of large scale performance (strategy)	4 80%	4 80%	8 50%	12 67%	15 65%	2 22%	10 77%	55 62%
notification of performance and guidance (strategy)	1 25%	3 43%	1 11%	3 19%	2 11%	2 29%	6 46%	18 24%
residents' agreement (strategy)	2 33%	3 60%			1 8%	1 20%	5 50%	12 18%
buildings contributing to landscape formation (strategy)			1 8%					1 1%

A Glance on Urban Chromaticscape and Architecture

A Visual Approach of "Colour Words Supports"

Michel & France Cler

Abstract

In the daly life, colour aspects completed with tactile aspectsare permanently used ; «coulour words», being parts of a «tool» e.g Chromatic Chart, which will be used, purposely or not , by each of us.

Too frequently, «Colour» is studied on an abstract aspect, which in a way seems important, but not on practical dealy reality.

How to use it, or to provide people some information on its meaning,on the way to use it with councils, architects, materials, inhabitants, and what will be the scale of time for material ?

Keywords : colour words, colourscape, colour memory

1. Introduction

Without light, no colour appearance; without a glance at a support no colour appearance. On an other hand, if no message, no meaning, no evocation being involved in the colour aspect, we will not perceive this colour appearance. Every one working with colour appearances will remember that, nevertheless quite easily we may forget it in our daylife practice.

In fact we are quite lucky to, physically, visually by our own, perceive the tiny segment of electro-magnetic waves that our brain will translate in colour aspects.

This colour message, being reinforced by the various other senses, help us to secure and seduce, in providing better information on our environments for "survival".

We will not try to land on the "technical" input in colour, for the reason, that in the time being, it seems not to provide more additional feeling and meaning aspects.

It may perhaps provides a reinforcement of a pure closed rational aspect, so that colour vocabulary seems to appear shorter, neutralised, with perhaps less meaning and information.

For daylife Chromatic aspects will give information's for each one in the group or for everyone.

Colour messages must be translated, some receiver may understand them as they were "trained" and for that reason they may feel and understand more their various environments.

Mr. Cler Michel
Colour Consultant - Architect
64 Rue VERGNIAUD
75013 PARIS FRANCE
Phone : 33 1 45 80 91 15
F a x : 33 1 45 81 38 66
E.mail : atmfcler@easynet.fr

2. Aim

2.1 Urbanscape & Architecture

Urbanscapes (Urbanspace) & Architectures seems to be. the best contexts for colour appearances, texture aspects, course of time. Those environments being supports of meanings and suggestions.

Message may be sent, received, translated by citizens. Supports for those messages can be clothes, skin, shops, advertising, cars, mineral or planted spaces, architecture, product design, natural landscape, water, sky.

Rhythm of time, speed, (day & night, seasons, years, fashion, pedestrian, driver...) give the messages different schedule of time.

"Colour words" and their "syntax" are used, on various social, cultural, functional targets in accordance with contexts so that same colour words may appear lucky or unlucky.

As language, colour words have their own life attached to classical or vernacular language, to long or short term language, to technical vocabulary (e.g.informatic words and syntax)...

Nevertheless to identify and name a colour appearance a visual vocabulary needs to be used easily by everyone in the streets, the colorimetric language being adapted and reserved to technical and industrialised aspects.

For our works we practise the NCS system as a structure for colour words, and a birth support for new colour appearances. It is important not to confuse with a simple colour list, a marketing grid of recipes, or a support for tinting machine.

The visual Colourscape presentation concerns :

* Urban and Architectural fields with major geographical, climatic backgrounds.
* On another scale, the diversity of sites and micro-sites,
* Then the complexity which is issued from materials aspects, building technology, different ways of life producing their own urban and architectural organisation.

As an information tool, this urbanscape world of colour appearances and textures aspects need to be... visual either in "colour" or in black & white, even if engineers use numbers for colour naming.

2.2 Appearances & Material Texture Aspects.

Colour and texture words what are the supports? Just a slide summary to remember the wide field of what has been and may be used for the harmonious and coherent moods to suggest.

"Colour words" have their own natural or artificial material supports, with their own texture aspects and identities; this will be the first part of the presentation.

"Colour words", ancient (senior) or bright new (junior), have to be used,in accordance with a syntax an a different message between groups.

This typology is based on our practise in Urban planning, and Architecture with sites, groups, materials.

- Multi-visual illusions materials playing with light : water - glass,
- Leaving materials, they rhythm the seasons with birth and death; short and long term materials.
- Mineral materials corporate images of geographical sites, long term material
- "Colour words" support materials. Messages used on skin, clothe, internal and external spaces, advertising, design products....Short term >long term.
- For memory "night" materials.

2.3 Chromatic Survey

In Urban planning maps and reports refer to transport, building location, facilities, parks, schools, industrial areas, some time architectural chart may be introduced as for landscape.

For decision makers, public or private,"Colour" is so simple", most of the time architects have to refer to material market, "exotism", fashion or tendency, heritage trends, if any.

Day & night under various lighting, we walk, drive, stop in "coloured" spaces, everyone pay attention, more often unconsciously, to the coherent and harmonious surrounding aspect they feel, perceive, know as a focused, identified point or a secret space reinforced by rhythm of seasons, or advertising...

Chromatic survey means a complementary map and a trend of colour appearances and texture aspects. As for other supports used for Urban development, follow up will be needed for adaptation.

This type of survey provides a global view or the Chromatic moods for all components of Urban spaces, but it cannot be ruled even it looks as a "technical"approach more than just an artistic or aesthetic work.

In that condition, as first basic support of all Chromatic surveys, we will mention the "Chromatic memory " of site and heritage.

Then after analysis of site, chromatic process and potentialities, the brief and scale of the development project survey being studied, the cultural, social, symbolic meanings in present daylife and the contemporary materials used have to be introduced.

Rehabilitation of a city, a leisure, or an industrial area will need a specific approach and for each project many choices have to be suggested as facadism, heritage, new contemporary architecture... which involves the use of complete memory domestic Colour language or the input of imported materials in the Domestic range.

New settlement or new town suggest a similar approach .

Their is no systematic answer, no recipe; it seems more important to be open-minded towards other visual colour appearance and tactile aspect meanings. The Chromatic range is a leaving process adapted to various components rhythms of development.

It is easy to understand the use of a neutral visual language system (e.g.NCS) is really needed, even if you have to work with "in between" .

References

- Examples of Chromatic surveys :

Analysis

- New Towns : Lille - Berre
- Areas colour trends : West Indies- other
- Hong Kong Housing Authority : Chromatic Chart Hue

Concept

- Geographical and material trends : Bresse Val de Saone Revermont Trevoux
- Industrial Area new settlement PIPA
- Hong Kong Housing Authority Chromatic Chart

Materials

- Gauthier : Paint company
- Weber & Broutin : Thick coating
- Interpon : Paint company - Futura collection

3. Conclusion

With "colour words" everyone or group of inhabitants or decision makers may, by using the Chromatic Memory linked to contemporary material input, will reinforce their personal or the group identity.

Harmony will appear slowly through the moving complexity of various chosen textures and coherent families of colour appearances which will need to suggest, to mean, to evoke, in fact they have basic "functions".

Anyway mood, identification will be in accordance with what the receiver will have in mind and what transmitter want to suggest.

What message will be proposed for one colour appearance or a group of colour appearance in accordance with different texture aspects, for short or long term?

Who will send it and who will receive? Each time a different answer will be produced, nevertheless process will be similar to suggest good relation ship and harmony.

Pleasantness and Frequency of Some Bi-colour Combinations: An Italian / Indian Cross-Cultural Study

Da Pos Osvaldo, Fossati Luigi, Broota Krishan Dayal

Abstract

Previous studies revealed that preference for colour combinations primarily depends on specific relationships between basic aspects of colours. We wanted to discover whether the more or less frequent presence of some colour combinations in the environment might affect the degree of their pleasantness; secondly we aimed also at showing possible differences in the preference for colour combinations between distant cultures. Ten basic colours were used to prepare a series of 45 bi-colour combinations. Four groups of 50 university students each were investigated, two in Milan (Italy) and two in India (Delhi). One group of subjects from each country had to rate in a 1 - 7 scale how much familiar each particular bi-colour combination was considered, being familiarity a subjective evaluation of the frequency of that combination in the environment. The other group of subjects had to rank the whole series of colour combinations from the most to the least agreeable one. As first result, a high correlation is found between Italian and Indian estimates of colour familiarity. Secondly, also judgements of pleasantness are highly correlated between the two countries. Moreover, independently of the country, pleasantness and familiarity scales are highly correlated, in favour of the hypothesis that the environment involves a strong effect on colour preferences. Suggestions about some gender non-uniformity derive from a detailed statistical analysis, but the male-female difference only appears significant within Indian subjects when the pleasantness was evaluated. The rather unexpected high correlation between Italian and Indian subjects in judging colour familiarity can be explained by the similarity either in the city environment or in the socio-economic status of the university students. The latter reason seems also appropriate to explain the similar preference for colour combinations in the two 'distant' cultures. Therefore a more detailed analysis of such cross-cultural comparisons seems appropriate.

Keywords : colour combination, preference, environment, cross-cultural study

1. Introduction

Many psychological studies deal with the preference for either single colours or colour combinations. In the one case subjective motivations leading to the predilection of some instead of other colours is the focus of many research, and personal characteristics of people are often the primary interest of this kind of research, to such a point that not few personality tests use the reactions to single colours as an indication of personal feelings (see for instance the Luscher test among the most often used), while in the other case the prevailing trend is towards the analysis of more objective relationships between colours which would govern the aesthetic appeal of the combinations (Sivik & Hard (1). According to a recent formulation of a well established theory, proposed by Spillmann (2) and elaborated by Da Pos (3), the chromatic characteristics which would determine the aesthetic appearance of bi-colour combinations are the similarity with white and black as a function of the

Da Pos Osvaldo, Fossati Luigi
University of Padua
Department of General Psychology
Via Venezia 8 - 35131 Padova - Italy
Phone : +39049 8276680 Fax : +39049 8276600
e-mail : (dapos@psico.unipd.it) (luifox@libero.it)
Broota Krishan Dayal
University of Delhi - Department of Psychology
Arts Faculty Extn. Bldg.
Delhi 110007 - India
Phone : +91 11 7256001
e-mail : krishandayal@hotmail.com

natural lightness of the hues. The new formulation differentiates three kinds of bi-colour combinations: a) the 'correspondent' combinations in which the colour of the naturally lighter hue appears whiter and less blackish than the colour of darker hue; b) the 'distinct inverted' (or simply 'inverted') combinations, in which the colour of lighter hue appears blacker and less whitish than the other colour; c) thirdly, the 'vague inverted' combinations, in which one colour is both whiter and blacker than the other colour. Although the appeal of a colour combination would depend, according to this theory, on the mentioned objective relationships, being the correspondent combinations generally pleasant and the vague inverted ones generally disagreeable, a more subjective aspect of the theory refers to personal aspects of the observer, like originality and nonconformism, which would make an inverted combination, although generally considered unpleasant, quite attractive.

2. Aim

This research was devised to analyse a new factor, namely the presence of specific colours in the environment, which is expected to affect the preference of the observers for bi-colour combinations. A secondary hypothesis was that different environments and different cultures would lead to different tastes for colour combinations.

3. Method

The presence of specific colours in the environment, which are supposed to affect the preference for colours in the observers, can be described and measured with some difficulty at a certain level of precision; moreover the expected psychological effect would not depend on the physical presence of the colours surrounding the observer but rather on the emotional impact exerted on him. It is well known that the internal representation of the external world also depends on some subjective predisposition which favour more or less profound emotional reactions to specific environmental stimuli, which therefore appear present in the subjective world of the observer with different degree of efficacy. For this reason we considered the subjective evaluation of familiarity given by the observer as an index of the environmental presence of the colour combinations to be studied.

Four groups of about 50 university students each, two from Milan (Italy) and two from Delhi (India), attending humanistic faculties and not expert in colour, collaborated to the research. The experimental material was made of all the 45 possible bi-colour combinations which could be derived from the 10 basic colours described in Tab.

The two colours of each combination were arranged in a four square (4 x 4 cm) checkerboard, and pasted over a white rectangular (30 x 30 cm) cardboard (Figure 1).

Figure 1.

The combinations were exhibited to single subjects in a naturally lighted classroom. The first task was performed by a group of subjects from each country, who had to evaluate in a 1 to 7 scale how much familiar each colour combination, shown in random order, looked at them (1-not familiar at all, 7-very much familiar). The second task was performed by the other group of subjects from each country : all the 45 colour combinations were laid over a table in random order and the observer had to rank them from the most to the least pleasant by extracting first the combination he liked more and then the combination he liked less, and by repeating the same procedure until the end of the series.

Before carrying out the task the subjects did not know the aim of the research, which was on the contrary explained them after completion of the procedure, and therefore their evaluations are completely independent.

To assess the internal coherence of the subjects each single observer was asked to evaluate again the combinations he previously positioned in the first 7 and in the last 7 place of the series: if the subject selected less than 5 cards among the 7 previously evaluated at the first places, he was discarded. The

Table 1. Single colours used to prepare the experimental colour combinations : NCS notation.

Pink	Red	Green	Blue	Ocre	light Blue	Brown	Purple	Yellow	Orange
05 10 R10B	15 80 Y90R	30 50 G10Y	30 60 R90B	20 70 Y20R	20 50 B	60 30 Y50R	30 50 R50B	05 70 Y10R	10 70 Y50R

experimental groups resulted at the end of 57 Italian and 53 Indian valid subjects as regard to the familiarity evaluation task, and of 47 Italian and 53 Indian valid subjects as regard to the pleasantness evaluation task.

4. Results

Familiarity evaluations and pleasantness rankings provided by the single subjects were transformed into normalised scales both for the Italian and the Indian groups. An internal consistency test was then performed to ascertain that single subject data would not significantly differ from the corresponding group average. In the case of familiarity evaluations, we examined only the scale values corresponding to the combinations classified by each subject of a group at the highest rank. Almost always more than one combination obtained the same highest score from a subject, and in the case of familiarity evaluations all the combinations which obtained the maximum score, not necessarily 7, were averaged. In the case of pleasantness evaluations we examined the scale values of the combinations ranked at the 10 highest places by each subjects, and the same statistical analysis was then performed. There is consistency when the variance of the means within subjects is significantly lower (at (= 0.01) than the error variance computed from all the scale values. The disagreement within two groups (the Indian group judging familiarity and the Italian group judging pleasantness) was large enough not to consider them significantly homogeneous (Table 2). Therefore in these cases the global normalised scales are not representative of the judgements given by the subjects of those groups. On the contrary, if the original four groups are divided in eight subgroups according to the subject sex then the difference within subjects of each such subgroup is not statistically different from the average normalised scale. For this reason only the eight subgroups can be considered enough homogeneous to make further observations about their characteristics. Nevertheless some useful indications can be derived also by comparing the results of the original groups, although in this case a general statistical homogeneity is missing.

A first series of comparisons deals with the familiarity evaluations given by Italian females and males on the one side, and by Indian females and males on the other side. If we consider the 10 colour combinations ranked as the most familiar and the 10 as the least familiar (Table 3), a great similarity appears between Italian females and males both in the first case (9 combinations among the 10 most familiar are common to both groups) and in the second case (still 9 common combinations among the 10 least familiar). In the Indian subgroups on the contrary the evaluations given by the males differ more from those given by the females: among the first 10 combinations only 6 are common, and among the last 10 combinations only 4 are common.

Similar results are found as regard to the pleasantness evaluations: Italian males give evaluations quite close to those given by Italian females (8 common combinations among the first 10 most pleasant, and 4 common combinations among the least 10 pleasant).

A larger difference appears between Indian females and males: only 4 combinations are common among the first 10 most pleasant, and likewise 4 common among the 10 least pleasant ones. By comparing the Italian and the Indian groups (m + f) less superposition is found: as regard to the familiarity evaluations half of the 10 most familiar and half of the 10 least familiar combinations are common. As regard to the pleasantness ranking, 4 combinations are common among the first 10 and only 3 are common among the last 10 combinations.

As expected from the theory the great majority of the pleasant colour combinations are correspondent, and the inverted or vague inverted combinations are most common among the least pleasant ones (Table 3).

Table 2. Internal consistency of all the subgroups.

Familiarity

It. m	It. f	It. m+f	In. m	In. f	In. m+f
F(27,60) = **1.41** (0.14)*	F(30,101) = **1.27** (0.2)*	F(53,275) = **1.42** (0.10)*	F(27,156) = **1.68** (0.027)**	F(26,119) = **1.59** (0.049)**	F(53,275) = 2.28 (0.00009)

Pleaseantness

It. m	It. f	It. m+f	In. m	In. f	In. m+f
F(26,234)= **1.39** (0.10)*	F(21,189) = **0.8** (0.71)*	F(47,423) = 1.95 (0.0003)	F(25,216) = **1.04** (0.42)*	F(28,252) = **1.23** (0.2)*	F(53,477) = **1.29** (0.09)**

Table 3. The first 10 and the last 10 colour combinations selected by the different groups and subgroups. Combinations which are common in the compared scales are in bold. All combinations are correspondent except : * = inverted, ° = vague inverted, ' = same nuance.

	Pleasantness						Familiarity					
	Italy		India		m+f		Italy		India		m+f	
	f	m	f	m	Italy	India	f	m	f	m	Italy	India
1	*Pi-Pu*	**B-lB**	*B-lB*	**Pi-lB***	**B-lB**	**B-lB**	**B-lB**	**B-lB**	**B-lB**	**R-B**	**B-lB**	*R-Or*
2	**B-lB**	*R-B*	*R-Or*	**Pi-Pu**	*B-Y*	**Pi-Pu**	**G-Y**	**G-B**	**R-B**	**G-Or**	**G-B**	**R-B**
3	**lB-Pu**	**B-Y**	**R-B**	*Pi-B**	*B-Pu**	**R-B**	**G-B**	**R-B**	*R-G°*	*Oc-Or**	*G-Y*	*G-Or*
4	**Pu-Y**	**B-Pu***	**G -B**	*Pi-G**	*lB-Pu*	*Pi-lB**	**lB-Y°**	**G-lB***	**G-Or**	**R-Or**	*G-lB**	**B-lB**
5	**B-Y**	*G-B*	*lB-Pu*	*Pi-Y**	*Pu-Y*	*G-B*	**R-B**	**G-Y**	**G-B**	**G-B**	*lB-Y°*	**G-B**
6	**B-Pu***	**R-Y**	**Pi-Pu**	*R-G°*	**R-B**	*R-G°*	**B-Y**	**R-G°**	**R-Or**	**B-Or**	**R-B**	**R-G°**
7	*Y-Or*	**Pu-Y**	*lB-Or°*	**R-B**	*lB-Y°*	**R-Y**	*G-Br**	*Oc-Br*	*G-Y*	*R-Y*	**R-Y**	*B-Or*
8	**lB-Y**	**lB-Y**	*R-Y*	*Pi-R**	**R-Y**	*Pi-R**	**G-lB***	**R-Y**	*G-lB**	**B-lB**	*B-Y*	**R-Y**
9	**G-Y**	**lB-Pu**	**Pi-lB***	**G-B**	*G-Y*	*Pi-B**	**R-Y**	**B-Y**	**B-Or**	*Pi-B**	*G-Br**	*R-Pi**
10	**R-Y**	**G-Y**	*G-Or*	*Pi-Br**	**Pi-Pu**	*R-Or*	**R-G°**	**lB-Y°**	*Pi-lB**	*Y-Or*	**R-G°**	*Pi-B**
...												
36	**R-Br***	*Oc-Br*	*Br-Pu**	*Pu-Y*	*Pi-Y**	**Br-Pu***	**Pi-Y***	**B-Oc**	*Pi-Or**	*B-Br**	*B-Oc*	**G-Pu'**
37	*G-Oc°*	*Br-Or*	*G-Br**	**G-Oc°**	*Pi-Br**	**B-Br***	**B-Oc**	**R-Pu°**	*B-Oc*	*Pu-Or*	*Pi-Or**	*B-Br**
38	*Pu-Oc°*	**Oc-lB***	*lB-Y°*	*B-Br**	*G-Br**	*R-Oc**	**G-Pu'**	*Pi-G**	*G-Pu'*	**Oc-lB***	**G-Pu'**	**Pi-Y***
39	*Pu-Br**	*Pi-Or**	**Oc-Pu°**	**lB-Br***	**lB-Br***	*lB-Y*	**Pu-Or**	**Oc-Or***	*Pi-Y**	**lB-Br***	**Pi-Y***	**Pi-Oc***
40	**Oc-lB***	*Br-Pu**	*Pi-Oc**	*Oc-Or**	**B-Br***	*Oc-Y*	*Pi-Or**	**G-Pu'**	**lB-Br***	*Pi-Pu*	*Pu-Or*	*Oc-Y*
41	*lB-Br**	*Pi-Br**	*Oc-lB**	*Oc-Y*	*Oc-lB**	*Oc-Pu°*	**R-Pu°**	**Pu-Or**	*Pi-Oc**	*lB-Or*	**R-Pu°**	**R-Pu°**
42	*G-Br**	*Pi-Y**	**lB-Br***	**B-Oc**	**Br-Pu***	**lB-Br***	**Pi-Oc***	**Oc-Pu°**	*Oc-Y*	*G-Oc°*	**Oc-Pu°**	*lB-Br**
43	**Oc-Or***	**R-Br***	**B-Oc**	**Oc-Pu°**	*R-Br**	*B-Oc*	**Br-Pu***	**Pi-Y***	**Oc-lB***	**Oc-Pu°**	**Pi-Oc***	*Oc-lB**
44	*B-Br**	**Pi-Oc***	*R-Oc*	*B-Or*	*Pi-Oc**	*G-Oc°*	**Oc-Pu°**	**Br-Pu***	**Oc-Pu°**	**Br-Pu***	**Br-Pu***	**Oc-Pu°**
45	**Pi-Oc***	**Oc-Or***	**G-Oc°**	*lB-Oc**	*Oc-Or**	*lB-Oc**	**Oc-Or***	**Pi-Oc***	**Br-Pu***	*R-Pu°*	*Oc-Or**	**Br-Pu***

Nevertheless some difference between Italian and Indian subjects comes out from the results, as already noticed in previous research by Da Pos (4): Indian subjects not only are less homogeneous but show greater preference for inverted combinations than the Italian subjects. A quite new result, which needs further confirmations, is found as regard to the combinations considered as most familiar: most combinations in the first 10 places of the familiarity scale are correspondent.

If we consider the full scales which include all the 45 colour combinations, a Spearman correlation index can be computed which shows how much similar are any two sequences, and moreover the statistical significance of the resulting similarity can be determined. The resulting correlations are displayed in the following Table 4, where the aspects which are compared appear in the first row; the successive rows show the subgroups and groups within which the comparison is performed. The upper number indicates the Spearman correlation and the lower one its statistical significance. Statistically significant correlation's ($p < 0.01$) are in bold, and show a substantial similarity between the scales under comparison.

Table 4. Correlations between the subgroups.

familiarity / pleasantness						male / female			
female		male		Italy	India	Italy		India	
Italia	India	Italia	India	m + f	m + f	pleas.	famil.	pleas.	famil.
0.38	**0.63**	**0.66**	0.11	**0.51**	**0.69**	**0.71**	**0.84**	0.31	**0.63**
0.04	0.0003	0.0001	0.59	0.004	0.00009	0.00003	0.000001	0.09	0.0002

Italy / India					
pleas.		famil.		pleas.	famil.
f	m	f	m	m + f	m + f
0.62	0.15	**0.61**	**0.46**	**0.54**	**0.55**
0.0005	0.41	0.0007	0.008	0.002	0.002

[If we observe the first column of Table 4, we find that within the group of Italian females the familiarity scale is little correlated - 0.38 - with the pleasant scale, and the correlation is not statistically significant - $p > 0.01$ -. This means that the order of the colour combinations in the two scales cannot be considered very similar. It seems important to remind that familiarity and pleasantness evaluations are given by different subjects, and therefore all comparisons are carried out between independent groups].

The two following figures show all the statistically significant correlations (thick lines) : in the one case (Figure 2a) between the subgroups distinct by sex (for these subgroups the internal consistency was already verified), in the other case (Figure 2b) between the original groups (although some groups were not enough internally consistent, as before mentioned, the global values can be nevertheless considered as indicative).

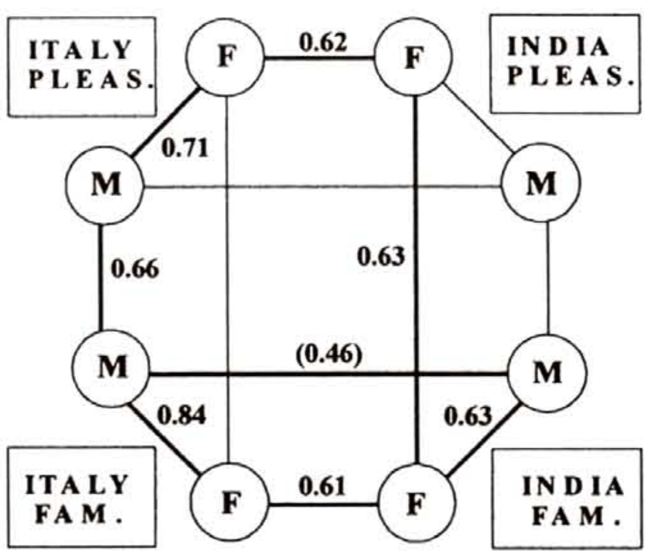

Figure 2a. Correlations between all the subgroups.

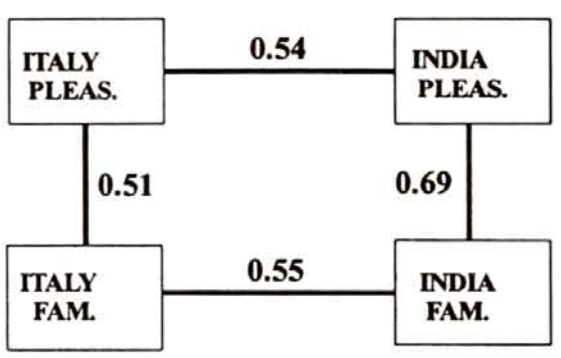

Figure 2b. Correlations between the main groups.

First of all the most interesting observations concern the correlations between females and males (oblique lines), which generally appear quite high, except between the Indians subjects as far as the pleasantness is concerned. In this case it seems that the data from Indian males are deviating from the general distribution, as this group is also little correlated with the corresponding Italian subgroup, while the two subgroups of females are highly correlated. Moreover the statistical analysis supports the observations previously proposed as regard to the first 10 and the last 10 preferred combinations.

About the relationship between familiarity and pleasantness (vertical lines) high correlations appear between Italian males, Indian females but not between Italian females or Indian males. From these data the hypothesis that colour familiarity exert some influence on colour pleasantness does not receive strong support.

Lastly we find high correlations between Italian and Indian subgroups (horizontal lines), with the already mentioned exception of the males as regard to the pleasantness evaluations.

Table 5 shows the preference order for the single colours on the basis of their frequency in the various levels of the combination scales. The resulting order therefore depends strictly on the combinations in which they are included, nevertheless some useful considerations and comparisons with previous research can be made.

Table 5. Pleasantness and familiarity scales of single colours derived from the corresponding scales of colour in combinations.

			1	2	3	4	5	6	7	8	9	10
Pleasantness	Italy	f	Y	Pu	B	lB	R	Or	Pi	G	Br	Oc
		m	B	Y	lB	Pu	R	G	Or	Pi	Br	Oc
		m+f	B	Y	Pu	lB	R	G	Or	Pi	Br	Oc
	India	f	Or	B	R	Pu	Pi	lB	G	Y	Br	Oc
		m	Pi	R	B	G	Y	Pu	lB	Br	Or	Oc
		m+f	Pi	R	B	G	Or	Pu	lB	Y	Br	Oc
Familiarity	Italy	f	G	Y	B	lB	R	Br	Pi	Or	Oc	Pu
		m	B	lB	G	Y	R	Br	Or	Oc	Pi	Pu
		m+f	B	G	Y	lB	R	Br	Or	Pi	Oc	Pu
	India	f	G	R	B	Or	lB	Pi	Y	Br	Oc	Pu
		m	B	Or	R	G	Y	Pi	Oc	lB	Br	Pu
		m+f	R	B	G	Or	Pi	lB	Y	Br	Oc	Pu

Ochre and brown appear in the least preferred combinations of all groups and subgroups, while core and purple are in the least familiar combinations. On the one side the general preference for blue shown by Italian subjects is rather well known, but on the other side their high appreciation for yellow appear unusual. The preference of Indian males for pink and red not only is contrasting the taste of Italian males but also that of the Indian females, who on the contrary put orange in the first place. Some difference in the preference for single colours seems therefore to exists between both the cultures and the sexes, although it needs further support. On the contrary the larger variability of Indian subjects as compared with the Italian ones agrees well with the findings of previous studies.

5. Conclusions

This research started from the theory on bi-colour combinations proposed by Spillmann (2) and Da Pos (3), according to which colour combinations can be classified in three fundamental categories, correspondent, inverted and vague inverted. The distinction is based on specific relationships between the main attributes of colours and leads to the prediction that the pleasantness of the correspondent combinations is generally high, low for the vague inverted combinations, and it would depend on some personality traits for the inverted combinations. The support given by this research to the theory is remarkable because of the number of the colour combinations which have been studied, and also because of the number and type of the subjects who co-operated in the research.

We afforded the problem whether other factors might influence the preference for colour combinations, apart from those connected with the characteristics of colours themselves and already pointed out by previous studies: we focused our attention principally on the environment and on the culture. The high correlations between pleasantness and familiarity, emerged from our results, can be interpreted as an evidence of a causal dependency, in the intuitive meaning that a subject exposed to some colours in the environment will show greater preference for the same colours. Nevertheless it is still undetermined whether the effect depends on the physical presence of the colours in the environment, or a conscious perception by the observer is anyway necessary. The experimental option of examining the familiarity of colour combinations led to the described result of a rather good correlation between pleasantness and familiarity both in India and in Italy, but it left open the question whether a third factor, a biological predisposition or psychological resonance of the observer, is responsible both of the familiarity and of the pleasantness.

Results are not supporting the hypothesis that culture plays a relevant role on the aesthetic taste for colour combinations, nevertheless the differences found between the sexes are probably due more to cultural factors than to biological determinants. The overall similarity of Italian and Indian students in their evaluations of colour familiarity and pleasantness can be considered as a cultural expression: in fact it is well known that the internationalisation of the universities and of the style of life of the high socio-economic classes can determine an unexpected cultural affinity of the involved subjects. If this hypothesis is tenable we expect greater difference between social classes within the same country than between socially high ranking groups of different countries. Nonetheless the nowadays fast globalisation makes a verification of this hypothesis quite difficult, although it would be extremely interesting especially for people interested in promoting the preservation of specific cultural characteristics of a given population.
nowadays

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Colour Design in Urban Planning - An Environmental Factor

Berit Bergstrom

Abstract

The individual's perception of what is ugly or beautiful is based on experiences gained over many years. One learns to see, understand and appreciate the colours in nature in all their variations and one gets used to the fact that houses usually have certain types of colours. New impressions are interpreted and evaluated against the background of the references which one already has. What one recognizes and can interpret is usually perceived as beautiful. Anything which is difficult to interpret, on the other hand, may be perceived as ugly - or sometimes as exciting.

The references differ between different countries, different cities, different cultures and different types of nature, and people's opinions of what is "beautiful" are stamped by the places in which they grow up. These differences between different places are worth noticing and preserving since the colour character is an important part of that quality which is difficult to define but which is called "mood" or "atmosphere" and which is the basis for how we perceive our environment to be good or not.

Colour is as important a factor in city planning and architecture as the interaction of volumes, the shape of details and the changing nature of the materials and one cannot merely "colour" something which is already regarded as a finished work. In order to fully interact with other active factors, colour must be introduced at an early stage of the work process and become a self-evident aspect in the creative process with sketches, reassessments and alternative solutions.

The background to this paper is two studies carried out by Fridell Anter & Enberg, 1997 and Janssens & K¸ller, 1997.

Keywords : colour design, exteriors, buildings, urban planning

1. The Colour Character of an Area

In a study "External Colouring" carried out by Fridell Anter & Enberg 1997 was aimed at giving guidance in the complexity of external colouring and from where I will give some examples. "Genius loci" - the soul of the place - is a concept which has stamped a lot of the colouring debates of the 1980s and 90s. Another way of expressing approximately the same thing are the words " local colour". What is it that gives a group of buildings, a city, a suburban district or a part of the country its particular character? It is completely clear that colour plays a central role, and to understand " the soul of the place" must therefore include the understanding of its colour character.

Berit Bergstrom
Scandinavian Colour Institute AB
BOX 49022, S-100 28 STOCKHOLM, SWEDEN
Phone : +46-8-617 47 00 Fax : +46-8-617 47 47
E-mail : berit.bergstrom@ncscolour.com

The colour character is unique for the place and is dependent on its conditions. Colours and their use contribute to a total environmental experience imprinted by an area, where they are hopefully perceived as self-evident ingredients. They create a home feeling and recognition to anyone who knows the area, and they make orientation easier to those who come from outside. We are often unable to explain what colours mean to us beyond that, and we sometimes believe that we do not even care about them. But they still arouse feelings, atmospheres and associations that are difficult to capture but are also decisive to the way we perceive the place.

Even if we cannot explain the colour character in all of its complexity, we can attempt to capture it and continue building on it. A careful inventory of colours and materials and their planning, together with a sensitive perception of the mood of the place, can give us valuable knowledge of the significance of the colour to " the soul of the place".

Understanding of the colour character of an area has several dimensions. In the first place, it is a matter of understanding how the colour creates variation, cohesion, orientability, etc. in the area and imparts to it a special character in relation to other areas. In the second place, an inventory must be made of the inherent colours and materials that have been used to achieve this. Moreover, there is the historical aspect. What did the area look like at different times and how has it become what it is today? A method of analysing the character of an area is to work with local selections of colours -" palettes" - created after an inventory of the traditional way of building, with its materials and colours, and of the colour character of the earth and vegetation.

Regardless of whether the building is old or new, the link with tradition is an interpretation task and not merely a simple re-creation. Achievement of this objective demands not only historical knowledge, but also the ability to create a meaningful entity. Having tradition as a sounding-board does not always involve following tradition. A new composition of forms and colours can also be viewed and assessed against the background of traditional references, and this can be used to give architecture an additional dimension.

Analysis of the perceived colour character describes how buildings and their colours are perceived. The measurement of inherent colours informs us of the means that have been used for achieving this. These two inventories together provide an excellent picture of the area, which can then serve as the foundation for considerations such as the colouring of additional buildings, improvement by colouring certain units, or the colour planning of other areas in which a similar character is to be achieved.

The Natural Colour System (NCS) offers a very useful analysis tool. By plotting the inherent colours in the NCS triangle and circle, answers can be obtained to questions such as: Which nuances and hues are most common? Which inherent colours dominated when the environment felt serene and harmonious, and when the environment felt light? Which inherent colours served as markers or exclamation marks, and which break out of an otherwise coherent pattern?

The term inherent colour used here means the colour that an object is considered to have "in itself", regardless of the prevailing lighting and viewing conditions. The inherent colour can unambiguously be defined as the colour that the object would have in a standardised viewing situation, with standardised light, viewing angle, etc. The perceived colour is the colour that is observed in its context - a context that is continually changing with changing light, distance, background and observer. Fundamentally, the perceived colour naturally depends on the inherent colour, although it is influenced by a number of other factors that may cause wide variations between the inherent colour and the perceived colour.

2. What Colours are the Preferred on Different Buildings

What is good colouring? The question may seem simple but, on reflection, involves the same complexity as all other questions regarding " good" and " poor" architecture. Colour is perceived instantaneously and spontaneously by the vast majority of people, and colour often has symbolic connotations and emotional valuations that may be very personal. It is often the significance or symbolic charge of a colour that gives the immediate experience in a built-up environment. We can all say what we feel on the question of "ugly" or " beautiful" colours, and the colour of a built-up area can often be perceived as being very important and characterising.

The choice of colours and their interplay are part of the total conception of a building. The colour selected makes its contribution to the place and time, and participates in a creation of our living environment ñ not only physical, but also social and cultural.

If a coloured environment is to produce a positive perception, the colour must be a stimulant, and must produce surprises and variation. At the same time, it must be understandable and recognisable. Excessive variation in colour can easily give a disjointed and restless impression, while an excessively coherent environment is likely to feel dull. (Fridell Anter & Enberg)

A study carried out by Janssens & K¸ller in 1997 was aimed at shedding light on the colours that are perceived as being suitable for various types of buildings. In the project, which includes both field studies and simulation studies, four different theories concerning colour preferences are set against one another. These theories were drawn from earlier research into colour samples or interior colouring, and from research into the field of aesthetics.

The following four hypotheses were tested:

1. When colours are applied in an exterior

environment, they have the same order of preference as that found earlier by research into preferences for colour samples (Eyseneck 1941, Sivik 1974).

2. The preference for a colour is guided by its attention arousing value, and above all by the amount it deviates from the colours surrounding it (Berlyne 1971, 1972).
3. Environmental valuation is dependent on certain visual criteria, including the balance between the complexity and the unity of the environment (K¸ller 1991).
4. The colour preferences of people are guided by their expectations based on experience (Whitfield & Slatter 1978, 1979, 1983).

In this study, the hypothesis also tested was that professionals prefer higher unity and laymen prefer greater complexity in the colouring of the exterior. Earlier comparisons of the preferences of architects and laymen for built-up environments indicate that professionals have a more distinct and unambiguous valuation profile than people in general (Craik 1975; Janssens 1984; Zube et al., 1975). The last hypothesis tested was that buildings that are sunlit are perceived more positively than the same buildings under cloudy conditions, regardless of the colouring in general.

The field study provided the basis for two simulation studies intended to shed light on the colour preference theories. Slides were shown in one of the simulation studies, and the judgements in the other study were made on a computer terminal screen. The pictures had been manipulated by digital picture processing, and centrally located buildings were then shown in nine different colours. In the simulation technique developed within the project, the computer is used to change the colouring of a building in a very realistic way. The naked eye cannot discern that it is a simulation.

The results of this study showed that the relationship between a specific building and its surroundings is of the utmost importance, and also that the type of building is of considerable significance. The preference of the observer for the exterior colours seem to be founded on conventions rather than on aesthetic grounds. The conjecture of a general order of preference for colours, or at least for colours on building exteriors, had to be discarded. The findings supported the assumption that the appreciation of environmental colours has both a biological and a cultural basis. The characteristics of the individual observer and the weather conditions had only minor influences on the perception of urban coloration.

The simulation technique developed within the project can very well be used in conjunction with project design, rebuilding and repainting. The decisive factors thus seem to be the suitability of the colour for the relevant building, and the relationship between the colouring of the building and that of its surroundings.

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Investigating Parametric Effects of CRT Displayed Colours

John H. Xin, Chuen Chuen Lam, M. Ronnier Luo

Abstract

This paper investigated five types of parametric effects in assessing the colour difference using CRT generated colour stimuli. The visual assessment experiments were conducted in six phases, one reference phase and the other five test phases which use different viewing conditions from the reference phase. The viewing conditions of the test phases include the separation of the two samples in a pair, the size of the sample pairs, the background colours and hairline colour. There are 87 sample pairs used in the experiments. The average colour difference of the sample pairs is about 5.0 CIELAB units. Grey scale method was used for colour difference assessment with 20 observations for each sample pair. It was found that if the sample pairs were assessed with a 3-inch gap between them, the parametric effect is around 12%. The small size sample pairs (0.6-inch square) has a parametric effect of 11% in comparison with normal size sample pairs (3-inch square). The mean parametric effects for green and blue colour backgrounds are 20% and 14% respectively. However, when considering green colours under the green background and blue colour under the blue background, much larger parametric effects of 42% and 33% were obtained. In the phase considering the colour of the hairline separating two samples in a pair, a small parametric effect of 7% was discovered when a grey colour was used instead of black.

Keywords : parametric effect, self-luminous colour, crispening

1. Introduction

There is strong demand in industry and commerce for accurate colour and image reproduction on CRT displays. The accurate colour display CRT monitors has been achieved through the device characterisation process. For a reliable monitor, the accuracy of monitor characterisation can be as low as 0.5-0.8 DECMC (1:1) units[1]. The use of screen colours virtually eliminates the transportation time and cost when compared with the method of sending physical colour samples. It is not surprised that screen colours are being used for colour quality assessment such as colour difference assessment. However, there are no sufficient researches on the correlation between the visual colour difference assessment and the objective evaluation by colour difference formulae for screen colours, since all of the advanced colour difference formulae were developed using surface colours. There are also few reports on the parametric effects for the screen colour if the viewing conditions are different from those of the reference. This research work reported is an extension of a previous study of parametric effects for surface colours using medium colour difference pairs [2].

John H Xin, Chuen Chuen Lam
Institute of Textiles and Clothing,
The Hong Kong Polytechnic University, Hong Kong,
Email : tcxinjh@inet.polyu.edu.hk.
M Ronnier Luo
Colour & Imaging Institute, University of Derby, Kingsway,
Derby DE22 3HL UK

2. Experimental Design

In this project, it is very important during the psychophysical experiments that the colours displayed on the CRT must be accurate. To achieve that, the monitor must have good repeatability for colour displayed. The monitor used in this study was a 21î Sony Trinitron monitor model 520GS. The Repeatability for all displayed colours was checked twice a week. The average of the colour difference measured comparing with the first measurement is 0.44 (E CMC(1:1) during the experimental period. This result shows that the colour displayed by the CRT were quite stable and the repeatability is good.

In order to display colours with required tristimulus values, the monitor was characterised using the GOG model [3]. The white point was set to equivalent to CIE illuminant D65 and peak white luminance is 78cd/m2. At least 5 minutes warm up time was used after switched on. A quick check of the white point for the luminance level and chromaticity was carried out just before every visual assessment experiment. In this study, the displayed colours were measured by Photo-Research PR704 spectroradiometer. A total of 87 sample pairs are used in the study, which include 12 in orange centre, 15 in yellow centre, 20 in grey centre, 20 in green centre, 16 in blue centre and 4 additional pairs along the lightness axis of the grey centre. The average L*a*b* values of five colour centres are shown in Table I. A panel of 10 observers with normal colour vision was invited to the psychophysical experiments. The observers also repeated the assessments once within a period of two to three weeks for all phases. Five-minute adaptation to the experimental arrangement was required before the observers started the visual assessment. A training session was also given to each observers before experiments.

Table 1. Average of L*a*b* values for five colour centres.

Colour centre	L*	a*	b* (D65/10)
Orange	49.13	17.70	11.64
Yellow	77.96	-1.178	17.81
Grey	48.66	-0.806	-0.387
Green	28.67	-13.16	-1.53
Blue	25.41	9.37	-21.34

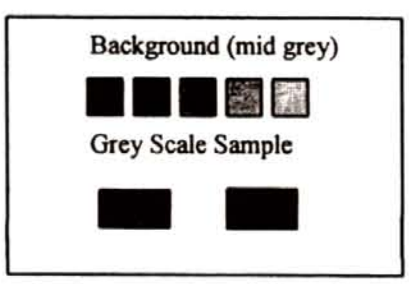

Figure 1. The schematic diagram of sample arrangement in phase I.

In this investigation, grey scale method of colour difference assessment was employed. This method is in accordance with previous studies [4]. The grey scale grading follows ISO standard ISO106 : A02. The grey background in this study has L*, a* and b* co-ordinates of 48.91, 0.50 and 0.26 respectively. If the grade of a sample pair did not equal to the grade of the closest grey scale, observers were encouraged to provide an intermediate steps, e.g. 2.4, 2.7 etc. for colour differences greater than grey scale 3 but smaller than 2.

The experiment was divided into six phases. Phase I is the reference phase which is according to the CIE guideline [5]. In Phase II sample pairs have a 3-inch gap and in phase III small size sample pairs are used, which corresponds to 2 degree viewing field. In Phase IV and V, green and blue backgrounds are used instead of grey background. The green and blue backgrounds in these two phases have the L*a*b* values of 31.66, -17.8, -1.39, and 21.03, 7.58, -17.98 respectively. They are very close to the green and blue colour centres listed in table I. In Phase VI, a medium-grey coloured hairline, the same as the grey background, is used for dividing two samples in a pair instead of a black hairline (grey scale pairs still use a black hairline).

Table 2. Details of experimental phases.

Phase	Back ground	Sample Size	Separation	Hairline Colur
I (reference)	Medium Grey	3-inch square	Hairline	Black
II (gap separation)	Medium Grey	3-inch square	3 inches gap	/
III (2° viewing field)	Medium Grey	0.6-inch square	Hairline	Black
IV (green background)	Green	3-inch square	Hairline	Black
V (blue background)	Blue	3-inch square	Hairline	Black
VI (grey hairline)	Medium Grey	3-inch square	Hairline	Medium Grey

After the grey scale assessment, the GS values were transformed into the visual colour differences (V using a third polynomial equation obtained from curve fitting to the grey scale standards :

$$\Delta V = 27.39 - 17.823GS + 4.4068GS^2 - 0.3878GS^3 \quad (1)$$

Performance Factor (PF) has been widely used by previous researchers as an indicator for the observer precision and the performance of colour difference formulae in comparison with visual results [4]. In this study, PF/3 is used:

$$PF/3 = 100[(\gamma - 1) + V_{AB} + CV/100]/3 \quad (2)$$

In the process of finding the parametric effects, the method of direct comparison between the visual colour differences under test conditions and those under reference condition is adopted. A ratio function K indicates the result of the comparison:

$$K = \Sigma(\Delta V_i / \Delta V_r)/N \quad (3)$$

$\triangle$Vr is visual difference of reference phase and (Vi is visual difference of test phase. A K value deviates from 1 indicates a parametric effect. The scattered graphs were generated by means of plotting $\triangle$Vr against $\triangle$Vi. A perfect agreement would result in the plotted points lining on the 45° line.

3. Results and Discussion

As the reliability of the psychological experiment is very important, observer precision and repeatability are calculated first. In calculation of the observer precision, individual visual data was compared with the mean visual data. In obtaining the observer repeatability, the difference between two assessments for each observer was calculated. The mean results of the observer precision and the repeatability are listed in table III. It is seen that the results of observer precision in all phases are acceptable with reference to previous studies[2,6]. Phase III to VI have similar precision of around 25.0, which are better than phase II but worse than phase I. This is because that in phase II, two samples in a pair have a 3-inch gap, which makes the visual assessment more difficult. In phase I, however, the assessments were made under the normal condition and thus the corresponding PF/3 is smallest. The observer repeatability shown in table III is also quite satisfactory. In phase IV and V, which have the coloured background, worse results are observed.

Table 3. Mean observer precision and repeatability indicated by PF/3 values.

Test item	Phase					
	I	II	III	IV	V	VI
Observer precision	18.8	28.0	24.5	24.9	25.0	24.7
Observer repeatability	25.6	22.8	13.5	28.6	27.1	16.5

Table 4. The overall K values of five test phases and the K values of each colour centre in the five test phases.

Colour Centre	Phase II	Phase III	Phase IV	Phase V	Phase VI
Orange	0.89	0.81	1.31	1.01	0.87
Yellow	0.83	0.82	1.03	1.00	0.89
Grey	0.84	0.76	0.94	1.03	0.91
Green	0.79	0.9	1.42	1.22	0.96
Blue	1.00	1.07	1.27	1.33	0.96
Grey(lightness)	1.05	0.95	1.09	1.05	0.92
Overall	0.88	0.89	1.2	1.14	0.93

The overall results of visual colour difference ratio K for each test phase and the K values of each colour centre within these five test phases are listed in Table IV. It is seen that the overall visual colour difference ratios (K) were 0.88, 0.89, 1.2, 1.14, and 0.93 for Phases II, III, IV, V, and VI respectively. These results indicate that in general the viewing parameters have effects within a magnitude of 20% on visual colour difference evaluation. The degrees of these effects vary from 7 to 20% in comparison to the reference condition. Amongst all the phases, Phase II, in which sample pairs has a gap of 3 inches, has a parametric effect of 12%. In other words, when the sample pair has a 3-inch gap, 12% smaller colour difference is perceived when compared with the reference phase. This result agrees well with what had been found in our previous study of surface colours [2]. If small size sample pairs were used in colour difference assessment, the colour difference perception is 11% smaller. The colour difference perceptions are 20% and 14% larger than those of the reference phase when the backgrounds are green (phase IV) and blue (phase V) respectively. When further analysing the K values of each colour centre in those two phases, it can be seen in Table IV that the K value of the green centre is the largest against the green background and the K value of the blue centre is the largest against the blue background. These two K values are 1.42 and 1.33 respectively. This means that the green and blue colour sample pairs exhibit 42% and 33% larger colour difference when assessed on the respective green and blue backgrounds than those of assessed on the mid-grey background. Such results strongly indicate the effect of crispening, which is an effect whereby an increased magnitude of colour difference is perceived when the background on which the two stimuli are compared is similar in colour to the stimuli themselves[7]. These results are also in agreement with our previous study of using surface colour samples [2]. In phase VI, the small parametric effect was found to be 7%, which indicates that the medium grey hairline instead of black hairline has only limited effect on colour difference assessment. The scatter plots of parametric effects for all colour pairs are shown in Figs. 2(a) to (e). It can be seen that in all the phases studied, the points are not lying on the 45° line.

4. Conclusion

In this study, we investigated the parametric effects in terms of sample separation, sample size, and the background colours using 87 pairs of CRT

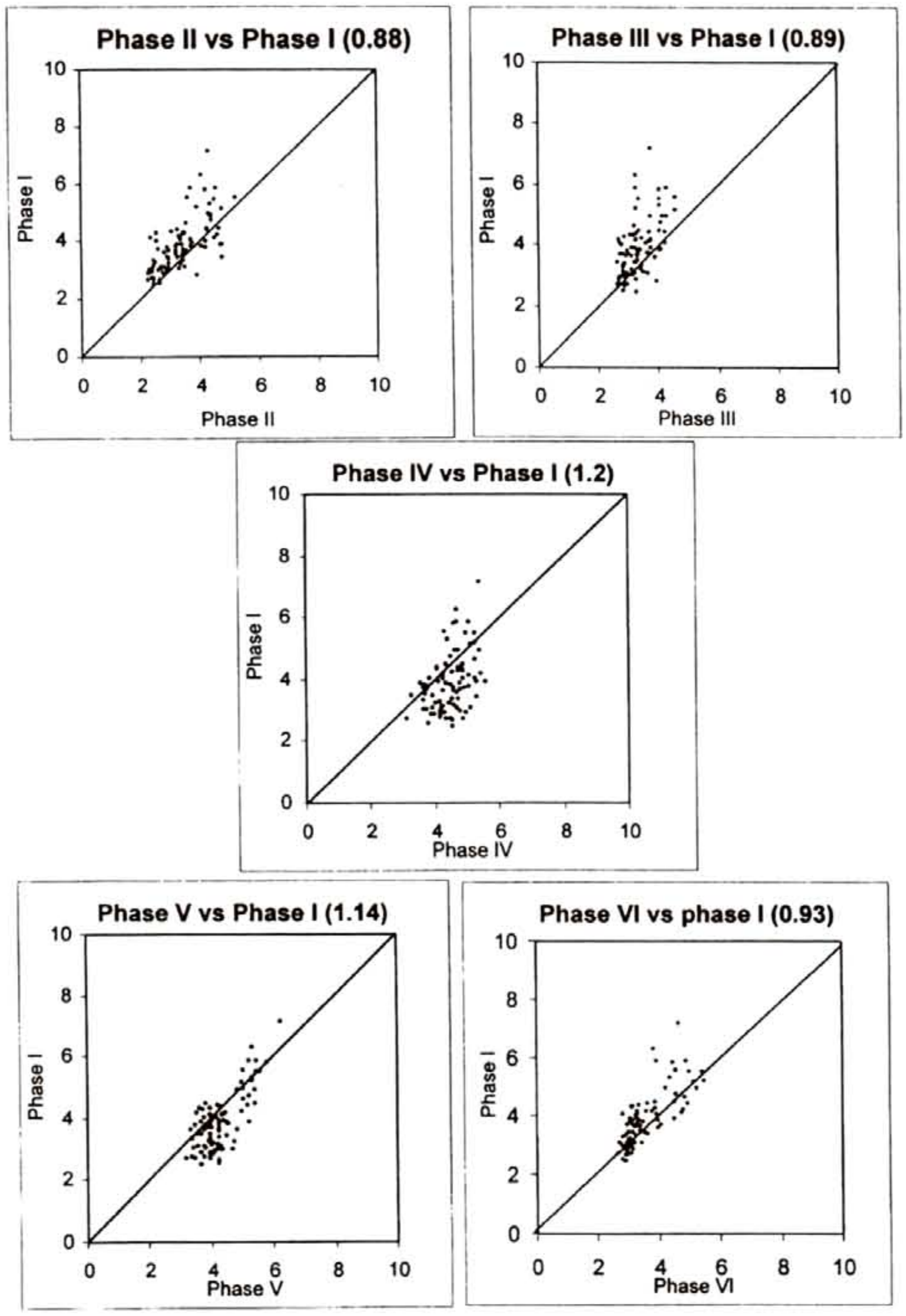

Figure 2 a-e. The visual colour differences (△V) in test phase II, III, IV, V, and VI against those of the reference

generated colour samples with an average colour difference of 5.0 CIELAB units. The parametric effects of all the six phases were found to be from 7 to 20% in comparison with the reference conditions, which indicates varying degrees of significance. However, the visual results show that the influence of background colour is the greatest among all the viewing parameters with a maximum effect of 42% found when examining similar colour sample pairs. This is considered to be attributable to the effect of crispening. More researches using other backgrounds would be carried out in the future to further evaluate the effect of crispening.

Acknowledgement

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Study of New Regression Model for Inter-Instrument Agreenent

Sidney Y. S. Chung, John H. Xin, K. M. Sin

Abstract

In previous studies, colour measurement results vary from 0.1 to 3.0 CIELAB (E units by using different spectrophotometers. Because of this poor inter-instrumental agreement, different mathematical models were developed to improve the agreement. In this study, empirical models are developed. The "Lab Model" developed can improved the inter-instrument agreement between spectrophotometers up to 42%. The other model "R Model" was also developed, which is based on the analysis of the spectral data from 400 - 700nm using regression method. The performance of the "R Model" is better than "Lab Model" and also "Bern and Petersen's Model". Applying those models to the measurement of the coloured samples, the reproducibility can be improved accordingly. The reproducibility in spectral data should benefit the global colour communication between designers, coloration companies and buyers, etc.

Keywords : spectrophotometer, Lab Model, R Model

1. Introduction

In colour-related industries, for example textile coloration, paint or printing, etc., objective colour difference evaluation is far more important nowadays. This imposes greater demand on the measurement of reflectance factors. Based on our previous continuous assessments[1], we found that the reproducibility of the two top-end dual beam spectrophotometers from different manufacturers are range from 0.575 to 0.854 CIELAB (E units. Because of this problem, different inter-instrument agreement models, "Bern and Petersen's Model".
[2],[3] were developed in order to improve reproducibility of reflectance measurement. "Bern and Petersen's Model" is a very complicated model which include the complicated matrix calculation. But in our models only simple linear regression are involved.

The poor performance of the reproducibility on the inter-instrument agreement is caused by many difference factors, for instant, the inherent design of the spectrophotometer, systematic and random error. If those errors are quantified, the regionalisation and globalisation of the digital colour communication for a variety of commercial and industrial applications can be further enhanced.

Sidney Y.S. Chung, John H. Xin, K. M. Sin
Institute of Textiles and Clothing,
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong
Phone : +852-2766-6497
F a x : +852-2773-1432
E-mail : tcrachys@inet.polyu.edu.hk

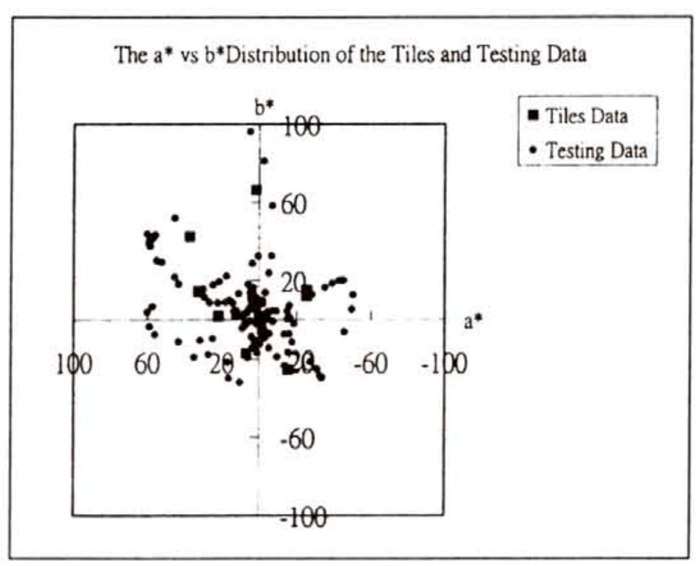
2. Experimental Samples and Instrument

2.1 Experimental Samples

Matt type of BCRA-NPL Series II Ceramic Colour Standard was selected to be the standard for the calibration of the mathematical models. In the paper, only MATT tiles calibration was reported because the textile samples are matt in nature.

And also 129 textile samples were selected to be the testing material for the mathematical models.

The L* a* b* distribution of the tiles and textile sample were plotted in the L*a* b* colour space as follow:



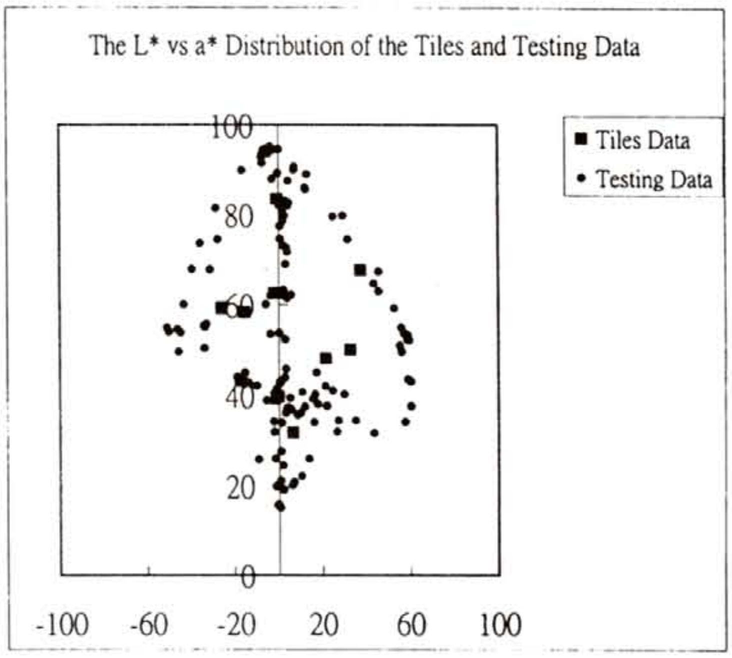


Figure 1. The distribution of tiles and textile samples in L*a*b* colour space.

2.2 Colour Measuring Instruments

Two different spectrophotometers were used in this experiment.

- COLOR-EYE®7000A (CE-7000A) from GretagMacbeth®
- Spectraflash®600 PLUS-CT (SF-600) from Datacolor International

3. Methodology

3. 1 Instrument Settings

The instrument settings are as the following :

- large area of view ;
- wavelength range : 400nm to 700nm at 10nm intervals

Both of the spectrophotometers are sphere type and only the specular component excluded (SCE) was reported in this paper.

3. 2 Sample Conditioning

All the CCS II tiles, textile samples, and reflectance spectrophotometer are well conditioned in the control laboratory (20±1°C and 68% relative humidity) 24 hours before the measurement to avoid the temperature and the humidity change which may affect the measurement result.

3. 3 Instrument Calibration

Before measurement of the tiles, all colour measuring instruments were allowed to warm up for the period recommended by the instrument suppliers. And the instrument should be well calibrated according to the manufacturer's guide by using the black and white standards provided.

3. 4 Measurement Procedure

Each tiles and textile sample should be measured once at the centre position for spectral reflectance factor from 400nm to 700nm at 10nm intervals.

3. 5 Evaluation of the Performance of the Models

After the measurement of the tiles and textile samples, the average (E units were reported in order to evaluate the performance. (All the colorimetric data[4] used in this paper was calculated using the CIELAB colour difference formula under D_{65} and CIE 1964 standard observer condition).

4. Results and Discussion

The "Lab Model" was well developed for a period of time and the results reported in this paper was based on the following three equations[5] :

Corrected L^*_{7000} value (CL^*_{7000}) = $1.005L^*_{7000} = 0.0529$ - - - EQ.1

Corrected a^*_{7000} value (Ca^*_{7000}) = $1.008a^*_{7000} + 0.007457b^*_{7000} + 0.0743$ - - - EQ.2

Corrected b^*_{7000} value (Cb^*_{7000}) = $1.011b^*_{7000} - 0.0239a^*_{7000}$ ñ 0.175 - - - EQ 3

In addition to the above model, a mathematical model, "R Model", was also developed. In this model, it is mainly derived by the reflectance value at each 10nm wavelength and the mathematical explanations are as follows :

At 400nm

Corrected $R_{(400)} = n \times R_{(400)} + o \times R_{(410)} + q$ - - - EQ.4

At 410nm - 690nm

Corrected $R_{(\lambda)} = m \times R_{(\lambda-1)} + n \times R_{(\lambda)} + o \times R_{(\lambda+1)} + q$ - - - EQ.5

At 700nm

Corrected $R_{(700)} = m \times R_{(690)} + n \times R_{(700)} + q$ - - - EQ.6

where m, n, o and q are constant.

Table 1. Inter-instrument agreement in terms of △E using the 12 MATT BCRA-NPL series II tiles

Tiles	Berns and Petersen's Model			Lab Model		R Model	
	Un-corrected ΔE	Corrected ΔE	% Improvement	Corrected ΔE	% Improvement	Corrected ΔE	% Improvement
Pale Grey	0.577	0.478	17.226	1.005	-40.311	0.094	83.709
Middle Grey	0.434	0.393	9.450	0. 299	31.152	0.066	84.793
Diff. Grey	0.419	0.375	10.564	0. 243	41.934	0.069	83.532
Deep Grey	0.209	0.173	17.048	0.209	0.027	0.092	55.981
Deep Pink	0.649	0.056	91.373	0.068	89.510	0.086	86.749
Red	0.711	0.115	85.251	0.138	82.288	0.067	90.577
Orange	0.909	0.022	94.669	0.049	88.262	0.076	91.639
Bright Yellow	0.716	0.092	89.185	0.111	86.988	0.242	66.201
Green	0.854	0.110	74.561	0.166	61.753	0.159	81.382
Diff. Green	0.78	0.374	58.906	0.492	45.919	0.234	70.000
Cyan	0.923	0.201	65.126	0.286	50.413	0.169	81.690
Deep Blue	0.871	0.421	40.840	0.499	29.824	0.241	72.331
Average ΔE	**0.671**	**0.314**	**54.517**	**0.347**	**47.313**	**0.133**	**79.049**

From table 1, we can conclude that the "R Model" shows a better performance in inter-instrument agreement, the average % improvement shows about 79% which is better that "ìBerns and Petersen's Model" and also "Lab Model".

In addition of the Matt tiles, 129 textile samples were also selected to evaluate the performance of the three different models, and the distribution of the colour difference before and after correction are shown as the following :

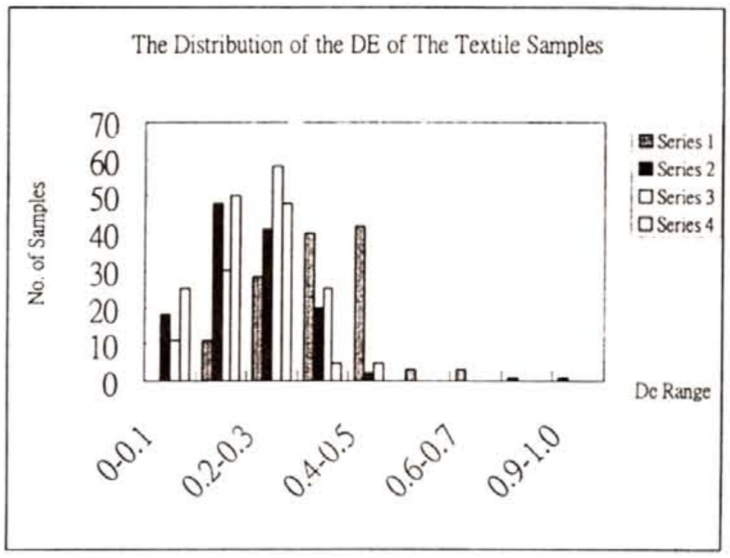


Figure 2. The distribution of the colour difference before and after inter-instrument of the textile samples by using MATT tiles as calibration data.

where:
Series 1 = Un-corrected DE*
Series 2 = Corrected DE* by Bern and Petersenís Model
Series 3 = Corrected DE* by Lab Model
Series 4 = Corrected DE* by R Model

The average △E and the %improvement for the two models are summarized in the table 2 below :

Table 2. Inter-instrument agreement in terms of average △E using the 129 textile samples (12 MATT tiles as calibration data)

		Average
Berns and Petersen's Model	Un-corrected △E	**0.421**
	Corrected △E	**0.238**
	% Improvement	**43.439**
Lab Model	Corrected △E	**0.246**
	% Improvement	**41.499**
R Model	Corrected △E	**0.210**
	% Improvement	**50.126**

From Figure 2, we can conclude that the colour differences are improvement after applying the correction models and the distribution of the (E shift to lower values.

5. Conclusion

In general, "Lab Model" and "R Model" are empirical models. However, "R Model" is a more accurate model compared with "Lab Model". Although the inter-instrument agreement result of "Bern and Petersen's Model" is slightly better than "Lab Model", "R-Model" shows a better performance compared with the other two models. In addition, the improvement of the inter-instrument agreement for the three models are around 50% in general, and this might be due to the limited number of tiles used in the calibration data.

Acknowledge

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Hue Change of Chromatic Lights in the Peripheral Visual Field

Masato Sakurai, Miyoshi Ayama, Akiyo Nakagawa, Masato Aoyama, Shoei Sugita

Abstract

Color appearance of ten different colored lights (pink, red, orange, yellow, greenish-yellow, green, bluish-green, pale-greenish-blue, blue, and violet, at the central visual field) presented across the horizontal meridian of the visual field were measured using hue and saturation judgments based on the opponent-colors theory. All the stimuli were presented in equal luminance of about 20 cd/m² with 2 deg × 2 deg square surrounded by a gray of about N5. Hue of the pink, red, greenish-yellow, green, and greenish-blue stimuli shifted toward unique yellow, and that of the violet shifted toward unique blue in periphery in both temporal and nasal visual fields. Hue of the orange, yellow, pale-greenish-blue, and blue did not change with eccentricity. Saturation for the ten stimuli all decreased from fovea to periphery with different slope of decrease in different stimuli. The present results were compared with the results of previous studies obtained using monochromatic lights.

Keywords : color appearance, peripheral vision, hue, saturation, unique hue component

1. Introduction

To investigate the property of color appearance in peripheral visual field is important for both fundamental visual science and applicative color engineering. In the previous study, we measured color appearance of red, yellow, green, and blue lights of a CRT display presented across the horizontal meridian of the visual field using hue and saturation judgments[1]. The stimulus settings were equal luminance and equal brightness at the fovea, with dark, gray, and white surround conditions. The perceived strength of the red, yellow, green, and blue components (we call it "unique hue components" here) in the stimuli decreased from the fovea to periphery under all conditions. Hue of the red and green stimuli shifted toward unique yellow in periphery, but the yellow and blue stimuli did not. This result is consistent with the hypothesis that the output of red-green opponent process decreases more rapidly than that of yellow-blue process in the peripheral retina. According to the hypothesis, the hue of yellowish stimuli at the central visual field, i.e. greenish-yellow or orange, would change toward unique yellow, and the hue of bluish stimuli toward unique blue in the periphery. Thus the first aim of this study is to examine whether the hue changes of color stimuli in between unique hues are in accordance with the hypothesis.

In the previous study, we showed the relative change of unique hue component with the eccentricity obtained using the CRT display agrees to the results of monochromatic lights reported in the literature[2)-7)]. The second aim of this study is to examine whether such an agreement between the results of complex lights and those of monochromatic lights can be found for the color stimuli of non-unique hues.

We measured the color appearance of pink, red, orange, yellow, greenish-yellow, green, bluish-green, pale-greenish-blue, blue, and violet lights of CRT display presented across the horizontal meridian of the visual field using hue and saturation judgments. The results were compared with the results of previous studies obtained using monochromatic lights.

2. Experiment

2.1 Apparatus and Stimuli

The top view of the apparatus is shown in Figure 1 The experimental booth was covered with a black

Masato Sakurai, Miyoshi Ayama, Akiyo Nakagawa, Masato Aoyama, and Shoei Sugita
Utsunomiya University
7-1-2 Yoto, Utsunomiya 321-8585, Japan
Phone : +81-28-689-6264
F a x : +81-28-689-6263
E-mail: masato@hawk.is.utsunomiya-u.ac.jp

curtain. The test stimuli, colored lights of CRT display with 2 deg × 2 deg square, were presented at six locations in the horizontal meridian : at 0, 20, 40, and 60 deg on temporal and 20 and 40 deg nasal visual field for observer's left eye by moving the fixation point. R, G, and B phosphors of the CRT display were used as Red, Green, and Blue stimuli, respectively, and a color nearly unique yellow, a mixture of R and G phosphors, was selected as Yellow. In addition to these nearly unique hue stimuli, the following stimuli were used ; YR (orange) in between Red and Yellow, GY (greenish-yellow) in between Yellow and0Green, BG2 (bluish-green) and BG1 (pale-greenish-blue) in between Green and Blue, and RB2 (violet) and RB1 (pink) in between Blue and Red. Luminance of all the0stimuli was set about 21cd/m^2. The surround of the test field was gray (about N5).

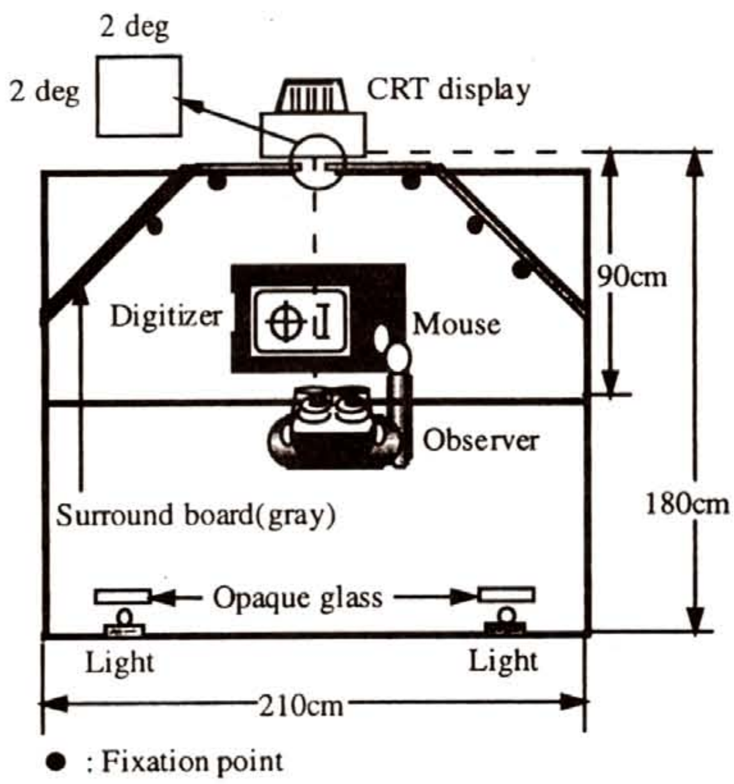


Figure 1. Apparatus

2.2 Procedure

Prior to each experimental session, the observer was light adapted for 3 min. Observer was instructed to fixate a proper fixation point, and 0.5 sec after the buzzer, the test stimulus was presented 1 sec. Then observer judged both hue and saturation of the stimulus using the opponent type color evaluation. The method is essentially the same as an opponent type color naming used in previous studies2)-7).

Instead of oral response, we employed a pointing technique using figures shown in Figure 2. The circle on the left is a hue circle based on the opponent-colors theory where four unique hues of red, blue, green, and yellow are placed at the 3, 6, 9, and 12 o'clock positions, respectively. The vertical line on the right is the saturation evaluation line where 0 % saturation lies at the bottom and 100 % saturation at the top. These figures were attached on the digitizer placed in front of the observer. Observer was instructed to respond hue and saturation perceived in the stimulus by pointing the corresponding positions on the hue circle and saturation evaluation line, respectively. The positions indicated by an observer were read out by the computer. In one session, for all of the 6 locations, all of the 10 stimuli were randomly presented. Each observer carried out 6 sessions. Two male observers (MS and TY) and two female observers (MA and AN) with normal color vision as tested by the Farnsworth-Munsell 100 Hue Test served as subjects.

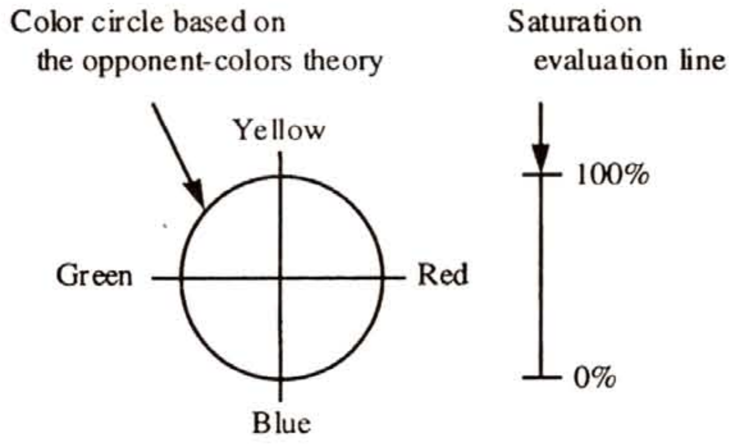


Figure 2. Opponent Type Color Evaluation

3. Results

3.1 Hue

Figure 3 shows the mean results of the hue judgment for the 10 stimuli. The abscissa indicates the hue shown in the hue circle in Figure 3. Notice that the edge of the left-hand side corresponds to unique red, and that of the right-hand side unique blue. The ordinate indicates the eccentricity in visual field, a positive and negative value shows in the temporal and nasal fields, respectively. Each symbol corresponds to the test stimulus shown at the right of Figure 3. Horizontal bars indicate the standard deviations among the observers. The results in Figure. 3 show that hue of RB1, Red, GY, Green, and BG2 stimuli shifts toward unique yellow, and that of the RB2 shifts toward unique blue as the eccentricity becomes far from the center of the visual field in both temporal and nasal sides commonly. Hue of the YR, Yellow, BG1, and Blue does not change.

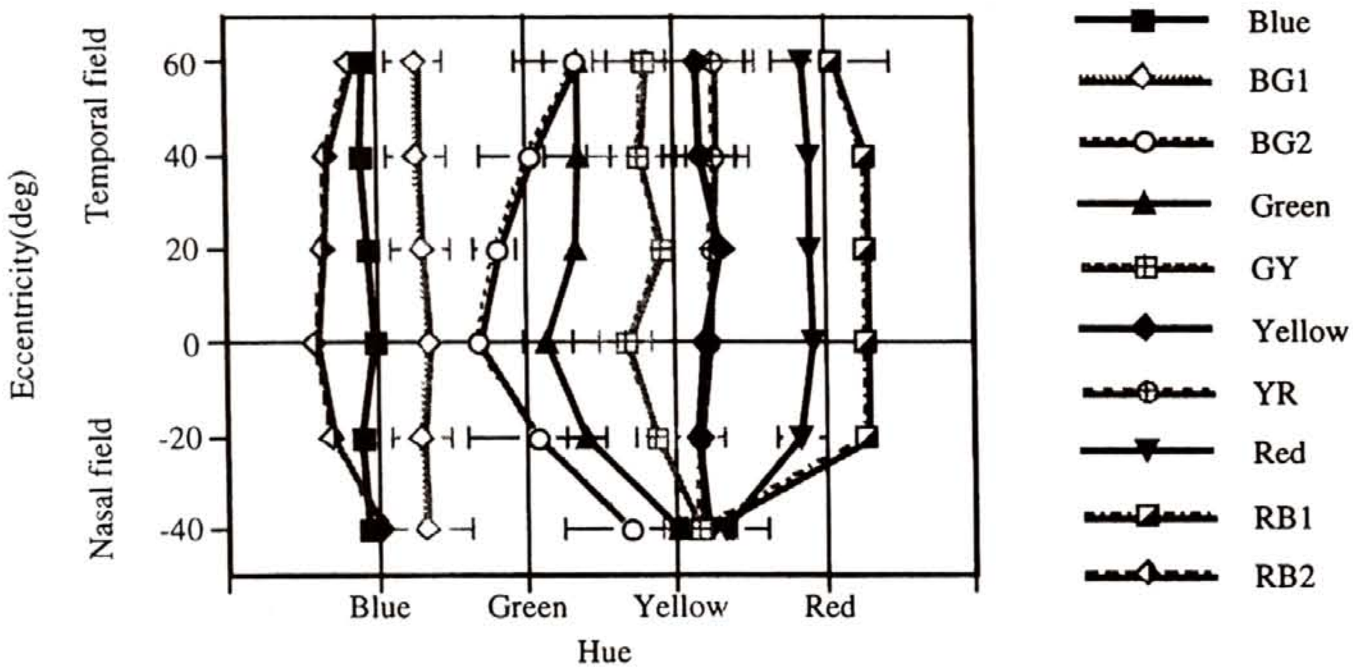


Figure 3. Hue

3.2 Saturation

Figure 4 shows the mean results of the saturation judgment for the stimuli in greenish region. The abscissa indicates the eccentricity in visual field, the ordinate indicates the percentage of subjective chromatic component, i.e. saturation, in the stimulus. Each symbol corresponds to the test stimulus shown at the top of Figure 4. These stimuli have the unique green component at 0 deg, for Green and BG2 the unique green component is dominant, while for BG1 and GY it is not. The mean result of saturation change of the unique green stimuli obtained using monochromatic lights in previous studies is also plotted by filled circles and solid line in Figure 4. It is shown that the saturation of each stimulus decreases from 0 deg to periphery more rapidly in the nasal field than in temporal field. Also comparing with the result of previous studies, only Green was the same curve.

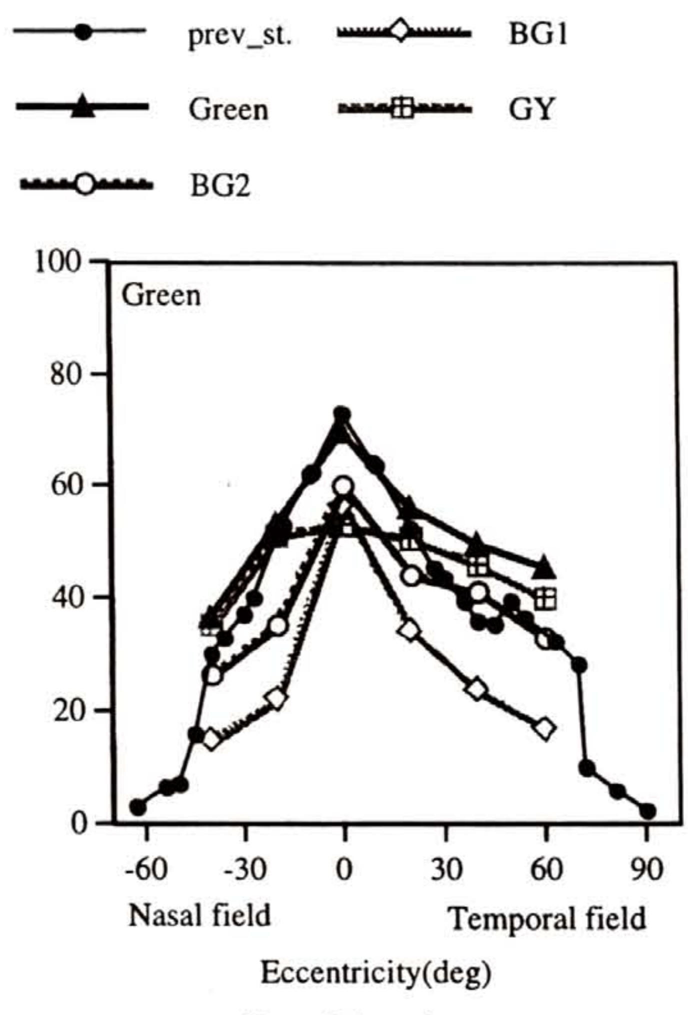


Figure 4. Saturation

3.3 Unique Hue Component

Unique hue component is a product of the saturation value and the percentage of the hue concerned. For example, if the result is 80 % saturation, and hue is 60 % (=0.6) green and 40 % (=0.4) yellow, then the unique green component becomes 80 % × 0.60= 48 %, and the unique yellow component of the same stimulus becomes 80 % × 0.4 = 32 %.

Figure 5 (a). shows the mean results of unique green component of the same stimuli as shown in Figure 4. Figure notations are the same as those in Figure 4 except that the ordinate indicates the percentage of unique green component. It is shown that the only the result of Green agree well with the mean result of previous studies. The result of BG2 is less than that of the previous studies at any eccentricity. The percentages of unique green component in BG1 and GY are poor at all the eccentricities and the curves do not agree to the results of previous studies at all.

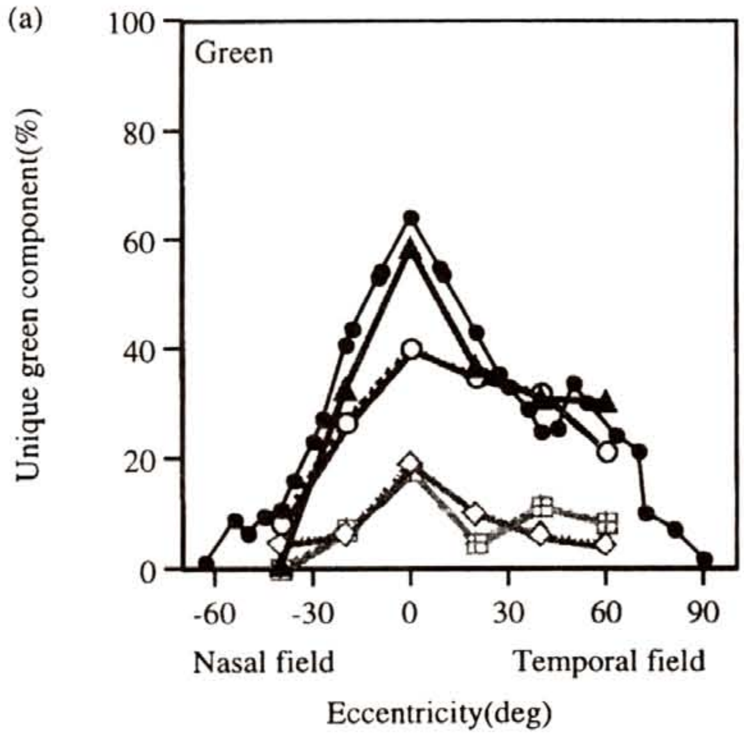
Figure 5 (b). shows the change of unique green component with eccentricity normalized at 0 deg for the same stimuli. Figure 5 (c). in a narrow frame is the original percentage of the unique green component at 0 deg. Vertical bar shown Figure 5. (c) indicates the standard deviation among previous results. As seen in Figure 5. (b), only the Green curve fits to the mean result of previous studies in both temporal and nasal fields. The curves of other stimuli deviate from the curve of previous studies especially in the temporal field. It is worth noting that only Green remain within the distribution range of previous studies shown in Figure 5. (c).

In reddish region, RB2, RB1, Red, YR, and Yellow had unique red component at 0 deg, and only Red among them showed similar curve to the mean of previous studies. In yellowish region, Red, YR, Yellow, GY, and Green had unique yellow component at 0 deg, and only YR and Yellow among them showed similar curve to the mean of previous studies. In bluish region, BG2, BG1, Blue, RB2, and RB1 had unique blue component at 0 deg, and only Blue among them showed similar curve to the mean of previous studies.

4. Conclusion

In this study, we measured the color appearance of pink (RB1), red (Red), orange (YR), yellow (Yellow), greenish-yellow (GY), green (Green), bluish-green (BG2), pale-greenish-blue (BG1), blue (Blue), and violet (RB2) lights of CRT display presented along the horizontal meridian of the visual field from 40 deg nasal to 60 deg temporal using hue and saturation judgments. The results show that hue of the stimuli near unique yellow (Yellow and YR) and unique blue (Blue and BG1) does not change with eccentricity, while the hue of other stimuli shifts toward either unique yellow and unique blue in periphery. This is apparently consistent with the hypothesis that the output of the red-green process becomes relatively weaker than that of the yellow-blue process as the eccentricity is far away from 0 deg.

However, some of the results can not be explained by such a simple model. For example, the hue of BG2 (bluish-green) and RB1 (pink) change to unique yellow, and BG1 (pale-green-blue) does not show hue change. All of these three contain unique blue component at 0 deg. For the former two stimuli, output of the yellow-blue process change from blue at 0 deg to yellow at 40 deg nasal field, whereas for the latter one, output of the yellow-blue process relative to the red-green process are kept constant.



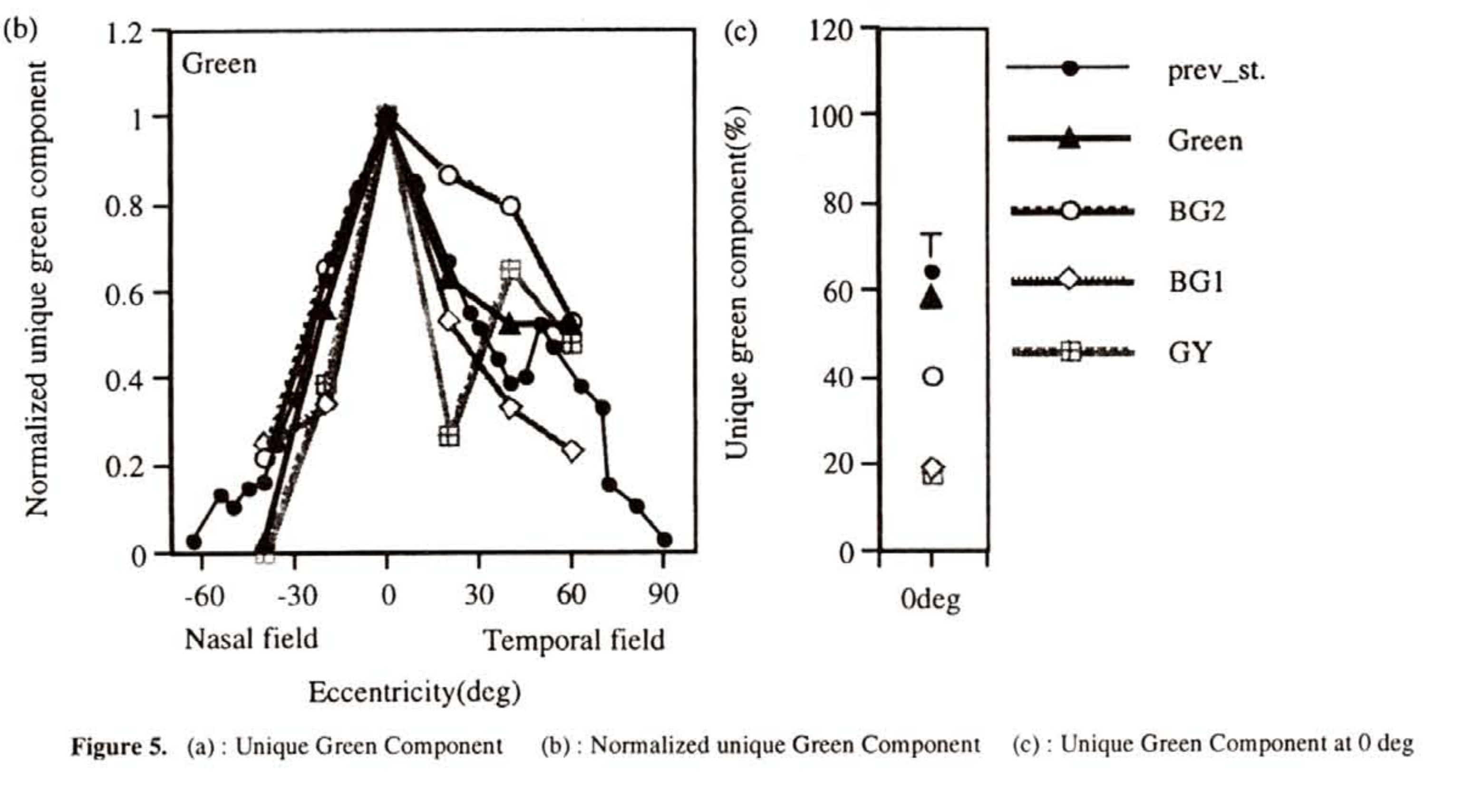


Figure 5. (a) : Unique Green Component (b) : Normalized unique Green Component (c) : Unique Green Component at 0 deg

To describe these results, the spectral sensitivity function of at least one of the opponent-processes, probably the yellow-blue process should be varied with the eccentricity.

In the unique hue component, comparing with the result of previous studies, the Red, YR, Yellow, Green, and Blue showed similar curves to the results of nearly unique hue stimuli of monochromatic lights in previous studies. This suggests that the change of unique hue component with eccentricity is not stimulus dependent so far as that unique hue is strongly dominant in the stimulus. And in order to make a color0appearance map based on unique hue component over the entire visual field (color zone map), CRT0display can be used as the stimuli.

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Color Identification Under Mesopic Lighting Environment
Effect of Stimulus Size

Masaru Ryuchi, Taiichiro Ishida

Abstract

To use colors effectively as an aid for a visual task, we need to know how colors are identified under various lighting environments. The purpose of this study is to examine the effect of stimulus size on color identification under mesopic illuminances. The subjects identified color chips by naming them using one of preselected color terms: red, orange, yellow, yellow-green, green, blue-green, blue, purple, pink, brown, white, gray, and black. The color chip was viewed through a square aperture of 4, 2, 1 or 0.5 deg in size against N5 background. The illuminance levels tested were 1000, 10, 1 and 0.1 lx. It was found that colors of the four sizes were identified in the same manner at 1000 lx. The effect of stimulus size began to appear at 10 lx. The steep decreases in the consistency of the identification occurred between 2 and 1 deg. The results will provide the basis for evaluating the color usage with considering the effects of the size and lighting.

Keywords : color identification, use of color, stimulus size, illuminance

1. Introduction

Colors are used for various ways as an aid of visual tasks, such as color signs, classification and labeling by colors. To make these color codes function effectively, we must know how colors are identified under various lighting environments 1, 2). We investigated color identifications at a wide range of illuminances from photopic to mesopic level 2). A lot of variables, however, influence the appearance of color3-5). Thinking of the use of colors, the stimulus size must be an important factor. In this research we examined the influence of the stimulus size on the identification of the color at the illuminance from photopic to mesopic levels.

2. Methods

In the present study color identification was carried out by naming color chips using one of the color terms: red (aka), orange (orenji), yellow (ki), yellow-green (ki-midori), green (midori), blue-green (ao-midori), blue (ao), purple (murasaki), pink (pinku), brown (cha), white (shiro), gray (hai), and black (kuro). Japanese color terms used in the experiment are given in the parentheses.

The experiment was carried out using 76 Munsell color chips which were selected from the Value of 4, 6 and 8 planes. A color chip tested was placed on a desk with black surface. Then it was covered by a N5 thick paper (38 x 25 cm) with an aperture of 4.0, 2.0, 1.0 or 0.5 cm. The color chip was viewed through the aperture at a distance of about 50 cm. Thus we tested the stimulus sizes of 4.0, 2.0, 1.0 and 0.5 deg of visual angle. The inside of the experimental booth was illuminated by fluorescent lamps(National, high color rendering type, FLR40S-N-EDL/M) attached to a ceiling of 2.4 m high. The chromaticity coordinates of the illumination measured at the center of the desk were $x = 0.34$, $y = 0.35$. The 4 illuminance levels, 1000, 10, 1 and 0.1, were examined in the experiment.

The 76 color chips were divided into 4 groups in randomized order; each group consisted of 19 colors. An experimental session which consisted of 4 blocks corresponding to each of the 4 stimulus size conditions was conducted under one of the 4 illuminances. Within each block, the colors from one of the 4 groups were presented one at a time. A subject was given an instruction before the experiment. Their task was to give a color name to

Ryuchi Masaru, Ishida Taiichiro
Dept. of Architecture and Environmental Design, Graduate School of Engineering, Kyoto University
Yoshida-Honmachi, Sakyo-ku, Kyoto, 606-8501, JAPAN
Phone : +81-75-753-4766
F a x : +81-75-753-4766
E-mail hm.ryuchi@archi.kyoto-u.ac.jp
ishida@archi.kyoto-u.ac.jp

the color chip by using one of the 13 color terms described above. No time limit was imposed.

The subjects adapted to the illuminance of the session for 10 minutes before starting trials. The 16 sessions per subject were needed to complete the entire set of the 76 color chips at the 4 size and 4 illuminance conditions. This consisted of 1216 trials per subject.

The experiment was conducted with 3 subjects having normal color vision from the author's laboratory.

3. Results and Discussion

Figure 1 shows the results of the color identification for the color chips of Value 6 at 1000 lx . The results of each of the 4 size conditions are plotted separately. A symbol in the plot shows a color chip tested in the experiment. The three answers for a color by the three subjects are combined in this figure. The abbreviation of a color term is given to each color chip if more than 2 subjects gave the same color term to that color. That is, a blank symbol means that the color was given three different color terms by the three subjects. A plot symbol with a double circle indicates that the color was identified by the same color term by the three subjects.

As we can see from Fig. 1, the answers by the subjects agreed well in the 4 deg condition. The colors are consistently identified as "orange", "yellow", "yellowish green", "green", "blue" or "purple". In addition, the results obtained from 4 deg in Fig. 1 exactly agree with the data in the same condition by 15 subjects in our previous study2), indicating the subjects in the present study may identify colors in the standard manner. The colors in the 2 deg condition were identified similarly as in 4 deg condition. Although the agreement of the identification was slightly decreased in the 1 and 0.5 deg conditions, considerable changes with the size did not occurred under 1000 lx.

The results of Value 6 at the illuminance of 10, 1 and 0.1 lx are shown in Figs. 2-4 as in Fig.1. At the illuminance of 10 lx (Fig. 2), the color identifications in 4, 2 and 1 deg conditions were almost similar. Coming to 0.5 deg, however, the color identifications were drastically changed; the agreements of the answers greatly decreased. In addition, it seems that "yellow" and "green" elements in the color sensation decreased. At the illuminance of 1 lx (Fig. 3), "blue" responses entered into "green" region and "orange" responses into "pink" region. The similar changes with illuminances were observed in the previous experiment2). The agreement in the identifications declined in all stimulus size, among all, it was remarkable in 1 and 0.5 deg conditions. Coming to 0.1 lx (Fig. 4), the agreement in color identifications was almost lost. Although chromatic color sensations seemed to remain slightly in 4, 2 and 1 deg conditions, the most of colors were judged as gray in 0.5 deg condition.

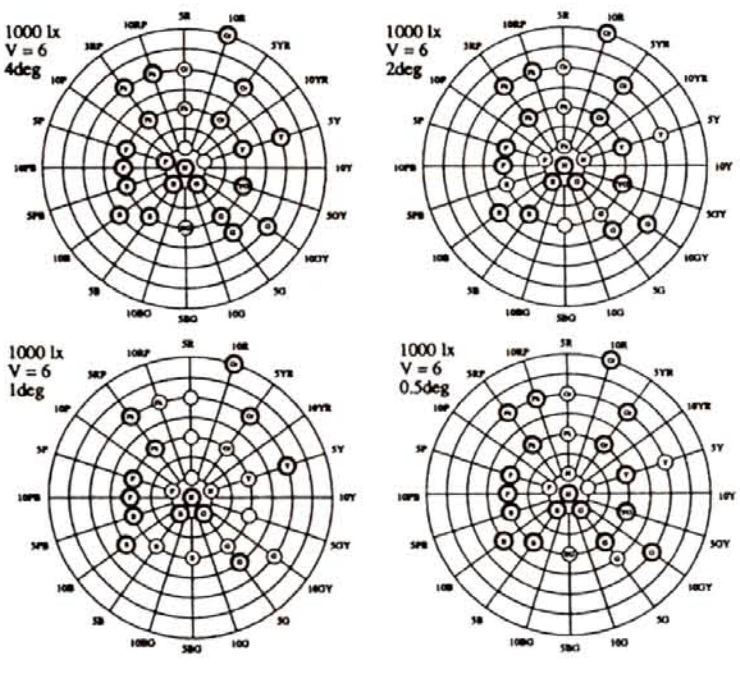

Figure 1. The results of the color identification:Value 6, 1000 lx
A symbol with the abbreviation of a color term indicates that the color was identified as the same color by more than 2 subjects. A symbol with a double circle indicates that the color was identified as the same color term by the 3 subjects. A blank symbol indicates that the color was given three different color terms by the three subjects.

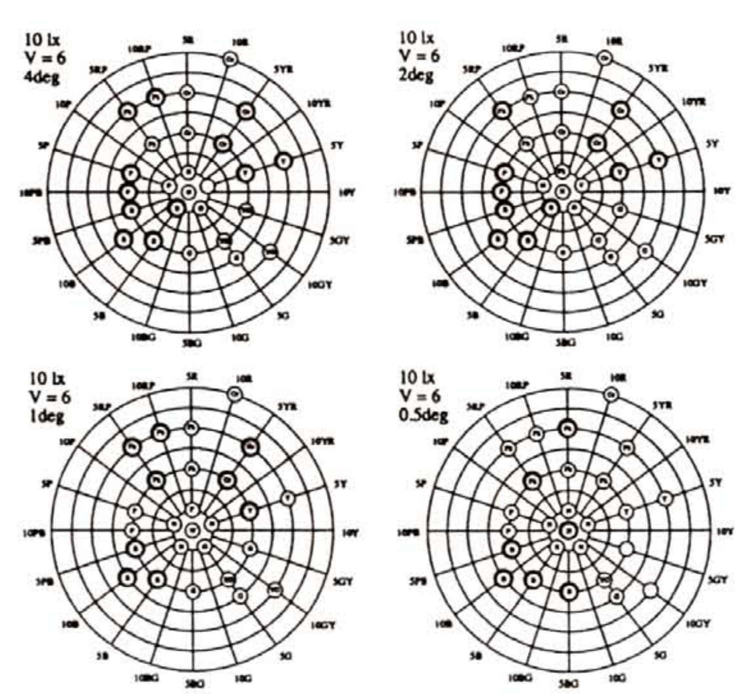

Figure 2. The results of the color identification:Value 6, 10 lx
The symbols are plotted as in Fig.1.

The color identifications of the Value 4 and 8 chips showed similar changes with the illuminance and size conditions. In Fig. 5(a), the percentage of the agreement colors to all of the 76 colors was plotted

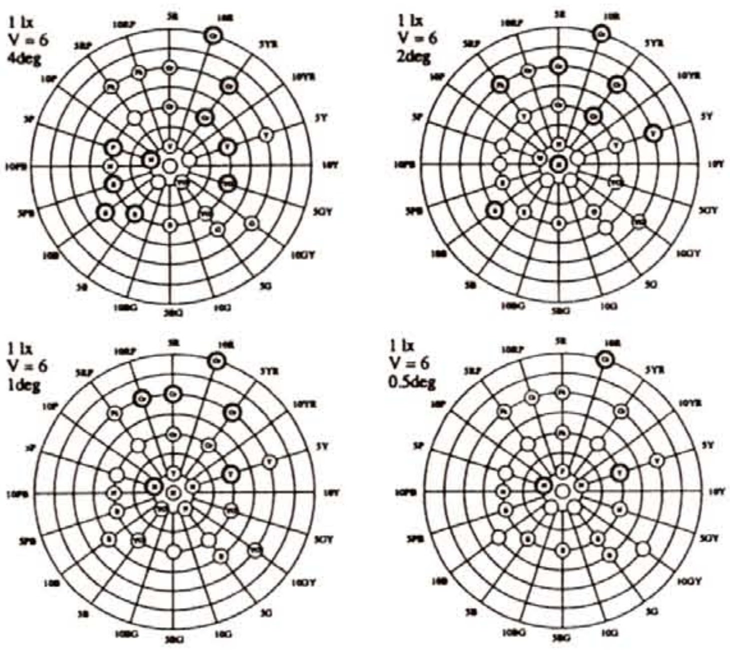

Figure 3. The results of the color identification :Value 6, 1 lx
The symbols are plotted as in Fig.1.

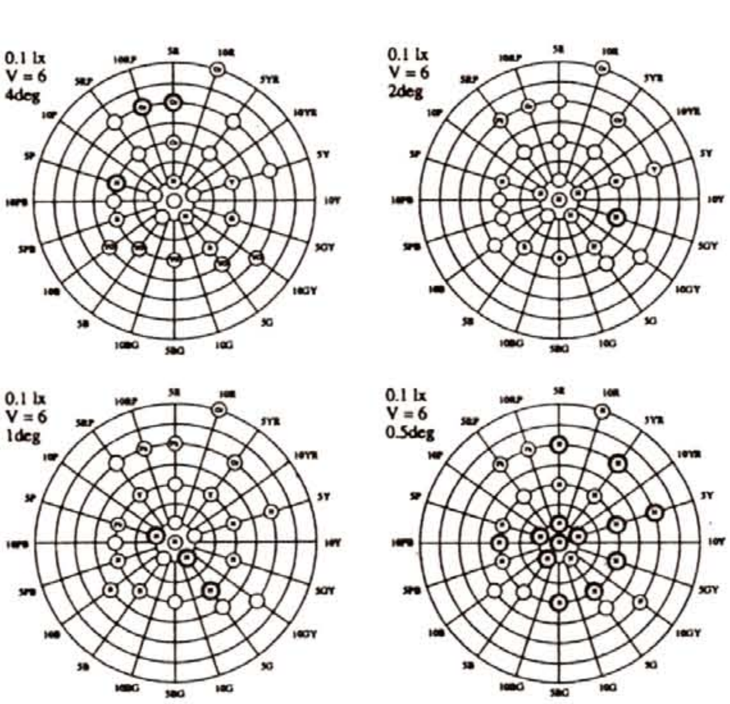

Figure 4. The results of the color identification:Value 6, 0.1 lx
The symbols are plotted as in Fig.1.

against the size of the color samples for the four illuminance conditions. Here we call the color which was given the same color term by more than two subjects as the agreement color. We can see from this figure that the percentages of the agreement are high in 1000 and 10 lx conditions, and decrease with the illuminance. On the other hand, it seems that the percentages of the agreement colors do not decline with reducing the size of colors. However, this does not mean that the identification of the colors are consistent though the size conditions. The colors tended to be identified as achromatic colors in the lower illuminance and the smaller size conditions, which raise the percentage in the agreement.

Next we summed up the colors which were the agreement colors and were identified as chromatic colors. Fig. 5(b) presents the percentage of the chromatic agreement colors to the 76 colors. Again, the percentage of the chromatic agreement colors remarkably decreases at the illuminance lower than 10 lx. In addition, it is clearly shown that the subject's agreements in giving chromatic color terms decrease with reducing the size.

Fig. 6 shows the number of the color chips which were identified as achromatic plotted against the size for the four illuminance conditions. At the illuminance above 1 lx, the number of the achromatic identifications stay nearly constant for 4 and 2 deg, but it significantly increases for 1 and 0.5 deg. Coming to 0.1 lx, the rate of achromatic responses suddenly increase, especially there is abrupt increase at 0.5 deg condition.

From the view of the use of color, it is important to know how the color identification changes from a standard viewing condition. Here we consider the 4 deg color size under 1000 lx as the standard condition. Moreover, we refer the color which was the agreement color and was given the same color term as in the standard condition as the consistent color. Fig. 7 shows the percentage of the consistent colors to the 76 colors. As can be seen from this figure, at 1000 lx, the color identification was in good agreement among the subjects, and it was almost constant for the changes in the size. However, the percentage of the consistent colors considerably descended with the illuminance. In addition, the steep declines in color identification occurred between 1 and 2 deg.

The results of the present study will afford the basis for the design and evaluation of colors as an aid of visual task with considering the effects of the size and lighting. Further investigation, however, must be required to improve the reliability of the data.

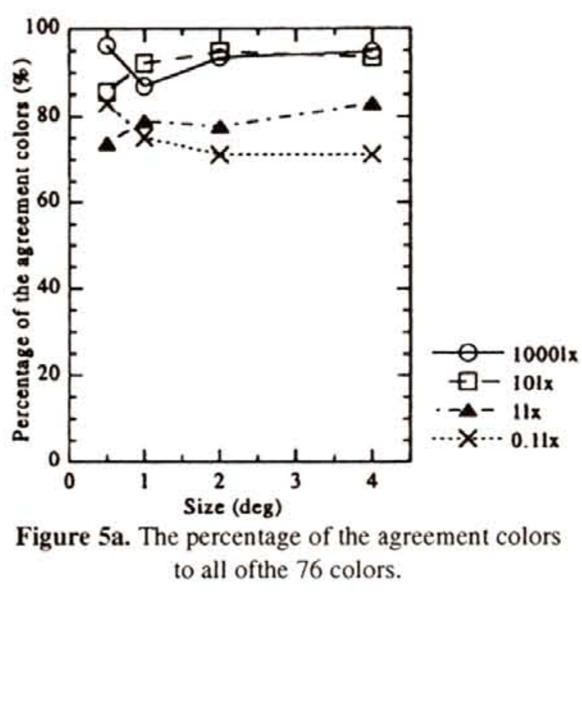

Figure 5a. The percentage of the agreement colors
to all ofthe 76 colors.

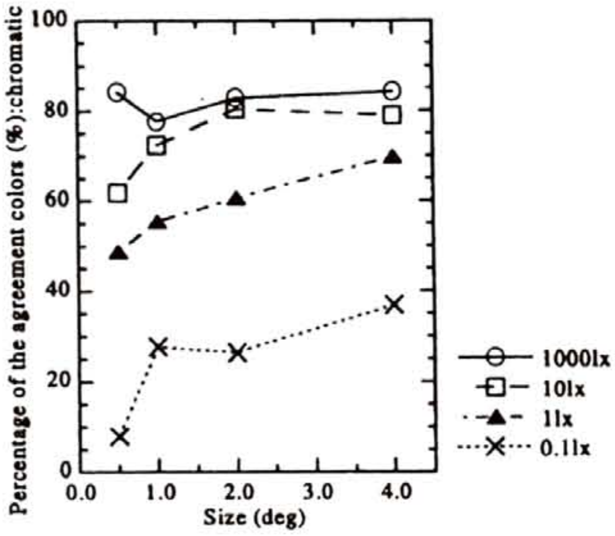

Figure 5b. The percentage of the chromatic agreement colors to the 76 colors.

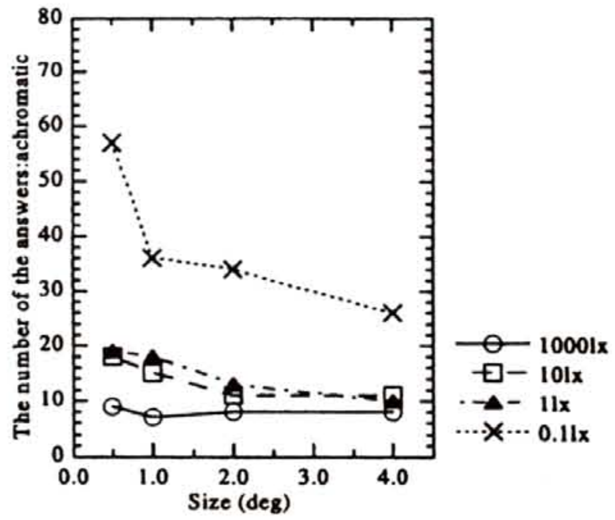

Figure 6. The number of the color chips which were identified as achromatic.

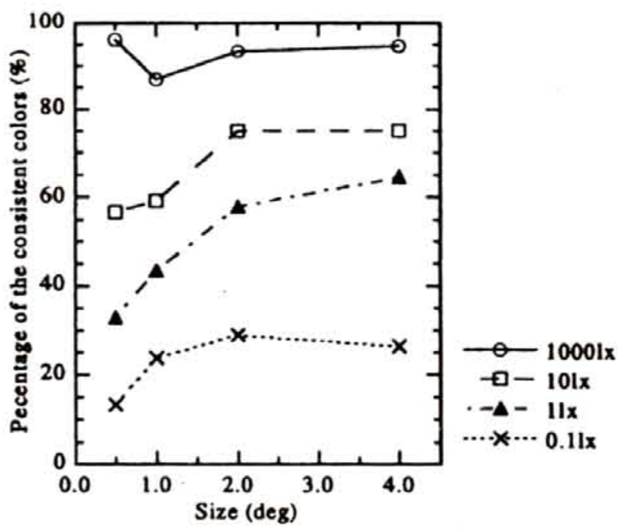

Figure 7. The percentage of the consistent colors to the 76 colors.

Acknowledgments

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Assimilative Color Shift Introduced by Change in Perceived Size

Hiroyuki Shinoda, Mitsuo Ikeda

Abstract

Colors of fine or small patterns appear less colorful or less saturate than original colors do. This phenomenon is called color assimilation. Its spatial characteristics were investigated in terms of perceived size. Appearance of color grating was assessed by color matching procedure at several vergence angles while the retinal size was kept constant. The perceived size was also measured as a function of vergence angle. Our results showed that the extent of color assimilation depends on perceived size: at larger vergence angle, the perceived size become smaller and the color of constituent stripes changes toward a spatially averaged color, in spite of constant width of stripes on a retina. They imply that assimilation might occur not at retinal level but at cortical level in the visual system.

Keywords : color perception, color assimilation, color contrast, size perception, vergence angle

1. Background

Assimilation is a well-known phenomenon observed in a color pattern: individual color appears to shift toward their neighboring color. The smaller or finer a color pattern is, the larger such shift in color appearance become and the weaker the perceived color contrast become. This spatial property of color assimilation has been well established by several studies where color appearance of patterns was measured for various pattern sizes and viewing distances[1-4]. The spatial characteristics of assimilation has been accounted mostly by the resolution limit of the early stage of visual system, such as the optical performance, the distribution of photoreceptors, and the size of receptive fields.

In the experimental settings of previous studies, the retinal size and the perceived size were inseparable as in normal observation conditions: larger/smaller perceived size was brought about by larger/smaller retinal size. But without change in retinal size, the perceived size could be changed, for instance, by manipulating an observer's vergence. The authors[5] have shown that the perceived size affects the visual acuity : the acuity improves/deteriorates at larger/smaller perceived size.

Hiroyuki Shinoda, and Mitsuo Ikeda
Photonics, Ritsumeikan University
1-1-1 Nojihigashi, KUSATSU, SHIGA 525-8577, JAPAN
Phone : +81-77-561-2844 Fax : +81-77-561-2663
E-mail: hshinoda@se.ritsumei.ac.jp

Since the visual acuity is the most primitive and fundamental character of vision, the following question arises: which of retinal size or perceived size of patterns is essential to the spatial characteristics of assimilation mechanism. Does perceived size have anything to do with the phenomenon mentioned above? Or just retinal size of a pattern defines its spatial characteristics? Here we address a question whether the change in the perceived size or fineness of color patterns causes the assimilative color shift.

We conducted two experiments. In experiment 1, appearance of color gratings was assessed by color matching at several vergence angles. In experiment 2, we obtained the perceived size as a function of vergence angle and examined two contributions from perceived size and retinal size to the mechanism of color assimilation.

2. Experiment1 : Appearance of Color Gratings at Various Vergence Angles

2.1 Apparatus

The retinal size and the perceived size are inseparable in normal situations. In order to manipulate the perceived size independently of image size on a retina, we controlled a subject's vergence angle using a stereoscope-like apparatus shown in Figure 1. A subject fused two images presented on two CRTs (SONY 21 inch GDM-2000TC) through two mirrors labeled M in Figure 1. Presentation of stimuli was controlled by Apple

PowerMacintosh 7500/100. The distance from an each eye to the screen was 40cm. Exact same stimuli were presented on the both screens but their position was shifted horizontally so that subject's vergence angle could be varied while the optical distance being kept constant. For instance, presenting a stimulus at the place labeled G makes a subject's vergence angle θ, and presenting it at G′ brings θ'. We controlled and defined the subject's vergence angle by this horizontal shift from the center d (cm) as shown in Figure 2. Its direction was defined positive as a left/right stimulus goes to the left/right. Positive value of d brings smaller vergence angle (divergence) and negative value larger vergence angle (convergence). Presenting both stimuli in the center of the screen, d=0cm, simulates a normal viewing condition where a subject looks at a single stimulus presented on the screen 40cm away.

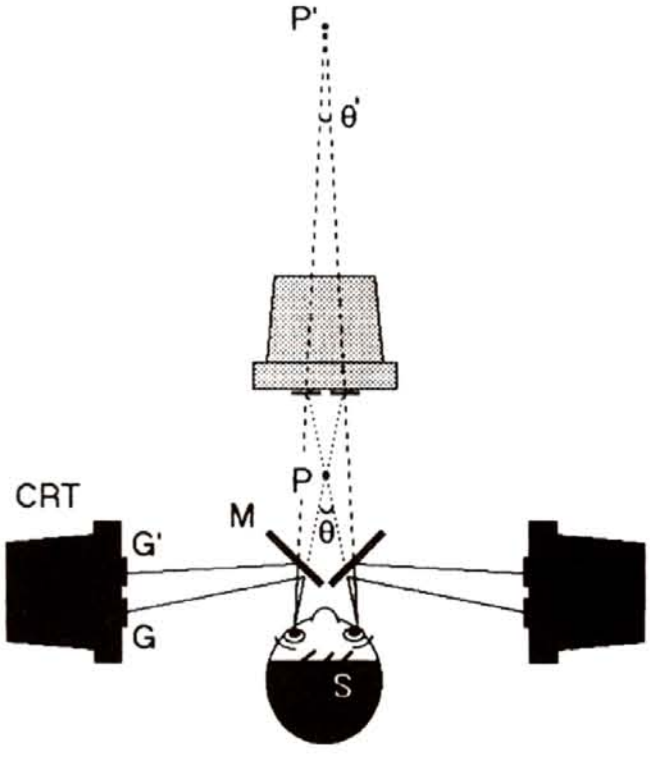

Figure 1. Schematic diagram illustrating experimental setting. Two monitors were placed on both sides of a subject.

2.2 Stimuli & Conditions

Color gratings were composed of two horizontal stripes of equal width called 'target stripes' and 'flank stripes', as shown in Figure 2. In all the gratings the color of the flank stripes was light gray (L). The color of the target stripes was one of either colors red (R), green (G), blue (B), or dark gray (D). The CIE xy chromaticities and luminance for these colors are shown in table 1, along with those for a white surround W. The color of the target stripes was matched with a color of a solid matching square presented 0.41cm (0.29deg) below the grating. Both of the grating and the matching square, 4.1cm x 4.1cm (2.9deg x 2.9deg) square, were presented in a white surround W. The color of the matching square M was varied along a straight line in the CIE XYZ color space that connects colors of the target and the flank stripes. The colors L, R, G, B, D, W, and the lines connecting them are shown in Figure 3.

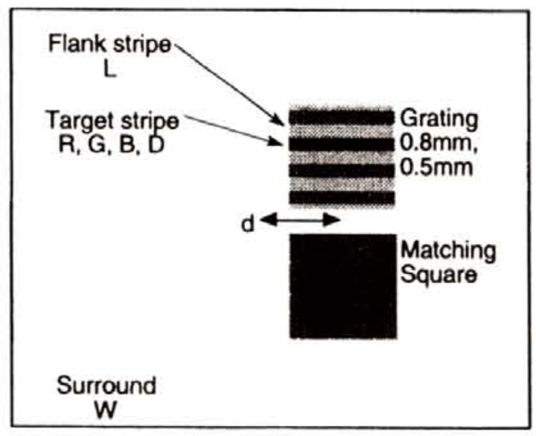

Figure 2. Stimuli configuration on one of the screens.

In the figure, a matching color M is, as an example, on a line between L and G. Here we introduce the assimilation index AI, as a measure of color assimilation. The assimilation index was defined as relative distance between a target and a matched color, to the distance between the target and a 'spatially averaged' color. When a target color was matched with an exact same color as an original color, AI become zero, and when matched with the spatially averaged color, AI become unity. If the width of stripes in a grating is finer than the resolution limit of visual system, two stripes should merge and AI should be unity. Positive value of AI stands for color assimilation and negative value of AI, color contrast. To examine the contribution of the retinal size to the color assimilation mechanism, we adopted two different stripe widths : 0.81 and 0.54 mm (3.44 and 2.15 min.). Thus we prepared 8 different gratings. Color matching was carried out at four different horizontal displacements : d = 2, 0, -2, -4cm.

Table 1. Luminance and CIE xy chromaticities of the gratings and the surround

Color	Y(cd/m2)	x	y
L	43.08	0.318	0.337
R	17.27	0.480	0.340
G	21.01	0.298	0.464
B	16.80	0.269	0.262
D	20.77	0.316	0.335
W	87.24	0.318	0.338

2.3 Task & Procedure

Subjects' task was to adjust the color of the matching square M so that its color matches to the color of target stripes in a given grating. One session

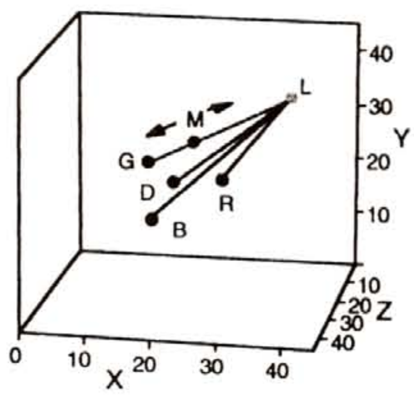

Figure 3. Colors of stripes in CIE XYZ color space. A color of the matching square was varied along a line connecting two colors of constituent stripes.

was composed of 8 blocks of matchings. In a single block subjects made four color matchings with a same grating at different d. In half of the sessions, matching was done in descending order of d, and in other half the matching was done in ascending order. After a few minutes dark adaptation the experimental session started. A subject adjusted the color of the matching square M through a trackball. A grating was kept presented on the screen during an entire block, that is, after a subject completed a color matching, the grating was dragged from current position to the next position.

2.4 Subjects

Four subjects, HS, YM, HY, HH participated in the experiment. They all had normal color vision verified by Ishihara plate. Subject YM and HH did the experiment with a pair of contact lenses, and subject HY with a pair of spectacles. Subject HS did twenty sessions of experiment and the other subjects ten sessions.

2.5 Results

As examples, results of color matching from subject HS are shown in Figure 4. A left graph shows AI as a function of vergence angle for stripe width of 0.81mm, and a right graph for stripe width of 0.54mm. The horizontal displacement of stimuli d(cm) is plotted along an abscissa. Four different symbols correspond to the colors of target stripes. Standard deviations for L-D and L-B gratings are shown by error bars. These graphs show large shifts in AI with vergence angle : AI increases as d(cm) decreases. In other words, the color of stripes appear to shift toward the spatially averaged color as vergence angle becomes larger. Since accommodation co-varies normally with vergence, one might claim that

misaccommodation by vergence could cause blurring of retinal images and optical one might claim that

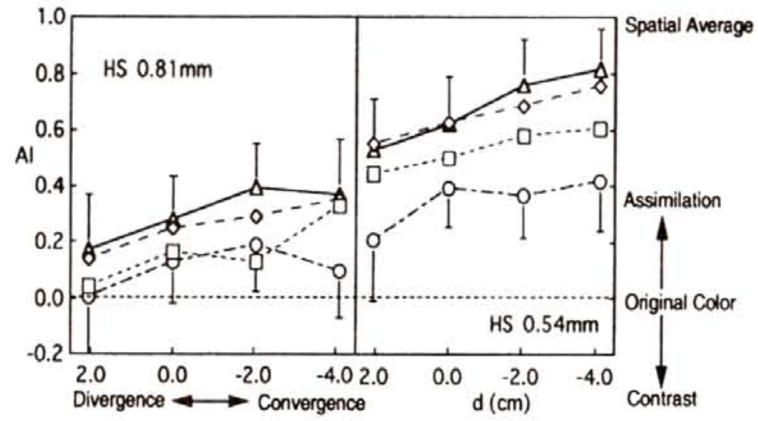

Figure 4. Assimilation index (AI) as a function of horizontal displacement of stimuli (d). Left chart shows AI for the gratings of 0.81mm width ; right chart for those of 0.54mm. Squares represent L-R grating ; diamonds, L-G grating; circles, L-B grating; triangles, L-D grating

misaccommodation by vergence could cause blurring of retinal images and optical averaging in patterns. If that account were correct, AI would be lowest at d=0cm. However no subjects reported blurred image of gratings. What is more, AI was lower at d=2cm than that at d=0cm, which rejects the account by an artifact of misaccommodation. All subjects reported the grating and matching square appeared larger/smaller at larger/smaller d(cm), which suggests that perceived size determines color assimilation. All subjects showed the same dependency of AI on vergence angle but the slope was varied subject by subject. The assimilation index was higher for stripe width of 0.54mm than that for 0.81mm. Since 0.54mm stripes obviously appear narrower than 0.81mm stripes, the elevation in AI from 0.81mm to 0.54mm might be stemmed from change in physical width itself but rather from change in perceived size. To make sure that, we quantified the perceived size as a function of vergence angle in experiment 2.

3. Experiment2 : Perceived Size as a Function of Vergence Angle

3.1 Apparatus

We used the exact same apparatus as used in experiment 1.

3.2 Stimuli & Procedure

Subjects' task was to adjust the horizontal displacement d(cm) of a grating so that the perceived size of the grating matches to that of a reference square of various sizes. The gratings in this experiment were identical to those used in experiment 1. The sizes of the reference square were

0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1.05, 1.1, 1.15, and 1.2 times of that of the grating. The color of reference square was always L.

First, a reference square was presented in the center of the screen, d=0cm. As a subject presses a button after memorizing its perceived size, the reference square was replaced by one of the gratings. The subject adjusted its horizontal diplacement d(cm) through a trackball to replicate the perceived size of the reference square. The subject repeated this procedure if necessary. The grating and the size of the reference square were randomly chosen and presented trial by trial. One session consisted of 72 trials. 9 sizes x 8 gratings, of perceived size matching. The same four subjects as in experiment 1 participated in experiment 2.

3.3 Results

Results from subject HS are shown in Figure 5. The horizontal displacement d(cm) of the grating square is plotted against the relative size of the reference square, which displacement were required for the same perceived size as that for the reference squares displayed in the center. As expected, small/large vergence angle (large/small d) was required to achieve large/small perceived size. Data points were missing at smallest and largest relative sizes since this subject was not able to achieve the same perceived size by manipulation of vergence angle. Solid and dashed horizontal lines are drawn at d=-4, -2, 0, 2, which value of displacement were used in experiment 1. Intersections of these lines and the curve of experimental data give the relative perceived size in experiment 1 (vertical lines in Figure 5). Using these values, assimilation indices obtained in experiment 1 were replotted against relative perceived width of stripes in Figure 6. The relative perceived width for 0.81mm stripes at d=0cm was defined unity and those for 0.54mm stripes were 0.54/0.81 times those of 0.81mm stripes. Note that AI goes down with perceived width. To put it other way, as stripes appeared narrower, assimilation become stronger.The slope varied depending on subjects, which reflects inter-subjects variance in the effect of perceived size on assimilation. For instance, gentle slopes for YM indicates small contribution from perceived size. Furthermore this subject shows large gap between the curves for 0.81mm and 0.54mm stripes, which indicates retinal size mainly determines assimilation. On the other hand, steep slopes for subject HH indicates large contribution from perceived size to assimilation. For subjects HS, HY, and HH, two curves for 0.81mm and 0.54mm seem to lie on a certain single curve, which means not retinal size but perceived size is essential to color assimilation. Thus, the perceived size obviously affects the color assimilation though the size of effect varies among subjects. These suggest the assimilation might occur not at lower retinal level, but at higher cortical level in the visual system.

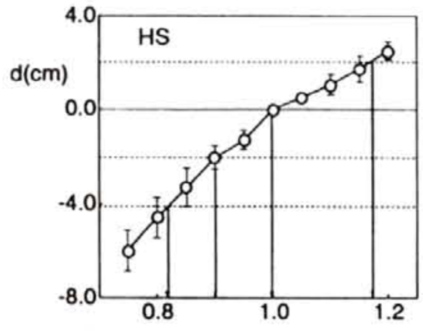

Figure 5. Horizontal displacement d(cm) of the grating square required to replicate the same perceived size for the reference presented in the center of the screen. Subject HS. The size of the reference square is plotted along the abscissa. Error bars show the standard deviations for 40 matchings.

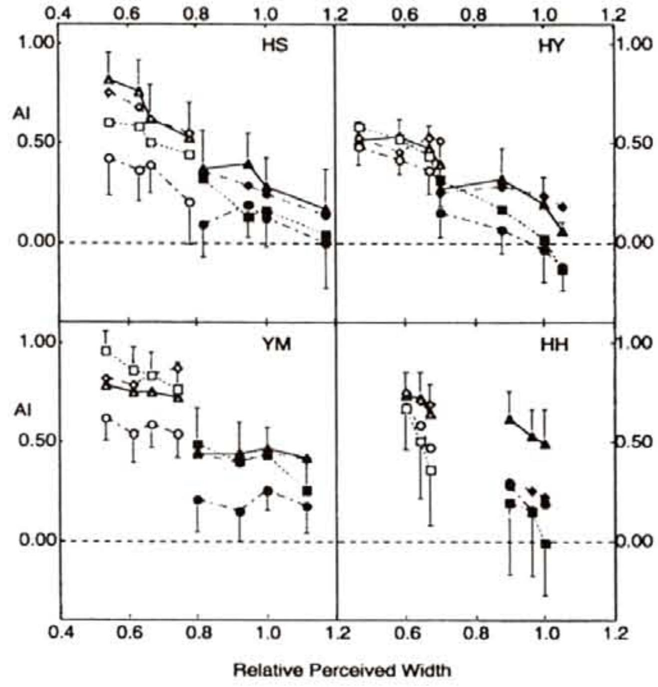

Figure 6. Assimilation indices as functions of relative perceived width of stripes. Relative perceived width is scaled so as to be unity for 0.81mm stripes viewed at d=0cm. Open symbols represent 0.81mm stripes and solid symbols 0.54mm. Perceived width for 0.54mm stripes were obtained by multiplying those of 0.81mm by 0.54/0.81. Symbol notation is identical to that in Figure 4.

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The Developing of Color Taste Scaling and its Application in Cosmetics

Song Kyung-Suk, Lee Hae-Sun, Kim Jong-Il

Park Soo-Kyung, Lim Hyo-Bin

Abstract

The purpose of this study is as follows : 1) To develop a method to measure Koreans' emotions by modifying the taste scaling method developed in Japan 2) To understand Koreans' emotions by classifying consumers into groups according to their lifestyles, purchasing patterns and tastes, particularly for men's cosmetics 3) To utilize this method in market research and in the receptacle design.

Taste research with the visual boards of basic colors and colorations and others (12) - each with at least 12 or a maximum 25 pictures - was conducted on consumers who have experienced purchasing men's cosmetics. Data was analyzed on computer by use of the frequency analysis, the taste factor analysis and the cluster analysis to classify 8 consumer's groups, according to the emotional taste factors.

As a result, 8 types of consumer groups were categorized : Group A "Ideal-oriented romantic"20.6%, Group B "Safety-oriented traditional" 7.2%, Group C "Emotional pleasure-seeking cute" 18.8%, Group D "Noble Elegant" 11.3%, Group E "5Humble pride dandy" 7.8%, Group F "Matured splendid gorgeous" 6.6%, Group G "Clear sporty"10.9%, Group H "Innovative modern" 16.9%. The result of the study was reflected in the development of a receptacle design for men's cosmetics.

**** This study has been consulted with Mr. Tohru Hirasawa, of the Image Marketing Institute, with his innovative taste scaling method.***

Keywords : Taste Scaling, Emotion, Life Style, Cosmetics, Cluster Analysis

1. Introduction

Modern society is regarded as the age of great information, emotion, variety, individuality, and, also, the age of material goods, leisure, wealth and prosperity.

In this age of abundance, most of people do not satisfy themselves only with the material itself, but with its quality. People satisfied with the quality of the material choose products which satisfied their emotions, the softer side of image or taste. So much so that we can say that the emotional evaluation is given priority over the rational evaluation.

Today, every field of society is becoming versatile. New levels of fields are being developed, segmented, detailed, minimized and individualized. Therefore, it is desirable to segment a market not as generations, but as preferences.

Kyung-Suk Song, Hae-Sun Lee, Jong-Il Kim, Soo-Kyung Park, Hyo-Bin Lim
Pacific Corporation / Marketing Department 181, Hankang-Ro 2 Ka, Yongsan-Ku, Seoul, 140-777, KOREA
Phone : +82-2-709-5656 Fax : +82-2-709-5559
E-mail: kssong@pacific.co.kr

2. Aim

It is most important to consider the preference of emotional value on the individualized mini-masses, because today's market is not a large scale of mass, but a conglomeration of mini-masses.

Therefore, the purpose of this study is to classify several looks of emotional objects according to emotional words based on peopleís objective image and taste, to draw a visual map of diagram and to understand the principles and the rules of preference.

3. Color Taste Scaling

3.1 Definition of Color Taste Scaling

This study was conducted to classify various emotional preferences of peopleís five senses not so much sensationally as scientifically, and to choose a design policy for a specific group of people with the market proportions.

The emotional evaluations of the people's five senses regarding the design elements of products, advertisement and surroundings will be plotted on the basic axes, X and Y, respectively, as follows.

The first basic axis is classified in view of dynamic and static taste, the second one is classified in view of feminine and masculine tastes, and the middle axis is positioned by added values of emotional evaluations in view of the two former basic axes.

3.2 Detail of Color Taste Scaling

Figure 1 shows various example diagrams of the emotional preference classification in this study.

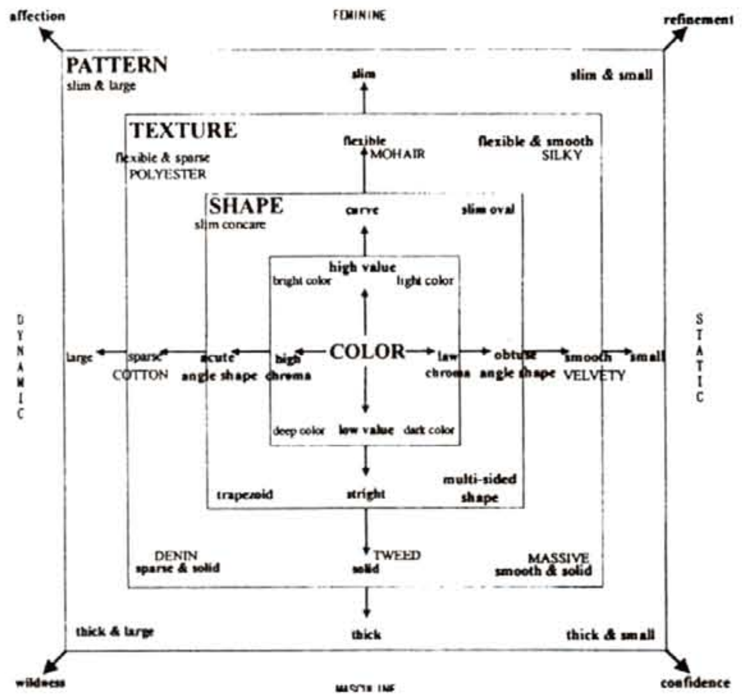

Figure 1. The emotional preference evaluated classification diagram

The scope of taste scaling is defined as the emotional value measurements of personal sense of sight, sound, taste, smell, touch, and the emotional design measurements of product color, texture, shape, function, etc.

For example, of colors on the first basic axis of dynamic and static taste, high chroma color preferences, such as vivid color tones, will be considered dynamic taste, and low chroma color preferences, such as gray color tones, will be classified as static taste.

On the second basic axis of feminine and masculine tastes, high value color preferences, such as white or pastel color tones will be considered feminine taste, and low value color preferences, such as black or dark color tones, will be classified as masculine taste. Moreover, high chroma and high value color preferences such as bright color tones will be considered feminine and dynamic (parallel taste), and low chroma and low value color preferences such as dark gray color tones, will be classified as masculine and static (parallel taste).

Consequently, the taste scaling will be based on the five personal senses and four design elements.

4. Example of Developing Men's Cosmetics by the Taste Scaling

4.1 The Purpose of Research

The purpose of this study is to develop a method to measure Koreans' emotions by modifying the taste scaling method developed in Japan, and to understand Koreans' emotions by classifying consumers into groups according to their lifestyles, purchasing patterns and tastes, particularly for men's cosmetics.

4.2 Experimental Subject

Main subjects were consumers who have experienced purchasing men's cosmetics. Ages ranged from the late teens to the 40's. Subjects resided in Seoul and nearby cities. 80% of the subjects were female and 20% of the subjects were male, to mirror the gender percentages of actual purchase of menís cosmetics. The quota sampling method was used to experiment with the same proportion of each age.

4.3 The Collection of Data

The research was conducted from June 1 to June 10, 2000 with 320 subjects.

4.3.1 Primary collection of data(Emotional taste research)

Basic colors and colorations were collected, including pictures of female and male garments, shoes, bags, watches, figures, entertainers, flowers, cars, interiors and landscapes. 15 to 25 pictures in each field were chose to be in four quarter of the two basic axes, feminine / masculine and dynamic / static, and the visual boards for research were made.

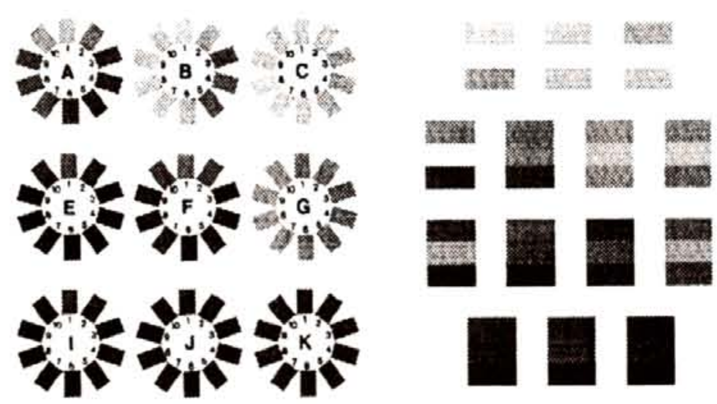

Figure 2. Examples of visual boards for research

4.3.2 Secondary collection of data

(emotional preferences, lifestyles and cosmetic usage)

The questionnaires for recognition, purchases, and usage of menís cosmetics, their values, consciousness, lifestyles, and social demographical properties were analyzed to understand the general properties of experimental subjects.

Each subject chose two most likes and two most dislikes among the pictures in each visual board.

4.4 Data Analysis and Results

Data was analyzed on computer by use of the frequency analysis, the taste factor analysis and the cluster analysis to classify 8 consumer groups, as shown in Figure 3, according to the emotional taste factors.

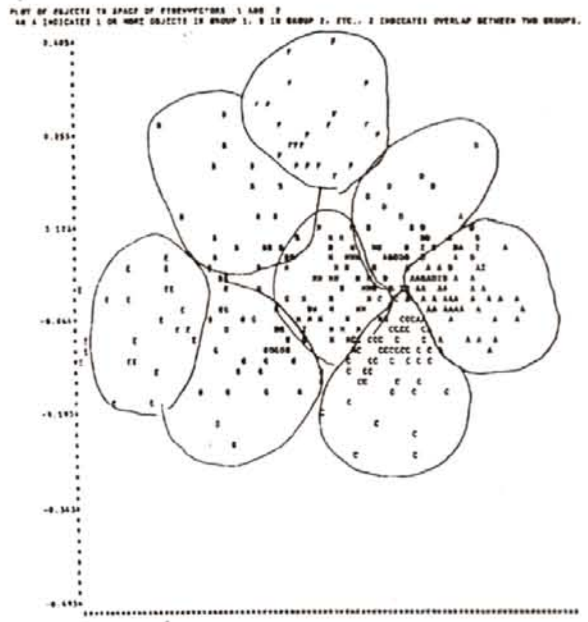

Figure 3. The result of cluster analyses

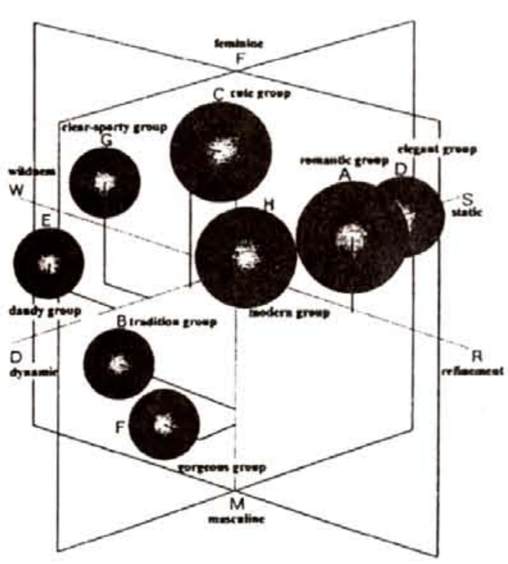

Figure 4. The solid distribution of emotional clusters

The frequency analysis conducted on each type of preference helps to understand the correlation between a type of preference and a type of factor and the frequency analysis on purchases, use, lifestyles and social demographical properties helps to understand the specific property of each consumer emotional cluster, as shown in Figure 4.

4.5 Details and Results of Emotional Clusters

In this report, the profiles of eight consumer groups and the taste scaling of colors and garments are introduced.

4.5.1 Group A : "Ideal-oriented romantic" 20.6% (The largest group)

60% of residents living to the south of the Han River show urban elegance. This portion of the subjects are concerned about not only health or disease, but also about the environment. They display interest in traveling, culture and the arts and have high dreams or desires for a joyful and cheerful life. The favorite colors of this group are vivid, middle tones and fresh-original and warm-middle colors. Coloration preferences include bright, tinted color, which displays emotions of soft-casual, soft-elegant, elegant and gorgeous. Preferential garments for both male and female are garments with a tall and slim silhouette and a light and soft texture. The women's dress displays elegant, gorgeous and pastel color tones and the men's dress displays an urban suit of elegant gray

4.5.2 Group B : "Safety-oriented traditional" 7.2%

A majority of males (30%) and teen-agers (40%) are found in this group. This group places emphasis on family, home, friends, and life stability. They show interest in health, medicine, sports and the economy and they prefer to adhere to tradition or habit. This group can be considered to follow the safe or middle ground. Favorite colors of this group are coolly mild and slightly dull colors of simplified gray. Coloration preferences display an unpolished beauty or folk-like nuances, such as romanticism, ethnicity, etc. This group favors matching or "twin" looks for men and women. They pursue quality and preferred highly traditional forms of garments and accessories in thin and thick textures.

4.5.3 Group C : "Emotional pleasure-seeking cute" 18.8%

This is the second largest group and is comprised of 85% women. This realistic and emotional pleasure-seeking group are interested in living a cheerful social life and a peaceful home life. Favorite colors include brilliant bright tones, original vivid tones and original strong tones such as gorgeous colors. Coloration preferences run to the feminine look of pastel tones displaying cute, romantic, noble and soft-elegant images. The women's dress is characterized by shanghai colors and different textures and the men's dress is the urban and modern suit. Light and low-heeled shoes and luxurious bags are preferred.

4.5.4 Group D : "Noble Elegant" 11.3%

This delicate, emotional, noble and elegant group displays interest in culture and the arts. This well-informed and educated group are devoted to self-improvement or self-development, such as a healthy and stable home life and to the education of their children. Favorite colors are mild middle colors of bright and light tones. Coloration preferences are for the low chroma colors, which display a simplified chic emotion, excluding contrasts of formal or elegant. Both the men and women prefer a chic and social style of dress, with a soft touch and a high dense texture. "Non-gorgeous", monotone colors and a mature and dressy look is preferred.

4.5.5 Group E : "Humble pride dandy" 7.8%

Comprised of a majority (70%) of younger people and 40% of people from areas neighboring Seoul, this group desires for self-trust and health. They enjoy shopping and reading and these educated people (this group had the largest number of college graduates) understand culture and the arts. Favorite colors are diversified, including pale, strong and dull colors. Coloration preferences display a noble, feminine and dandy image mingled together with a masculine and self-confident image. The women's dress is of a very precautionary style, which portrayed their unique expression. The men's dress, consisting mainly of dark suits, tends towards a look of urban roughness. Precautionary and conservative styles are preferred for shoes and bags.

4.5.6 Group F : "Matured splendid gorgeous" 6.6%

This group is comprised of people in their 20's and 30's, residing mainly in the northern part of the Han River or in areas neighboring Seoul. They display dreams of success and self-improvement. They are interested in a stable life and a happy marriage and displayed interest in culture and the arts. Favorite colors are simplified grayish, dark and very dark tones as low value colors. Coloration preferences display sporty, classic, gorgeous, mature and wild images. Both men and women prefer a mature and sophisticated style of dress and high-quality shoes and bags.

4.5.7 Group G : "Clear sporty" 10.9%

This group is a free, active, and sporty group, interested in home life, culture, arts, economy, and sports. They enjoy reading editorials and were confident about their health. Favorite colors are bright, pale, dull and grayish tones. Coloration preferences for the three original colors shows a certain exciting mix of romantic, noble and dynamic images. Men and women both prefer casual, free and active styles of dress and sporty and active shoes and bags.

4.5.8 Group H : "Innovative modern" 16.9%

This innovative group is very trendy and urban with styles running towards the traditional and boyish. This group is sensitive to advanced and futuristic phenomena and is interested in sports and health. They enjoy splurging on vacations or hobbies and they are focused on self-innovation and self-development. Favorite colors are pale and dull grayish and neutral tones of black and white. Coloration preferences display a romantic, elegant, gorgeous and fresh image. Both men and women display an innovative and progressive style of dress of mildly dense and transparent textures. Shoes and bags are plain, practical and functional.

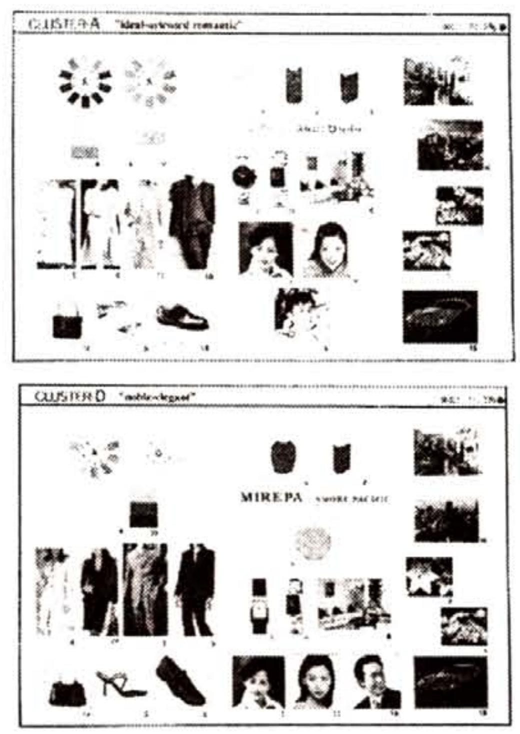

Figure 5. Examples of visual boards of groups, A and D

5. Conclusion

Among the eight cluster groups mentioned above, groups A, D, and H, whose styles are most in keeping feminine styles, were selected. Their preferences for color and shape (middle color tones and rectangular and circular shapes) will be used as the basis for the design of receptacles for men's cosmetics. This study is thought to be a good marketing example of the use of the emotional marketing method with consumer research and its application to direct product development in the cosmetic industry.

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Psychological Study on the Preference for Fair Skin in China

Miho Saito

Abstract

Fair skin recently becomes one common desire in Asian women, which epitomizes feminine beauty. In order to better understand the aspiration for fair skin, one in-depth study among Chinese was conducted to study Asian women's psychological images and preference for color and texture of the skin. Nine photographs of the skin (cheek) which involved both information on color and texture of the skin were used as stimuli. The subjects were to choose three most appropriate photographs for each word on the list, which was consisted of 25 words representing personal images. The results were analyzed by binomial test and Fisher's exact test. Positive impression such as beautiful, cute, healthy, vivid, likable, clean, and attractive were mainly due to the finer texture. The results suggested that the texture, as well as color, play an important role for the personal impressions.

Keywords : preference for skin color and texture, personal images, study of Chinese women, cognition on beauty

1. Introduction

Beauty is a world common aspiration, but perceptions of what make a woman beautiful vary across cultures. Many reports in Asia indicated that unlike much of the Western world, one common desire in Asian women is fair skin that epitomizes feminine beauty. In fact, it has been reported that the sales figures of "whitening products", which make skin fairer, brighter and clearer soared to an annual total of approximately 1.7 billion dollars in Asian cosmetic market last year. Moreover, some old proverbs in Asian countries are actually telling that girls with fair skin have the benefit of covering their bad sides both in their personality and their appearance. These facts above show that the fair skin has been preferred for many years in Asian countries.

Saito (1996) has reported a comparative study on the preferences for fair skin among Japanese and Indonesian women to understand their strong aspiration for fairer skin psychologically and culturally. For each of 52 words described personal images, the subjects were to rank in order four colored-paper samples representing fair skin to dark skin. Each of these colors was the average rate, which represented Japanese skin color. The study showed that fair skin was preferred with its images of weakly, delicate and aristocratic. The study also suggested some cross-cultural differences among two countries on the psychological images of fair skin.

Miho Saito
Waseda University, School of Human Sciences.
2-579-15, Mikajima, Tokorozawa, 359-1192, JAPAN
Phone : +81-42-947-6769
F a x : +81-42-948-1993
E-mail : miho@human.waseda.ac.jp

2. Aim

Although the appearance of the skin contains both information of color and texture, the stimuli of the previous study were colored-paper and did not involve the aspect of texture. Further study for the integrated evaluation with both aspects of color and texture was required together with another study carried in other Asian area to find Asian women's strong preference for fair skin. The main purpose of this study is to research Chinese women's psychological images and preference for color and texture of the skin, The study was carried in Beijing, China and thirty women aged 20 to 40 were selected as the subjects.

3. Method

Nine photographs of Chinese women's skin (cheek) were used as stimuli. The photographs involved both information on color (fair, medium, and dark from Chinese skin color data) and texture (fine, medium, and rough) of the skin. Table 1 indicates the level of the texture and L*a*b* of nine (A to I) stimuli. The finer the texture, the values are smaller in this table.

Table 1. Texture and L*a*b* of the stimuli

	stimulus A	stimulus B	stimulus C	stimulus D	stimulus E	stimulus F	stimulus G	stimulus H	stimulus I
Texture (0-100)	0.00	11.25	0.00	20.00	50.75	0.00	20.50	42.25	58.25
L*	75.51	75.93	69.17	68.98	69.29	63.25	51.83	52.78	51.25
a*	26.25	27.81	15.06	15.19	15.43	7.57	-10.51	-8.27	-11.60
b*	28.64	27.26	25.34	21.67	23.61	22.81	10.19	11.69	14.06

The subjects were asked to choose three most appropriate photographs for each word on the list, which was consisted of 25 words representing personal images, i.e., weakly, clean, quiet, elegant, passive, feminine, arrogant, conservative, gently, beautiful, cute, eye-catching, old, intelligent, likable, attractive, merry, intimate, disagreeable, characteristic, looks-tired, slovenly, healthy, vivid, serious. The results were analyzed by binomial test and Fisher's exact test.

4. Results

Table 2 to Table 10 show the rank order of each stimulus with the results of binomial test. The main results are as follows :

(1) The stimuli with fine texture were associated with beautiful, likable, cute, healthy, vivid, clean, feminine and attractive images.

(2) Elegant, gentle, arrogant, eye-catching and intelligent images were associated stronger when the stimuli were not only fine but also fair.

(3) According to the analysis by binomial test and Fisher's exact test, these positive images were mainly due to the texture.

Table2. Rank order (stimulus A)

stimulus A		%
beautiful	27**	90.0%
cute	27**	90.0%
likable	26**	86.7%
clean	24**	80.0%
healthy	23**	76.7%
feminine	23**	76.7%
eye-catching	23**	76.7%
elegant	22*	73.3%
gently	22*	73.3%
attractive	22*	73.3%
weakly	22*	73.3%
vivid	21*	70.0%
intelligent	20 †	66.7%
quiet	19	63.3%
arrogant	15	50.0%
intimate	12	40.0%
characteristic	12	40.0%
merry	11	36.7%
serious	7	23.3%
conservative	6	20.0%

** p<0.01, * p<0.05, † p<0.1

Table3. Rank order (stimulus B)

stimulus B		%
merry	17	56.7%
weakly	15	50.0%
serious	14	46.7%
elegant	12	40.0%
gently	12	40.0%
feminine	11	36.7%
intelligent	10	33.3%
intimate	10	33.3%
quiet	9	30.0%
eye-catching	9	30.0%
clean	8	26.7%
arrogant	8	26.7%
conservative	8	26.7%
attractive	8	26.7%
cute	7	23.3%
beautiful	6	20.0%
likable	6	20.0%
characteristic	6	20.0%
vivid	6	20.0%
passive	5	16.7%

** p<0.01, * p<0.05, † p<0.1

Table4. Rank order (stimulus C)

stimulus C		%
likable	27**	90.0%
beautiful	26**	86.7%
healthy	24**	80.0%
clean	24**	80.0%
cute	24**	80.0%
attractive	24**	80.0%
elegant	23**	76.7%
feminine	23**	76.7%
vivid	23**	76.7%
characteristic	22*	73.3%
arrogant	21*	70.0%
weakly	20 †	66.7%
intelligent	19	63.3%
eye-catching	19	63.3%
quiet	16	53.3%
serious	13	43.3%
merry	11	36.7%
intimate	11	36.7%
conservative	6	20.0%
passive	2	6.7%

** p<0.01, * p<0.05, † p<0.1

Table5. Rank order (stimulus D)

stimulus D		%
passive	17	56.7%
slovenly	16	53.3%
conservative	10	33.3%
disagreeable	10	33.3%
looks-tired	8	26.7%
intelligent	7	23.3%
quiet	6	20.0%
merry	6	20.0%
characteristic	6	20.0%
serious	5	16.7%
clean	4	13.3%
feminine	4	13.3%
weakly	3	10.0%
elegant	2	6.7%
old	2	6.7%
intimate	2	6.7%
vivid	2	6.7%
cute	1	3.3%
eye-catching	1	3.3%
likable	1	3.3%
attractive	1	3.3%

** p<0.01, * p<0.05, † p<0.1

Table6. Rank order (stimulus E)

stimulus E		%
old	24**	80.0%
looks-tired	15	50.0%
disagreeable	14	46.7%
intimate	13	43.3%
passive	12	40.0%
merry	11	36.7%
slovenly	9	30.0%
serious	8	26.7%
conservative	8	26.7%
quiet	6	20.0%
elegant	6	20.0%
arrogant	6	20.0%
healthy	5	16.7%
gently	4	13.3%
eye-catching	4	13.3%
attractive	4	13.3%
clean	4	13.3%
weakly	3	10.0%
feminine	3	10.0%
intelligent	3	10.0%

** p<0.01, * p<0.05, † p<0.1

Table7. Rank order (stimulus F)

stimulus F		%
vivid	23**	76.7%
likable	22*	73.3%
beautiful	20 †	66.7%
cute	20 †	66.7%
healthy	20 †	66.7%
eye-catching	18	60.0%
attractive	18	60.0%
clean	17	56.7%
quiet	17	56.7%
weakly	16	53.3%
elegant	16	53.3%
merry	16	53.3%
feminine	15	50.0%
arrogant	15	50.0%
gently	15	50.0%
intelligent	15	50.0%
characteristic	12	40.0%
intimate	9	30.0%
serious	8	26.7%
slovenly	6	20.0%

** p<0.01, * p<0.05, † p<0.1

Table8. Rank order (stimulus G)

stimulus G		%
conservative	12	40.0%
intimate	11	36.7%
arrogant	9	30.0%
serious	9	30.0%
merry	8	26.7%
slovenly	7	23.3%
characteristic	7	23.3%
gently	7	23.3%
intelligent	6	20.0%
looks-tired	5	16.7%
weakly	5	16.7%
elegant	5	16.7%
passive	5	16.7%
feminine	5	16.7%
healthy	4	13.3%
eye-catching	4	13.3%
vivid	3	10.0%
old	2	6.7%
disagreeable	2	6.7%
	1	3.3%

** p<0.01, * p<0.05, † p<0.1

Table9. Rank order (stimulus H)

stimulus H		%
disagreeable	25**	83.3%
old	24**	80.0%
looks-tired	23**	76.7%
passive	21*	70.0%
slovenly	19	63.3%
conservative	16	53.3%
serious	5	16.7%
weakly	4	13.3%
merry	4	13.3%
characteristic	4	13.3%
quiet	3	10.0%
elegant	3	10.0%
intimate	3	10.0%
feminine	2	6.7%
clean	1	3.3%
arrogant	1	3.3%
eye-catching	1	3.3%
intelligent	1	3.3%
	0	0.0%
	0	0.0%

** p<0.01, * p<0.05, † p<0.1

Table10. Rank order (stimulus I)

stimulus I		%
old	30**	100.0%
looks-tired	25**	83.3%
disagreeable	24**	80.0%
passive	20 †	66.7%
slovenly	16	53.3%
conservative	10	33.3%
elegant	9	30.0%
intimate	7	23.3%
serious	5	16.7%
characteristic	4	13.3%
arrogant	3	10.0%
intimate	3	10.0%
quiet	2	6.7%
weakly	1	3.3%
clean	1	3.3%
elegant	1	3.3%
beautiful	1	3.3%
intelligent	1	3.3%
healthy	1	3.3%
gently	1	3.3%

** p<0.01, * p<0.05, † p<0.1

(4) On the other hand, darker skin with rough texture made negative impression such as old, looks-tired and disagreeable to Chinese women.
(5) Slovenly and passive images became stronger when the stimuli had skin troubles such as pimple and wrinkle.
(6) Serious and conservative personal images were relatively independent of color and texture of the skin.

5. Conclusion

Whereas Saito's study in 1996 indicated that fair skin had weakly impression, the fairest stimulus in this study indicated healthy, beautiful and cute impressions, rather than weakly image. It was obviously caused by the added aspect of texture in the stimuli. In fact, fairer skin tends to make weakly impression; however, its image could be changed by finer texture. These results suggested that the texture, as well as color, might play an important role for personal images in our social interaction.

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Prediction of the Degree of Pollution of Reactive Dyeing Effluent by Using Computer Colour Matching Technique

Keith W.Y. Kwok, John H. Xin, K.M. Sin

Abstract

The concern over the condition of the environment has grown tremendously in recent years. Most industries use water at some point in their processes producing wastewater in various composition and concentration. The textile dyeing industry is no exception, using extremely large quantity of water in various stages of production. Effluents of dyes and their associated chemicals are usually considered as the source of water pollution. In order to reduce the environmental pollution at the source, an attempt has been made in this study to assess the environmental properties, for example, Chemical Oxygen Demand (COD) and Total Kjeldahl Nitrogen (TKN) of various reactive dyes before dyeing and the feasibility of combining colorant recipe calculation with pollution prediction by using computer colour matching technique that commonly adapted in textile dyeing industry for recipe formulation. The program for predicting the degree of pollution from the dyeing effluent of Cibacron dye series was found to be satisfactory.

Keywords : dyeing effluent, environmental pollution, computer colour matching

1. Introduction

The textile wet processing industry has been very conscious over the environmental care as a result of stringent government environmental regulations and the increasing cost of treating the waste. An important alternative to waste treatment is prevention via waste reduction. In textile coloration industry, effluents of dyes and their associated chemicals are usually considered as the source of water pollution[1]. Previous studies have used the material load balance methods to evaluate the dyeing processes ecologically[2]. In order to reduce the environmental pollution at the source, an attempt has been made in this study to assess the environmental properties, for example, COD and TKN of various dyes before dyeing. By using these environmental data together with various dyeing parameters, prediction of the degree of pollution in terms of COD and TKN can be obtained. Collection of this information can assist to identify the type and extent of environmental impact of different dyes. It can also be utilised effectively for waste minimisation in a dyehouse through dye substitution.

Moreover, although computer colour matching (CCM) system is commonly used in textile dyeing industry to assist the colorists to determine the most suitable colorant formula that will give a prefect colour match using a mixture of a few colorants, up to now, there has been no study on using this powerful technique to provide useful information on alternative dyeing systems with various impact on environmental pollution. Thus, another aim of this study is to incorporate the environmental information of the dyes obtained before dyeing with the computer colour matching system, so that pollution prediction of the effluent generated by the predicted colorant recipes can also be achieved. This will assist the colorists to select "green" formula while satisfying the basic colour quality requirements and let the colorists know well ahead in time the impact of these colorants on the subsequent dyeing process in waste generation.

Keith W. Y. Kwok, John H. Xin and K. M. Sin
Institute of Textiles and Clothing,
The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong.
Phone : 852-27666497
F a x : 852-27731432
E-mail : mailto:tcrskwwy@inet.polyu.edu.hk
tcrskwwy@inet.polyu.edu.hk

2. Methodology

2.1 Collection of Dyeing Effluent Samples

In order to collect dyeing effluent samples for analysis with respect to certain environmental parameters, various reactive dyeings were carried out. Two series of dye, Cibacron LS and Cibacron F obtained from Ciba Specialty Chemicals Limited were used. Desized, scoured and bleached cotton fabric and infra-red dyeing machine - Ahiba was used. 1%, 2%, 3%, 4% and 5% shade depth with liquor ratio 10:1 were dyed according to the dyeing methods recommended by the dye supplier[3].

2.2 Analysis of the COD and TKN of Dyes and the Dyeing Effluent Samples

After collecting the dyeing effluent samples, the COD and TKN of the dyes and the dyeing effluent samples were determined according to the standard testing method, ASTM D 1252-88 and ASTM D 3590-89 respectively.

2.3 Theoretical Prediction of the Degree of Pollution of the Dyeing Effluent Samples

Prediction of the degree of pollution of the dyeing effluent can be achieved by using the environmental data of the dye examined before dyeing together with the degree of fixation of each dye and several dyeing parameters. For example, in order to predict the COD of the dyeing effluent, degree of fixation of the dye as well as the COD per each gram of dye has to be known. Then using the following calculation, the amount of COD (mgO2/l) of the dyeing effluent can be predicted.

$$\underset{(\mathrm{mgO_2/l})}{\mathrm{COD}} = \frac{\text{shade depth} \times \text{weight of fabric} \times \text{L.R.} \times 20}{\text{conc. of dye stock solution}} \times (1\text{-}\%f) \times \mathrm{COD}\ (\mathrm{mgO2/g\ of\ dye}) \text{ - - - - - } (1)$$

where shade depth is the shade of dyeing (%), L.R. is the liquor ratio of the dyeing, %f is the percentage fixation of the dye and multiplication of 20 is for the conversion of unit to mgO2/l. Also, the COD (mgO2/g of dye) is the examined environmental data per each gram of dye examined before dyeing.

Using the above calculation, prediction of TKN, and other environmental parameters of the dyeing effluent can also be obtained. After calculation, the COD and TKN of the dyeing effluent with respect to different shade depth can be obtained. These theoretical data can then be used by a computer colour matching system for pollution prediction.

2.4 Pollution Prediction by Using Computer Colour Matching System

Computer colour matching system can generate a large number of alternative combinations of dyes to match the target colour. It is now usual to store in the computer the data for a variety of illuminants and for a whole library of colorants. Many programs are written to calculate matches for all possible combinations of colorants. Many techniques can be used for the colour matching program, such as linear programming and spectral curve matching by least-squares technique[4]. However, no matter which type of CCM program is using, once the colorant formulas generated, pollution prediction of the calculated recipes can be made by using equation (1) provided that the environmental information of the dyes are also known. The prediction of the degree of pollution with respect to COD or TKN can then be achieved by incorporating equation (1) into the CCM program.

After the predicted results generated, the reliability of the pollution made by CCM system will be investigated by calculating the percentage error between the predicted pollution data and the measured pollution data.

$$\%\ \text{Error} = \frac{|\ \text{(predicted data) - measured data)}\ |}{\text{measured data}} \text{ - - } (2)$$

3. Results and Discussion

The measured and predicted COD and TKN of the dyeing effluent samples with respect to different shade depth were calculated.

The result of Scarlet F-3G was used as an example to explain the result and was shown in Table1 and the relationship between the COD and shade depth as shown in Figure1. From Figure 1, It was found that the degree of pollution of the dyeing effluent in terms of COD and TKN was directly proportional to the percentage shade depth. Furthermore, the linearity of the degree of pollution of the dyeing effluent with the percentage shade depth was found to be satisfactory.

Moreover, the percentage errors of the prediction of various pollution parameters by the theoretical data for each dye were also calculated. For Scarlet F-3G, the percentage error of COD and TKN were 3.842 and 3.448 respectively.

It was observed that the average percentage errors of the pollution prediction of the dyeing effluent by using the predicted data were only 3.02 and 2.18 respectively.

Thus, it can be concluded that the degree of

Table 1. Measured/Predicted COD (mg/l) and TKN(mg/l) of the Scarlet F-3G and the % error between measured and predicted data

	0%	1%	2%	3%	4%	5%	%Error between measured & predicted data
Measured COD	0	343	611	1032	1303	1701	3.842
Predicted COD	0	334	668	1002	1336	1670	
Measured TKN	0	22	41	66	88	108	3.448
predicted TKN	0	22	45	67	90	112	

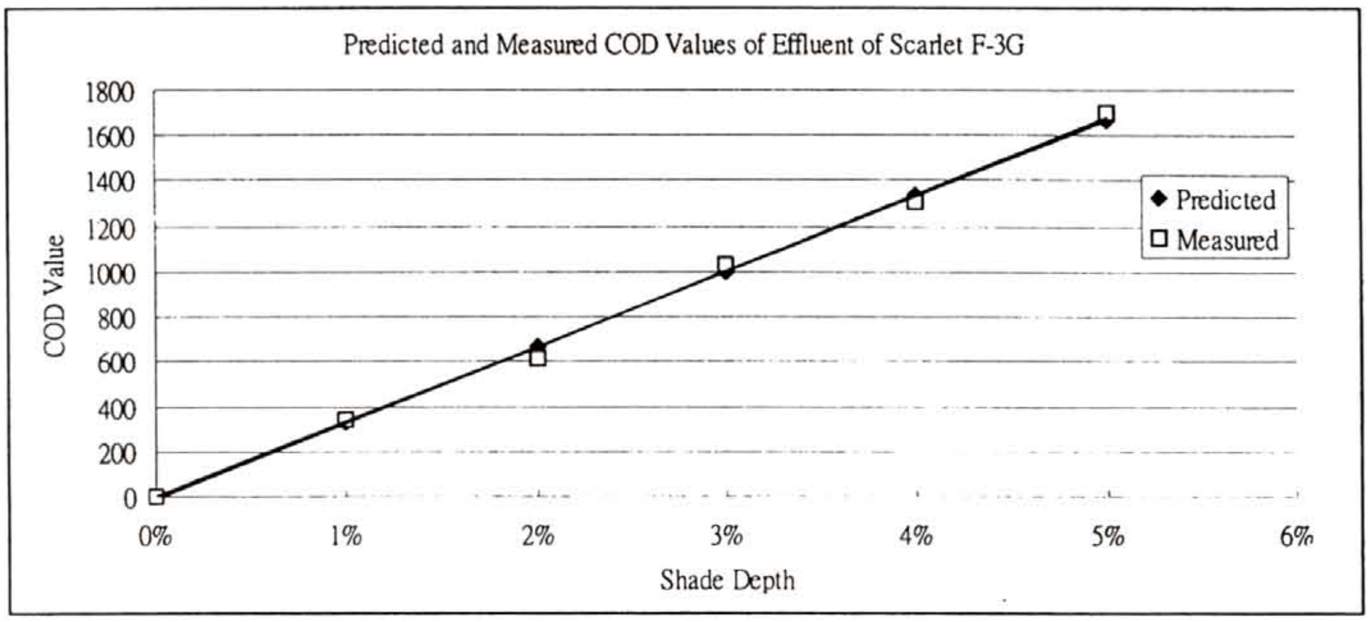

Figure 1. Predicted and Measured COD value of effluent of Scarlet F-3G with respect to different shade depth

pollution of the dyeing effluent can be predicted accurately provided that the environmental properties of the dye were examined before dyeing and the necessary dyeing parameters were known.

As the degree of pollution of the dyeing effluent can be predicted accurately, it is expected that by combining this theoretical calculation together with the CCM system, the degree of pollution of the dyeing effluent can also be reduced so as to meet the standard set by the government. Assuming that there is a colour needed to be matched and the CCM system generated two recipes that almost all the other quality parameters are the same, such as colour difference and fastness. We can then choose the most environmentally friendly dyeing recipe according to the degree of pollution. An example was shown in Table 2.

From Table 2, the COD and TKN of the two dyeing recipes generated can be seen. It was found that the colour difference of both recipes are also about 0.2 and their quality are about the same, but for the degree of pollution, recipe 2 was found to be more environmentally friendly and can fulfil the standard set by the Government. The calculation of the COD and TKN of the recipes can be achieved by substituting all the necessary information into the equation (1). Using recipe 1 as an example, the weight of fabric is 5g, L.R is 10, the concentration of dye stock solution is 10g/l, the COD (mgO2/g) and percentage fixation of Yellow F-4G, Red F-B and Blue F-R are 811, 909, 950 and 60, 61, 56 respectively. Then after the concentration of each dye in the recipe was generated by the CCM system,

Table 2. Degree of pollution of recipes generated by a CCM system

	Recipe 1	Recipe 2	HK Government Standard[5]
Dyestuffs	2.88% Yellow F-4G 0.53% Red F-B 2.60% Blue F-R	3.32% Yellow LS-R 0.48% Scarlet LS-B 2.46% Blue LS-3R	
ΔE	0.21	0.20	---
Light fastness	3	3	---
COD (mg/L)	2209	1684	2000
TKN (mg/L)	207	198	200

the COD can then be obtained. Thus, by using CCM system, the colorists can select the ìgreenî formula while satisfying the basic colour quality requirements and let the colorists know well ahead in time the impact of these colorants on the subsequent dyeing process in waste generation.

4. Conclusion

Based on the results, it can be seen that by using the mathematical formulae developed in this study together with a CCM system, the degree of the pollution of the dyeing effluent can be predicted accurately before dyeing. Prediction of the degree of pollution of the dyeing effluent will be very useful to the colorists for selecting dyes based on their environmental properties and let them know well ahead in time the impact of these products on waste generation in the subsequent dyeing process.

Acknowledgement

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New Effect Pigments for the Environment and Their Goniochromatic Quality Contorl

P. W. Gabel

Abstract

Test methods for typical color measurement problems, and results from goniospectrophotometers with different measurement geometries and concepts will be discussed. Explanation will be given for the correlation of instrumental data versus visual assessment, comparison of draw-down cards and panel spray-outs, and for the consequences concerning analytical work. Furthermore, the need for continuing improvements in instrument performance to allow colour measurement techniques for new generation effect pigments will be discussed.

Keywords : color measurement, effect pigments, quality control, goniospectrophotometer, visuall assessment

1. Introduction

Color measurement and color measurement management will play key role in quality control in the paint industry in the next years.The reason for this is twofold: First, paint accepted by instrumental color data of the supplier is becoming an increasingly important cost factor for a company's competitiveness. Second, the exchange and transfer of data between suppliers and clients is not only a question of information, but just as much a question of corporate culture, trust, and mutual respect.

In addition, the development of new effect pigments requires new color measurement concepts.

2. Effect Pigments , Color and Appearance

For many years now, effect pigments have been used as important colorants for automotive, technical and cosmetic applications. They are used to make an object distinctively appealing. Effect pigments fulfill this requirement admirably because of their gonioapparent nature, e.g., the change in their appearance with the change in angle of illumination or view. For some years now, effect pigments have been undergoing a rapid change.

Looking at the past, stylists started with conventional metal pigments, like aluminum or bronze pigments, followed by pearlescent pigments, also know as mica pigments, pearl pigments or mineral effect pigments. In the last two years a new generation of effect pigments has become more and more popular. They are based on innovative substrates, like silika flakes or alumina flakes, ultra-thin multilayer interference film flakes and crosslinkable liquid crystal silicones.

Dr. Peter W. Gabel
MERCK KGaA
Analytical Laboratory Pigmente Mainzer Strasse 41
D-64579 Gernsheim Germany
Phone : + 49-6258-12355
F a x : +49-6258-12375
E-mail : peter.gabel@merck.de

Table 1. Trademarks and manufacturers of effect pigments

1. Generation		
metal pigments	STAPA®	ECKART,
	SILVET/SILVEX®	SILBERLINE
pearlescent	IRIODINÆ/AFFLAIR®	MERCK,
(mica) pigments	MEARLIN®	ENGELHARD
2. Generation		
silika flake pigments	COLORSTREAM®	MERCK
alumina flake pigments	XIRALLIC®	MERCK
multilayer film	CHROMAFLAIR®	FLEX,
pigments	VARIOCROM®	BASF
liquid crystal silicones	HELICONE®	WACKER

Metal pigments [1] consists of thin metallic platelets acting as small mirrors. They exhibit mainly a lightness change with viewing angle, appearing lightest near specular or mirror reflection of the illumination and darkening rapidly as the angle of view moves away from specular. Light reflection is affected by the scattering of the light at the pigment corners and edges. Brilliance is dependant on particle corners and edges. Brilliance is dependant on particle size, respectively particle size distribution, particle shape and the orientation of the pigment. The dominant class of pearlescent pigments consist of a thin layer of metal oxide deposited on supporting mica flakes. [2] The color of these pigments is based on the layer-substrate interference principle and on their composition. This kind of interaction is responsible for the impression of depth. The optical principles of interference pigments are described elsewhere. [3] However, the interference color (e.g. TiO_2-pigments) diminishes as the viewer moves away from specular direction. The metal oxide may also provide color through light absorption (e.g. Fe_2O_3-pigments). Mica pigments exhibit not only a lightness flop but also a flop in hue and chroma.

Extraordinary optical effects are achieved by the combination of transparent silica flakes [5] and controlled deposition of metal oxide coating layers. Due to the substrate particles of uniform thickness new coloristic effects can be realized by suitable combinations of carrier and coating. The goniochromatic color shift of these pigments is extremly high and improved (interference-) color strength and very high lustre are produced by this new effect pigment generation.

Pigments based on alumina flake substrate [5] coated with metal oxide are characterised by very flat surfaces, colorless masstone and very uniform particle size and thickness distribution. The lustre of these pigments is extremely strong and a crystal-like, glittering appearance is exhibited. The interference types exhibit high chroma, silver has a pure white masstone.

Opaque, ultra-thin multilayer interference film pigments give high saturated and bright pigments. The chromaticity is produced by the combination of interference and absorption of light. [6, 7]

The liquid crystal pigments [8] are produced from highly crosslinked, cholesteric, silicone liquid crystals. The layers of the liquid crystal molecules are arranged helically in the pigments. The pitch of this helix, which can be altered via the chemical composition of the liquid crystals, plays a crucial role in the color of the coating. The light rays reflected by each layer interfer with each other. The flakes are transparent across the whole visible spectrum .

3. Color Measurement Systems and Visual Assessment

In 1992 the authors presented some papers on the state of the art in colorimetry [9, 10]. The main requirements were :

- from the physical point of view , the special characteristics of mica pigments require special measuring geometries and methods of evaluation.
- experts agree that classical colorimetric determination with standard geometries (d/8° (sphere) or 45°/0° (directional) do not provide reliable results for a complete colorimetric description of interference pigments and their applications.
- at least two measuring geometry groups are necessary in order to be able to characterize pearlescent pigments Fig. 1. Masstone angle with 45°/ 90°,and modern diagonal viewing angle,e.g. 45°/25°,as well as gloss angle with 0° to 15°from gloss at flat 25°- and acute 70°-illumination, are necessary in order to be able to characterize pearlescent pigments
- colorimetric results are in agreement with visual assessment.

Figure 1. Proposal for measuring geometry groups for interfence pigments according to [9]

From the present point of view these old requirements based on "common looking" effect pigments are more and more necessary. However, what has happened in the market since than? Manufacturers of color measurement systems have developed new equipement. But are these developments really helpful?

Nowadays we find only a few different companies on the market for multi-angle measurement color systems, Table 2.

This overview shows that only the MURAKAMI system fullfills former measurement geometries like the ZEISS MCS 333/GK 311/ M. Unfortunately, this instrument is no longer available. OPTRONIK announced in 1999 a new "Spaceflash Gonio-Spectralphotometer." Minimum angle of illumination 15∞ from the horizontal. This is 10∞ more than the ZEISS system. However, at the present time, the instrument is still not available. The GON 360 from INSTRUMENT SYSTEMS is just under investigation.

MERCK KGaA, as the leading manufacturer of mica pigments, has, in recent years, played a significant role in supporting the development of color measurement equipment. The result is the PHYMA WICO 5+5 concept with two sources of illumination and five angles of observation.

Table 2. Manufacturers of commercially available goniospectrophotometers including their different systems.

Company	System	Ilumination*	Viewing*
X-RITE	MA68II	45°	65°,30°,0°,-20°,-30°
MINOLTA	CM-512m3	25°,45°,75°(circular)	0°
PHYMA	WICO 5+5	22.5°, 45°	67.5°,0°,-22.5°,-45°,-67.5°
GRETAG MACBETH	Color Eye 740GL	45°	65°,30°,0°,-30°
OPTRONIK	Multiflash M45	70°,30°,20°,10°,0°,-10°,-20°,-25°	45°(1°interval)**
MURAKAMI	GCMS-3	16° - 180° - -16°	
INSTRUMENT SYSTEMS	GON 360	0° - 360°	(0.1° interval)**

(* Degrees from perpendicular 90° = 0° ** Degrees from horizontal)

This system is an intermediate step for continuing improvements in instrument performance for our in-process quality control of our mica pigment production.

Figure 2 shows a comparison study of different goniospectrophotometers which was just finished. [11]

Figure 2. Measurement results "degrees from gloss" for different goniospectrophotometers in the a*-, b*-sytem for an ultra-thin, multilayer interference film effect pigment on black background.

The figure shows that the instruments with fixed 45∞ illumination, independent from the number of viewing angles, are not able to measure the extraordinary color shift. The curve of absolute values shows that the results from instruments with directional 45∞ illumination are very close together. Only the spherical illumination of the MINOLTA leads to different values in the 75∞ angle of observation.

To determine the visual color flop of this pigment we need the possibility of variable settings for the angle geometries like in the ZEISS-system. However, it is not possible to measure to complete visual color flop. The reason is the limitation to 25∞ illumination. Looking close to the horizontal you see yellow-green but this color is not measured. Further our investigations show that a minus degree angle from gloss, like the -75∞ ZEISS or -67,5∞ PHYMA observation, is able to measure only a part of the extraordinary color shift (Fig. 3). This is working out in all other new effect pigments and even in color formulations (Figure. 4 and 5).

Compared to the first generation pigments, the new effect pigments require a different method for visible judgement. For interference and masstone evaluation of the first generation pigments, light source behind the observer, sample in front of the observer, perpendicular position for interference color, tilting the sample to the horizontal (flat position) for masstone. In the case of the new effect pigments for complete visual color interference flop, light source and sample in front of the observer, sample in the horizontal position and moving down from the flat to the tight observation angle, see Fig.

Figure 3. Comparison of lustre curve 25°- 140°flat illumination to 70°- 95°tight illumination 15°from gloss and fixed 45°illumination 15°, -10°and -30°from gloss (ZEISS)

Figure 4. Comparison of lustre curve 25°- 140°flat illumination to 70°- 95°tight illumination 15°from gloss and fixed 45°illumination 15°, -10°and -30° from gloss (ZEISS)

Figure 5. Comparison of lustre curve 25°- 140°flat illumination to 70°- 95°tight illumination 15°from gloss and fixed 45°illumination 15°, -10°and -30°from gloss (ZEISS)

Figure 6. Schematic diagrams of different methods of visual judgement for the old and new generations of effect pigments

Figure 7. Correlation of HUNTER Delta L-, a- , b-values versus visual judgement (3 steps system) of a blue pearl TiO2-pigment. Lustre and masstone conditions

4. Instrumental and Visual Evaluation

Color control, one of the most sensitive parameters during the production process (nm scale of coating layer thickness) and final assessment of effect pigments is done by instrumentation and human eyes. [12]

A comparison study of different spectrophotometers from different manufacturers is just under investigation for instrumental and visual evaluation datas. [13] The statistical evaluation is done by SIMCA PLOT from the company UMETRICS.

Figure. 7 presents results of the study of a mica interference blue pigment based on final pigment batches. The plot shows two parts, Delta L-values on the left side and Delta a-b-values on the right. There is a positive correlation of all values; that means Delta instrumental datas agree with our internal (3 visual step system, (the final judgement of acceptance of our pigments based on the visual assessment of our color team). Regarding the color there is a better correlation of instrumental a-b-values and our internal system than in the L-values-lightness evaluation. Going into details, this study pointed out for the property of the interference blue pigment.

- Interference blue is a function of lightness.
- b/+b-scale: the more blue the higher the lightness.
- a/+a scale: the more red the lower the lightness.

No agreement is found in the correlation of visual evaluation of lustre and scattering behavior while, on the other hand, the instrumental datas agree.

However, the most important point of this study is that the standard deviation is within the range of acceptance. This and the above mentioned results should be taken into account when discussing the acceptance of color differences. Finally, these results clearly demonstrate how important negotiations of color tolerances or limits should be.

5. Conclusion

With regard to all this information this paper shows the following points:

The importance of precise color quality control for our customers and the complex, difficult nature presented by effect pigments in achieving precise color measurements.

The specific techniques MERCK has instituted to make sure color measurement is as meaningful and reproducible as we can make it.

The need for continuing improvements in instrument performance to allow color measurement techniques to continue to keep up with the increasing demands of our customers.

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Digital Color Palette for Specific Use Groups

Chang Dong-hoon, Moon Eun-bae

Abstract

This study aims to construct a practical digital color palette(MC palette) which is convenient to use and interchangeable enough not only for universal usage but for specific use groups in digital era. In order to use colors in computer environment, based on a research, analysis, and arrangement by color value via RGB code, this study provides two palettes which help to represent accurate colors by regulating the numbers of colors and arrangement rules for each demand of various field such as medical industry, architecture and simulation, and product design. MC palette is composed of two different combinations: 20 basic colors and 400 applied colors. It was made by choosing the most frequently needed colors according to the ISCC_NBS color namings, Korean standard color dictionary, and traditional Korean colors. The major competence of MC palette is that it is composed mainly of the most frequently used colors, and represented by color names which helps linguistic conversation for specific international use groups possible.

Keywords : MC palette, digital-analogue interchangeable, ISO interchangeable, integrating system

1. Introduction

This study aims to construct a practical digital color palette (MC palette) which is convenient to use and digital-analogue interchangeable enough for specific use groups. MC palette is systematically devised for a quick application at a practical simulation especially for the characteristic of each industry.

Thus, the main end of MC palette is two folds: for laymen, it solves the difficulties of choosing colors on digital instrument in daily use, meanwhile, for specialists, it helps to enable a ISO interchangeable palette without extra modification or CIE color transformation. MC palette is expected to represent each industry's function and esthetic ends as well as to minimize ambiguity on various international color representation system by integrating major representation systems in one.

2. Method and Range of Research

This study is largely composed of three dimensions :

First, literature study of existing color palettes and color studies, second, a field survey based on categorization of industries for user needs , and last, a construction of MC palette which is user oriented for solving laymen's difficulties of choosing colors on digital instrument. The MC palette is supposed to developed for direct use without extra modification or CIE for specialists as well as easy expansion and level-up. The stages this research takes are as follow :

- **Research of color order system** : Literature study about existing color system such as color name, ISCC_NBS designating color, RGB, L*a*b* and survey.

- **Analysis of palettes** : Pantone, NCS Color system, as well as digital image program palettes such as Adobe Photoshop.

- **Choosing Object Industry** : Based on Industry and Resources Ministry's industry category, three representative industries were chosen as the most color using industries.

- **Survey and Analysis** : Survey and Analysis 300 samples on chosen three representative industries such as medicine, architecture, and industrial design field

Chang, Dong-hoon
Division of Design, Ewha Womans University
11-1 Daehyun-dong, Seodaemun-gu, Seoul 120-750, KOREA
Phone : +82-2-3277-2547 Fax : +82-2-3277-2519
E-mail: dhchang@ewha.ac.kr
Moon, Eun-bae
MoonEunBaeColorDesignResearchInstitute(MCDRI)
85-5 Eungam-dong Eunpyung-gu, SeoulL, KOREA
Phone : +82-2-358-8801 Fax : +82-2-358-8802
E-mail: mooncd@koreacolor.net

- **Making Pre-MC palette** : 683colors applied Pre-MC palette based on research
- **Color Coding** : Coding colors based on RGB value. Using Munsell Conversion Software for the color transformation

- **Making MC palette** : Making basic 20 color, and applied 400 color MC palette based onPre-MC palette

3. The Analysis stages for MC palette

Division	Range of Research	Method of Research	Others
Research Color System	Individual color name ISCC_NBS designating color L*a*b*System RGB System	Research of standardization materials ISO, KS, JIS ISCC-NBS	Survey
Making MC palette	Making palette for each level	R,G,B coding L*a*b* coding	Meeting with System Manager

- Color Names : Making a data base for individual color names (400 in total) based on KS-A-0011
- ISCC_NBS designating color: Making a data base for ISCC_NBS designating color by using ISCC-NBS system which is currently used
- RGB System : Making 200 colors by composing each 10 Hue Circle by using 24bit channel which is the basic color system of computer monitors
- Survey : Out of 7 industrial fields, Architecture, Medicine, and Product Design (of using plastic or paint) were provided color palettes for survey first

4. The Process of Color Palette Making

- **Composition on Color Palette** : Color palette is made for the functions as follow.
  - Including hues from spectrum and hues from Red-Purple Zone on CIE.

  Selected colors are supposed to meet the numbers of 20 and 40 colors from Korean Industrial Standard
  - Making color tone even
  - Composing systematic visibly equable color difference
  - Making exchangeable with international and Korean standards

- **Range of Color expression** : Color palette is conditioned to have following properties
  - expansion : There are two different aspects of expansion in MC palette. First, expansion by itself based on the regular order within the palette in order to expand the range of color tone between colors or the basic color palette. Second, in case of a new color add could be expressed within the range of palette colors. The definition of the self-expansion function refers a palette that is able to proceed color division as well as to expand by employing the concept of tone within a selected categories when more specific division is needed
  - identification : Human beings can distinguish about 100 colors in hue, 35 levels in value (2.5~9.5 in Munsellís) and 30 levels in chroma (in the case of yellow with chroma 15) under the case of two or more colors are used together. Thus, it is about 200 colors for identifying precise color value or the level of coding by seeing a color.
  - equability : In order to choose or combine colors, it is necessary that each color around a color is located with same space. It is needed to compose all colors in palette with equality and minimum value and the maximum value for each property to be represented

- **Contents of Making MC paletter** : Research of palette and color materials

(1) MC palette used color names.
(2) MC palette used ISCC_NBS designating color
(3) MC palette used RGB system
(4) MC palette used Munsell or NCS palettes
(5) MC palette is customized and user oriented : For satisfying user oriented palette, it needs to proceed to set up representative color using industry categories as follow :

division	industries	material	color using range
	-machinery, vehicles	-paper	
	-garments, fiver	-paint, dying material	
	-architecture, ornaments	-CRT	-users with 125 colors or more
	~~-prints, photos~~	~~-leather~~	~~-users with 80 colors or more~~
	-plastics, products	-color sheets, polyester	- users with 40 colors or more
	-medicine, pharmacy	-powder, liquid	-users with 20 colors or more
	-information, signage	-transparent materials	
	-books, toys, stationary	-human body	

Also, here is Kelly's table of functional palette for reasonable allocation of colors for the industries. And, the Range and Usage section is uniquely provided by this study for MC palette.

	Level 1	level 2			level 3	
	1	2	3	4	5	6
contents	generic hue names & neutrals	all he names and neutrals	ISCC-NBS all hue names & neutrals w/ modifiers	color order system	visually interpolated Munsell notation	instrumentally interpolated Munsell notation
examples	brown	yellowish brown	light yellowish brown	5R 4/14 N5	52.R 4.5/6.2 N2.8	x-0.362 y=0.520 Y=12.12
Rrange	about 30 colors	about 100 colors	about 300 colors	about 3,000 colors	about 100,000 colors	about 5,000,000 colors
	basic research palette	professional color research	selecting color, color cording		color tolerance RGB coding	
Usage	color marketing research		color design		color management	

5. Survey and Its Analysis

Aim of survey

A series of survey was held for the end of this study which was preparing customized palette for color users as follow:

1. Color cognition
2. Media for each industryís color usage
3. Usage of color
4. Quantity and range of color usage
5. Color Table for Survey(two kinds)

Date and Subject of Survey

1. Date: 2000.4~5.6
2. Subject of Survey
   - Hospitals and medical clinics
   - Design firms
   - Architectural firms
   * 300 subjects in total/ 100 subjects in

representative industry

3. Analysis : Statistics Institute at Ewha Womans University

The results of survey which are directly influential to the MC palette are as follow:

- Importance of usage of colors during the work→ Colors are overall important
- Representative media during the work→Colors through PC monitor
- Numbers of colors needed during the work→Two folds of laymen and
- Usage of during the work→Mostly for visual esthetic ends
- Arrangement of colors→Systematic arrangement needed
- Side info of color→Representation of PC colors, numbers of colors, interchangeability emerging important

6. Conclusion

6.1 Choosing colors

MC palette chose 683 colors which is composed of 325 colors from the color name dictionary, 268 colors from ISCC_NBS designating color, and finally 90 colors from Korean traditional colors. Finally, MC palette chose 400 colors which are representative.

6.2 Composition of the palette

Based on the above survey, mc palette is composed of two types : one is for laymen who use colors only for official end such as distinction or briefing, the other is for specialists who approach colors with emotional and esthetical end.

First palette is a basic one composed by Munsell's hue, composed of 20 colors with 3 different tone such as pale, vivid, and deep. (20 hue 60 colors) This palette is easy to use colors since it is easy to grasp tone difference by each hue. Second palette is composed of 20 hues in 20 tones according to chroma and value.(20 hue 400 colors) This palette includes user's necessary colors as well as ISCC-NBS family colors. It makes users to find frequently used colors easily. Users can easily distinguish from family colors to applied colors due to the arrangement of colors of standard coordinate and Korean traditional colors on standard coordinate.

Hues are regulated on the most frequent 7,300 degree K color temperature and arranged by based on SONY, SAMSUNG monitors not the linear arrangement of RGB data, but for a perceptual equality.

The strength of MC palette is the transformation of Korean industrial standard color names and Munsell's hue value to both RGB value for digital palette and CIEL*a*b value for offline uses such as paint, print, and acryl application.(Used Munsell CMC Software) Accordingly, MC palette is a standardization and integration of by use of names of colors and lineage as well as delivery of color code and color value.

The Mc palette could be applied to an expansion of color palette use, developing digital palette, integration of digital and analogue method in color application, finally to a basic infra-structure for color study and application. MC palette is looking forward to a development of palette providing a color combination standard for more specific need of special groups.

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Analysis of Fashion Fabric Image under Control of Color and Texture

Sunhyung Choo, Youngin Kim

Abstract

Modern fashion consumer respond to fashionable trends with utmost sensitivity. Therefore to satisfy the consumer with an trendy image, element of fashion design must be found first, followed by an analysis of each design element's effect on the total image composition. In previous studies of fashion image, it is discussed that the positive correlation between fashion design elements of color, fabric, and form as the central issue. In this thesis, two of the fashion design elements, color and fabric are simultaneously considered to classify the image of fabric in fashion. For the color variables, 10 hue are selected from Munsell's system of color notation, and 12 tones are selected from PCCS color notation., which is currently used in the fashion industry. Texture variables used in this survey are classified by luster, prominence-depression of surface, thickness, and density of fabric. For the survey, graduate students aged from 20 to 50 years old and the specialists in fashion companies participated.

The results of this survey are as follows:

The fashion fabric image is classified as 5 main images : 'elegant' , 'comfort' , 'characteristic' , 'light' and 'simple' .

The influence of hue, tone and texture is significant to the fashion fabric image. In the color, yellow-red, red hues and light grayish, dark grayish tones convey the elegant image. The texture property for the elegant image is luster, thin and low density. Properties of fabric conveying the comfort image are yellow-red and green-yellow hue, soft, light tones, matte and high density. Furthermore , hue turned out not to be a significant variables for the characteristic image, while dark grayish, grayish tone, luster and prominent texture convey a unique image. For light image, properties of fabric are blue-green, purple hues, light, bright tones with thin , low density texture. Properties of fabric conveying the simple image are blue-green, purple-blue, green-yellow hues, and strong , vivid tones, with luster and flat texture.

Keywords : fashion image, color , fabric, texture

1. Introduction

Modern fashion goods consumers react to trends with great sensitivity, and by the same token, fashion goods designers attempt to roll out products that match the current fashion trends as close as possible. The fashion product will be an even greater target of sensational satisfaction as time goes on, which makes knowledge of fast-changing consumer tastes and applying the insights to the production process imperative to any fashion manufacturer's market plan. Such a process needs to be implemented not only in production, but also in fashion design research - making characteristic-specific evaluation of fashion products a foundation to applying human sentiment to design effectively. Character-specific analysis on a fashion product is said to be an analysis on image, and fashion good's image analysis must be achieved in order to garner the data necessary for design and planning. The fashion design research industry is currently taking on just such studies that categorize fashion products by their image, and this becomes basic image information in subsequent design plans. The fashion image has been seen to transform according to its color, fabric and form, and

Sunhyung Choo
Graduate School of Yonsei University
Clothig & Textiles dept , 023613100
Email : sunhyung@yonsei.ac.kr
Youngin Kim
Yonsei University Environmental Design dept, 023613105
Email: youngin@yonsei.ac.kr

initial studies into fashion image have endeavored to examine the resulting image when each of these elements are varied. Especially in the case of color, adjective-dependent color image categorization as well as analysis research is occurring, allowing actually use of this knowledge, but in actual fashion products, there is very little research being done that considers the special characteristics of fashion fabric that transmit the color to the consumer. The fabric is not only the medium that delivers the color, but its texture plays an important role in creating a unique product that follows the fashion trend, which the modern consumers desire. Through a wide variety of fabric, unique styles and recognition can be expressed when numerous similar styles come to exist through mass production. At a point where novel fabric sentiment creates the new fashion trend, considering a given fabric's texture along with its color and analyzing the image portrayed can be a fashion image analysis on the combination of design elements, and such research is necessary for inclusive image analysis.

2. Aim

This study separates fashion fabric's image transmitting characteristic into color and texture, and its color into hue and tone, its texture into luster, surface prominence, thickness, and density, in order to evaluate the fabric's image.
Therefore, the study's intention is as follows:

1) Analyze the fashion fabric's image composition basis and classify by image styles.
2) Analyze each fabric's image transmission according to its hue, tone and texture.

3. Method

3.1 Stimulus

In order to visually analyze natural colored fabric's image, excluding effects of embroidery, fabric samples were selected with regards to their color and texture. The color used for stimulus was made into 10 hues with 12 tones through Munsell's separation technique of 10 hues and PCCS tone separation technique. As a result, 120 colors came about in color variables. With the texture of stimulus, surface characteristics' major factor was selected as luster and surface depression prominence, while thickness and density was selected as factors that contribute to the weight. Each factor's standard was: for luster, luster and non-luster, for density, close-woven and loose, for surface depression, irregular depression, regular depression, and the three stages of flat and thin, medium, thick. Fabric samples used in this study was collected from December 1999 to March 2000 from domestic national brand clothing merchants and fabric converters. The collected fabrics were put under color-detection system Color Eye 1500, using L*a*b* values to extract color values, then the values were separated into hue and tone through Munsell's color, value, chroma categorization. Fabric samples used in survey investigations composed of 120 samples that were cut in 10cm X 5cm to 15cm X 15cm and attached onto white paper surface, labeled with stimulus numbers for survey purposes.

3.2 Survey

Adjectives used in this study are a collection of previous studies and popular fabrics indicated for 1994-2000 in the fashion fabric information journal "Textile View". Adjectives selected finally through preparatory survey are 35 in count. In the survey, fabric samples presented were scored along 7 points regarding these 35 adjectives and the participant was allowed to evaluate subjectively the visual image of six samples' color and texture.

4. Results

The survey used in this study was conducted on an exclusive group of fashion specialists, totaling 337 participants, and the final analysis resulted using surveys from 328 participants, excluding those with incomplete answers. Gathered data went through factor analysis and perception map using SPSS 8.0 program.

4.1 Fashion Fabric Image Factor

As a result of collected data, 5 image factors were extracted, and description was shown to be 58.86%. The first factor was named 'elegant image' as adjectives defining feminine and sophisticated image composed in this group, including 'elegant', 'romantic', 'feminine', 'luxurious', 'delicate', 'splendid', 'refine', 'classic', 'soft', 'sexy' and 'iridescent'. The second factor was 'comfort image' as 'comfort', 'natural', 'practical', 'sober', 'familiar', 'warm' and 'casual' composed the fabrics'perception as comfortable yet practical. The third factor was 'characteristic image', fabrics of unique and fresh image with adjectives such as 'unique', 'characteristic', 'high tech', 'fresh', 'melange', 'strong' and 'urban'. The fourth factor was 'light image' that transferred lightness and freshness with adjectives such as 'cool', 'airy', 'refresh', 'transparent' and 'light'. The fifth factor was 'simple image' that described simple and plain fabric image through adjectives 'flat', 'smooth', 'simple' and 'modern'.

4.2 Fabric Property according to Image Factor

Perception map was formed in order to find out how the selected fashion fabric image factors 'elegant', 'comfort', 'characteristic', 'light' and 'simple' change with respect to their color and texture, which are fabric's composition factors. Perception map analyzes by comparing two-dimensional graphs composed using average scores with each of the 5 image factors with regards to the changes affected by the hue, tone and texture on each image factor. Therefore, in a graph that uses each of the image factors along its axis, greater absolute score per factor explains appropriate image or changes that affect opposite image. In order to analyze all 5 image factors, this study used one flat graph with 2 factors each, resulting in 3 total flat graphs for analysis.

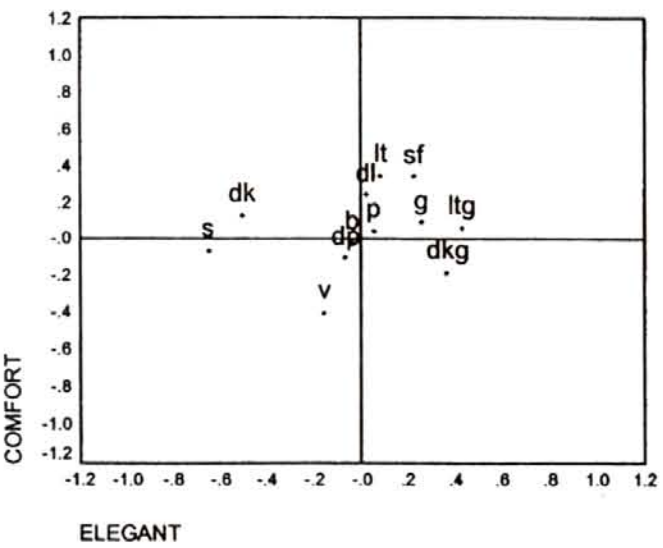

Figure 1. tone distribution 'elegant/comfort' image

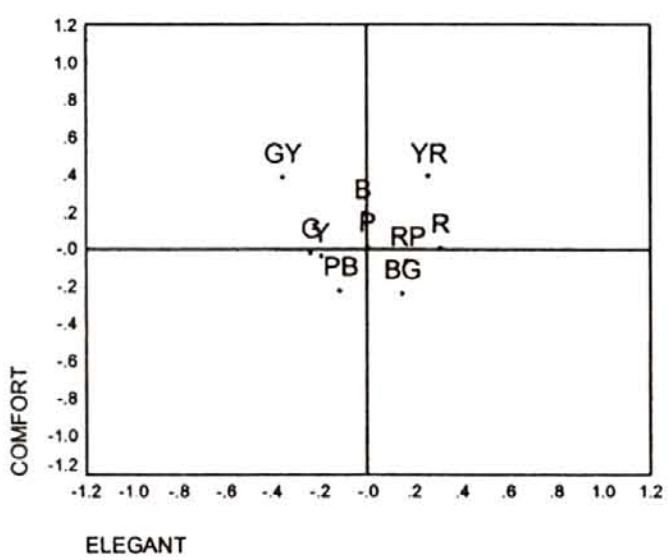

Figure 2. hue distribution 'elegant/comfort' image

<figure 1>, <figure 2> is a plotted graph for the 'elegant/comfort' images tone and hue. As easily seen from the graph, red, yellow-red, red-purple appear with relation to the the axis on 'elegant

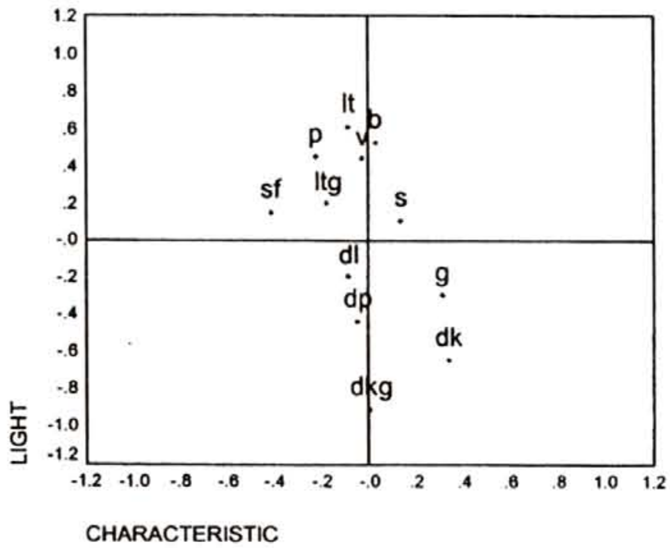

Figure 3. tone distribution 'characteristic/light' image

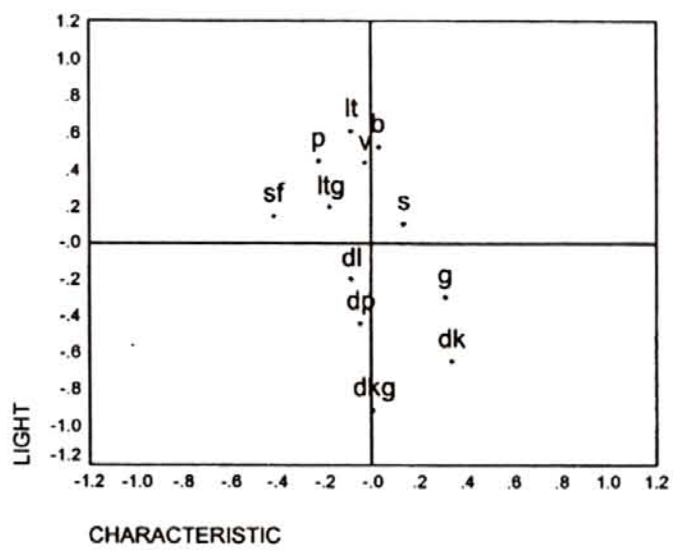

Figure 4. hue distribution 'characteristic/light' image

image' while green shades of green-yellow, green do not seem to portray the 'elegant image'. This finding agrees with previous studies that state the positive correlation between shades of red and image of high class. The 'elegant image' was also achieved through tones of ltg, dkg, g and sf that contain shades of gray and soft tones, while sharp and deep tones of s, dk and v do not agree with the 'elegant image'. This is likely an indication of the 'elegant image' being feminine and romantic, which would reasonably point to the shades of red, and the soft and calm tones also contribute to build the 'elegant image'. Along the axis of 'comfort' image, yellow-red and green-yellow was recognized as comfortable hue, while blue-green and purple-blue were not. Tones that give the most comfortable image were light, soft and dull, while vivid and dark grayish were found to be the most uncomfortable tones. Tone distribution affinity shows that tones above medium chroma and below medium value give uncomfortable image, as the tones that are medium chroma and above medium chroma give comfortable image.

<figure 3>, <figure 4> are ëcharacteristic/lightí image graphs on tone and hue. As seen from figure3, 4, most hues plotted on the center of characteristic image axis but scattered hue along the light image axis. The characteristic image achieved through dark, grayish tone and soft, pale, light grayish tone was less effective for the characteristic image than others. The hue and tone are not effective variables for the characteristic image because most hue and tone are place on the center of characteristic image axis. In hue, blue green perceived most light image and red was not.

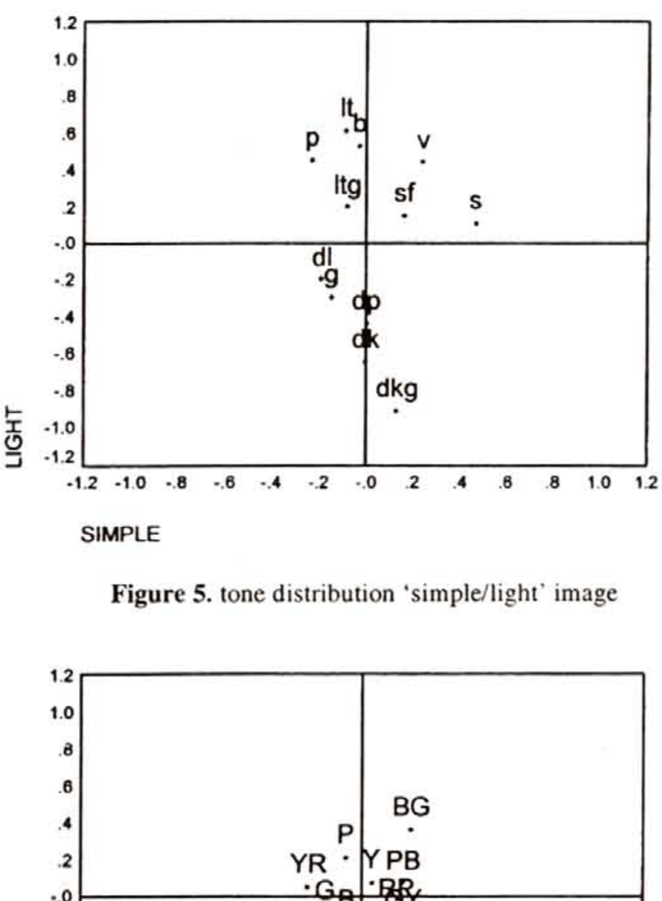

Figure 5. tone distribution 'simple/light' image

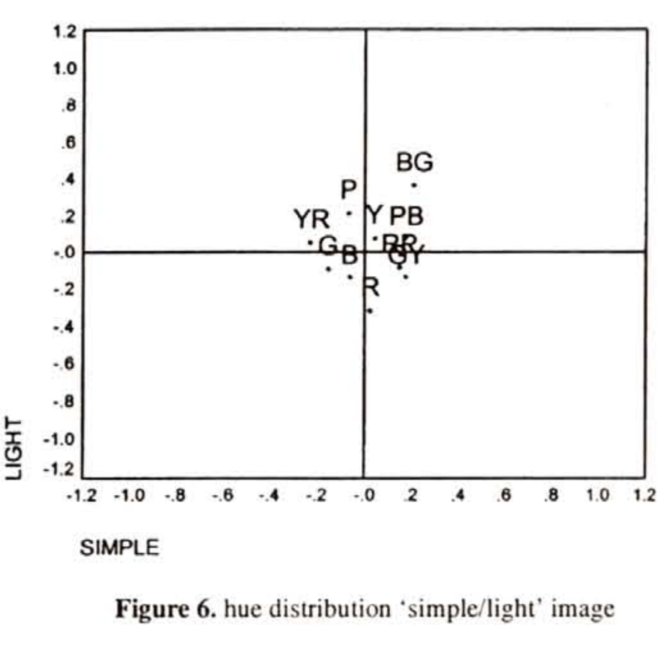

Figure 6. hue distribution 'simple/light' image

This result agrees with image of blue green in previous studies. In light image axis, the light image varied by the tone because most tones are scattered along the axis. In a graph, the clear and bright tone imply the light image which agree with the theory of color psychology means more high value color feels light. So, the light image related with the bluish and high value colors.

<figure 5>, <figure 6> are a plotted graphs for the

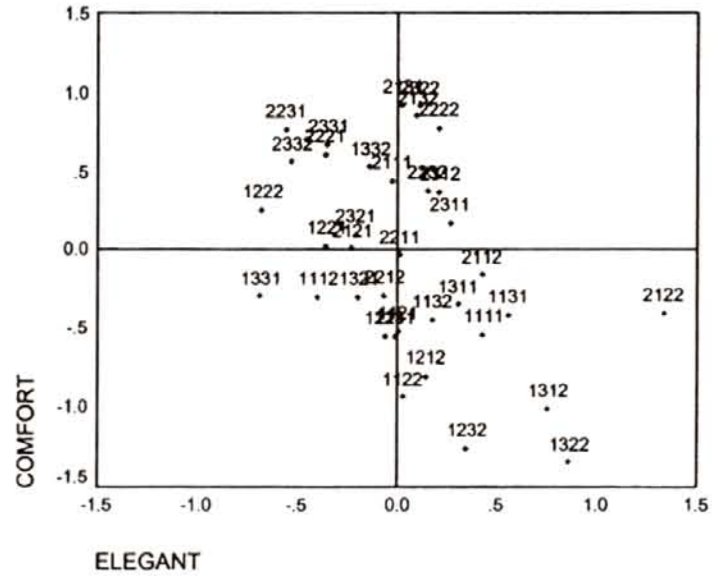

Figure 7. texture distribution 'elegant/comfort' image

'light/simple' image. Blue-green was most related the simple image and yellow-red was not seem to imply the simple image. The related hue with simple image was the cold colors like blue-green, purple-blue and green-yellow. The strong and clear tones give the simple image like strong, vivid, soft tone and pale, dull, grayish tones affect opposite image.

<figure 7> was a plotted texture variables graph for the 'elegant/comfort' image. The number was shown in this graph indicate the texture property. The texture variables which imply the elegant image were a luster, flat, thin, medium and low density fabric. The prominent, thick and high density fabric gives a opposite image. The distribution of thickness and density variables was divided by the elegant image axis which means these two variables more effective for the elegant image than others. In this graph, the non luster fabric imply the comfort image and the luster fabric related opposite image, so the luster variables most effective one for the comfort image. In previous studies KIM(1998), luster fabric gives a luxurious and non practical image. So, the luster was the effective texture variable for the comfort image. But prominent-depression of surface and thickness were not the effective variables for the comfort image.

<figure 8> was the plotting of texture variables for the ëcharacteristic/lightí image. As seen this graph, characteristic image varied by the prominent-depression of surface and luster variables. The luster, low density and prominent-depression fabric imply the characteristic image. The light image affected by

weight of fabric, so the thin and low density fabric related the light image.

<figure 9> was a plotted graph for the ësimple/lightí image. For the simple image, the

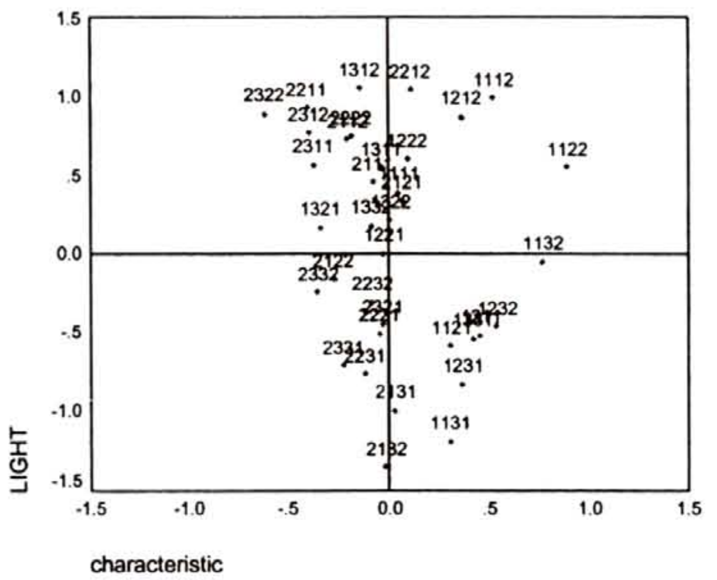

Figure 8. texture distribution 'characteristic/light' image

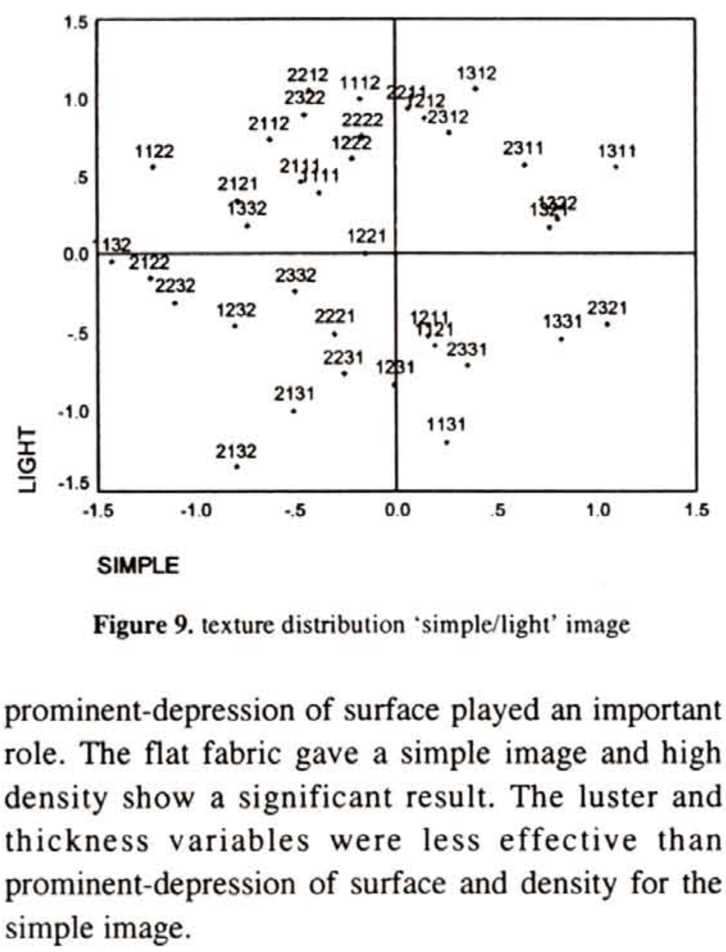

Figure 9. texture distribution 'simple/light' image

prominent-depression of surface played an important role. The flat fabric gave a simple image and high density show a significant result. The luster and thickness variables were less effective than prominent-depression of surface and density for the simple image.

5. Conclusion

Summerized this results were as follows;

First, fashion fabric image was classified by the factor analysis as 5 main images; 'elegant' , 'comfort' , 'characteristic' , 'light' and 'simple' .

Second, the influence of hue, tone, and texture was significant to the fashion fabric image. And the luster, prominence-depression of surface, thickness, and density of fabric was significant factors. In this study It found that the hue, tone, and texture was a fabric characteristic points to classify a fashion fabric image. The texture property of the elegant image was hue, tone, luster, thickness density, and that of the comfortable image was hue, tone, luster, density. The characteristic image was significantly affected by tone, texture, luster, prominence-depression of surface, density. The textile property of the light image was hue, tone, luster, prominence-depression of surface, density. And its prominence-depression of surface was the important to the simple image.

As the results, color and texture of fabric were significant variables for the fashion fabric image. It was meaningful results in interpretation of previous studies related the color image because 120 colors were used for stimulus in this study.

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Quantifying Colour Appearance for Projected Images

Young-shin Kwak, Lindsay W. MacDonald M. Ronnier Luo

Abstract

A new set of colour appearance data for colours projected by a LCD projector was accumulated under three sets of viewing conditions: grey and black background with a luminance level of 154 cd/m2 and grey background with 19 cd/m2. Forty-two colours were assessed by a panel of twenty-one observers in terms of lightness, colourfulness and hue using a magnitude estimation method. The performances of the observers were analysed and the data were used to evaluate the predictive accuracy of various colour appearance models: CIELAB, LLAB, RLAB, CIECAM97s and Hunt94.

Keyword : Projected image, Magnitude estimation method, Colour-appearance model

1. Introduction

The purpose of a colour appearance model is to predict changes of colour appearance of a visual stimulus under various different viewing conditions. Such a model can provide industry with a quantitative measure for assessing the quality of colour reproduction and enable more rapid and accurate proofing simulations of colour images. During the past decade colour appearance models have been developed that predict the magnitudes of perceived attributes for a wide range of viewing conditions. These models were derived from several sets of experimental data. However, most of these data sets were based on reflection (nonluminous) and monitor (luminous) colour[1][3]. There have been relatively few experimental investigations of the appearance of colours projected onto a screen. The experimental results accumulated by Luo et al using 35-mm slide projector as a part of LUTCHI data set [4] found surprisingly large perceptual differences between the projected and reflected or luminous viewing conditions. Based on this new data set, Hunt94 model was revised and LLAB and CIECAM97s were also based on this data set to decide the viewing parameters for dark surround condition. In this report new colour appearance data for projected colours were accumulated and colour models Hunt94, CIECAM97s, LLAB, RLAB and CIELAB were tested. In the case of LUTCHI data set only the luminance effect was investigated. In this study not only the luminance but also the background effect were examined.

Youngshin Kwak, Lindsay W. MacDonald and M. Ronnier Luo
Colour & Imaging Institute, University of Derby,
Kingway House East, Kingsway, Derby DE22 3HL
United Kingdom.
Telephone: +44 (0)1332-622217
Facsimile: +44 (0)1332-622218
E-mail : y.kwak@derby.ac.uk

2. Experiment Setting

The experiment condition is illustrated in Figure 1. A Sanyo PLC-5605B LCD projector driven by a Samsung Sense 820 laptop computer was used to project the image onto a white matte screen, which was a veneer painted with Dulux White paint. The projected image size was 117x88 cm2. The distance between screen and observer (or spectroradiometer) was adjusted to be within the recommended distance (3(1 picture heights from the screen) for normal cinema by ANSI [5]. Figure 1 also shows the viewing pattern including many colour patches. Each patch had a size of 5.5x5.5 cm2 subtending a visual angle of about 1(. Twenty-five decorating colours were used to form a complex viewing field. Three different decorating patterns were displayed in sequence during psychophysical experiment.

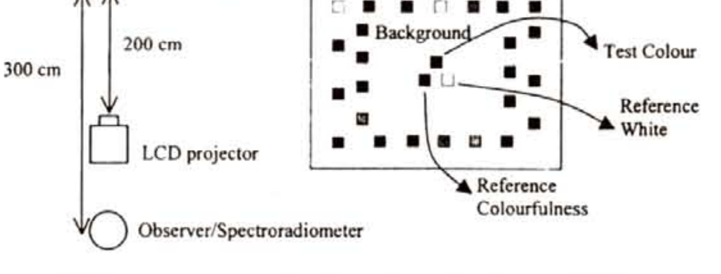

Figure 1. Experimental Situation and Viewing Pattern

The experiment was divided into three phases according to the different parameters studied ñ background and luminance of reference white changes.

Table 1. Summary of the experimental phase

	Background	Colour Temperature	Luminance of Reference White	No. of Colours	No. of Observers
1 (Grey)	Grey	7190 K	154.0 cd/m^2	42	21
2 (Black)	Black	7229 K	152.7 cd/m^2	42	21
3 (Filter)	Grey	7191 K	18.77 cd/m^2	42	21

Dark Surround

The luminance of the reference white for each phase was chosen according to the fact that for projected images 150 cd/m2 gives excellent results for colour pictures and about 16.7 cd/m2 is minimal luminance[6]. The low luminance was achieved using a polyester neutral density filter with a density of 0.9 to cover the projector's lens. Each phase used thirty-two test colours chosen to cover the whole colour gamut of LCD projector and ten colours were chosen from those thirty-two colours. These were repeated to check repeatability of an observer. Therefore observers had to make assessments of forty-two colours per phase. For each phase, test colours were measured using a Photoresearch PR-650 spectroradiometer under the experimental viewing conditions studied. The chromaticity coordinates of test colours using Figure 2.

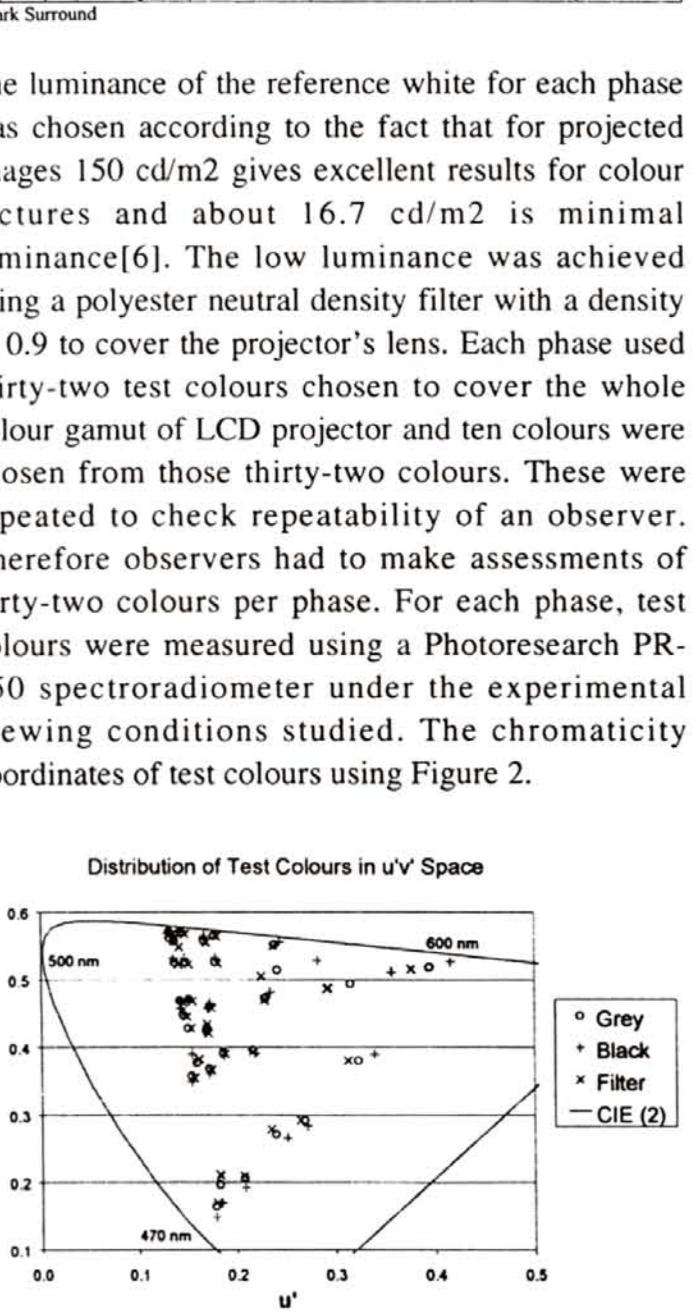

Figure 2. Test colours plotted in u'v' chromaticity diagram

Twenty-one observers having normal colour vision participated in the psychophysical experiment. They were students and staff at the Colour & Imaging Institute. The panel of observers consisted of eight females and thirteen males, ten Asian and eleven European. Each observer attended all three phases.

3. Experimental Procedure

The magnitude estimation method was used to assess the colour appearance of each test colour. Magnitude estimation method provides absolute perceptual values for colour attributes and the results are equivalent to those predicted by colour appearance models. Therefore the results can be used directly to test various existing colour models or consequently for deriving a completely new colour models[1]. Observers were asked to assign numbers to the test colour according to the magnitude of the lightness, colourfulness and hue perception. For lightness scaling reference white used as a standard, which has a lightness of 100 and imaginary black has a lightness of zero. Observer was asked to assign a number in the right relationship to the reference white and the imaginary black. In the case of colourfulness a neutral colour has no colourfulness - zero colourfulness - and it is an open-ended scale since no top limit is set. A reference colourfulness sample was used to help the colourfulness judgement. A different reference colourfulness sample was used for each phase. All results were on a common visual scale in relation to the reference colourfulness sample used in phase one (grey background), for which colourfulness was set to 40. Before commencing a new phase, observers were asked to readapt under phase one experimental conditions and to memorise the reference colourfulness sample, then adaptation to the new experimental conditions was followed. After adaptation, observers were asked to estimate the new reference colourfulness sample against the previous one from memory. For hue scaling, four psychological primaries: red, yellow, green and blue were used, which can be arranged as points around a circle. Observers were asked to describe a hue as a proportion of two neighbouring primaries. If no hue was perceived, they replied 'neutral'. The results were recorded into computer by the experimenter for data analysis.

4. Data Analysis

The data analysis was carried out using the same method as used by Luo et al[1]. The arithmetic mean values of lightness and hue for each stimulus were calculated. For lightness, the results were on the scale 0 (imaginary black) and 100 (reference white). For hue, all the results were transformed on to a 0-400 scale. That is, 0-100 for R-Y, 100-200 for Y-G, 200-300 for G-B and 300-400 for B-R. For colourfulness scaling, an unconstrained scale was used. The appropriate central tendency measure in such cases is the geometric mean, because magnitude responses tend to be normally distributed in logarithmic form [7]. If the individual data are either logarithmic or power functions of stimulation according to Fechner's Law or Stevens' Power Law, they will each be related to the geometric mean function by a power transform. Computation of the geometric mean automatically establishes a basis for normalising the results of an individual's data. If S_i is the individual's rating of a test colour i, and Si is the geometric mean of all observer's ratings of the same test colour, then logSi can be plotted against logSi for all the test colour. A regression line can be established to determine the a and b factors of each observer in the equation $\log S_i = b \cdot \log S_i + a$. Where a is a scaling factor and b is a compression (or expansion) factor. The constants a and b for each observer enable each observer's data to be adjusted to a common scale. The coefficient of variation (CV) was used as a statistical measure to investigate the agreement between any two sets of data, say x and y.

$$CV = 100\frac{\sqrt{\sum(x_i - y_i)^2 / n}}{\bar{y}},$$

n : sample number in x and y sets
$\bar{y}$: the mean value of the y set

5. Observer Performance

The repeatability of each observer was examined using the repeated ten colours in each session. The CV value between two sets of estimation results was calculated as the repeatability of each observer. Also the CV between the individual's and the mean visual results was computed, which represents accuracy for each observer. The mean and standard deviation of overall repeatability and accuracy of twenty-one observers are given in Table 2.

Table 2. Overall Repeatability and Accuracy of 21 Observers (Mean ± Standard Deviation)

	Repeatability			Accuracy		
	Lightness	Colourfulness	Hue	Lightness	Colourfulness	Hue
Grey	18.0 ± 7.5	27.3 ± 10.6	8.2 ± 3.3	18.0 ± 6.0	23.0 ± 3.3	7.7 ± 1.8
Black	18.5 ± 9.5	28.7 ± 10.6	11.1 ± 5.6	16.7 ± 5.5	25.6 ± 6.5	7.7 ± 2.1
Filter	20.5 ± 11.8	23.6 ± 12.6	10.6 ± 7.6	21.1 ± 7.8	24.8 ± 5.5	8.0 ± 2.0
Average	19.0	26.5	9.9	18.6	24.5	7.8

The results show that the repeatability and accuracy had similar magnitude, which means the observer's internal variation by repeating the estimation of same colour was similar to the deviation between observers.

Relation between repeatability and accuracy of the observer

The relation of each observer's repeatability and accuracy was examined. Figure 3 shows the results of Phase 1 (grey background). In the case of repeatability and accuracy for lightness, a linear relationship was found that observers give good repeatability also show good accuracy. However for colourfulness, good repeatability does not mean good accuracy. This implies that the result by the observer who has persistent own colourfulness scale cannot represent the average result by many observers. Each observer must have a slightly different concept about colourfulness. Hue results are both repeatable and accurate for each observer.

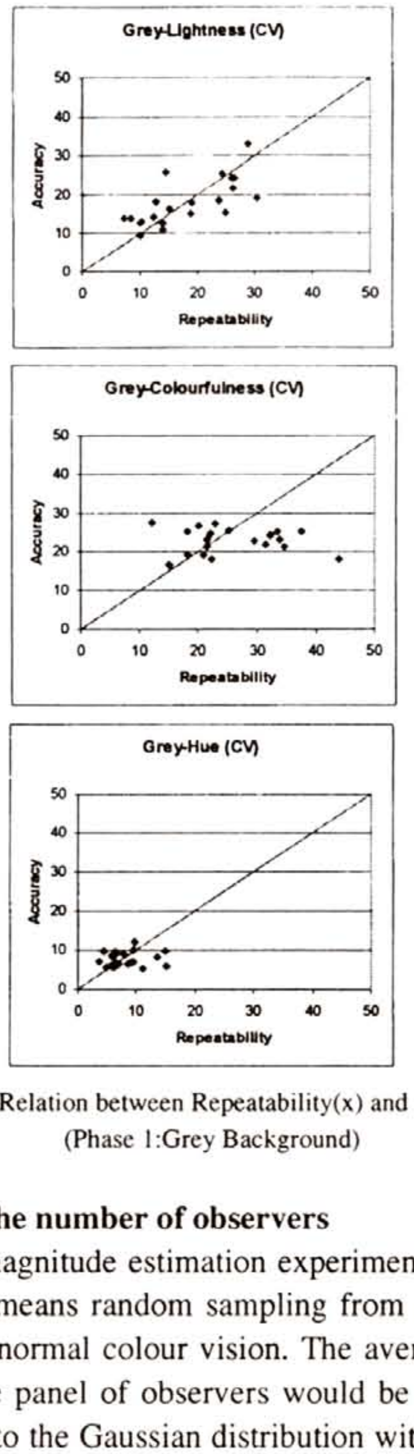

Figure 3. Relation between Repeatability(x) and Accuracy(y) (Phase 1:Grey Background)

Effect of the number of observers

In the magnitude estimation experiment, choosing observers means random sampling from all humans who have normal colour vision. The average results (μ') by the panel of observers would be distributed according to the Gaussian distribution with the mean (μ) and standard deviation of those of parent distribution (all humans) and the uncertainty (σ_μ) of estimated average would be represented like as:

$$\sigma_\mu \approx \frac{s}{\sqrt{N}}$$

s : sample standard deviation
N : number of observation

Therefore more observers give better results. (Note that only the experiment by well-trained observers can give the proper result.) Until now, six to nine observers were commonly used for magnitude estimation experiments [1][4][7][8]. In this study twenty-one observers participated, i.e. about three times more than in the other studies. To check the compatibility with other data set, the effect of number of observers was examined using Phase 3 results. For this test, the forty-two subgroups were constructed and each group consisted of randomly chosen members from twenty-one observers. (10 groups with 3 observers, 5 groups with 5 observers etc. refer Table 3) The comparison between subgroups and the group of all observers is shown in Table 3 and Figure 4. The subgroups with more than eight observers have less than ten CV values compared with all observers. Note that these values were much smaller than the average accuracy of lightness and colourfulness of twenty-one observers which were 18.6 and 24.5 respectively. Therefore we can conclude that the results of six to nine observers gave reasonable agreement with those of twenty-one observers.

Table 3. CV values between the main group based on twenty-one observers and subgroups

CV	Y	21	21	21	21	21	21	21	21
	X	3	5	8	10	12	15	18	21
	No. of Groups	10	5	6	6	5	5	5	1
Lightness	Mean	12.1	9.1	5.3	4.9	4.5	2.7	1.9	0
	Stdev	3.8	1.1	0.9	0.8	0.4	0.3	0.4	
Colourfulness	Mean	18.5	11.4	8.4	6.9	6.1	5.2	2.8	0
	Stdev	7.3	1.7	1.7	1.6	1.5	0.9	0.3	
Hue	Mean	4.5	3.9	3.1	2.8	2.6	2.4	2.4	0
	Stdev	0.7	0.6	0.5	0.3	0.4	0.1	0.1	

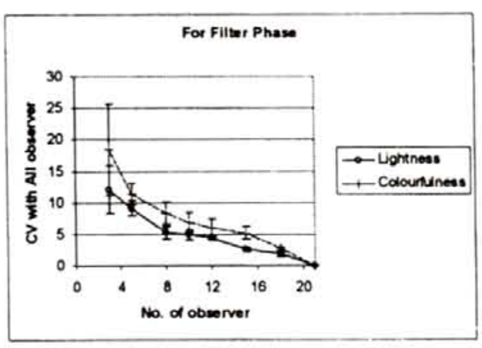

Figure 4. CV values between the main group based on twenty-one observers and subgroups

6. Parametric Effects

The experimental results for Phase 1 (grey background) and Phase 2 (black background) were compared to examine the background effect (see Figure 5) and to examine the luminance effect between Phase 1 (high luminance) and Phase 3 (low luminance) (seeFigure 6). Calculation results between phases are summarised in Table 4.

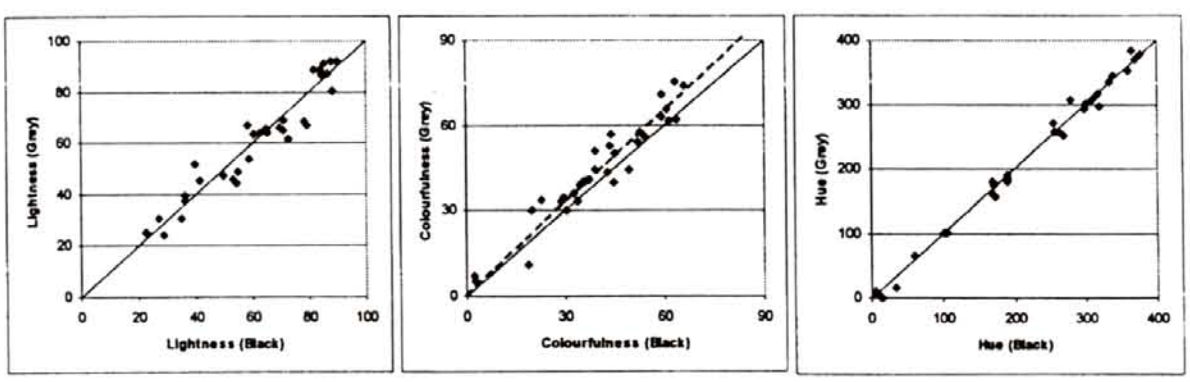

Figure 5. Comparison Results between Grey and Black Background

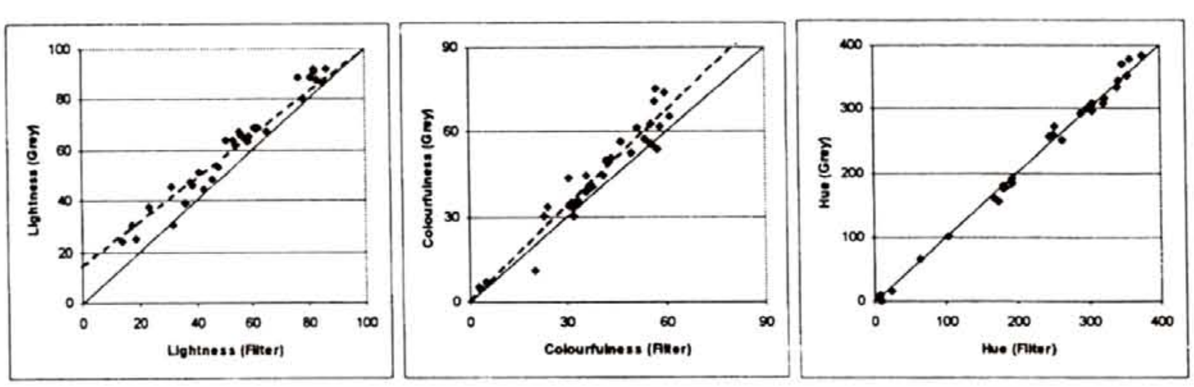

Figure 6. Comparison Results between High and Low Luminance

The results show that lightness and hue were not affected by the backgrounds studied but colourfulness increased about 9% for grey than black background. Note that for dark surround, background change also means the change of the luminance of adapting field. In the case of the luminance effect, all colours tend to look lighter in high-level luminance than in low-level luminance and colourfulness increases about 12% under high luminance, which demonstrates the Hunt effect [9].

7. Testing Performances of the Colour Appearance Models

The visual results from the above experiment were used to evaluate the performance of five colour appearance models for projected images in dark surround. The same analysis method as for LUTCHI data set was used [1]. Table 4 shows the comparison results between visual data and the predictions by colour appearance models. Jp in the Hunt94 model is a lightness equation specially derived to predict projected colours [4].

Table 4. Performances of the Colour Appearance Models Tested

CV	Y	Mean Visual Data					
	X	CIECAM97s	Hunt94		LLAB	RLAB	CIELAB
			Jp	J			
Lightness	Average	13.0	13.2	15.8	14.9	20.7	16.6
Chroma	Average	22.5	21.8		20.6	33.0	32.6
Colourfulness	Average	24.4	23.0		25.5	N/A	N/A
Hue	Average	8.1	8.2		9.9	10.9	N/A

For lightness and hue estimation, CIECAM97s performed the best. LLAB gave the best performance for chroma and Hunt94 for colourfulness. Considering the observer accuracy for each attribute (18.6 for lightness, 24.5 for colourfulness, 7.8 for hue), the performances of CIECAM97s, Hunt94 and LLAB models were very similar.

8. Conclusion

New colour appearance data for projected colour were accumulated. Forty-two colours were assessed by a panel of twenty-one observers for three phases (a grey background with a high luminance, a black background with a high luminance, a grey background with a low luminance). Observer repeatability was 19.0, 26.5 and 9.9 and observer accuracy was 18.6, 24.5 and 7.8 for lightness, colourfulness and hue respectively, showing colourfulness is the most difficult attribute to judge. Accuracy of the observer had linear relationship with repeatability for lightness. For colourfulness, repeatability did not affect the accuracy of the observer, which means each observer had a slightly different concept about the colourfulness scale. Also the accuracy was compared between the result of all twenty-one observers and subgroups consisting of randomly chosen observers. It was found that randomly chosen groups of more than eight observers had accuracy difference less than 10 CV units compared to that of all observers. Therefore the results of former psychophysical experiment conducted using six to nine observers were not so different from the results with twenty-one observers. Projected colours on grey background showed higher colourfulness than those on black background, and lightness and colourfulness under high luminance reference white were judged higher than those under low luminance level. CIECAM97s colour appearance model gave best predictions for projected colours followed by Hunt94 and LLAB model.

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Color Modification for the Exact Color Perception in Photographs in Different Environments

Yuko Hattori, Mitsuo Ikeda, Hiroyuki Shinoda

Abstract

When an observer sees a picture, taken under an incandescent light, in an environment illuminated by a white fluorescent light, he/she cannot have the same color impression on the photograph as perceived for real objects at the shot site, but have much reddish impression on the photograph. This example indicates that some color modification is necessary for the observer to have the exact color impression that he/she experienced before. The amount of color modification was investigated, which was required to ensure the same color appearance under the different illumination. In an experiment, a subject modified a color of a photograph using a hidden illumination technique, to make the same color appearances on a photograph as those perceived for real objects under CIE illuminant A or D_{65}. In order that a photograph, observed under the illuminant D_{65}, provides the color appearance of real objects illuminated with the illuminant A, the color of the photograph needs to be shifted near D_{65}. On the other hand, a photograph, observed under the illuminant A, needs not be modified to provide the color appearance of objects illuminated with the illuminant D_{65}.

Keywords : color appearance, color impression, color modification, photograph, recognized visual space of illumination.

1. Introduction

When a person enters a room, he/she can instantly understand how the room is illuminated, brightly or dimly, or whitely or a little bit reddish, and so on. This state is expressed as that he/she constructed the recognized visual space of illumination RVSI [1] for this room in his/her brain. It is hypothesized that he/she perceives the colors of objects in this room in relation to the RVSI.

One of the purposes of a photograph is to give observers the same impression about scenes as photographers had [2]. For that particular purpose it is necessary to provide observers the exact same color appearance as photographers perceived. It is not easy to achieve the same color appearance when photographs are seen under the different illumination from that of the shot site where the photographs were taken. For example, when we see a photograph, which was taken under incandescent lamps, in a room illuminated with white fluorescent lamps, the color of the photograph appears reddish. This phenomenon is easily described by the concept of RVSI as follows. When a photographer takes a photograph in a room illuminated with reddish incandescent lamps, the RVSI for this reddish illumination is constructed in his/her brain. Here this RVSI is labeled RA. Although lights reflected from objects were reddish, the colors of objects do not appear so reddish to him/her, since he/she perceives the colors of objects in relation to RA. On the other hand, when observers see this photograph in another room illuminated with white fluorescent lamps, the RVSI for this white illumination RD is constructed in their brain. Since they perceive a color of the photograph in relation to RD, the photograph should appear more reddish this time. This discrepancy in the color appearance between on a photograph and in a shot site comes from the difference in the perceived color of illumination for an observing room and a shot site.

To compensate this shift in color appearance, some color modification for photographs is necessary. We investigated the amount of color modification

Yuko Hattori, Mitsuo Ikeda and Hiroyuki Shinoda
Department of Photonics, Faculty of Science and Engineering, Ritsumeikan University
1-1-1 Nojihigashi Kusatsu Shiga 525-8577 JAPAN
Tel : +81-77-566-1111(ex.8552)
Fax : +81-77-561-2663
E-mail : re104958@se.ritsumei.ac.jp

required to ensure the same color appearance under the different illuminations. In an experiment, a subject modified a color of a photograph using a hidden illumination technique, to make the same color appearances on a photograph in an environment as those perceived for real objects in other environments with different illuminations.

2. Experiment

2.1 Experimental Designs

The experimental booth was arranged as shown in Fig. 1. The booth was divided into two spaces by a wall. A photograph was placed in the right-hand space called a 'photo room' and illuminated with a set of luminaries, FL_P. The left-hand space was further divided into two rooms, 'learning room' and ëobserving room'. The learning room was illuminated with a set of luminaries FL_L and the observing room was illuminated with FL_O. Each of three sets of luminaries, FL_P, FL_L and FL_O, consisted of four fluorescent lamps of different colors; red, green, blue, and white. They were designed to provide various color temperatures of illumination ranging from 3000K to 10000K along the black body curve. Both rooms in the left-hand space were decorated with artificial flowers, dolls, books and others on shelves and walls to simulate real rooms.

In the experiment, a subject first spent five minutes observing various objects in the learning room to establish his/her color impression about a scene as illustrated in Fig. 1a. This period was called a 'learning' phase. The view from the subject's eye in this phase is shown in Fig. 2a. The subject then turned around to the observing room illuminated with FL_O as illustrated in Fig. 1b. The subject saw the various objects in the observing room and a photograph placed in the photo room through a window of 21cm high and 26cm wide. This period was called an 'observing' phase. The view from the subject's eye in this phase is shown in Fig. 2b. The photograph in the center of Fig. 2b was taken in the learning room beforehand. The positions of FL_O and the photograph were arranged so that rays from FL_O could not fall onto the photograph. As the subject viewed the photograph monocularly, he/she felt as if it were pasted on the wall and perceived it as one of the objects in the observing room. The color temperature of FL_P was changed by the subject through a light-controller. Since the FL_P was hidden from the subject, he/she felt as if the colors on the photograph were modified when the color temperature of FL_P was changed. The subject's task was to adjust the color of a hidden illumination FL_P so that color appearance of the photograph matches the color impression perceived in the learning phase.

2.2 Preparation of Photographs

The photograph, viewed in the observing phase, was taken in the learning room with a digital camera OLYMPUS C-2500L. When photographing, the CIE (x, y) chromaticity of FL_L was set at (0.333, 0.333), and the white balance of the camera was set at 6500K, and a color-compensating filter FUJI CCM5 was used. This made it possible for chromaticities of various objects on the photograph to be equaled to those of real objects in the learning room when the colors of FL_P and FL_L are equal.

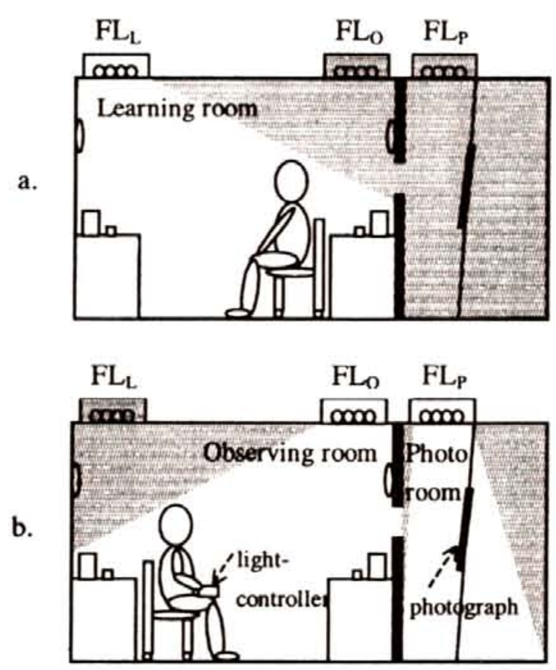

Figure 1. Scheme of the experimental booth. a, the learning phase; b, the observing phase.

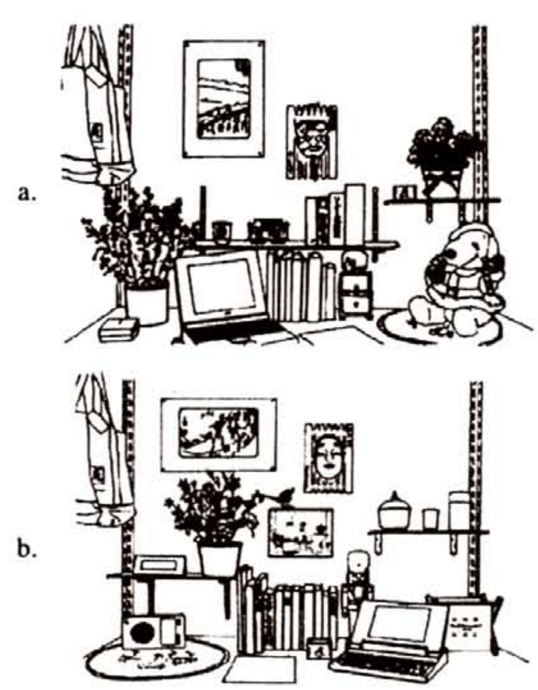

Figure 2. Two different subject's views. a, the learning phase; b, the observing phase.

2.3 Experimental Conditions

We conducted two different series of experiment, A-series and D-series. In A-series of experiment, we investigated the color of a photograph on which we could see the same color appearance as perceived in the learning room illuminated with the CIE illuminant A. In this series, the color of FL_L was set at L1 and that of FL_O at one of colors O1, O2 or O3 in Fig. 3a. Colors of illumination were measured with MINOLTA CL-100 and described by the CIE (x, y) chromaticity. A subject adjusted the color of FLP to get the same color appearance on the photograph as perceived in the learning phase. The dotted line in Fig. 3a shows a trace of FL_P color and agrees with the black body curve. In D-series of experiment, the color of a photograph was investigated which provided the same color appearance as perceived in the learning room illuminated with the CIE illuminant D_{65}. In this series, the color of FL_L was L2 and that of FL_O was either O4 or O5 as shown in Fig. 3b. The dotted line in Fig. 3b shows a trace of the color of FL_P. Intensities of FL_L, FL_O and FL_P were kept constant so as to provide the illuminance of about 700lx at the place of 140cm below them. Only when the color of FL_O was set at O1, the illuminance was 520lx.

2.4 Subjects

Five students with normal color vision, YM (26, female), RY (25, female), YH (24,female), HY (22, male) and HA (22, male), participated in the experiment. Each subject carried out fifteen adjustments of FL_P for each condition.

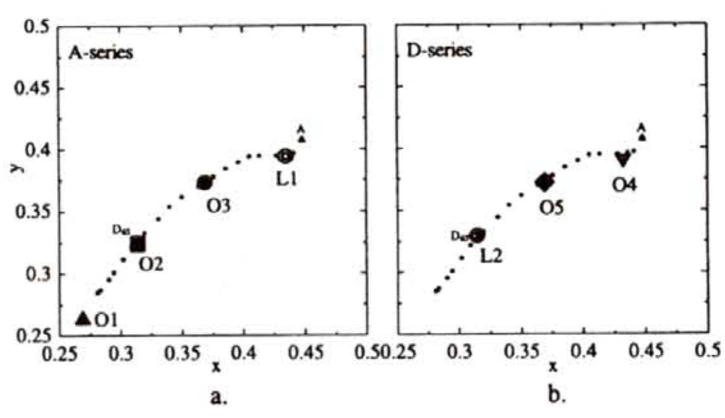

Figure. 3 The illumination colors of FL_L and FL_O.
a. In A-series; color of FL_L, L1 and ⊚ ; FL_O, O1 and ▲ , O2 and ■ , O3 and ●.
b. In D-series; color of FL_L, L2 and ⊖ ; FL_O, O4 and ▼ , O5 and ◆.

3. Results and Discussion

The results from a subject YM in A-series are shown in Fig. 4 as examples. The double circle indicates L1 and filled symbols show colors of FL_O, O1, O2 and O3. Open symbols show colors of individual adjustments of FL_P. Symbols represent colors of FL_O: circles represent O3, square O2 and triangle O1. It should be first noted that all of the data points do not coincide with L1 but rather distributed around the colors of FL_O. That means we see completely different colors on a photograph when chromaticities on it are equated with those of real objects. The goal of color modification should not be a mere reproduction of same chromaticities on a photograph. When the photograph was observed under FL_O of O3, the data points distributed around O3. Under FL_O of O2, the distribution of data points slightly shifted in the direction of L1. When the photograph was seen under FL_O of O1, the data points shifted further toward L1. To quantify the required color modification, we introduce a ëmodification ratio'. Its definition, in the case of O2, is illustrated in Fig. 5. It was defined as a relative distance from L1 to a required chromaticity coordinate of photograph, to the distance between colors of illumination O2 and L1. We calculated the modification ratios from each subject and plotted them in Fig. 6. The modification ratios are shown as functions of color difference △IL between FL_L and FL_O. Symbols represent different subjects. The modification ratios were around 80% in general. That is to say, we have to modify a photograph taken under the illuminant A, to equate its color to the color of the illuminant D_{65} when we see it under D_{65}. Data points from a subject YM in D-series are plotted in Figure. 7 in the same way as in Figure. 4. Though data points do not coincide with L2, their deviations from L2 are small compared to those in Figure. 4. The modification ratios were obtained for all subjects and plotted in Figure. 8. As suggested in

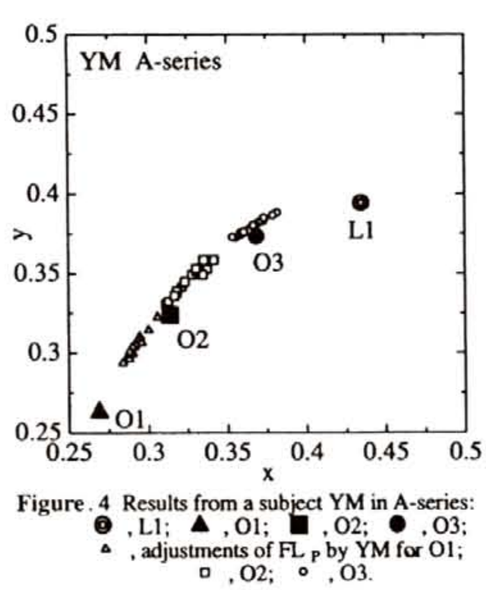

Figure. 4 Results from a subject YM in A-series: ⊖ , L1; ▲ , O1; ■ , O2; ● , O3; △ , adjustments of FL_P by YM for O1; □ , O2; ○ , O3.

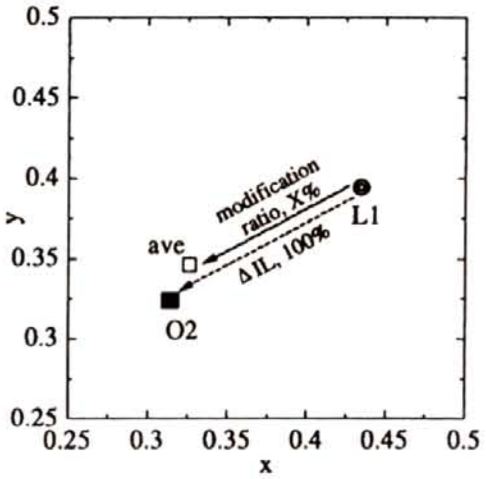

Figure . 5 The definition of a modification ratio in the case of O2.

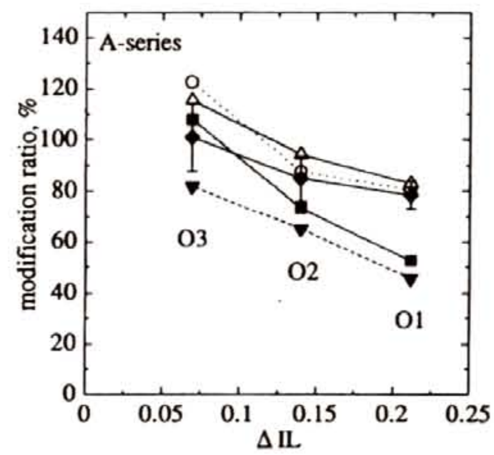

Figure . 6 The averaged modificaion ratio of each subject for A-series.
Different symbols correspond to different subjects: —◆—, subject YM; ···○···, RY; —△—, YH; ···▼···, HY; —■—, HA.

Figure. 8, the modification ratios are so small and nearly zero. This means that we need not modify the color of a photograph of a scene illuminated with D_{65} when observing it under the illuminant A. This result obtained in D-series has not been predicted from the theory of the RVSI. We have no good accounts for that at the moment.

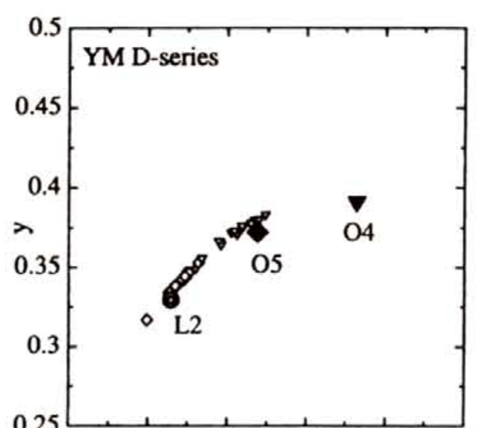

Figure 7. Results from a subject YM in D-series: ◎, L2; ▼, O4; ◆, O5; ▽, adjustments of FLP by YM for O4; ◇, O5.

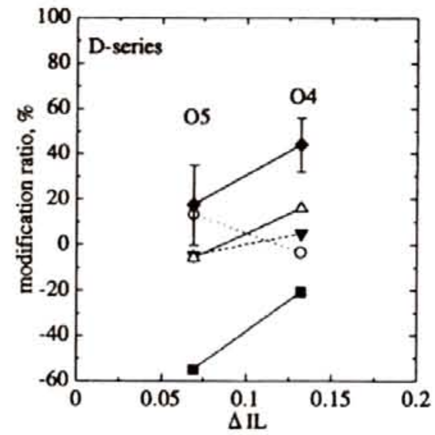

Figure 8. The averaged modification ratio of each subject for D-series.
Different symbols correspond to different subjects: ◆, subject YM; ○, RY; △, YH; ▼, HY; ■, HA.

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Dimension-Up from 2 to 3 in a Photograph to Yield Color Constancy for the Environment

Yoko Mizokami, Mitsuo Ikeda, Hiroyuki Shinoda

Abstract

We recognize the outside world as a three dimensional space in spite of its two-dimensional retinal image. This fact suggests that a two-dimensional photograph can be perceived as a 3-D scene if only the photograph is given to the retina as incoming outside information. A photograph taken for a room illuminated by incandescent lamps was hung on a wall of an experimental booth illuminated by daylight type fluorescent lamps. A subject looked at the photograph with the dimension-up viewing box and the color appearance of a test patch was investigated to see whether the appearance coincided with the color perceived in a 3-D space illuminated by the incandescent lamp. They did not coincide exactly, but the color perceived in the photograph shifted to come closer to the color perceived in the 3-D space showing that the color constancy holds even in a photograph to some extent if the photograph was perceived as a 3-D scene.

Keywords : color constancy, recognized visual space of illumination, photograph, 3-D perception

1. Introduction

We have shown that the color appearance of an object is determined in relation to the recognized visual space of illumination, RVSI which is directly constructed in our brain for a three-dimensional outside space[1-3]. When the illumination changes from the daylight to the incandescent the RVSI changes in its color property accordingly by shifting its recognition axis RX to a new position from the fundamental recognition axis FX as shown in Fig. 1. On this model the illumination is shown by the illumination axis IX positioned at a proper angle depending on the color of the illumination and a neutral white object is shown to locate on this axis as shown by the filled circle. The color perception of the white object is determined by the angle θ from the RX to IX and the color constancy is said 100 % when the RX coincides with the IX . For the construction of a RVSI an observer must first look at the objects placed in the room to understand how the room is illuminated, and they are called the initial visual information, IVI. In other words a same RVSI is constructed as long as a same IVI was presented to the observer whether by illumination or by colors of the objects. We showed the color constancy to hold for the environment decorated by objects of which colors were same as those illuminated by an incandescent lamp while they were actually illuminated by a daylight type lamp[2,3].

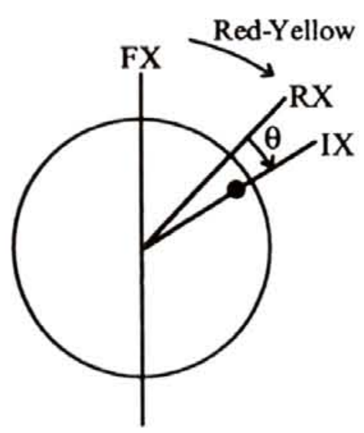


Figure1. The model of RVSI for a space illuminated by incandescent light. FX, fundamental recognition axis; RX, recognition axis; IX, illumination axis. Filled circle shows the color of a neutral white object under the illumination and θ indicates the color perception of the white object.

We will introduce here a new method to construct a RVSI and show that the color constancy still holds. Let us consider a case where we are looking at, in a room illuminated by a daylight type lamp, a photograph taken under an incandescent lamp. We

Yoko Mizokami, Mitsuo Ikeda, Hiroyuki Shinoda
c/o Prof. M. Ikeda, Dept. of Photonics, Ritsumeikan Univ.,
Nojihigashi, Kusatsu, Shiga, 525-8577 JAPAN
Phone : +81-77-566-1111 (ex.8552)
Fax : +81-77-561-2663
E-mail: see30136@se.ritsumei.ac.jp

normally see a very yellowish scene in the photograph contrary to our experience when we stay in a real space illuminated by the same incandescent lamp, where the color constancy holds and we don't see yellow as much as for the photograph. To use the concept of the RVSI we are seeing the yellow photograph with the RVSI constructed for the room under the daylight type illumination having the RX at around the FX. The angle θ is very large and the photograph should appear very yellowish.

If we could construct a three-dimensional space from a two-dimensional photograph the story becomes quite different. When we see the outside world we recognize it as three-dimensional space in spite of the fact that we have only two-dimensional retinal image of the outside. In other words our brain changes the two-dimensional information to the three-dimensional recognition. In this paper we present a subject only with the photograph to be seen by cutting off the room scene surrounding the photograph completely from his/her visual field. As the retinal image is now only for the photograph the scene should be automatically changed to that of three dimensions. If that can be done a RVSI is constructed for the photograph and the RX shifts toward yellow side and the photograph will not appear too yellowish. We will show the color constancy to hold for the photograph.

2. Experimental Apparatus

We constructed a booth which simulated a real room as shown in Figure 2a. Various objects such as artificial flowers, dolls, books and cups were arranged on a shelf and walls, and their colors were selected to cover various hues. The front view of the booth is shown in Figure 2b. The booth was illuminated by daylight type fluorescent lamps FL of the correlated color temperature 6000K and the illuminance was kept at 700 lx on the shelf in front

Figure 2. (a) Scheme of the experimental booth. P, photograph; T, test patch; S, subject; FL, daylight type fluorescent lamps; VB, dimension-up viewing box. (b) View from a subject.

of a subject S. A photograph P on the wall had a size 37.5 cm wide and 30cm high and was observed by the subject at a distance 60 cm. T is a test patch of the size 1 cm × 1 cm for the color judgment in the experiment. It was held at the tip of a pole of 3.5 cm long projected from the photograph at around its center. In order to present a subject only the photograph in his/her visual field a dimension-up viewing box VB was used. It was a black box with a rectangular aperture facing the photograph. When the subject inserted his/her head to the box he/she could see only the photograph monocularly without noticing any of the booth. The monocular vision was to eliminate the information from the subject that the photograph was a plate. By removing the VB the subject could see the photograph in the booth binocularly.

Figure 3. The photograph for the experiment.

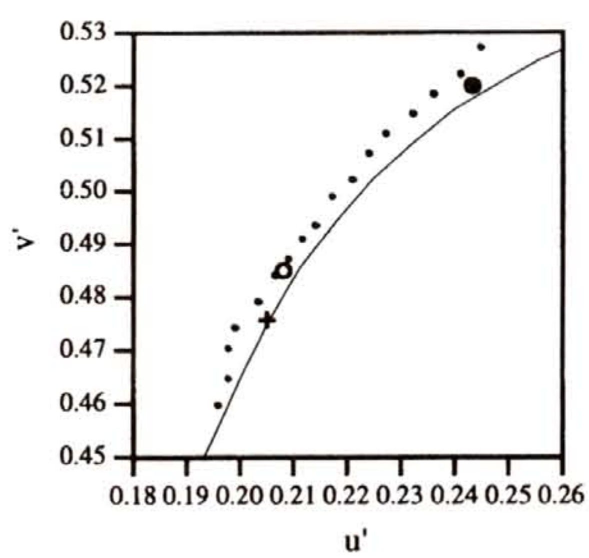


Figure 4. Averaged chromaticity coordinates of achromatic color charts for each environment; filled circle, photo I; open circle, Photo D; cross, booth. Small dots indicate test patches.

Two kinds of the photographs were prepared by a digital camera taking for a living room where a chest of drawers, a table, a sofa, plants, paintings and others were arranged as shown in Figure 3 and illuminated by incandescent type fluorescent lamps and daylight type fluorescent lamps, respectively.

We call them Photo I for the incandescent lamps and Photo D for the daylight lamps. The colors in the photographs were controlled so that they became the same colors in the living room as close as possible by referring to six achromatic color charts with Munsell Value, 2, 3, 4, 5, 7, and 9.5 placed in the room. Their averaged u'v' chromaticity coordinates are shown in Figure 4 by a large filled and open circle for Photo I and Photo D, respectively, when they are placed in the booth. Those of the same charts are shown by a cross when they were placed in the experimental booth. These correspond to the filled circle on the IX in Fig. 1 for the illumination in Photo I, in Photo D and in the booth. The degree of the color constancy can be expressed by the distance from the chromaticity point for neutral perception determined for test patches to one of these three points in respective environment. Seventeen test patches were prepared to have the chromaticity coordinates along the blackbody locus on which above three points located. They are shown by small dots when measured in the booth. Their lightness was kept at L*=70.

3. Procedure

The color perception for the test patches was investigated for Photo I with and without the dimension-up viewing box, corresponding to the normal and dimension-up viewing condition respectively, and the similar experiment was carried out for Photo D. A subject was asked to report the color of the test patches when presented one after another by distributing 10 points to one or two hues of four unique hues, Red, Yellow, Green and Blue, such as 4R and 6Y. The saturation was very low in any test patch but the subject was asked to report the hues. Response such as neutral was not allowed though the subject normally perceived neutral for some test patches. About 9 test patches were selected for the presentation for one photograph to cover the neutral perception. An experimenter changed the test patches in a random order. When the color report was completed for the test patches of 9 for a photograph with the viewing box, the subject went out from the box to observe the photograph without the viewing box and the task of the color perception was again done for all the 9 test patches. Then the same process was done again with and without the viewing box to complete one experimental session. Another photograph was then investigated. Five sessions were conducted for each photograph to obtain ten data for one particular test patch of any experimental condition. Five subjects, HA, AK, HY, RY, YM participated in the experiment. All had normal color vision. The subjects HA and AK did not know the purpose of the experiment.

4. Results and Discussion

All the subjects perceived the perspective in the photograph when they saw it by using the dimension-up viewing box. In one case a subject asked the experimenter to put a test patch on the chest rather than to put in the air indicating that he really perceived the upper surface of the chest of drawers flat. In another case a subject felt the drawer is too far to touch in spite of the fact that the picture was only 60 cm away from her. These examples clearly show that the subjects recognized a three-dimensional space in the photograph. It was also reported about the color perception for the photograph. Some subjects reported that the color perceived for Photo I was much desaturated when they observed it with the viewing box when compared with the color perceived without the viewing box. The color constancy seemed to hold in the dimension-up viewing condition.

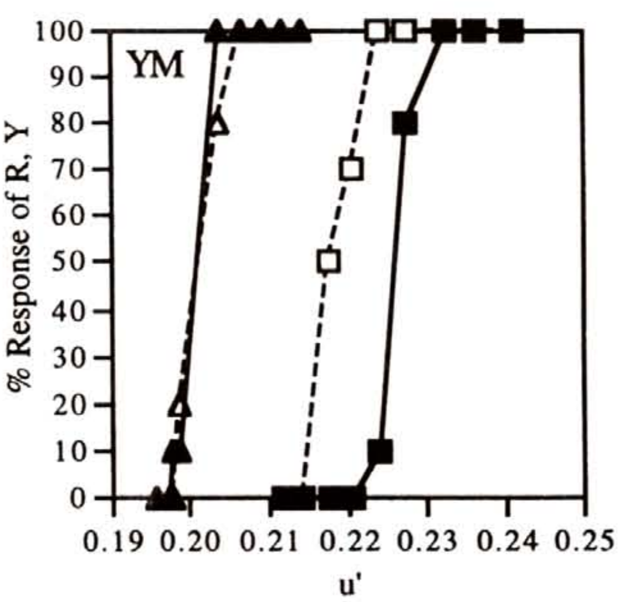
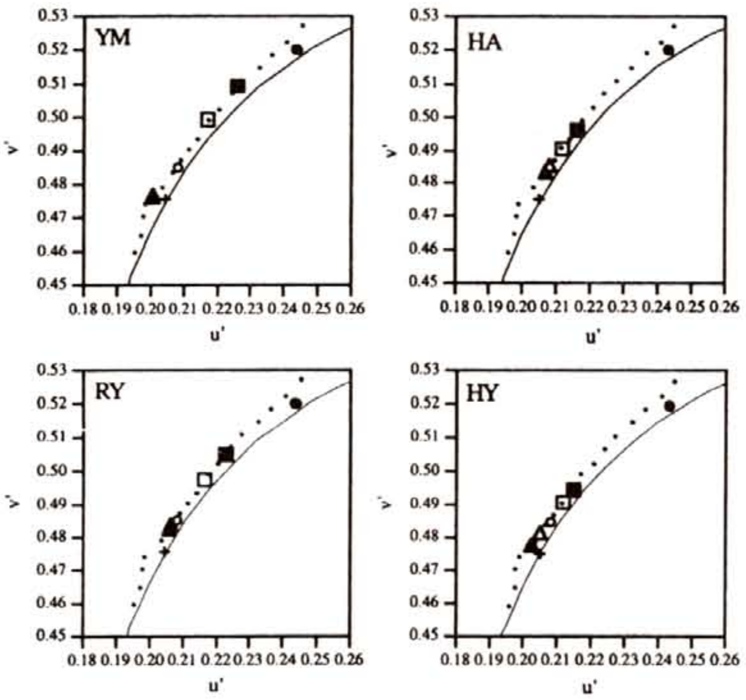


Figure 5. The responses of subject YM. Squares, Photo I; triangles, Photo D. Open symbols, normal viewing condition ; filled symbols, dimension-up condition.

The results are shown for the subject YM in Figure 5. The abscissa indicates the chromaticity coordinate u' of the test patch and the ordinate the percentage of responding R, or Y, or R and Y calculated from ten responses for the test patch. The raw response such as 4R and 6Y for a test patch was counted as one R and Y response. Triangles show the results for Photo D and squares for Photo I. The open symbols indicate the responses for the normal viewing condition and the filled for the dimension-up viewing condition. The test patches of u' at 50 percent in these curves give the neutral perception for the respective condition.



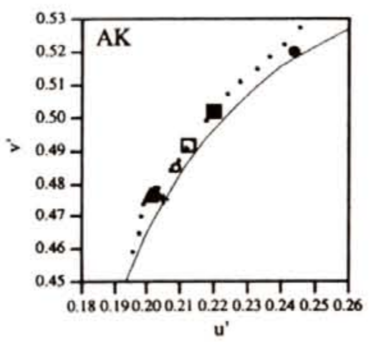


Figure 6. Neutral perception of five subjects at the CIE u'v'chromaticity diagrams shown in Fig.4. Squares, Photo I; triangles, Photo D; open symbols, normal viewing condition 1; filled symbols, dimension-up viewing condition.

The test patches of the neutral perception were obtained for all the subjects and their chromaticity coordinates were plotted on Figure 4 and shown here as Figure 6. Newly added large triangles denote for Photo D and large squares for Photo I. Open symbols indicate the normal viewing condition and filled the dimension-up viewing condition, respectively. In the case of Photo D the open triangle and the cross come very close with each other, and so the filled triangle and the small open circle. The results indicate no difference in color perception whether with or without the viewing box as long as the illumination was the daylight type for both the photograph and the booth. In other words the recognition axis RX for Photo D did not move from the RX of the RVSI constructed for the booth or for the photograph. In the case of Photo I on the other hand open square shifted toward the small filled circle by a rather large amount in every subject. In other words the RX of the RVSI constructed in the subject while he/she was looking at the photograph placed in the booth rotated unexpectedly toward the illumination axis IX of the RVSI constructed for the incandescent lamp. How did it happen without the viewing box? One reason would be the phototgraph was observed at too a short distance and it gave the subject a large visual field so that the subject perceived a three dimensional scene in the photograph. The most important result here, however, is the shift of the filled square from the open square toward the small filled circle. The viewing box indeed worked to create the three-dimensional scene in the photograph to increase the degree of the color constancy.

To conclude, the present experiment demonstrated the color constancy for a photograph by raising a photograph of the two-dimensions to that of the thee-dimensions with a help of a dimension-up viewing box.

Acknowledgment

This study was supported by a Grant-in-Aid for JSPS Fellows from Japan Society for the Promotion of Science.

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Determination of Borders of Object Color Mode at Various Environmental Illuminance

Yuwadee Thiangthangtum*, Rumi Yamauchi, Pontawee Pungrassamee*,**

Aran Hansuebsai*, Mitsuo Ikeda**

Abstract

When the luminance of a particular surface of an object is gradually increased by spot lighting, the color changes but the appearance remains natural in the environment keeping still the object color mode. For a further increase of the luminance, however, the surface begins to appear unnatural as an object placed in the environment. This situation was expressed as that the luminance of the surface became too high and the surface appearance went beyond the border of the recognized visual space of illumination, RVSI. The appearance then becomes luminous to indicate the light color mode. To know the border points of color charts is useful when one wants to make a color object conspicuous by selectively lighting the object by a spot light in an environment. This paper determined the border points for 39 color charts covering hue and saturation while keeping lightness at middle range and for two differentilluminance of the environment, 5 and 50 lx. The border luminance was high for yellow and greenish yellow color charts while it was low for red color charts. The difference in luminance between the two groups was about 0.45 in log unit in one subject implying that a little less than three times of spot light strength is needed to make yellow and greenish yellow color objects conspicuous similarly as red color objects in an environment. To investigate whether the brightness of the color charts determines the border, the brightness matching was the brightness of the color charts determines the border, the brightness matching was conducted for all the color charts against a reference chart of N7. There was a relationship between the border points and the brightness to some extent but there were some exceptions, where relatively low spot lighting caused the charts to appear unnatural to be the objects to belong to the environment.

Keywords : Color appearance mode, object color, light source color, recognized visual space of illumination, brightness matching, spot light

1. Introduction

When a color chart is locally illuminated among other objects in a room the color appearance changes according to the illuminance[1]. When the illuminance is low the appearance changes to increase saturation and lightness, and it remains as the object color. The appearance finally reaches that of the border, namely the upper limit of appearance to belong to an object in the room. For a further increase the color chart begins to appear too bright or unnatural to be an object belonging to the environment. For a further increase of the illuminance the surface begins to shine of which color depends on the color of the chart. This phenomenon can be expressed in the realm of the concept of the recognized visual space of illumination, RVSI [2]. The RVSI is a state of his/her brain of understanding how a space is illuminated, brightly or dimly, and whitely or a little bit reddish

Y. Thiangthangtum*, R. Yamauchi**, P. Pungrassamee*, A. Hansuebsai*, M. Ikeda**

* Department of Imaging and Printing technology, Faculty of Science, Chulalongkorn University, Phya-thai Road, Pathumwan, Bangkok 10330 THAILAND

Phone: 662-218-5588-9,218-5568, Fax: 662-2553021,254-6530

e-mail: 42723726@student.chula.ac.th

** Department of Photonics Faculty of Science and Engineering Ritsumeikan University, Noji-Higashi, Kusatsu, Japan 525-8577

e-mail: mikeda@se.ritsumei.ac.jp

when the observer stays in the space. It can be expressed as in Fig. 1 by a sphere of which radius represents the brightness size of the RVSI. If the local illuminance on the color chart is low as indicated by C_o the luminance of the color chart is inside the sphere or a circle for simplicity and the surface exhibits the object color mode. The appearance reaches the border as shown by C_b and then shifts further outside to the position C_u which results with unnatural appearance. The final appearance is the light source color indicated by C_l.

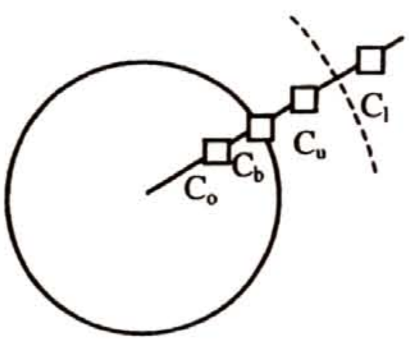

Figure 1. Scheme to show the color mode change by the concept of the RVSI.

The investigation of the color appearance mode is important because it tells us about the mechanism of the visual system for color perception on one hand and gives us some knowledge about lighting effect in environment on the other. We will determine C_b of Figure 1, namely the border between the object color appearance and the unnatural color appearance for various color charts. In particular we will investigate whether the border is determined uniquely by the brightness of color chart as shown by some researchers [3]. They concluded that the mode of color perception is determined by brightness, and not by luminance. In our experience through many experiments on the border in the past, we found very unnatural appearance on the surfaces of some colored objects before their brightness reaches the upper limit to be naturally included to the space in question. In still another experiment when a color chip was locally illuminated among other chips in a sheet of the Munsell Book of Color, its appearance became unnatural such that there was no corresponding color chip in the sheet while its appearance did not reach the edge of the sheet of the Book [2]. There seem some colors which behave curiously when they are locally illuminated to approach the boundary of the object color. In this paper we employed 39 color charts including these colors for the determination of the border and compared the results with the brightness data of the color charts to see whether there exists a good correlation between the two kinds of data, and if not, to investigate the reason for it.

2. Apparatus

The experimental apparatus is composed of Room A and B separated by a wall having a small square aperture A as shown in Figure 2. The room A is of the size 1 m wide, 1.5 m long and 2.4 m high and it simulates a living room having being decorated by artificial flowers, dolls, books, framed pictures and others. The colors of these objects were selected so that they cover various hues. The room was illuminated by the fluorescent lamps of the day light type FL and they were controlled by a rotary switch so that the room illuminance was adjusted at any level. The illuminance was measured by the colorimeter Minolta CL-100 placed on a table as seen in the figure.

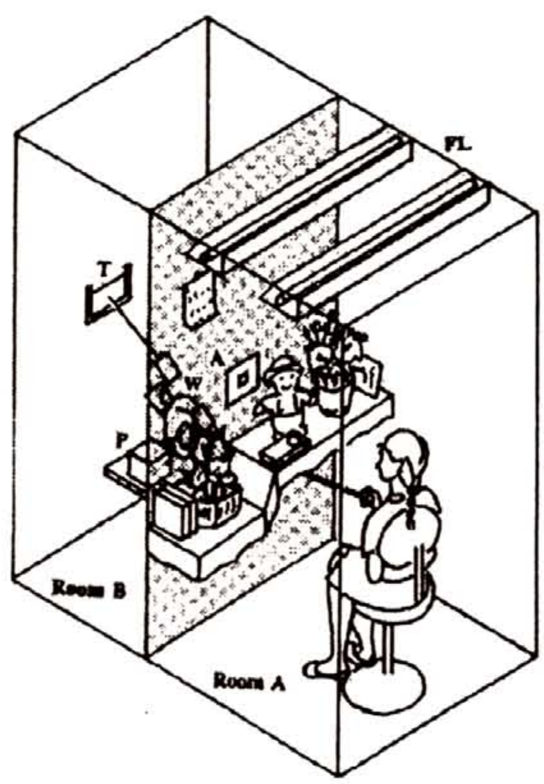

Figure 2. Scheme of the apparatus.

A subject sat in Room A and consequently he/she constructed a RVSI in his/her brain for this room.
At the subject's eye level an aperture A of the size 2 cm × 2 cm was opened on the wall separating the two rooms and he/she could see through the aperture a test chart T placed in Room B. When the subject saw the test chart it appeared as if it was pasted on the aperture. In other words the subject saw a small square patch at the place of the aperture.

To illuminate the test chart a projector P was used. The light from the projector passed through lenses and a circular neutral density wedge filter W and was reflected by mirrors before it reached the test chart.

The illuminance on the chart was controlled by the wedge filter and it was operated by the subject through a knob and a shaft. The luminance of the test chart was measured with a SpectroScan of Photo Research from the subject's eye position through a large aperture opened by taking off a card of the aperture A.

For the brightness measurement of the test chart the card of the aperture was replaced by another card on which an achromatic N7 chart of the same size as the aperture A was pasted at the right side of the aperture A with a separation of 2 mm.

3. Subject's Tasks

Subjects were engaged in two experiments, border and brightness matching. In the border experiment they were asked to obtain the upper limit of the luminance of the test chart while the test chart still appeared normal as an object in Room A. If the chart appeared too bright as an object placed in the room, it was considered unnatural. If it appeared luminous, it was also considered unnatural. Whatever the subject began to feel unnatural for the test chart it was considered beyond the border of RVSI and the subject should set the wedge filter just below the luminance. In the brightness matching experiment the subjects were asked to match the test chart with the achromatic standard white of N7 in brightness by rotating the wedge filter.

Five subjects participated in the experiment; MI (67 years old, male, Japanese), RY (25, female, Japanese), YT (24, female, Thai), NJ (23, male, Thai) and WR (22, female, Thai). The first two were well experienced subjects in this kind of experiment and the third an experienced to some extent, but the rest two were quite naive subjects. All the subjects had normal color vision.

Each subject repeated the determination for each test chart for ten times as separate sessions for both the border and brightness matching experiments.

4. Test Charts and Experimental Condition

Thirty-nine colors were selected for the test chart and their nominal Munsell HVC are shown in Table 1. The light from the projector to illuminate these charts had the color temperature of about 3500K and color of all the charts shifted toward orange when viewed by subjects. Their chromaticity coordinates are shown in Figure 3. We selected these charts in intention to make three different saturation contours, of about Chroma 3, 6 and 10 as seen in Table 1, but because of the color shift the intention was not fulfilled.

Two levels of room illuminance were investigated, 5 and 50 lx.

Table 1. Nominal Musell HVC of 39 test charts.

No.	Munsell	No.	Munsell	No.	Munsell
1	5R4/10	14	10B4/10	27	5GY5/6
2	10R4/10	15	5PB4/10	28	5G5/6
3	5YR5/10	16	10PB4/10	29	5BG5/6
4	10YR5/10	17	5P4/10	30	5B5/6
5	5Y7/10	18	10P4/10	31	5PB5/6
6	10Y7/10	19	5RP4/10	32	5P5/6
7	5GY6/9	20	10RP4/10	33	5RP5/6
8	10GY6/10	21	10RP3/8	34	5R5/3
9	5G5/10	22	5R5/6	35	5Y5/3
10	10G5/10	23	10R3/4	36	5G5/3
11	5BG4/9	24	5YR5/6	37	5B5/3
12	10BG4/9	25	5Y5/6	38	5P5/3
13	5B4/9	26	5Y4/6	39	N5

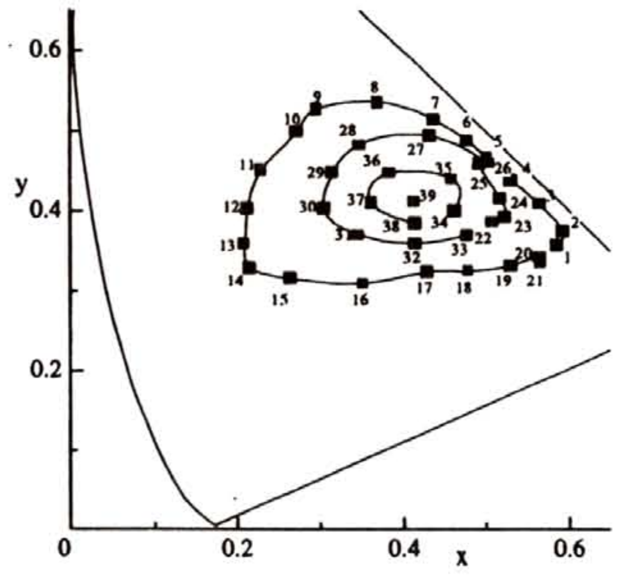

Figure 3. Chromaticity coordinates of the test charts when illuminated by the projector.

5. Results and Discussion

Raw data of the subject RY are shown in Fig.4. The upper section shows the results for 5 lx and the lower for 50 lx. Along the abscissa the number of test charts denoted in Table 1 is taken and along the ordinate the luminance of the test chart at the border or at the brightness matching in logarithmic unit.

Each point represents the average of ten determinations and for the border experiment the standard deviations are shown by vertical lines. Similar standard deviations were observed in the brightness experiment. It should be noted that the vertical position of the brightness matching data depends on the lightness of the reference white used and it is subject to shift if we use a different lightness rather than N7. The size of the standard deviation was generally smaller in 5 lx than in 50 lx, which implies easier determination of the border at darker environment. There seems to exist good relationship between the border and the brightness data as their curves have a similar shape.

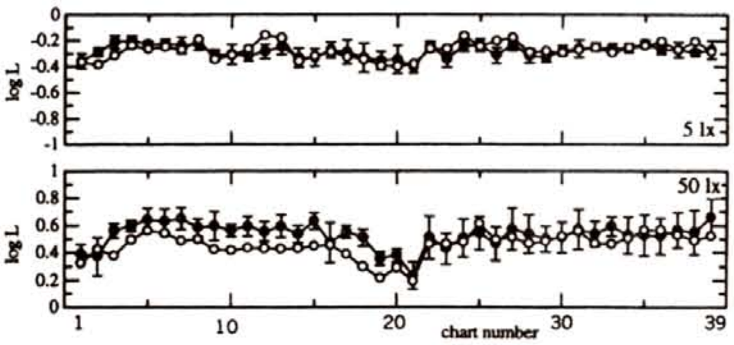

Figure 4. Results of the border expeniment (—●—) and the brightness matching experiment(—○—) from the subject RY. The upper section is for 5 lx and the lower 50 lx.

To see the correlation we plotted the brightness data against the border data in Figure. 5 for the subject

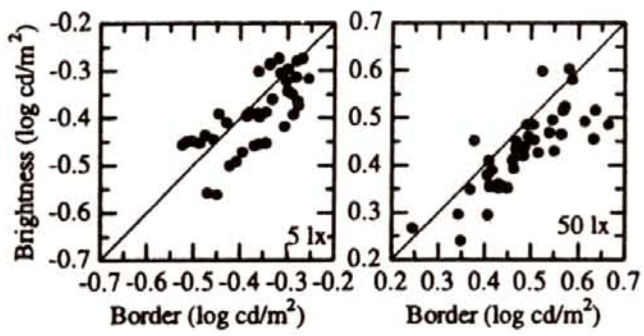

Figure 5. Brightness matching-vs-border plot for the subject MI. Left, 5 lx; right, 50 lx.

Table 2. Correlation factors between the broder and the brightness matching luminance.

	MI	RY	YT	NJ	WR	mean
5 lx	0.719	0.618	0.746	0.647	0.476	0.641
50 lx	0.798	0.649	0.691	0.685	0.695	0.704

MI. To the first approximation it seems that larger border data correspond to larger brightness data and that the border is determined by the brightness. But actually the correlation factors are not high, 0.719 for 5 lx and 0.798 for 50 lx. It is interesting note, however, that the data points in 5 lx can be roughly divided to two groups, a lower right group and a upper left group and the correlation factors should be higher if we calculate for the groups respectively. The test charts in the upper left group reached the border at lower luminance than those in the lower left group relative to the brightness. This property, however, was not found in other subjects. Table 2 shows the correlation factors for both illumination conditions from all the subjects. The factors are not high.

To find out some other factors to determine the border than the brightness we replotted data of Figure 4 in the order of luminance for brightness as shown in Figure 6. The filled circles are for the brightness and the open circles for the border. The test charts were arranged along the abscissa in the order of the luminance value of the brightness matching. Let us look at the data shown by filled circles from 50 lx. The test charts to show high luminance, namely the charts arranged at the left end in the figure, are of achromatic and yellow color as can be confirmed in Figure 3, while those to show low luminance, the charts at the right end are of orange and red color. This property is well known as the Helmholtz-Kohlraush effect. The luminance difference between the two ends is much larger in 50 lx than in 5 lx, which was also well established[4)]. The difference clearly exists in the shape of curves between the border and the brightness in the case of 50 lx. We already saw a low correlation factor, 0.649 for this case.

What is then determining the border? If we are to pick up the test charts which showed relatively low luminance compared to the luminance of the

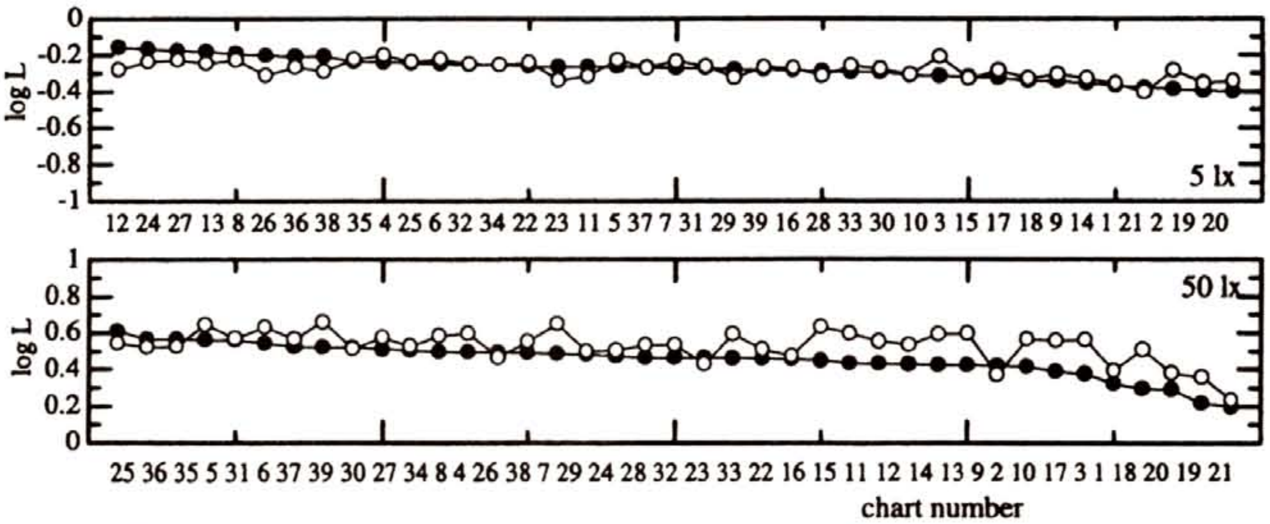

Figure 6. Luminance of the test charts for the border(—●—) and the Brightness(—○—) arranged in the order of the latter. Subject RY.

brightness at the right end, they are No. 21, 1 and 2 to pick up only three. When the luminance of these test charts is increased by the projector via the neutral density wedge filter as in the experiment, their chromaticity coordinates x and y do not change. But their Munsell Values increase and their colors finally go out from the object color boundary as they locate at the lower right in the xy chromaticity diagram where the boundary shrinks with increase of Value. It is conceivable that this early going-out situation from the object color boundary caused the test charts to become unnatural at relatively low luminance compared to the luminance of the brightness matching. The subjects often reported that the brightness of the test charts could be still increased if the criterion for the test chart to be natural in the room is mere the brightness but the appearance was very unnatural being luminous in some cases and transparent in other cases.

Our conclusion is then that an object color appearance reaches the border of the recognized visual space of illumination if the brightness reaches the maximum level that objects in the space can take under the main illumination. Or the spectral composition of the light coming from the object goes out from that of objects inside the object color boundary, although we can not exclude still other factors at this moment.

Acknowledgement

We acknowledge Ms. Yoko Mizokami at Ritsumeikan University for her help in preparing theapparatus and her participation in the experiment at the early stage. This experiment was conducted at Chulalongkorn University supported in part by Thailand-Japan Technology Transfer Project.

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Color Change in the Construction Process of the Recognized Visual Space of Illumination for a New Environment

Rumi Yamauchi, Mitsuo Ikeda, Hiroyuki Shinoda

Abstract

We move from one environment to the other quite often in our daily life. But we almost never misjudge colors of objects in spite of the illumination change. This is because we can immediately understand how the new environment is illuminated and see the objects based on the understanding. We called the understanding the recognized visual space of illumination, RVSI. To construct the RVSI we need to see various objects in the environment, which we call the initial visual information, IVI. In other words we need to have enough IVI in the space to construct the complete RVSI for the space in order to correctly judge the colors of objects1). In this experiment the process how the RVSI is constructed was investigated by measuring the apparent color of a test patch as a function of the amount of IVI. We employed a colored spotlight called the hidden illumination in a test room to illuminate a limited area surrounding a gray test patch. Four colors, red, yellow, green and blue were employed for the hidden illumination. The apparent color of the test patch of N4 was judged by subjects when IVI composing of objects and walls as parts of a miniature room was gradually introduced into the hidden illumination. The color was simply same as the color of the hidden illumination when there was no IVI giving a large value of the chromaticness. The hue did not change but the chromaticness gradually decreased with increase of the IVI and finally it almost returned to the gray color of the test patch itself when the patch was completely included in and surrounded by the miniature room implying the complete construction of a new RVSI for the hidden illumination.

Keyword : apparent color, initial visual information, hidden illumination, spot light, color naming, recognized visual space of illumination

1. Introduction

We proposed the concept of the recognized visual space of illumination, RVSI and could successfully explain various visual phenomena such as the lightness constancy, the color constancy, the simultaneous color contrast and so on[2, 3]. When one comes to a new environment he/she can immediately understand how the space is illuminated, brightly or dimly, and a little bit reddishly or whitely. This situation is expressed as that the observer constructed the RVSI for the space in his/her brain. For the construction the observer saw various objects, luminaires, and/or windows etc. in the space and we called them the initial visual information. If the observer felt the space illuminated brightly we expressed the RVSI by a large size of sphere and if

Rumi Yamauchi, Mitsuo Ikeda and Hiroyuki Shinoda
Department of Photonics, Faculty of Science and Engineering, Ritsumeikan University
Nojihigashi Kusatsu Shiga 525-8577 JAPAN
Tel : +81-77-566-1111(ex.8552)
Fax : +81-77-561-2663
E-mail : re141952@se.ritsumei.ac.jp

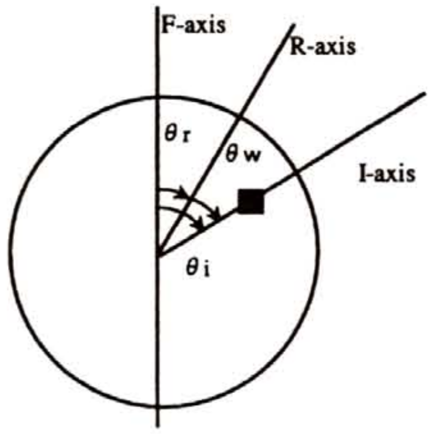

Figure 1. Scheme of RVSI: F-axis; fundamental recognition axis, R-axis; recognition axis at work, I-axis; illuminations axis.

Once the RVSI is constructed the observer now recognizes the appearance of any object in the space in relation to the RVSI. A circle in Fig.1 expresses the RVSI for a space illuminated for example by an incandescent lamp. In this model a white patch in the space can be shown by a filled square taken on the illumination axis, I-axis which is rotated from the fundamental recognition axis, F-axis toward red direction by the amount of the red color of the illumination θ_i. The observer is in the space and he/she does not see the very red color because of the color constancy. In the model of Fig.1 the state is expressed by a recognition axis at work, R-axis rotated toward the illumination color by some amount θ_r not equal but closer to θ_i depending on the degree of the color constancy. The observer now sees the color of the white patch a little reddish corresponding to the angle from R-axis to I-axis,θ_w.

Let us consider a situation where only a white object is illuminated in a room by a reddish spotlight in addition to a white ceiling light. An observer in the room constructs the RVSI for the room illuminated white, but not the RVSI for the area illuminated by the red spotlight because there is not enough initial visual information within the area to construct the RVSI. In other words he/she sees the white object based on the white recognition axis which can be assumed same as F-axis and should sees the object very reddish given by the large amount of the angle θ_i.

If we insert other objects into the reddish spotlight to work as the initial visual information for the area, the RVSI should be constructed with the recognition axis at work closer to the illumination axis and the observer should see the white object white closer to its own white color. It is predicted then that the color of a white patch in a colored spotlight will change from red to white with increase of the initial visual information in the new environment. The purpose of this experiment is to prove the prediction for various colors of the spotlight.

2. Experiment

2.1 Apparatus

The experimental setup is shown in Fig.2. It is made up of two rooms, a subject's room and the test room, illuminated by fluorescent ceiling lights FL. A subject can see the test room through an opening of the size 27cm high and 50cm wide. Both rooms are decorated with objects of various hues so that the subject can construct RVSI for the rooms. T indicates a test patch for which a subject judges the apparent color. It was supported by a stick extended from the back wall so that the subject could see the test patch in the air without seeing the supporting stick. A spotlight is provided to cover the test patch with a slide projector P, a mirror and a color filter CF as shown by unshadowed area. The subject can see only the test patch within the spot light because of the opening and he/she can not notice the existence of the spotlight. We call it the hidden illumination. Its illuminance is controlled by a circular wedge density filter W placed in front of the projector.

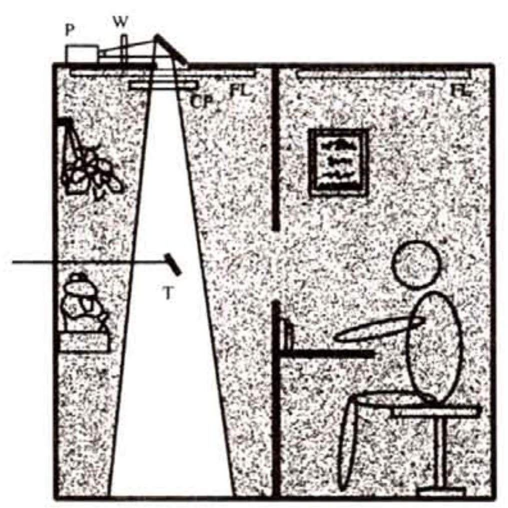

Figure 2. Side view of the apparatus: T; test patch, CF; color filter, FL; ceiling light, p; projector, W; neutral wedge density filter.

To introduce the initial visual information in the area of the hidden illumination we utilized two movable platforms on which objects to work as the initial visual information are mounted as shown by meshed areas in Fig.3. The platforms shown by thick black lines move horizontally by belts in opposite directions with each other with the test patch T in between. The initial visual information is made of a miniature room with left, right and back walls and a floor. It is in fact cut at the middle to make two parts to be placed on the respective platforms. There are some furniture such as a table, a sofa and a potted plant in the miniature room.

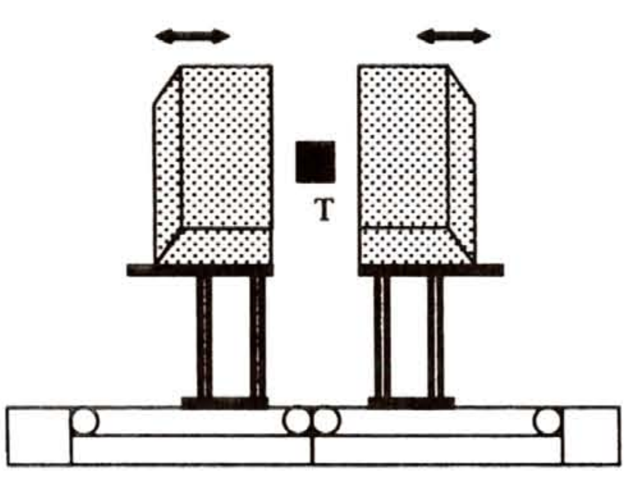

Figure 3. Initial visual information inserted into hidden illumination area: T, test target; meshed figures, IVI.

When both portions of the miniature room are gradually inserted in the hidden illumination they finally surround the test patch completely so that the subject sees the test patch placed in one miniature room illuminated by the hidden illumination. The hidden illumination is no longer hidden illumination. We can expect the subject constructs another RVSI for the miniature room and sees its own color in the test patch. When the two portions are still separated the RVSI may not be complete at the immediately nearby area of the test patch although there are initial visual information within the hidden illumination area. We can see how incomplete the RVSI is by measuring the apparent color of the test patch.

2.2 Condition

An achromatic chart of N4 of the size 4cm◊4cm was employed as the test patch. The hidden illumination was kept at 400 lx and the ceiling light at 60 lx measured at a level 30 cm below the test patch. The illumination in the subjects' room was kept at 60 lx. Four color filters, red, yellow, green and blue, were employed for the hidden illumination and their chromaticity coordinates are plotted in Fig.4 by open circles together with that of the ceiling light by a large open circle. They were measured respectively with Minolta colorimeter CL-100 on the floor of the miniature room. The chromaticity coordinates of illumination when both the ceiling light and the hidden illumination were lit were similarly measured and they are shown by open squares. Then the test patch was placed at its position and the chromaticities were measured from the subject's eye position by using Minolta colorimeter CS-100. They are shown by filled circles in the figure. They are different from those shown by open squares and this is probably because of the different reflection property of the test patch surface for the ceiling light and the hidden light.

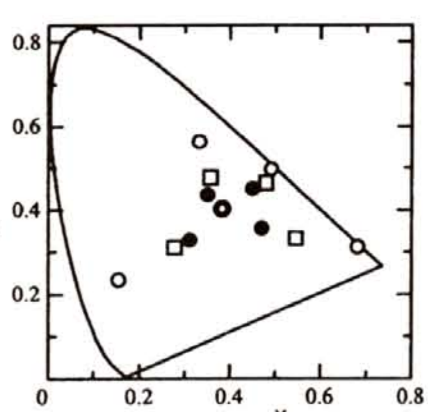

Figure 4. Chromaticity diagram:
○; ceiling light, ○; colored hidden illumination,
□; colored hidden illumination and ceiling light,
●; on test patch illuminated by both lights.

To change the amount of initial visual information in the hidden illumination the movable platforms were placed at five positions, 0, 37, 74.1, 88.9 and 100%. The rates are defined by the total horizontal length of the miniature room illuminated by the hidden illumination to the length of the hidden illumination viewed from the subject. Fig.5 shows three conditions, 0, 37 and 100%. The clear area indicates the illuminated area by the hidden illumination. At the 0% condition any portions of the miniature room are not illuminated at all by the colored hidden illumination and only the test patch is illuminated. Shadowed area shows the test room illuminated only by the ceiling light. At 37% only small parts are illuminated. At 100 % the miniature room is completed to one room and the entire portion of the room is illuminated by the colored hidden illumination.

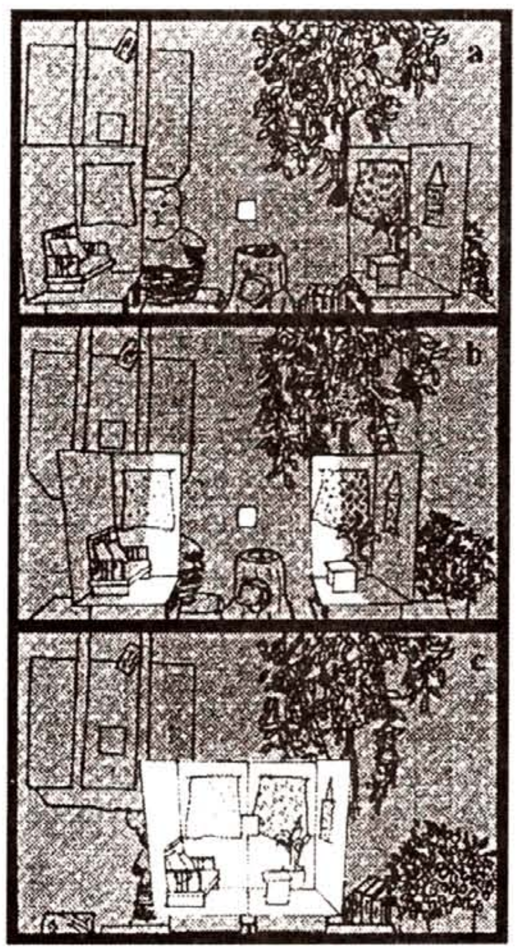

Figure 5. Initial visual information in the hidden illumination area for 3 positions. (a), 0%;(b), 37%;(c), 100%

One experimental session is composed of 20 judgments of color of the test patch for the conditions of 5 positions of initial visual information and of 4 colors of hidden illumination.

Five subjects, YM (25years old, female), RY (24, female), YT (24, female), HY (22,male) and TM (22, male) participated in the experiment. The subjects' task was to judge the apparent color of the test patch by the color naming method. He/she allotted points to the amount of the chromaticness seen on the test patch out of 100 points and distributed 100 points to the unique hues, red, yellow, green and blue.

3. Result and Discussion

Data from the subjects RY and HY are shown in Fig.6 for the red hidden illumination. Along the abscissa the rate of the initial visual information is taken and along the ordinate the amount of the chromaticness of the test patch. The mean values from ten determinations at each rate are shown with the standard deviations as vertical lines. Although there exists difference in standard deviation to show the individual difference in variation of ten determinations we can see a clear property in the curves. The subjects saw large amount of chromaticness, 70 by RY and 53 in HY, in the test patch at the rate 0 % as predicted from the concept of

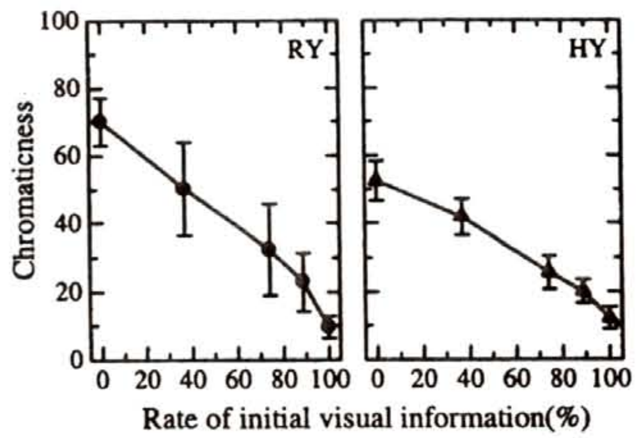

Figure 6. Results for the condition of the red hidden illumination from subjects RY and HY.

the recognized visual space of illumination shown in Figure 1. The subject is seeing the test patch illuminated by red hidden light and located on the I-axis but his/her RVSI is still for the test room illuminated by white light. The chromaticness should be given by the angle θ_I and consequently large. The angle however is subject to the color of the hidden illumination and the absolute values observed here should not be too much stressed. When the initial visual information is increased the chromaticness gradually dropped and finally to about 10 for both subjects. This value corresponds to θ_W. This implies that the new RVSI is constructed for the hidden illumination area and the recognition axis of the RVSI shifted from the F-axis toward and very close to the I-axis. The color constancy is almost perfect for the space illuminated by the red hidden illumination.

Results from all the subjects are shown together in Figure 7. There are some variations among the subjects but the property of gradual drop of chromaticness holds for all the subjects. For example, the subject TM denoted by inverted triangles gave large amount of chromaticness for the green hidden illumination. Yet the property of gradually dropping is clearly seen and if the whole curve is shifted downward by about 30 it completely overlaps with other curves. Only exception is the result of the same subject for the red hidden illumination. The recovery of the color constancy is rather small even if he was shown the initial visual information of 100%. The reason for this is not clear.

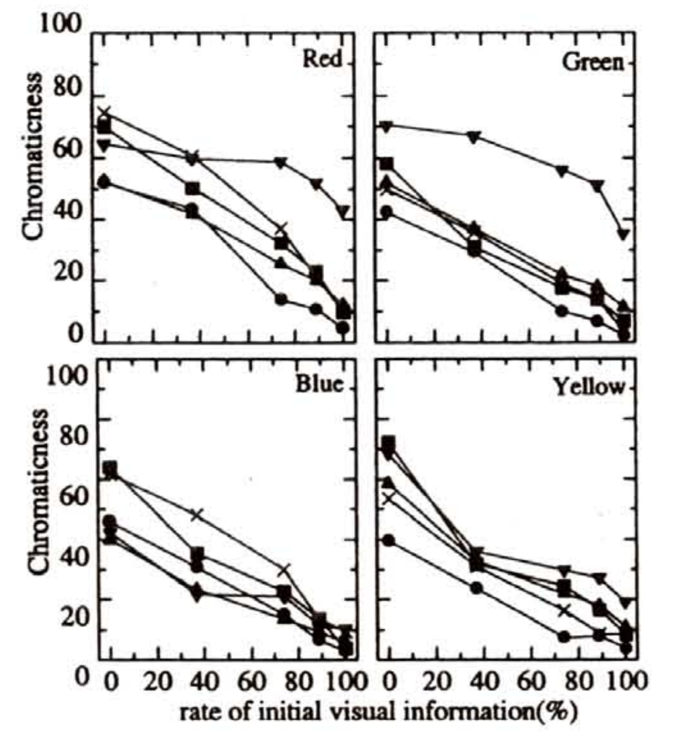

Figure 7. Result of five subjects for 4 colored hidden illumination: —●—,YM; —▲—,HY; —■—,RY; —▼—,TM; —×—,TY.

The average chromaticness at 100% of the initial visual information is 7.0 excluding the results of the subject TM, which may indicate almost perfect color constancy. It should be remembered, however, that the chromaticities of the test patch when viewed from the subject were a little desaturated from those on the miniature room floor shown in Figure 4. As the subjects should have constructed their RVSI for the miniature room for the color of illumination falling on the room, the desaturation should have caused to estimate less chromaticities for all the test patches. We should say that the color constancy is less perfect than the results indicate.

When the rate of initial visual information was 37% the chromaticness took a value intermediate between those at 0 and 100%. For this situation the subject sees the left and right half of the miniature room separated widely and only partly illuminated by the hidden light as indicated in Figure 5b. According to the subject's impression, he/she feels to see the hidden illumination itself over the objects in the illuminated portions. In other words the recognition axis, R-axis, did not shift yet to the final position to be established by 100% initial visual information. The angle θ_w in Fig. 1 is still large, which resulted with an intermediate value of the chromaticness. It must be mentioned also that the two portions of the miniature room were widely separated for this condition. Even if there are constructed two RVSI for them, though incomplete as mentioned above, these two RVSI may not fill out completely the open space between the two portions and the color appearance of the test patch is partly influenced by the RVSI of the test room. This may be another reason why the chromaticness took a value between those of 0 and 100 % of the initial visual information rate.

Figure 8 shows the hue shift of the test patch for different rate of initial visual information. The ordinate indicates the rate and the abscissa apparent hue. The abscissa G50Y50 indicates, for example, the subject gave 50 points to green hue and 50 points to yellow hue for the appearance of the test patch. It may be concluded that the hue did not change even if the rate of initial visual information was increased. But we should point out that the conclusion might have been different if we employed a colored test patch in stead of a gray patch, say a pale green test patch with red hidden illumination. We can expect achromatic appearance for 0% of initial visual information but green appearance for 100%.

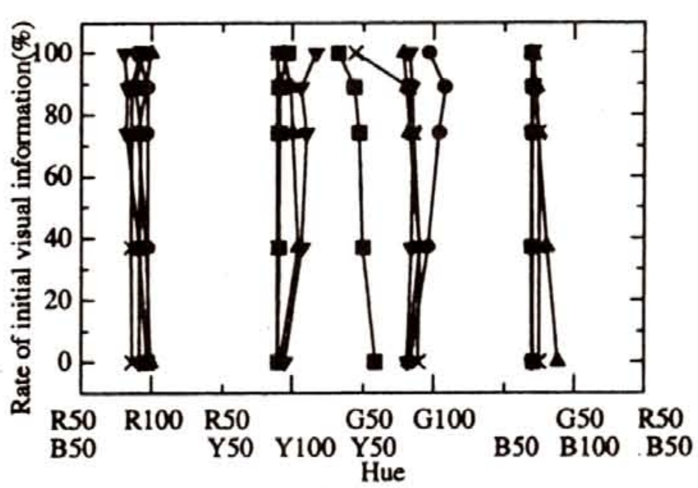

Figure 8. Result of hue for 4 color hidden illumination from 5 subjects:
—●—, YM; —▲—, HY; —■—, RY; —▼—, TM; —✕—, YT.

There are many instances in our daily life to have a similar situation as the present experimental setup. In a show window, for example, some goods are spot illuminated by a light source of which color temperature differs from that of a main ceiling light. From our experimental results a customer might misjudge the color of the goods if there is not many objects within the spotlight to work as the initial visual information. A certain amount of objects are recommended to be placed in the spotlight to avoid such misunderstanding.

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A Mathematical Method for Classification of Color Combinations Based on Fuzzy Color Zones

Kobayasi Mituo, Nagano Kana

Abstract

The aim of this study is to present a new mathematical method for classification of color combinations.

The method uses the fuzzy set theory. A color space is partitioned into a finite number of color zones that have fuzzy boundaries. A selection of a set of zone names makes one color combination pattern. Several patterns are grouped into one color combination type.

Classification of color combinations can be obtained by means of a combinatorial procedure. The procedure was applied to a set of design patterns, which proves the effectiveness of the method.

Keywords : fuzzy color zone, color combination pattern, color combination type

1. Introduction

A color is roughly identified by its name, and a color combination is distinguished by a combination of color names. A color name, however, can not define a 'crisp' region in a color space. A color space can be divided into several regions according to color names, whose boundaries are ambiguous, or fuzzy.

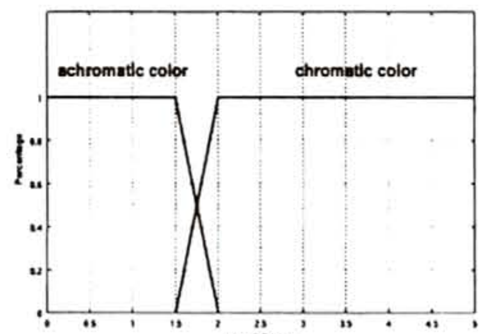
In this study, the fuzzy set theory with combinatorial calculation is utilized to classify color combinations.

2. Definition

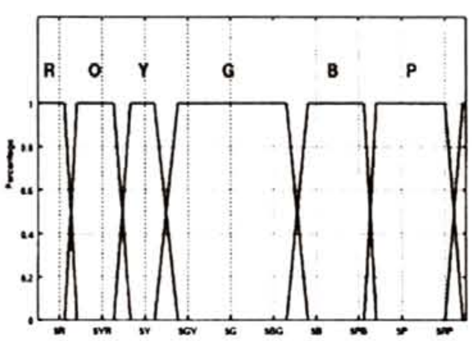
2.1 Fuzzy Color Zone

The color space is divided into a chromatic zone and an achromatic zone. The chromatic zone is subdivided into six hue zones : red(R), orange(O), yellow(Y), green(G), blue(B) and purple(P).The achromatic zone is subdivided into three lightness zones : white(W), gray(N) and black(K).

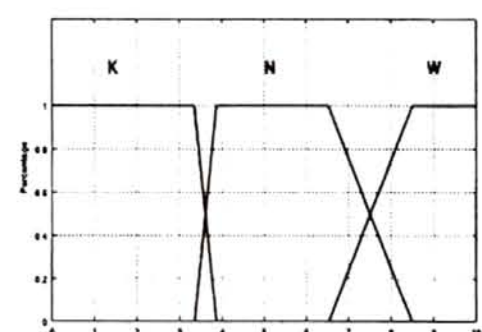
The boundaries of the zones are not crisp but fuzzy. The fuzzy boundaries are defined by membership functions illustrated in Fig.1. These membership functions were obtained from color naming experiments. In this study, Munsell color space is adopted.



(a) Chromatic and achromatic zones



(b) Chromatic zones



(c) Achromatic zones

Figure 1. Definition of membership functions

Kobayasi Mituo, Nagano Kana
The University of Electro-Communications,
1-5-1 chofugaoka, chofu-shi, Tokyo 182-8585, JAPAN
Phone : +81-424-43-5324
Fax : +81-424-43-5334
E-mail : kobayasi@ice.uec.ac.jp

2.2 Color Combination Pattern

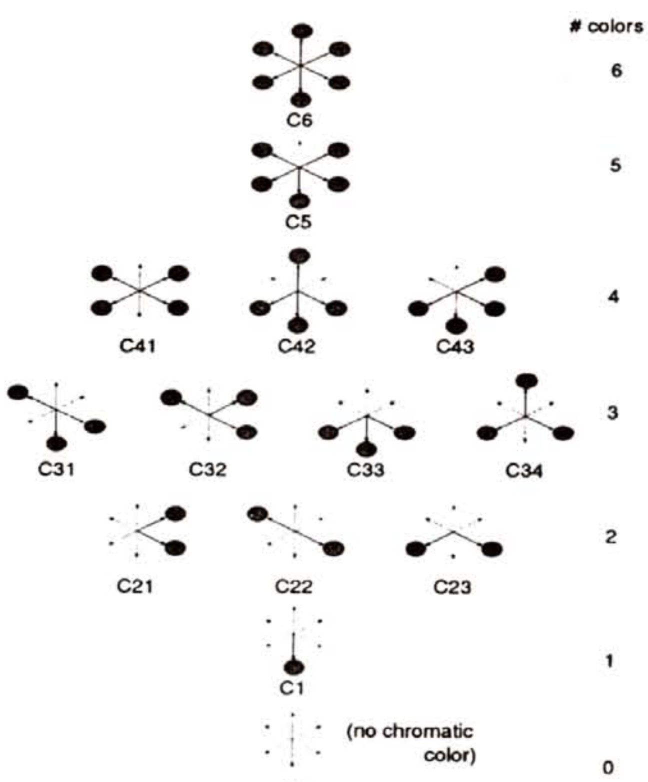
A color combination pattern (C.C.pattern) is an arbitrary selection of color zone names. A chromatic C.C.pattern is a selection from six hue names (R, O, Y, G, B, P), which makes 64 ($=2^6$) chromatic C.C.pattens. An achromatic C.C.pattern is a selection from three achromatic names (W, N, K), which makes 8 ($=2^3$) achromatic C.C.patterns. The total number of C.C.patterns, i.e., the number of combination of chromatic and achromatic C.C.patterns, are 511($=2^6 \times 2^3-1$).

Table 1. Color Combination Patterns

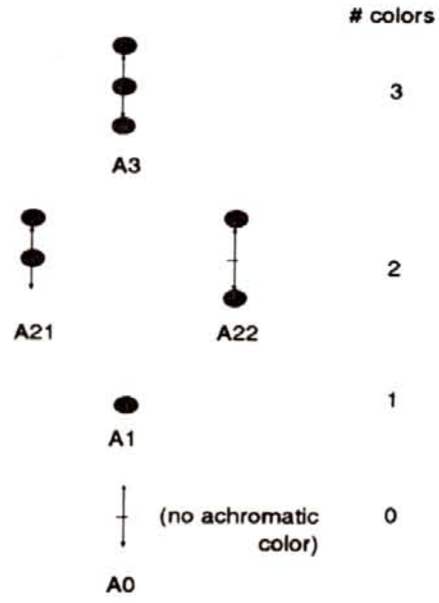
	#colors	color combination	#combinations
Chromatic Pattern	0	none	1
	1	R, O, Y, G, B, P	6
	2	RO, ..., RY, ...	15
	3	ROY, ..., ROG, ...	20
	4	ROYG, ...	15
	5	ROYGB, ...	6
	6	ROYGBP	1
Achromatic Pattern	0	none	1
	1	W, N, K	3
	2	MN, NK, KW	3
	3	WNK	1

2.3 Color Combination Type

A color combination type (C.C.type) is an equivalence class in the set of all C.C.patterns defined by a geometrical relationship of constituent colors in a C.C.pattern. For example three C.C.patterns, RG, OB, and PY are, in all cases, combinations of two antagonistic colors, which are grouped into one C.C.type (C22, antagonistic type). There are 14 chromatic C.C.types and 5 achromatic C.C.types (Fig.2). Thus the total number of C.C.types is 69 ($=14\times5-1$).



Chromatic Color Combination Types



Achromatic Color Combination Type

Figure 2. Color Combination Types

3. Classification Procedure

A classification procedure of color combinations of a color image is described as follows:

i) An image is scanned and stored in a computer system.

ii) A finite set of representative colors is extracted from the image. The extraction can be carried out, e.g., by K-means method.

iii) Zone names and values of membership functions, to which each representative color belongs, are computed.

iv) Then the value of possibility of each C.C.pattern is calculated from the membership values of all representative colors.

V) Finally the value of possibility of every C.C.type is calculated.

4. Application to Color Combination Analysis

4.1 Sources for Analysis

The procedure was applied to analyze features of color combinations of design patterns. We selected a number of design plates from two documents :

[FL] E.A.Séguy : Exotic Floral Patterns in Color, Dover, 1974;

[SH] Sakura Horikiri : Nihon Monyó(Japanese Patterns), Kureo, 1995.

E.A.Séguy is a French designer in early 20c. SH is a collection of traditional Japanese color patterns. Many of these design patterns consist of rather vivid colors. We selected 118 pieces from FL and 213 pieces from SH.

4.2 Result of the Analysis

Fig.3 illustrates the classification of C.C.patterns. The abscissa of the graph indicates C.C.pattern names, while the ordinate indicates percentage of possibility of the patterns.

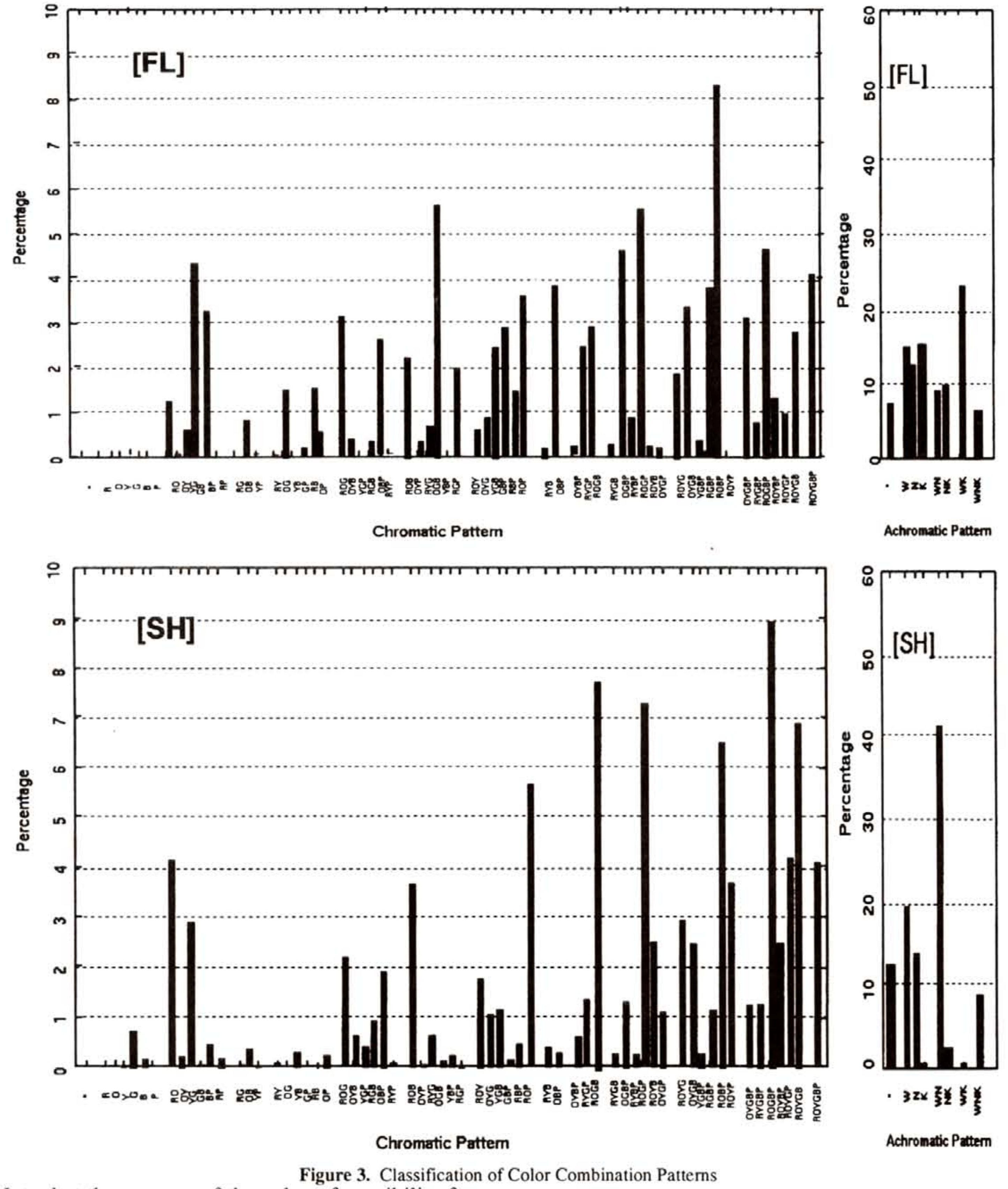


Figure 3. Classification of Color Combination Patterns

Note that the average of the value of possibility for a certain chromatic C.C.pattern is around 1.6% (=100/64), and 12.5% (=100/8) for an achromatic C.C.pattern. Typical chromatic C.C.patterns, whose values of possibility are greater than 5%, are listed in Table 2. ROP and ROBP are found to be common typical chromatic C.C.patterns in FL and SH. For achromatic C.C.patterns, W(white), N(gray) and K(black) are equally used in FL, while in SH black is seldom used.

Table 2. Typical chromatic C.C.patterns

	Pattern (%)
FL	OGB(5.7), ROGP(5.5), ROBP(8.3)
SH	ROP(5.6), ROGB(7.8), ROGP(7.3), ROBP(6.5), ROGBP(9.0), ROYP(6.9)

seldom used.

Fig.4. illustrates the classification of C.C.types. The average of the values of possibility for a certain chromatic C.C.types is 7.1% (=100/14), and 20% (=100/5) for an achromatic C.C.types.

Typical chromatic C.C.types (possibility is greater than 10%) are listed in Table 3. These are almost similar in FL and SH. For achromatic C.C.types, there are great differences in A21 and A22 between FL and SH.

Table 3. Typical chromatic C.C.types

	Type (%)
FL	C32(10.9), C33(11.9), C42(11.7), C43(17.7), C5(13.7)
SH	C33(10.2), C42(12.7), C43(16.9), C5(25.0)

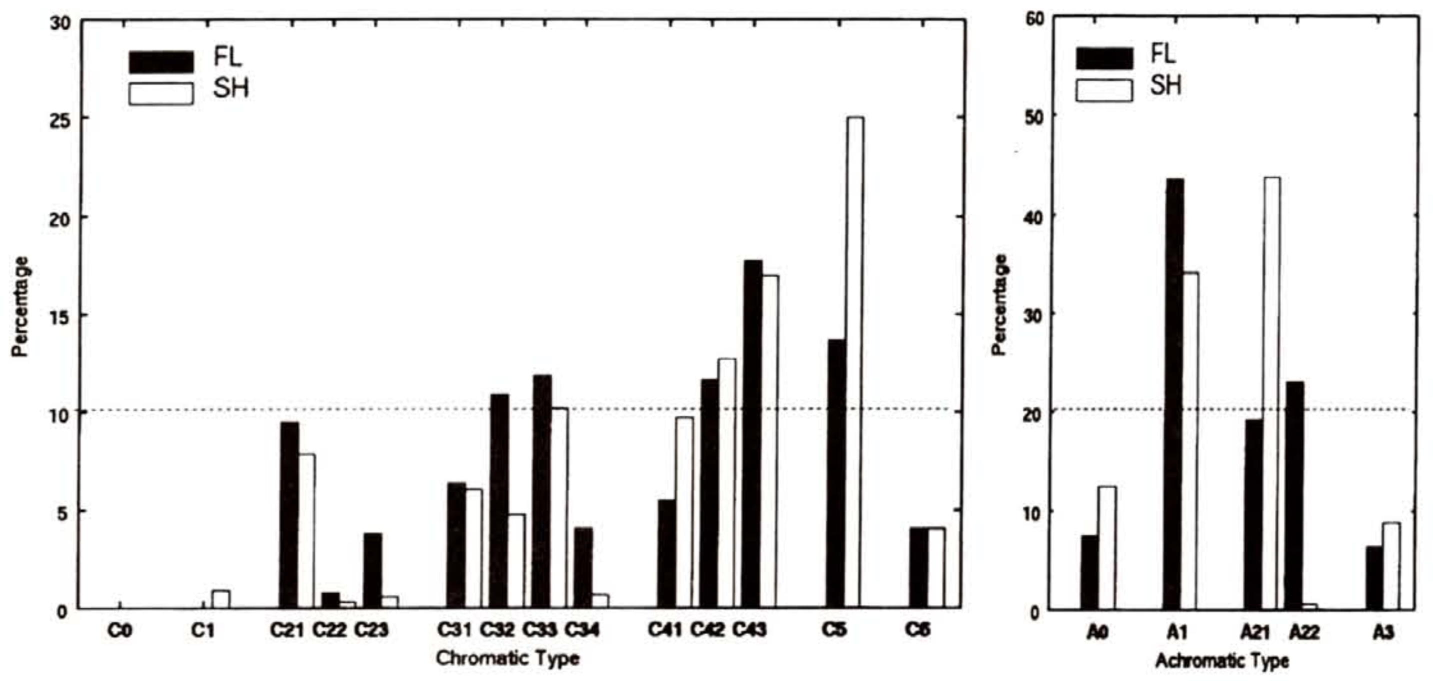


Figure 4. Classification of Color Combination Types

5. Conclusion

A new mathematical method for classification of color combinations using the combinatorial method based on the fuzzy color zoning was introduced. An example of the application proved the usefulness of the method.

Future problems are :

- Application to other samples of images;
- Adoptation of other kinds of color zones, e.g., NCS hue-nuance, JIS hue-tone, and PCCS hue-tone;
- Consideration on areal proportion of constituent colors to the picture plane.

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A Tale of Two Cities : Complementary Colour in the Environments of Two Moroccan Imperial Cities

David Buss

Abstract

The Lonely Planet Guide to Morocco states that 'just as the colour blue is synonymous with the city of Fes, so red has become the colour of Marrakech. A local Berber legend has it that when the Koutoubia was planted in the city's heart, it poured so much blood that all the walls, all the houses and all the roads turned this colour'. Red is indeed the predominant colour in Marrakech. Almost all the buildings, whether in the medina (old city) or the ville nouvelle, are red. This can arise from the natural redness of sandstone, or from the red colour washes used to tint the city's walls. Throughout the city, this ubiquitous redness is contrasted with its complementary colour, green. Doors, window frames, fences, grills, the street furniture of lampposts and bus shelters all complement the predominant red.

By contrast, the blueness of Fes is discreet to the point of being almost secretive. But where it occurs, it too is complemented with its opposite hue of yellow/orange. The complementary red/green contrasts which are evident everywhere in Marrakech are echoed in the national flag of Morocco. Fes, however, presents a more subtle and restrained series of manifestations of blue complemented by yellow/orange.

The author of this paper is a photographer and this presentation consists principally of visual imagery in the form of the author's own slides taken in Marrakech and Fes. These demonstrate the deployment of complementary contrast in the environments of these two ancient and vibrant Imperial Moroccan cities. The contrasting impact of the two Moroccan cities is explored and illuminated through the text and images.

Keywords : Complementary. Colour. Environment. Marrakech. Fes.

1. Introduction

My paper takes its title from the novel by the 19th century English author, Charles Dickens. Dickens's novel is about opposites. It opens as follows:

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way.

My paper is also about opposites, but there the similarity with Dickens's novel ends. His Tale of Two Cities is about the European capitals of London and Paris. My paper focuses on two Moroccan imperial cities - Marrakech and Fes - and the opposites which concern me are chromatic ones, namely complementary contrasts.

2. Aim

During Easter of this year, I visited Morocco for the first time. The clearness of the light and the intensity of the colours of the North African country were in strict contrast to the haze, mists, and subtle palette of my native England. As a practising photographer, I was instantly seduced by everything I saw around me, but one feature of the environment attracted me in particular and provided the material for this paper on Colour and the Environment. I will be showing you many of my own photographs to illustrate my text although they are intended to have artistic merit in their own right.

David Buss
Director of Academic Affairs
Kent Institute of Art and Design
Oakwood Park
MAIDSTONE ME16 8AG
UK

3.

Marrakech is Morocco's fourth largest city. Founded almost one thousand years ago, it commands a spectacular setting against the snow capped High Atlas Mountains, and is home to the Koutoubia Mosque. Red is indisputably the colour, which is synonymous with Marrakech. It permeates the entire city whether it is the ancient heart - the Medina - or the adjacent Ville Nouvelle built by the French during the period of colonisation of modern Morocco. A local Berber legend has it that when the Koutoubia was planted in the cityís heart, it poured so much blood that all the walls, all the houses and all the roads turned red.

While one may dismiss the Berber tale as mere legend, it is indisputable that so much of the city of Marrakech is red and at dusk, in the last rays of the setting sun, the walls of the city turn almost crimson. Whether it is the natural reddish brown of the earth used to construct the walls, or the pigment used to paint the facades of the modern buildings, red is the ubiquitous colour of Marrakech. The predominant red is repeated in the colours of the blinds, the leather seating on the horse drawn carriages, and even in the colour of the ALSA buses which serve the city.

What is equally noticeable to the visitor to Marrakech is how the predominant colour red is repeatedly and deliberately contrasted with its complementary colour, green. This can be through the pigments used to paint the doors and the gateways set into the red walls. It can be in the colour of the street furniture - the lampposts, the bus shelters, the benches, etc. - or in the additions to buildings such as the sunblinds and the grilles. Green is even in evidence in the colouring of the doors of the meter boxes. The lush green vegetation, which also serves to provide complementary contrast with the red walls and buildings of Marrakech, seems in this context to have been selected quite consciously to provide a complementary contrast. One of the local bus companies, clearly a poor relation of the smarter ALSA buses, uses red and green in its livery. Even the national flag of Morocco provides this same complementary pairing of primary and secondary colour.

Some three hundred miles to the north of Marrakech lies the oldest of the imperial cities, Fes. All of the great dynasties have left their mark on this city, but Fes has retained a distinctly Arab identity. The colour blue is synonymous with the city of Fes but, unlike Marrakech, one does not find a city where all the buildings conform to its chosen hue, despite what the logo on the ARTF buses might suggest. Fes is in fact a city where the overwhelming majority of the buildings are of a pale, yellowish cream colour. In fact, the blue with which the city has been identified is taken from the colour of the ceramics which have been produced in the city for centuries and which now are available at all of the stalls throughout the souks - the labyrinthine markets - in the city of Fes.

Nevertheless, complementary contrast is a feature of the city of Fes, but it is more subtle and discreet in its manifestations, and one has to look that little bit harder and closer to find the innumerable examples of how the colours blue and yellow are heightened to their juxtaposition. This may be achieved in the form of mosaics both old and modern. It may be in the contrast of the colours chosen for the paving and for the walls which abut them, or both colours may be interlaced within the tiling of the same surface. Here in Fes, the colour blue is predominant in the blinds of the yellowy cream buildings. Once again the liveries of the local bus companies appear to have been carefully chosen to reinforce the complementary contrast. Whereas in Marrakech the choice of green to complement the reds seemed so deliberate and obvious, in Fes it is more restrained, almost secretive and perhaps apologetic, but it is nevertheless just as ubiquitous as this selection of photographs have demonstrated.

And now, a bonus! Complementary contrast in a third Moroccan city. A day trip to Essaouira, the seaside town half way down the Atlantic coast of Morocco, provides yet another example of the use of complementary contrast in the environment. Blue is the predominant colour of Essaouira. A rich cobalt blue predominates. Here it is complemented with bright yellow or orange paint, tiles of a similar hue, or the more restrained yellow ochre which is the natural colour of the stone or the wood.

Finally, I will leave you with this postscript about colour in the environment of Moroccan cities. Taxis. Moroccan taxis are painted a particular colour. In each city it is a different colour. Here are some red taxis, but they were not in Marrakech, they were in Fes! The taxis in Marrakech are actually an ochre colour. Here is a blue taxi - but it was not in Fes, this is the colour of the taxis in the neighbouring city of Meknes. How unfortunate that the people who made the decision about the colour of the taxis did not use this wonderful opportunity to reinforce the very positive identities and associations which the cities of Marrakech and Fes have respectively with the colours of red and blue, or alternatively to have provided the complementary contrast of green or yellow.

4. Conclusion

The examples of the cities of Marrakech and Fes demonstrate how the use of complementary colour contrast can enhance the built environment and give a location a distinctive visual identity. In the case of Marrakech, this has been achieved through an extensive, deliberate and consistent deployment of complementary contrasts of red and green. Fes provides a radically different solution - more subtle and restrained but nevertheless one which achieves the same ends. What is particularly impressive about both cities is how the use of complementary contrast embraces both the old and the new.

Ankara 1980-2000; Architects' Approaches to the Use of Color in the Built Environment

Susan Habib

Abstract

While the Sixties and "the Seventies witnessed an emergent group of architects, among them the Post-Modernists, who began re-experimenting with color by engaging it as an important facet of their design", as Tom Porter mentioned in his book: Architectural Color (1984), a similar tendency started among Turkish architects in the Eighties.

In my MS thesis I had studied "The Color Dimension in Urban Space" and concluded that generally architects' use of color in urban space have followed five main approaches: For reinforcing or enriching architectural form, color is used without giving any reference to a specific concept; otherwise it is referred to history and traditions; to nature; to the built environment; or finally to materials.

After investigation of Turkish architects' approaches to color, after 1980 in determined arteries of Ankara, this paper concludes that actually similar approaches is valid in the architectural world, and aims to share and discuss this conclusion with experts in this field.

Keywords : color, architectural form, history and traditions, nature, built environment, building material

1. Introduction

Rapid increases in population, technological improvements, speed of travel and communication means, new necessities, new ideas and solutions, new materials and other factors caused the 20th century to be an era marked by the fastest changes in history. Social, economical and politic changes have evolved continuously and art and architecture as inseparable facets of life have followed the conditions and necessities of the period. Architectural color is no exception. Color is life and life is colorful.

Architects and their designs probably have been more widely published, discussed and known, in their age, than in any other period. Undoubtedly, they are indebted this to advances in media: printing presses, cameras, photography, and publications, and then for architectural color and, their ideas expressed by their color combinations of their buildings to color photography, press and color media. The latter has a very important role in prevalence of different movements, styles or tendencies in the 20th century architecture and their colors throughout the world.

During first decades of the 20th century, architectural students in different parts of the world followed the architectural news mostly from black and white magazines. Only those who had the chance to travel to Europe and United States, where Modern architecture was represented first hand, and to see the buildings of their favorite or well-known architects, not all the buildings were in different gray tones. Even if they took some photographs to show to their friends those had to be in gray tones. Architectural students drew their projects with black ink on white papers. Architectural education tried to follow the new, modern architecture. (Vernacular and traditional architectures were not in fashion, although there were lots of lessons to be taken from them. Furthermore they were more available than today.) Although color has been neglected in modern architectural education, and this neglect would come at a high price in the following years, the prevalence of black and white photography can be taken as one of the reasons for this misconception of many buildings designed and built in first decades of the

Susan Habib
6. Sokak 47/4
Bahcelievler 06500
Ankara, TURKEY
Phone : + 90 312 2120531
Fax : + 90 312 2308434
E-mail: Habibsuzan@hotmail.com
suzanh3003@yahoo.com

20th century. We know that, however, for example Le Corbusier loved "the powerful hum of color".[1] We know the importance of color for De Stijl in their manifesto on 1923, or Rietvelt's Schroder House. We know Bruno Taut's "Paintbox Settlement" and how he battled for a colorful Magdeburg.[2] But then two World Wars took color and life from many cities, as they also took the color from many lives. So architectural color waited its turn until the late 1960's. However it was not until the 1980's that this revitalized architectural color display waited to show its influence in Turkey, and its capital Ankara. The reason may be rooted in the point that Turkish architects were trying to assimilate modernity and Modern architecture.

European architects like Bruno Taut, Clement Holzmeister, Paul Bonatz had important roles in formation of modern Ankara in 1930's and 1940's. The main element giving color to the facades of their buildings was a pinkish brown Andezit (known as Ankara Stone in Turkey). According to Uğur Tanyeli, no modernist building had been constructed until 1957 in Turkey. He refers the period between 1960-80 as a pluralistic one, since Turkish architects had designed and constructed their buildings in a very wide range of styles, from brutalisme to organic architecture.[3] So, the color combinations of the buildings' faces ranged accordingly, although gray was the dominant color. Tanyeli believes that roughly since 1985 a real change has been experienced in architecture in Turkey.

2. Short History of Modern (Today's) Ankara

After the Republic in 1923, Ankara, a former steppe, small town of Anatolia, which had being hosted ancient civilizations such as Hittites, Phrygians, Lydians, Persians, Galatians, Romans, Byzantines, Sassanids, Seljuks, and finally Ottomans, became a rival to the magnificent Istanbul with a 2000-year tradition as a capital city. In urban scale, the aim of selecting this small Anatolian settlement as the capital city of the new born Turkish Republic was to construct a model city providing modern and contemporary conditions. With new social norms developed in this new urban space, this new capital was going to be the initiator of urbanization in Anatolia, and the most important to symbolize the Republic's successes. Modern Ankara was designed by Hermann Jansen (the city planner of Berlin) in 1932, with an estimated population of 300,000 in 50 years (the population of Ankara in 1927 was 75.000, 750.000 in early 1960's, and 4.000.000 in 1990's). This was the first municipal plan controlling development and construction in Ankara, and actually many applications were done during 1932-1950 with this plan. But then the unexpected increase in the population of Ankara, mainly based on migration from rural area, caused the second planning in 1957 (by Yücel-Uybadin), and the third one in 1969. The forth one (Structural plan of Ankara: 1985-2015) was prepared by Middle East Technical University, but has not being legally applied.[4]

3. Ankara's Important Arteries, and their Colorations

The Ataturk Boulevard runs in a north-south direction, binding Ulus in north and Cankaya in south, has been the main artery of the city. Most of the governmental, ministry and important buildings are built on or near to this boulevard. With almost all these formal buildings featuring pinkish brown Andezit stone facades, or some imitations of this stone, it seems that that pinkish brown color has found its place in the majority's memory. Although the style of the first buildings of the first years of the Republic are very different than the ones built in 1930's the color scheme of the boulevard has remained same. Even other buildings constructed in the following years have mostly respected this general color scheme. This scheme appears between Ulus (the old or first center) and K1 1 ay Square (the following or second center), and partially continues on one side of the boulevard, where the National Assembly Building takes place. Whereas, the other side of the boulevard s face, or the rest of the boulevard towards Cankaya, has been altered several times, with changing regulations and plans. The scale, height, volume, density, facades and colors all have been changed. In early 50's there were some violet-pink, pale olive green or grayish houses and cafes under the shadows of Horse Chestnut and Plane trees with people sitting or walking around. Nowadays, only two of those houses are still standing as witnesses of their time. People are passing hastily before them, either by car or on foot. High commercial buildings have replaced houses, and small apartments, pavements made narrower, roads widened for cars and other vehicles. The changes continue with an enormous speed, not only on this main artery, but also in all 'old' settlements (built since 1930's). With the formation of new centers around the city, and a wider range of colored materials, whether natural or not, submitted in front of their eyes by new technology, one can see more colored buildings, streets, and settlements in Ankara. A 'recoloration' period has also started in Ankara. Almost everyday you can see several buildings that are being painted. Not all of these, whether new or old building colorations, have been determined by architects. Owners and users mostly decide on recoloration of their apartment houses, and contractors on the new ones. While users' color combinations are more conservative, the contractorís are braver. Those decisions can be evaluated as a "trial and error" phase or category, as with such a wide range of available paints, plasters and color materials people simply want to try those. Probably the dominant grayness in many neighborhoods has an important role. Their reasons for using them may be very subjective or fashionable, with or without a background. This can be the subject of another research, but what about architects? How they make their choices among all those new and old paints, plasters and materials providing countless range of colors and textures. Which factors do they take into account in selecting and using them on facades of their buildings, which are shared by the public?

4. How Turkish Architects Approach to Architectural Color

Today we have a great chance to find information about buildings and designs, which have just recently been finished, see color photographs of them, read interviews with their architects, or even ask our questions and discuss the answers directly by e-mails. At the same time, the virtual world gives us endless possibilities.

In my Master thesis, after studying the architectural color in different periods of history and in various traditional/vernacular architectures in several countries, I researched approaches of the architects to the architectural color in 20'th century. My research was primarily based on published articles and books on works of architects who had used color in their designs in urban spaces, and had explanations for their usage. Published color photographs of those works were examined in detail, and then compared with the written explanations and criticisms. I determined there were five main categories in their approaches to the use of color in urban space: to reinforce or enrich the architectural forms color was used without giving any reference to a determined concept; otherwise it referred to history and/or traditions; to nature; to the built environment and finally to materials.5 But how do Turkish architects approach this architectural element? Do their works and colors fit to this categorization or there were other different approaches? The buildings and urban spaces that I studied were carefully chosen. This time I had the chance to see and walk around the buildings and to talk directly with the architects.

Ataturk Boulevard has been the main artery of Ankara. Ulus and Kizilay Squares, in turn, were two important centers on this route. The boulevard, after Kuglu Junction, continues towards Cankaya, where the President's Palace is seated, with rows of apartment houses, parks and embassy buildings on both sides. But Cinnah Street is the main route, after the same junction, nurturing and bearing the load and importance of the Ataturk Boulevard. Tunal1 Hilmi Street, parallel to the boulevard became the third important center of the city after 1960's. Main shopping center, housing, entertainment, and other functions take place on this street. These two streets have been the most dynamic routes in Ankara, and many buildings have been added since the 1980's. Their importance continued, even after decentralization became prevalent in Ankara -and other large cities in Turkey- especially after 1990's (The routes binding the city to new centers have not been included in this study, and can be considered for future researches).

Buildings on these selected arteries formed merely examples among other works of those architects. Evaluation was therefore made according to both selected buildings on chosen arteries with other applications of the architects in other parts of the city or country.

So, I prepared my questions to ask:

- Their opinions on the role of color in architecture and city,
- Which factors they bear in mind regarding the materials and colors used on the facades of their buildings,
- When and why they have started using color materials,
- As a design and architectural element, do they think or make their decisions about color and color scheme of their buildings in design process or later,
- Do they take into account the effects of variable climatic and light conditions during the day, seasons, and under artificial light for night illumination,
- Have they had any problems in finding some determined color or material in order to arrange their designed color combination,

· Do they design or take part in designing, or assert some conditions for shop windows in their buildings, logo's or advertisement signs attached on them.

· Do they take into consideration the continuity of the especial impression they had created by color or color materials used on the facades,

· Do they receive criticisms, whether positive or negative, on coloration of their buildings, as a part of their designs, and how they have been influenced by them,

· What is the color of Ankara in their opinion, and whether it has changed from past to present?

I interviewed fifteen architects, then one industrial and one urban designer. Except one of them, other architects had at least one building on the selected arteries, but their other buildings on other streets or regions were also taken into account.

All of the architects with whom I interviewed said that color design was not included in architectural design during their education. This deficiency in architectural education in Turkey remains today.
For some of them climatic and environmental conditions were taken into account, and for others the main factor for their color combinations was harmony and contrast. Another architect considered the whole scheme in both building and urban scales, consonance or dissonance and the proportions of color surfaces to each other. Some considered color in first stages of design process, others believed that it gained importance later.

Daily light conditions and the appearance of colors in artificial light were rarely considered in the color design of the facades.

Almost all of them have started to use chromatic colors (aside from natural colors of building materials) on their exterior surfaces after 1980. The reasons have some political and economic roots, however the primary factor is the availability in the 1980ís of more imported goods, including building materials, which color plasters or coating materials featured prominently. And as Tanyeli says "Turkish architects had missed a gap between Post-War architecture till 1980's when the International Style had been seriously criticized, since they were trying to assimilate the modernity, and Modern architecture".[3]

Turkish architects' approaches to architectural color fit to my earlier categorization. There was no different approach or criteria for the use of color in architecture and urban space. I saw, however, that same building could fall within two or more categories at the same time, or one architect's different buildings could be evaluated in different categories. The majority has used color merely to reinforce their architectural forms. Second are those who have used color with referring to "the built environment". Those referring to building "materials"are in third category. "History and traditions" are referred by the forth group and finally "nature" by the fifth one.
The architects in the first group generally claimed that they had used color according to the function or character of the building, and that color had a complementary effect on form. Two architects believed that the color of their buildings had caused them to become landmarks in the street or region. The reasons shown by architects for this category of color usage in their buildings can be summarized as: breaking the monotonous view of the street or region, bringing some sort of joy and merriment to the bleak and gray view of the city, grabbing public attention, reinforcing the imagined effect of the building, and sometimes individual preference of the architect for one or some colors.

For the second group, creating a harmonic effect within the built environment, or on the contrary, a contrast influence on it was important. For a harmonic effect they gave some references to the existing colors in the environment, and for a contrast influence new colors were brought on the facade and other architectural elements.

In this study the third group had used Andezit Stone as the building material to be referred in their buildings on Ataturk Boulevard and other buildings in Ankara.

Andezit stone was not taken only as a reference to a building material, but also its color was accepted as color of a period of Ankara's contemporary history, since it had been used in most of the formal and governmental buildings belonging to the first years of Republic. Traditional colors used in vernacular Turkish architecture were also shown as reference for coloration of some projects. Mondrian's paintings and his use of primary colors of red, blue and yellow were used in one of the architect's works. This example can be taken as ones which refers to an era of history of man-kind, not a national history, by means of color.

There were two approaches for those who referred to nature for their color combination and material selection of their buildings: First with reflecting the green axis on the opposite side of the boulevard on his building, and second by using green color referring to green valleys color.5

In addition, there were also some cases where contractors claimed that the color combination and materials of the facades were chosen by them in consultation with the architect(s). The conspicuous point with such buildings is that more chromatic colors are used on their facades, than those decided solely by architects (The tendency of 'non-architect' individuals, versus architects, towards the use of color is known). There are lots of paints applied on facades of buildings in Ankara, especially in late 1990's in new settlements that remain as paints, since they have applied on surfaces just to cover them. Probably a sensitive touch in the design process is necessary to transform the "paint" which is applied on surfaces to the "color" which occults the dynamism of life.

Although a wide range of new paints, and color materials, especially on apartment houses, have been used on buildings in Ankara, during the past 20 years, the majority of the architects still mention 'gray' as the color of Ankara. The color of Andezit stone, which had been used in formal or governmental buildings in first years of the Republic, has found its place in the memories, representing the color of a period of Ankara's history. Some imitations of that color on buildings near to the region confirm this theory. This dominant effect of gray in spite of such variety of used color plaster and covering materials on facades can be a sign that none of those 'paints' had used their inner potential to gain the honorific title of 'color' of the city. May be its too early to decide, or maybe cities are losing such historical phenomena, to have one color or a color scheme unique to them.

5. Conclusion

An urban space is not formed only by buildings and there are many other factors that should be considered, however, for the purpose of this study those other factors have been disregarded.

This study was started in 1993 by researching the publications on architectural works, where the architects had used color as an architectural element in their designs on exterior surfaces, where the colors are shared by public after 1960's, in different parts of the world, as far as they took place in publications; finding their explanations for those usage's; comparing those with color photographs of those buildings (although color photograph may not be a very reliable means); and reading interpretations and criticisms of them. I disregarded different movements such as Post-Modernism, Neo-Modernism, Deconstructivism, etc. in my evaluation. In spite of an expanded use of color in architecture they were classified mainly in five categories as mentioned above. Then I turned to a closer urban space where the tendency to the use of color was newer in 1994. I walked around the buildings, photographed them, talked with the architects, continued my observations and read publications about them. But the same categories also appeared valid. I carried on with my studies and observations, and now in 2000 I can say that I have not found a new category to add them. Architects mainly use color for enriching their architectural forms, or refer their colors to nature, the built environment, building materials, and to history or traditions.

I believe that the milieu, where "color and environment" are discussed in their various aspects is the best place to share, discuss and receive new ideas, suggestions and criticisms on this categorization of the use of color in architecture and the built environment.

With special thanks to architects Murat Artu, Sezar Aygen, Cengiz Bektas, Ragip Buluc, Yüksel Erdemir, Can Ersan, Merih Karaaslan, Erhan Kocabiyikoğlu, Yalcin Oğuz, Gündüz Özdes, Haldun Sunal, Murat Uslu, Sevki Vanli, Oral Vural, and Affan Yatman who spent their time and shared their experiences with me for this study.

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A Multi-Modal Color Study for Creating Branding Strategy with a Case of Herbal Cosmetic Brand

EunSook Kwon, Jong-Il Kim, Kyung-Suk Song, Yumi Choi

Abstract

The newly emerging paradigm emphasizing human emotions and sensibilities has made it possible to expand the scope and methods of color studies from the visual-oriented study to the multi-modal one. Creating a new cosmetic brand implies more possibilities to investigate the role and function of color studies than any other product development. A shorter life-cycle of creating new cosmetic brand and the its multi-sensory features make the color study as one dominant research and communication tool for developing its brand strategies.

This study is designed to develop a methodology to integrate quantitative and qualitative research methods by investigating the multi-modal characteristics of color. A case of herbal cosmetic product is used to study the multi-dimensional factors of interaction between herbs and people. By identifying the visual and tactile meanings and values of the herb, this study creates color image maps and provides a holistic approach of developing its brand strategies.

1. Introduction

1.1 Research Background and Purpose

Cosmetic is a product possessing sensitive adherence with the user. Not only functional features of the product but also the exchange with the visual, emotional, and symbolic beauty of the using process are a premise of true reliance. Creating a cosmetic brand, therefore, needs to build a unique communication system, which can make the user and product respond to each other.

Color is a very effective tool for building a compound language system for the development of a cosmetic brand and establishing its color strategy. The more sensitive messages a product has, the compound characteristics using psychological and physiological communication system should be emphasized. In a case of cosmetics, the establishment of color is not only applied for visual effect in the product or package but being used for deciding in the total brand image. It is a new paradigm of color research that can extend a role of color from a simple expressive tool of visual and feel, to a conceptual one for creating a total image and strategic plans. The purpose of this study is to develop a color research methodology for identifying multi-sensory channels between a cosmetic brand and the user, and to suggest a color strategic plan of integrating multi-modal features that can be used for the company.

EunSook Kwon
Associate Professor
KAIST, Dept. of Industrial Design
eunsook@sorak.kaist.ac.kr
Jong-Il Kim, Kyung-Suk Song, Yumi-Choi
Beauty Research Team
Marketing Division, Pacific Co.

1.2 Research Methods

This study is designed to develop a methodology to integrate quantitative and qualitative research methods by investigating the multi-modal characteristics of color. A case of herbal cosmetic product, *Primera*, is studied to enhance the quality of products through multi-sensory interactions between the brand and people. The nature-oriented cosmetic using the energy and treatment effect of the herb comforts the mind and body. By identifying the visual and tactile features and benefits of herbs, this study creates color image maps and provides a holistic approach of creating its brand strategies. The research is through diverse research methods such as literature review, questionnaire, and case study.

2. Functional and Visual Characteristics of the Herb

2.1 Functional Use of Herb

The herb is a Latin word defined as 'green grass,' which originated from 'Herba.' It was a common name for a healthy plant that is recently defined as all herbal plants using flower, seed, stem, and roots for medicine, cookery, spices, sterilization, and vermifuge. Recently the herb has developed into many cosmetic products, forming an important trend such as aromatheraphy. Despite of the increased number of herbal cosmetics, however, the current market study shows the limited usage of color for expressing visual image: The diverse functions of herbs are not well delivered to the user. The herb cosmetics, therefore, can be a good case for investigating the multi-modal characteristics of color and creating a new brand identity through its multi-modal color study.

2.2 Identifying Multi-Functions of Herbs

The new brand, Primera, is planned to use three-year old herb grown in Cheju Island in Korea. At the site visiting, the diverse characteristics of herbs were identified. People can see the visual image of the herb, and smell it by touching the leaves with hands. The interrelated behaviors between touching and smelling provide unique experience. The research is, therefore, designed to emphasize the multi-sensory channels between the herb and the new cosmetic product. The following Figure 1 explains the way in which the characteristics of herbs are investigated to create a color strategy for *Primera.*

In addition to the color palette captured from three-year old herbs, the natural color images in April and May are collected periodically from flowers and trees. Figure 2 is an example of collecting the plantís color palette during the period of April and May.

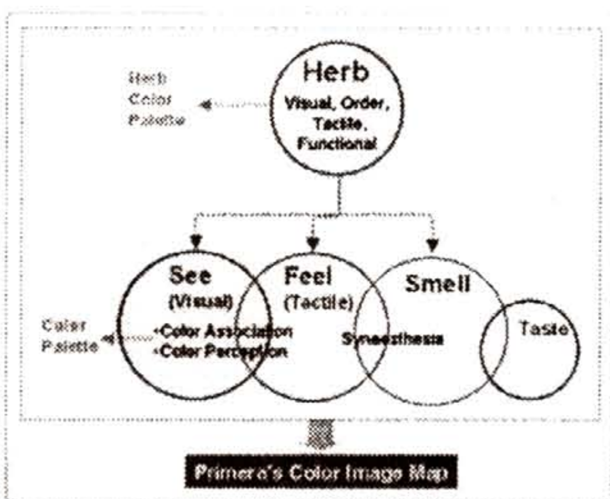

Figure 1. The Multi-modal Characteristics of Herbs

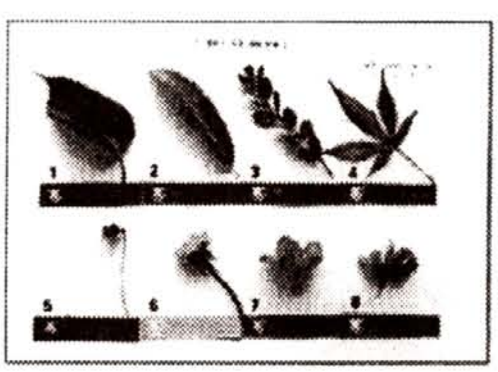

Figure 2. Plant's Color Study in April and May

3. Research for Identifying Diverse Images of Herbs

3.1 Questionnaire Design

To analyze the user's color association and perception of the herb and the herbal cosmetics, we conducted a questionnaire. The contents of the questionnaire using both language and three visual color palettes were designed to integrate quantitative and qualitative research. Because of the multi-modal functions of herbs, the qualitative methodology is useful for generating the ground-theory by crosschecking diverse data in order to overcome the limited data collection and the interpretation of data. Triangulation is a qualitative method, which contributes to enhance the trustworthiness of the research by using at least three types of data collecting methods. This research, therefore, is designed to combine a questionnaire with the three color palettes and the site observation of herbal farm. Among the color palettes, each palette is designed for identifying basic color name (A), herbal color (B), and tactile image (C). Figure 3 shows one of color palettes.

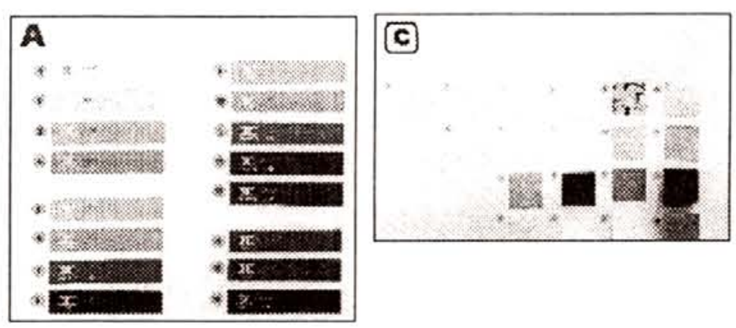

Figure 3. Color palette (A) and (C) used in the questionnaire

The questionnaire was conducted to 185 women under 25 years old (35.7%), between 26 to 35 years old (36.2%), and over 36 years old (28.1%). The important data found in the question of identifying their images towards herbs are shown below.

3.1.1 Understanding Herbs

The majority group answered that knew a little about the herb was 45%, and that didnít know anything about herbs was 11%.

3.1.2 Understanding the Herb Applications Used in Life

Fragrance, tea, plant, bath & show products, cosmetics were recognized as the usual application of herbs in life. The understanding of herbal cosmetic products was lower than 50%, which was the lowest score among the other answer.

3.1.3 Adjectives Used in Herb Images

In order to analyze the compound cognitive images of the herb, the twenty-five adjectives related to the cosmetic products were selected from women magazines and books. These adjectives represented visual, tactile, smell, and taste modalities. The most representative adjectives for the herb were refreshing (14%), natural (12%), fragrant (11%), and fresh (10%). Even though the number of adjectives in the category of 'visual and tactile (20)' were larger than the category of 'smell and taste (5), the most preferred image of herbs were related with smell (55.52%) than visual (22.75%).

3.2 Research analysis of visual and tactile information of the herb

3.2.1 Color perception through name and color palette

In order to identify the user's color perception of the herb, a basic color name representing herbs, and a color sample representing it's color name were asked in the questionnaire. These sequential questions dealt with the perceptual scale of the user, whether that is abstract or concrete. Light green yellow (27%) and light green grass (18%) were strongly selected as the basic color name of herbs. The analysis between the basic color name and the preferred color of herbs in color palette A showed a severe age difference between under 25 and over 35 years old: The age group of over 35 years old preferred 'vivid', 'deep', and 'strong' tones comparing with the age under 25 preferred ëbrightí and 'pale' in the NCD system. The individual difference was also found when the preferred color name and its color sample were matched: light yellow showed the highest match (38%) between the color name and the color sample; light green yellow (34%) and light leaf green (29%) showed a lower match. This explained that people perceived the basic color name such as light leaf green and light green yellow in a larger perceptional zone than light yellow.

3.2.2 The relationship between the herb and its cosmetic product

From the comparative analysis between the preferred color name for cosmetic products and its representative color sample, it was found that there were some significant groups whose answers possessed different color perceptions. From the following Figure 4, group A showed a similar tendency of selecting the color for herbs and its cosmetic products. Group B had a different tendency of selecting the color for herbs and its cosmetic products in a totally different way. Group B showed a larger perceptual zone in selecting color name as well as color samples.

Even though it was found that the preferred color name and its perceptual zone had made different user groups, there was a strong tendency in color changes from the question of preferred color name for the herb and its cosmetic products. Comparing with preferred color for

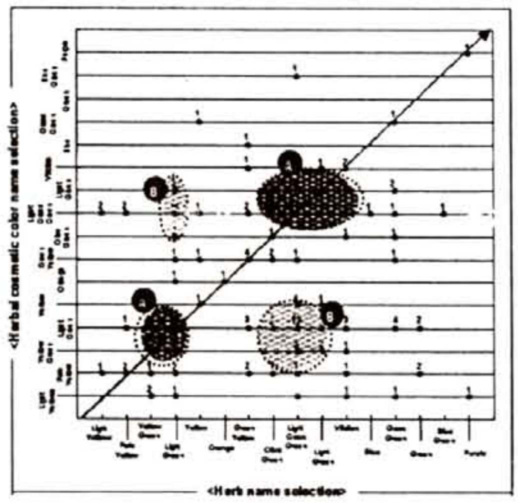

Figure 4. The relationship of color name between the herb and its cosmetic product

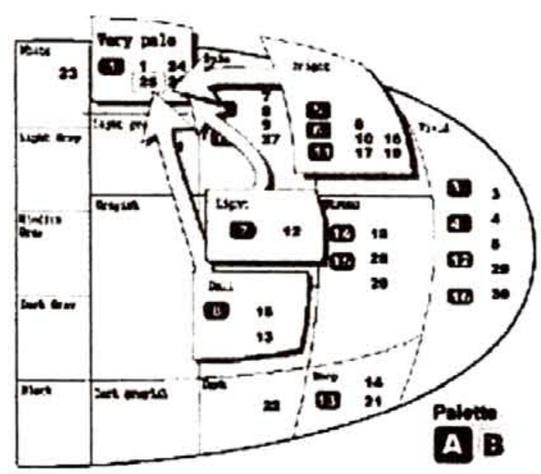

Figure 5. The preferred color move from the herb and its cosmetic product

the herb, the cosmetic color showed a tendency of being 'pale' or 'very pale' in the NCD system: one group moved from 'bright' 'light' to 'pale' and the other group moved from 'pale' 'bright' and 'light' to 'very pale'. Figure 5 explains one group's tendency of moving to the preferred color zone.

4. Developing Primera's Brand Strategy with Color Image Map

4.1 Brand Strategy for Primera Emphasizing Images of the Herb

Through the result of the questionnaire and observation, the basic strategy for Primera was developed. The brand strategy is focused on the multi-modal characteristics of the herb, when they interact with people through the visual, tactile, and smell modalities. Considering the functions of *Primera* as a cosmetic, the 'lavender', 'lemon balm', and 'rosemary' were selected because of its unique visual, smell, and functional characteristics which were arranged for each characteristics of herbs for comparison data. Generalizing the compound research of the above process, the important directions of Primera's color strategies are determined as follows.

First, the brand image would emphasize 'refreshing', 'fragrant', 'natural' 'fresh', and 'cool'.

Second, the preferred color of the herb would be applied effectively.

Third, the image of the herb considered not only the visual characteristics but also the smell and tactile feel based on the multi-sensory modalities.

Fourth, in order to create different product identities for three skin types of products, three image maps were created to provide a common language system, which could be used as the foundation of all the product development.

4.2 A Case of Three Image Map for the Three Skin Types

Based on the basic brand strategy, the different color image was developed and applied to three skin products. Because lavender is used for the rough skin type, this product emphasizes the clean and simple image in order to make an inclination of the simplicity and a softness of the skin. This skin type can be visualized by emphasizing a semi-transparent white in a gel type.

Lemon balm is for the dark and dull skin. Related with the herb's name and its visual image of wide leaf, this product can show the natural image of the lemon balm emphasizing the harmony of yellow and its soft feel. From the yellow background and transparent image of leaves, the image map in Figure 6 focuses on the brightness and softness of lemon balm. Rosemary can be associated with a warm image related to the red color but the visual image of the sharp and moisturized leaf gives the herb itself a clean, smooth image. The image map in Figure 7 demonstrates the coolness and sharpness of rosemary with the contrast of glass and stone. The final product emphasizes the transparent and cool image in a liquid type. These images show a descriptive, interpretative, and an analyzed understanding that is used as an alternative language. The color image map makes it possible to overcome the ambiguity of language.

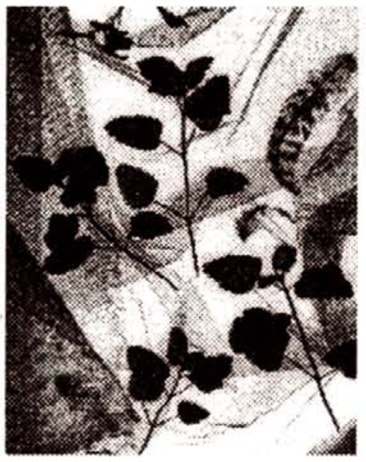

Figure 6. Image map of Lemon Balm

Figure 7. Image map of Rosemary

5. Conclusion

The herb is a very unique plant having strong smell and tactile feeling than visual one. The case of developing a cosmetic brand with the herb, therefore, should consider the multi-modal characteristics of the herb. This study investigates the possibility of extending the color study from the visual to the multi-modality. With the development of color image map, the herbal cosmetic brand, Primera, includes the multi-modal characteristics of the herb in the bottle design, package, and the form of contents. By emphasizing the tactile feeling of the contents, three products apply different combinations of liquid or gel, and transparent or semi-transparent.

Through the case study of creating color strategies for Primera, this study presents a new design direction interacting with technology and emotion. The way of including qualitative research methods, such as triangulation, was analyzed as an effective way of integrating a personís emotional feeling as well as interpreting the hidden meaning of the data. On the basis of new research methodology integrating quantitative and qualitative methods, the color study can be an effective tool for creating brand strategies which is not only focusing on visual identity, but multi-modalities for creating a total image and experience.

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Environment, Light and Poetry

Yves Charnay

Abstract

Nowadays artists naturally include space, temporality and dynamics in their fields of expression. On this adventurous ground, forms are invented and new processes likely to renew environmental creation are set up. Crossing disciplines such as visual communication, design or scenography, new artistic practices give birth to works with singular poetic dimensions. Light and colour nurture this poetry.

1. Sources

Before presenting some works in space, I would like to mention some of the sources from which I draw my plastic and technical ideas.

The variety and proliferation of forms in nature is a never-ending source of inspiration. Natural materials and their rich textures, leaves, trees and minerals constitute complex constructions of colours and the reflection-quality of their surfaces, the particularities of their transparency offer an infinite number of paths to light. Our very daily environment is full of 《natural plastic events》 to which we do not pay much attention. [dia]

The way people have built their towns, houses, castles, churches or temples proves the ressources of invention they have resorted to in order to make the materials 《live》 through their colours, their textures and the rich forms on which light plays. The sunlight on the bluish walls in the town of Gardahia, in the South of Algeria, gives the limpid and fresh shade of lagoon water to this harsh city of the desert.[dia].

The world of science and technics invents amazing materials with strange properties as well as new sources of light. For plastic creation, these discoveries open up ways which are still not enough explored.

Since the twenties especially, some artists such as Duchamp for instance, have not hesitated to use fluorescent lamps, polarized glasses, cathodic tubes, ultraviolet light, lasers or coloured shadows to realize their works. The experiments were reconducted notably in the sixties by the artists from the 《Groupe de Recherche d'Art Visuel》. (Resarch Group on Visual Art). Contemporary technology renews our means of expression. [dia]

Yves Charnay
3 Rue d'Aboukir, 75002, Paris, France
e-mail : ycharnay@chub-internet.fr

2. Creations

To express feelings inspired by a site, I often - without excluding the traditional techniques- favour light for its features of fluidity, immateriality, lightness or mobility. I also sometimes invent more or less complicated techniques, some of them have led to the creation of patented devices.

My first work for an architectural environment was realized in 1968 [dia]. The aim was to create a work for a supermarket belonging to the Carrefour chainstore which opened its first shop near Paris. What was at stake was to express at the same time the dynamism of a company as well as that of the Paris area. As the people could do their shopping during a part of the night, I enhanced the play function of light. The variations of the colours of the lighting metamorphosed the coloured graphism and created a feeling of movement. An electronic timer had been especially conceived to manage the frequency variations of the illumination sequences[anim]

I have worked several times in collaboration with Jacques Fillacier notably to colour a motorway tunnel : the tunnel of Saint-Cloud, inaugurated in July 1974 in Paris [dia]. The project was incredibly original since its conception took into account the dynamics of the traffic flow. The colours of the shapes painted on the walls of the tunnel had been chosen so that their aspect would change according to the ambient light.

The transformation of the aspect of the walls had been conceived, in agreement with the road safety officials, so that they would incite the driver to slow down. [anim]

The colourization of Rhône Poulenc's Research Centre centre gave rise to an experience which combined the creation of a specific plastic work and a more traditional colourization. To realize this work I had finalized an original liquid crystal inclusion technique. The aspect of this 3 square-metre work changed according to the variations of temperature and the angle of incidence of light. The surprising aspect of this work located in a strategic zone of the site and the innovative feature of the process used have played an important role in the expression of modernity and inventiveness claimed by the firm. [dia]

In 1985 I was commissioned by the Ministry for the Arts to realize a work for an event called 《La rage de lire》 (the will to read.) The aim was to incite people, youngsters especially, to read. I chose to use the image of germination to express the pleasure of reading. The lighting is ultraviolet light. [dia]
In March 2000, I created an environment which exploits sunlight in a chapel in the South of France. The chapel is now the Music School of Apt, a town in Provence. The title of the installation is : 《Colours fallen from heaven》. A series of devices is set in openings such as stained-glass windows. The diffuse reflection of light lights the inner space of the chapel. When the sky is cloudy, the intensity of the colours changes. The atmosphere changes between morning and evening. In the late evening artificial lighting replaces natural light. [dia]

Expanding Color Design Methods for Architecture and Allied Disciplines

Harold Linton

Abstract

The color design processes of visual artists, architects, designers, and theoreticians included in this presentation reflect the practical role of color in architecture. What the color design professional brings to the architectural design team is an expertise and rich sensibility made up of a broad awareness and a finely tuned visual perception. This includes a knowledge of design and itís history, expertise with industrial color materials and their methods of application, an awareness of design context and cultural identity, a background in physiology and psychology as it relates to human welfare, and an ability to problem-solve and respond creatively to design concepts with innovative ideas. The broadening of the definition of the coloristís role in architectural design provides architects, artists and designers with significant opportunities for continued professional and educational development.

Keywords : industrial color materials, cultural identity, problem-solve

1. Introduction

During the closing decades of the 20th century, a broadening of the definition of the coloristís role within architecture and the allied design professions has helped to distinguish the discipline of color design and increase itís relevance and significance in design industry and education. The methods that the color designer utilizes for work continues to expand due to the imaginative application of science, technology and the integrative processes of art and design. What the color design professional brings to the architectural design team is not only an expertise devoted to supporting the guiding design concept of a building, but also a richly diverse sensibility made up of a broad awareness and a finely tuned visual perception. This includes a knowledge of design and itís history, an expertise with industrial color materials and methods of application, a knowledge of new technologies for visualization, an awareness of design context and cultural identity, a background in physiology and psychology as it relates to human perception and human welfare, and an ability to problem-solve and respond creatively to design concepts with innovative ideas.

Harold Linton
Heuser Art Center, Bradley University
1501 West Bradley Avenue, Peoria, Illinois 61625
Phone: (309) 677-3330
Fax: (309) 677-3642
E-mail: Linton@Bradley.edu

2. Recent Precedents of Architectural Color

The role of the color designer striving to complete the work of the architect did not really appear until the 1950's, shortly after the end of the second world war. Historically, in Europe, it was industrial architecture that made use of and supported the work of colorists. A little later in the 1960's, the appearance of huge apartment complexes that tended to be somber and repetitive in appearance created the need to personalize these buildings with color. In France, beginning in the early 1970's, new multi-disciplinary teams came together to build new cities: urban planners, architects and colorists. It became evident that colorists had found themselves in a new, experimental territory and there was no formal education nor school for color applied to architecture. Colorists and architects used traditional studio media for planning color for architecture, i.e., drawing tools, paint and paper to visualize color as well as different planning methods in a way one could describe as fumbling and speculative that, with experience, progressively became more concrete.

From the burgeoning corporate giants of the entertainment industry in the 1980's and 1990's including the architecture of urban renewal and the ubiquitous urban mall, office buildings and office parks, restaurants, environmental graphic design and signage, the practical role of color in the landscape and design of our time demonstrates that the creative processes of architects, visual artists and designers, theoreticians, and those of a more analytical and rational method are together opening a new and essential chapter. The wealth of color design accomplishments in the last half of the 20th century have engaged the public and sparked more than passing interest in color in architecture. A few examples of current methods of color design follow that reflect contemporary practice and beckon us to imagine what lies ahead - a future where the expectation will be for color throughout the built environment.

3. Color Function and Legibility

With more than twenty-five years of experience in the field of architectural design, Gerald A. Reinbold, vice president of SHG Incorporated, considers himself an architect who frequently uses color to enhance legibility, clarify function, and (particularly in healthcare projects such as the Veteran's Administrative Medical Center Replacement Hospital and Research Center) promote an attitude of optimism and hope. Mr. Reinbold states, "Everything in the designer's toolbox must be brought to bear in the process of developing large-scale polychromatic architecture. Typically these tools include: conceptual sketches, renderings, 3-D models, material samples, large-scale mock-ups, etc. However, it is very difficult to simulate in the design process the effects of scale and distance on the perceptual quality of the built work. Here, our most reliable tools are experience and intuition."

The hospital occupies three full blocks in the mile-long, nine block Detroit Medical Center superblock. With siting requirements to reinforce the existing setback and green space adjacent to the facility, the program for three major building components included: diagnostic and treatment, medical and surgical nursing, and psychiatric nursing. Each component is expressed as its own building, both in color and massing, and all three are joined by an inner court.

As the project evolved during the conceptual phase, it became clear that a spirit of optimism, clarity of organization, and sense of scale could be effectively delivered through the use of color. The question then became one of selecting the appropriate materials to execute the concept. The criteria for material selection included: wide variety of colors available; permanent, nonfading or chalking characteristics; reasonably low first cost; low maintenance, low life-cycle cost.

A local project, 30-year old Saarinen-designed General Motors Tech Center in Warren, Michigan, provided inspiration for the major material: sand-molded ceramic glazed brick. This material not only met the primary requirements but offered the additional benefits of a subtle range within each color; a tactile, handmade quality; and the desirable images of tradition and solidity. Complementing this material is another material popular in the same era: porcelain-enameled metal panels. Used as cornices, copings, sills, column covers, and spandrels, these panels provide brightly colored accents with the same assurance of permanence as the glazed brick.

Just as the plan is a three-part composition, the articulation of the hospital's exterior uses a palette consisting of three saturated colors and three neutrals to identify the three major building components and to create a system of pattern to further break down the scale. The primary facade, along John R. Street, is articulated as a tripartite composition in which the two main nursing units are clearly identified and are separated by the silver tones of the third unit, which identifies the main entry. Overlaying this composition is a second layer of smaller tripartite compositions of vertical elements offering a reading of the facade as an urban streetscape. The exterior color concept is also carried through on the interior, providing an additional aid in way-finding, and creating a cheerful and optimistic environment.

4. Icons, Themes and Images

John Outram, a British architect known for his provocative use of interior and exterior color and decoration, believes in an architecture of ideas and themes. His use of building materials and his innovative applications of color, texture, form and space have been considered a new visual language for interior and exterior design and surface treatments. As he believes that buildings and their inhabitants interact in fundamental ways, his architecture employs ideas and themes to create thought-provoking spaces. His recent commission for the new Computational Engineering Building at Rice University in Houston, Texas, surrounds a striking and colorful interior with a deep facade of brick and pre-cast concrete. The design successfully bridges across the academic landscape of various departments with the physical attributes of large interior distances between offices and internal functions. The interior vistas catch the eye, as do the building's exterior materials, which harmonize with the campus. But most of all, it is the visual language of Outram's ideas - an extension of material innovation and design research - together with his narrative for the project at hand that create an extraordinary lively and provocative environment.

One of the most remarkable aspects of Outram's architecture is the planning and execution of the ceiling decoration for the main hall. The study was created in Outram's office by Tanya Hunter and printed onto canvas by 4-color inkjets driven by computerized information, then transferred to a giant 70 x 50 foot vaulted ceiling. The process, originated by Anthony Chanley of Outram's office, reproduces his A-1 size watercolor painting and explicates its narrative of Cosmic Time.

All of the surfaces of the interiors are colored from the floor to the ceiling. Outram uses color to convey larger ideas; each choice is rich in symbolism. Color, therefore, is included to covey meaning and to stimulate both conscious and subconscious thought. The entrance hall is an expression of multihued columns, tiled flooring, and painted ceiling that create a spectacular fusion of volumetric color.

5. Sign and Image

The London architectural firm of Madigan and Donald approaches design from an intellectual and scholarly point of view. The richness of these architect's methods and style is reflected in a recent project, the Cube Bar, which inhabits a former bank in a multilevel adaptive reuse project in Londonís Swiss Cottage district, north of Regent's Park.

The Cube Bar is situated at the intersection of the Jubilee and Metropolitan transportation lines and presents itself as an urban oasis for pedestrians anxious for a break from the frantic pace of the city. With signage in cold blue cathode tubing advertising the building as a place for rest and relaxation, highly visible graphics and signage help to frame a dominant window true to the scale and formidable presence of the building towers above it.

Stephen Donald states, "Contemporary science provides contemporary artists, architects, and designers unlimited access to a phenomenal range of polychromatic media with which to express and represent ideasÖhowever, colors are not out there in the world-not an automatic correlate of wavelengths-but rather constructed in the branch..."

The color design was planned in part on a computer to understand the basic composition and possibilities of materials. The interior is a reflection of machine-age materials and a vision of the urban culture inside out. Painted panels and overlapping planes with recessed lighting in deep tones of blue-violet, yellow, and green recall both today's street culture and the Carnaby Street of the era in which the original bank was first opened. The spatial ambiguity between levels of caf'e and bar is visually inseparable, allowing one space to flow into the next without artifice of separation. Colored light is also directional and pulls the visitor into the space, acting as a visual cue to explore and read the interior design as a three-dimensional abstract composition. The Cube Bar is more than a bar. Reflecting an architectís determination to explore everything, no matter how modest, as possibly being beyond the literal reality of its material, it is a celebration of the interacting elements of light, color, form, and space.

6. Virtual Space

As we look ahead to the future, the new technology of Virtual Space will be a formidable color design tool. Immersive environments such as the CAVE (Computer Animation Video Enhanced) system-a rear-screen, three-dimensional stereo display device allows the viewer to step into a stereo-viewed theater plunging into the three-dimensionality of the synthetic computer world. Architectural spaces can be designed and then viewed from within the CAVE. Although true color will require advances in technology for the system, the experience is profoundly better than seeing a computer graphics view on the front of a small computer screen; rather, the viewer is surrounded with a stereo view of a three dimensional modeled world for a total, immersive experience.

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A Comparative Study of the Basic Color Categories in Japanese and Korean : On the NCS(Natural Color System)

Choi, Jung-Yi

Abstract

In 1969, Berlin-Kay published their pioneering anthropological study, which indicated that color space was partitioned naturally into a maximum of eleven basic color categories three achromatic and eight chromatic each defined by its own focal region.

I conducted the survey on the differences between eleven basic color categories of NCS(Natural Color System).The respondent judgment of the basic color categories almost corresponded both0country. They were shown both country color categories and requested to report their color perception; how different each color appeared in their respective native language. The comparative basic color categories were then analyzed by the result. There was hardly a difference in the judgment result in both languages. As for each four basic color terms, the basic color terms was perceived similarly and having the same meaning. Moreover, as for these basic color terms, it could be regarded that the same color perception is a characteristic found generally in common human beings.

Keywords : NCS, color category, basic color terms

1. Introduction

Berlin-Kay[1] pointed out that the "Basic Color Terms" as a common color to a certain particular language were commonness in positioning of the focal color even if there were some differences in ranging its category. The hypothesis model of the 11 basic color terms by Berlin & Kay had developed into the revision model of Kay-McDaniel (1987)[2]. It can be said that it is a color vision of psychological model known as an antagonistic color theory of Hering to have played a role in thinking the universal characteristics of the basic color terms in process.

The idea of Hering's phenomenological and psychometrical techniques were applied to the NCS (Natural Color System) developed in Sweden. Based on the NCS documentation of Hering's original concept of whiteness, blackness, and chromaticness as characterizing attributes, a corresponding categorization can be made for the NCS nuances, based on the proportional relations between whiteness, blackness, and chromaticness[3].

Choi, Jung-Yi
JOSHIBI University of Art and Design, Dept. of Color Theory
TURUMAKI 5-40-3, TAMA, TOKYO 206-0034, JAPAN
Phone : +81-42-376-1427
Fax : +81-42-376-1427
E-mail: seramin@pk.highway.ne.jp

In this study I am going to confirm whether 11 basic color terms that Berlin-Kay took up are to apply to the Japanese and Korean language. According to Berlin-Kay, it is assumed that Japanese and Korean have a basic color term of the same number that shows the same category in the languages that belong to the Altaic family both. I made comparative study of the judgment of 11 basic color terms in color chips of NCS, and considered the difference of the hue judgment of Japanese and Korean by the color perception. If the result of the experiment in both the nations almost shows the same color, and it can be confirmed that a color term of both the nations is each basic color term has same meaning and content. However, it is forecasted that the color category of 11 or more exists in a color culture at presents. Then, the Japanese and the Korean were made to point out 11 colors of Berlin-Kay and on the color categories.

In other hand , according to the custom of each language. Incidentally, the color category named in a loan word from English was pointed out. It is the number of color categories that is thought to be the basic color terms that was perceived and judged to be a frame in daily life of the testees.

2. NCS color categories[3]

The concept of color category indicates that a number of colors in one way or another are perceived to be alike, though they may in other respects be very dissimilar. In a lecture at the first of the AIC international color congresses, Color 69, Hard showed that in everyday speech (Swedish) there is limited number of color category names. The eleven color names he referred to were the same "basic color terms" that we later found Berlin-Kay had shown in their cross-cultural survey, namely white, black, red, yellow, green, blue, brown, violet purple, pink, orange, and grey. It seems highly probable that the overall mutual resemblance of the colors within a category is perceived by most people, and that it is connected with such essential color phenomena in daily life for which there has been a need for communication and, therefore, the need to give specific names to the categories.

The NCS color space provides another, perceptually and analytically based partition into primary color categories with reference to which of' the elementary color attributes that constitute a main attribute and which are secondary attributes in all the colors making up one and the same category. By the term main attribute we refer to the elementary color attribute that is the dominating one in the color in question, and by secondary attribute we mean that or those elementary color attributes that can be seen in addition to the main attribute. The meaning of the concepts main and secondary attributes is illustrated on the uni-dimensional scale between black and white in primary color categories. Our phenomenological analysis of colors and color combinations reveals, however, that perceptual color categories are characterized not only by the main and primary color categories, as shown in [Figure 1].

The symbol a signifies that the redness constitutes the MA (main attributes) which means that the redness in absolute amounts is greater than the other attributes taken together.

Secondary attributes on the absolute level, but also, to a certain extent, by the relative relationship between elementary attributes, as shown in [Figure 2].

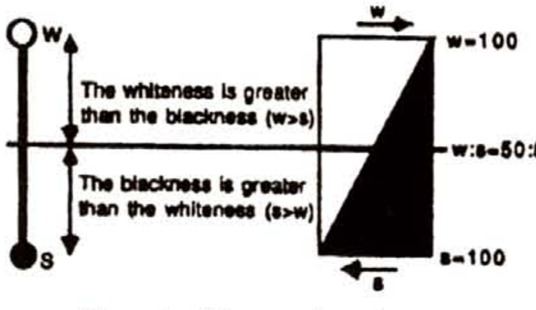


Figure 1. Primary color category

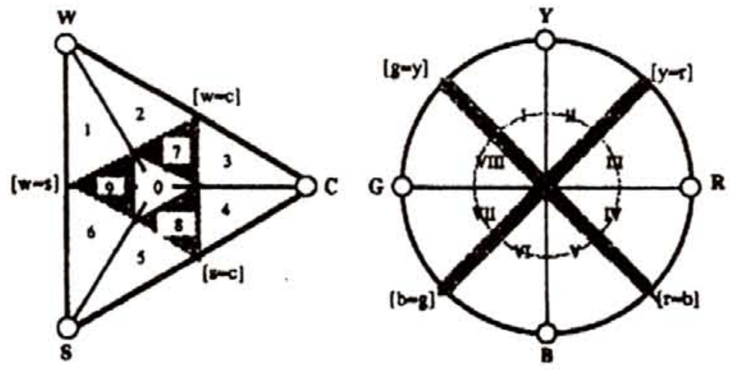


Figure 2. Secondary color category

3. Methods

3.1 Subjects

The subjects consisted of 50 Japanese and Koreans females each with normal color perception. They were shown the NCS color space and requested to report their color perception how different each color appeared in their respective native languages. They were undergraduate art students of each country, ranging in age from 20 to 30.

3.2 Process

I used the NCS color chart made by myself, framed N7, and arranged 212 color chips of the Scandinavian Color Institute AB published, as shown in [Figure 3] [Table 1]. The illuminant employed approximated daily light. Illumination level was 1000 lux. I presented to the subjects 11 basic color terms by each native language respectively as follow :

Red (aka; ppalgang), Yellow (ki; norang), Green (midori; nok-saek), Blue (ao; parang), Brown (cha; gal-saek), Purple (murasaki; bora), Pink (pinku; pinkeu), Orange (orenji; orenji), White (siro; hayang), Black (kuro; kkamang), Grey (haiiro; hoe-saek).

The subjects were requested to check the ranges of presented 11 colors in NCS color chart, and add other colors terms if were individually recognized in usual.

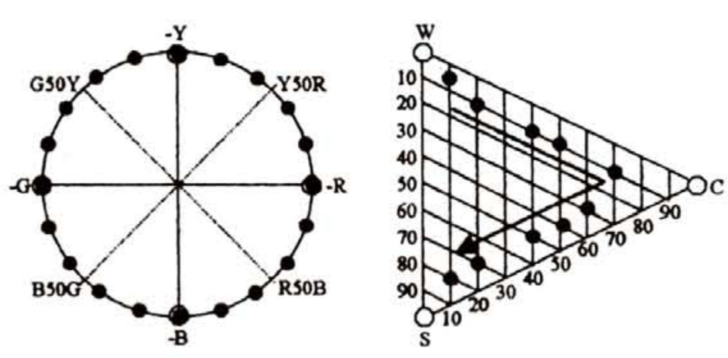


Figure 3. NCS Color Circle and Triangle

Table 1. NCS(Natural Color System) Color Chart of stimulus material

	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
A'	0500-N																					
A	1500-N	1510-Y	0510-Y20R	0510-Y40R	0510-Y60R	0510-Y80R	0510-R	0510-R20B	0510-R40B	0510-R60B	0510-R80B	0510-B	0510-B30G	0510-B50G	0510-B70G	0510-B90G	0510-G	0510-G20Y	0510-G40Y	0510-G60Y	0510-G80Y	A
B	2000-N	1020-Y	1020-Y20R	1020-Y40R	1020-Y60R	1020-Y80R	1020-R	1020-R20B	1020-R40B	1020-R60B	1020-R80B	1020-B	1020-B30G	1020-B50G	1020-B70G	1020-B90G	1020-G	1020-G20Y	1020-G40Y	1020-G60Y	1020-G80Y	B
C	3500-N	1040-Y	1040-Y20R	1050-Y40R	1040-Y60R	1040-Y80R	1040-R	1040-R20B	1040-R40B	1040-R60B	1040-R80B	1040-B	1040-B20G	1040-B40G	1040-B60G	1040-B80G	1040-G	1040-G20Y	1040-G40Y	1040-G60Y	1040-G80Y	C
D	4500-N	1050-Y	1050-Y20R	1050-Y40R	1050-Y60R	1050-Y80R	1050-R	1050-R20B	1050-R40B	2050-R60B	1550-R80B	1050-B	1050-B20G	1050-B40G	1050-B60G	1050-B80G	1050-G	1050-G20Y	1050-G40Y	1050-G60Y	1050-G80Y	D
E	5500-N	1070-Y	1070-Y20R	1070-Y40R	1080-Y60R	1070-Y80R	1070-R	1070-R20B	2050-R40B	3050-R60B	3050-R80B	3050-B	3050-B20G	3050-B40G	3050-B60G	3050-B80G	2060-G	1070-G20Y	1070-G40Y	1070-G60Y	1070-G80Y	E
F	6500-N	3060-Y	3060-Y20R	3060-Y40R	3060-Y60R	2070-Y80R	2070-R	3060-R20B	3055-R40B	3555-R60B	3060-R80B	3060-B	3060-B20G	3060-B40G	3555-B60G	3555-B80G	3060-G	3060-G20Y	3060-G40Y	3060-G60Y	3060-G80Y	F
G	7000-N	4050-Y	4050-Y20R	4050-Y40R	4050-Y60R	4050-Y80R	4050-R	4050-R20B	4050-R40B	4050-R60B	4050-R80B	4050-B	4050-B20G	4050-B40G	4050-B60G	4050-B80G	4050-G	4050-G20Y	4050-G40Y	4050-G60Y	4050-G80Y	G
H	7500-N	5040-Y	5040-Y20R	5040-Y40R	5040-Y60R	5040-Y80R	5040-R	5040-R20B	5040-R40B	5040-R60B	5040-R80B	5040-B	5040-B20G	5040-B40G	5040-B60G	5040-B80G	5040-G	5040-G20Y	5040-G40Y	5040-G60Y	5040-G80Y	H
I	8000-N	7020-Y	7020-Y20R	7020-Y40R	7020-Y60R	7020-Y80R	7020-R	7020-R20B	7020-R40B	7020-R60B	7020-R80B	7020-B	7020-B30G	7020-B50G	7020-B70G	7020-B90G	7020-G	7020-G30Y	7020-G50Y	7020-G70Y	7020-G90Y	I
J	8500-N	8010-Y10R	8010-Y30R	8010-Y50R	8010-Y70R	8010-Y90R	8010-R10B	8010-R30B	8010-R50B	8010-R70B	8010-R90B	8010-B10G	8010-B30G	8010-B50G	8010-B70G	8010-B90G	8010-G10Y	8010-G30Y	8010-G50Y	8010-G70Y	8010-G90Y	J
J'	9000-N																					

4. Results

In the survey of Japanese, the check on description of 5,783 color chips was gotten from 50 subjects. As for the average of 11 colors it was 525.73 chips. Moreover, the NCS color chart becomes 27.29 on the average for 212 color chips.

The ranges of NCS blackness and hue to each color in the Japanese data are as follows:

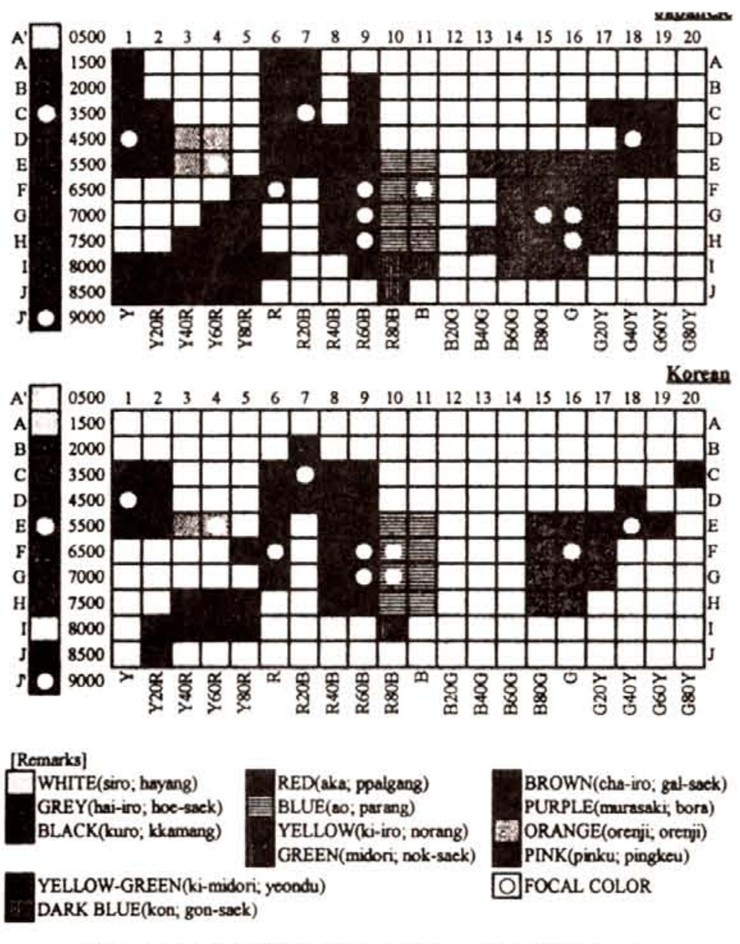


Figure 4. Basic color terms ranges at the 50% level

yellow(ki): blackness(15~75), hue(G40Y~Y40R)
red(aka): blackness(35~80), hue(Y80R~R40B)
blue(ao): blackness(15~85), hue(R90B~B60G)
green(midori): blackness(15~85), hue(B20G~G80Y)
orange(orenji): blackness(15~75), hue(Y20R~Y80R)
purple(murasaki): blackness(15~85), hue(R~R80B)
brown(cha): blackness(65~85), hue(Y~R40B)
pink(pinku): blackness(20~55), hue(Y40R~R40B)
white(siro): blackness(05~20), hue(N); blackness(15), hue(R80B~G)
grey(hai-iro): blackness(15~85), hue(N)
black(kuro): blackness(85~90), hue(N) ; blackness(85), hue(B~B80G)

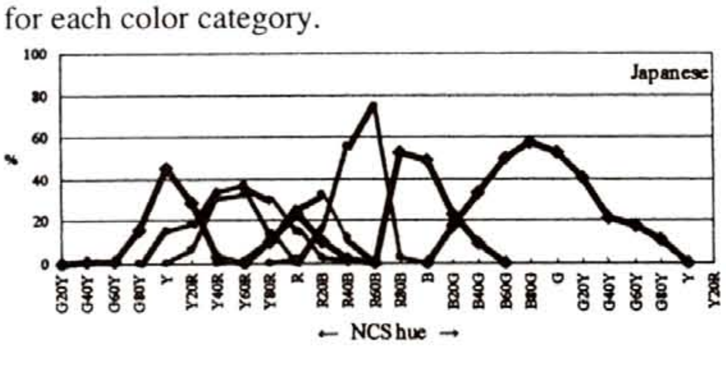
In the survey of Korean, the check on description of 3,717 color chips was gotten from 50 subjects. As for, the average to 11 colors it was 337.91 chips. Moreover, the NCS color chart becomes 17.53 on the average for 212 color chips of NCS color chart. The ranges of NCS blackness and hue to each color are as follows:

yellow(norang): blackness(15~65), hue(G60Y~Y40R)
red(ppalgang): blackness(55~80), hue(Y80R~R20B)
blue(parang): blackness(35~80), hue(R80B~B20G)
green(nok-saek): blackness(35~80), hue(B20G~G80Y)
orange(orenji): blackness(25~70), hue(Y20R~R)
purple(bora): blackness(20~85), hue(R20B~R80B)
brown(gal-saek): blackness(65~85), hue(Y~R20B)
pink(pingkeu): blackness(15~55), hue(Y80R~R40B)
white(hayang): blackness(05~20), hue(N); blackness(15), hue(R80B~G40Y)
grey(hoe-saek): blackness(15~85), hue(N)
black(geomjeong): blackness(75~90), hue(N) ; blackness(85), hue(R80B~G80Y)

In the colors of yellow, red, blue, green, and purple, the NCS blackness and hue of the Japanese data tended to be wider in range than that of the Korean.

In orange, the blackness of Japanese data was wider than that of Korean, and in pink and black it was opposite. In White and grey they were similar in ranges for both languages data. Especially, for blue, green, and purple of Japanese data, if ranged from 15 to 85 in blackness; that's about 70% above orange and pink.

The figures of each hue data of Japanese and Korean, as reflected by the survey result, shows the number of people. Here, this was converted into percentage, and showed in the frequency. [Figure 5]
All the colors put out by the testees were shown in the NCS color space according to the color category. In this graph, the range of hues can be interpreted.
Nevertheless, several loan words appeared from the results of the survey, judging from the two native languages. Orange and pink appeared in a high frequency rate, while brown and yellow was about 30% of the two data.The other 6 colors among the Japanese and Korean data were appeared as blue green (ao-miodri; cheong-rok), yellow green (ki-midori; yeondu), dark blue (kon; gon-saek), sky blue (sora-iro; haneul-saek), aqua blue (mizuiro; mul-saek), seashell blue (hada-iro; sal-saek).
Next, among the data of both data, the chips of 50% or more and each focal color chip are shown in the NCS color chart, as shown in [Figure 4]. Focal colors are defined as the fastest named consensus samples for each color category.



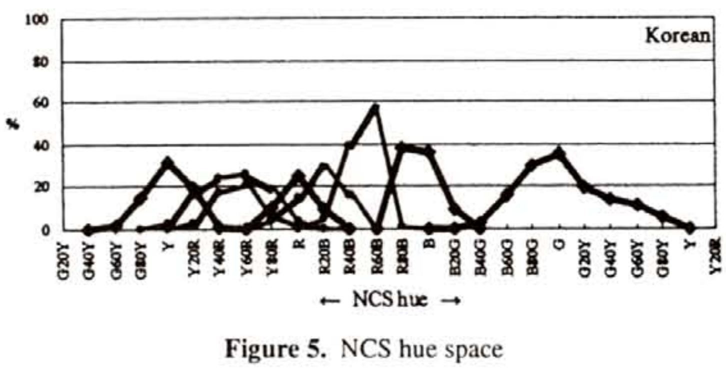


Figure 5. NCS hue space

5. Conclusion

Kay-McDaniel proposed the persuasive revision model related to the characteristic of human's color perception compared with a basic model of Berlin-Kay. I wonder if the derivation category, which derives basic categories based on six main color of Hering, for instance, brown, grey, pink, orange, and purple, can be really called a basic color term with a universal character based on the color perception. It seems that it changes to distinguish the derivation category by the difference of cross culture.
Color terms of the derivation category in English do not necessarily exist in any language. Moreover, it is not necessarily a basic color term in one language even if there is a color term by which the same color gamut is shown.
However, a color term is being used for pink and orange, as a category in Japanese and Korean. Now at a time when English is becoming the common language of the world, the problem is whether these loan words should be taken as a basic color terms.

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A Relation Between Color-Affection and Color Categories

Lee Sangmyung, Ohmi Gentarow

Abstract

Various studies have been made to find out a common rule to all mankind and the difference of culture, in relation to color terms and color categorization. However, most of them were linguistic studies or those of visual system through psychophysics, not the studies from psychological angle like emotion for the example. Our studies aimed the comparison between Japan and Korea from two sides, color-affection and color naming. Experiment 1 confirmed the existence of 4 primary dimensions, namely Evaluation, Activity, Potency and Naturalness, for both countries on color-affection. Experiment 2 on color naming, showed the difference for some colors between Japan and Korea. As to the area ranging from 5G to 10P (green, blue, purple and dark blue in color names), a high similarity was recognized between Experiment 1 and 2. Namely, it is considered that there are some relations between color-affection and rating of prototypicality.

Based on these results, we wish to review hereunder the relations between color naming/color categorization and color-affection.

Keywords : color-affection, prototype, color categories, basic color terms.

1. Introduction

It is said that people with normal color vision are able to discriminate approximately 7.5 million colors. However, this does not mean that they classify and properly divide the continuous color space by using 7.5 million languages. According to the investigation on characteristics of Japanese color names in daily use1), the number of colors that normal Japanese can recall in about 10 minutes was 34.9 on an average. There are 11 basic color terms almost common to world languages2). In the case, what is the criteria which classify the continuous color space into several color names?

Basic color terms or color categories are famous study theme taken up by many scholars since Berlin and Kay. Most of them were approaches from linguistics or cultural anthropology. From their studies, a common rule beyond country or language is confirmed in respect to the order of the emergence and evolution of basic color terms. However, on the other hand, it is also a fact that cultural difference exists among different languages in respect to the evolution and emergence of color terms. There are several theories proving the fact but it is difficult to find the past studies made from the angle of color-affection.

On the 1st stage for emergence of color terms and color categories, the judgement of [bright-dark] or [warm-cool] is a most primary dimension even in the study of color-affection using SD(Semantic Differential)method. The relation between primary dimension and 3 attributes of color is at present clarified to a certain extent. It is suggested from the cross-cultural studies that this dimension be more or less influenced by culture. In addition, prototypicality of color and color categorization still leave the room for further studies. Although we have no intention to insist that evolution of color terms etc. is totally prescribed by color-affection, our study is based on our consideration that the color naming and the color categories are influenced not only by linguistic or psychophysics factors but also by psychological factors such as emotion.

2. Experiments

2.1 Experiment 1

The purpose of this experiment is to clarify the difference in structure of color-affection, between

Lee Sangmyung, Ohmi Gentarow
Dept. of Color Theory , Joshibi university of Art and Design
4-22-6 #301, Eihuku, Suginami, Tokyo, JAPAN 168-0064
Phone : +81-03-3325-5525
Fax : +81-03-3325-5525
E-mail: d982101@joshibi.ac.jp

Japan and Korea. A very high similarity was pointed out from past studies in the primary structure of color-affection between Korean people and Japanese. However, several differences are suggested through the detailed comparison, on which we wish to confirm hereunder.

2.1.1 Method

Subjects: College students majored in arts(age:18-24 years old) Japanese 34 persons and Korean 67 persons.

Stimuli : Totally 40 color cards were used, the details of which are as follows.

First of all, 10 standard colors were, determined. For each, 3 kinds of comparative stimulus which were systematically altered in Hue, Value and Chroma, were prepared.

The standard colors were red, orange, yellow, green, blue, purple, brown, pink, dark blue and yellow-green. Among them, red, orange, yellow, green, blue, purple and brown (5R4/14, 5YR6/14, 5Y8/14, 5G4/10, 10B4/10, 5P4/12, 5YR4/4) were selected only from the chromatic colors of basic color terms2) by Berlin and Kay. Yellow-green(5GY7/12) and dark blue were selected as important color names for present Japanese people as written in our previous thesis1). As to the color cards corresponding to above standard color names, pink, brown and dark blue(2.5R7/8,5YR4/4,7.5PB2/4) were in accordance with JIS ,and red, orange, yellow, green, blue, purple were referred to Indow3) central colors.

Comparative stimulus were determined against standard color on the basis of following criteria.

Comparative stimulus 1: same Hue, Value±3, Chroma±4

Comparative stimulus 2: Hue±5, same Value, same Chroma

Comparative stimulus 3: same Hue, same Value, Chroma±8

40 color cards of the 15◊10cm size were put in the center of the mount (N8, 30◊25cm), and those were represented by random.

Semantic-scale: The following 13SD semantic-scale were used in 7 point scale method.

In order to exclude the difference of meaning between Japanese and Korean languages, the scale written in Japanese was translated in Korean language and then re-translated in Japanese, and the scale with different meaning in these repeated process was deleted.

Scales:[dynamic-static],[showy-sober],[strained-relaxed],[like-dislike],[beautiful-ugly], [natural-artificial], [warm-cold], [manly-feminine], [strong-weak], [heavy-light],[bright-dark], [new-old] and [happy-sad].

Procedure: Color cards were presented at random and investigation was made in accordance with group method.

2.1.2 Results

Table1. Factor structure of Japan and Korea
Factor loadings for the 13 scales in Japan and Korea

	JAPAN					KOREA			
Scales	F1	F2	F3	F4	Scales	F1	F2	F3	F4
dislike	**0.95**	0.13	-0.13	-0.05	old	**0.96**	-0.19	0.12	-0.08
ugly	**0.92**	0.10	-0.21	-0.17	sober	**0.94**	0.04	0.30	0.13
old	**0.84**	0.43	-0.18	-0.06	statical	**0.93**	0.02	0.29	-0.03
sober	**0.71**	0.61	0.09	-0.24	ugly	**0.93**	-0.16	0.24	-0.16
cool	-0.03	**0.92**	-0.12	0.02	dislike	**0.92**	-0.12	0.15	-0.30
sad	0.43	**0.86**	-0.22	0.02	sad	**0.84**	-0.28	0.32	-0.30
statical	0.39	**0.85**	0.23	-0.14	dark	**0.70**	-0.51	0.40	-0.29
dark	0.63	**0.69**	-0.31	0.01	weak	-0.09	**0.86**	-0.37	0.20
feminine	-0.28	**-0.53**	0.44	0.48	light	-0.55	**0.71**	-0.38	0.23
weak	-0.17	-0.10	**0.92**	0.00	relax	0.52	**0.59**	-0.05	0.41
relax	-0.04	0.10	**0.81**	-0.43	cool	0.26	-0.29	**0.84**	-0.26
light	-0.53	-0.43	**0.68**	0.00	feminine	-0.45	0.40	**-0.76**	0.00
artificial	-0.12	0.01	-0.19	**0.77**	artificial	0.24	-0.36	0.19	**-0.69**
eigenvalue	4.12	3.84	2.51	1.11	eigenvalue	6.48	2.37	2.13	1.10
Contributions	0.32	0.30	0.19	0.09	Contributions	0.50	0.18	0.16	0.08
Cumulative	0.32	0.61	0.80	0.89	Cumulative	0.50	0.68	0.84	0.93

2.1.3 Factor Structure

Table 1 shows the results of factor analysis. Based on the criterion of more than 1 eigenvalue, 4 factors were extracted both from Korea and Japan. As to the cumulative contribution up to 4 factors, Korea is a little bit higher than Japan, especially Korea is much higher for the contributions, of the 1st factor.

The 1st factor in Japan is regarded as Evaluation, since the factor loadings of [dislike],[ugly],[old] and [sober] are high. The 2nd factor is regarded as Activity, since the factor loadings of [cold], [sad], [static], [dark] and [feminine] are high. The 3rd factor is regarded as Potency, since the factor loadings of [weak], [relaxed],[light] are also high.

On the other hand, in case of Korea, Evaluation like [dislike],[ugly]and Activity like[sad],[static],[dark] are mixed in the 1st factor. The 2nd factor is Potency which corresponds to the 3rd factor of Japan. The 3rd factor is Activity especially with a big loading by the judgement of [cold-warm], being composed only by [cold] and [feminine].The 4th factor is composed by [artificial] both for Japan and Korea.

These results show that there exists 3 axes of Evaluation, Activity and Potency in the structure of color-affection, as indicated by Osgood4). However, through the careful comparison in factor loadings of each scale, several points of difference were closed up. The meaning between Japan and Korea seems to be different particularly on the 3 scales of [sad],[static] and [dark].

2.1.4 The Relations Between Factor Scores and 3 Attributes of Color

The correlation coefficient of factor-wise factor scores among two countries is shown in Table 2. In addition, we studied the correlation between factor scores and Value/Chroma. As a result, in respect to 3 attributes of color, the correlation with Chroma for Evaluation, with Value/Chroma for Activity, with Value for Potency were respectively confirmed. As to [naturalness] which is the 4th factor, the correlation with 3 attributes of color was not recognized. The Activity which showed the highest correlation in Japan and Korea (0.77, p<.01), the correlation with Hue was confirmed, with two poles of warm colors and cool colors.

Table 2. Correlation between each factor and Munsell's Value/Chroma
Correlations coefficients were calculated by factor scores of colors and Munsell's Value/Chroma

	JAPAN					
KOREA	F 1	F 2	F 3	F 4	Value	Chroma
F 1	**0.73 ****	0.30	0.17	-0.23	-0.29	**-0.64 ****
F 2	-0.05	-0.26	**0.68 ****	-0.01	**0.66 ****	-0.17
F 3	-0.27	**0.77 ****	0.06	-0.22	**-0.34 ***	**-0.43 ****
F 4	-0.24	-0.11	0.15	**-0.58 ****	-0.28	-0.06
Value	-0.26	**-0.56 ****	**0.60 ****	0.05		
Chroma	**-0.48 ****	**-0.47 ****	-0.25	0.24		

* .01<p<.05 , ** p<.01

2.1.5 Difference between Japan and Korea

Fig.1 shows the difference in factor scores of Activity between Japan and Korea. For 13 colors with high Chroma, the cool colors (10B,10P) showed bigger difference than warm colors(10RP, 10YR) among two countries, especially for the area ranging from 5G to 10P(green, blue and purple in color names).

Red showed a minimum difference and dark blue/brown showed a maximum difference. In Korea, both colors seem to give a warmer impression.

2.2 Experiment 2

The purpose, of this experiment is to clarify the difference in color categorization between Japan and Korea, finding a clue to prototypicality in color.

2.2.1 Method

Subjects: College students majored in arts (age:18-24 years old)

Japanese 71 persons and Korean 50 persons

Stimulus Materials: same with Experiment 1

Rating-scale: Rating of prototypicality toward standard 10 colors was defined by 7 stage scale.

Standard 10 colors: red, orange, yellow, green, blue, purple, brown, pink, dark blue and yellow green.

Procedure: To make them select one of color names, Which they think most similar to the color on the color card given to them at random. By such manner, the rating of prototypicality was defined. Investigation was made by group method.

2.2.2 Results

In respect to prototypicality score against each of 10 color names (selected prototypical color), the results from two countries were almost same. However, one color in comparative stimulus showed higher prototypicality than orange, purple and brown which were not defined as standard colors.

The top 10ths which gained high prototypicality score in Japan and Korea are as follows.

Japan : green(5.99), purple(5.89), yellow(5.77), red(5.73), yellow2(5.73), dark blue(5.59), pink(5.55), purple2(5.39), blue(5.30), and green2(5.04)

Korea : green(6.16), blue(6.12), red(6.06), yellow(5.92), yellow-green(5.64), orange(5.42), yellow2(5.10), green2(5.08) and pink(5.04)

In Korea, Herring's primary scores rank high. On the other hand, in Japan, blue ranks 9th and purple ranks 2nd. In particular, dark blue ranks under 15th as well as brown in Korea whereas it ranks 6th in Japan. This means that in comparison with Korea, purple has a more important meaning than blue in Japan. It was further confirmed that dark blue is almost regarded as one of basic colors in Japan.

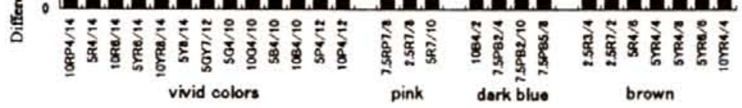

Figure 1. The comparison of Japan and Korea about 「Activity」's factor scores

3. Discussion

From the result of Experiment 1, in respect of color-affection, existence of 3 axes (Evaluation, Activity and Potency) was confirmed. However, it remains such question that this kind of the structure of color-affection, might be an inherent result led by the SD (Semantic-Differential) method using poles modifiers. An investigation5) was made by a method of selection (not SD method) which uses 60 words expressing emotion or condition. The results being compared between Korea and Japan, more variable 13 factors [pleasantness-unpleasantness], [excitement-calm],[frivolous],[high-class] etc. were extracted. However, taking up to the 7th factor (Cum. contribution: more than 80%), up to 5 factors showed a high correlation coefficient among two countries and 4 factors [pleasantness-unpleasantness],[excitement-calm],[cool-warm],[artificial]were extracted as above 4th ranks in order.

In Experiment 2, the color with highest rating of prototypicjality against each of color names, corresponds to ëfocal color'í taking Berlin and Kay's insistence into account. A comparison being made taking up the rating score of color names which was chosen by the selectors of more than 30%, a high similarity was confirmed among two countries for focal color. This coincides with the results of past studies. The colors wherein difference was confirmed among two countries on rating are yellow-green(1/3), purple(2/2), blue(2/1), brown(2/1), orange,(1/3), dark blue(1/1), red(1/0), yellow(1/0) and pink(0/1). For blue and purple, a difference was recognized in spite of basic color terms. For green, no difference was shown. (Student's t-test, a/b; a :p<.01,b:p<.05) Purple, blue and dark blue which difference were confirmed among two countries in Experiment 2, are similar to the result of Experiment 1 wherein Activity was compared. (e.g., speaking of cool colors and color names, in respect of color corresponding to green, blue and purple, a big difference is shown).

4. Conclusion

In respect to the structure of color-affection, existence of 4 dimensions ; Evaluation, Activity, Potency and Naturalness, are extremely basic and important.

For standard 10 color names(e.g., red, orange, yellow, green, blue, purple, brown, pink, dark blue and yellow-green), the colors which are rated as most prototypical color are almost same between Japan and Korea.

For color-affection, in respect to the area ranging from 5G to 10P (green, blue and purple in color names), a big difference is shown among two countries.

Same trend is also confirmed by experiment of prototypicality. For color-affection(Experiment 1) and rating of prototypicality(Experiment 2), it was confirmed that different points between Japan and Korea were similar.

This means that the relation between color naming/color categories and color-affection is considered.

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Opponent Colors and Visual Comfort

Ken Sagawa

Abstract

To evaluate visual comfort to an image of normal colored scene, effects of opponent colors i.e. red, green, yellow and blue on visual comfort were investigated. With a specially developed image processing software, the red/green (r/g) and the yellow/blue (y/b) opponent components of all the pixels in a test image were changed in its amount by the observer until the most comfortable point along with the change was reached. These optimum r/g and y/b component data were compared with direct comfort estimation to the image. It was found that the r/g component has a stronger negative effect on visual comfort than the yellow/blue one. Direct estimation on how much each component is contained in the image was also investigated, and the data were also compared with the comfort estimation data. It was found that the amount of redness over the image was in a stronger negative effect on the comfort estimation than any other opponent colors. These results showed that visual comfort to an image can be evaluated by the amount of red/green opponent colors, particularly by the amount of red color, contained in the image.

1. Introduction

Psychological visual comfort to colored environments or images are becoming of interests among the people not only who design colors in visual environment such as buildings or interior rooms but also who receive such design in their daily life. An objective method to evaluate the comfort is socially needed. In the previous studies, it was shown that the visual comfort is affected by a mean saturation defined as the CIE1976uv saturation in such a way that the higher the mean saturation the less comfort is felt when viewing the image 1), 2). In the present study, as a further study on the relation between the mean saturation and visual comfort, it will be investigated that how opponent colors i.e. red/green (r/g) and yellwo/blue (y.b) that constitute saturation affect the visual comfort.

2. Experiments

2.1 Variable red/green and yellow/blue component experiment

Sagawa developed a variable saturation method to show an effect of saturation on visual comfort, and an optimum percent saturation obtained in this method was in a good correlation with the direct estimation of visual comfort 2). The similar method was applied to the red/green and yellow/blue opponent components to show their effects on the visual comfort.

A total of 40 colored images taken by a digital still camera (SONY DSC-F505K) from normal colored scenes in Tsukuba Science City in Japan were used as test images including houses, shops, parks, and so on. These images were presented on a 20-inch CRT display in the experiment, and by means of a specially developed software for image processing, opponent chromatic components, r/g and y/b components, of each pixel over an entire image were varied continuously by the observer by manipulating a track ball connected to the software without changing the luminance and hue. This change is illustrated in Fig. 1(a) and 1(b). Chromaticity of each pixel was shifted along with the unique hue line of r/g and y/b component as indicated in the figures. The observer could adjust the percentage of r/g or y/b component contained in each pixel of the image as being close to one of the unique hue lines in Fig.1. At the zero percent of r/g component, the image was constructed only by y/b component (just on the unique y/b line) , and on the other hand at the zero percent of y/b component the image was formed only by reddish or greenish parts (just on the unique r/g line).

Ken Sagawa
National Institute of Bioscience and Human-Technology
1-1 Higashi, Tsukuba, Ibaraki 305-8566, Japan
Phone: +81-298-61-6750
Fax : +81-298-61-6752
e-mail: sagawa@nibh.go.jp

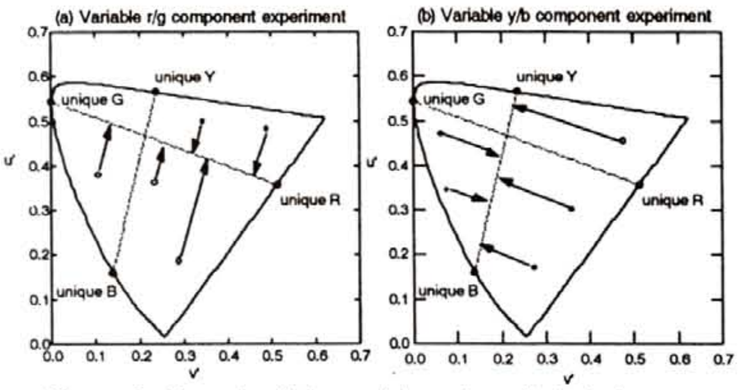


Figure 1. Example of chromaticity points of pixels that are changed in (a) variable r/g and(b) varialbe y/b experiment.

The observer's task was to adjust each of the r/g or y/b component to the point where the most comfortable impression was obtained for the image along with changing of the variable. This is called as optimum percent r/g or y/b component. This setting was carried out for all the 40 images twice in different days. For comparison, the optimum percent saturation employed in the previous study was also carried out at the same time for all the images used in the experiment. These data are to be compared with the direct estimation of visual comfort to the images.

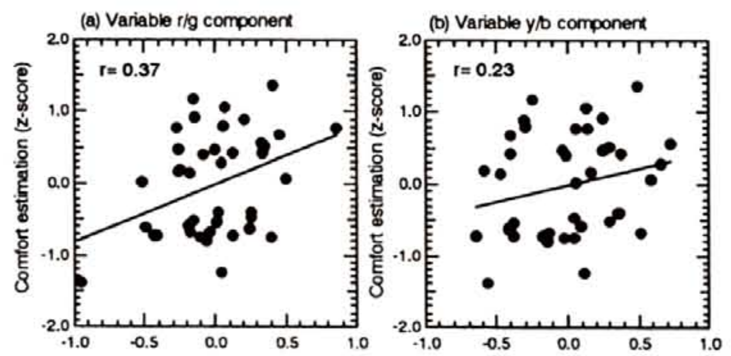
2.2 Direct Estimation Experiments

Direct estimation of visual comfort was done by the observers to all the 40 images used in the variable r/g y/b experiments in consecutive experimental sessions. In addition to the comfort estimation, the observers were also asked to judge the impressions on how much the image is colored by the opponent colors i.e. redness, greenness, yellowness and blueness of the image, in order to see the effect of each opponent color on visual comfort. All of these estimations were done by a ten-point scale from 0 to 9 without any restriction of viewing time. A total of 30 color normal observers participated in the experiments.

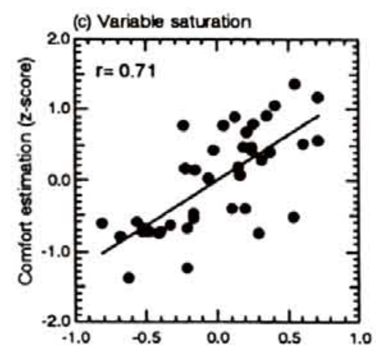
3. Results

3.1 Optimum Percent r/g and y/b Component

Figures 2(a) and (b) show a correlation between direct estimation of visual comfort and optimum percent r/g and y/b component respectively. As the range of data distribution is different for different observers, all the individual observerís data, both for direct estimation and optimum percent r/g or y/b data, were converted so as to give a mean value of zero and a unit standard deviation, that is so called z-score. All the data hereafter are plotted in this z-score. In the Figures 2(a) and 2(b), each data point means the data of each of 40 test images that is averaged over a total of 30 observers. Figure 2(c) shows the data obtained by variable saturation experiment to confirm the results in the previous study. Straight lines mean the linear regression lines and the numbers in the figures denoted as r are the correlation coefficients.



Percent r/g component (z-score) Percent y/b component (z-score) as a inunction of (a) optimm



Percent saturation (z-score) percent r/g component, (b)

Figure 2. Estimation of visual comfort as a function of (a)optimum percent r/g component, (b) optimum percent y/b component and(c) optimum percent saturation respectivery.

As shown in Fig. 2(c), a good positive correlation between the optimum percent saturation and the comfort estimation is observed which means that a discomfort image tends to be seen in lower saturation and therefore saturation has an strong influence to visual comfort. This confirms the previous results 2). Same trend is observed for the variable r/g component experiment (Fig. 2(a)) where the optimum percent r/g component is in a good positive correlation with the direct estimation of visual comfort. Similar positive correlation is obtained for the data of the variable y/b component experiment (Fig. 2(b)) but with a less extent. This means that both r/g and y/b components have more or less an influence on the visual comfort. The difference of the correlation coefficient between the variable r/g and the y/b component experiment, however, indicates that the r/g component has a stronger effect on the visual comfort than the y/b one.

3.2 Direct Estimation of Redness, Greenness, Yellowness and Blueness of an Image

In order to investigate an effect of each opponent color (red, green yellow and blue) on the visual comfort, additional experiments were carried out in which the observer was asked to estimate how much extent the image appears colored with each of four opponent colors in a ten-point scale, that is to evaluate the redness, greenness, yellowness and blueness of the image. A care was taken so as to make the evaluation as an entire impression of the image but not for a particular portion of the image. Figures 3(a) to 3(d) are the results of these experiments. The averaged estimation score for each of the four opponent colors over the 30 observers (z-score) are plotted against the comfort estimation. Each data point means the data for each of 40 test images and the straight line is a linear regression. Correlation coefficients are also shown in the figures.

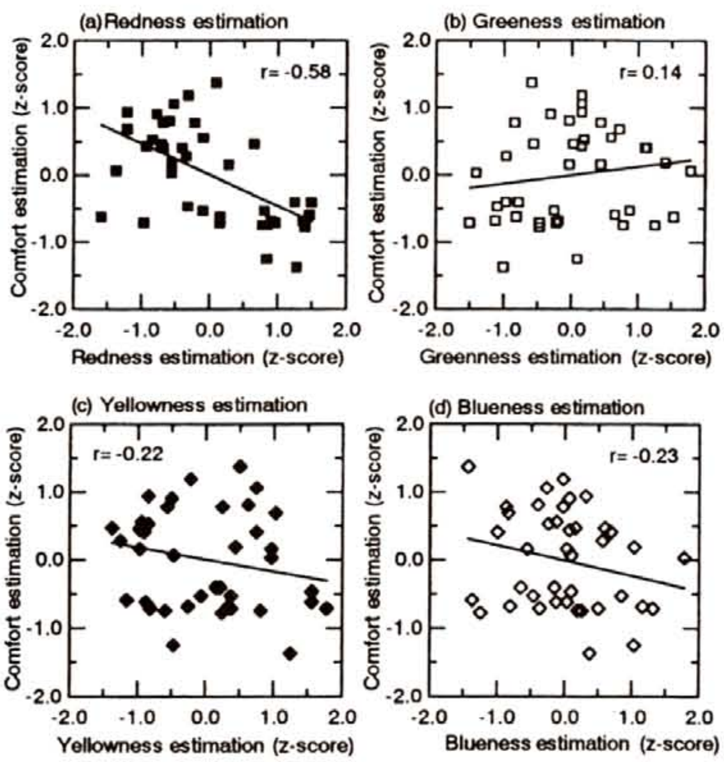


Figure 3. Estimation of(a) redness, (b) greenness, (c) yellowness, and blueness for an entire image appearance subjectively evaluated in comparison with the comfort estimation.

A clear negative correlation is seen for the redness estimation vs visual comfort meaning that the more reddish an image appears the less comfort is felt to the image. A weak negative correlation is also seen for the yellowness as well as for the blueness estimation while a slightly positive correlation is obtained for the greenness estimation. Positive correlation for the greenness implies that the green component might have an opposite (i.e. positive) effect with the redness component in the previous variable r/g component experiment. A higher negative correlation could have obtained if only the redness is varied while the greenness is kept constant.

By using colorimetric analysis of the images and a categorical color classification, it is possible to estimate how much area of an image covered by each of the fundamental colors, such as red, orange, yellow, green, and so on 3). Figures 4(a) to 4(d) show the results of these colorimetric analysis of the images, i.e. percentage area of reddish, yellowish, greenish and bluish parts, in comparison with the comfort estimation data. In each figure the abscissa indicates the percent area of colored area for each of opponent color in logarithmic scale and the ordinate the comfort estimation in z-score. In this colorimetric analysis. a clear negative correlation is observed only for the red fundamental color and almost no correlation with other opponent colors, such as green, yellow and blue color.

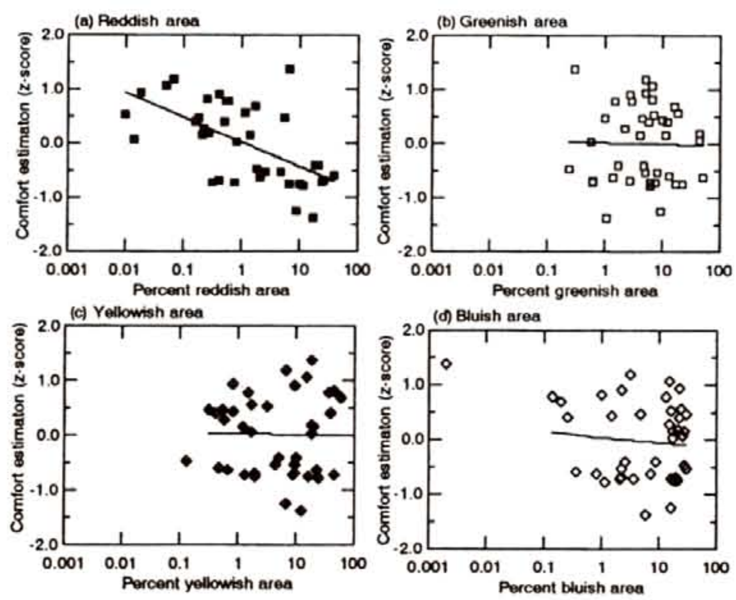


Figure 4. Percent area colored by each of opponent colors in an image obtaimed by colorimetric analysis and its correlation to visual comfort estimation. (a) red, (b) green, (c) yellow and (d) blue.

From these subjective and colorimetric analysis of the image, it was found that red color has a clear negative correlation with visual comfort, i.e. the more the red color is contained in an image the less comfort is felt when viewing the image. For other opponent colors such as green, yellow and blue, the effects are not so remarkable and it is difficult to say how extent do they affect the visual comfort from the present results. Further investigation will be needed.

4. Conclusion

The present study investigated the influence of opponent colors on the visual comfort of the images of ordinary scenes. The variable r/g component experiment shows the r/g component has a negative influence on visual comfort, meaning that the more the r/g component is contained in an image the less comfort is felt for the image. A further analytical study showed that the red opponent color of the r/g component exhibits a negative effect on visual comfort rather than any other components such as green, yellow, green and blue. This concludes that visual comfort cab be evaluated by amount of red color contained in the image.

Acknowledgement
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The Mystery of ISHIHARA Pseudoisochromatic Plates

Yasuyo G. Ichihara

Abstract

The Ishihara pseudoisochromatic test is the most widely used screening test for red-green color deficiency. The full version contains 38 plates. Plates 18-21 are hidden digit designs. For example plate 20 that has 45 hidden digit designs cannot be seen by normal trichromats but can distinguish by most color deficient observers. In this study, we have measured the Ishihara pseudoisochromatic test. The Minolta new 2D-colorimeter system, CL1040I that can be all pixels on 4cm*4cm, was used to take measurements. From the results, all 9 colors in the Ishihara plates 18-21 can be seen on isochromatic line of CIE-xy color spaces.

The form of number are composed the 4 colors and the background colors are composed the remaining 5 colors. Normal trichromats can distinguish these 9 colors one another but can not detected the form of number. For normal trichromats, it is difficult to found the difference of the 4 colors group of the form of number and the 5 groups of the background colors.

We conclude that for normal trichromats, the colors of like orange and red that are highly salient and are included the warm color group, are distinguished from the cool color group of blue, green and gray.

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Keywords : Color Vision, ISHIHARA pseudoisochromatic plates , colorimetry

1. Introduction

1.1 Color Vision Test

Most people can see six or seven colors in a rainbow, and few people can see less than three. Those who can see 6-7 colors have normal color vision and those who can see less than three usually have red-green color vision deficiency. These variations have been linked to differences in the photoreceptors in the eye. There are many kinds of color vision tests that have been developed over the years to detect colorblindness and color vision confusion. The typical 4 tests are as follows:

1. Anomaloscope Test
2. The Farnsworth-Munsell D-15 Hue Test
3. Pseudoisochromatic Test

For example; Ishihara plate, SPP plate, Tokyo Medical College plate, AO-HRR plate etc.

4. The Farnsworth Lantern Test

Yasuyo G. Ichihara
Hosen Gakuen College, Faculty of Art and Design
-33-26,Chuo, Nakano-ku, Tokyo, 164-8631 JAPAN
Phone : +81-3-3370-4022
Fax : +81-3-3370-4022
E-mail: ichihara@po2.hosen.ac.jp

Firstly, Anomaloscope is a color-matching test of mixed red and green light. Secondly, The Farnsworth-Munsell D-15 Hue Test is similar to a 100-hue test. The 15 or 100 colored pieces are arranged in wavelengths. Thirdly, the Pseudoisochromatic Test consists of having a person examine a set of color images called pseudoisochromatic plates. The test pattern can be distinguished from the background, only by its color. Lastly, the Farnsworth Lantern Test is a test involving some color lights matched to their corresponding color names.

In each of these tests, the quantitative diagnosis on color vision deficiency is difficult. For example, the Standard Pseudoisochromatic Plate (SPP) is produced by the same 15 colors as the Farnsworth-Munsell D-15 Hue Test, but there is no correlation between the results of these 2 tests.

Any subjects that have passed the F-M D-15 Hue Test fail the SPP test. We guess that the F-M D-15 Hue test arranges similar colors on a 1-dimensional line but the Pseudoisochromatic Plate consists of color dots like a 2-dimensional picture.

1.2 The Advantage of Human Color Vision

As Mollon1 acutely pointed out, the following 3 points highlight the advantages of human color vision:

1.Detection of targets against dappled backgrounds
2.Perceptual segregation by color
3.Identification by color

It is not necessary for the purpose of this study to enter into the details of 1. and 3. The Pseudoisochromatic test is concerned with 2. Perceptual segregation by color. People could make out the shapes from the segregated figure-background differentiation through color.

2. Methods

2.1 The Measurements of Ishihara Plates

Firstly, we measured the 38-plate version of the Ishihara plates. Its best feature is the segregated figure-background differentiation through color in all the Pseudoisochromatic Plates.
The new Minolta 2D-colorimeter system, CL1040i that can define all pixels in a 4cm * 4cm square, was used to take measurements. This colorimeter is used to measure complex colors such as picture drawings. From the results of the measurements, we show the colors used in the Ishihara plates on CIE xy color spaces.

3. Result and discussion

3.1 The Analysis of the 38-plate Version of the Ishihara Plates

The 38-plate version of the Ishihara plates is composed of the 7 color groups in table 1. The 7 color groups are A, B, C, D, E, F and K.

Table 1. The color groups of the 38 plate version of the Ishihara plates

Number	type	color groups
1	1)Introduction	K
2,3,4,5	2)Transformation	A
6,7,8,9	2)Transformation	B
10,11,12,13	3)Vanishing	C
14,15,16,17	3)Vanishing	D
18,19,20,21	4)Hidden digit	E
22,22,23,24	5)Protan/deutan class.	F
26,27	5)Protan/deutan class.	F
28,29	4)Hidden digit (pathway designs)	E
30,31	3)Vanishing (pathway designs)	D
32,33	3)Vanishing (pathway designs)	C
34,35	2)Transformation (pathway designs)	B
36,37	2)Transformation (pathway designs)	A
38	1)Introduction (pathway designs)	K

Plate 1, which is an introductory plate, constitutes the K color group. It is composed of 2 colors and is seen correctly by all observers.

The A and B color groups are composed of 10 colors. Plates 2-9 are transformation designs used by these 2 color groups. Normal trichromats see the form of a number in these plates and color deficient observers see the form of a different number.

Plates 10-17 are vanishing designs. These plates make up the C and D color groups. These 2 color groups include 8 colors.

The E color groups create an interesting effect. Plates 18-21, which make up the E color groups, are called the hidden digit designs. A number cannot be seen by normal trichromats but can be distinguished by most color deficient observers. These designs are less efficient in demonstrating color deficiency than the preceding ones.

F-the last color group is composed of plates 22-25. These plates are classification designs to determine protan and deutan defects. These consist of 9 colors.

In the 38-plate test, plates 26-38 contain pathways and are intended for use with nonverbal subjects. Each plate from 26 to 38 is composed of one of the groups A, B, C, D, E, F and K.

Figures 1-7 indicate the chromaticity x, y, and their reflectance Y of A, B, C, D, E, F and K color groups.

We can recognize from the reflectance Y in figures 1-7, that the brightness has no connection with the main subject of the perceptual segregation by color. In the 38-plate version of the Ishihara plates, all the colors in the figures and background have random brightness as shown in the reflectance Y. Under normal conditions, we could make out the shape by the figure-background differentiation and also by the difference in brightness. The conventional view on the transformation designs and the hidden digit designs in the Ishihara plates has shown that most color deficient observers distinguished the shape, with only a small difference in brightness in the colors of the figure and the colors of the background. But this old view is contradicted by this data.
The transformation designs and the hidden digit designs are Ishihara originals. These plates are complicated for the manufacturing technicians to

make. However, the screening of color deficient people is not always necessary.
So the SPP plate and AO-HRR plate can be simpler. They are made with the aid of the isochromatic line theories by Pitt-Judd. They do not include any transformation designs or hidden digit designs.

There are 2 systematic colors in the Ishihara plates. Firstly, the color - Japanese green tea - is included in A-8,9,10; B-8,9,10; C-4,5,6; D-1,2; E-5. These colors have almost the same chromaticity x and y. Secondly, the color - Chinese dark orange tea - is included in A-5,6,7; B-8,9,10; C-1,2,3; D-4; E-7,8. These colors also have much the same chromaticity x and y. The difference of wavelength and colorfulness between the Japanese green tea color and the Chinese dark orange tea color is very small, but Normal trichromats are very sensitive and can see the small difference in the nearby Yellow line that has the wavelength of 572 nm. These 2 colors are positioned on both the ìprotanî and ìdeutanî isochromatic lines.

In the history of Ishihara plates (1924 ñ1998), these 2 colors - Japanese green tea and Chinese dark orange tea - have basically remained unchanged. The colors that have changed are the color of green grass - A-1,2; B-1,2; C-7,8; E-4 and the color of coral red - A-3,4; B-6, 7; E-2.

The C color groups and D color groups are vanishing design types. There are 8 colors in these plates.
C-4, 5,6 and D-1, 2 are Japanese green tea color. C-1, 2,3 and D-4, 5,6 are Chinese dark orange tea color. Shimizu3 stresses that the components of yellow and blue that color deficient observers can distinguish, create confusion in the figure-background differentiation. The confusion colors are C-7,8; D-3 which is blue green and D-7, 8 which is yellow and vivid orange.

In the A, B groups and E groups, it is important that the colors on the isochromatic line and the line crossing at right angles form 4 areas.
In the A color groups, the main background color is the Japanese green tea color. Normal trichromats see the Japanese green tea color and A-1, 2 as background color. They see the Chinese dark orange tea color and A-3, 4 as figure color. Color deficient observers see the Japanese green tea color and the Chinese dark orange tea color as background color, and see A-1, 2 and A-3, 4 as figure color.

In B color groups, the main background color is the Chinese dark orange tea color. Normal trichromats see the Chinese dark orange tea color and B-6, 7 as background color. They see the Japanese green tea color and B-1, 2 as figure color.
Color deficient observers see the Japanese green tea color and the Chinese dark orange tea color as background color, and see B-1, 2 and B-6, 7 as figure color.

In the E color groups, the form of a number is composed of 4 colors and the background colors are composed of the remaining 5 colors. Normal trichromats can distinguish these 9 colors from one another but cannot detect the form of a number. For normal trichromats, it is difficult to find the difference between the 4 color group in the form of a number and the 5 color group of the background colors. We found that for normal trichromats, the colors like orange and red that are highly salient are included in the warm color group, and are distinguished from the cool color group of blue, green and gray.

Hukami4 stresses that for color deficient observers and normal trichromats, there is a significant difference between the similar color category groups. However, our study of Ishihara plates shows that color deficient observers and normal trichromats see a close similarity in the color category groups in the 4 areas.

We concluded the Ishihara plates can screen both color deficient people and normal trichromats. Hence, the clinical trials of Ishihara plates have shown it is the most sensitive and efficient color vision test in the world.

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Application of Numerical Expression of Colour Emotion

Tetsuya Sato, Kanji Kajiwara, Hiroshi Hoshino, Taeko Nakamura,

John Xin, Aran Hansuebsai, Jim Nobbs

Abstract

Feelings are communicated through words and languages. Word is the output of the colour perception and the most useful key for colour communication. Therefore, we tried to derive visual scales of psychological sensations described by kansei words. With the results, the scales of colour emotion were expressed as empirical formulae based on a colorimetric system.

In this paper, we would like to suggest a few applications of the numerical expression, for example, an attempt of translation of colour emotions among languages, and a colour emotion display on a computer monitor for colour communication through Internet.

Keywords : colour emotion, kansei database, numerical expression, colorimetry, information technology

1. Introduction

In order to analyse the software mechanism of colour perception and cognition in brain, it is needed to make quantitative scales. Word is the output of the colour perception, cognition and feeling. Our research group is paying attention to words and languages. We investigated the use of the colour emotional words such as deep, warm and dynamic, which describe psychological sensations, and also we have been trying to derive visual scales of the psychological sensations. The scales were numerically expressed as empirical formulae based on CIELAB and Munsell colour systems [1-5]. With the scales, the magnitude of human colour emotions can be predicted through an instrumental method.

On the other hand, colour communication systems through multimedia instruments are needed. Many trials have been doing for developing colour communication systems. The main target of the trials is to communicate colour images accurately, not to communicate our feelings induced by colours. Generally, feelings are communicated through words and languages. In this paper, we would like to introduce a few applications in using the empirical colour emotion formulae derived from kansei database (database of sensory assessments).

Tetsuya Sato, Kanji Kajiwara
Kyoto Institute of Technology
Goshokaido-cho, Matsugasaki, Sakyo-ku, Kyoto 606-8585, JAPAN
Phone/Fax: +81 75 724 7578, E-mail: tsato@ipc.kit.ac.jp
Hiroshi Hoshino
Yamaguchi University
Yoshida, Yamaguchi 753-8513, JAPAN
Taeko Nakamura
Nara Saho Jogakuin College
Rokuyaon-cho, Nara 660-8566, JAPAN
John Xin
Institute of Textiles and Clothing, Hong Kong Polytechnic University
Hung Hom, Kowloon, HONG KONG
Aran Hansuebsai
Faculty of Science, Chulalongkorn University
Phyathai Rd., Bangkok 10330, THAILAND
Jim Nobbs
Dept of Colour Chemistry, University of Leeds
Leeds LS2 9JT, U.K.

2. Numerical Expression of Colour Emotion

We have already derived empirical colour emotion formulae, which predict the magnitude of human emotion induced from colour through an instrumental method [1-5]. The first trial of the numerical expression was carried out for the colour emotions described by 12 kansei word pairs as shown Table 1.

Table 1. Word pairs used for visual assessments [1,4]

Kansei word pairs in Japanese	English translated
Akarui - Kurai	Light - Dark
Atatakai - Tsumetai	Warm - Cool
Azayakana ñ Kusunda	Vivid - Sombre
Doutekina - Seitekina	Dynamic - Passive
Hadena - Jimina	Gaudy - Plain
Hakkirishita ñ Bonyarishita	Distinct - Vague
Koi - Awai	Deep - Pale
Medatsu - Medatanai	Striking - Subdued

Omoi - Karui	Heavy - Light
Sunda - Nigotta	Transparent - Turbid
Tsuyoi - Yowai	Strong - Weak
Yawarakai - Katai	Soft - Hard

The each colour emotion formula has an ellipsoid-shape. The shape is similar to that of colour difference formula. A colour difference value such as CIELAB (E*ab is defined as a distance between colorimetric coordinates of two colours. A colour difference value is going larger with the growth of colour difference. Colour emotion values computed by the formulae are going larger with the growth of colour emotions as well. A visual scale for assessing a colour emotion in the CIELAB colour space is given as the following formula;

$$CE = [\{k_L(L^*-L^*_O)\}^2+\{k_A(a^*-a^*_O)\}^2+\{k_B(b^*-b^*_O)\}^2]^{1/2}+k_M \quad (1)$$

Where,

CE	: Prediction value of a colour emotion
L^*	: CIELAB metric lightness
C^*	: CIELAB metric chroma
L^*_O, a^*_O, b^*_O	: CIELAB L^*, a^* and b^*, when the colour emotion is minimum
k_L, k_A, k_B	: Constants of the contribution of CIELAB L^*, a^* and b^*
k_M	: Constant for scaling

3. Application

At this moment, the keyword of the application of colour technology is colour communication. The colour communication is to reproduce colours and to manage colours. Especially, it is the most important to communicate colour images accurately.

Our research group is paying attention to another colour communication. That is to communicate our feelings induced by colours, not to communicate colours directly. With kansei database and colour emotion formulae, we would like to suggest a few applications as shown in Figure 1.

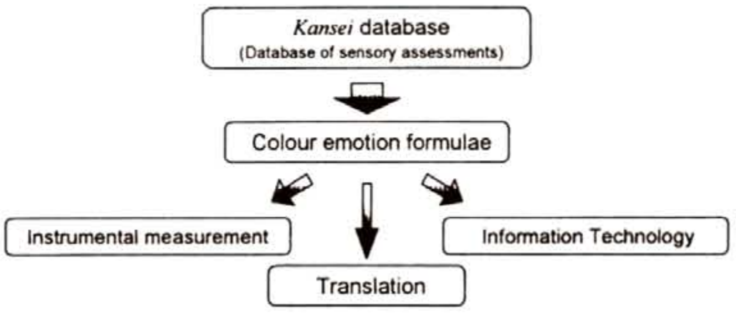

Figure 1. Applications in using colour emotion formulae and *kansei* database

3.1 Application to Instrumental Measurement

We can instrumentally predict the magnitudes of colour emotions through colour emotion formulae derived from visual assessments. For example, ëDynamic - Passiveí colour emotions in Japan, Thailand, Hong Kong and United Kingdom are expressed as the following formulae.

$$DyP_{JP} = [\{0.6(L^*-50)\}^2+\{4.6(1-\Delta h_{290}/360)C^*\}^2]^{1/2}-115 \quad (2)$$

$$DyP_{TH} = [\{2.7(L^*-40)\}^2+\{7.0(1-\Delta h_{290}/360)C^*\}^2]^{1/2}-160 \quad (3)$$

$$DyP_{HK} = [\{0.5(L^*-50)\}^2+\{4.0(1-\Delta h_{290}/360)C^*\}^2]^{1/2}-100 \quad (4)$$

$$DyP_{UK} = [\{3.5(L^*-75)\}^2+\{7.6(1-\Delta h_{290}/360)C^*\}^2]^{1/2}-195 \quad (5)$$

where, JP, TH, HK and UK are Japan, Thailand, Hong Kong and United Kingdom, respectively.

L^*	: CIELAB metric lightness
C^*	: CIELAB metric chroma
$\Delta h290$	: CIELAB metric hue-angle difference from h=290, $0 \leq \Delta h_{290} \leq 180$

3.2 Application to Colour Communication

The formulae for assessing various colour emotions can provide us some information as numerical values predicting human colour emotions. Therefore, the colour emotion formulae can be applied to develop some tools on Information Technology.

Figure 2 shows the process for the projection of predicted colour emotion on a computer monitor. Colour emotion values, which are computed by the colour emotion formulae, can be transformed to CIELCh, CIELAB, XYZ and RGB values by a reverse operation. Finally, the colour emotion values can be outputted as real colours on a computer monitor. Using the colour output, we can develop some computer tools for communicating human colour emotions. Consequently, the colour emotion system based on the numerical expression can be applied to the colour communication through a computer network system such as Internet.

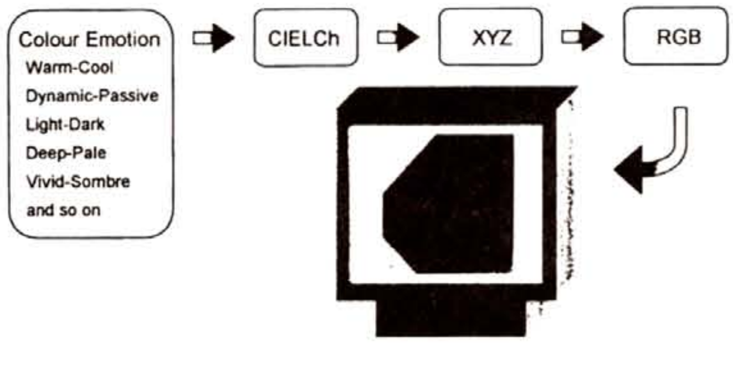

Figure 2. Process for the projection of predicted colour emotion on a computer monitor

3.3 Application to Translation

It is difficult to communicate feelings between two languages, especially the magnitudes of the feelings. In general, a word is not corresponding to just one word in other languages.

How can we communicate the magnitude of colour emotion on cross-culture?

We would like to suggest a translation through colour emotion formulae. For example, a translation between 'Dynamic - Passive' colour emotions expressed in Japanese and Thai can be done instrumentally as following formulae.

$$DyP_{JP} = [\{0.6(L^*-50)\}^2+\{(4.6/7.6)[(DyP_{UK}+195)^2 -\{3.5(L^*-75)\}^2]^{1/2}\}^2]^{1/2}-115 \quad (6)$$

$$DyP_{UK} = [\{3.5(L^*-75)\}^2+\{(7.6/4.6)[(DyP_{JP}+115)^2 -\{0.6(L^*-50)\}^2]^{1/2}\}^2]^{1/2}-195 \quad (7)$$

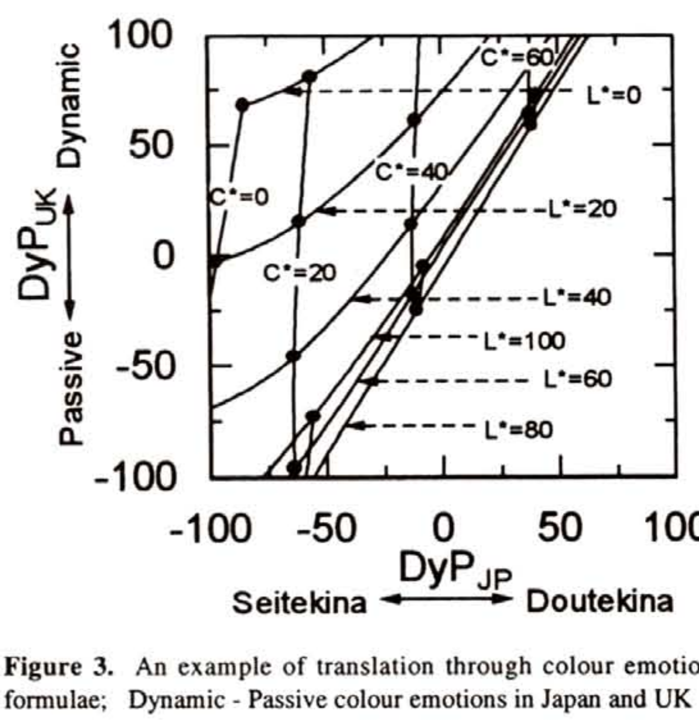

Figure 3. An example of translation through colour emotion formulae; Dynamic - Passive colour emotions in Japan and UK

Equation (6) is for quantitative translation from the colour emotion described as ëDynamic - Passiveí in Japanese to that described in English. Equation (7) is from the colour emotion described as ëDynamic - Passiveí in English to Japanese one as well as the equation (6). We can also see the quantitative translation through the computer display method suggested in 3.3. Figure 3 shows an example of the quantitative translation through a projection of CIELAB colour system.

4. Summary

We suggested a few applications in using the numerical expression of colour emotions. Those are to measure human colour emotions instrumentally, to communicate the magnitude of colour emotions through computer network, and to translate among colour emotions expressed in several languages.

As the instrumental system can be to communicate our feelings induced by colours more quantitatively, the applications based on the instrumental colour emotion system will be helpful for various fields.

But, in order to develop a useful application system, it is essential to make a kansei database which answers the purpose. Therefore, we have to collect many sensory assessments carefully, and also to express them numerically.

Acknowledgement

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Heat Influence of Color under Standard Solar

Masayuki Ohta, Yasuo Kurotani, Shoji Iijima

Abstract

When light incident on the material, the reflection light cause various color. It thus appeared that difference of spectral reflectance means that of reflective energy. Therefore in this paper we dealt with heat influence of color with the spectral reflectance of the book of JIS (Japanese Industrial Standard) color standards and the conventional data on the solar spectral irradiance under standard solar in Japan. The book of JIS color standards founded on Munsell color system. Spectral reflectance in a wavelength range from 300 to 2500 nm was measured by spectra-photometer. Result reflectance tended the higher Chroma and Value was, the higher reflectance was.0Also it was different from Hue though Value and Chroma was same. Reflectance of Green-Yellow was the lowest, and it of Red-Purple was the highest. Reflectance of color in same Value be thought same rate, but the fact was different.

Keywords : heat s reflectance, irradiance

1. Introduction

When light incident on the material, the reflection light cause various color. It thus appeared that difference of spectral reflectance means that of reflective energy. Therefore in this paper we dealt with heat influence of color with the spectral reflectance of the book of JIS (Japanese Industrial Standard) color standards and the conventional data1) on the solar spectral irradiance under standard solar in Japan.

2. Measure Method

The spectral reflectance of the book of JIS color standards was measured in National Industrial Research Institute of Nagoya. There were measured by the ISN-470 integrating sphere and V-570 photometer-photometer. Measured material was the book of JIS color standards. The book of JIS color standards founded on Munsell color system. And 20 charts of it were used. There were chosen 5R, 10R, 5YR—10R, 5RP, 10RP Hues. All tips of chart were chosen. The spectral reflectance of wavelength range from 300 to 2500 nm was measured at 2nm intervals. Visible spectrum was wavelength range from 380 to 780 nm, but the purpose of the investigation was deal with color not only visible range but also reflective range of solar energy. It thus appeared that the spectral reflectance of wavelength range influenced of the solar energy was measured.

Masayuki Ohta, Yasuo Kurotani, Shoji Iijima
Institute : Department of Natural Resources Process Engineering Faculty of Science and Engineering
Address : Matsue, Shimane, 690-8504
Country : Japan
Phone : +81-852-32-6509
Fax : +81-852-32-6123
E - mail : kurotani@riko.shimane-u.ac.jp

Table 1. Measured 20 color chart names of JIS color standards

5R	10R	5YR	10YR
5Y	10Y	5GY	10GY
5G	10G	5BG	10BG
5B	10B	5PB	10PB
5P	10P	5RP	10RP

3. Measure Result

An example of measure results was shown in Fig.1. Because we didn t have enough space to describe everything about there, we introduced five typical examples.0These curves were shown remarkable change over 600nm. And the higher value of chroma

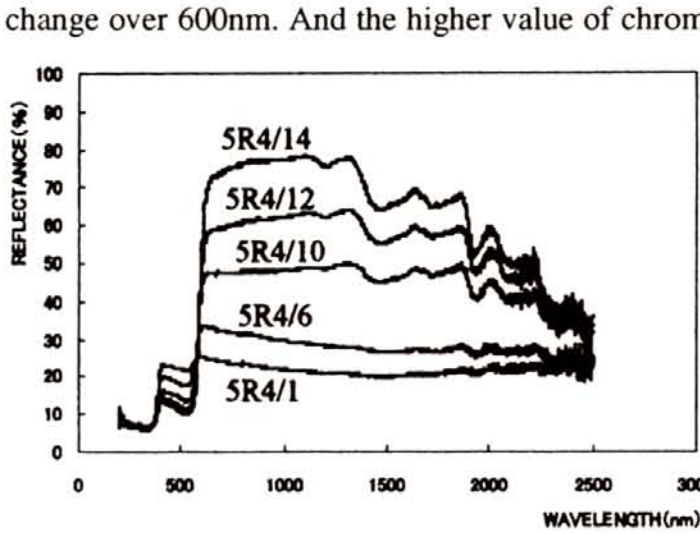

Figure 1. The measured curve of reflectance (wavelength from 300 to 2500nm)

was, the bigger change was shown. Other results were shown same phenomenon, too. Generally speaking, in visible range the higher value of Chroma and Value was, the bigger the character of Hue was shown. In infrared range the higher value of Chroma and Value was, the higher reflectance of all Hue was.

4. Calculate way of Heat's Reflectance of Color under Standard Solar

The first the spectral irradiance on the direct solar spectral distribution was set. In the investigation the date1) published from the Electro technical Laboratory was used. The wave intervals of the date were changed random to 2nm by linear interpolation. The date obtained by the result of it was shown in Fig.2. The second the date of irradiance of each colors were obtained by the integral from 300 to 2500nm of the date of the spectral reflectance multiplied by the spectral irradiance of colors. The third reflectance of irradiance of each color was obtained by the ratio reflection to incident light.

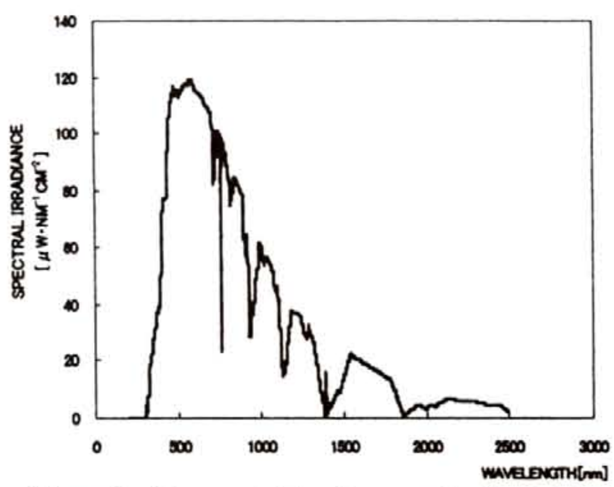

Figure 2. The spectral irradiance on the direct solar spectral distribution

5. Calculate Result of Heat's Reflectance of Color under Standard Solar

TABLE.2 was shown some examples of calculate result of heat s reflectance of color under standard solar. And it was especially shown twenty values of Value in each Hue had the longest Chroma-axis. Result tended the higher Chroma and Hue was, the higher reflectance was.0Fig.3 and Fig.4 were shown the lines of reflectance of five colors. Reflectance was different from Hue though Value and Chroma was same. In general the following statement can be made. Reflectance of Green-Yellow was the lowest, and it of Red-Purple was the highest. On the effect of Chroma, color (between 10R-5Y-5GY of color circle) ís reflectance was about 1.1 times as high as the previous value of Chroma. For example, the value of reflectance of 5GY7/8 was about 1.1 times as high as it of 5GY7/6. And the ratio of change (between 10GY-5P-5R of color circle) was inclined to be big as the value of Chroma was high. The ratio of change of low Value was big, and it of change of high Value was small. On the effect of Value, the ratio of change of low Value was various. The biggest of it was 2.2 times, and the smallest of it was 0.5 times. But it of high Value abated from 1.3 to 1.5

Table 2. Reflectance of each value's color has the longest Chroma-axis〔%〕

Chroma		0	1	2	3	4	6	8	10	12	14
5R	Value4	15	14	15	17	18	21	27	36	43	55
10R	Value5	20	21	22	24	25	30	35	40	47	52
5YR	Value7	41	42	44	47	47	48	55	57	58	65
10YR	Value6	29	31	30	31	33	34	36	37	41	
5Y	Value8	58	56	56	57	57	58	58	59	61	64
10Y	Value7	41	40	41	41	41	40	41	46		
5GY	Value7	41	39	39	40	39	40	43	50		
10GY	Value5	20	19	19	20	19	20	26	29		
5G	Value4	15	12	13	13	13	14	20	23		
10G	Value4	15	14	13	13	13	14	16	25		
5BG	Value3	9	9	9	9	10	11	17			
10BG	Value4	15	13	13	14	15	17	27			
5B	Value4	15	13	14	15	15	18	26			
10B	Value4	15	14	14	15	17	19	23	34		
5PB	Value3	09	10	11	11	14	15	18	33		
10PB	Value3	09	10	11	12	13	17	26	41		
5P	Value4	15	13	15	16	19	25	47	52		
10P	Value4	15	14	15	16	17	23	51	54	54	
5RP	Value5	20	20	22	25	25	29	34	60	62	
10RP	Value6	20	21	21	23	24	28	37	45	56	61

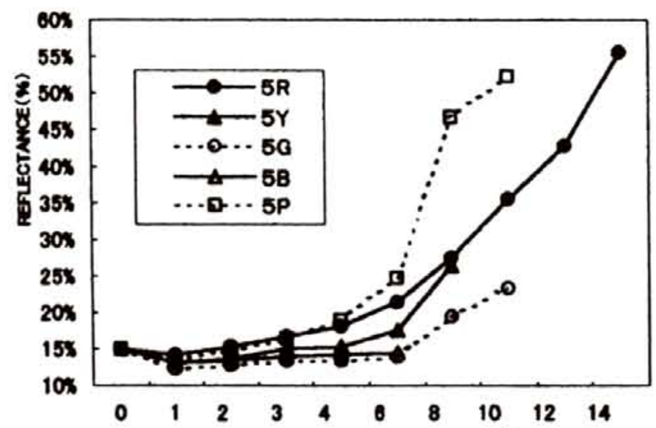

Figure 3. Reflectance of irradiance(Value 4)

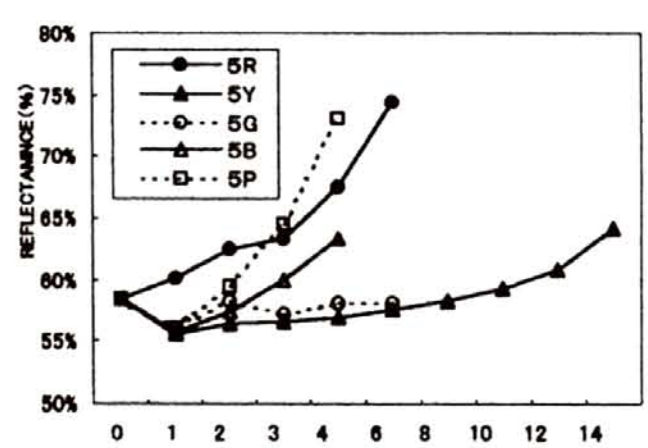

Figure 4. Reflectance of irradiance(Value 8)

times. In case of low Chroma, color (existed between 5YR-5Y-5G of color circle)'s reflectance was big change. In case of high Chroma, it (existed between 5PB-5P-5RP) was big change. In general the value of Chroma were from 1.3 to 1.5 times as high as the previous value of it. On the effect of Hue, in case of middle Chroma and low Value the ratio of change of Hue was big, and in case of low and high Chroma and high Value it was small.

6. Conclusion

In this investigation, we confirmed effect of color, in case to think the reflection to incident light. Reflectance of color in the value of same Value be thought same rate2), but the fact was different. Measured material was the book of JIS color standards, but other materials were not necessarily resulted in the same Further investigation is necessary with other sample of measurement.

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A Study on Local Authorities' Aesthetic Consciousness of Color Environment

-From the Questionnairing About Color Environment Policy in Japan-

Suguru Sato, Shoji Iijima

Abstract

The importance of color comfort in landscape is recognized. Many local authorities are endeavored to keep and create the beauties of color condition on townscape in Japan. So, they plan landscape ordinances, and enact these ordinances. Now, local authorities mainly guide their townscape condition in the path of the beauty and comfort. But, a few landscape ordinances touch upon color control sufficiently. The aim of this study is to gain a proper understanding of local authorities aesthetic consciousness of color environment on townscape. The questionnairing was conducted on 79 local authorities at Okayama perfectare in Japan. As the result of the questionnairing, local authorities comprehend color environment on townscape as one component of townscape environments. And, we discuss the effect of ordinances and difficulty of policy on townscape color environment to keep and create the beauties of color condition on townscape in Japan.

Keywords: Authorities' Aesthetic Consciousness, Color Environment policy, questionnairing

1. Intoroduction

Recently, local authorities tend to interest in life environment according to highly developed economic system. And, resident consciousness tend to focuse to their life environment, especial to landscape environment.

We discuss the effect of ordinances and difficulty of policy on landscape color environment to keep and create the beauties of color condition on townscape in Japan.

2. Method

We surveied each authoritie consciousness as to landscape color environment. We made the questionnaire about the situation of landscape conservation, problem of landscape protection and policy, and improvement and maintenance of landscape. We sent questionnaire paper to 79 authorities in Okayama prefectural and we received 46 returns.

3. Result

About question that "What do you think about typical landscape color of your covered territory ? ",

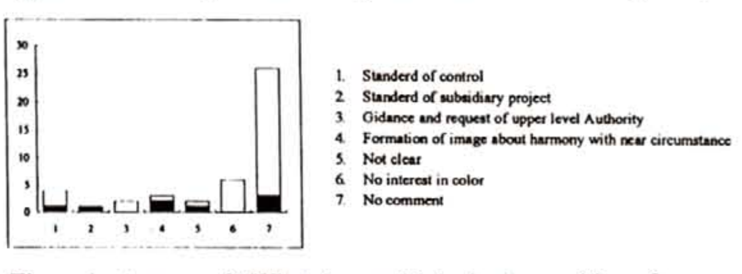

Figure1. Answer of "What do you think about a position of landscape color in conservation and formation? "

Black area is the number of authority that enacted landscape ordinance

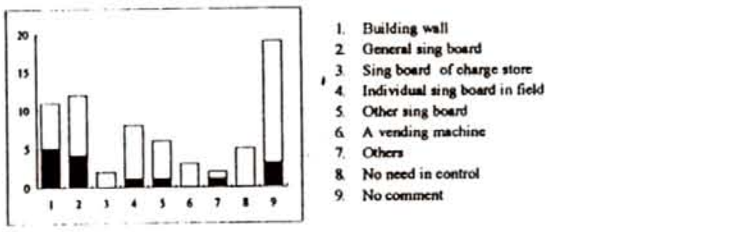

Figure 2. Answer of "What parts of landscape color do you want to control? "

Black area is the number of authority that enacted landscape ordinance

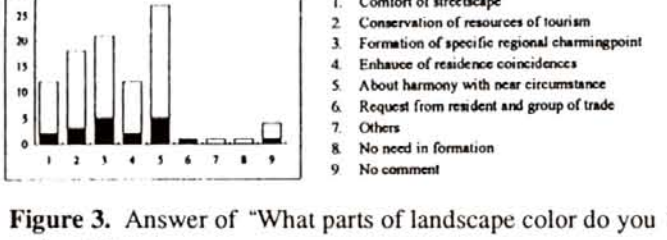

Figure 3. Answer of "What parts of landscape color do you want to form? "

Black area is the number of authority that enacted landscape ordinance

Suguru Sato, Shoji Iijima, Okayama Shoka University
2-10-1 Tushima-kyoumachi Okayama 700-8601 JAPAN
Phone : 086-252-0642
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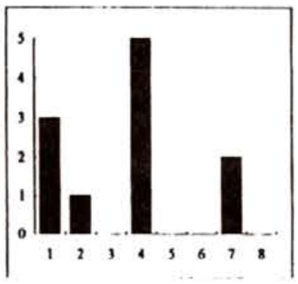

Figure 4. Answer of "What do you think about a position of landscape color in conservation and formation?"

authority of 50% answered indefinable. Here, they think that judgment about landscape is difficult to mention for judgment holds aesthetic aspect.

About question that "What do you think that landscape color is important to landscape conservation and formation?", authorities of 44% answered rather important. This is suggests that many authorities think landscape color is important, for landscape policy.

About question that "What do you think about a position of landsca pe color in conservation and formation ? (Description)", authorities listed 7 sorts of answer. Figure 1 suggests that authorities that is answered "no comment" tend to enact no landscape ordinance. And four authorities answered that landscape color is the standard of control.

About question that "What parts of landscape color do you want to control? (Choice plural)", figure 2 suggests that many authorities want to control building wall and general sing-board. About question that "What parts of landscape color do you want to form? (Choice plural)", figure 3 suggests that landscape color needs the harmonyover near overall environment and conservation of resource of tourism.

About question that "What do you think about a condition on conservation of landscape of your covered territory?", authorities of 70% answered tendency of improvement.

About question that "What is obstacles to landscape? (Choice upto three)", answers of hard aspect are vacant house and overage house, problem of rubbish, and waste of farmland. And answers of soft aspect are no control, limit of guidance, and low consciousness of resident, many authorities think that resident do not catch up with policy of administration.

About question that "What do you think about difficulty of landscape project and policy?", many authorities answered that cooperation with resident, and making a budget.

About question that "Are you going to enact landscape ordinance in future?", many authorities answer "no". Because they use ordinance of upper authority, and low of priority order of policy.

About question that "Is there request to landscape policy from resident and group of resident?", 9 authorities recieved their request. The contents are assist for streetscape conservation, subsidy system to local project, and control and grievance about dispose of rubbish.

About question that "What is a chance on enactment of your landscape ordinance?", figure 4 suggests that mainly mayor's judgement by request from resident.

About question that "Is there district where residents tend to enhance their consciousness from near authority's landscape policy?", there are concrete cases that formation of walk on the border of the shore, and plant flower and tree.

About question that "Is there acknowledgment and support system of group of residence and conference for landscape formation?", all authorities answer "neither", reason is that they use other system.

About question that "Is there penalty in your ordinance?", the only one authority answer "yes". Penalty is hard to gain understanding of resident.

About question that "Are there result or problem of your ordinance?", answered results are that formation of relative region progress by slow degrees, effect on streetscape conservation, and individual landscape formation and landscape aesthetic action appear to some region. And answered problems are that restriction of private right, designate of region of landscape formation is difficult, and insufficient formation penal regulation, and pass decline off consciousness to landscape.

4. Conclusion

Many authorities think landscape color is important, for landscape policy. Four authorities answered that landscape color is the standard of control. Hard aspect of result are gain by slow degrees. But,soft aspect has many problem. Partnership between residence and authority, is important to form amenity.

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Analyzing of an Image and Making of a Color Palette for Color Planning of the City

- A Case Study on the Color Planning of Dae-Jon -

Lee Jin-Sook, Lee Mi-Jin, Kang Young, Kwon Hyuck-Il

Abstract

The aim of this study is to present the color palette for Dae-jon' s exterior color planning through image analysis as a case study. This study was composed of four steps, and was carried out as follows. First, the existing architectures and natural environment in Dae-jon were surveyed and the target images of each district were established by analyzing the results of the surveys. For analyzing color characteristics by image types, the evaluation experiments were performed by using computer graphic. Finally, the practical color palette for planning was made on the basis of the color characteristic analysis.

Keywords: color palette, exterior color, color characteristic, case study

1. Introduction

Up to now, because of the awareness of color the cityscape has been planned without a systematic and detailed methodology for color planning. As a result unplanned and uncontrolled color works as a dominant factor which lowers the whole quality of the cityscape. So it is necessary to establish a systematic and detailed guide which can give an arranged order for it.

The aim of this study which uses Dae-jon as a case lies in making the target image by analyzing the views of each region and district in order to set up the color composition that can be harmonized with the established environment and making color palettes which will match the regional images for each region and district through the color characteristics on each image.

The process of this study is composed of four steps; 1) The existing architectures and natural environment in Dae-jon were surveyed, 2) The target images of each administrative area were established by analyzing the results of the surveys, 3) For analyzing color characteristics by image types, the evaluation experiments were performed by using computer graphic, 4) Finally, the practical color palette for planning was made on the basis of the color characteristic analysis.

Lee Jin-Sook, Lee Mi-Jin, Kang Young, Kwon Hyuck-Il,
Chungnam National University Department of Architectural Engineering, College of Engineering 220 Kung Kong, Yosung-Ku, Taejon, 305-764, Korea
Phone : +82-42-821-7733
F a x : 82-42-823-9467

2. Survey and Image Analysis

2.1 The Field Survey on Exterior Colors of Administrative Area in Daejon

We surveyed the environmental colors made from the architectures and the natural environment in Dae-jon. Natural environmental colors were measured centering around important mountains surrounded by each of administrative areas in Dae-jon. Dong-ku was measured in Mt Sikjang, Jung-ku Mt Bomun, Seo-ku Mt Sanjung, Yusung-ku Mt Wosungi, Daeduck-ku Mt Gaejock. The results of color distribution about each of administrative areas in Dae-jon were as following table 1.

Table 1. The color distribution of natural environment

		Dong-ku	Jung-ku	Seo-ku	Yusung-ku	Deduk-ku
short view	needle-leaf tree	5GY 5/2	7.5GY 4/2	5GY 4/4	2.5GY 3/4	7.5GY 4/4
	broad-leaf tree	7.5GY 6/4	5GY 5/6	5GY 6/4	5GY 5/8	5GY 6/6
intermidiate view	meedle-leaf tree	7.5GY 5/2	7.5GY 6/4	2.5GY 5/2	7.5GY 7/2	5GY 3/2
	broad-leaf tree			2.5GY 5/4	10GY 5/4	10GY 5/4
distant view	Mountain		10GY 4/2	7.5GY 4/2	7.5GY 5/2	10GY 4/1
	Sky	2.5PB 9/2	2.5PB 8/4	2.5PB 9/2	2.5PB 6/4	2.5PB 6/4
		5PB 9/2		5PB 9/2	5PB 9/2	5PB 6/6
				7.5PB 9/2		5PB 7/6

The colors of architectures were used with unnatural colors which were not harmonized with natural environment and they showed distracted mood because of disorder of the colors and visual anxiety. Dong-ku was not under the influence of building but under that of natural environment. Jung-ku was under the control of the image of the existing residential streets and the tone of color was middle value or low chroma of bricky-red which was R group.

Most of Seo-ku is apartment complex and its various color group was high value or low chroma. The color tone of Yusung-ku was influenced by group of N in Expo or the Deaduck Science Complex and that of Daeduck-ku was at the mercy of hard N group.

2.2 Analyzing Image and Establishing Target Image

2.2.1 Analyzing Image

The analyzing image which was positive or must be improved about administrative area in Dae-jon was as follows.

1) General Image

Dong-ku is surrounded by mountain on all sides and located on the out-corner of Dae-jon. So, it was quiet and a rural district. Jung-ku is the oldest downtown which has long history and gravity. Seo-ku is composed of apartment complex which has been built lately centering around a new section of city. The image of Yusung-ku is magnificent and huge owing to the large buildings of Daeduck Science Complex and EXPO. Daeduck-ku is centering around industrial complex and its image is huge and dynamic.

2) Positive Image

Dong-ku has affinity for nature. Jung-ku is centering around main street and it is colorful and active. Seo-ku has an ordered, clean and urban image centering around Dunsandong. Yusung-ku also has a neat and tidy image centering around Deaduck Science Complex and the residential complex is well-polished and bright.

3) Image to be Improved

Dong-ku looks dark, dull, and disordered because of its falling behind and not being put in order. Jung-ku has a complex and disordered commercial districts. Seo-ku looks artificial and closed on account of apartment complex. Yusung-ku forms in close order and has a confused tourist area. Daeduck-ku has a dreary and oppressive mood.

2.2.2 Establishing Target Image

The main analysis data are concerned with social and physical environment and the color which was surveyed chapter 2.1.

Dong-ku is surrounded by many mountains on all sides and has not been developed. So, it can play an important role for Dae-jon. For selecting the tone of color, it should be harmonized with natural environment for the purpose of rural and intimate image.

Since Jung-ku already completed old-downtown, the possibility of its development is very little. Because the bricky-red which was R group of exisiting residential street has a good effect on the whole impression, the tone of color must be fixed and be settled by using colors for the tone of gravity, history and stability.

Most of Seo-ku is composed of apartment complex. So the existing color has been distributed variously. For this place, we choose the ordered color which is polished and cleared tone for the purpose of urban beauty as a new city.

In this Yusung-ku, the image of EXPO is very powerful. The main image of this area is represented by metallical N group or intellectual Deaduck Science Complex. So, it should be given expression of bright and clean modern beauty centering around high-grade image.

The image of Daeduck-ku' s industrial complex is stiff, dark and huge N group. To convert this image to a brighter one, it is suitable to use colorful tone which is in harmony with pastel tone. According to this result, the arrangement of the type of distinction head for image is like table 2.

Table 2. The target image types by a administrative area

	Target Image	Image Types
Dong-ku	The tone harmonized with nature for rural and intimate mood	Pastoral Comfortable Natural
Jung-ku	The tone of color settled such as gravity, history and stability	Grave stable
Seo-ku	The ordered and cleared tone for the urban beauty	Urban Clear
Yusung-ku	The bright and clear tone for modern beauty with high-grade image	Quiet Subdued
Deduk-ku	The colorful and soft tone with pastel tone	Light Active

3. Evaluation Experiment

3.1 Summary

3.1.1 Adjectives for Evaluation

Through the image analysis in section 2, we extracted a total of following eleven adjectives ; [rural], [comfortable], [natural], [stable], [grave], [clear], [urban], [quiet], [subdued], [light], [active].

3.1.2 Experimental Factors and Objects

The experimental factors are the hue, value and chroma of color scheme classified by the harmonies. The objects were composed of 171 by means of the computer graphic. The following figure 1 is the example of objects.

Figure 1. The example of objects

3.1.3 Experimental Method and Subjects

Measuring scale is Semantic Differential method. The fact that colors are very sensitive to light let us to maintain stable illumination equally when the color palettes were made. Eleven adjectives in paragraph 3.1.1 were selected as evaluation words. Subjects were restricted to twenty-five architecture students who have perceptive ability for stable evaluation. The following table 3. shows the composition of the subjects.

Table 3. The composition of the subjects

Sex	Female : 13 Male : 12
Position	Graduate Students : 18 Senior Students : 7
Age	23 ~ 30
Total	25

3.2 Experimental Analysis

Data were analyzed by means of a statistical program SPSS/PC+. And the characteristics by color images were analyzed by using the multi regression.

3.3 Result

To analyze the visual effects of variables, we analyzed the color characters of color images on each harmony by using the multi regression.

The images of [light],[active] were affected by R,G,YR group of high value/low chroma in harmony with similarity, PB group of low chroma in harmony with hue, and G-Y-BG group of high value/low chroma in harmony with tone.

The images of [clear],[urban] were affected by PB group of high value/low chroma in harmony with similarity, PB group of low chroma in harmony with hue, PB-YR-B-BG group of high value/low chroma in harmony with tone, and cool or neutral color of high value in harmony with neutral color.

The images of [grave],[stable] were affected by PB,R,YR group of middle value/low chroma in harmony with similarity and PB, RP group of low chroma in harmony with hue.

The images of [quiet],[subdued] were affected by PB group of middle value/low chroma in harmony with similarity, PB group of low chroma in harmony with hue, and neutral color of high value in harmony with neutral color.

The images of [natural],[comfortable] were affected by R,YR,Y group of high value/low chroma in harmony with similarity, G,R,YR group of low chroma in harmony with hue, GY-PB-Y-YR group of high value/low chroma in harmony with tone, and warm color of middle value in harmony with neutral color.

Table 4. shows the effects of evaluation factors classified by image types. The quantity of the standardized categories represents how many estimating image types are influenced by each category.

Table 4. The effect table by image types

Harmony	Division factor	Categories	Light	Urban	Stable	Subdued	Rural
Similarity	Hue	R	[illegible]	0.157	[illegible]	0.150	[illegible]
		YR	0.253	0.198	0.219	0.191	0.506
		Y	0.103	-0.109	0.098	0.088	0.344
		GY	0.176	-0.391	-0.429	-0.596	-0.083
		G	0.295	0.057	-0.106	-0.185	0.042
		BG	-0.017	-0.498	-0.322	-0.336	-0.193
		B	-0.377	-0.115	-0.192	-0.023	-0.389
		PB	-0.480	0.425	0.318	0.580	-0.233
		P	0.100	0.102	0.003	0.039	-0.246
		RP	-0.152	-0.191	-0096	-0.221	-0.328
	Value	High	1.190	0.540	-0.008	-0.188	0.108
		Medium	-0.409	-0.164	0.120	0.180	0.078
		Low	-1.035	-0.500	-0.177	0.003	-0.253
	Chroma	Medium	0.009	-0.349	-0.505	-0.527	-0.304
		Low	-0.009	[illegible]	[illegible]	[illegible]	[illegible]
Hue	Hue	R	-0.410	-0.124	0.194	0.170	[illegible]
		YR	0.050	-0.244	-0.026	0.050	0.212
		Y	0.130	-0.304	-0.306	-0.430	-0.008
		GY	0.270	-0.264	-0.426	-0.470	-0.088
		G	0.190	0.076	0.194	0.190	0.412
		BG	-0.290	-0.204	0.034	0.110	-0.168
		B	-0.050	0.196	-0.066	0.050	-0.228
		PB	0.070	0.916	0.614	0.750	0.112
		P	-0.110	-0.184	-0.446	-0.510	-0.628
		RP	0.150	0.136	0.135	0.090	0.032
	Chroma	Medium	-0.070	-0.536	-0.678	-0.706	-0.404
		Low	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tone	Hue	PB,YR,B,BG	-0.143	0.200	0.024	0.149	0.180
		P,Y,PB,B	-0.076	-0.047	-0.052	0.050	0.053
		GY,PB,Y,YR	0.033	0.081	0.088	0.155	0.026
		BG,RP,G,GY	-0.118	-0.079	-0.102	-0.063	0.003
		G,Y,BG	0.244	-0.007	0.008	-0.024	-0.040
		B,G,PB	0.071	-0.080	-0.085	-0.224	-0.094
		R,P,YR	-0.063	0.026	0.082	0.070	-0.114
		YR,RP,Y	0.031	-0.107	-0.172	-0.217	-0.014
	Value	High	1.330	0.754	0.306	0.113	0.347
		Medium	-0.308	-0.230	-0.075	-0.004	-0.077
		Low	-0.938	-0.477	-0.212	-0.102	-0.249
	Chroma	Medium	-0.010	-0.306	-0.487	-0.523	-0.280
		Low	0.010	[illegible]	[illegible]	[illegible]	[illegible]
Neutral Color	Hue	Warm	0.124	-0.041	-0.073	-0.137	0.312
			-0.082	-0.162	-0.087	-0.133	0.022
		Cool	-0.116	0.236	0.053	0.140	-0.013
		Neutral	0.035	0.382	0.072	0.259	-0.095
	Value	High	0.101	0.015	-0.040	0.024	-0.030
		Medium	-0.051	-0.007	0.020	-0.012	0.060

(shaded cells) Hue > 0.2 Value > 0.0 Chroma > 0.0

4. Making a Color Palette

According to the above statements, the characteristics of color images were applied to the target image of each administrative area. The results were as follows.

Dong-ku is related with YR,R,Y group of high value/low chroma as images [comfortable], [pastoral], [natural]. Jung-ku is related with PB, R,YR group of middle value/low chroma as Images [grave], [stable]. Seo-ku is related with PB,N group of high value/low chroma as images [clear], [urban]. Yusung-ku is related with PB,B,N group of middle value/low chroma as images [quiet], [subdued]. Deduk-ku is related with R,G,YR,GY group of high value/middle chroma as images [light], [active].

The following is the color palette which suits the target images of each administrative area in Dae-jon.

1) Dong-ku

5R 7/4	5R 8/4	5R 9/2	7.5R 8/4	7.5R 9/2
10YR 8/2	10YR 8/4	10YR 9/1	10YR 9/2	10YR 9/4
2.5Y 8.5/2				

2) Jung-ku

5R 6/2	5R 7/2	5R 7/4	5R 8/1	
5YR 3/2	5YR 6/2	5YR 9/1		
7.5PB 4/2	7.5PB 5/2	7.5PB 7/2	10PB 9/1	10PB 9/2

3) Seo-ku

N9.5	N9	N8.5		
5PB 7/2	5PB 7/2	5PB 9/2	7.5PB 9/2	10PB 8/2

4) Yusung-ku

7.5YR 9/1	10YR 9/1	7.5B 4/2	7.5B 5/4	10B 7/2
2.5PB 7/2	2.5PB 9/2	5PB 9/2		
N9.5	N8.5	N7.25	N6.5	N5.5

5) Deduk-ku

2.5R 9/2	5R 9/1	7.5R 9/2		
2.5YR 8.5/4	5YR 9/4	5YR 9/2		
10G 8/2	10G 8.5/1	10G 9/1	10GY 9/2	2.5GY 8/2

5. Conclusion

In this study, we established Dae-jon's target images through image analysis, analyzed the color characteristics of the images by means of evaluation experiments, and finally made color palette suited the target images of Dae-jon's administrative area as a case study.

The color palette resulting from this study will be proposed to designers for their practical use.

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Color Factor in Environmental Effect Evaluation in Bursa

Nihal Cetinturk, Susan Habib

Abstract

Bursa is a city in the Marmara Region of Turkey, with an original and still vibrant historical/traditional color scheme. The city is famous for its silken textiles and high-quality, colorful ceramics (Iznik). According to one theory, the houses originally were not coated, because bricks, used as filling materials, were arranged in a decorative manner and such a careful decoration should not be covered by plaster. It seems, however, that during the 19th century Bursa houses started to be coated with different colors. This tradition continues until our time in many older neighborhoods, but in other new neighborhoods, new buildings follow the international fashions and individual tastes. The same can be said for architectural colors. Bursa, as in many other cities in Turkey, is losing its original urban texture and color scheme. Although life conditions have changed (life style, architecture, urban pattern), the traditional color scheme of a city is a historical phenomenon, and to develop a range of the traditional architectural colors of Bursa is a step towards binding the past and the future of the city. In our study, we will try to consider all information about colors, by which we mean colors of the natural and built environment, used in traditional civil architecture of Bursa, to objectively develop a range of paints in the architectural colors of the city.

Keywords: vernacular architecture, traditional color combination

1. Introduction

While the use of color in interiors may give clues about the owner or user of that space, the color of cities as a historical phenomenon discloses economical and environmental, social and cultural attributes of the residents of that city. Although the use of color in vernacular/traditional architectures all over the World seems to be a common facet, in fact the selection or combination of them are peculiar for their environment and region. Lois Swirn off compares traditional/vernacular colors with languages, local and specific to place, which arise in a particular environment, repeat over time and become a part of the public memory and express a human response to that environment.

Swirnoff writes: "The human impulse to embellish and enliven the surroundings appears to be universal." And continues: "Color usage in the habitat and immediate surroundings extends the sense of the individual's intimacy with the environment. The use of color in the city or place, however, is a collective expression. Extended to the urban field it no longer reflects personal or subjective choices; as it confers special identity to place it is a cultural marker."[1]

Today's technology provides countless paints, plasters, covering materials, etc., which do not belong to special places (regardless of trade marks and factories). These can be used in any part of the World, in any city, on any building. While the World Wide Web abolishes the borders between countries, and provides more chances to find common human attributes, there are still some differences peculiar to cultures, which have deep relationships with people who share the geography, history and traditions. At the same time today's rapid life necessitates rapid solutions to several needs. While proper answers must be found for these needs, historical and cultural values, which have had important roles in the formation of identity for each society, should not be overlooked. They not only belong to each specific society, but also to human kind's common history, nurturing our future. We perceive each city's

Dr. Nihal Cetinturk
Faculty Of Engineering & Architecture, Department Of Architecture, Maltepe, 06570 Ankara, TURKEY
Phone : + 90 312 230 74 00/2712 Fax : + 90 312 230 84 34
E-mail:nehal@mikasa.mmf.gazi.edu.tr

Susan Habib
6. Sokak 47/4, Bahcelievler 06500 Ankara, TURKEY
Phone : + 90 312 212 05 31 Fax : + 90 312 230 84 34
E-mail:Habibsuzan@hotmail.com
suzanh3003@yahoo.com

traditional/vernacular color scheme as a historical phenomenon, and so to develop a range of traditional/vernacular architectural colors would be a step to bind the past and the future of those cities. Bursa would be the first city with such a study in Turkey.

2. Bursa through History

The Bursa region has 5000 years of history. Early Bronze age (2500-2700 BC) ceramics were found during the excavations of nearby mounds. But the foundation date of Bursa, as a city, is not clearly known. According to the historian Strabon, Bursa was founded by Prusias, the king of Bithynia, who fought with Kroisos, the king of Lydia (~550 BC). Young Plinius, the governor of Bursa, at the reign of Traianus, the Roman Emperor has another story for the city's foundation. He claims that the city of Bursa (Prusia) was founded at the slopes of Uludag Mountain (Olympos Mysios) by the Carthageon king Hannibal II, to show his gratitude to Prusias I, the king of Bithynia who protected him against Scipio, the Roman commander of North Africa (232-192 BC). The city was quite developed in Roman Period. This development continued during the Byzantine period and the hot-spring baths of Cekirge (Pythia), a nearby district, had been visited by Theodora, the Queen of Byzantine. After seven years of siege by the Ottomans, in 1326 AD, the magistrate of the city surrendered the city in return for 30000 golden coins. In 1335 AD, Bursa became the second capital of the Ottoman Empire. During this period many great monuments such as mosques, madrasas, khans, hot-spring baths were built. Silk worm, silk cocoon, and woven silk were among the important productions of the city since Byzantine times, and flourished during the Ottoman Period.2 Today Bursa continues to produce very good quality silk clothes and carpets. World wide famous Iznik tiles of Ottoman period were produced in Iznik, a district of Bursa. The color richness of silk clothes was apparently reflected in Iznik tiles. The richness of this color scheme originates from the nature surrounding Bursa: Forests with different shades of greens and browns, fruit orchards with a variety of flowers in different colors accompanied with the human sensitivity were naturally reflected on the silks, tiles, and architecture, either monumental or civil.

Today Bursa is an important industrial center of Turkey. Many factories have been built around the city and inevitably the fruit orchards and greenness, which had brought the "Green" nickname for Bursa, are gradually disappearing.

3. Color Factor in Public Architecture of Bursa

Bursa's public buildings are mostly built of stone and brick. The colors of the materials along with other constructional materials such as mortar, timber, plaster, clay-roofing tile, and lead roof covering take part in the color composition of these buildings. These color combinations offset by blue tiles here and there are very impressive. Simultaneous contrast effect which "results from the fact that for any given color the eye simultaneously requires the complementary color, and generates it spontaneously if it is not already present"[3], can be easily seen on Muradiye Mosque's facade, where the orangish mortar used among stones of the walls in different gray tones causes them to appear bluish.

Color ornaments and tiles were not usually preferred on the exterior walls in the Ottoman architecture, but interiors were quite colorful. Ulu Camii of Bursa with its light grayish yellow stony exterior walls and brick minarets is one of these examples. Blue tile is usually used in small proportions on the exterior facades, as in Yesil Mosque (Green Mosque), however, Yesil Turbe (Green Tomb) covered extensively with its brilliant turquoise tiles on its facade is an exception. Interiors of the Ottoman public and house architectures are colorful.

4. Color Factor in House Architecture of Bursa

The plainness preferred by the Ottomans in public buildings was also reflected in civil architecture (or vice versa). Houses of Bursa, like other examples of Turkish house architecture in most regions, have timber structures with brick or stone used as filling materials (half-timber structure). According to Leman Tomsu, the writer of the book, "Bursa Evleri"(Houses of Bursa, 1950) houses were uncoated, because bricks, as filling materials, were arranged in a decorative manner and such a careful decoration should not be plastered.[4] Tomsu gave several details about the colors of ornaments in interiors (which has been more colorful than exteriors) but rarely wrote about the colors of the exterior walls. In spite of this, her notes on the colors of interiors produce clues to the colors of exteriors, because today we can see (similar colors, which she had mentioned for the interiors) on the facades. This is not surprising, as both the colors used in interiors and exteriors are made by the same natural earthy pigments. But Tomsu's approach reflects the general tendency of her period, because Turkish architects were acquainted with Modern architecture and its deny of ornament and color.

In 1985, thirty-five years after Tomsu's book was published, Maggie Quigley described color and asymmetry as typical characteristics of Bursa traditional house architecture.[5] One can easily find the characteristics mentioned by Quigley in houses built in the Hisar region (around the citadel) during the 19th century.

Although, a large number of houses in Bursa were damaged and many restored examples covered with white plasters, walking through Bursa's colorful streets (in older neighborhoods) is still an enjoyable experience. In our last visit to Bursa in June 2000, we observed that the tendency to use white in restorations has changed and more houses were restored or renovated in colors similar to the traditional ones. Such applications may be done with good intention, but at the same time, they could be dangerous, since the similarities are limited by the use of, for example a yellowish paint, commercially produced rather than one of the yellow ocher tones, originally used in traditional/vernacular houses.

Therefore, creating a color map of Bursa for restoration, renovation studies would be helpful to avoid such misleading applications. It should be developed fastidiously. Developments of taste and color schemes over different periods of the city should also be considered.

As there are very limited sources on house architecture of Bursa (and generally on vernacular architecture from earlier times in Turkey), we have to rely on available sources. If we accept Tomsu's theory, we can imagine a homogenous town view with natural colors of stone, brick, and timber with tiny touches of color, in both public and house architectures. However, since having decorative facades with brick was an expensive application, only a minority could afford it. Others had to use brick or mud-brick, or cut-stone and rubble as filling material and cover them with plaster, either in white or in other chromatic color. So, although the color scheme, which can be estimated by Tomsu's notes, can be accepted for a period in some regions of Bursa, it would not be universal. Over time, aging, changes and developments of taste, or other needs might have caused more colorful facades to emerge.

Although there are only one or two examples (according to some sources) from 17'th or 18'th century, and the existing ones remain from last years of the 19th and first years of the 20'th century, some black and white photographs of the 1880's show plaster on facades and different gray tones of them can be taken to reflect different colors. Other photographs show the use of tile in small areas on buildings and shops. At the same time, we talked with some old people who remember younger faces of the houses and buildings, which nowadays we can see and describe them as "old". Their memories of bursa are colorful.

Ancient Plane trees are seen in almost every old region of Bursa, and walking in streets of these regions with the smell of Linden tree flowers, especially in June, is a wonderful experience. Bursa is also famous for peaches and other fruits, which have caused the city to have a agricultural-based industry (although nowadays it has changed to the automotive industry). We believe that the colorful nature of Bursa, the green background color of its environs; the manufacturing colorful silk goods, which have been one of the main economical sources of Bursa; and the colorful Iznik tiles produced in one of its districts, all have important impacts on the collective memory of the people of Bursa, and are reflected on the facades and interiors of house architecture of the city.

Houses of Bursa have generally two stories. The first floor facades of houses are coated with various tones of indigo blue (civit mavisi), yellow and red ocher's (asi boyasi), white, green and black. The predominance of yellow ocher tones and indigo blues draws attention to the facades. Usually, stones are used for basements, ground floor and the walls of gardens (courtyards). Nowadays, however, these stones are covered, usually, by red ocher or black paint. In some cases the whole facade is covered by plaster, so the different uses of building materials can not be seen.

Usually (or almost always), a timber beam divides ground and first floors. While, new surface colors of these may vary, originally timber beams and either plain or ornamental timber buttresses remain with their natural colors (with the slivery brown color of the timber patina).

Originally, doors, windows and other timber architectonic elements were not painted, but recently, in order to prevent deterioration and aging, these were painted by brown tones of oil paint (close to the natural color of timber). But a light green paint (probably earthy) is seen on doors and windows of some of the older houses. Also some imitations of this green, by oil paint, are seen on more recent painted widows and doors. Some believe that this green color shows that the owner of the house has completed the pilgrimage to Mecca.

Several samples of plasters, paints of doors and windows or wooden parts with their natural colors, and clay roofing tiles with samples of leaves and seasonal flowers of trees and plants of the region were gathered. Meanwhile, many slides were taken of either each house, or their locations and relations with neighbor houses, or details of colors of different architectural elements. Both paint samples and slides were used to form the main structure of bursa's color map to be used in architectural and chromatic restorations and renovations.

Perhaps, color in the townscape is the architectural element that has been most overlooked and taken for granted, because it is always around us and we can not imagine a world without color, just as we can not imagine life without air or oxygen. We recognize it only when something is wrong with it. The same can be said for color.

While permanence was a factor considered in both building materials and color schemes of the monumental or public buildings (especially in mosques and other religious buildings), being temporary of both of them in civil architecture attracts attention. This attribute seems to be common in many Islamic cities, originating from the idea of eternity of God against mortality of temporal and mundane world. Therefore, glazed tile with its constant color stands in front of natural or earthy paints coating the houses. And that brings difficulties in estimation of colors in house architecture. So, the available sources such as existing houses with their color schemes, new combinations painted by the users of those houses, paintings remain from native painters and the colors those remain in the collective memory and taste are helpful to form the color map of the city. Visual parts of our study would be seen in our poster presentation.

5. Conclusion

Cities of our age are losing the human scale, historical facets, and psychological contacts with the individuals, local cultures and societies.

While proper solutions should be found for new problems and necessities, some needs have not changed and remain as they had been before. Some of these are humane needs, which if they are not been met, may cause psychological and social problems. Color is a powerful means to catch the human scale, to define ideas and reflect many aspects of individuals and societies. Traditional/vernacular architectures belong to their regions and have their own color languages, reflecting many aspects of the society, cultures, traditions, climate, etc. which have passed through the filter of history. Therefore, cities with their own historical color scheme have deep relationships with the people sharing that history and culture. New technology may bring new facilities into architectural and urban world, but some bonds, which relate the society to their history, should not be overlooked. And color maps of cities with peculiar color schemes are one of the means binding past, present and future of them.

While many examples of traditional/vernacular architecture in Bursa have been lost, the existent ones are still showing the main structure of the cities color scheme. In this study (paper and poster) this color scheme of Bursa has been determined in order to establish a base for architectural and chromatic restorations and renovations.

Acknowledgement

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Characteristics of Environmental Colors and Costume Colors in Theme Park

Nahm Il-Kyung, Kim Young-In

Abstract

The aim of this study is to present the color palette for Dae-jon's exterior color planning through image analysis as a case study. This study was composed of four steps, and was carried out as follows. First, the existing architectures and natural environment in Dae-jon were surveyed and the target images of each district were established by analyzing the results of the surveys. For analyzing color characteristics by image types, the evaluation experiments were performed by using computer graphic. Finally, the practical color palette for planning was made on the basis of the color characteristic analysis.

Keywords: Theme Park Costume, theme park, Festival World, color, color image

1. Introduction

There are a lot of design elements to visualize the specific theme of theme park such as architectural style, the external images of attractions, landscape and etc. But the Theme Park Costume is the most direct communicator to let the visitors know its specific theme. The importance of Theme Park Costume has been perceived in Disney Theme Parks, thus the total plans about its theme, color, silhouette, fabric, management manual and etc. have been set up in their own way since the master plan was established.

But in case of Korea, there have been neither preceded studies about Theme Park Costume at all, nor the general understanding of its importance.

In this paper, the concept of Theme Park Costume was established, and the color characteristics of theme parks-Everland Festival World, Tokyo Disneyland, and Disneyland Paris - were analyzed. Especially the whole service areas were regarded as stages, employees as casts, and uniforms as stage costumes in Everland Festival World to take a great leap forward theme park.

2. Methods

To establish the concept of Theme Park Costume, the documentary studies related to stage costume, uniform, theme park were performed, and the contents for the characteristics and roles of Theme Park Costume which researcher have acquired through the occupation of Costume Designer in Everland Festival World were collected.

The color characteristics of theme park were analyzed with the costume colors and environmental colors which were used in Everland Festival World, Tokyo Disneyland, and Disneyland Paris. The environmental colors were set limits to the colors of artificial environment (Y.J. Kim 1997, 27-32), such as facilities, attractions, street furniture in theme park except those of natural environment

To analyze the features of costume colors and environmental colors in theme park, the comparison has been made between the colors of costumes, facilities, attractions in Festival World and COS (Color System). The colors of costumes, facilities, attractions in Tokyo Disneyland and Disneyland Paris were initially compared with DIC Color Guide, based on the photographs that were taken by researcher with the memory colors, and then converted to COS.

3. Results

3.1 Characteristics of Theme Park and Theme Park Costume

Theme park is an outcome created by human ideas and imaginations, which means creative space where attractions, facilities, event programs, and characters are arranged in accordance with the specific theme (J. H. Lee, J. K. Kim 1996, 128).

The focus of theme park is to conceptualize theme

Nahm Il-Kyung
The Graduate School of Human Environmental Sciences, Yonsei University
YONSEI UNIVERSITY 134 SHINCHON-DONG, SODAEMUN-KU SEOUL 120-749
Phone : +82-31-320-8677
Fax : +82-31-320-9798
E-mail : basic@unitel.co.kr

distinctively, and to let visitors revisit again and again by making their imagination richly and impressing their minds deeply (Masami Ito 1995, 8-9). The true meaning of theme park can be realized when the human nature and generality rather than the shallow entertainment are pursued in conceptualizing the theme and enhancing an atmospheric condition.

Theme Park Costume is the most direct communicator to let the visitors know the theme of each theme area among the various design elements. It is of mixed concept of stage costume and uniform. It is not only a creative artwork to visualize the specific theme as a stage costume, but it can also satisfy employees considering the working conditions and seasonal factors in terms of uniform. Eventually it can make the employees serve the customers in their best conditions.

Theme Park Costume also plays an important role of building an image for space, and contributes to the completion of space art, creating style by expressing and analyzing entire environment. Theme Park Costume is not meaningful by itself. Whereas it is put on the cast who perform Theme Service, its characteristics and atmosphere can be made up.

3.2 Color Characteristics of Theme Park

The distributions of costume colors and environmental colors in all theme parks were shown in <Figure 1> and <Figure 2>. The distributions of colors were mostly shown in warm colors like Yellow-Red, Red, Yellow and partially in Blue, Blue-Green. But the features of tones were characterized quite differently. Tones of costume colors were mostly shown in middle and high chroma such as strong and dull tones, but environmental colors were in middle and low chroma such as dull, soft and pale tones. In case of Disneyland Paris the difference of color distribution appeared in value rather than in chroma. Costume colors are mostly shown in middle and low value and environmental colors in middle and high value.

Eventually as an environmental factor, Theme Park Costume stands out clearly from the environment, harmonizing with it.

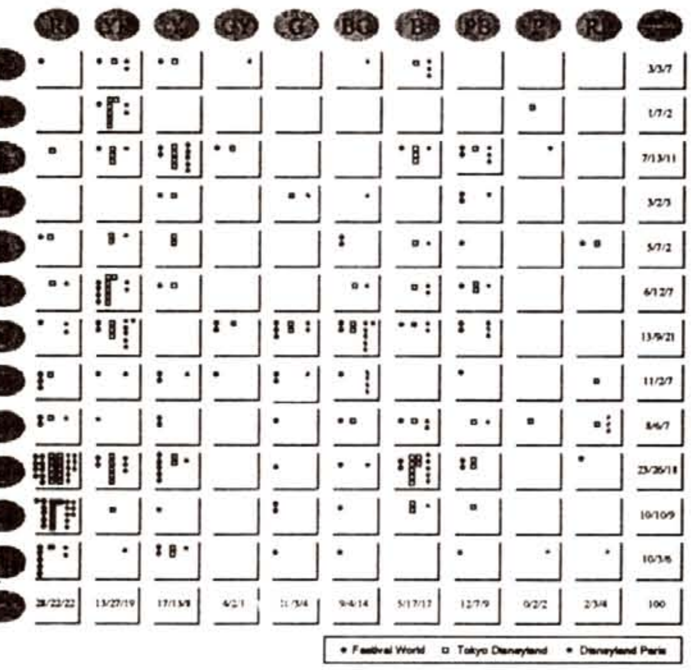

Figure 1. The distributions of costume colors

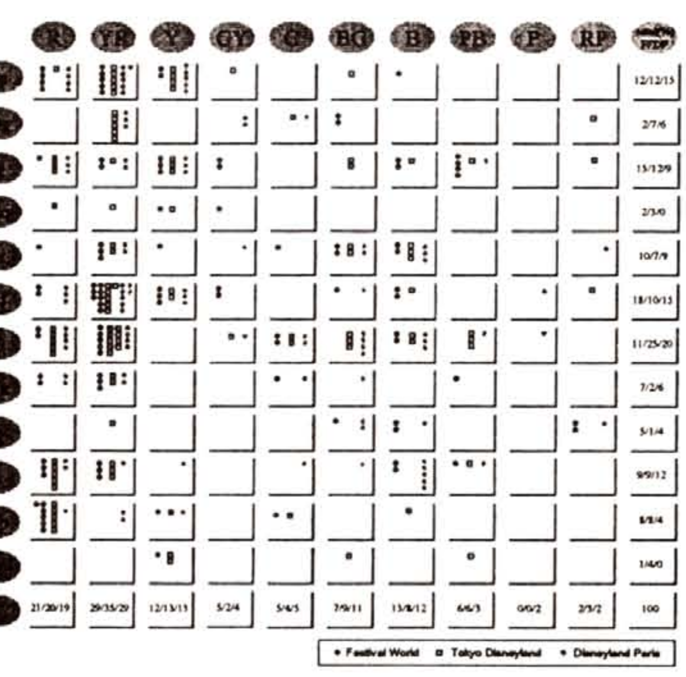

Figure 2. The distributions of environmental colors

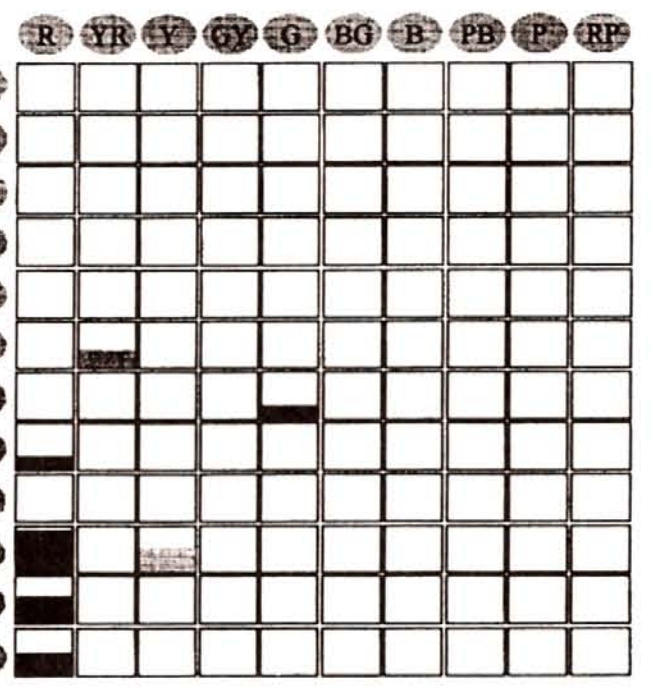

Figure 3. The costume color palette for Everland FastivalWorld

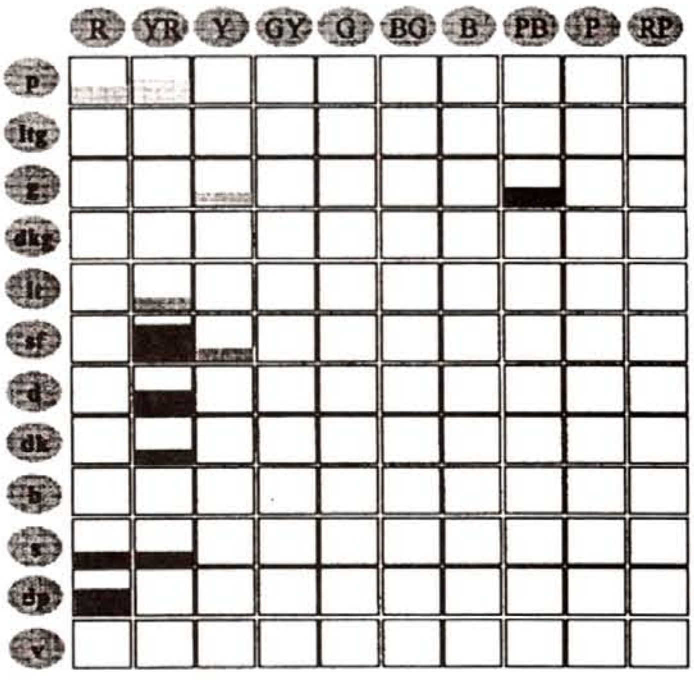

Figure 4. The environmental color palette for Everland Festival World

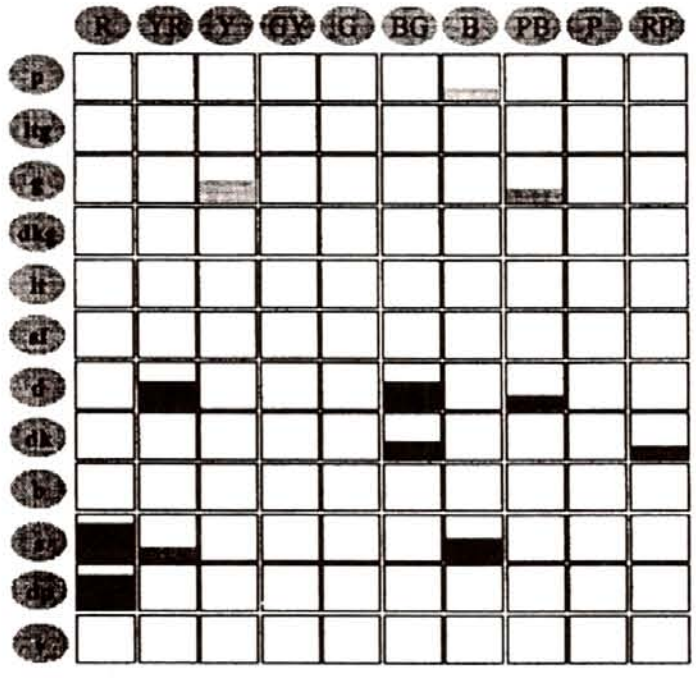

Figure 7. The costume color palette for Disneyland Paris

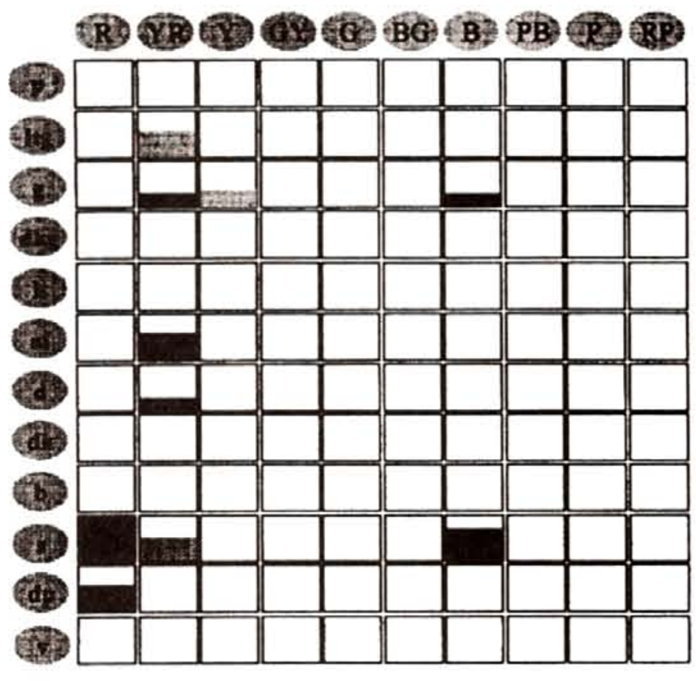

Figure 5. The costume color palette for Tokyo Disneyland

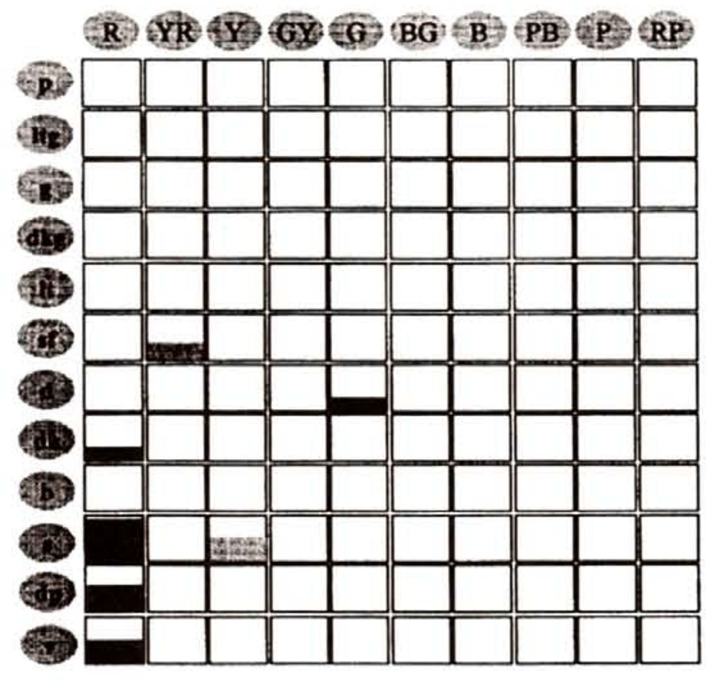

Figure 8. The environmental color palette for Disneyland Paris

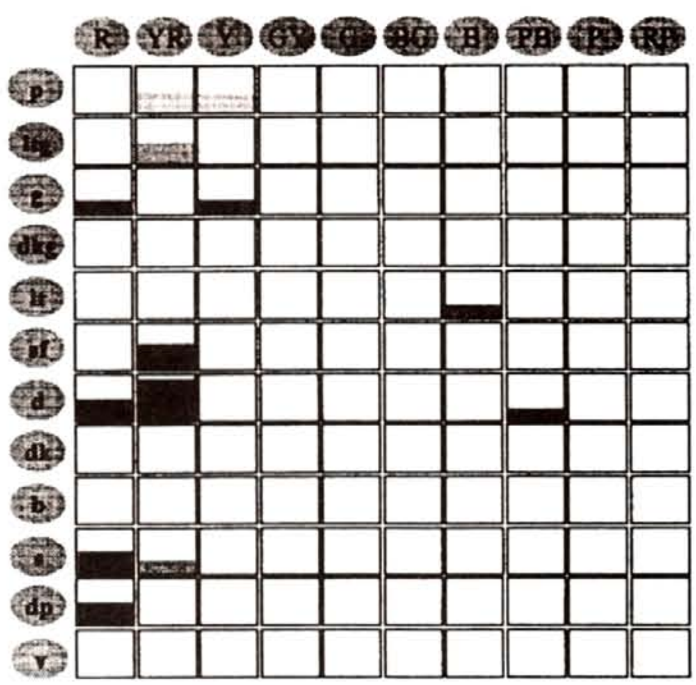

Figure 6. The environmental color palette for Tokyo Disneyland

<**Figure 3**>to<**Figure 8**> show the color palettes which were mainly used for Everland Festival World, Tokyo Disneyland, and Disneyland Paris.

Table 1. The grouping of theme area by its thematic nature

Theme	Festival World	Tokyo Disneyland	Disneyland Paris
Bazaar	Global Fair	World Bazaar	Main Street, U.S.A.
Adventure	Equatorial Adventure	Adventureland	Adventureland
Western	American Adventure	Westernland	Frontierland
Fantasy	Magic Land	Fantasyland	Fantasyland
Space/Future	-	Tomorrowland	Discoveryland

<**Table 1**> show 5 thematic categories by grouping similar theme areas in Everland Festival World, Tokyo Disenyland, and Disneyland Paris.

The color characteristics of theme areas in Tokyo Disneyland, Disneyland Paris and Festival World were analyzed by their thematic natures, such as:

- Bazaar: The main color distributions were especially in Yellow-Red, Red, Yellow and partially in Blue-Green, Purple-Blue and Blue. Dark tone was used appropriately to symbolize the classical and noble image.

- Adventure: Warm colors such as Yellow-Red, Red, Yellow and dull, grayish, soft tones were most widely shown, using strong tone as an emphasis.
- Western: Yellow-Red color group and dull, soft tones were dominantly used, and strong tone was also used to express the theme.
- Fantasy: It was proposed to use Blue, Blue-Green, Purple-Blue color groups and dull, grayish, soft tones with strong, bright tones as an emphasis to symbolize the theme effectively.
- Space and Future: Silver was mainly used with primary colors in Tokyo Disneyland, but Gold was widely shown with subdued tones to visualize the ancient and old-fashioned Future images in Disneyland Paris. It is distinctly noted that Disneyland Paris was well characterized its cultural identity based on its long-lasting history and traditions differentiated from that of, for example, Tokyo Disneyland in its custom of color selection.

4. Conclusion

Because Festival World was not a perfect theme park like Disney but a growing-up theme park and most theme areas had more than 2 themes mixed, the color distributions of each theme area were ambiguous unlike Disney. Although there was no intensive color planning which Disney does very carefully for several years, the general color distributions of costume colors and environmental colors in Festival World were similar to those of Disney. In use of colors expressing the specific theme of each theme area, the composition of theme and environment itself were not same to those of Disney, so the color distributions in Festival World is not same. But in spite of all the differences as described the costume colors and environmental colors in each theme area in Festival World were well harmonized with its theme image. Finally each theme park utilized the colors positively as the principal solutions to express the unique theme images.

This research will contribute to theorize the concept of Theme Park Costume which research activities have never been carried out in Korea. It can also be used as useful data to the companies planning theme park in making a scheme about entire color planning, and will expand the field of uniform by regarding uniform as an element of environment.

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The Tree of Life : First Chromatic Sculpture Powered by Solar Energy: Contemporary Example of Color Design in the Environment

Silvia Rizzo

Abstract

A retraining on color is fundamental if we really believe in the need of people for a more complete inner balance and a more positive life in "gray and anonymous" environments.

The subject matter of my paper is based on contents rooted in the historical culture of city spaces in Genoa, the city where I live. Genoa, by tradition, has always been a "chromatic city on the sea". Its ancient splendor came in the past from its climate and special light.

A project for chromatic reconstruction is currently in progress. Some old palaces have already been individually restored. However, owing to the sensitivity of the Department for City Quality of the Municipality of Genoa, through the restoration of all the buildings along a semi-elliptical route overlooking the waterfront (the old Ripa Maris built from the 12th century), the entire area will resume its original colors.

With regard to my personal research work on color design and the environment, in addition to previous aesthetic interventions to highlight the various frescoes on the facades of ancient buildings and the reconstruction of related drawings through color, today my work focuses on contemporary design to make our city habitat richer. Within this line, I also designed the "Playground of colors" and I devised a new teaching method "Play with your Eyes", etc. aiming at a re-training on colour in its widest sense; color which is part of life and our daily environment, like a bridge between color design in the past and in the present.

This latter color-design project of the first sculpture powered by solar energy falls within this line. "The Tree of Life", to which I have collaborated, was designed by Alessandro Picasso, a young artist and student at the School for Architecture of the University of Genoa.

Keywords: color design, retraining on color, chromatic city, sun-powered sculpture

1. Introduction

Reflecting on the role of the environment and its liveability is becoming an ever more important issue in today's context.

While the topic of contemporary cities with their communication and information systems, multimedia and technological development is being debated, environment-related issues acquire ever more topical value together with discussions on sustainable life systems and on the quality of life.

There are also discussions about the philosophy of metabolism "for a future creativity in response to ideas found in nature".

The conference on "Color and the Environment" is indeed the right context to discuss the role of color in a life of confused perceptions, of sensitivities that are at a loss and unconsciously deprived.

2. Aims

Re-education to color is indeed one of the several routes that can be followed in order to develop a more humane existence, which is more aware of the surrounding world. Re-appropriation of color is therefore an element of cultural evolution for a more harmonious and sensitive relationship with the environment. Hence, it is the responsibility of scientists and industry members to investigate and communicate new directions for research towards

Silvia Rizzo
Liceo Artistico Barabino, Genova
Via Mogadiscio 2A/7, 16141 Genova, Italy
Phone : +0039-010-8362185
F a x : +0039-010-5305169
e-mail : gsonnewa@tin.it

wider perception spaces, in order to identify what is still unexpressed, suggestive, and exciting in the field of color.

Aesthetic operators side by side with scientists may contribute to a richer exploration in the use of color in innovative circumstances, in order to stimulate sensitivity to colors.

3. Contents

Through my personal artistic research, I have found new suggestions as to the useful employment, for public use, of significant examples describing the cultural topicality of the aesthetic role of color in both a historical and contemporary context.

Sculpture, or rather contemporary "tensisculpture"- a word made up for this unique type of work "The Tree of Life", namely an innovative example of color design, being the first sun-powered chromatic sculpture - is the specific subject of my paper at this conference. However, it is essential to give some background information on the more general environmental context in the city of Genoa, where I live, by quoting a major example of color restitution design, originating out of the sensitivity and decision of the Department for City Quality of the Municipality of Genoa, jointly with the School of Architecture of the University of Genoa, and a few public and private institutions.

The project refers to an ancient group of historical, 12th century palaces stretching along a semi-elliptical route overlooking the waterfront.

Following the rationale of this conservative restoration project of Ripa Maris (by architects Mantero and Salvarani), all facades shall be reconstructed resuming their original colors which used to distinguish the various palaces in an elegant, bright way. This color-design follows a historical environmental tradition, where the dynamic series of different colors, the importance of light, the presence of the sea were all considered through a careful and sensitive design.

This reconstruction is going to return to the city all its lost colors.

In the restoration design, warm colors alternate with paler, amber-like hues, while bright red and green colors will be offering a color articulation to the series of palaces.

Therefore, we will be able to experience again this encounter between colors and the sea, which will change the color shades by means of its natural light, depending on the time and the weather. All this falls in line with Genoa's unique tradition of Painted Facades.

With regard to my personal artistic research work on color design and the environment, through the in-depth analysis of the Painted Facades theme, I have devised color signals on frescoes worn-out by time and I have redesigned the shapes and images according to a process that I have called "chromographic system on the time dimension of color".

Today my work focuses on contemporary design to make our city habitat richer. For this reason, I have designed the "Playground of colors" and devised a new teaching method "Play with your Eyes", etc. aiming at a re-training on color in its widest sense; color which is part of life and our daily environment, like a bridge between color design in the past and in the present.

And the color-design product of the first sculpture powered by solar energy is the latest outcome of my research. **"The Tree of Life"**, to which I have collaborated, was designed by Alessandro Picasso, a young artist and student at the School for Architecture of the University of Genoa.

The 4.5 m high sculpture has since March 2000 been located in the Porto Antico(Old Port) area.

Horizontal shapes, like colored signals, interspersed with other aluminum shapes are vertically interconnected and revolve around an axis, powered by photovoltaic solar panels, which changes depending on the weather, the time, and the season. The entire assembly is contained inside a steel structure. A point of dynamic attention is thus created in the environment by means of an ever changing perceptive motion. The design, despite its minimalist nature, acquires variability and vitality by reflecting environmental light. Owing to the essential nature of its color design shapes and the direct involvement of solar energy, the sculpture is projected as a shape of the future, through its visual information within the environment, as well as with the ethical and poetic content of the solar energy which powers its motion.

The sculpture, which has become a meeting point, draws the attention of both adults and children and develops their aesthetic imagination of color and scientific awareness.

4. Results

4.1 Color Design and Movement

The Tree of Life can be considered as an innovative form of color-design, with special cultural and ethical meanings related to the environment. It features new, more complex and synergistic forms of color perception (color+movement+outdoor environment).

Indeed, the color-shapes which are of bright and "saturated" red, green, yellow and blue colors, cannot exist (visually) without the energy which is moving them. They are interspersed with metallic plates which reflect light like shining interferences. They thus become a dynamic point in the landscape, a DNA-shaped signal system which changes perceptions depending on the weather and the time of the day, following the mere changes in the blue color of the sky.

This structure is for public enjoyment and, through its deliberate simplicity, it acquires value by providing a form of almost educational communication. And yet, through the movement of colors, it stirs up some unconscious psychological reaction, and a desire for some, actually absent, resonance.

4.2 The Role of Energy

The movement obtained with solar energy is synchronous with an ethical environmental approach. Photovoltaic solar panels are linked to a simple revolving mechanism. Hence, alternative energy for the first time ever is linked to an aesthetic form in color-design. It becomes the symbol of a specific approach and of a message promoting greater attention to the quality of life. The author expresses this idea in the following way: "Just like trees in nature need the sun to grow and develop, the "Tree of Life" - a structure that has been designed and manufactured - acquires its symbolic *raison d'etre* through the same energy of the sun".

4.3 The Civil Importance of "The tree of life"

This "tensisculpture" is dedicated to the European Union in synergy with all the other world nations. It was promoted by the Department for City Quality and by the Department for Polycentric and Educational city of the Municipality of Genoa, as well as by the European Council of Regione Liguria under the Patronage of the European Commission in Italy. For its ethical-cultural value, it has also obtained the patronage of Unesco National Commission in Rome. The "Technology project for solar energy photovoltaic panels" was realized by A.N.I.T. This sculpture was received and located by the "Porto Antico S.p.A." in front of "Magazzini del Cotone".

5. Conclusion

The previously mentioned examples, although deliberately very different in time and nature, are consistently linked to the visual features of the environment to which they refer. The color project becomes a common expressive subject determining its role and functions along routes that are very close to art and the history of art. Contents are being developed with new complex expressions and implications for perception: they are not an end in themselves, but rather aimed at the social sphere. For example, by getting to know and experiencing again the urban culture of the past through color or venturing in a creative way into the contemporary ar' of a spatial, chromatic and "solar" sculpture.

These suggestions are useful in order to get used again to appreciating the topical features of color, not only as a need of our senses, but also in the awareness of its ethical result in terms of care for life and the environment, by starting from its aesthetic design.

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Colours Fallen from Heaven

Yves Charnay

Abstract

<Colours fallen from heaven> is the title of an environmental creation which uses a particular lighting device.

The site is a baroque chapel which has now become the concert hall of the Music School of Apt, a town in France.

One of the properties of the works realized with this device is to be set in front of openings such as stained-glass windows. They take part in the expression of an architecture. In some versions, the lighting is composed of one or several sources of artificial light.

1. A Site

Formerly set in the HÙtel Dieu, the chapel appeared as a peaceful island in an ocean of pain.

The pain rattle and the cries of despair that carried away the sick to their tragic ends have fallen silent.

The complaints and moanings have been replaced by trills of new voices with incertain tones. The nuns and doctors have let their places to teachers and conductors. The prayers have made way for music. Hesitant at first, music now, asserts itself, carried by the splendour of trumpets, the warm sound of clarinets or the murmurs of cellos. Highest reward given to those who have come to an agreemnent : express together, in a concert, a found harmony.

2. Aesthetics

Baroque light is multiform : radiating or diffuse, soft or insistent, warm or cold. Sometimes bright and direct as beams of theatre spotlights, the rays of sunlight, in which golden dusts sparkle, pierce through the openings of a dome. Or as if diffracted by the bumps in the architecture, the light bounces in cascades on the walls splashing them with colurs.

On the ceilings and walls God, the saints, men and angels often hail each other amidst a proliferating mineral vegetation. The memory of these vanished figures still watches over the glorious universe of their origins. Colours send us back the echo of disappeared chorus, ultimate harmonies as well as the memory of all the voices of the music instruments which have formed our taste since centuries.

3. An Expression

Colours fallen from heaven plays with the empty space of the chapel to shape the light which floods it into coloured reflections. Whether discreet or intense, the light reflects on the ceiling and the walls a multitude of enveloping and diffuse nuances which clothe the edifice in velvet shades.

In the light specific to each season, the scenographist-sun dramatizes space. The cycle of the daily variations of the sun sets the quality of light. The intensity of the lighting is modulated by the flows of the clouds. The baroque edifice, a medium between men and cosmos, plays whimsical meteorological scores in which the moods of our star are transcribed.

Then the vault of the edifice, echoing the vault of heaven, matches its tones with those of heaven.

4. Reflections

The lighting device metamorphoses the aspect of heavy and opaque materials such as stone, wood or iron. It endows the architecture with a sense of lightness and immateriality.

The transmission of colour through the reflection of light presents a high plastic interest. My studies on the properties of diffuse reflection gave birth to works called 《Solar Sculptures》. The materials used for these works are quite varied, wood, plaster, metal or concrete. The choice of the materials depends on the site whether it is an open site or not, whether it is protected from bad weather or not. The shapes are linked to the quantity of sunshine and to the axis of vision. The shapes and the ways of assembling are determined by the management of the axes of reflection.

The mixtures of colours change according to the angle of incidence of light. The tone and the brightness of the colours evolve during the day.

Yves Charnay
3 Rue d'Aboukir, 75002, Paris, France
e-mail : ycharnay@chub-internet.fr

Color Philosophy in Korea

Kim, Ok Hyun

Abstract

In korea, we can see the mental world of the significance given to the philosophical principle of colors that cannot seen in the western culture.For example, when selecting only two colors blue and red is selected.

As seen in the Taeguk ideas of the Taeguk flag - the national flag of korea- and wedding gift, red signifies sky and blue signifies the earth. This is based on the principle of Yang and Yin. When selecting three colors like on Daesamjak Norigae - traditional body ornament- blue, yellow, and red is used. The red stands for sky, blue for the earth and the yellow stands for human.When choosing 5 colors, besides red, yellow and blue, black and white are added. These colors are the five directional colors of the Five Ways of the Yin and Yang that signify the harmony of creation and decline. These colors and principles apply to Saekdong fabrics. This preference for bright colors shows the other emotional color of korean people. Our ancestors applied not only beauty, but also meaning on their formative arts and the color.

1. Introduction

Korean has always been fond of the simplicity of achromatic color and the cleanliness of pure white, for which korea was named "the white-clad race". Accordingly the korean thought that something on colors was undignified. Even today, koreans are inclined about their ancestors, saying that they liked white color and were dressed in white delightfully.

Geographic environment, was a factor for koreans to be fond of in the nature and to prefer non-saturated colors like white and gray.

In contrast to the white color effect of our ancestors, bright colors of Saekdong are used on national holiday clothes, clothes that wish great happiness, and also in many items used in everyday life. This preference for bright colors shows the other emotional side of Korean. We can see the mental world of the philosophical significance of colors that is not well known in western culture. In the East, color does not only mean the beauty of color itself but is combined with many philosophical ideas.

2. Aesthetic Character of Color

The traditional color view of our nation is rooted in the idea formulation of the blue and red Taeguk ideas of Korea and the universal view focuses on culture built independently according to the given conditions of our natural features, climate, economy and culture. Korea has beautiful scenery and four distinct seasons. When they use colors in daily life, they usually select korean-style colors. It is deep-rooted habit inherited from ancestors.

3. Philosophical Background

*Taeguk ; red, blue - For example, when selecting only two colors, blue and red are used. As seen in the Taeguk idea (the Great Absolute in korean philosophy) of the Taeguk flag (the national flag of korea). Koreans also like to use blue and red for wedding colors. Red signifies man, sky and Yang. Blue signifies woman, earth and Yin.

**Dae-samjak norigae ; red, blue, yellow - When selecting only three colors, blue, red and yellow are used. For example, Dae samjak Norigae, traditional body ornaments are made as jewelry ornaments in jade, amber and coral. The red coral stands for sky, blue jade for the earth and the yellow amber stands for humans.

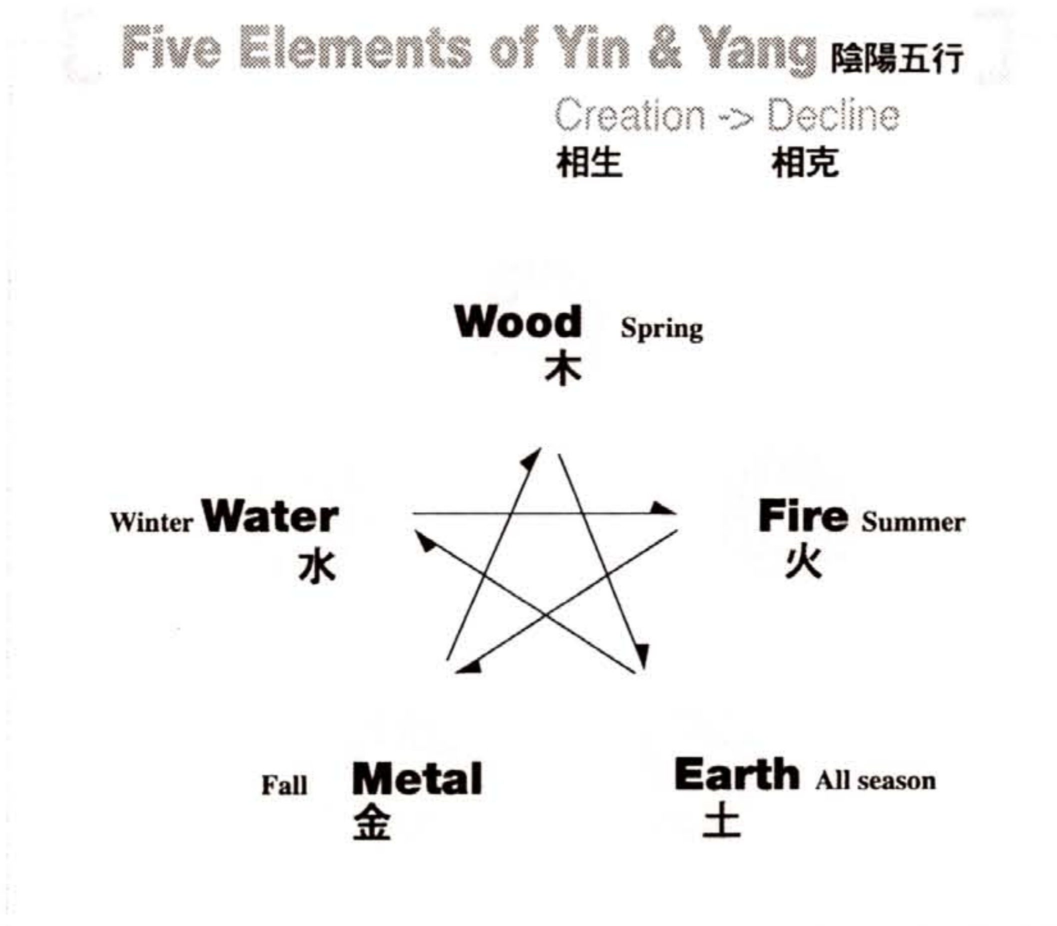
***Obang color ; red, blue, yellow, white, black - When choosing 5 colors, besides red, blue and yellow, black and white are added. These colors are the five directional colors of the Five ways of the Yin and Yang that signify the harmony of creation and decline. These colors and principles apply to Saekdong fabrics.

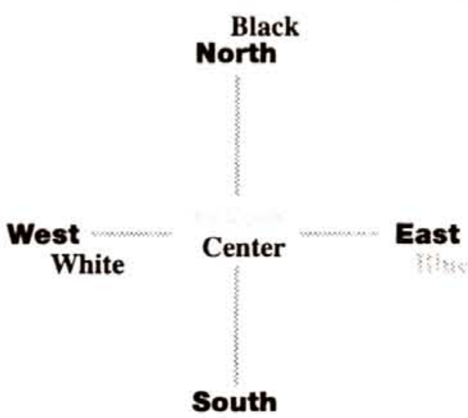
Kim, Ok Hyun
Dongduck women's University
Sungbuk-gu, weolgok-dong, 23-1, seoul, korea
e-mail : okeekim66@yahoo.co.kr

4. History and Symbolic Significance of Saekdong

Saekdong was made by connecting pieces of primary - colored cloth in various colors-order by the women of the old times. They gathered all the remnant fabric together to come up with beautiful saekdong. It is used on children's clothes and as decorations in objects used on daily life. Saekdong was used as a typical patch work in Korean garments. The skirt worn by the noble lady in the murals of Susanri and Dukhungri of the Koryo Dynasty, is expressed with different colors in each pleats which reminds of Saekdong. The murals of Susanri tomb is a very important historical material as it shows the fashion trend of Koryo Dynasty through which we are able to conclude that Korea and Japan had good relations.

Saekdong is a korean stripe color pattern in use since the Koryo - 1500 years ago. Saekdong fabrics represent the unique color harmony in korean culture and for festive occasions shows happiness through the use of manu colors.Traditionally Saekdong colors were patched together on stripes with remnant fabrics on red, blue, yellow, black and white. In ancient time, korean ancestor-women made new material by recycling. The color rhythm is the repetition of units of a certain number of colors. In a color rhythm as whole and as a unit m the same colors are repeated, This is the rhythm of Saeksong color. However, Saeksong is not just repetition of certain beautiful colors, but has philosophical symbolism. The color combinations and arrangements of Saekdong are made according to concepts of creation and decline in the Yin and Yang principle and the Five element Theory. The





Obang means 5 directional color (Blue, Red, Yellow, White, Black)

The color combinations and arrangements of Seakdong are made according to the concepts of creation and decline in the Yin and Yang Principle and the Five Element Theory.

arrangement of colors signifies that the universe is cooperation and harmony for long life, luck and happiness so it is used for making clothes for holidays and special occasions.

5. Saekdong Color with Natural Dyeing

Before the present of artificial dyes in 1856, all the relics used as the research object is considered to be dyed with the natural dyes. Generally dyeing from the natural dyes has a disadvantage of having a low color fading or color revival, buy the color is very sophisticated, natural and noble.Studying about the natural objects where our ancestors acquired Saekdong colors from, will allow us to define the artistic characteristics of Saekdong as korean traditional color.

Saekdong with natural Dye

COLOR	Plants or Roots	Mordant	Color
Reddish Dyeing	Safflower	Fruits of Schisandra Chinensis	Red
	Redwood	Alum Venegar Iron Venegar Salt	Red Yellow Violet Red Brown
Bluish Dyeing	Indigo	Lime, Lye Iron Venegar	Blue Dark Blue
Yellowish Dyeing	Gardenia	Lye, alum	Dark Yellow
	Turmeric	Lime Lye	Amber Red
	Gold Thread	Alum Lime	Yellow Greenish Brown

Natural Dying of Saekdong Color

When analysing the colors used in the old Saekdong color fabrics from Korean heritage, the colors may look faded due to the lapse of time, but in fact they were dyed with natural dyes.

That is why those colors with high brightness and low saturation are considered sophisticated and noble colors.

However, today's Korean Saekdong fabrics are composed of strong colors with high saturation.

This makes us realize that the current Saekdong fabrics sold in the marketplace consist of incorrectly-used colors.

We have to do consistent research about natural dyeing and natural mordants.

And we have to revive the old Saekdong fabric colors.

6. Conclusion

This study focused on korean traditional color philosophy. It is a trial of recovering korean traditional beauty find the internal beauty to find the internal and external meaning of color It is also known as the color of korea where our ancestors' formative arts and the color effect are artistically submitted. Thus korea is fond of the simplicity of achromatic color and the cleanliness of the white which named korea as the white-clad race. As the other side of the color effect of our ancestors, bright colors of Saeksong is used. This preference for bright colors shows the other emotional side of korean people.In the beginning there were only two element, Yang and Yin. Yang became the sky, Yin the Earth. Five more elements were created from the tree, fire, soil, metal and water,and they called Five ways. Each of these acted with others and affected the ways all things were created and declined.

According to these thinking, cosmos itself is comprised of five times and spaces. Each time and space is defined with its own colors and thus, there are five colors ; blue, red, yellow, white and black. Blue defines the direction of east, where as climate is warm and all things are exuberant, Yang is active. Yellow defines the center. White defines the west. In contrast, black of the north and red of the south are colors of Yin, Yin is negative. Therefore, we can see the mental wold of the significance given to the philosophical principle of colors that cannot be seen in the western culture.

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The Outside Colours of the Traditional Hungarain Country Houses

Zsuzsa Kárman

1. Introduction

I maked a study on the colours of Hungarian country-houses. I looked in sources, asked people,who know this part of the country, if they remember where coloured country houses are.
I walked all around villages and towns. I took photos and sometimes slides of the outside look of the houses, which saved their old shapes and colours.

I measured the colours of the various parts of the buildings / pedestal, wall, ornament, door, window etc /,mainly with comparative method, using the Coloroid Colour Atlas from Nemcsics.

Coloroid Colour System has been developed specifically for enviroment colour design - lead by Antal Nemcsics in Hungary at the Technical University Budapest.In this colour system the colour space is continuous, the members of the colour space are aesthetically the same distance from each other.

Coloroid is in exact correlation with the CIE XYZ system-its the most often employed system till now.

The coloroid is raising to be an international and Hungarian standard. In Coloroid colours are treated as being mixed from tristimuli of boundary colour, black and white.

The Coloroid Colour System accomodates the colours inside an orthogonal circular cylinder so that hue varies /A/ along the cylinder shell, saturation /T/ along the radius and lightness /V/ along the axis. The spectrum colours and purples, which are the boundary Colours of Coloroid accomodates along a line on the cylinder shell. Among boundary colours of the Coloroid System 48 approximately aesthetically equidistant colours with special codes have been adopted as Coloroid basic colours.Yellow colours are marked with the following "A" numbers - marking the hue varies-10-16, oranges 20-26, reds 30-35, purple-violets 40-46, blues 50-56, coldgreens 60-66, warmgreens 70-76.

2. Aims

The main objective to be achieved in my research work is to preserve the traditional colouring of the country-houses in the Northern Hungary, at least defined -measured the colours- and in photos. The colouring tradition of the country-houses are more than hundred years old. It is based on people's impulzive colour choice.

Traditional colouring is an elaborated art which created colour harmony.There are less and less original country-houses because of being pulled down or transformed.The colouring of the houses is simplified at renewal.The tradition of colouring is coming to an end.We have to save it because it is a part of Hungary' national values.

3. Result

It is typical of the whole folk art, but mainly of the architecture that it has remaind only a few material and written relics from the time before the XVIII.c. We can't suppose for lack of material relics that there weren't carved, graved and painted decorations on the houses of lower nobles, the members of middle classes and the well-to-do peasants, since this kind of decorations appeared on peasant-furnitures in the XVI.c. There was a more peaceful period and relative wealth in Hungary in the XVIII. c. which was necessary for the spread of decorations. At first only the privileged stratums and the free peasants of the privileged areas have built such houses where decorations were, these rated as luxury.

The golden age of the vernacular ornamentation developed from the middle of the XIX.c. till 1900. This is that period in the Hungarian vernacular architecture when the most beautiful, -considered to be the traditional- houses have built.

The places of the ornaments obviously first of all are on the streetfronts of the houses, less the court-side where the most important decoration is the veranda what is general already at this time.Itís prevailing structural forms supersede the applied ornanents.The veranda appeared on the streetfront of the houses on some territories. There isn't generally any ornament at the back side and at the side looking into the neighbouring tenement.

The colouring of the wooden constructions, doors, windows, coloums of the veranda, plank ridges were common, specially in the XIX.c. Red, blue and white colours dominated similarly to the works of the

Zsuzsa Karman
Administration office of Budapest

coloured folk art.

Plastering of the walls with clayey mud was used for to protect the houses, but at the same time it was an aesthetical claim,too. The plastered face was painted with clayey mud, which sometimes containd sand,too. People intended to use yellowish, bluish, whitish soil. Painting became rarer from about 1850, when the whitewashing spread widely, painting was used only on the back side of the houses around 1900. The painted houses are very nice where the openings were stressed with frame whitewashing.

Whitewashing the walls isn't relatively an old custom. Some settlements ordained it.

Some signs shows that blue painting of the walls -which was made first by blue mineral matters, later industrial paints-precaded or was in the same age as the whitewashing.The blue walls were already rather rare in the XX. c. in Hungary, but there are yet in Hungary and we can find more blue houses in Slovakia and Romania at the present time. The whitewashed walls became generalin on some areas of Hungary in the XIX. c.

Painting the pedestal of the walls into darker colours became general for practical reasons. Darkbrown or grey earth to be found in the neighbourhood or soot was mixed and improvement of the delivery possibilities in consequence of the industrial often into the lime.

There are only a little datas about the ornamental paintings of the facades,as nobody has dealed with this topic.Such kind of findings came up accidentally.

The colouring of the peasant-houses haven't been constant. Long ago when there was only a choice of harmonizing earth pigments of a particular region the changing of the colours depended on the proportion of the components. In our days possibilities of coloration have become almost unlimited. The used colour still depends on the current pigment-choice and fashion.

4. Colour Using Nowadays

It's typical of North-Hungary that there aren't or if there are only very few peasant-houses which can be called original old ones.

I'm showing you the most characteristic types of the houses founded until this time during my search. These houses are about 100 years old. I'm defining the colours in Coloroid Colour System and looking for the connection between used colours.

We can say in general, that the tricom harmony of red, yellow and blue colours is generally received on the original peasant-houses of the area. According to the searches of colour preferences these are the most popular colours today. The lightness of these colours are average, but the saturation was intensive which was liked in the Middle Ages. You can find such houses nearly in every village. It is a matter of course - on the basis of the earlier-mentioned - that there are everywhere in the territory whitewashed houses with coloured pedestal. This convention has grown up -as I wrote - because some local order.

5. Other Colour Harmonies Used in the Areas of North Hungary

In the North Mountain of medium height, near the Karancs hill, in Nógrád county the most prefferred colours are here the colours between yellow and orange (from A-12 to A-16). It is tipical, that there are several types of yellows on facades together. (A-12 staw yellow, A-13 light cadmium yellow, mimosa yellow etc, A-14 cement yellow,Chinese yellow, A-15 orange, Naples yellow, a-16 Indian yellow, oxide yellow) and it is complited with it's complementer colour the blue. (A-51 mauve blue, Babylonian blue, A-52 whitish cobalt blue, A-53 gentian, A-54 Medici blue) what is the pedestal or at least the fence.

In this teritory you can see often the trichrome harmony of yellow (A-12, A-13) the red (from A-25 to A-30) and the blue colours.

In flat country in the lowland, in Pest county the most prefered collective colours here are the above mentioned tricome harmony the blue (A-51 Babylonian blue, mauve blue) and its complementer colour the yellow (A-12 staw yellow, A-13 light cadmium yellow) the other group is the yellow (A-14 orpiment, Chinese yellow) the red (A-26 rusty brown) and the blue (A-52 whitish cobalt blue) colours in trichrome harmony.

On the East edge of Hungary, near to the river Tisza, in regio Bereg, in Szabolcs-Szatmar county duality is typical . On one side the usage of the red, yellow and blue colours which are typical of the whole searched territory, appears here in such colours which saturation and lightness is less: rose-red colours, unsaturated yellow colours and light blue colours. Within this the most popular colours are the rose-red and the fallow orange colours. The dull shades were general in the Renaissance. You can find often more from these warm colours on the same facade. The white, shell-white (A 11) or yellow (A 12,13) ornament is common on the rose-red houses.

On the other side we can see a forcefull lightness contrast on some houses.It was typical for the Middle age. There are darkblue, darkbrown nearly black ornament on the light walls (white, yellow).

The yellow walls are popular yet. Generally there is its complementer colour the blue:the window-freame, the ornament on the wall, the pedestal or the fence. There are saturated monochrome red (A 32 crimson) houses in Gulacs.

In the northeast corner of Hüngary, in the Hegykoz, in the Zemplén mountain, and in Hegyalja, in Borsod-Abauj-Zemplén county the colours most of the remained houses are typical for the all territory. That is or the white or when the wall is red and yellow, the pedestal is blue. The difference from the territory's average is that the yellow colours - used here - are lighter (A10 pale yellow, A11 pastel yellow etc.) and the red colours are more brown (A25 Memphis red, A33 copper brown etc.). The blue colours has generally little saturation and big lightness. It's common that the pedestal isn't blue but that red which is already on the facade. There are also monocrome red houses and with blue pedestal in this area.

There are nearly as many saturated, warm yellow colloured houses here (A13 Mimosa yellow, A14 cement yellow) as red. There are monochrome yellow houses, too, but rather with blue pedestal,sometimes with red pedestal, but there was black, too. The yellow houses are often decorated with white or pastel yellow colours, there are red decorations in less number (e.g. A25 brick red).

We can find houses with big lightness contrast. Generally the colour of the wall is yellow (A13 chicken yellow, A10 yellowish white) and it is decorated with dark colours (darkbrowns, A43 aubergine) or black. This contrast can be find in opposite rate in Füzérkomlós where is a darkbrown house(A22 peanut) with warm broken white (A12) decoration. In this area are blue houses,too. It shows that the very old traditions remained, too.

6. Conclusion

The characteristic of the Hungarian popular monuments are the few and simple decoration. The decorations are markable and existant. The monumentarism is apsent from these houses. The space , the building materials, the constructs,the colours and the shape of each house are in a harmony and these form the tipical, independent style and character of the houses.These are the characters which give high art level.

The historical styles reach the vernacular architect always with lateness. The elements of the historical styles in the village-houses appear in unusual proportion, without logic.It can be because in the villages didn't use the best experts. They built irregular architectural elements. Later the home-made repairing, repeated paintings continued the changing of the elements. This was the way how the popular architecture, these special aesthetic value was born, with its origian shapes, relations and colours.

The number of the traditional coloured and designed country houses is growing less in Hungary. The painted plaster-works on the gable of the remained houses were changed into grey slate in many case. The facades of the houses had more colours formerly. Nowadays they are simplified at the renovation stage. The materials of the roofs are changed for burned tile mostly. There are a lot of cases when the original two little windows are exchanged for a bigger one. The colouring material of the houses is often sandstone powder .

The colours of the peasant-houses haven't been defined so far. This topic hasn't been investigated. I hope, my research work will be the beginning of these general work. Though, I could define only the colours which are on the houses now, I think these colours remained from old tradition, are worth to preserve them. The traditional colouring of the houses is a part of the national wealth.

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Color Characteristics Based on the Image of Toddler's Wear

Kim Young-in, Joo Mi-young

Abstract

The purpose of this study is to classify the image of toddler's wear in the korean fashion market, and to analyze practical colors used in the industry in order to inquire the relation between image and color, to suggest the representative color palette of each image which can be utilized for effective color planning.

Results of the study shows that the domestic toddler's wear market can be classified into five images, which are 'Classic', 'Romantic', 'Enjoyable', 'Casual', and Modern'. The hue and tone of main colors used in these five separate images differ, which proves the characteristics of fashion colors are important to express the fashion image. In addition, this study suggests the representative images in the current toddler's wear market through systematizing image adjectives and image scale, as well as the color palette of each image for effective color planning.

Keywords: fashion color, fashion image, toddler's wear

1. Introduction

The current domestic children's wear market shows growing demand for quality and sophistication, as can be seen especially in the toddler's wear market. The reason being is that this is the stage of when the parents wish to have their children stand out, with character and differentiated image. With this in mind, the purpose of this study are as follows :

1) To classify the image of toddler's wear in the domestic fashion market
2) To analyze the characteristics of practical colors used in each image brands.
3) To suggest the representative color palette of each image.

2. Methods

2.1 Image Classification of Toddler's Wear

The questionnaires have been made displaying 48 color prints with 30 toddler's wear image adjectives to classify the image of toddler's wear for the domestic market. In order to select the color prints, reviews have been made through information from toddler's wear market positioning data by Inter Fashion Planning (1999), Textile Journal (form 1999 to 2000), and Fashion Conspectus on baby/children's wear brands (1999). Based on the above, brands have been selected who are targeted towards the toddler's wear market. The color prints were collected from '99 and '00 magazine advertising prints of those brands or pictures provided from the merchandising team within the selected brands. This resulted in a total of 48 color prints, consisting of one to three pictures from eighteen brands.

Adjectives have been collected through professional fashion magazines and children's fashion trend book(Inter Fashion Planning from 1996 S/S to 2001 F/W, Textile Journal from Jan. 1995 to Mar. 2000, Fashion Conspectus on baby/children's wear brands 1999) describing concepts of fashion image, and resulted in 30 appropriate adjectives by categorizing similar meanings.

A total of 250 copies were used in the survey to students who major in apparel and specialists in the baby/children's wear companies. The questionnaires displayed each color print with 30 toddler's wear image adjectives with the results analyzed via Factor Analysis and MDS (multi-dimensional scaling).

2.2 Analysis of the Practical Colors

In order to analyze the characteristics of practical colors for the toddler's wear industry, 546 color samples used by 11 brands from 1999 F/W to 2000 S/S are collected and analyzed. The 11 brands selected for the analysis were based on representative visual image that rated high in color prints which are

Joo Mi-Young*, Kim Young-In**
Yonsei University
* Dept. of Clothing & Textiles
**Dept. of Human Environment & Design
134 shinchondong sudeamunku, Seoul 120-749, KOREA
Phone : +82-02-361-3105
Fax : +82-02-361-3105
E-mail : Joomiyoung@hotmail.com
youngin@yonsei.ac.kr

the following ; 'NauticaBoys', 'RoemGirls', 'MezzoPiano', 'BeBe', 'BabyQuiz', 'BabyHunt', 'BlueDog', 'Cankids', 'TwinKids', 'PoloBoys', and '012Benetton'. The collected colors are converted into H V/C of Munsell notation and the color tones are categorized into 12 tones for analytical purposes. And with this, a 9-color palette was suggested per image for effective color planning.

3. Results

3.1 Classification of Toddler's Wear Images

5 representative images were defined through the factor analysis of 250 respondents, which are - 'Classic', 'Romantic', 'Enjoyable', 'Casual', and 'Modern', with description ability points resulting in 63.07%. The credibility alpha value figure resulted in 0.67 to 0.82, showing reasonable credibility. The relative positions of 30 adjectives make clear from MDS. The axes of the toddler's wear image scale were 'decorative-simple' and 'cheerful-serious' from factor analysis and MDS result. 30 adjectives and 5 main factors have been placed on the image adjective space (Fig 1). The positioning of adjectives were based on MDS and groupings of these adjectives were done through primary factor analysis.

'**Classic**' image is placed close to the serious zone, expressing a traditional outfit. '**Romantic**' image comes into the cheerful and decorative zone, mainly consisting pretty and fairytale like one-piece dresses that are preferred by girls. '**Enjoyable**' image sits close to 'Romantic' image in terms of being in the cheerful and decorative zone, but shows more activity and brightness. '**Casual**' image is positioned in the most simple and comfortable zone, showing styles that are plain and comfortable. '**Modern**' image also sits in the simple zone, and have more of a simple but sophisticated casual look with urbanity.

Through this study we can see that toddler's wear image have different characteristics.

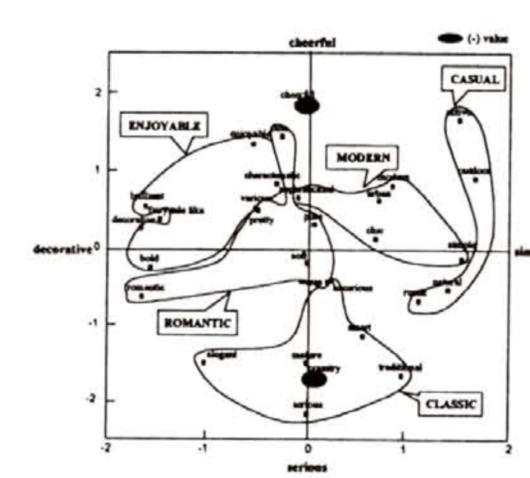

Figure 1. Toddler's Wear image adjective space

3.2 Color Characteristics by Toddler's Wear Images

In order to analyze color characteristics by image, it is necessary to systematize the colors based on both hue and tone. <Fig. 2> and <Fig. 3> shows the results using Munsell color system's 10 colors and 12 tones.

'**Classic**' image is concentrated in the dark grayish, grayish and pale tones of purple-blue, yellow-red and yellow. This shows that 'Classic' brands generally use pale blue, beige, ivory, brown, khaki, navy and has a tendency to use deep tones of red compared to other images. Dark grayish tones of green are also being used frequently with the usage of hunter green as a basic color. 'Classic' brands use dark colors to express gravity and high-class traditional image, and these colors are used together with pale tones such as beige, ivory and pale blue for color combination.

'**Romantic**' image is concentrated in the pale tone of Red, Yellow- Red, Yellow and Purple-Blue. Main colors are light pink, pale yellow and pale blue which are soft, sweet and dreamy, with a touch of fantasy. The main color combinations are light pastel tones and white, giving a poetic, soft effect with a feeling of delicacy and sweetness.(Kobayashi 1991, 18)

'**Enjoyable**' image is in the pale and bright tones of Yellow-Red, Yellow, Blue, Purple-Blue. Main colors are coral, bright orange, yellow, sky blue. Orange works best in combination with other clear colors. With yellow, it has a lighthearted, open, friendly image, with blue, it is lively and young. As for bright orange, combining with other pale or bright tones brings out a sunny, cheerful, lighthearted image, appropriate to products aimed at children, particularly infants. (Kobayashi 1991, 36-37)

'**Casual**' image is concentrated in pale and grayish tones of Yellow-Red, grayish tone of Yellow, deep tone of Red, dark grayish and grayish tones of Purple-Blue. Main colors are beige, khaki, grayish pale blue with deep red and navy. 'Casual' brands express rusticity and activeness at the same time, and this is also seen in the usage of color, in which grayish tone express rusticity and red, blue - used as a basic color in children's wear - for activeness.

'**Modern**' image is concentrated in pale, grayish and light grayish tones of Yellow-Red and grayish tone of Blue and Purple-Blue. Main colors are grayish toned and colorless colors such as pale beige, grayish beige, grayish pale blue and gray to express sophistication.

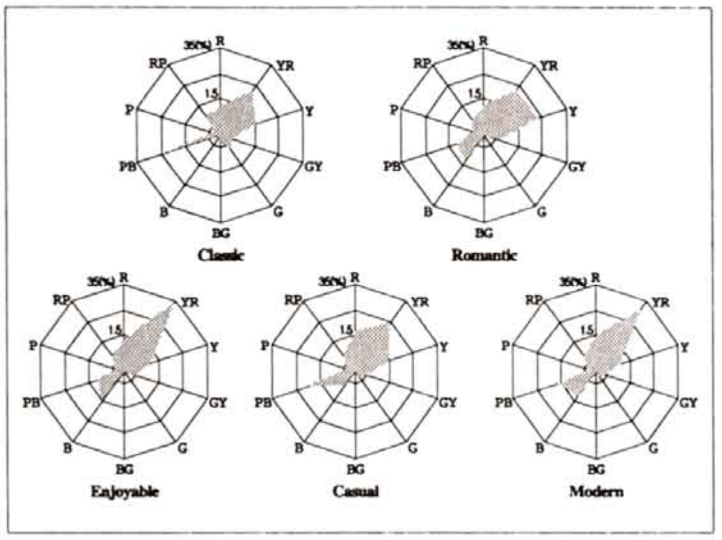

Figure 2. Hue distribution by Toddler's wear Images

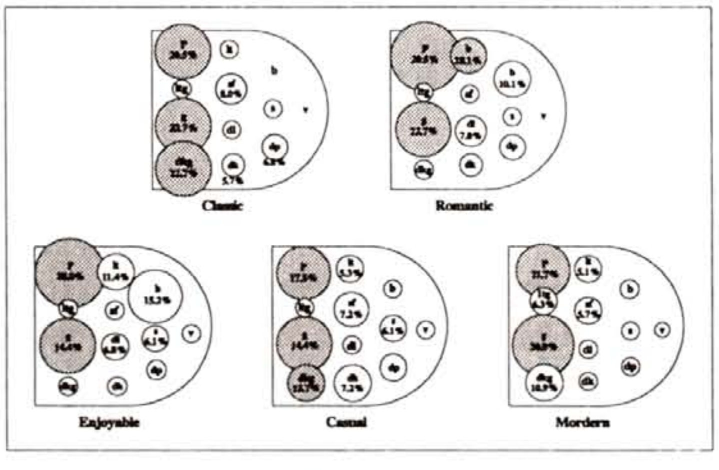

Figure 3. Tone distribution by Toddler's wear Images

3.3 Representative Color Palette of each Image

Based on the analysis outcome, a 9-color palette per image is suggested; using 'Munsell' signs and COS (color system) signs generally used in the domestic fashion industry for accurate communication.

5PB 5.0/4.0 (PB2-50040)	5YR 3.0/4.0 (YR2-30040)	7.5YR 5.0/3.0 (YR3-50030)
5PB 8.0/4.0 (PB2-80040)	2.5Y 9.0/1.0 (Y1-90010)	10YR 7.5/2.5 (YR4-75025)
7.5PB 2.0/1.0 (PB3-20010)	5R 3.0/12.0 (R2-30120)	5G 3.0/3.0 (G2-30030)

Classic

5R 8.0/4.0 (R2-80040)	5YR 9.0/2.0 (YR2-90020)	2.5Y 9.0/1.0 (Y1-90010)
10YR 8.0/10.0 (YR4-80100)	2.5Y 9.0/4.5 (Y1-90045)	5RP 8.0/6.0 (RP2-80060)
2.5Y 6.0/1.0 (Y1-60010)	2.5P 6.0/3.0 (P1-60030)	2.5PB 8.0/3.0 (PB1-80030)

Romantic

10YR 8.5/4.0 (YR4-85040)	7.5YR 8.0/8.0 (YR3-80080)	2.5Y 9.0/4.5 (Y1-90045)
5YR 6.5/11.0 (YR2-65110)	5YR 9.0/1.0 (YR2-90010)	5PB 8.0/4.0 (PB2-80040)
7.5R 4.0/14.0 (R3-40140)	7.5Y 5.0/2.0 (Y3-50020)	7.5B 6.0/8.0 (B3-60080)

Enjoyable

10YR 7.5/1.5 (YR4-75015)	7.5YR 8.5/2.0 (YR3-85020)	2.5Y 5.0/2.5 (Y1-50025)
10Y 5.0/1.0 (Y4-50010)	10YR 9.0/1.0 (YR4-90010)	10YR 5.0/2.0 (YR4-50020)
5R 3.0/10.0 (R2-30100)	7.5PB 3.0/4.0 (PB3-30040)	5PB 2.5/3.0 (PB2-25030)

Casual

7.5RP 7.0/2.0 (RP3-70020)	10YR 8.0/2.0 (YR4-80020)	7.5Y 8.5/2.0 (YR3-85020)
10B 7.0/3.0 (B4-70030)	10YR 9.0/1.0 (YR4-90010)	5YR 6.0/2.0 (YR2-60020)
2.5Y 4.0/1.0 (Y1-40010)	5PB 5.0/4.0 (PB2-50040)	5PB 3.0/2.0 (PB2-30020)

Modern

Figure 4. Color Palette of each image

4. Conclusions

Based on the analysis study of image and practical color usage, the domestic toddler's wear market can be classified into 5 different images - 'Classic', 'Romantic', 'Enjoyable', 'Casual', 'Modern', and colors used in these images can be clearly distinguished.

'Classic' brands use dark grayish and grayish tones of Purple-Blue, Yellow-Red, Yellow, Red, Green to express high-class and intellectual image. 'Romantic' brands use pale tone of Red, Yellow-Red, Yellow, Purple-Blue to express images of lovely, sweet and dreamy. 'Enjoyable' brands use bright and colorful colors, which are pale, bright tones of Yellow-Red, Yellow, Blue, Purple-Blue that expresses more of a cheerful image compared to others. 'Casual' brands mainly use grayish tones with deep red and navy to express rustic, natural and active image. 'Modern' brands use grayish tone of Yellow-Red and Purple-Blue for urbanity and sophistication.

The above shows that color plays a major role to efficiently express a design concept for toddler's wear brand.

Toddler's wear market is becoming more segmented and dominant within baby/children's wear market, and to gain competitiveness, there needs to be a uniqueness in image to constantly approach the consumers. And with this, the color should be used in a more objective and systematic way.

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Wildflowers - A Design for Silk Scarves

Jeon, Kyung Ae

Abstract

The purpose of this article is to present an elegant, contemporary design for silk scarves. Interpretations and variations of the wildflower motif are developed. Computer graphics are utilized to create the designs.

Keywords: design for silk scarves, wildflower motif

1. Introduction

This design depicts wildflowers in a field in their natural state, using the entire scarf space, without a repetitive pattern. The color scheme captures the vivid colors of the different wildflowers. This idea originated from my travels in the countryside of the United States. These designs are suitable for printing on silk. These scarves are not only functional but also are fashionable accessories.

2. Discussion

These designs are developed by computer graphics. Adobe Illustrator and Adobe Photoshop software are used. Photographs of wildflowers and creative drawings are scanned for input to the software. This input is reconstructed in the design development process. The unique features and colors of individual wildflowers are accentuated in this process. The overall effect is to reflect the beauty of wildflowers in their natural setting.

3. Conclusion

The purpose of these designs is to meet the human aspiration for nature. Color presentation simulates natural settings. Natural silk fiber has a smooth, lustrous surface and is most suitable for printing. This study presents both the function and fashion of the product with the source of inspiration from nature. This design approach is original and suitable for changing tastes in the modern era.

Jeon, KyungAe
Dong-Eui University
BUSANJIN-KU GAYA-DONG 24
BUSAN 614-714, KOREA
Phone : +82-51-890-1601
Fax : +82-51-890-1579
E-mail : kajeon@hyomin.dongeui.ac.kr

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Sportwear Design Assisted Tool Based on Human Colour Emotion

Hitofumi Yamaguchi, Hiroshi Sumino, Tetsuya Sato, Kazunari Morimoto, Takao Kurokawa, Kanji Kajiwara

Abstract

Colour is important for sportswear design. Because colour is one of main factors for customers to buy a sportswear. We investigated the use of kansei words for assessing colours of sportswear, and quantitatively analysed colour emotions expressed by the kansei words. We also derived empirical formulae to express the colour emotions through an instrumental method.

In this paper, we briefly discussed about the application of the numerical expression, and also suggested an interface model for assisting the colour planning of the sportswear as a sportswear design assisted tool based on human colour emotion.

Keywords : colour planning, sportswear, colour emotion, numerical expression, information technology

1. Introduction

Nowadays, industrial goods manufactured in various industries are mostly designed by computer assisted systems. Designers and manufacturers add value to the industrial goods through the design of colour and shape. Until now, they have been providing various industrial goods for customers with the estimation of customers' interests. They have been taking the initiative in this economic system. But, in the near future, the relationship between manufacturers and customers will be changed step by step. Because customers more actively buy the industrial goods through multimedia tools such as Internet. This means customers will take the initiative more than now. In the situation, we need to consider how customers can communicate their interests and feelings. We also have to develop some *Quick Response* systems between customers and manufacturers.

Our research group has been trying to apply to the *Quick Response* through the numerical expression of human colour emotion [1-5]. In this paper, an attempt of a development of a computer assisted tool, which can communicate the magnitude of colour emotions for colour planning of sportswear, is briefly introduced.

Hitofumi Yamaguchi, Hiroshi Sumino, Tetsuya Sato, Kazunari Morimoto, Takao Kurokawa, Kanji Kajiwara
Kyoto Institute of Technology
Goshokaido-cho, Matsugasaki, Sakyo-ku, Kyoto 606-8585, JAPAN
Phone/Fax: +81 75 724 7578, E-mail: tsato@ipc.kit.ac.jp

2. Assessment

We have already investigated *kansei* words, which are generally used for assessing colours of sportswear. 114 colours were assessed by 30 observers through two-point and seven-point assessments. The trial of the numerical expression was carried out for the colour emotions described by 16 *kansei* word pairs in common use as shown Table 1. We have already derived empirical colour emotion formulae through two-point assessments [1]. As the next study, we are trying to derive empirical colour emotion formulae corresponding to seven-point assessments.

Table 1. Kansei word pairs used in visual assessments

Symbol	*Kansei* word pair	Word pairs translated in English
BD	Kirei - Kitanai	Beautiful - Dirty
BR	Kigahikishimaru - Kigayurumu	Braced - Relax
CN	Seiketsuna - Fuketsuna	Clean - Not clean
DP	Koi - Usui	Deep - Pale
ES	Ugokiyasui - Ugokinikui	Easy to move - Stiff to move
FS	Hayai - Osoi	Fast - Slow
GP	Hadena - Jimina	Gaudy - Plain
HC	Atsui - Suzushii	Hot - Cool
HL	Omoi - Karui	Heavy - Light
LD	Akarui - Kurai	Light - Dark
RD	Sawayakana - Sawayakadenai	Refreshing - Dull
RN	Kakkoii - Kakkowarui	Refined - Not refined
SE	Kigasizumaru - Kigatakaburu	Settling - Exciting
SS	Medatsu - Meadatanai	Striking - Subdued
SW	Tsuyoi - Yowai	Strong - Weak
YO	Wakawakashii - Toshiyorikusai	Youngish - Oldish

3. Application

Colour emotion values, which are computed by the colour emotion formulae, can be outputted as real colours on a computer monitor through CIELCh, CIELAB, XYZ and RGB conversions. Using the colour output, we can develop some computer tools for communicating human colour emotions, and we can apply to a colour communication through a computer network system such as Internet. Figure 1 shows an interface model for displaying a colour emotion map on a computer monitor, which is corresponding to two-point assessments [1]. Unfortunately, this figure was not colour-printed.

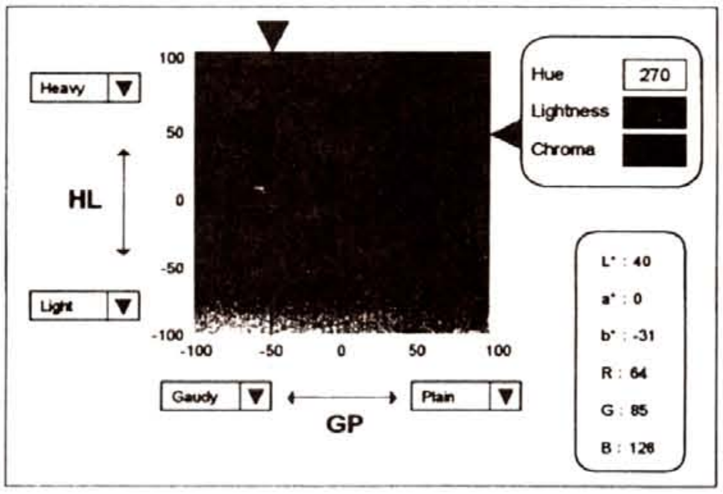

Figure 1. An interface model for displaying a colour emotion map on a computer monitor

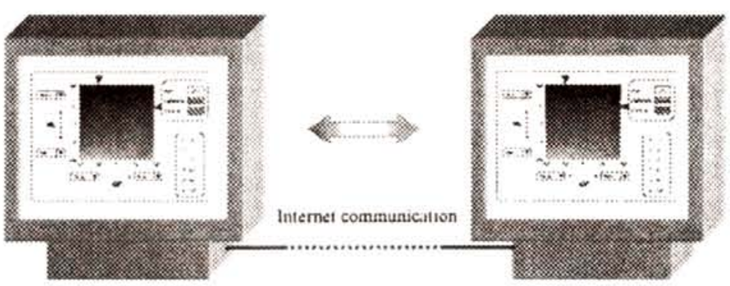

Figure 2. A communication model of colour emotions through Internet

If we arrange the display system for a computer network such as WWW, we can have a network communication system through Internet as shown in Figure 2. Internet is essential for the Quick Response. Needless to say, we can globally communicate in a moment through Internet.

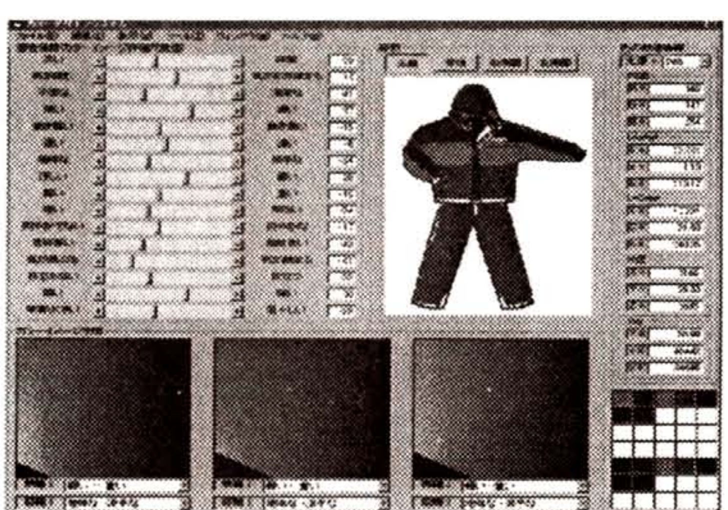

Figure 3. A sample of an interface model of a colour design assisted tool; Japanese version

In order to apply the colour emotion map to Internet, we need to develop an assisted system for users, which has some interface models for input and output. Figure 3 is a sample of the interface model of the assisted system. The interface model has the parts of colour emotion maps, shape of sportswear, emotion scales with kansei words, colorimetric values and colour samples. The input/output parameters are converted each other through colour emotion formulae.

4. Summary

We briefly discussed about an application of the numerical expression of colour emotions for the colour design of sportswear, and also suggested a computer assisted tool for sportswear design through Internet. The system is helpful to communicate the magnitudes of colour emotions for assessing sportswear colours, and also useful to know the differences between assessments of manufacturers and customers. We would like to develop more useful and practical system, which contributes for colour planning and Quick Response.

Acknowledgement

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Colour Management in the Design of Apparel Collection

Vera Golob, Majda Kuzmic, Darko Golob

Abstract

The paper presents a novel approach to styling and to the colour design of a fashionable apparel collection. The approach incorporates colour management and colorimetry into apparel design. The styling of dresses for the collection was inspired by "Charleston" looks and implemented in two-colour combinations. The colour design for the collection was performed on advanced computer-aided colour management equipment. The process includes model scanning, the preparation of colour combinations and their printing out. Individual models were made in different colour combinations. Colorimetry was used to evaluate the combination of colours for every model and to choose the right textile material from paper patterns.

Keywords: Design of Apparel Collection, Colour-combination, Colour Management, Colorimetry, CIELAB

1. Introduction

Garments belong among the most important material goods mankind needs, so they have to be comfortable and fashionable. Every season fashion houses launch dress styles, of which some are quite novel, and some a nostalgic reminiscence of past styles. To remake a known style is a challenging task because the garment stylist has to stress the typical traits of a known style and refresh it by new colours and materials. Styling is an innovative art based on the dress stylists's subjective understanding of fashion, whilst the inclusion of computer-aided colour management into colour design enables the designer to create a large number of colour drafts and colour combinations. In this way the creative art of dress modelling and advanced computer technology are combined in the design of an apparel collection.

The apparel collection presented in this paper was inspired by the "Charleston" style that marked the period from 1925 to 1927 [1,2]. In the late twenties and early thirties of the 20th century shirt-like dresses became fashionable. The waist of dresses became loose and was lowered under its natural position, while the skirts became short, short enough to uncover the knees in 1925. The fashion trend of that time cherished youthful and relaxed sportive looks rather than dignified elegance. Expensive jewellery and accessories were not appreciated.

The modern apparel collection consisting of seven dress models in two-colour combinations presented in this paper was created after a thorough study of the characteristics of the "Charleston" style, which was followed by the incorporation of current fashion trends. The colour design of the collection was created employing advanced computer technology. The procedure consists of model scanning, colour selection and preparation of colour combinations on the monitor, and printing out of the apparel collection on a colour printer. Four colour combinations in stylish veiled shades of brown, violet and green-grey were created for each model. The colour combinations of individual models in different contrasts were evaluated using colorimetry, a method of growing importance in apparel design. The choice of textile materials used for the apparel collection was based on the colorimetric evaluation of colour drafts.

2. Experimental

Experimental work on the design of the apparel collection ran as follows:

- Drawing of apparel design sketches for the collection in the 1925-1927 retro-style
- Scanning of models
- Selection of colours for the collection and creation of colour combinations on the monitor
- Printout of the selected colours on a colour printer
- Selection of appropriate textile materials
- Colorimetric evaluation of apparel collection

Prof. Vera Golob, Ph.D., University of Maribor, Textile Department, SI-2000 Maribor Slovenia
Majda Kuzmi, B.Sc., Textile School Maribor, SI-2000 Maribor Slovenia
Darko Golob, M.Sc., University of Maribor, Textile Department SI-2000 Maribor Slovenia

2.1 Modelling and Drawing Sketches for the Collection

The characteristics of the newly created apparel collection are:

- A tall silhouette and soft lines, which creates a romantic look
- A lowered waist line implemented in every possible variant
- Skirt length some centimetres below the knees
- Various accessories like zippers, buckles, pockets of accentuated shapes, etc.
- Handbags hanging not only over the shoulders but also around the waist and hips, and fastened with thin belts on the chest, back or belly. The size of handbags is not defined, it should follow the purpose it serves. The colour of the handbag agrees with the colour of the dress so as to produce a cheerful effect.

The collection consists of seven models shown in Figure 1.

2.2 Scanning of Models

The drawing sketches were scanned on the HP ScanJet 5P scanner and prepared for computer-supported colouring. The contrast and brightness were adjusted to eliminate the spots caused by paper surface, the shading made by pencil was left. Then the discontinued lines were repaired in order to enable easier painting.

2.3 Selection of Colours for the Collection and Creation of Colour Combinations on the Monitor

The models of the collection are designed in two-colour combinations. Based on the testing of various colours on the monitor seven colours were selected and each model was created in the next four colour combinations:

A - light brown (1)- medium brown (2)- dark brown (3),

B - light violet (4)- dark violet (5),

C - light grey (6) - dark grey (7)

D - light violet (4)- light grey (6); dark violet (5)- dark grey (7)

2.4 Printout of the Selected Colours on a Colour Printer

Colour preparation on monitor differs from the output on the printer. While printers use subtractive mixture with CMYK inks, monitors use additive mixing with RGB phosphors [3]. Printed colours also depend on printing art (inkjet, laser, wax) so it is very hard to predict the output colour on the base of monitor colour. The selected colours were adjusted to achieve the same shade on the printer using the of CMY basis colour palette.

2.5 Selection of Appropriate Textile Materials

On the basic of the selected colour combinations of models in the collection we picked out the fabrics of adequate colour and quality. The chosen fabric is a blend of 50% PES, 10% flax and 40% viscose, which has the good properties of natural fibres, but lower creasing.

2.6 Colorimetric Evaluation of Apparel Collection

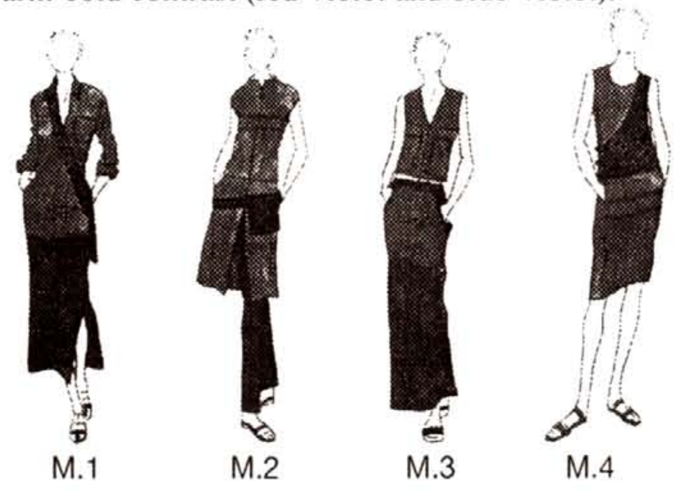
Textil samples selected for colour combinations (T1-T7) were colorimetric evaluated using CIELAB system [3]. Colour values for lightnes L*, chroma C* and hue h are shown in Table 1 and graphically presented in Figire.2.

Table 1. CIELAB colour values and colour differences of colour combinations

Colour comb.	Textile	L*	ΔL*	C*	ΔC*	h	ΔH*
A	1T	59.65	-6.81	5.15	5.61	67.08	0,08
	2T	52.84		10.76		67.64	
	3T	45.59	-7.25	14.20	3.44	67.61	0,01
B	4T	53.08	-13.40	19.34	-9.26	276.36	7.09
	5T	39.68		10.08		303.98	
C	6T	51.49	-17.29	7.09	-1.5	239.36	0.62
	7T	34.20		5.59		244.95	
D	4T	53.08	-1.59	19.34	-12.25	276.36	8.53
	6T	51.49		7.09		239.36	
	5T	39.68	-5.48	10.08	-4.49	303.98	8.07
	7T	34.20		5.59		244.95	

The colour values of the shades of brown contained in the combination A show that these three fabric specimens are ideal to produce the light-dark contrast because they all have the same hue h (dH* < 0,1), while the differences in lightness L*decrease evenly (one step cca 7 units) at an evenly increasing chroma C* (one step cca 5 units).

The colour values in combination B show that the specimens differ in lightness (dL* = 13,4), chroma (dC* = 9,26) and hue (dH* = 7.09). The combination is suitable to produce a light-dark contrast and a warm-cold contrast (red-violet and blue-violet).



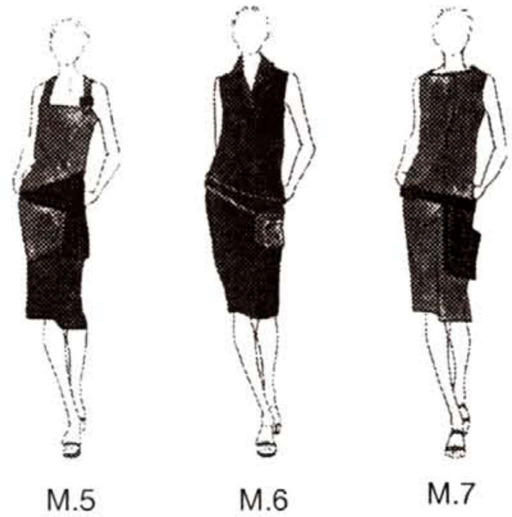


Figure 1. Models of the apparel collection

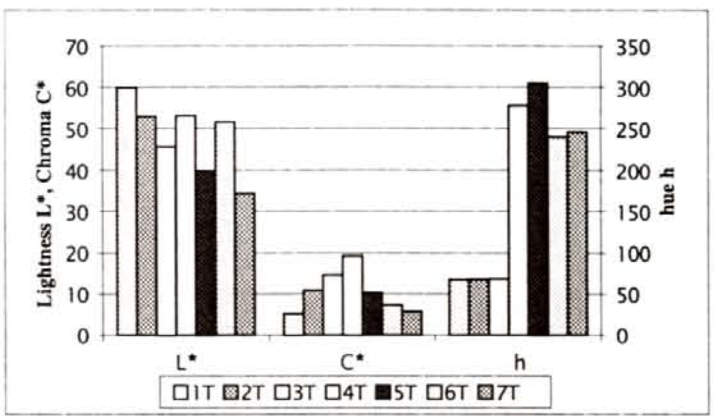


Figure 2. Graphical presentation of L*, C* and h values of textile samples

The colour combination C consists of specimens 6T and 7T. They have an equal hue (dH* = 0,62), low chroma (near achromatic grey) and great difference in lightness values (dL* = 17). The light-dark contrasts between individual garment parts are accentuated.

The models in colour combinations D are created in colours of different hue but equal lightness. The models made from specimens 4T and 6T have the medium lightness value (L* - 50), the difference in chroma is (C*= -12.25 and in hue (H*=8. Models, made from a combination of specimens 5T and 7T have similar lightness and chroma ((L* = 5,48, (C* = -4,49). The same difference in hue ((H* - 8) of the two combinations was achieved.

3. Conclusion

The presented apparel collection consists of seven models. It was designed to reflect an era that brought new dances, like Charleston, and a new style of dressing for ladies. The models were created in four colour combinations using stylish veiled shades of grey, brown and violet. The colours of individual models were combined in different contrasts, which were evaluated objectively using colorimetry. The results of our work can be summarised in following conclusions:

The models of our collection clearly show the characteristics of the retro style "Charleston"

Considering current fashion trends, the look of models was modified by various accessories in order to make them beautiful, comfortable, practical and appropriate for casual daily and formal evening occasions. The lines express a relaxed, leisurely attitude, while the high requirements show in the choice of material.

The simple cut of models and the chosen material make these models suitable for series, small-batch and single-item production.

The colour combinations of individual models follow the fashion trends for the year 2000/2001. The colours used for the apparel collection look best if no other intensive colours are added.

Numerical evaluation of colour combinations ensured the right choice of materials.

The design of an apparel collection combines the creative art of dress modelling with colour management, which includes model scanning, colour matching on the monitor, printing out of models on a colour printer and numerical evaluation of colours.

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Subjective Colors Observed for Deviced Benham Type Figures

Yutaka Kurioka, Atsushi Tanaka, Shunshiro Ohnishi

Abstract

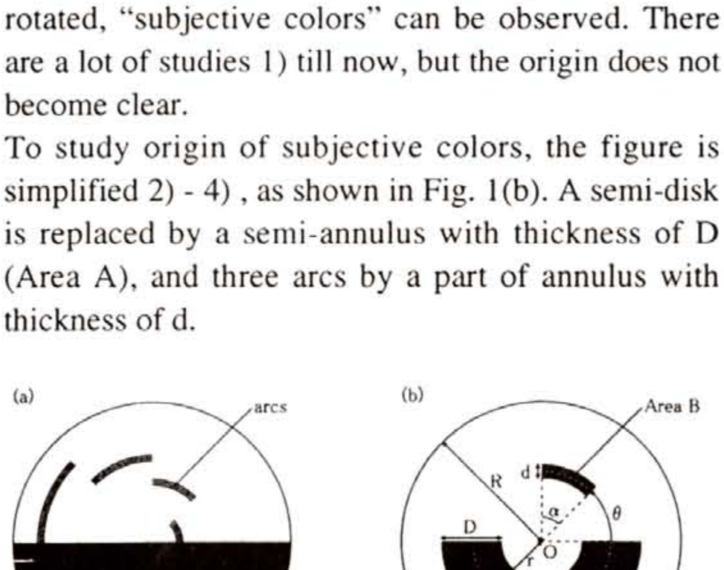
A Benham type figure usually consisits of a black semi-disk and arcs. When it is rotated, "subjective colors" can be observed. We use two black areas on a white disk for observing subjective colors. One is Area A, which is a semi-annulus with thickness of D. Another is Area B which is a part of annulus with thickness of d. If d equals to D, subjective color can not be observed. When there is small difference between d and D, subjective color can be observed. From the results, we conclude that lateral inhibition relates to Benham type subjective colors.

Keywords : Benham type figure, subjective color, lateral inhibition

1. Introduction

A Benham type figure usually consists of a black semi-disk and arcs as shown in Fig. 1(a). When it is rotated, "subjective colors" can be observed. There are a lot of studies 1) till now, but the origin does not become clear.

To study origin of subjective colors, the figure is simplified 2) - 4) , as shown in Fig. 1(b). A semi-disk is replaced by a semi-annulus with thickness of D (Area A), and three arcs by a part of annulus with thickness of d.



(a) Usual Benham type figure (b)Deviced Benham figure

Figure 1. Usual Benham type figure and deviced Benham figure

In the following section, observed subjective colors are described for changing the ratios of thickness d to D. Results are illustrated when θ increases from 0 to 135 degrees at 5 degrees step. Then, observation limit of subjective colors is discussed concerning to thickness D and d. Distributions of subjective colors are observed over Area B.

Yutaka Kurioka, Atsushi Tanaka, Shunshiro Ohnisi
Kinki University, Interdisciplinary Graduate School of Science and Technology
3-4-1, Kowakae, Higashi Osaka, Osaka 577-8502
Phone : +81-6-6721-2332
Fax : +81-6-6727-4301

2. Methods

The figure used for observation is shown in Fig. 1(b). The radius R of a disk is 100mm. The centers of two annuli agree with the center O of the disk. Angle θ is an angle between Areas A and B. Angle θ is subtended by the annulus of Area B, and is taken as 45 degrees in the experiments. Samples of the figures were made on a white paper (value N1.5) by black toner (value N9.5) of a laser printer.

The figure was illuminated by an incandescent lamp (TOSHIBA, 100W), and illuminance of the figure was about 300 lux. Experiments were made, comparing with the standard color chips of Munsell renotation. The standard color chips were illuminated by the standard fluorescent lamp with high Ra value (FL20S-N-EDL), and illuminance of the standard chips were about 470 lux. The darkroom was used to avoid stray light. A subject AT is a male of 24 years old with normal trichromat. Illumination-observation condition was 0/45 degrees. A distance between the center of the figure and subject eyes was about 60 cm.

3. Results

1) Subjective colors were observed changing thickness D from 100, 50 to 10 mm, angle $\theta = 0$, 45, 90 and 135 degrees. The ratios of d to D were taken 1, 0.8, 0.4, and 0.1. The results are shown in Table1.

When thickness d of Area B equals to thickness D of Area A, subjective colors can not be observed. When thickness d becomes smaller, chroma of subjective colors becomes higher. Thickness D becomes larger, value becomes higher. Different colors are observed for four angles of θ ; R or RP, Y or YR, Y, and B or PB for $\theta = 0$, 45, 90 and 135 degrees, respectively.

Table 1. Subjective colors observed for θ=0, 45, 90 and 135 degrees

(a) θ = 0 degree

Thickness D	Ratio d / D 1	0.8	0.4	0.1
100	N3	2.5R8/4	5RP8/6	10RP8/6
50	N2.5	2.5R7/10	2.5R8/6	2.5R8/6
10	N2.5	2.5R5/10	2.5R4/10	2.5R4/10

(b) θ = 45 degree

Thickness D	Ratio d / D 1	0.8	0.4	0.1
100	N5.5	2.5Y9/2	5Y9/3	10Y8/4
50	N3	2.5Y8/8	10YR8/6	10YR8/6
10	N3	2.5YR8/4	10R7/6	5YR8/6

(c) θ = 90 degree

Thickness D	Ratio d / D 1	0.8	0.4	0.1
100	N5.5	5Y9/1	10Y9/4	10Y8/4
50	N3	7.5Y8/2	10Y8/3	10Y9/4
10	N3	5Y2/1	5Y6/4	2.5Y4/6

(d) θ = 135 degree

Thickness D	Ratio d / D 1	0.8	0.4	0.1
100	N3	5PB2/2	5PB2/8	2.5PB2/8
50	N2.5	5PB2/1	5PB4/4	10B2/4
10	N2.5	2.5PB2/1	10B2/2	2.5PB2/6

2) Subjective colors were observed for continuous change of θ. The results are shown in Table 2. Thickness d and D were 1 mm and 100 mm, respectively. When angle θ increases from 0 to 135 degrees, hue is changing from RP to P (Fig.2 (a)).

Variations of value are 4 to 8 and its variation is not so much (Fig. 2 (b)). Chroma decreases from 14 to 1 when θ increases from 0 to 80 degrees (Fig. 2 (c)).

Chroma is 1 for hue of G, BG and B, and then increases when θ increases from 110 to 135 degrees.

Chroma is 6 for hue of PB and P.

Table 2. Subjective color observed for changing angle θ (d=1mm, D=100mm)

Angle θ	Subjective Color	Angle θ	Subjective Color	Angle θ	Subjective Color
0	5RP5/12	50	5Y8/6	100	10BG6/1
5	7.5RP6/12	55	10Y8/4	105	5B6/1
10	10RP6/12	60	2.5GY8/4	110	7.5B6/2
15	2.5R5/12	65	5GY7/3	115	10B5/3
20	5R5/12	70	7.5GY6/3	120	5PB4/6
25	7.5R5/12	75	10GY7/3	125	7.5PB4/6
30	10R5/14	80	5G7/1	130	10PB4/6
35	2.5YR6/12	85	5G6/1	135	2.5P4/6
40	5YR7/12	90	10G6/1		
45	10YR8/8	95	5BG6/1		

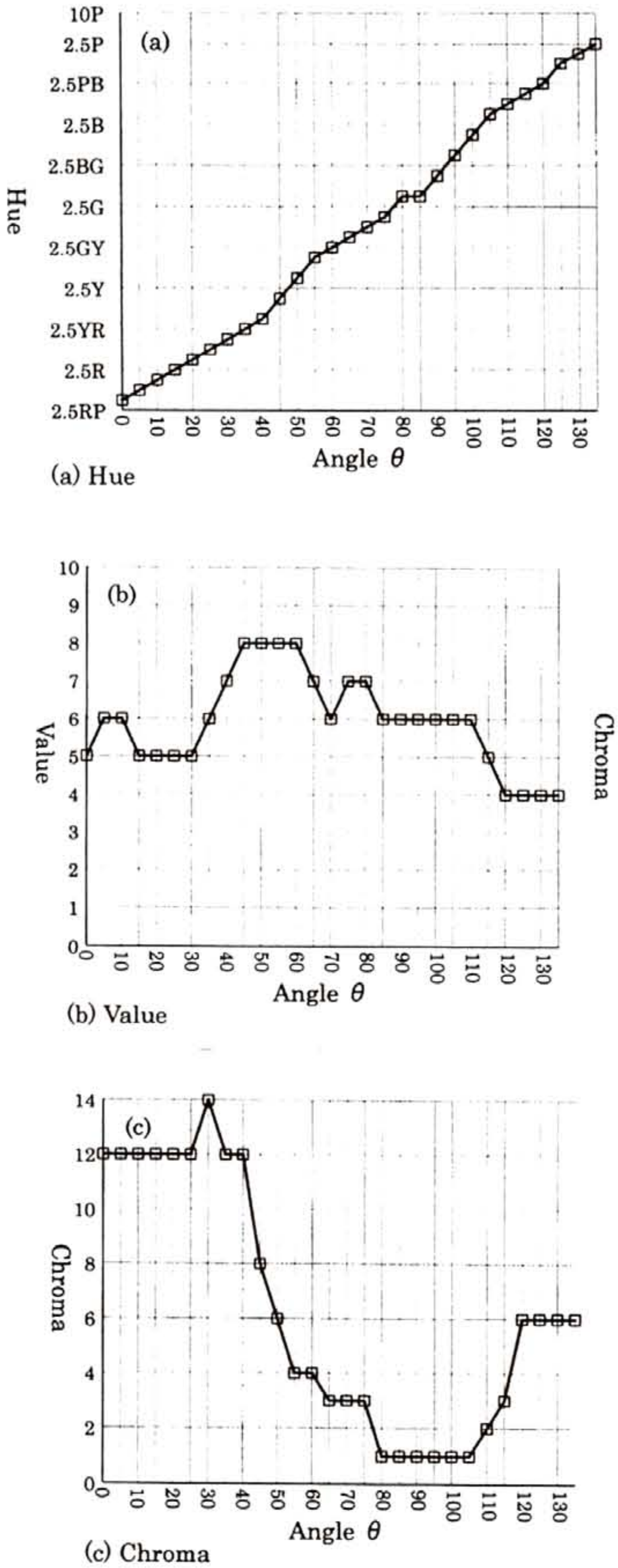


Figure 2. Subjective color observed for changing angle θ

4. Discussion

4.1 Observation Limit of Subjective Colors

As shown in the previous section, subjective colors can not be observed, when thickness d of Area B equals to thickness D of Area A. Table 3 shows observation zones of thickness d which subjective colors can be observed, for thickness D of 100, 50, 10 and 5 mm. θ is 0 degree. Observation zones of

D - d are added in the table. From the results, the limit of difference (D - d) / 2 between both sides of Area A and B is 1 - 2 mm.

Table 3. Observation limit of subjective colors(θ= 0 degree)

Thickness D[mm]	Zone of d [mm]	Zone of (D−d) [mm]	(D−d) / 2 [mm]
100	less than 96	larger than 4	larger than 2
50	less than 46	larger than 4	larger than 2
10	less than 8	larger than 2	larger than 1
5	less than 3.	larger than 2	larger than 1

4.2 Distributions of Subjective Colors

Distributions of subjective colors over Area B were observed. Positions observed subjective colors are 0, 1, 5 and 10 mm from the right edge of Area B, as shown in Fig 3(a). d was changed from 1 to 80 mm, D was fixed at 100 mm, and θ was 0 degree.

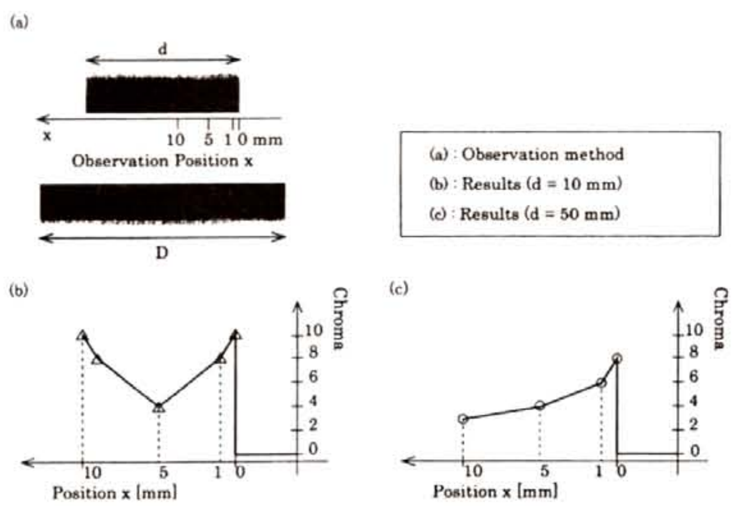


Figure 3. Observation method of subjective colors distribution and results

Results are shown in Table 4. When thickness d is larger, chroma of subjective colors decreases. Representative distributions of chroma are shown in Fig 3(b), (c). In Fig. 3(b), chroma takes the highest value at both edges of Area B. In Fig. 3(c), chroma takes the highest value at the right edge of Area B and becomes lower when the position x is larger.

From the results of discussions 1) and 2), we conclude that lateral inhibition relates to Benham type subjective colors.

Table 4. Distributions of subjective colors (θ=0 degree, D=100mm)

Thickness d	Observation position x [mm]			
	0	1	5	10
1	7.5RP6/12	7.5RP6/12		
5	7.5RP6/10	7.5RP7/8		
10	7.5RP6/10	7.5RP7/8	7.5RP8/4	7.5RP6/10
20	7.5RP6/10	7.5RP7/8	7.5RP8/4	7.5RP8/3
30	7.5RP6/10	7.5RP8/6	7.5RP8/4	7.5RP8/3
40	7.5RP7/8	7.5RP8/6	7.5RP8/4	7.5RP8/3
50	7.5RP7/8	7.5RP8/6	7.5RP8/4	7.5RP8/3
60	7.5RP7/8	7.5RP8/6	7.5RP8/4	7.5RP8/2
70	7.5RP8/6	7.5RP8/4	7.5RP8/3	7.5RP8/2
80	7.5RP8/4	7.5RP8/3	7.5RP8/2	7.5RP9/2
90	7.5RP8/4	7.5RP8/3	7.5RP8/2	N9

5. Conclusion

5.1 Subjective colors can not be observed when thickness d of Area B equals to thickness D of Area A.

When there is small difference between d and D, subjective colors can be observed. Lateral inhibition relates to Benham type subjective colors.

5.2 Subjective colors observed for continuous change of angle θ are described.

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2) A. Tanaka, N. Hashimoto, S. Ohnishi, Y. Kurioka : Henkei-Benham-Zukei niyoru Shyukansyoku no Kenkyuu, Denkikankei-Gakkai Kansai-Shibu Rengoutaikai G341, 1999.

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A Study for Natural Dyeing Colors of the Dyeing Antiquities of China Silk Road and the Korean Traditional Dyeing Aniquities

Ji-Hee Kim , Young-Lan Kim

Abstract

After doing research on the exchange and trade of textile through the Silk Road, we studied and compared the traditional SilkRoad of Chinese and Korean colors. The purpose of study is to be grafted together an today with the ancient preciousness techniques, and it give a motivation for originality of textile crafts.

Scope of Study, It will be studied for the textiles of silk road in China and for the existing the dyeing antiques of Korean traditional textiles rough coloring of standerds(COS) and natural colors in Korea.

In result, we could discover the dye colors, dye material, history, virious methods passed through the Singang area, which was the center of trade between the east and west cultures. We could also learn the connection between the past and the present in the textile history.

The colors used in generally between both countries were blue by indigo, Red pink by safflowrdye, Violet by the root of Gromwel, Jade color by Madder dye, Purple by Soppan wood dye, Yellow by Cape jasmin, or Amur Cork Tree, White by own color of the Fibers, Black by Indigo composited dyeing of Rhusjavanica and chestnat shell and black Chinese ink.

1. Introduction

The textiles of China, Korea and Japan have given many influences to each other through the Silk Road. This study is focused on the similarities and differences of the colors and patterns of various dyeing antiquities, by comparing the dye stuff and dye colors. In doing so, we could learn about the cultural exchange and understandings of that period between the countries. Furthermore, we could adopt some of the ancient patterns, colors and dyeing methods to the modern textile craftworks.

The antiquities which were studied were Chinese textile from Singang area where active trade took place via the Silk Road, and those from the Han-Dang Period. The Korean textiles studied were those observed from the wall paintings of Kogureo Dynasty and also from the Baekje, Shilla, Koryo, and Chosun Dynasty. Among these, texiles which are similar to the Singang textiles were chosen.

We did our research by photograph and using Coloring of Standards(COS)[1]. We could not use the color measuring device directly on the antiquities and the colors were quite faded. Therefore we did our studies based on the dye stuff and dyed colors[2] of those periods.

Kim, Ji-Hee : Professor, Fine Arts College and Graduate School of Design, Catholic Univ. of Taegu, Korea.

Kim, Young-Lan : Poster Master, Department of Textile Engineering, Textile Univ. Shanghai, China.

1.1 Dye Colors of Chinese singang Textile

After doing research on textile[3] trades in the Singang area of the Silk Road. We have studied the traditional colors of China and Korea through antiquities of that period.

We could learn the connection between the present and the past in terms of dye colors and textile history, through the east and west exchange in trade[4]. The influence of Silk Road textiles on Korean is Shown, compared in Chart 1 and 2.

We could see that the western culture had flown into the Singang Silk Road and so the Singang textiles have rather dissimilar colors 5, compared with the Chinese and Korean 5 bright color groups.

1.2 Dyed Colors of Korean Traditional Textile

1) COS : Sample Survey for Fashionable Color, Prefer the COS almost Traditionl Color than Munsell Sample.
2) Kim Je-Hee, Traditional natural Dyeing of Korea DAEGU, Metropolition City, Myoung In Press, 1992.
3) Wang binghua, A Conception for Xinjiang and The sentral districs Relation History, Archaeology Magazine, Beijing, 1996.
4) Wu min, Dye and print culture discovered in Tulufen from the Tang age. Culture, No.10, 1973.

The Traditional dyeing cloth were hemp cloth, ramie fabric, cotton, silk, wool, wooltop, and they were classified as "Joo", "Sa", "La", "Neun", "Keum", "Dan"(kind of silk)[5] according to the different patterns and weaving techniques. The 3 examples of historic textiles which are not shown in the chart 1 and 2 below are Silk of weaving by slanting pattern, Brocade of warp threads, Costume for Dancers and Musicians.

Table 1. Comparisum color of Traditional Textile remains from the Silk Road and korea

China remains	Color Investigation	Photo No	Korea remains	Color Investigation	Photo No
1.silk kerchif with red and blue rhombus checks [6]	PB3-40060	Photo A1	1.Blue twill weave silk with pattern	PB2-40080	Photo B1
2.mesh kerchief with brown and black [7]	R2-25010	Photo A2	2.black lacker cap from the Tombs of Nakrang Age at the Subrbs of Pyungyang [8]	R2-25010	Photo B2
3.woolen fabrics with triangular embroideries on the red ground	R4-80100 YR4-70100	Photo A3	3.Brocade with weave[9]	R4-60120 YR4-70100	Photo B3
4.brocade with geometry and beads design	R1-50120	Photo A4	4.twill weave silk with flower pattern	R1-40100	Photo B4
5-1.felt with brown and blue check pattern	PB2-50025	Photo A5	5. felt cap (the suk joo sun Memorial Folk Arts Museum)	PB2-50040	Photo B5
5-2.woolen twilled fabrics with projecting line	R4-50140	Photo A6	6.leno patterned "La" Silk bag (Onyang Folk Museum)	R4-50160	Photo B6
6.woolen tapestry with square spiral pattern on bright red ground	R3-00100 R3-40120 GY4-40020	Photo A7	7.brocade from the silla age (by Min Gill-Ja)	R3-70060 R3-60020	Photo B7
7-1.woolen robe with paired human figures, animals and trees design on red ground	R4-50140 R4-70120	Photo A8	8.satin weave silk with cloud pattern from the Chosun age	R4-50110 R4-70080	Photo B8
7-2.long triangular woolen fabric with a pattern of creeping plants, trees design	R2-60080	Photo A9	9.orange color textile by woven in golden threads [10]	R2-60080	Photo B9
8.woolen rug with lion pattern	R3-60065	Photo A10	10. envoy of correspondence 10-9 woolen carpet with mystical unicorn lion pattern [11]	R3-60080	Photo B10
9.brocade with large beads and deer design	R4-60060 R1-20030	Photo A11	11. woolen carpet by deer pattern[12]	R4-75025 R1-20060	Photo B11
10.brocade with medallion and beads design	RY3-60100 YR3-30049	Photo A12	12. envoy of correspondence 10-10 woolen carpet with flower pattern design [13]	YR2-60080 YR2-45050	Photo B12

3) Wang binghua, A Conception for Xinjiang and The sentral districs Relation History, Archaeology Magazine, Beijing, 1996.
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7) kim youngran, A Study on the Traditional Technology and Aesthetic Characteristics of Woven and Embroidered Products in Ancient China, Textile University, Doctoral dissertation, Shanghai,1999.
8)-9) Min Gill-Ja, Traditional Textile, (as shown reference NO.5 on page2)
10) Museum of Dongkook University
11) -12) Onyang Folk Museum

Table 2. Comparison color of Traditional dye and print[13], gold foil with printed Textile remains from the Silk rode and korea.

China remains [14]	Color Investigation	Photo No	Korea remains	Color Investigation	Photo No
1. Brocade weacen of letter pattern	PB4-50080 YR2-85030	Photo A13	1.indigo color textile by weaven in goden threads	PB2-30100 YR4-70100	Photo B13
2. silk tabby with printed hunting design	YR1-80100 YR3-80100	Photo A14	2.wall painting of Kogury hunting pattern	R3-80020 R4-40045	Photo B14
3.green silk gause with printed white spots	YR3-60030	Photo A15	3. twill weave silk with turiioise shell pattern on yellow	YR3-70060	Photo B15
4.silk gause with printed flowers on dark red ground	R3-80080 R3-90020	Photo A16	4.clamp resist dying silk [15]	R3-80060 R3-90020	Photo B16
5.gold foil with printed pattern	YR2-55050 R4-40045	Photo A17	5.leno with printed gold foil[16]	R4-50140 YR4-70100	Photo B17

2. Conclusion

The common characteristic of both Chinese and Korean colors was that under the principle of Yin-yang[17], the same tone of 5 bright color groups and 5 pale color groups were used in dyeing. The 5 bright color groups are blue, red, yellow, white and black, which imply Yang, the sky and masculinity. The 5 pale color groups are light blue, light red, light yellow, green and purple, which imply Yin, the earth(ground) and feminity. These two color groups were used to symbolize such meanings.

The borderlines of color, chroma, luminosity were not formalized, so their usage were quite flexible. Therefore green could be substituted by blue and red, by brown. This flexibility extends to the daily life, religion and the philosophy of life. Of course, since dyeing was traditionally done in the palace and homes, the differences in dye stuff, dyeing methods, the number of dyeing times lead to color differences.

The most popular colors used in both countries were blue from indigo, red(pink) from safflower, sappan wood or madder, yellow from cape jasmin, amur cork tree, Chinese scholar tree flower, white from the natural color of non-dyed cloth, black tone from composite dying of melphis and indigo or Mordants acetic acid(FeCH3Coo2) with one of the three materials; chestnut tree, ori tree, amur maple. Also black can be obtained by pine tree, charcoal, black Chinese ink. Various colors were made by mixing two bright colors into pale colors.

Among the Chinese colors, the western colors and patterns were shown, introduced through the Silk Road, in the Singang area. Also, there were Haetae(imaginary animal) patterns or lamb patterns found on Korean wool woven carpets[18], which were also the influence of the west by trade.

The color names were mostly similar and common in both countries but still, there were many discrepancies in the names. It would be interesting to study those names in other future studies.

Photography of Comparisum color by Traditional Dyeing Textile Remains from the Silk Road and Korea.

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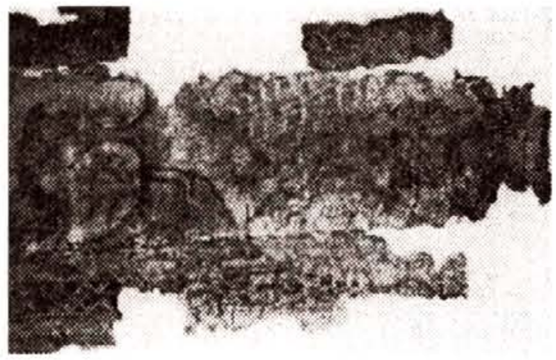
5) Wang binghua, A Conception for Xinjiang and The sentral districs Relation History, Archaeolagy Magazine,Beijing,1996.


〈Photo A1〉


〈Photo A1〉


〈Photo A1〉


〈Photo B1〉


〈Photo B9〉


〈Photo B 10〉

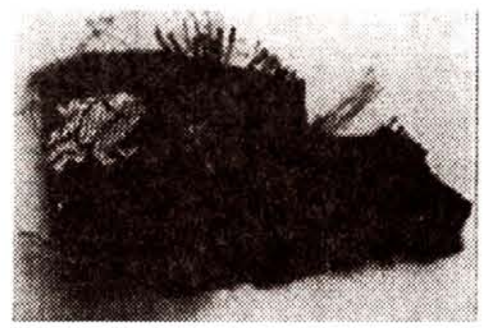

〈Photo A11〉


〈Photo A12〉


〈Photo A13〉


〈Photo B11〉

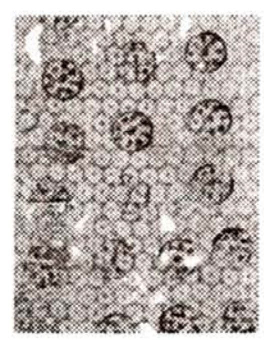

〈Photo B12〉


〈Photo B13〉


〈Photo A14〉


〈Photo A16〉


〈Photo B14〉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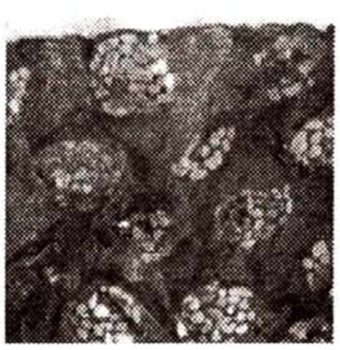
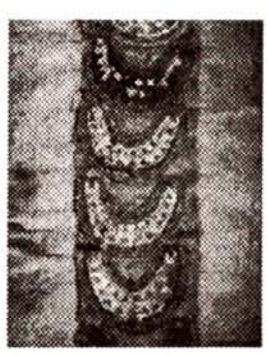

〈Photo B17〉


〈Photo A17〉

Photograph of colors of the Dyeing Antiquities in China Silk Road and Korean

Color Analysis for the Color Planning of Traditional Casual Wear

Hyunji Oh, Young In Kim

Abstract

The purpose of this study is to understand and show how traditional casual wear brands organize practical color information that match the needs of both of the market environment and consumer requirements. In this study, focused on Traditional Casual Wear, practical colors were collected and color-planning processes were researched. The results are as follows:

Traditional Casual Wear as a whole showed high concentration color ranges in the order of Yellow-Red, Purple-Blue, Yellow and Red. The tones are concentrated in dark grayish, grayish, light grayish and pale colors in which various hues of toned down colors are used. The noticeable seasonal characteristic in practical colors does not appear in hue, but in tone. Subtle, modern, warm, and unified images are pursued with color combinations and the mixture of colorless color and monochromatic combination are distinct.

On the basis of these results, the representative colors of traditional casual wear and color palettes for the different brand images are chosen.

Keywords : traditional casual wear, brand image, color image, practical colors

1. Introduction

As color palettes and color combinations used in fashion brands represent image of the brand and product, as well as brand character, we should closely look into whether the practical colors in fashion are appropriate in actually delivering the right brand image.

The subject of this study is focused on Traditional Casual Wear, which in the domestic market has started in the late 80s and is an area that has recently shown the biggest growth. This market has steady consumers due to the products being basic and not being effected by trends. It satisfies the needs of current consumers' life style, seeking for quality and comfort, and is appreciated from those who are conservative elite with high income.

And traditional Casual Wear brands differentiate their image with color palettes through basic styles.

Hyunji Oh, Young In Kim Dept. of Clothing and Textile
Dept. of Human Environment and Design*
Yonsei Unversity
Shinchon-dong 134, Sudaemun-ku
Seoul 120- 749 Korea
Tel : 82) 02- 361-3105
Fax : 82) 02- 361-3105
E-mail : jioh@hotmail. Com Youngin@yonsei.ac.kr

Therefore this study that focus on Traditional Casual Wear, aims to suggest a representational color story that can be utilized for different brand images. In order to do so, there needs to be analysis of color characteristics that are actually used and find out the sort of image that it represents.

By closely analyzing the difference of colors used in different brand images and defining the field, will enable us to establish a basic color information resource that can contribute to the brands to have scarcity value in a rapidly changing fashion industry.

2. Method

In this study, an analysis has been done on Traditional Casual Wear brands color planning process as well as actual colors used in the domestic apparel market. For a rational accumulation of color information, 10 brands (Bean Pole, Cart Blanche, Henry Cotton, Hunt, Ken Collection, Lyle & Scott, Nautica, Olzen, Polo, Scofield) have been chosen that have high awareness with high market share.

Color palettes for '99 F/W and '00 S/S has been accumulated from each brands design or product planning department and measured against Macbeth Color-EYE 580, then converted into 10 colors and 12 tones using Munsels HV/C value.

3. Results

According to the results of this study, characteristics of color planning and practical colors used in Traditional Casual Wear brands are as follows.

First of all, domestic Traditional Casual Wear brands in general, has a basic color palette khaki, beige, white, ivory, navy blue - and color combination regardless of season. The basic color range is conceived more important than seasonal colors, with the tonal changes depending on trends.

Secondly, Traditional Casual Wear as a whole showed high concentration color ranges in the order of Yellow-Red, Purple-Blue, Yellow and Red. In terms of seasonal difference there is a concentration on Purple-Blue for S/S, where as high concentration is seen in Yellow for F/W (Figure 1).

Also, different color palettes are used in terms of brand image, where as can be seen in European image, the concentration is on Yellow-Red which expresses richness, warmth and comfortableness versus American image where they use more Purple-Blue, showing more variety and activeness.

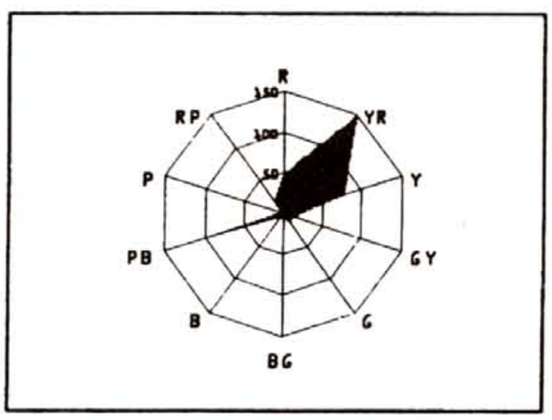


Figure 1. Color Distribution in Hues

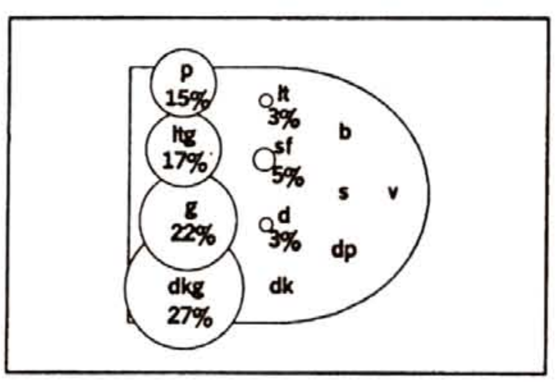


Figure 2. Color Distribution in Tones

Third, the tones are concentrated in dark grayish, grayish, light grayish and pale colors in which various hues of toned down colors are used. This expresses gravity, plainness and softness in image (Figure 2). Compared to F/W where more dark grayish colors are dominant, S/S use more high hues of toned down colors through pales and light grayish colors.

By image, American/Basic image shows more variety with same levels of various color concentrations. American/Trendy image has more concentration in dark grayish colors that shows more gravity and somewhat dull image. European image in general has high concentration in darker colors compared to American image, which leads to gravity and masculine image.

Fourth, major colors used for í99 F/W are grayish Yellow-Red, dark grayish Purple-Blue, dark grayish Yellow-Red, dark grayish Yellow and light grayish Yellow. For í00 S/S, dark grayish Purple-Blue, grayish Yellow-Red, light grayish Yellow-Red, pale Yellow-Red, grayish Yellow, and pale Yellow are mainly used (Figure 3). This proves that colors used in Traditional Casual Wear does not show much difference in the colors used, but has a distinct difference in the tones of color. In terms of image, American image and European image both use a districted zone of colors, but with American image using more variety of colors within it, shows more variety.

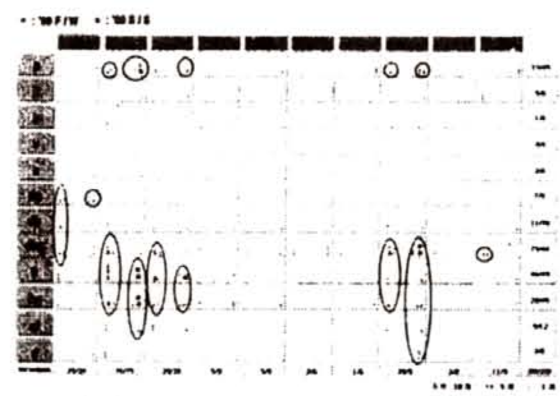


Figure 3. Color Distribution by Season

Fifth, as for color combination used in Traditional Casual Wear, combination of colorless colors shows faintness and modernism, where as identical colors have easiness and mildness in 2-color combinations. 3-color combinations use dark grayish or neutral colors, which has modern and energetic or dynamic atmosphere. Also in terms of color combination by image, American/Basic image uses strong and dynamic combinations, American/Trendy image uses a soft combination with little variation in color, European/Basic image uses various colors and tones, and European /Trendy image uses familiar, friendly color combinations.

Sixth, based on the results above, 31 colors were abstracted from Traditional Casual Wear based on the frequency of usage, and a color palette was suggested by image(Figure 4). Red shows maturity and classic, Yellow-Red shows sophistication and comfortableness, Yellow shows soft and elegance, Green-Yellow and Green shows gravity, Purple-Blue shows modernism and stableness. These are representational colors and images used in Traditional Casual Wear.

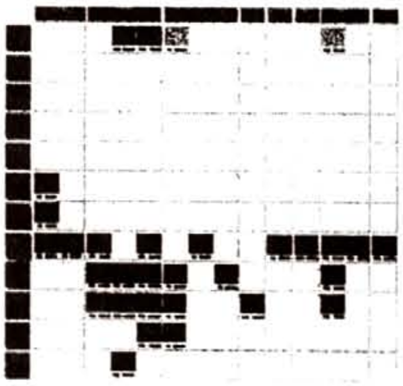


Figure 4. Color Palettes for Traditional Casual Wear

For color palettes by image, beige and navy blue are suggested basic colors and with this, American/Basic expresses a familiar and active image with the use of various colors and tones, American/Trendy suggests a palette concentrated towards darker colors in the dark grayish, and grayish color zones. European/Basic suggests a soft gravity atmosphere through the use of Yellow-Red and Red with more light grayish colors. European/Trendy has grayish and dark grayish colors for a stable and masculine image.

4. Conclusion

With the importance of color being used as a tool for expressing a brands original image, and image being a key factor in the current fashion industry, it is essential to analyze color in all areas of apparel. Through colligation of this study outcome, the importance of color in expressing the image for Traditional Casual Wear is proven, and shows difference in major colors and color combinations. In the area of Traditional Casual Wear, where the use of basic colors and basic color combination is highly important in emphasizing the tradition and maintenance of basic style images, systematic color information is highly necessary in order to establish and express the unique character of a brand image.

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Analyzing the Influence of the Lightsource Color on the Evaluation of the Interior Color

Eun-Mi Jin, Jin-Sook Lee

Abstract

The aim of this study is to measure the colorimetric shift by lightsources, analyze the characteristics of color evaluation by lightsources and analyze the influence of the lightsource color on the evaluation of the interior color.

The process of this study is composed of three steps ; 1) Selecting lightsources used in the office interior and measuring the colorimetric shift by physical characteristics of lightsources 2) Analyzing characteristics of color evaluation by lightsources through the evaluation experiment 3) Proposing the index of color design under characteristics of lightources by image types based on the analysis.

Keywords : Lightsource Color, Color, Color Temperature, Hue, Value, Chroma

1. Introduction

Thesedays, the usage of an office is variable and professionalized. So, it is necessary to consider the comfort as the residential space not the labor space. As the color is one of the most important elements of considering the comfort in the space. It is perceived differently by the characteristics of lightsources.

Therefore, the aim of this study is to measure the colorimetric shift by lightsources, analyze the characteristics of color evaluation by lightsources and analyze the influence of the lightsource color on the evaluation of the interior color.

The process of this study is composed of three steps ; 1) Selecting lightsources used in the office interior and measuring the colorimetric shift by physical characteristics of lightsources 2) Analyzing characteristics of color evaluation by lightsources through the evaluation experiment 3) Proposing the index of color design under characteristics of lightources by image types based on the analysis.

2. Measuring the Colorimetric Shift

2.1 The Selection of Objects

As the sample lightsource, four types of fluorescent lamp and two types of incandescent lamp were selected : like bulb color, warm-white color, daylight color, and cool-white color of fluorescent lamp, and halogen and krypton of incandescent lamp. These have color rendering index over 80 that can be used in the interior space.

Among wall color in the interior space, each hue from ten group, R, YR, Y, GY, G, BG, B, PB, P, and RP, was adopted, which was given value 9 and chroma 2 used in general for the interior space in terms of preceded study[1]. Also, value 9,8, and 7 were chosen among neutral, and in the long run total 13 type colors were selected for the experiment. Table 2 shows the used color in the interior space.

Table 1. Lightsources

Kind of lamp	Fluorescent lamp				Incandescent lamp	
	bulb color	warm-white	cool-white	daylight	halogen	krypton
Color rendering index(R_a)	85	85	85	85	99	99
Color temperature (K)	2700	3000	4000	6000	2800	2750
Luminous flux (*lm*)	3350	3350	3350	3250	1450	1500

Jin Eun-Mi, Lee Jin-Sook
Dept. of Architecture, College of Engineering, ChungNam National University
KungDong220, YUSONGKU, TAEJON 305-764, KOREA
Phone : +82-42-821-7733
Fax : +82-42-823-9467
E-mail: jinem@dreamwiz.com

[1]) Lee Jin-Sook, etc., 「A Field Survey on the Interior Color in Office Building」, The Proceedings Paper of the Architectural Institution of Korea, 4., 85~88, 1996.

Table 2. The Wall Color of Interior Space

5 R 9/2	5 YR 9/2	5 Y 9/2	5 GY 9/2	5 G 9/2
5 BG 9/2	5 B 9/2	5 PB 9/2	5 P 9/2	5 RP 9/2
N 9	N 8	N 7		

2. 2 The Method of Measuring

For the purpose of leading to the distorted degree of lightsource colors, color stimuation measured through using colorimeter (CS-100, Minolta) was calculated by colorimetric shift. For measuring colorimetirc shift, D65 was employed as standard lightsource. Based on the wall color shift shown from the standard light, wall color shown from object lightsources was measured and calculated. Used calculating method for it was the equations for CIE L*a*b* color space[2)] defined by CIE.

distortion of the color is rated, in order, at like bulb color and warm white color fluorescent lamp with 3000K color temperature, and at cool white fluorescent lamp with 4000K color temperature. The least distortion is marked at daylight fluorescent lamp with 6000K color temperature.

Table 3. The Colorimetric Shift of Color Samples by Lightsources

Lightsource / Color	Fluorescent lamp				Incandescent lamp	
	Bulb color	Warm-white	Cool-white	daylight	krypton	halogen
5 R 9/2	77.32	71.71	55.98	42.69	87.12	90.87
5 YR 9/2	74.32	70.97	53.05	64.58	84.10	86.85
5 Y 9/2	71.23	66.16	50.16	40.41	82.62	86.68
5 GY 9/2	73.24	68.31	52.93	42.20	84.22	88.52
5 G 9/2	76.39	71.69	55.84	38.61	88.65	92.19
5 BG 9/2	82.88	77.03	60.95	40.44	95.40	98.82
5 B 9/2	90.68	78.26	63.15	46.88	96.29	98.81
5 PB 9/2	84.16	78.49	62.73	43.12	96.39	99.45
5 P 9/2	81.99	76.28	59.76	42.55	93.57	95.55
5 RP 9/2	82.08	76.15	60.15	44.55	93.49	96.29
N 9	88.83	83.83	69.86	53.81	100.94	104.46
N 8	73.35	68.26	53.33	36.23	83.18	85.99
N 7	62.79	59.22	49.24	40.97	71.31	73.46

2.3 Colorimetric Shift

Table 3 is the measuring and calculating result of variation of the colorimetric shift by lightsources. As a result, the colorimetric shift of halogen and krypton of incandescent lamp shows over 80 at almost all color, which tells its higher distorted degree than at any other colorimetric shift. Less

3. The Evaluation Experiment

3.1 The Outline of Experiment

3.1.1 Subjects

Subjects are consisted of graduate and graduated students in department of architecture who have perception of light and color, and their each reformed eye sight was over 1.0.

Table 4. The Composition of Subjects

Sex	Male : 13 Female : 17
Position	Graduate Students : 18. Senior Students : 12
Total	30

3.1.2 Evaluation Adjectives

Six pairs of color image from the preceded study)

Table 5. Evaluation Adjectives

Variable - Simple	Comfortable - Disturbed	Chic - Country
Clear - Dull	Warm - Cool	Soft - Hard

were selected as evaluation adjectives

3.1.3 Evaluation Parameters and Objects

The parameters of the evaluation were value and chroma shown in case of changing both lightsources and wall color.

The lightsources for evaluation were four types of fluorescent lamp, warm-white color, daylight color, and cool-white color, and two types of incandescent lamp, halogen and krypton. Among wall color in the interior space, each hue from ten groups, R, YR, Y, GY, G, BG, B, PB, P and RP, was adopted, which was given value 9 and chroma 2 used in general for the interior space in terms of the preceded study). Value 9, 8 and 7 were chosen among neutral as well. Therefore, totally 78 types objects were made by compounding of six type lightsources and 13type wall colors.

3.1.4 Manufacturing the Scaled Model

Scaled model for the experiment was inevitably built with the reason of peculiarity of the study estimating lots of evaluation objects within short time. As the scaled model experiment already proved its validity), this study was proceed by the 1/10 scaled model.

To be uniformly kept horizontal average illumination in the scaled model interior by the pencil of light of fluorescent and incandescent lamp, the number of lamp was adjusted. Thus one of fluorescent lamp and two of incandescent lamp were set. Horizontal average illumination by these lightsources was ranged around 700lx in the scaled model interior.

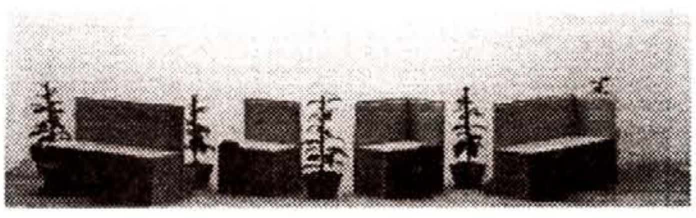

Figure1. The interior of the scaled model

3.2 Experiment Method

First of all, subjects should not be influenced by other lightsources. Thus, first subjects had 5minutes adaptation in the darkroom and then 1minute adaptation by the lightsources through the observation window. After that, the interior image rated from variation of wall color and lightsources was evaluated by the seven step semantic differential method.

4. Analysis

With the value and color by lightsources, which were evaluation parameters, multi-regression analysis was taken the extract color characteristics on the image types. Those each parameter was categorized into the ten colors of R<"RP, 11 steps of neutral, and 3 steps of value 9, 8 and 7.

4.1 Analyzing the Characteristic of the Color by Lightsources

4.1.1 Characteristics of Color at the Warm-White Fluorescent Lamp

All the lightsources under 3000K color temperature had a similar tendency for image types. Table 6 shows the influence of color to the image types in the warm-white fluorescent lamp utilized extensively in the office.

According to the Table6, the 「variable」 image was highly rated at the hues, GY, R, and YR, of the warm color and at the value 9, and the 「chic」 and 「clear」 images was greatly rated at 「soft 」image also had a similar effect at the Y and YR hues of the warm color and at the value 8, and so did the 「warm」 image at the hues, R, YR, and Y, of the warm color and at the value 8.

4.1.2 Characteristic of Color at the Cool-White Fluorescent Lamp

The influence of color to the image types in the cool-white with 4000K color temperature are as follows. The 「variable」 image is highly rated at most of chromatic color with the value 7 except the hue of YR and Y, and the 「comfortable」 image is highly evaluated at the hues, YR and Y, of the warm color

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2) CIE $L^*a^*b^*$ color space was suggested by R.S.Hunter in 1948, and recommended by CIE in 1976. The equation is calculated by the following.

$L^*=116(Y/Y_n)^{1/3}-16$

$a^*=500[(X/X_n)^{1/3}-(Y/Y_n)^{1/3}]$

$b^*=200[(Y/Y_n)^{1/3}-(Z/Z_n)^{1/3}]$

Here X_n, Y_n and Z_n are the tristimulus values of the reference white under the standard lightsource. The colorimetric shift of the two color was calculated by the following.

$E_{CIE}(L^*a^*b^*)=[(\ L^*)^2+(\ a^*)^2+(\ b^*)^2]^{1/2}$

3) Lee Jin-Sook, etc., 「 The Analysis of the Characteristics and the Extraction of the Evaluation Construct Model in the Office Interior Color 」, Journal of Korean Society of Color Studies, No. 7, 61~71, 1996.

4) The former reference

5) Lee Jin-Sook, etc.,「 Verifying the Validity of Experiments in the Scaled Model for Evaluating Colors 」, Journal of Korean Society of Color Studies, No.13, 87~94, 1999.

Table 6. The Influence of Color by Image Types under the Warm-White Fluorescent Lamp

parameter \ Adjective		Variable	Comfortable	Chic	Clear	Warm	Soft
Hue	R	0.421	0.004	0.788	0.054	1.107	0.326
	YR	0.108	0.704	0.655	1.054	1.430	0.650
	Y	-0.169	-0.038	-0.422	-0.220	0.130	0.726
	GY	0.665	0.096	-0.055	-0.220	-0.703	0.126
	G	0.231	0.129	-0.088	0.213	-0.703	-0.060
	BG	-0.102	0.529	0.112	0.146	-0.703	0.141
	B	-0.743	0.284	0.231	-0.028	-0.034	0.112
	PB	-0.433	0.062	-0.222	-0.720	1.097	0.559
	P	0.098	-0.504	-0.322	0.013	0.530	0.493
	RP	-0.169	-0.038	-0.322	-0.420	0.997	0.226
	N	-0.002	0.362	0.845	1.080	-1.703	-1.007
Value	9	0.099	0.086	0.104	0.279	0.300	0.152
	8	-0.601	-0.347	-1.073	-1.655	1.800	1.081
	7	-0.484	-0.601	-1.065	-1.410	1.501	0.588

: The highest value in the score of the categorie

: Difference by 0.1 from the highest value

with the value 9 and 8 ; The 「chic」and 「clear」 images have high effect at the hues, B and PB, of the cool color with the value 9. Also, the「soft」 and 「warm」 images is marked highly at the hues, R, YR, and Y, of the warm color with the value 9.

4.1.3 Analyzing the Characteristic of Color by the Daylight Fluorescent Lamp

The influence of color on image types under the daylight fluorescent lamp with 6000K are grasped through the score of categories. The influence are as table 8.

The 「variable」 image are estimated high in the hue, G, BG, and B of cool-color, and in the value 8, 7. The「comfortable」, 「modern」 and 「clear」 image are marked high in the hue, P, R and RP of warm color, and in value 9. The 「soft」, 「warm」 image are estimated high in the hue, R, YR and Y of warm-color, and in the value 9.

Table 7. The Influence of Color by Image Types under the Cool-White Fluorescent Lamp

parameter \ Adjective		Variable	Comfortable	Chic	Clear	Warm	Soft
Hue	R	0.286	0.023	0.161	-0.093	1.101	0.484
	YR	-0.281	0.423	-0.105	-0.160	1.235	0.617
	Y	-0.047	0.323	0.061	0.140	1.068	0.684
	GY	0.953	-0.277	-0.372	-0.527	-0.165	-0.116
	G	0.619	-0.177	-0.205	.0140	-0.765	-0.150
	BG	0.186	-0.077	-0.505	-0.260	-0.632	-0.150
	B	0.269	0.156	0.259	0.188	-0.453	0.069
	PB	0.886	-0.443	0.261	0.240	-1.532	-1.416
	P	0.481	0.023	0.028	0.273	0.068	-0.083
	RP	0.447	0.057	0.228	0.040	0.468	-0.083
	N	-0.647	-0.010	0.061	0.007	-0.132	0.050
Value	9	0.020	0.023	0.071	0.079	0.026	0.094
	8	0.014	0.023	-0.295	-0.155	-0.107	-0.439
	7	0.202	-0.270	-0.487	-0.714	-0.174	-0.601

: The highest value in the score of the categorie
: Difference by 0.1 from the highest value

4.2 Analyzing the Influence of the Lightsource Color on the Interior Color

The color which can present each image according to lightsources classified by the color temperature was analyzed as follows, based on the result, table 6 to 8, of multi-regression analysis.

In the case of 「variable」 image, the lightsource with 3000K color temperature is appropriate to high value, low chroma color and the hue of R and G groups, and the cool-white fluorescent lamp befitted value 7, chroma 2, and GY and P groups in the hue. Lastly, value 8, chroma 2, and the cool color of G and BG groups were matched well with the 「variable」 image.

Table 8. The Influence of Color by Image Types under the Daylight Fluorescent Lamp

Adjective / parameter		Variable	Comfortable	Chic	Clear	Warm	Soft
Hue	R	0.106	0.450	0.655	0.374	0.466	0.162
	YR	-0.506	0.525	0.388	0.241	0.766	0.329
	Y	0.060	0.359	0.321	0.274	0.333	0.396
	GY	0.627	-0.241	-0.212	-0.159	-0.167	-0.038
	G	0.994	-0.541	-0.712	-0.159	-0.567	-0.171
	BG	1.194	-0.975	-0.579	-0.159	-0.901	-0.771
	B	1.113	-0.611	-0.298	-0.290	-0.989	-0.481
	PB	-0.340	-0.141	-0.612	-0.859	-1.033	0.529
	P	0.194	0.259	0.488	0.641	-0.834	-0.671
	RP	-0.406	0.025	0.495	0.374	-0.234	-0.271
	N	-0.940	0.292	0.021	-0.092	0.366	0.362
Value	9	0.145	0.104	0.035	0.045	0.146	0.106
	8	0.885	-0.396	-0.065	-0.255	-0.787	-1.104
	7	0.736	-0.751	-0.321	-0.243	-0.818	-1.058

: The highest value in the score of the categorie
: Difference by 0.1 from the highest value

In the case of 「comfortable」, 「chic」, and 「clear」 images, the lightsource with 3000K color temperature, was suitably adapted to high value, low chroma and cool-color groups. Under the circumstance of the 4000K lightsource, the 「comfortable」 image was apt for high value, low chroma and the warm-color of YR and Y groups, and also the 「chic」 and 「clear」images befitted high value, low chroma and the cool-color group. High value, low chroma and the warm-color group were suitably matched with the daylight fluorescent lamp. In the「soft」 and 「warm」 iamge's case, high value, low chroma and warm-color were fit for all colors.

5. Conclusion

In this study, the light sources which can be used in the interior space of an office were classified ; Variation of color by the lightsources was measured ; moreover, the characteristics of the color evaluation by the lightsources were analyzed, and the influence of lightsource colors on the evaluation of interior color. The results are as follows.

(1) Under the circumstance of the fluorescent lamps of the bulb color and warm-white color, krypton lamp, and halogen lamp with 3000K color temperature, warm color and value 8 and 9 are fitted with the 「variable」,「soft」 and 「warm」 images. The cool color and value 9 are adapted for 「comfortable」, 「chic」 and 「clear」 images.

(2) In the case of the cool-white fluorescent lamp with the 4000K color temperature, it is highly effective to use the chromatic color and value 9 for the 「variable」 image and the warm color and value 9 for the 「soft」 and 「warm」 image. To apply the YR and Y groups and value 9 and 8 to the 「comfortable」 image is greatly suitable. Also, the cool color and value 9 are fit with the 「chic」 and 「clear」 image.

(3) Under the circumstance of the daylight fluorescent lamp with 6000K color temperature, the cool color of the G, BG and B group and value 8and 7 were highly fitted with the 「variable」 image ; the warm color of the P, R and RP group and value 9 showed good harmony with the 「comfortable」, 「chic」 and 「clear」 images. Lastly, the warm color and value 9 were the most suitable to the 「soft」 and 「warm」 image.

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A Study on the Emotion-Based Evaluation of Color Pattern

Jinsub Um, Sunghan Doo, Kyungbae Eum, Joonwhoan Lee

Abstract

In this paper, we propose two emotional evaluation systems; one is based on the artificial neural network and the other is based on adaptive fuzzy logic system. To realize the proposed systems, for a color pattern we define physical features that can be obtained from digital image processing and emotional features that can be collected from the psychological experiment and represented on the linguistic image scales. According to the Soen's psychological experiment, the two types of features can not be related with linear relations. Therefore, we propose two models to capture and approximate the nonlinear relations between the two features. The two models are inherently nonlinear and capture the relations according to the supervised learning. Proposed systems show better performance to Soen's multiple regression scheme. The evaluated results of color patterns can be used to the emotion-based color image retrievals.

Keywords : emotional evaluation system, neural network, adaptive fuzzy system, image scale

1. Introduction

Nowadays, we live in various color environments. These environments have an important effect on the emotion of human beings. So, the use of color which is suitable to the emotion of a human being is very important in graphic design, fashion design, commodity design, and urban color planning[1-6]. Because the emotions on color can be varied with the environment and human feeling, it is hard to organize and apply it. But the image scale shows how colors are related to images of human beings commonly. It consists of two scales having opposite concepts of 'warm-cool' and 'hard-soft'[1]. Single colors and emotional adjectives are related and arranged in this image scale. This image scale is frequently used in color design. But, this shows the relations between emotions and single color or simple color arrangement. So this is insufficient for applying to color pattern in which various colors are randomly mixed as the textiles and wallpaper. Soen tried to analyze and evaluate human-being's emotion on the color pattern[2,3]. The evaluation system proposed by Soen do not well accord with the evaluated results by subjects, because the human visual system is too simplified into a linear system.

In this paper, we proposed two kinds of the emotional evaluation systems motivated by Soen's psychological experiment. According to his experiment, physical features affect to the emotional features, and it is difficult to define the relation by just linear combination, because there is a non-linear relation between physical features and emotional features. In this paper, two kinds of the emotional models based on the neural network and adaptive fuzzy system are proposed to approximate this non-linear relation[8-10]. These models show good performances, which can approximate the non-linear function through the supervised learning.

Jinsub Um : Korea Research Institute of Standard and Science, E-mail : Youme@chollian.net Joonwhoan Lee, Sunghan Doo : Dept. of Electronic Engineering Chonbuk National University Kyungbae Eum : Dept. of Computer Science Kunsan National University

2. Emotional Evaluation System of Soen

Soen have constructed 30 random color patterns to present them to subjects, and let them evaluate emotional amounts of patterns assigning a numerical value from 7 to 1 on the each 13 linguistic image scales. 18 patterns representing different chromaticity, equal intensity, and 4x4 dot size are on hexagonal plane in fig. 1. 12 patterns representing gray, different intensity, and 2x2, 4x4, 8x8 dot size are in fig. 2. Different dot sizes represent various dynamic components. Image scales he has used include 'like-dislike', 'beautiful-ugly', 'natural-unnatural', 'dynamic-static', 'warm-cold', 'gay-sober', 'cheerful- dismal', 'unstable-stable', 'light-dark', 'strong-weak', 'gaudy-plain', 'hard-soft', and 'heavy-light'. Fig. 1 shows the result of first 18 patterns and Fig. 2 shows the result of second 12 patterns. Here the center and the diameter of a circle mean the position and the evaluation value of each pattern. From the experiment, he concluded that there are several physical features that affect on human feelings including average chromaticity and intensity, and the low, medium, and high frequency components in the color pattern.

Soen has also constructed a system that follows the psychological experiment results using the multiple regression analysis. The system takes inputs as physical features extracted from a color pattern and provides outputs as grades, evaluation values or emotional features, on 13 image scales. Features for the system include average color components $\overline{L^*}, \overline{u^*}, \overline{v^*}$ on CIE-LUV color space, one of uniform color scales, and energies D_L, D_M, D_H in each low, medium, and high frequency band of the Fourier domain. The system is modeled by equation (1). Where, Pi is the emotional value for i-th image scale.

$$P_i = c_{i1} + c_{i2}\overline{u^*} + c_{i3}\overline{v^*} + c_{i4}\overline{L^*} + c_{i5}\overline{u^{*2}} + c_{i6}\overline{u^* v^*} + c_{i7}\overline{v^{*2}} + c_{i8}\overline{u^{*3}} + c_{i9}\overline{u^{*2} v^*} + c_{i10}\overline{u^* v^{*2}} + c_{i11}\overline{v^{*3}} + c_{i12}D_L + c_{i13}D_M + c_{i14}D_H \quad (1)$$

3. Proposed Emotional Evaluation System Based on Nneural Network

The first emotional evaluation system proposed in this paper used the multi-layer feed-forward neural network model for converting physical features to emotional features. The same physical features as Soen's system are used to compare with it. The equation (1) proposed in the Soen's model includes nonlinear terms of $\overline{u^*}$ and $\overline{v^*}$ because effects of average chromaticity are more sensitive than other features. The general characteristic as well as an independent characteristic of the six physical features can be considered in neural network based model, because the six physical features through the hidden layer are nonlinearly combined. Proposed neural network model consists of the 6 input units, 5 hidden units, and 13 output units as shown in Fig. 3. Each input of the input layer is the physical feature value such as average color components and energies. Each output of the output layer is the emotional evaluation value on the 13 image scales. Input in the set of training data consists of physical features and outputs are emotional evaluation values of 30 random color patterns, that is the same set in Soen's experiment. The error back-propagation algorithm is used for training of the neural network.

4. Proposed Emotional Evaluation System Based on Adaptive Fuzzy Logic System

Soen's experimental results show two types of random color patterns have an influence on the emotional evaluation. They explain the effect of average chromaticity in equal average intensity and average intensity and dot size in gray as shown in fig. 1 and fig. 2. The results in fig. 2 and fig. 3 are based on RGB space. So, we use new physical features on HSI space converted from RGB space.

As H and S, which represent hexagonal plane in Fig.1, are expressed by the polar coordinate, they are converted to V_a and V_b which are expressed by the rectangular coordinates.

$$V_a = S\cos H, \quad V_b = S\sin H \quad (2)$$

The I is used as an average intensity of fig. 3. Instead of spatial frequency features, the texture feature of intensity image is used, which represent the degree of the coarseness and the fineness of image in fig. 3. The SRE(short run emphasis) of GLRLM(gray level run length matrix), one of the statistical matrices that captures the texture features, is used as texture feature C. So, if image is coarse, C is small and if image is fine, C is large. Now, the "fuzzy If-Then rule" can be created on emotional evaluation value and new four physical features according to fig.1 and fig. 2. The fuzzy rule base on V_a and V_b in i-th image scale can be defined as

$$R^i : IF\ V_a\ is \begin{bmatrix} positive \\ zero \\ negative \end{bmatrix} and\ V_b \begin{bmatrix} positive \\ zero \\ negative \end{bmatrix}, THEN\ EV_1^i\ is \begin{bmatrix} high \\ middle \\ low \end{bmatrix}. \quad (3)$$

and the fuzzy rule base on I and C can be also defined as follows.

$$R^i : IF\ I\ is \begin{bmatrix} high \\ middle \\ low \end{bmatrix} and\ C \begin{bmatrix} fine \\ medium \\ coarse \end{bmatrix}, THEN\ EV_2^i\ is \begin{bmatrix} high \\ middle \\ low \end{bmatrix}. \quad (4)$$

The EV_1^i and EV_2^i are the output value of each logic system on i-th image scale. Final evaluation value is determined after the outputs of two systems are fused by the γ-model, which is a mixed operator of the intersection and union and shows similar characteristics to human decision-making. The block diagram of whole system is shown in fig. 4. 30 random color patterns are also used in training and the error back-propagation algorithm is used for training of the adaptive fuzzy logic system.

5. Experiments and Results

The performance of two emotional evaluation system proposed in this paper is compared with the one of Soen's one. The comparison of performance is done through the approximation ability of emotional evaluation value of 30 random color patterns and the comparison of evaluation value by the color patterns used in reality. Each approximation ability of three systems is evaluated by the correlation between the subjects' evaluation value and the system output according to random color patterns used in training. The results of three model's performance are shown in table 1. The correlation in each scale is equal to following correlation coefficient

$$\rho_i = \frac{\mathrm{cov}(\mathbf{x}_i, \mathbf{y}_i)}{\sigma_{\mathbf{x}_i}\sigma_{\mathbf{y}_i}} \quad (5)$$

The more ρ_i is close to one the more a model is exact. The *i* is a number of the image scale and xi is an evaluation value of random color patterns by a subject. The y_i is the output of the system. Most correlation coefficient except 'hard-soft' is better than Soen's model when comparing Soen's model with neural network model as table 2. There are the 14×13 coefficients in Soen's model and the $(7 \times 5 + 6 \times 13)$ coefficients in proposed neural network model. So, neural network model is superior to Soen's model from this standpoint. The model based on the fuzzy logic system shows better result on correlation coefficients than Soen's model and neural network model. We can know the model using a fuzzy logic system and γ-model is best one to approximate a non-linear system for recognizing the human feeling after seeing color patterns. But, this model has more coefficients than Soen's model and neural network model. The neural network model can exactly approximate, when the non-linear characteristic is increased by adding hidden layers and units.

The performances of proposed models are also evaluated by experimenting with five real color patterns in fig. 6 used in the evaluation experiment of Soen's model. Those results are summarized in table 2. First, the mean and standard deviation of the obtained results by the evaluation of six subjects are calculated. After that, we investigated how much degree of deviation from the mean value is in the emotional evaluation value of models. The cases having five patterns within 1 σ error are two in Soen's model an four in neural network model and fuzzy logic system model. The fuzzy logic system model and neural network model generally shows high performance. But, the fuzzy logic system model shows low performance in 'warm-cool' and 'light-dark' image scale.

5. Conclusion

In this paper, we proposed two emotional evaluation systems which objectively evaluate the human feeling with linguistic image scales when seeing the color patterns. Proposed emotional evaluation systems are based on the neural network and adaptive fuzzy system. The adaptive fuzzy system consists of the fuzzy logic system and γ-model. The 13 image scales were used to evaluate the emotional value. The physical features of color patterns are used as an input of system to get the emotional features. The physical features such as average color components and the low-, medium-, and high-frequency components are used in neural network model. And, the average color components and the texture feature are used in fuzzy model.

The research result obtained in this paper has a meaning as follows. At the first, the area using neural network and fuzzy theory was expanded into the psychological area. In this research, the neural network and fuzzy rule base used in the control area was applied to quantify the relatin between the emotion and physical characteristics of the color pattern. At the second, the application area of emotional engineering can be expanded. We believe that this research contribute to the expansion of research area of emotional engineering by quantifying the knowledge of color science and color psychology. So, proposed system can be efficiently applied to emotion evaluation and retrieval in interior design, fashion design, and product design. We believe that this research open a new chapter of retrieval system when using in internet area as well as a analysis of design trend.

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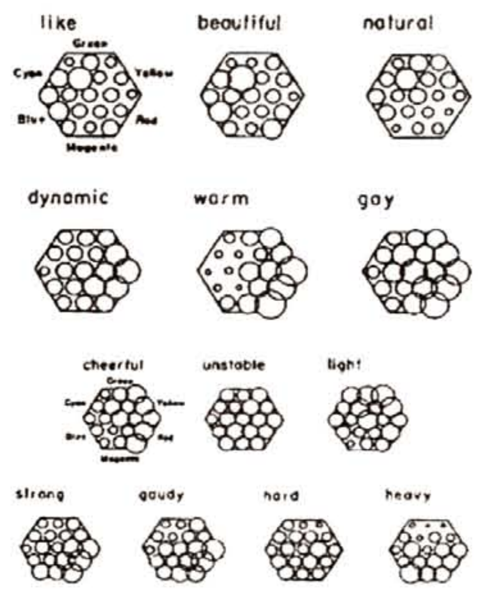

Figure1. Subjects' evaluation value on chromaticity plane

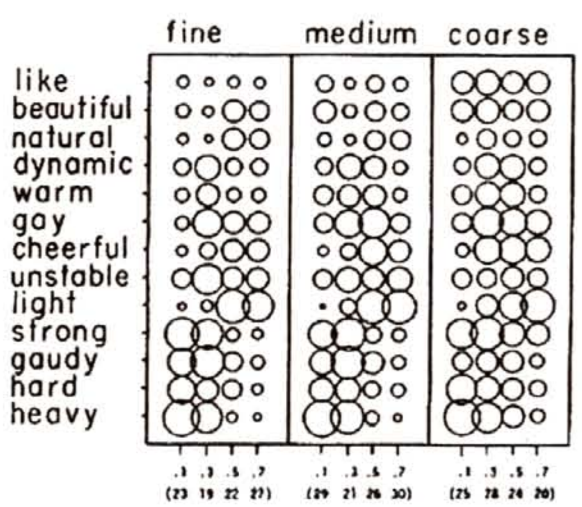

Figure 2. Subjects' evaluation value on intensity and dot size

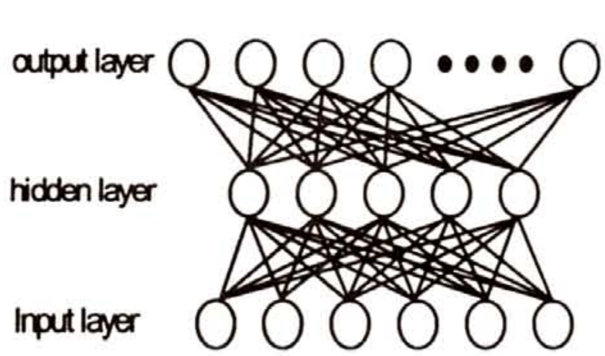

Figure 3. Proposed neural network model

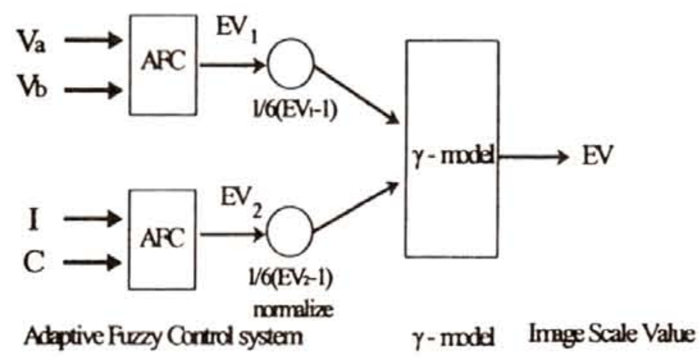

Figure 4. Mixed system of fuzzy logic and γ-model

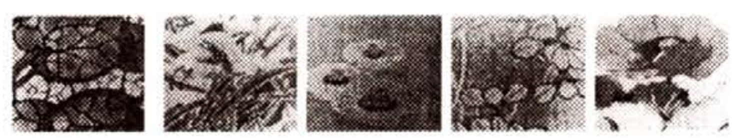
Figure 5. 5 Color patterns which used in test of table 2

Table 1. Correlation coefficients between subjects' evaluation values and outputs of each three systems

Image Scale	Soen's System	Neural Network System	Fuzzy Logic System
like - dislike	0.812	0.825	0.985
beautiful - ugly	0.728	0.727	0.980
natural - unnatural	0.786	0.897	0.998
dynamic - static	0.946	0.942	0.999
Warm - cold	0.917	0.923	0.998
gay - sober	0.925	0.903	0.999
Cheerful- dismal	0.934	0.932	0.985
Unstable - stable	0.836	0.866	0.967
light - dark	0.908	0.945	0.999
strong - weak	0.910	0.959	0.981
Gaudy - plan	0.911	0.912	0.996
hard - soft	0.924	0.884	0.998
heavy - light	0.940	0.967	0.996

Table 2. Number of test patterns within 0.3, o.5, 0.7, and 1 σ

Image Scale	Soen's System				Neural Network System				Fuzzy Logic System			
	.3σ	.5σ	.7σ	1σ	.3σ	.5σ	.7σ	1σ	.3σ	.5σ	.7σ	1σ
like - dislike	1	3	3	5	2	3	4	5	1	2	4	5
beautiful - ugly	2	2	2	3	2	2	4	5	2	2	3	3
natural - unnatural	1	3	3	5	0	3	4	5	1	2	3	4
dynamic - static	0	0	0	0	1	1	2	3	1	2	3	3
warm - cold	0	1	1	1	1	2	2	2	0	0	0	1
gay - sober	0	1	2	3	0	1	4	4	0	0	3	3
cheerful - dismal	1	1	1	2	1	1	1	1	0	1	1	2
unstable - stable	1	2	4	4	4	4	4	4	2	2	5	5
light - dark	0	1	2	2	1	2	2	2	0	0	0	1
strong - weak	0	0	1	2	2	4	4	4	4	4	4	4
gaudy - plan	0	0	0	1	1	2	2	3	1	3	4	5
hard - soft	1	1	3	4	1	2	4	5	1	1	4	5
heavy - light	1	1	1	2	0	0	1	3	0	0	2	4

Distribution of Skin Colors of World Population and its Application for Preparing Make-up Products

Sadaki Takata, Makio Akimoto, Yukio Murui, Akihiro Munakata, Motoji Takahashi, Shigenori Kumagai

Abstract

The expression of skin color is an extremely important element in the evaluation of cosmetics. In this study, we attempted to analyze the skin color of women from the world using identical apparatuses and under identical conditions. The data was used for developing cosmetic products. The skin colors of a total of 1703 women over the world were measured to clarify the characteristics of skin color. Skin color measurement was done by using a spectrometric colorimeter. We modified the conventional erythema and melanin indices and established new respective indices which can reflect various spectral information of whole visible region. The present results were used to design new cosmetics in consideration of the optical properties of skin. Two kind of novel powders were developed to solve the skin problems.

Keywords : skin color, world population, skin pigments, cosmetic research

1. Introduction

To obtain physicochemical properties of human skin color is necessary for developing make-up cosmetics that can produce good finishing. The finishing depends on the extent of suitability for the original color of skin. In the development of make-up cosmetics it is important to reflect basic properties of skin color on cosmetic design. In addition, the requirement of color design which is applicable to the native skin colors of various nations in the world has been increasing as the recent globalization of cosmetic business. Optical measurement by a colorimeter has been used as an objective method for skin color. However, for materials by which light is strongly reflected, it has been known that the inaccurate color measurements can be made by optical instruments. Whereas for living objects such as skin, the color measurement tends to vary with instrumental properties (e.g. the strength of light and the kind of detector), because the proportion of diffuse reflected light is larger than that of surface reflected one. Thus, the measurement using an identical instrument under identical conditions is required. There is no report on skin color evaluation of various races under an identical condition. Aiming at the development of new cosmetics which allows a pretty make-up for the skin of various colors over the world, we measured skin colors under an identical condition using an identical instrument and analyzed the data to clarify the determinants of skin color. Furthermore, the technology which solved the skin specific problems that found frequently in specific race was examined. As the result, two kind of novel powders were developed, and it was applied to the development of new make-up cosmetics which conformed to every women in the world.

Sadaki Takata, Makio Akimoto, Yukio Murui, Akihiro Munakata, Motoji Takahashi, Shigenori Kumagai,Shiseido Research Center at Shin Yokohama
P. O. BOX 224-8558, 2-2-1, HAYABUCHI, TSUZUKI-KU, YOKOHAMA, JAPAN
Phone : +81-45-590-6031 Fax : +81-45-590-6082
E-mail : sadaki.takata@to.shiseido.co.jp

2. Optical Properties of Skin

Skin is composed of epidermal, dermal, and corneal tissues in order from the surface, and horny layer is present on epidermis. The thickness of horny layer, epidermal layer, and dermal layer are 0.01~0.015 mm, 0.1~0.3 mm, 0.3~2 mm, respectively. These are different among regions and races. Either of these layers is optically translucent. In dermis, there are capillaries running deep into the dermis and melanocytes that produce melanin pigment in the substratum of epidermis. It is known that hemoglobin in the capillary blood and melanin, a melanocyte producing pigment as well as carotene, and bilirubin in the epidermis might be involved in the development of skin color. Figure 1 shows that the two reflected components of light are generally produced when the incident light goes into the skin. One is surface light reflected from the skin surface and the other is diffuse reflected light that goes out again from the skin surface after absorption and scattering to the pigments in the skin.(1,2) Surface reflected light is closely related to the brilliance and the feeling of material, which are related to the morphological properties of the skin surface. The skin color is directly influenced by the diffuse reflected light than the surface reflected one.

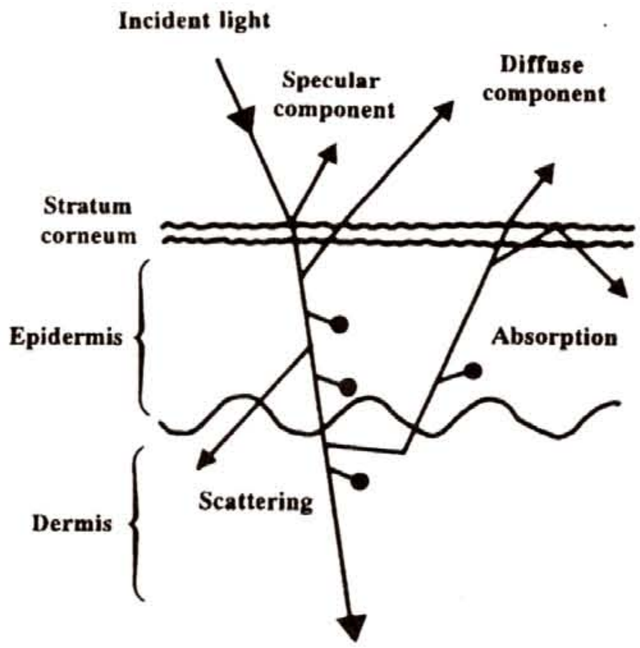

Figure 1. Schematic diagram of light pathway in skin tissue.

3. Experimental Methods

3.1 Subjects

Table 1. Participating subjects.

Subjects	Number
Caucasian	
USA	120
Italy	76
France	60
Australia	48
Canada	5
UK	4
Russia	3
Mongoloid	
Japan	967
Hong Kong	126
Taiwan	60
Malaysia	89
Thailand	62
Negroid	83
Total	1703

A total of 1703 women at 20~40 years of age including 316 Caucasian, 1304 mongoloid, and 83 Negroid were used for color evaluation at an identical skin site. The regions and races subjected to evaluation were shown in Table 1. The skin colors at right and the left sites on the check and the forehead were determined under the same conditions for a period of seven years from 1992.

3.2 Evaluation of Skin Color

Skin color measurement was performed by using a spectrometric colorimeter (CM-1000RH, Minolta, Osaka, Japan). 0Spectro reflectance was measured for each interval of 10 nm in a range of 400~700 nm. The light reflected from an area of approximately 12 mm in diameter is received. Measurement was performed three times at each site in the above mentioned sites excluding uneven-colored and damaged one, and the respective mean values were used for analysis. To measure the skin color with accuracy, the face was washed before the measurement and photograph was taken as a record. The contact pressure was kept constant to minimize the measurement error due to the head contact with the skin.

4. Results

Race-specific skin spectral reflectance that was estimated from the measurements of a total of 1700 or more women over the world were shown in Figure 2. The skin color differences among races were well reflected in these values. For Caucasian womenís skin, the spectral reflectance of light having all wavelengths was high since the lightness of Caucasian womenís skin is high. Especially, the spectral reflectance for red light ranging in 600~700 nm was high. This suggests that there is marked absorption caused by blood hemoglobin of which absorption peak is at 560 nm. Whereas the spectral reflectance of Negroid women was low in all range of wavelengths measured than those of Caucasian and Mongoloid women, showing that the skin lightness was low. The absorption due to hemoglobin was indistinct, resulting in an insufficiency of red component. The skin color of Negroid was thought to be less reddish because the reflected light inside the skin was blocked by melanin pigment in epidermis. Mongoloid women were intermediate between Caucasian and Negroid women in respect of the features of skin color.

Figure 3 shows the skin color distribution expressed by Munsell color system for the representative 800

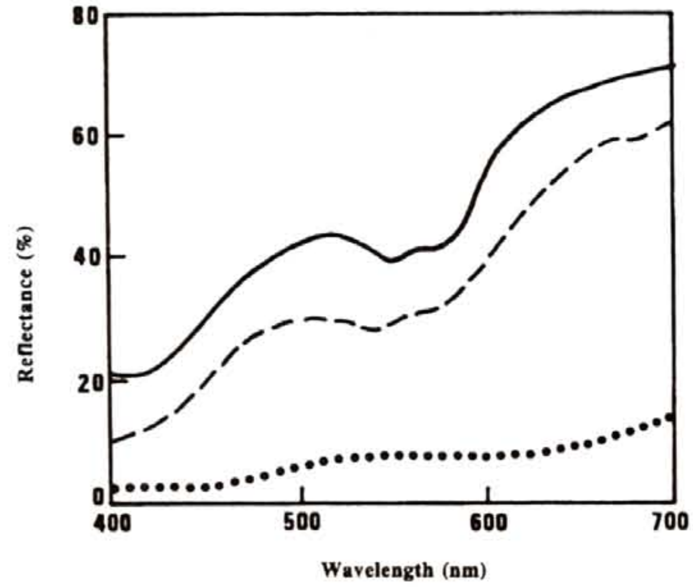

Figure 2. Normal skin diffuse reflectance spectra different of world populations. The line (—), the dash line (– – –), and the dot line (···) represent the skin spectrum of Caucasian, Mongoloid, and Negroid, respectively.

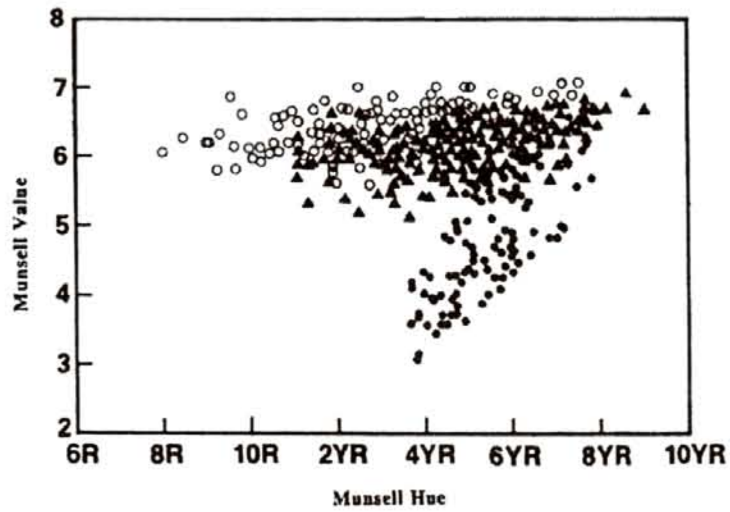

Figure 3. Distribution of skin color of world populations by Munsell color system. The open circle(○), the closed triangle(▲), and the closed circle(●) represent the skin color of Caucasian, Mongoloid, and Negroid, repectively. The x-axis and y-axis are Munsell's hue and value, respectively.

women chosen from 1703 in the whole world. The x-axis and the y-axis show Munsell- hue and its value, respectively. The mean value of Munsell scale was 3.1YR6.4/3.7 for the Caucasian women, 4.9YR6.2/3.8 for the Mongoloid, and 4.8YR4.1/3.4 for the Negroid. These data show that the skin lightness of Caucasian women was similar to that of Mongoloid and both values of lightness were within a range of 6.2~6.4. The Caucasian women's skin was more reddish than the other. The mean lightness of Negroid women's skin was lower by about two than either lightness of Caucasian and Mongoloid women, showing that the former skin was different from the latter two in respect of skin lightness. It is thought that the differences in skin color among races were due to the differences in the amount of melanin pigment produced by melanocytes in the epidermis. Especially, the melanosome which is transferred from melanocyte to keratinocyte in skin, is a larger size than that in Caucasian and Mongoloid women's skins, therefore, the amount of melanin distributed in the keratinocyte is larger and the skin lightness becomes lower. Thus, the hue of Negroid women's skin is shifted to yellow because internal red light due to blood hemoglobin in dermal capillaries is interrupted by melanin pigment. Whereas for Caucasian women's skin, the melanin distributed in the epidermis is less and the red hue of hemoglobin in the dermal layer is more perceptible the internal reflected light, resulting that the skin color becomes reddish in general. (3~7) These facts suggest that melanin pigment and blood hemoglobin in the skin might be the important determinants of skin color.

5. Discussion

Quantitative evaluation was made to clarify the effects of melanin pigment and hemoglobin on skin color. Conventional erythema and melanin indices have been well known as such determinants. These determinants were defined on the basis of pigment absorption, which varies with wavelength, but no data of all visible light range were taken into consideration. Therefore, we modified those conventional indices and defined new respective indices which reflect various spectral information of whole visible region:

$$\text{Hemoglobin factor} = \frac{\log(1/Rg)}{\log(1/Rr)} \qquad (1)$$

$$\text{Melanin factor} = \log(1/Ro) \qquad (2)$$

Spectral reflectance at 400, 560, and 600 nm (Ro, Rg, and Rr) were chosen focusing on the wide range absorption specific to melanin pigment and hemoglobin-specific absorption spectra. Figure 4 shows relationships between the two indices. There was very close correlation between the factors related to melanin and hemoglobin, indicating that skin color differences between Caucasian and Negroid women could be expressed with two factors as to hemoglobin and melanin. We re-examined the problem due to the pigment caused in skin of high hemoglobin factor and skin of melanin factor each other. In addition, we discussed the method to improve the problem. In the skin of Caucasian and the high hemoglobin factor skin of Mongoloid, incident light is scattered in dermis layer, resulting red light go out through the epidermis. Then skin color is more reddish. Therefore, to make up a natural beautiful skin, it is needed to reduce the reddish color. Meanwhile, for high melanin factor skins of Negroid and Mongoloid women, it is likely that the incidence light can hardly reach the dermis or the light which come back to the skin surface is poor even if the light can reach the dermis because, melanin pigment is rich in the epidermis.

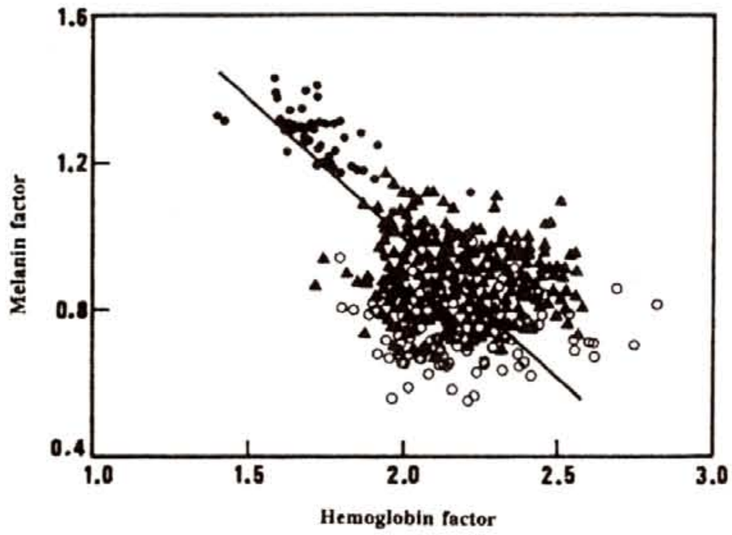

Figure 4. Relationship between the hemoglobin factor and the melanin factor of world populations. The open circle(○), the closed triangle(▲), and the closed circle(●) represent the skin of Caucasian, Mongoloid, and Negroid, respectively. The line shows the regression line.

Thus, such skin has a tendency of unnatural bad complexion. However, the skin with such complexion would be improved by correcting the red hue. Generally, make-up of high hemoglobin factor skin is carried out by correcting its color with a slightly yellow colored foundation, in which the red hue is reduced by compounding with yellow iron oxide. On the other hand, less-reddish skin with a high melanin factor is generally corrected with a foundation containing much amount of red iron oxide. However, such skin color correction by subtracting color mixing method gives rise to a reduction of lightness and a loss of feeling of vivid skin, resulting in unnatural make-up face. Therefore, we here attempted skin color correction by additive color mixing method based on light interference effects but not color correction with pigment.

Two kinds of mica powders coated with thin titanium dioxide were used as the basement of powder materials for adjustment of interference light. For color correction of high hemoglobin factor skin, powders attached with fine spherical polymethyl methacrylate powder (diameter: 0.3°m) after coating with titanium thin film (thickness: 80~100nm) on the mica of a particle size ranging 5~30°m was used. A scheme of the powder model named as prismatic powder A and its electron micrograph is presented in Figure 5.

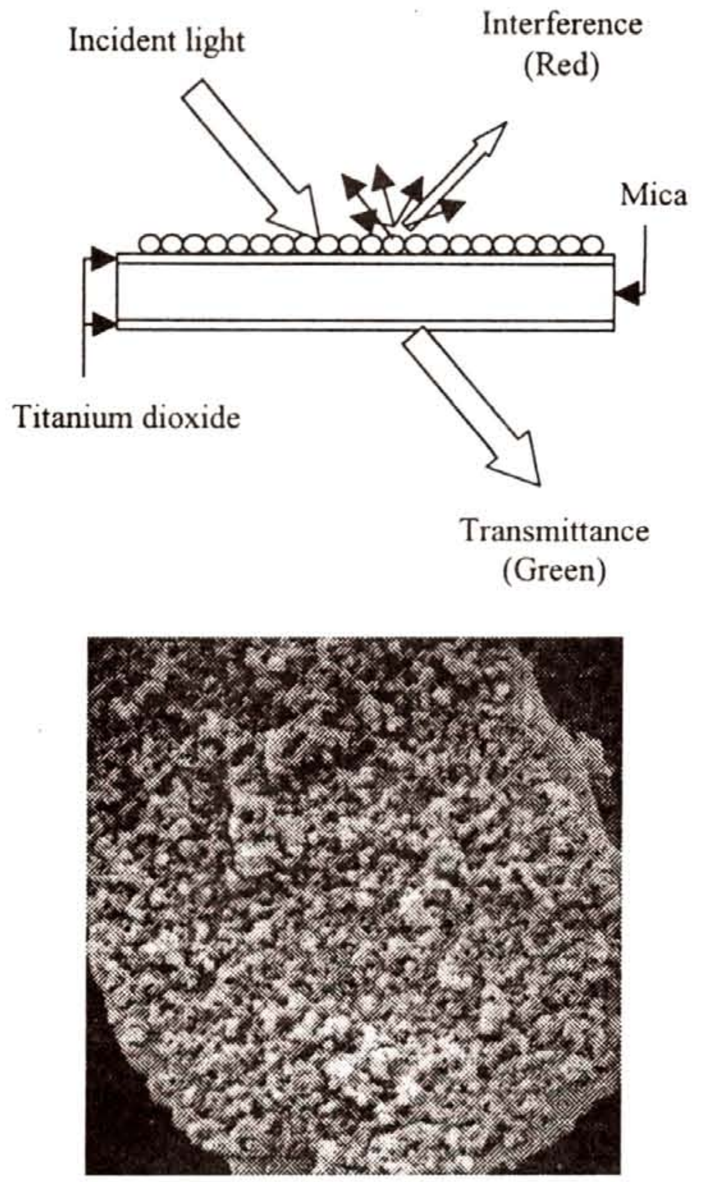

Figure 5. Schematic model and the electron micrograph of prismatic powder A. Note that there are many small particles (diameter: 0.3μ m) on mica coated with titanium dioxide thin film.

As transmitted interference light of prismatic powder A was green light, the light was absorbed by hemoglobin in dermis layer. As the result, excess red light was reduced. The color of high melanin factor skin was corrected using prismatic powder B which produces strong reflected interference light of red color. Thus, poor reddish skin could be improved. A scheme of powder model named as prismatic powder B and its electron micrograph is presented in Figure 6. The optimal combination of these two powders was examined to produce a foundation suitable for each skin color. In this study, we succeeded to produce highly effective make-up foundations applicable to the skin of any colored women in the world.

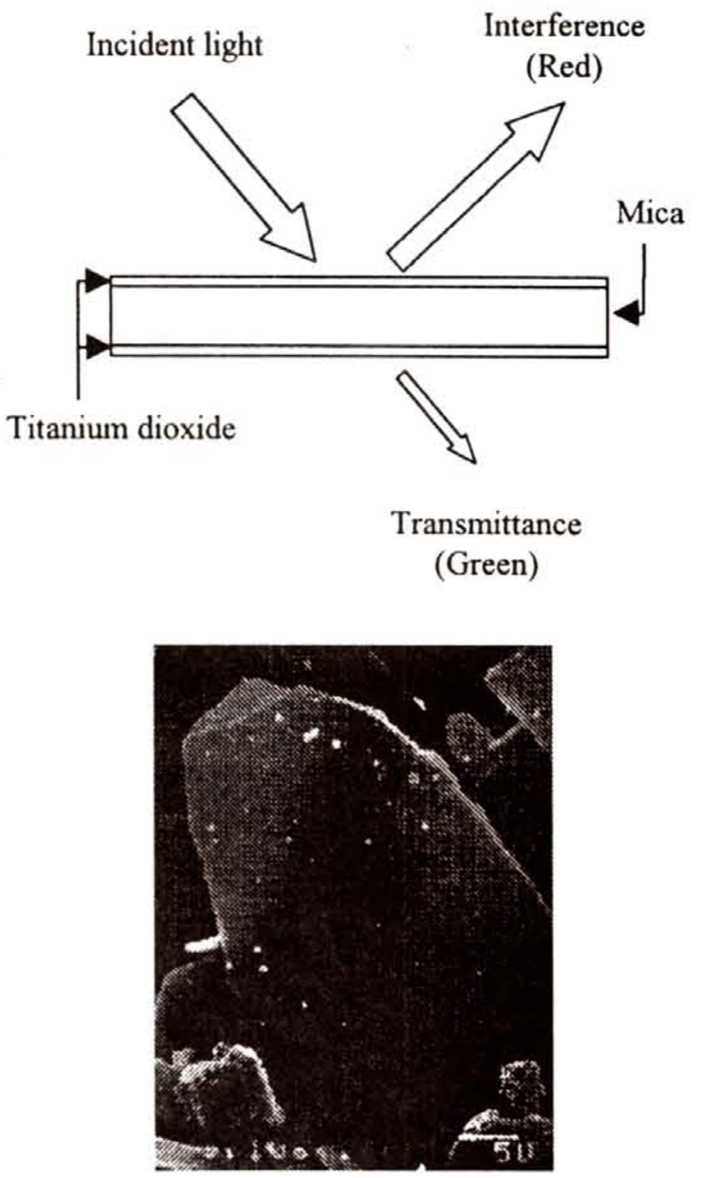

Figure 6. Schematic model and the electron micrograph of prismatic powder B.

6. Conclusion

We evaluated skin colors of a total of 1703 women over the world under identical conditions to clarify the characteristics of skin color. It was demonstrated that the skin color can be expressed with two factors; hemoglobin factor and melanin factor. The present results were applied to formulate new cosmetics in consideration of the optical properties of skin. Thus, it became possible to correct the skin problem and produce translucent and beautiful skin of high lightness by using make-up cosmetics formulating the two novel powders.

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The Developing of Make-up Image Types and Color Palettes According to the Color Sensibility Analysis

Eun-Young Shin, Kyung-Suk Song, Yoo-Mi Choi, Jin-Sook Lee, Chang-Soon Kim

Abstract

This study is a trial for providing further details on sensibility data used in the market. The factors of this study are cosmetic colors and the factors were simulated by the Color Image Processor. An experiment was created and the results were analyzed.

We developed the predictable model of Make-Up Image Types according to the Color Sensibility Analysis. As a result, 5 image types of 「Classic · Elegant」, 「Romantic · Cute」, 「Casual · Active」, 「Sexy · Glamorous」, 「Natural」 were extracted. Then a quantitative predictable model was made between each image and the color factors. Finally, we suggested color palettes for each image based on the results and these palettes will be used for the customerís counseling.

Keywords : color sensibility analysis, make-up image types, color palettes

1. Introduction

Recently, our market was opened to foreign companies and our companies are looking for a market abroad. In doing so, our products must have originality and supremacy. At this point, if the function and quality of the products are similar to each other, there must be a difference in the visual design.

The design of the products is related to human sensibility. Therefore, a scientific study and understanding of this sensibility are important. In this way, we can attain customer satisfaction.

To project color sensibility of the customer to product design, it is necessary to have a scientific tool that can analyze the customerís color sensibility.

This study is aimed at developing a predictable model for researching, predicting and analyzing the cosmetic sensibility of our customers.

Using the Repertory-Grid Development method of an interviewing research method, we extracted image words and estimated a construct model. The construct model is a networking between image words and color factors. The color factors of the second experiment were based on this model. First, a preliminary examination was conducted before the major experiment. Then, after experimentation by computer color simulation, the results were analyzed in factor analysis. The image words extracted in the first step were classified and summarized to establish the cosmetic colors for the image types. Next, we analyzed, in regression, the results of the second experiment and grasped the color characteristics of the image types. Finally, we constructed a predictable model picture to easily comprehend the results of the color characteristics in a network picture.

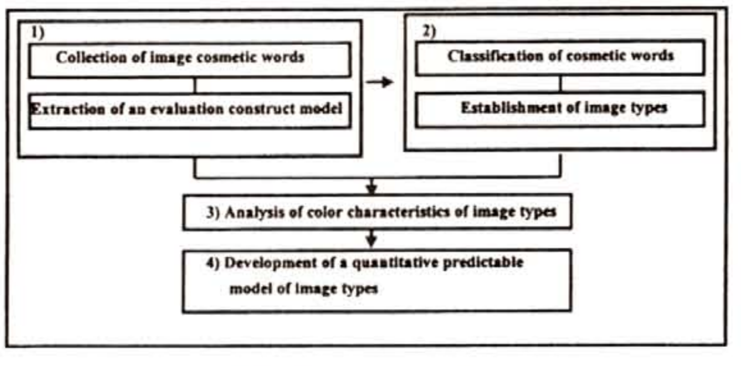

Figure 1. The process of the study

2. The Extraction of an Evaluation Construct Model in Make-up

We made the evaluation construct model using the Repertory Grid Development method of interview

Eun-Young Shin, Kyung-Suk Song, Yoo-Mi Choi 1)
Jin-Sook Lee 2) Chang-Soon Kim 3)
1) Pacific Corporation, 181, 2Ka Hangang-Ro, Yongsan-Ku, Seoul, Korea 140-777
- Phone : +82-2-709-5985
- Fax : +82-2-709-5559
- E-mail : sey@pacific.co.kr
2) Chungnam National University
3) Korea Research Instiued of Standards and Science (KRISS)

research. Evaluation construct model is a connection between image words and color characteristics by frequency ratio.

The Repertory Grid Development consisted of 3 steps. First, a selection of sample elements used in research was taken. Secondly, the voluntary evaluation items conducted on the experimental subjects were extracted. Finally, the data was laddered. The final results of the evaluation were connected with detail characteristics, image words, color characteristics and detail color factors and a structure between the image words and color characteristics were presented. This model was used in the next experiment for establishing experimental factors and words.

2.1 Summary of the Research

2.1.1 Making and Selecting the Elements

In this study, we conducted an interview research on cosmetics. The selection of elements was made by a computer simulator. The elements were created for easy comparison and presentation of the actual cosmetic characteristics

2.1.2 Extraction of Voluntary Evaluation items Used on the Experimental Subjects

We asked the subjects to order the elements in the order in which they liked them. Then, we tried to lead them to answer the direct color sensibility questions when they had seen the elements.

2.1.3 Laddering

Laddering is a method for extracting recognition structure of the higher or lower ranks. By this method, the causal relationship of evaluation items can be made clearly and the mechanism of evaluation can be given some structural reasonability. Laddering consists of ladder-up and ladder-down. Through laddering up, we can extract sensitive image words or the subjectsí evaluation of the higher ranked elements. Through laddering down, we can extract detail color characteristics the subjects had about the elements. Laddering was carried out in the following way:

Ladder-up : "You said that it was good because ◇ ◇. Why was ◇ ◇ good for you? Tell me the reason, please"

Ladder-down : "You said that it was good. Can you please tell me exactly the conditions ◇ ◇ that made you feel this way? "

2.2 The Composition of the Subjects

Subjects consisted of three males and seven females who displayed outstanding word presentation ability. They were specialists in that field.

2.3 Making of the Evaluation Construct Model

Through the above steps, we made the evaluation construct model. The example of evaluation construct model is shown in Figure 2.

The evaluation items extracted above were selected by evaluation words used in section 3. We also extracted the evaluation factors referring to the voluntary evaluation item of the evaluation construct model and extracted the color simulation range of experiment based on the color range of the lower evaluation item in the evaluation construct model.

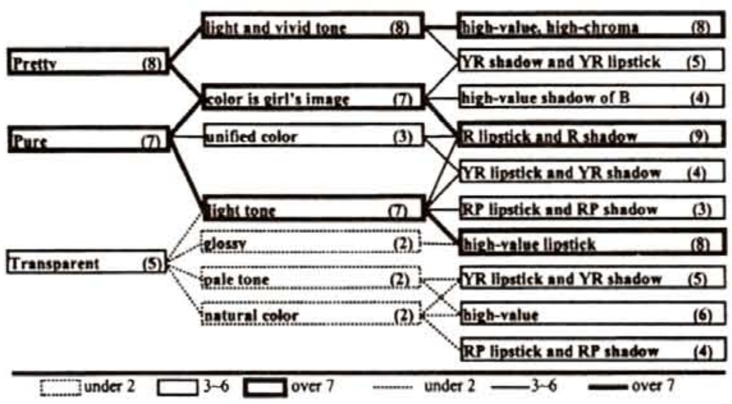

Figure 2. The example of the color evaluation construct model in make-up

3. Evaluation Experiment and Analysis for Developing a Predictable Model and Establishing Image Types

3.1 The Summary of the Experiment

We analyzed the color characteristics of each image type quantitatively by establishing, analyzing and predicting the image types.

3.1.1 Experimental Factors and Objects

The experimental factors consisted of 3 items, eye shadow, lipstick and skin color. These were the lower item extracted in the evaluation construct model in section 2. The objects of the experiment were created in the computerized image processor. The standard factors for each object were the three types of skin colors and the variety of eye shadow and lipstick colors for each skin color type. <Figure3>. During the creation process, we excluded all non-harmonious patterns for a total of 74 objects of which 27 were light skin color, 27 were medium skin color and 20 were dark skin color. The experimental objects were varied only by color and the other factors including face structure and hair style were fixed.

3.1.2 Experimental Contents and Methods

There were a total of 28 evaluation words used, which were extracted from the evaluation construct model. These words are in Table 1. We let the subjects evaluate the objects in 'Semantic Differential Method'. Subjects, all of whom were female, were limited to 12 cosmetic company employees and 8 college graduates in related fields, for a total of 20 subjects.

Experimental objects relied on computer output for easy simultaneous comparison.

Table 1. The experimental image words

Image words		
Glamorous	Formal	Transparent
Gorgeous	Static	Pure
Sexy	Refined	Simple
Unique	Classic	Soft
Active	Intense	Comfortable
Casual	Cheerful	Bright
Natural	Lively	Clean
Clear	Pretty	Elegant
Modern	Innocent	Feminine
Intelligent		

Figure 3. The example of experimental objects

3.2 Results and Analysis

3.2.1 Analysis Method

Data was analyzed using the statistical program SPSS/PC+ and by factor analysis using the varimax rotation method by which the image words were classified. As a result, image types were established and the characteristics by color image were analyzed using HAYASI I, a multi-regression method.

3.2.2 Factor Analysis Results

From the factor analysis, 28 image words were classified. The results are shown in Table 2 . From this analysis, 3 factors were extracted.

The first factor consisted of positive factors [classic, intelligent, elegant, modern, refined, formal, static] and negative factors [casual, cheerful, lively, active]. Therefore, from the first factor [classic and elegant] image was extracted.

The second factor consisted of [clear, romantic, clean, bright, pure, transparent, innocent, pretty] images. Therefore, from the second factor, image of [romantic and cute] was extracted.

The third factor consisted of positive factors [intense, sexy, gorgeous, glamorous, unique] and negative factors [natural, soft, comfortable]. Therefore, from the third factor, the image of [natural] was extracted.

Table 2. The result of factor analysis

factor / image words	1	2	3
Classic	.977	-.145	-4.136E-02
Intelligent	.975	-.116	-.105
Elegant	.970	-.126	8.179E-02
Modern	.962	-7.177E-02	.135
Refined	.947	-.261	-2.308E-02
Formal	.943	-.225	4.032E-02
Static	.898	-.148	-.373
Casual	-.793	.532	2.924E-02
Cheerful	-.780	.557	.212
Lively	-.755	.628	7.725E-02
Active	-.707	.416	.507
Natural	.646	.450	-.538
Clear	-3.866E-02	.948	-9.645E-02
Feminine	-.100	.945	.135
Clean	-.272	[illegible]	-.164
Bright	-.542	[illegible]	.243
Pure	-.428	[illegible]	-.345
Transparent	-.461	[illegible]	-.413
Innocent	-.388	[illegible]	-.518
Pretty	-.630	.707	-.271
Intense	5.429E-02	-9.970E-02	.981
Sexy	3.935E-02	-6.231E-02	.978
Gorgeous	-.148	.157	[illegible]
Simple	.109	.297	[illegible]
Glamorous	.491	.177	[illegible]
Soft	.192	.543	[illegible]
Unique	-.426	-.111	[illegible]
Comfortable	.139	.666	[illegible]
Eigen values	**13.928**	**8.673**	**3.683**
% of variance	**49.742**	**30.975**	**13.155**
Cumulative	**49.742**	**80.717**	**93.872**

3.2.3 The Establishment of Image Type

The image types consisted of the representative image words of the 3 factors extracted in 3.2.2. In the case of the first factor, [classic & elegant] and [casual, active] image types were extracted. In the second factor, a [romantic & cute] image, and in the third factor, a [sexy & glamorous] and [natural] image types were extracted. There were a total of 5 extracted image types as shown in Table 3.

Table 3. Image types

The extracted image types
(1) Classic & Elegant
(2) Casual & Active
(3) Romantic & Cute
(4) Sexy & Glamorous
(5) Natural

3.2.4 The color characteristics analysis of each image type

We analyzed the effect of make-up color sensibility quantitatively by the multi-regression method.
The [classic & elegant] image was under the influence of the medium skin color, gray, brown and red-purple eye shadows and red-purple & brown lipstick colors.
The [romantic & cute] image was affected by the light skin color, pink and orange-yellow eye shadows and pink and orange-yellow lipstick colors. The [sexy & glamorous] image was affected by the medium-dark skin colors, red-purple eye shadow and red, orange-yellow and red-purple lipstick colors. The [casual & active] image ranked high in the medium-dark skin colors, green, blue and orange-yellow eye shadows and pink and orange-yellow lipstick colors. The [natural] image had a great influence on the light skin color, pink and orange-yellow eye shadows and pink and nude lipstick colors.

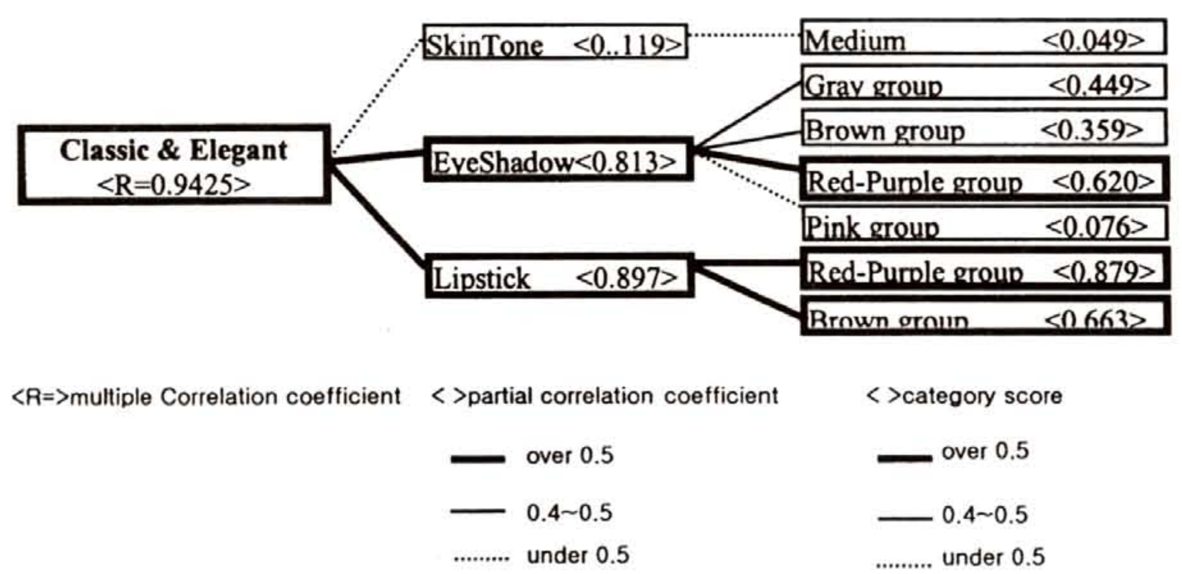

Figure 4. The example of predictable model in [Classic & Elegant] image

3.3 The Development of Predictable Model of Color Characteristics for Each Image Type

We developed the predictable model of color characteristics based on the multi-regression results in 3.2.4. This predictable model suggested the relations between image and color characteristics.
The predictable model of [classic & elegant], [romantic & cute], [casual & active], [sexy & glamorous] and [natural] images were extracted. And the example of [Classic & Elegant] image is shown Figure 4.

4. Results

This study proceeded from the developing of a tool necessary to examine, analyze and predict the consumer's color sensibility in make-up.
4.1 The result of collecting the image words and practicing the interview research through the Repertory-Grid Development Method, the results were as follows:

- 28 image words related to make-up were extracted.
- A visual relationship between the image words and color characteristics were suggested.

4.2 For the purpose of establishing the image types through image word classification and color characteristics analysis, we experimented in computer color simulation and conducted the factor analysis and multi-regression. The results were as follows.

- From the factor analysis, 3 factors were extracted.

5 make-up image types were established representative of each factor. They were [classic & elegant], [casual, active], [romantic & cute], [sexy & glamorous] and [natural].

- We analyzed the color characteristics quantitatively by multi-regression. The results were as follows:

The [classic & elegant] image was greatly influenced by red-purple and brown lipstick colors and red-purple, gray and brown eye shadows.
The [romantic & cute] image was greatly influenced by both pink lipstick and eye shadow colors.
The [sexy & glamorous] image was affected by the red and orange-yellow lipstick colors and red-purple eye shadow.
The [casual & active] image was deeply influenced by pink lipstick and green and blue eye shadow.
The [natural] image was affected nude and pink

lipstick colors and pink and orange-yellow eye shadows.

The results of this study will be used as the basis for understanding the customer's color sensibility and for various color marketing. We will also develop new colors based on this study and will continue the study to understand further color characteristic details.

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Evaluation of Colour Emotion of Male and Female

Ka-Man Cheng, John H Xin, Gail Taylor

Abstract

Colour is an essential component in our daily life. When viewing a colour, an associate feeling or emotion is induced in the minds of the viewer. This feeling or emotion is termed as colour emotion. Different colours usually have different meanings to people. This study aims at evaluating the human colour emotion and quantifying the colour emotion with standard colour specifications. Since different cultural and traditional backgrounds are considered as influential parameters in colour emotion, all the subjects in this study are Hong Kong Chinese and the semantic words describing colour emotions are expressed in Chinese language. The colour emotions described by these words are mathematically modeled using standard CIE colorimetric attributes. The similarity and difference towards colour emotions of male and female are studied and reported in this study.

Keywords: Colour emotions, quantitative, effect of gender towards colour emotion

1. Introduction

The corresponding feeling or emotion induced in the observerís mind during the colour perception process is termed as colour emotion. As suggested by many researchers that colour directly affects the parts of human's nervous system which are responsible for emotion arousal, different colours or colour combinations usually have different meanings to people[1,2]. This study aims at evaluating the colour emotion of human and quantifying the colour emotion with standard colour specifications. Since different cultural and traditional backgrounds are considered as influential parameters in colour emotion for its psychological nature[3], all the subjects in this study are focused on Hong Kong Chinese and the semantic words describing colour emotions are expressed in Chinese language. The influences of hue, lightness and chroma on the colour emotions are studied, and mathematical models are then derived to correlate the colorimetric values and the colour emotions. To examine the similarity and difference towards colour emotions of male and female, i.e., the effect of gender, their visual assessment results are studied and compared in this paper.

Cheng Ka-Man, Xin John, Taylor Gail
Institute of Textiles and Clothing, The Hong Kong Polytechnic University
Hung Hom, Hong Kong
Phone : +852-27666497
Fax : +852-27731432
E-mail : tcrschkm@inet.polyu.edu.hk

2. Experiment

2.1 Visual Assessment

Seventy native Hong Kong Chinese in the age of around twenty were invited to do the visual assessments. Before doing the visual assessment, each subject was asked to undertake the Isihara Colour Blindness Test in order to ensure all subjects possess normal colour vision.

There were 218 colour samples in the size of 1.0 cm x 1.5 cm. They were selected from the SCOTDIC PLUS 2000 system. The SCOTDIC system is a colour specifier containing 2450 shades dyed with disperse dyes on polyester. It is the physical specifications of the Munsell colour order system on textile substrates.

A Verivide artificial daylight D65 with colour temperature 6500K was used as the light source for visual assessment according to the British Standard Specification for Artificial Daylight for the Assessment of Colour (BS 950: Part I: 1967). The colour of background for the visual assessment was neutral gray according to the ASTM Standard for Visual Evaluation of Colour Differences of Opaque Materials (ASTM: D 1729-89). During viewing the colours, a neutral gray mask was used to cover each colour sample in order to ensure the assessment was not influenced by the colour of the surround. The colour samples were illuminated along their normal, i.e. directly facing the light, while viewed at approximately 45° to the normal.

Each subject was asked to fill in the questionnaire when doing the visual assessment. In the questionnaire, five pairs of opponent words for describing the human emotions were "deep-pale", "heavy-light", "transparent-turbid", "soft-hard" and "strong-weak". Since the mathematical models were derived to correlate the colour emotions of the Hong Kong subjects and the standard colour specifications, the word pairs were written in Chinese language. After viewing a colour sample, each subject was requested to select a more appropriate word for describing the colour from each word pair.

2.2 Two-point Method

After receiving the response of the subjects from the visual assessments, two-point method was used to quantify the colour emotion of each colour. In assessing a colour of each word pair, +1 point was given to the selection of "deep", "heavy", "transparent", "soft" and "strong" while − 1 point was given to the selection of "pale", "light", "turbid", "hard" and "weak". The deep-pale, heavy-light, transparent-turbid, soft-hard and strong-weak colour emotions are expressed in term of percentage as DP%, HL%, TT%, SH% and SW% respectively. For example, when the deep-pale colour emotion of colour sample 5R1 are assessed by the subjects, the calculation of the deep-pale percentage (DP%) of 5R1 becomes:

$$DP\,\% = \frac{x \cdot (+1) + y \cdot (-1)}{x + y} \cdot 100\,\% \qquad (1)$$

where x and y are the number of subjects selecting deep and pale colour emotions for colour sample 5R1 respectively; and x+y is the total number of subjects, i.e. 70.

If all subjects select "deep" to describe the colour, DP% equals to +100%. If all subjects select "pale" to describe the colour, DP% equals to − 100%. HL%, TT%, SH% and SW% are calculated using the same method as the calculation of DP%.

2.3 Mathematical Models

The results obtained from the visual assessments as well as the two-point calculation method were used to find out the quantitative relationships between colour emotions and standard colour specifications. Mathematical multiple regression technique was used as a tool to derive models for representing the relationships. The CIE colorimetric attributes, L*, C* and $h°$ are the independent variables whereas each colour emotion percentage is the dependent variable in the mathematical model.

2.4 Comparisons between Different Genders

The visual assessment results obtained from male and female were compared by the correlation coefficient, r, which was calculated as an indication of the similarity or difference in their colour emotions. The correlation coefficient measures the strength and direction of a relationship between two variables and it ranges from − 1 to +1. If r is near or equal to +1, there is a strong and positive linear relationship between the variables. If r is near or equal to -1, there is a strong and negative linear relationship between the variables. If there is no linear relationship or only a very weak relationship between the variables, the value of r will be equal or close to 0. In addition, the colour emotions of male are plotted against those of female so that their relationship can be more clearly shown by the graphical presentations.

3. Results and Discussions

3.1 Mathematical Models

The mathematical models showing the relationships between colour emotions and the CIE colorimetric attributes were derived and shown as follows. Since h ranges from 0° to 360° and the hue at 360° is equivalent to that at 0°, which are equivalent to red colours in perception, but with a very large difference in magnitude, two models were derived for each colour emotion pair, in which one model is for $0° < h \leq 180°$ and another is for $180° < h \leq 360°$, so that the contribution of hue to the colour emotion pair can be better represented.

For deep-pale colour emotion index,

$$DP_{0^0 < h \leq 180^0} = -3.590L^* + 0.451C^* - 0.040h^0 + 189.467 \qquad (2)$$

$$DP_{180^0 < h \leq 360^0} = -3.674L^* - 0.216C^* + 0.098(360-h^0) + 189.127 \qquad (3)$$

For heavy-light colour emotion index,

$$HL_{0^0 < h \leq 180^0} = -3.340L^* + 0.476C^* + 0.037h^0 + 175.467 \qquad (4)$$

$$HL_{180^0 < h \leq 360^0} = -3.477L^* - 0.264C^* + 0.072(360-h^0) + 182.866 \qquad (5)$$

For transparent-turbid colour emotion index,

$$TT_{0^0 < h \leq 180^0} = 2.363L^* + 0.876C^* + 0.040h^0 - 180.640 \qquad (6)$$

$$TT_{180^0 < h \leq 360^0} = 2.119L^* + 1.863C^* + 0.072(360-h^0) - 169.497 \qquad (7)$$

For soft-hard colour emotion index,

$$SH_{0^0 < h \leq 180^0} = 2.900L^* - 0.510C^* - 0.051h^0 - 146.700 \qquad (8)$$

$$SH_{180^0 < h \leq 360^0} = 2.953L^* + 0.424C^* - 0.020(360-h^0) - 159.795 \qquad (9)$$

For strong-weak colour emotion index,

$$SW_{0^0 < h \leq 180^0} = -2.625L^* + 1.185C^* + 0.053h^0 + 116.320 \qquad (10)$$

$$SW_{180^0 < h \leq 360^0} = -2.758L^* + 0.353C^* + 0.050(360-h^0) + 135.877 \qquad (11)$$

where *DP, HL, TT, SH* and *SW* are the deep-pale, heavy-light, transparent-turbid, soft-hard and strong-weak colour emotion indices respectively;
L^* is the CIELAB lightness; C^* is the CIELAB chroma; and h is the CIELAB hue-angle;
the models with $0° < h \leq 180°$ are derived from the visual assessment results obtained from the hue-angles between 0° to 180° and those with $180° < h \leq 360°$ are derived from the visual assessment results obtained from the hue-angles between 180° to 360°.

These colour emotion indices range from -100 to +100. When an index equaling to +100, "deep", "heavy", "transparent", "soft" or "strong" colour emotion is perceived by the subjects. A value of -100 indicates the colour emotion of "pale", "light", "turbid", "hard" or "weak". If the calculated index is outside the boundaries of -100 to +100, it is truncated to -100 or +100 respectively.

From the equations established above, it can be seen that the colour emotions can be affected by lightness, chroma and hue. However, lightness is found to have the largest impact to all the colour emotion pairs than the other attributes because the coefficients of lightness are the largest among all the attributes. As the lightness of a colour increases, it gives the observers paler, lighter, more transparent, softer and weak impressions; while as the lightness of a colour decreases, it induces deep, heavy, turbid, hard and strong feelings to the observers' minds. The influences of chroma and hue are found to be less significant on colour emotions than that of the lightness. Therefore, lightness of colour can be considered as the dominant factor in these colour emotion pairs.

3.2 Comparison between Different Genders

The correlation coefficients, r, of the visual assessment results between different genders were determined and illustrated in Table 1. From the table, it is found that the correlation coefficients between male and female for all colour emotion pairs are larger than 0.9. Among them, the best correlation is found in the deep-pale colour emotion.

Table 1. Comparison of colour emotions between different genders by correlation coefficients

Colour Emotion Pair	Correlation Coefficient of Male and Female
Deep-Pale	0.973
Heavy-Light	0.958
Transparent-Turbid	0.957
Soft-Hard	0.925
Strong-Weak	0.935

In order to have a better investigation on the colour emotions of male and female, the graphical presentation of the correlation of colour emotions between them are shown in Figure 1 to Figure 5.

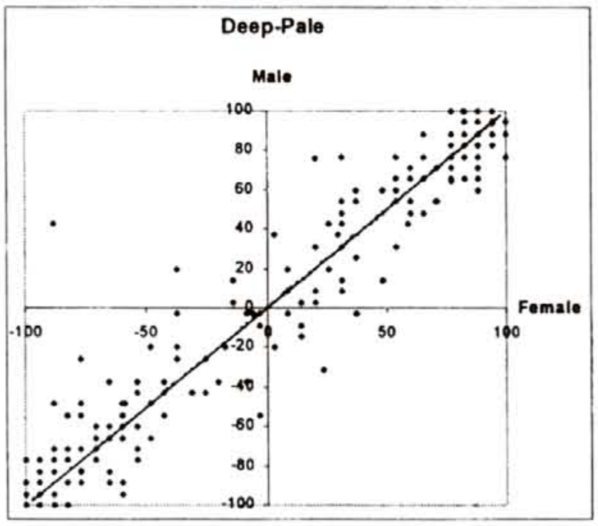

Figure 1. The deep-pale colour emotion of male against that of female

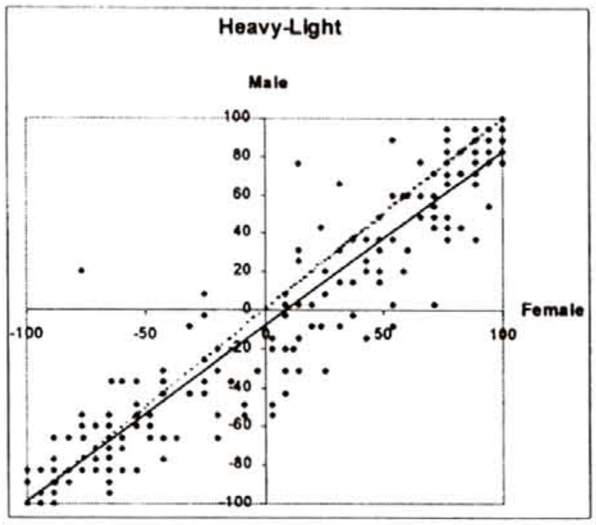

Figure 2. The heavy-light colour emotion of male against that of female

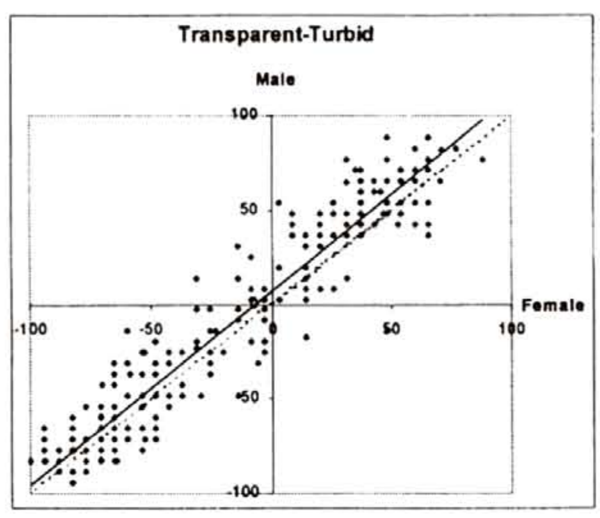

Figure 3. The transparent-turbid colour emotion of male against that of female

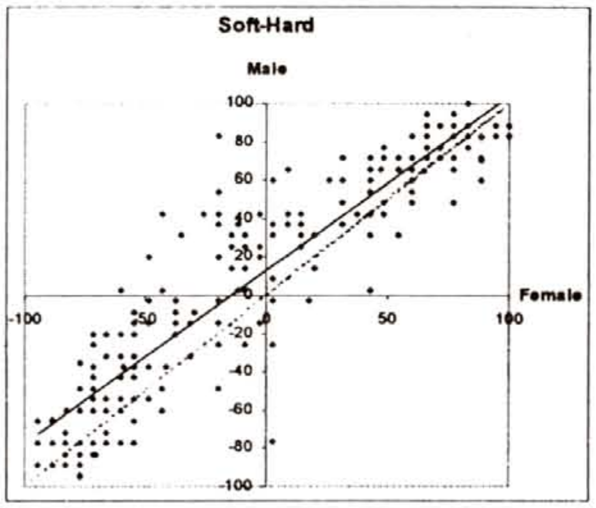

Figure 4. The soft-hard colour emotion of male against that of female

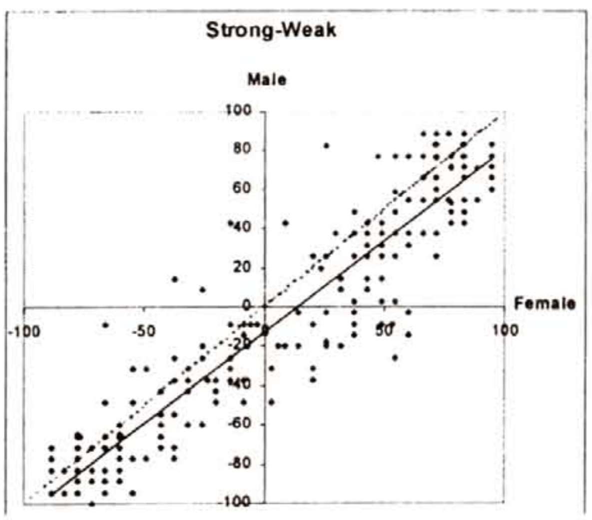

Figure 5. The strong-weak colour emotion of male against that of female

The solid lines in Figure 1 to Figure 5 show the relationships of colour emotion of male and female whereas the dotted lines are the 45° line representing the exact equivalent in colour emotion between them. Figure 1 shows that the solid line appears to be the same as the dotted line, this represents the deep-pale colour emotion of male and female approaches to be the same. In Figure 2, the solid line and the dotted line lie very close to each other at the "light" emotion end, i.e near the - 100 area, whereas the males assess the colour to be lighter than the females do in the "heavy" end, i.e. near the +100 area. This is indicated by the solid line positioning lower than the dotted line in the "heavy" emotion end. For the transparent-turbid colour emotion pair, Figure 3 shows that the solid line is parallel to the dotted line, but the former one shifts to the left of the latter one. This represents the male observers assess the colour samples to be more transparent than the female observers do in general. Figure 4 illustrates that the solid line for the soft-hard colour emotion is close to the dotted line in the ìsoftî emotion end, but the difference between them increases as the points approaching the ìhardî end. It can be concluded that the colour samples induce softer feeling to the male observers than female especially when the colours are approaching to ìhardî colour emotion end. In Figure 5, the solid line of the strong-weak colour emotion shifts to the right of the dotted line, with a comparatively larger difference in the "strong" end. This indicates the male observers assess the colour samples to be weaker than the females do, especially in the stronger emotion area.

4. Conclusion

In this study, deep-pale, heavy-light, transparent-turbid, soft-hard and strong-weak colour emotions were quantified with the CIE colorimetric attributes by the linear mathematical modeling techniques. Ten mathematical models, two for each colour emotion pair, were derived and it was found that these colour emotions have large dependency on the lightness of colours. When comparing the colour emotions of different genders, the deep-pale colour emotion pair was found to possess the best correlation, i.e., the male and female have very similar deep-pale emotion towards most of the colours. For the other pairs, the males normally have lighter, more transparent, softer and weaker feelings for the same colour than the females do.

Acknowledgement

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Categorical Color Naming and the "Missing" 12th Category

Lucia R. Ronchi

Abstract

The appearance of various sets of colored samples is assessed by the use of color naming techniques: the traditional [4+1) one, based on unique hues and that based on the eleven basic categories. However, for every set, some samples are found which cannot categorized in this latter way, so that the observers agree invoking the existence of a XII category. Further work is needed to assert whether the XII is shared by all the considered set of samples. By now we note that it is widely used, e.g., for painting houses, that it is included in several arrangement tests and in Atlases and it might include some of the numerous genera and species of bamboo.

Keywords : color categorization, application to design

1. Introduction

When "the eye" was regarded as a zero instrument, the observer was allowed to use three words: yes, no, doubtful. When suprathreshold techniques entered the visual laboratories, the observer could choose one of five to ten judgements, prudently flanked by numbers, denoting the steps of a subjective scale. The rigidity of Psychophysics warned against the possible contamination due to Psychological factirs. Through accurate selection, training and instructions, the disturbing influences of "higher centers were assumed to be "frosted". Next, the quantification of color appearance needed both an enlargement of the set of responses and modified strategies. It was soon realized that the objective assessment of appearance is possible through a linguistic-based scale.

However, unconclusive data were obtained by allowing the observer to specify the image by using an arbitrary and uncontrolled terminology. The correlation between color and image words is of interest from both theoretical and applied stand points. Through the NTC, ot has been shown that the mental feeling induced by a color, for different people, has some consistencies, and encouraged the systematic investigation of the relation between color image and word meaning. Thus, the image- word research is nowadays one of the official psychological investigations of color (Kobayashi and Iwamatsu, 1997). Moreover, the numerical evaluation of color image words through projections in various color spaces, including the CIELAB space has been proposed. Working along these lines, the membership function between colors and color perception, and between adjectival words and image perception has been determined.

The above concepts have been applied to color design harmony by various authors. A systematic research along the above lines could help the designer to use a color to give the product a particular image perception and to further differentiate the products.

In parallel with the wide field recalled above, another technique to assess color appearance developed, called color naming. The standardized procedur, ealled [4+1] technique, consists in making reference to the unique hues, in terms of percentage of redness versus greenness, or yellowness versus blueness (the sum of these percentages had to equal 100). Next, the percentage of the chromatic versus achromatic component os to be scaled. In a recente paper, Guest and van Laar (2000), after a review of the available literature, describe the structure and the theoretical meaning of the color naming space. Let us consider now the extension of the assessment of color appearance through the following steps:

- while the traditional [4+1] color naming was becoming a method within science to investigate various important issues of perception,
- a naturalistic window onto perceptions was open on the early sixties, by revealing the existence of a limited number (eleven) of corner-stone, universal names, the so-called basic monolexemic categories

Lucia R. Ronchi
Associazione Ottica Italiana
1, Via Suor Maria Celeste
50125 Florence, Italy
Phone : +39.055.223112 Fax : +39.055.222090
e-mail : n.rositani@flashnet.it

(black, white, red, green, yellow, blue, brown, purple, pink, orange, grey)
- cross-cultural investigations continued
- categorization was employed in experiments on complex visual phenomena, such as color constancy, by calling into play memory color
- by preserving a link with the instrumental assessment of color appearance, for instance, the location of categories was assessed in OSA-UCS color space , or in Munsell space , or in further uniform color systems (Guest and van Laar, 2000).

2. Aim of the Work

Our research program, some results of which are reported in the present Poster, aims at assessing color appearance through traditional and categorical color naming, by the use of the samples of Atlases, the caps of a number of screening tests, as well as of sets of samples of colored surface materials used in environmental color design. Ten normal young adults (tested by the use of F-M- !00-Hue test and anomaloscope) took part in the experiment. Moreover, we report the responses of some old observers, as preliminary accounts of a research concerning the optimization of color design in health care units and residences for elderly (Schefrin and Werner (1993).

By anticipating the results, we confirm that the traditional color naming technique, the [4+1] one, based on the four unique hues, which works well for monochromatic stiumuli, represents a constrain for some surface colors. Observers are feeling better when allowed to use the eleven basic monolexemic categories, however, in some cases they declare that an additional name would be needed. The question whether a basis category is missing, has been often. In fact, they identified a region of the OSA-UCS region where color naming is extremely difficult, there is intra-observer incoinsistency and no inter-observer consensus. Non basic names are therefore used, such as peach, tan, brown, salmon, orange, pink. If in this region a basic color sensation would exist, it would be near enough to each of its neighbors to serve as a stable bridge between the opposite colors,.... "where now none exists.... and it is of course impossible to imagine what such a color would like".

We think that a general solution of the problem of the missing category is difficult. However, a working solution might be found by considering, separately, various sets of samples, used for different applications it. For each set, a group of samples is found, which are difficult to name by the use of eleven categories (having in mind the consensus/consistency approach) . For these samples, instead of using disparate non basic names, a common new name may be found. By now, we label it as "XII". In a future research the various colorimetric specifications of various XII' will be compared, and it will be decided whether they all may be ascribed to a unique category.

3. Experimental Data

Test samples are presented, one after the other in a booth internally coated by middle gray paper, lit by a fluorescent tube (chromaticity coordinates x= 0.289; y= 0.292), the luminance being of 26 cd /sq.m. The observer is well adapted to it. (In some cases other light sources were used, such as an incandescence one, or the North Sky).

3.1 The F-M 100 Hue Test

The frequency distributions of the four unique hues across the 85 caps are bell shaped. The cap range, at half-height width, by averaging the responses of the ten young adults, is as follows:

Hue	yellow	green	Blue	Red
Cap range	7-16	16-33	33-65	45-7

The observer considers a constriction the imposition of the four unique hue. He feels better when allowed to use the eleven basic categories (by forcibly adding mauve). The results are:

Category	Purple	Orange	Yellow	Green	Blue	*mauve*	Pink
Cap range	79-3	3-12	12-17	17-39	39-55	55-70	70-78

Now, all our observers met some difficulties in naming the caps in the range 4-14, between orange and yellow. They decided to identify it with the missing XII. However, the validity of this assumption is limited to the 100-Hue caps.

3.2 The NCS 2nd Edition

We have been looking for a possibly missing 12th category (X) through the samples of the NCS 2nd ed. It cannot be excluded that the name X be assigned in various ranges, however, we limit ourselves here to consider the red - yellow one. The X category is met for the displayed amount of perceptual R content for four different values of blackness (bl = 5, 10, 20, 30), for a constant whiteness given by W = 100 - (bl + c), being c the colorfulness. The perceptual content of yellow, not displayed in the plots, is given by Y = 100-R.

	W=5	W=15	W=25	W=35	W=45	W=55
bl	R%	R%	R%	R%	R%	R%
5	15	30	30	20-30	30-40	30-50
10	20-30	10-40	20-40	30	30-50	30-60
20	0-40	0-50	0-60	0-70	0-90	0-90
30	10-50	10-60	0-70	0-70	0-90	30-60

bl	R%	R%
5	30-50	30-70
10	20-70	40-80
20	30-90	

In conclusion, in our normal young adults, the X category is found in the set of red-yellow perceptual mixture samples. From the data it emerges that, to get the X category, the greater the colorfulness, the smaller the R content, and hence the greater the Y one.

3.3 Paints for Walls (indoor, outdoor)

Our ten young normal young adults were requested to subdivide into the eleven basic categories a set of 132 samples of house paints. None of the eleven names, however, applied to a set of 19 samples. The observers agreed to label them as XII. These samples, in some way, share the hue, appearing as a mixture, in various proportions, of red (R) and yellow (Y). By the use of traditional color naming technique, being, of course, R + Y = 100, by putting together the responses of all the observers, the frequency of occurrence (f∞) of responses R and Y is as follows:

% amount	10	20	25	30	....	70	75	80	90
% f° of R	5.2	68	10.5	15.8					
% f° of Y						15.8	10.5	68	5.2

In turn, the saturation S (ratio of chromatic to achromatic content) is found to vary within a wide range:

S%	5	15	25	35	45	55	65	75	85	95
%f°	12	11	9	4.5	6.5	5.5	10.5	7.5	17	16.5

In matter of application to the color scheme in urban environments, let us limit ourselves to recall that, by analysing some urban streets, flanked by colored facades, we recurrently note that the less saturated XII has been employed to paint larger buildings, which are sequentially to thinner buildings painted with various saturated colors, in obedience to the basic law of harmony "area x chroma" = constant.

Moreover, ten out of the nineteen paint samples which our ten young adults agreed to name XII, were also presented to other three subjects: RS, strongly myopic, 45 yrs; TT, with an incipient cataract, 76 yrs; ZM, 97 yrs. Their responses are displayed below.

NCS notation	Ten normal	RS (45)	TT (76)	ZM (97)
S10 20 Y 20R	XII	Pinkish	Ivory	White
S10 80 T 20R	XII	Yellow	Lemon	Rosé
S20 20 Y 30R	XII	XII	XII	XII
S20 40 Y 30R	XII	XII	Cream	Dark
S20 60 Y 20R	XII	XII	XII	Chocolate
S30 40 T 20R	XII	Brownish	Yellowish	Chocolate
S30 50 Y 20R	XII	Brown	XII	Chocolate
S30 50 Y 20R	XII	Brownish	XII	XII
S30 65 Y 10R	XII	Dark yellow	yellowish	Chocolate

The analysis of the responses of the patients, which would require an accurate description of their opthalmological and optometric situation, would led us too far. Here we limit ourselves to note that, in line with Schefrin and Werner (1993), it is difficult to deduce the age related changes in color appearance from physiological and pathological findings, as well as from the ìpreferencesî.

3.4 The Samples of 158 a/PCCS (Jpn)

Out of the set of 141 of these samples, 12 were named as XII (missing category) by our ten normal young adults. Again, they were found to contain a variable mixture of red, R, and yellow, Y. The results of the match with the NCS samples 2nd Ed., in terms of percent frequency of occurrence (f∞) of R and Y are displayed below (being, of course, R + Y = 100).

R	90	80	70	60	50	40	30	20	10	0
Y	10	20	30	40	50	60	70	80	90	100
% f°	18.5	3.7	14.8	7.4	29.6	3.7	18.5	-	-	3.7

In turn, the frequency distribution of colorfulness c, versus blackness bl, is

bl (%)	0-10	11-20	21-30	39
c (%)	10	5	7	2
f° (%)	42	21	29	8.3

While the above said selection of XII fairly agrees with our ten young adults, strong discrepancies are found with old-aging subjects. For instance, a 75 year old observer, with incipient cataract, took part in six different sessions, in a different days each. What is named XII by normals, has a color appearance which varies from sample to sample, and from day to day. The frequency of occurrence f∞ of various names, by putting together the data gathered in various sessions, is displayed below:

category	pink	red	yellow	orange	Brown	*beige*	violet	grey	*ivory*
f° (%)	23	15	17	9	11	5	4	4	2

4. Conclusion

Our work along these limes is in course. We do hope to succeed in understanding how environmental color appear to the elderly, possibly by correlating what they see with inferences about their physiological and psychophysical changes, compared to young adults. From our preliminary inquiry emerges that various cases are to be dealt with individually. Times are not yet ripe to produce general rules. This problem is a challenge for the researchers of the 3rd Millennium.

The elegance of Korean color design (Lee and Seo, 1997) is well known across the world. Korea is also expected to make use of bamboo, valuable as construction material and for hundreds of other applications: in an Encyclopedia we read that the heaviest concentration and largest number of species is in eastern Asia and on islands of Indian and Pacific oceans. We realized that, in the mind of our observers, the XII (missing category) should be similar to bamboo.

We started "naming" the color of bamboo, but not in a hurrt! More than 75 genera and over 1000 species are proposed in the literature.

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A Study on the Variation and the Development of Color Classification in Korea

Kim Sun-Hee

Abstract

This study attempts to describe the system of color categories presently in use in Korean language, and to assess its developmental processes. This is accomplished by establishing taxonomic structures of the entire set of color terms shared by informants encountered in field, and examining foci and ranges of color terms in Berlin and Kay's (1969) Munsell color array. As a result, it is found that the Korean color category system is undergoing change from stage c!, which stands in correspondence with the system available to the elder generations of native Korean speakers, to stage state VII, a structure mostly actualized by the younger generations. Furthermore, its developmental processes by and large conform to the scheme of Berlin and Kay's universal evolution. This study reports a new ethnographic case of folk color classification, and suggests the usefulness of semantic approaches like taxonomy for understanding rules of color classification in complex situations of heterogeneous speech community.

Keywords : cognitive anthropology, basic color terms, folk classification, taxonomy, classification variation and development

1. Introduction

This study attempts to describe the system of color categories presently in use in Korea, and to assess its developmental processes. This purpose is carried out by establishing taxonomic structures of the entire set of color terms shared by informants in field, and examining foci and ranges of color terms in Berlin-Kay's (1969) Munsell color array. The findings on the semantic organization and the development of color space in Korea are discussed in relation to Berlin and Kay's theory on the universality of basic color terms and color encoding sequence, one of the most important and influential theories in the field of color categorization.

Berlin and Kay suggested that color categories were organized hierarchically, that is, into basic and non-basic categories. At the same time, constraints on intercultural variation of basic color categories were discovered; the basic color categories of all languages were drawn from a set of eleven universal categories composed of six equivalence classes corresponding to seven temporal-evolutionary stages.

stage I stagea II stageb III stagec IV staged V stagee VI stagef VII

WHITE → Red → GRUE → Yellow → Green/Blue → Brown → Purple
(Warm-Light) ↘ Yellow → GRUE ↗ Pink
↑
BLACK Orange
↑
(Dark-Cool) Grey

Figure 1. Universal evolutionary stages of basic color terms

A language with two terms would comprise terms for black and white (or dark-cool and warm-light). A language with three terms would contain a term for red. A language with four terms would include a term for either yellow or grue, that is, the composite category for green and blue. A language with five terms would contain terms for both yellow and grue. A language with six terms would include terms for black, white, red, yellow, green, and blue, and so forth.

Upon reckoning eleven basic categories (considering that GREEN was subdivided into green and blue), Berlin and Kay ranked Korean basic color terms as stage VII (1969:96). At the light of further

Kim Sun-Hee
Department of Anthropology, Seoul National University
Apt. Hyundai 107-1306, Dangsan-dong 2, Youngdungpo-gu, Seoul, Korea(ROK)
Phone : +82-02-2635-6929
Fax : +82-02-878-8621
E-mail : ksehsnu@chollian.net

fieldwork, however, heterogeneity turned out to lie in the speech community, and Berlin and Kay's simple methodology for classifying total color terms into basic and non-basic was found insufficient for the acquisition of systematic and consistent insights on such complex color systems. Hence, the present study relies on the general methodology coined by cognitive anthropology for the study of folk classification systems, that is, taxonomy and componential analysis. This methodology leads us to deal with a given color category not as an individual vocabulary item but as one belonging to an integral system.

The general results of the study are the following: (1) There exists variation between the lexicosemantic organization of color domain, the number and the kind of basic color terms employed by the elder and the younger generations of native Korean speakers.

This seems to imply that the Korean color category system is undergoing generation-linked change, namely from stage Ⅳ – which stands in correspondence with the system available to the elder generations – to stage state Ⅶ – a structure mostly actualized by the younger generations –, in terms of the sequence predicted by Berlin and Kay. (2) The change in focus, range, and taxonomic status of basic color categories underlying the developmental processes that affect the Korean color system are by and large consistent with the Berlin and Kay's theory of universal evolutionary stages. The only exception found is that purple seems to evolve from red rather than from blue.

2. Methods

Basic color terminology has become a major subject since publication of Berlin and Kay 's seminal study on Basic Color Terms (1969), while order and frequency in listing task and naming response measuring psychological salience have been main procedures in the anthropological studies of color domain. Such a research program tends to isolate basic color terms from other color terms.

Then, how are color categories, including both basic and non-basic categories, organized? Since Kay and McDaniel (1978), color semantics, like neurophysiological processes, have been modeled after fuzzy set theory rather than after the traditional discrete-feature theory. Color category is the best-studied example of prototype category with degrees of membership, that is, a category with fixed foci and variable boundaries (Casson 1994:78; Taylor 1995:1-20). This approach casts doubt on the general usefulness of the feature model in structuralist schools (Kay and McDaniel 1978:644). If that is so, are taxonomy and componential analysis, which have been main traits of structuralist studies, unavailable in color semantics?

Kay and McDaniel suggested that more powerful formalisms ómuch broader than the restricted Boolean algebra postulatesó were needed in order to provide realistic accounts of the meanings of color words (1978:644). This research seeks to establish taxonomy and to apply the procedure of componential analysis to color domain. Frake argued that if several words correctly designated the same object then they did not contrast at the same level (1961:109). Naming behavior in field showed that an object named scarlet was concurrently called red, but the opposite was not true. In that case, it can be said that red includes scarlet, that is, red is a superordinate of scarlet in a hierarchy of color domain. In the same manner, informants' statements accompanying naming behaviors showed that color terms were selected according to the degree of similarity and difference of the color percept to ideal examples of certain contrasting color categories. If so, contrasting meanings of color words can be analyzed in terms of relative approximation to foci of certain root categories. This implies the need for additional degree-manifesting symbols, other than the '+' traditionally used for discrete semantic feature in componential analysis: ' =', ' > ', '< ', '→', '←' are, at least in Korea, also necessary degree-manifesting signs[1].

The procedures for discovering folk color classification system and its development comprised the following activities: (1) The data for color classification, that is, for taxonomy and componential analysis was gathered in three stages; ① listing as many terms as possible, ② naming color on a restricted set of 66 Munsell color chips selected randomly, and ③ defining color terms elicited through ① and ②. ① offers kinds of color terms used for communicating color in field. ②enables the establishment of taxonomy because of indication overlap and possible inclusions between terms (Casson 1994:177). ③ reveals by which degree of membership, from which categories, and at which hierarchical level the given color term is differentiated.

Taxonomy and componential analysis are useful tools for elucidating folk color classification systems, including intra-variation and, even roughly, change processes. Developmental processes can be clearly

understood through changing distribution of color terms on color space.
(2) The data for color development was collected through mapping foci and boundaries of color terms on 329 Munsell chips, a task applied only to basic color terms and to several terms playing important part in the evolution of basic color system.
(1) was carried out among a total of 93 subjects, 31 men and 62 women, whose age ranged from 5 to 84 years. All of them lived in a rural village in Korea. Task ① was successfully accomplished by 90 subjects, while 73 fulfilled ②, and only 18 achieved ③. (2) was performed on 14 subjects known to possess relatively exact color knowledge. The stimuli used in ② were 66 Munsell color chips (1.7 ×2.1 ㎝ rectangles) mounted on gray hardboard (9 ×10 ㎝ rectangles, 0.2 ㎝ thick). (Figure 2)

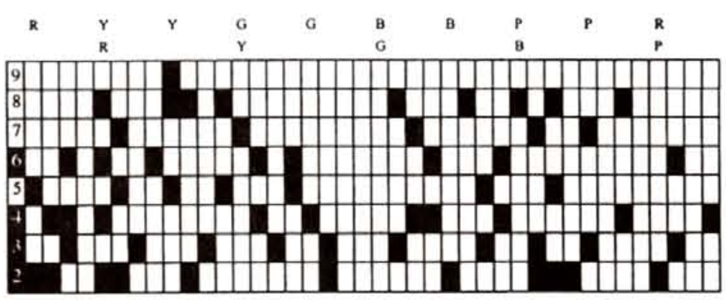

Figure 2. 66 color chips used in naming response

3. Results

Two different patterns for classifying and using color categories were found. Respondents aged 40 or above showed an 85-category taxonomy, subdivided into 5 superordinate categories. On the other hand, younger respondents displayed the taxonomy of 88 subordinate categories organized into 8 superordinate ones. Componential analysis - through which all color terms used by elder respondents could be identified with any degrees of a total of 5-kind memberships and all terms used by younger ones, with any degrees of a total of 8-kind memberships - confirmed taxonomic divergence2.

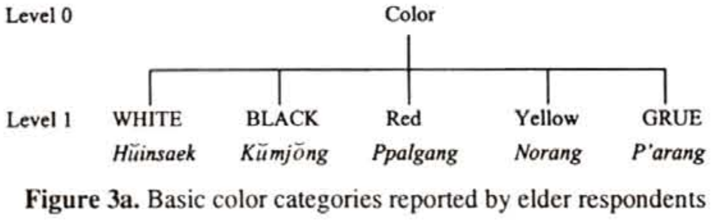

Figure 3a. Basic color categories reported by elder respondents

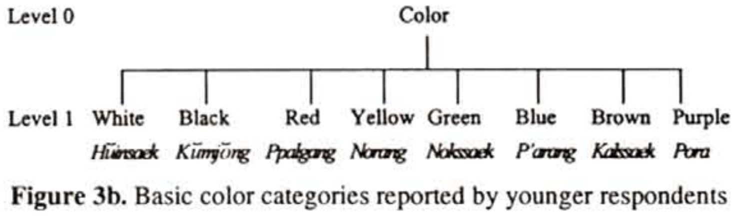

Figure 3b. Basic color categories reported by younger respondents

Additionally, while younger informants used many subordinate categories as well as the 8 basic categories consistently and systematically, the elder ones showed high consistency in the use of 5 basic categories but used subordinate categories in a variety of ways. Age-positive taxonomy divergence - and especially the variety of uses reported by the elder age group - made it possible to elucidate certain re-organizational processes that affect color category system. In this study, development of color classification system was explored by focusing on the basic color system. The results of task (2) informed foci and boundaries of basic color terms, differentiated between generations, as shown in the graphs below. In Figure 4a and 4b, shading represents low-cognition areas.

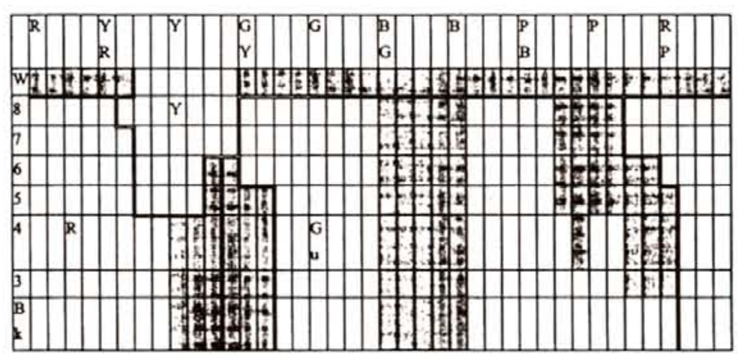

Figure 4a. Distribution of basic color terms corresponding to the elder generations

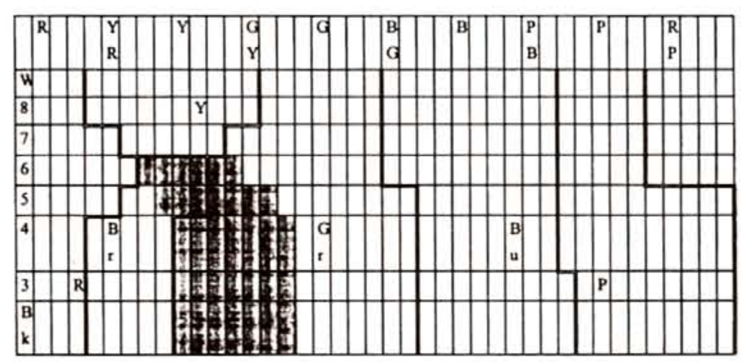

Figure 4b. Distribution of basic color terms corresponding to the younger generations

1) These signs are borrowed from Leech's (1974, reciting from Casson 1981) five types of contrasting dimensions of semantic features. Out of five types, not only binary contrast but also ranked contrast and relational contrast are found to be available for Korean color contrast dimensions.
2) For examples, the componential definitions of some Korean color terms of the younger generations are as follows: ppalgang (red): [+red], Tahong (pale yellow red): [+red, +yellow, <yellow, ←yellow], chuhong (red orange): [+red, +yellow, <yellow, →yellow], chuhwang (orange): [+red, +yellow, =yellow], orenjisaek (pale yellow orange): [+red, +yellow, >yellow, ←yellow], kyulsaek (yellow orange): [+red, +yellow, >yellow, →yellow], punhong (pink): [+red, +white, =white], subakssaek (watermelon-color): [+green, +black, →black]. The first component in each definition shows the superordinate category of the given color term. And the kinds of first components of younger generations are 8 in total. In addition, the total kinds of memberships possessed by all color terms of the younger generations are also 8. Therefore, componential analysis can be said to be a useful tool for discovering basic color category system.

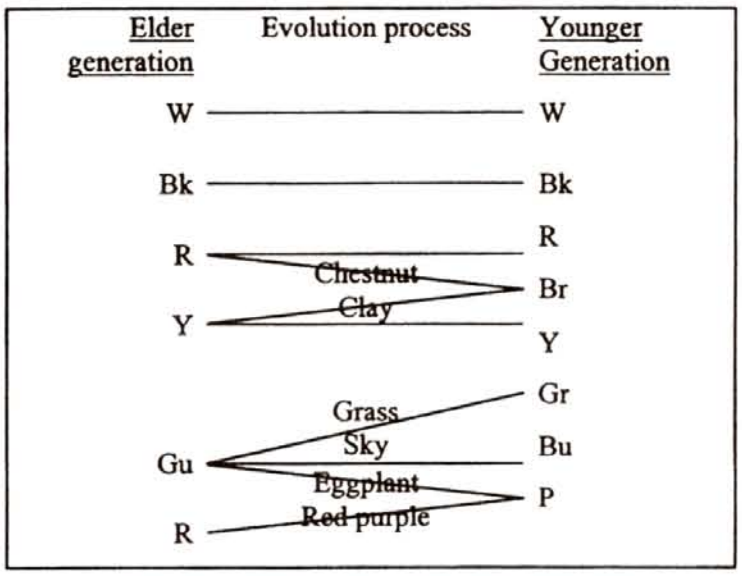

Figure 5. Development of basic color categories across generations

Categories corresponding to the most salient subordinate orders proved to be significant for the development of basic color system: *pamsaek* (chestnut), *hŭkssaek* (clay), *ch'orok* (grass-grue), *hanŭlsaek* (sky-color), *kajisaek* (eggplant-color), *chaju* (red purple), etc. *Pamsaek* (chestnut), *hanŭlssaek* (sky-color), ch'orok (grass-grue) and *kajisaek* (eggplant-color) evolved towards the status of basic categories, and *hŭkssaek* (clay) and *chaju* (red-purple) became each reorganized under other superordinate categories (Figure 5).

All of these processes went along with change of foci, boundary, and semantic relations. Taxonomy and distribution on color space of color categories significant to color system development are as follows.

(1) The elder respondents have more cognition in low brightness, and the younger have relatively balancing cognition in entire gray grades. Focus of gray lies in the fifth brightness grade for elder respondents and in the sixth grade for younger ones.

(2) Out of the basic categories, red is the one most elaborately subdivided into subordinate categories, some of which are used as frequently as basic color terms. This means that red was formed early and has been undergoing division and development for a long time. Across generations, the focus and boundary of pink become contracted to higher grades of brightness, and consensus of focus and frequency of use of orange increases. Conceptually, orange stands in the middle of red and yellow, but definitions of orange gathered as field data indicated that the unmarked-membership of orange was red and its marked-membership corresponded to certain degrees of yellow (The componential definition of orange is +red, +yellow, =yellow). Therefore, orange can be said to emerge from red. The dominant category indicating low-brightness areas between red and yellow changes from chestnut to brown, both subordinates of red, and concurrently brown comes to acquire basicness. Consequently, brown can also be said to emerge from red.

Ppalgang(red)					
…	*Chaju* (red purple)	*Pamsaek* (chestnut)	*Punhong* (pink)	*Chuhwang* (orange)	…

Figure 6a. taxonomy of *ppalgang, chaju, pamsaek, punhong* and *chuhwang* of the elder respondents

Ppalgang(red)				*Kalssaek*(brown)			*Pora*(purple)		
…	*Punhong* (pink)	*Chuhwang* (orange)	…	…	*Pamsaek* (chestnut)	…	…	*Chaju* (red purple)	…

Figure 6b. taxonomy of *ppalgang, punhong, pamsaek* and *chaju* of the younger respondents

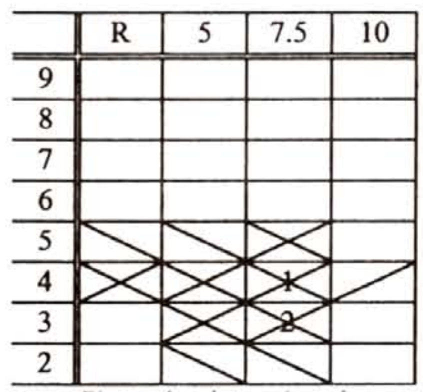

Figure 6c. change in red

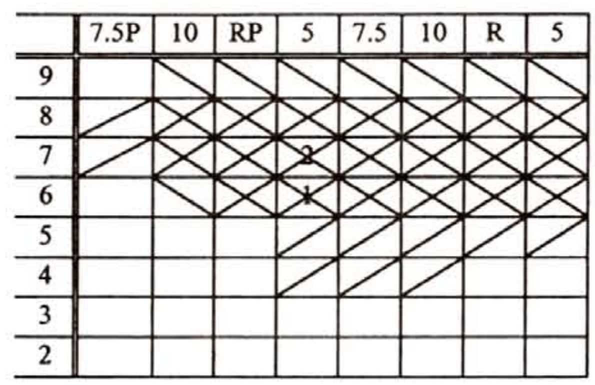

Figure 6d. change in pink

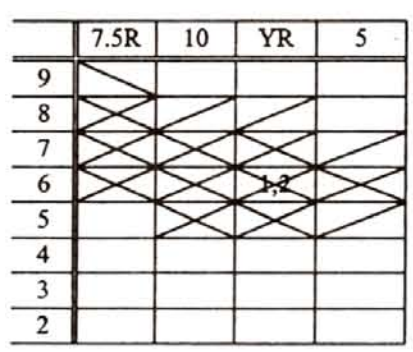

Figure 6e. change in orange

3) In figures of distribution, '1' refers to color category focus for the elder informants and '2' for the younger ones, while '/'refers to color category range for the former, and '\' for the latter.

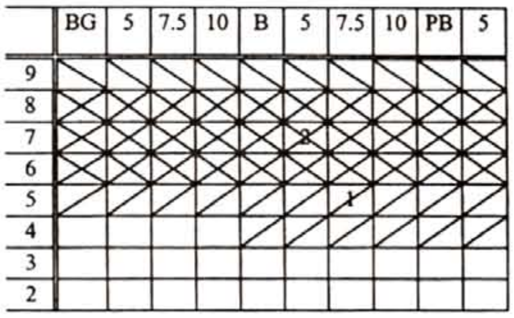

Figure 6f. change in brown

(3) Yellow is readily discriminated from green, but not from red. This shows an affinity between yellow and red that echoes the ancient category of warm suggested by Berlin and Kay. The dominant term representing the dark yellow area changes from *hŭkssaek* (clay) to *hwangt'osaek* (ochre), and some categories in the dark yellow area of the elder respondents system are reorganized into subordinates of brown in the system of younger informants. This is why the range of yellow in Figure 7c decreases. These phenomena are related to the development of brown into a basic category.

Yellow		
…	*Hŭkssaek*(clay)	…

Figure 7a. taxonomy of *hŭkssaek* of the elder respondents

Yellow	Brown		
…	…	*Hŭkssaek*(clay)	…

Figure 7b. taxonomy of *hŭkssaek* of the younger respondents

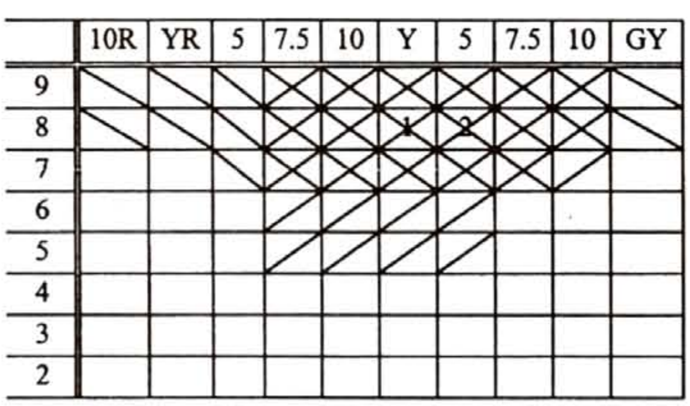

Figure 7c. change in yellow

(4) The persistence of grue is the most peculiar characteristic of color system actualized by elder informants. Grue is one of the most reported composite categories4. *P'arang* extensively indicates grue and, narrowly, green in the elder generation's system, but indicates blue in the system of the younger informants. This means that one term can represent different categories according to the contrast level and classification system used at a given moment. The same applies to *hanŭlssaek* (Figure 8e). This is why the semantic structure of entire set of color terms is necessary to understand color classification systems.

Subdivision of grue (*p'arang*) into green (*ch'orok*) and blue (*hanŭlssaek*) in the second level of the elder informants' system shows a considerable degree of evolution. It is interesting to note here that the dimension of the contrast between ch orok and hanm ssaek, both first subordinate categories of grue in this system, can't be expressed linguistically. This might be due to the characteristic composite structure of grue. In other words, the semantic-based findings of this study coincide with the findings in Kay and McDaniel's neurophysiological study.

Ch'ŏngnok (turquoise) stands conceptually in the middle of green and blue. Unlike orange, taxonomic structure of ch'ŏmngnok is not clear yet ('†' in Figure 8b). Anyway, the reference to ch'ŏngnok made by younger informants indicates that differentiation between green and blue is already at work in their color classification system.

P'arang(grue)			
Ch'orok(green) or *P'arang*(green)			*Hanŭlssaek*(blue)
…	*Nokssaek* (yellowish green)	…	…

Figure 8a. taxonomy of p arang, ch orok, nokssaek and hanm ssaek of the elder respondents

Nokssaek(green)				*P'arang*(blue)			
…	*Ch'orok* (dark green)	*Ch'ŏngnok* (turquoise)†	…	…	*Hanŭlssaek* (light blue)	*Ch'ŏngnok* (turquoise)†	…

Figure 8b. taxonomy of *nokssaek, ch'orok, p'arang, hanŭlssaek*, and *ch'ŏngnok* of the younger respondents

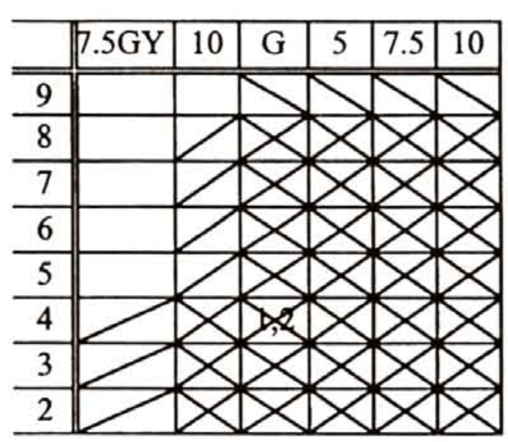

Figure 8c. change in green: *ch'orok* or *p'arang* of the elder respondents and *nokssaek* of the younger respondents

4) The internal structure of grue active in Korea turns out to be a combination of the union model and the skewing model. (Burgess, Kempton, and MacLaury 1983) The modifier of '*sae-*' or '*si-*' representing the highest membership is used for the foci of green and blue. And in the area lying between green and blue, the response of "not know" or the modifier '*-ŭsrm*' representing lower membership is observed. Concurrently, membership of grue is strong in focus of green rather than in focus of blue.

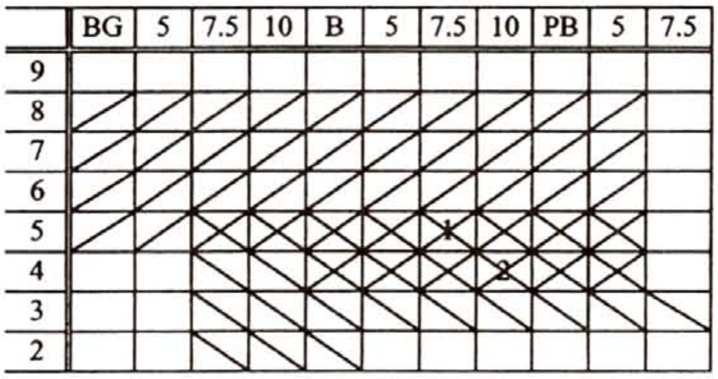

Figure 8d. change in blue: *hanŭlssaek* or *p'arang* of the elder respondents and *p'arang* of the younger respondents

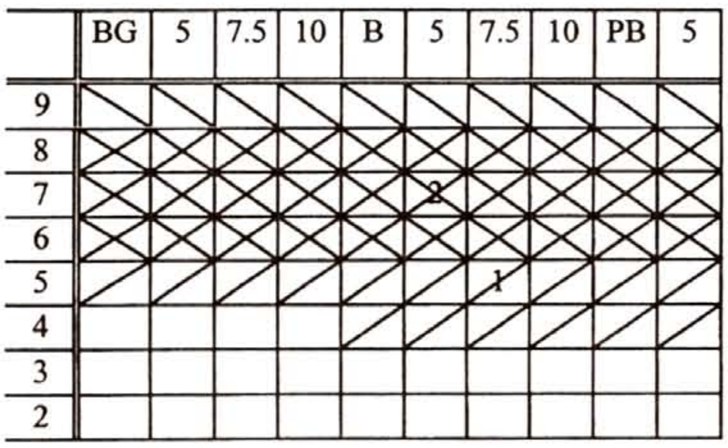

Figure 8e. change in *hanŭlssaek*

(5) Across generations, the pervasive term representing low-brightness areas between blue and red changes from eggplant to purple (violet), and purple develops into a basic color term. That is, purple evolved from not red but from blue in Korea and, hence, the focus of purple comparatively tends toward blue (*2po* Figure 9c). As is the case with brown, some categories of dark yellow in the previous stage begin to be identified with some categories of light brown, so that when purple acquires basicness, *chaju* (red purple), an important subordinate of red in the previous stage, is reorganized into a subordinate of purple (see change of focus in Figure 9d).

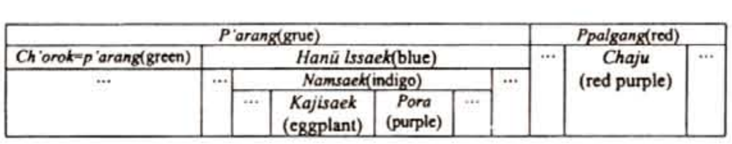

Figure 9a. taxonomy of *namsaek, kajisaek, pora* and *chaju* of the elder respondents

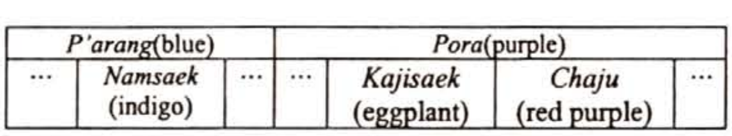

Figure 9b. taxonomy of *namsaek, kajisaek, pora* and *chaju* of the younger respondents

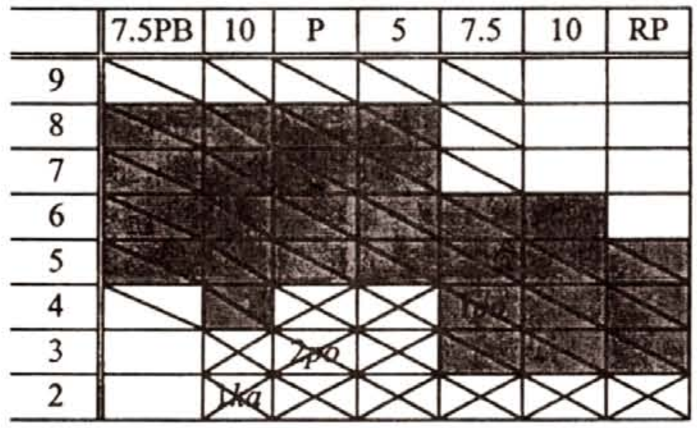

Figure 9c. change in purple: *kajisaek* of the elder respondents and *pora* of the younger respondents

4. Discussion

This study detects variation in the semantic structure of color categories in Korea, and through intra-cultural variation, describes the development of color classification system focusing on basic and some significant non-basic color categories. All things considered, developmental processes of color classification in Korea turn out to support universal evolutionary theory. The main results of this study, at the light of universal theory, can be summarized as follows:

(1) Two basic color systems, that is, superordinate categories employed by elder and younger generations in Korea conform to two of Berlin and Kay's basic color system. Additionally, variation in color taxonomy between generations suggests that the Korean color system has developed from a stage Ⅳsystem characteristically available to the elder generations to a stage Ⅶ system mostly employed by the younger ones. Such development conforms to the universal theory of color evolution.

(2) Subordinate categories in the warm-light area are even more elaborated than in the dark-cool area.

(3) The younger the informants, the more distant foci of red and yellow become. This means that red and yellow result from subdivisions of a red-dominated warm category.

(4) Orange and brown emerge from red.

(5) The existence of grue in the system actualized by the elder generations supports an ancient dichotomy of warm-light and dark-cool (Berlin and Berlin 1975). Green and blue in younger informants emerge from their elders' grue.

(6) Brown and purple acquire basicness after complete separation of grue into green and blue. And, when brown and purple become basic terms, some categories come to be reorganized into subordinates of brown or purple.

(7) Black is observed to have an affinity to blue (Cf.

Kay, Berlin and Merrifield 1991:18). In addition, it is thought that the emergence of purple from dark blue (indigo) in Korea can be associated with neutral processes of dark into black and grue.

Here, developmental processes of purple from blue (indigo) are considered as a peculiar quality of Korean color evolution, inconsistent with the scheme Berlin and Kay's scheme. Besides, which out of brown and purple emerges earlier is not clear in this research. Berlin and Kay argued that brown emerged earlier than purple, but the World Color Survey shows that there is no fixed order in the temporal appearance of brown and purple (Kay, Berlin and Merrifield 1991:18).

Change and development of color classification were found to go along with reorganization of taxonomic relations of color categories. This study sought not only to establish basic color terms but also to discern organizational rules applicable to an entire set color terms, so that all processes accompanying evolution of basic color category system from stage Ⅳ to stage Ⅶ could be observed in detail and understood systematically.

Out of the four features Berlin and Kay suggested as the notion of basic color term, namely monolexeme, taxonomical superordinate, broad applicability, and psychological salience, the approach used in this study centers attention on the second one. The results are therefore somewhat different in number, kind and foci of basic color terms from those of Berlin and Kay's study, which focused on the forth. Divergence is thought to arise from the deployment of different methods as well as from scarcity and inaccuracy in Berlin and Kay's Korean color terms data. Berlin and Kay recognized Korean basic color system could be reconstructed to a five-term system on the basis of internal linguistic evidence, that is, Old Korean terms and Chinese loans. But they merged two classifications together, and consequently came to describe a disorderly color system. This study then, not only reports a new ethnographic case of color classification but suggests that investigation of semantic structure through taxonomy and componential analysis is particularly useful to discover the rules underlying classification and use of color categories in situations of complex and heterogeneous speech community.

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Color Names and Characteristics of the Fashion Forecast-Color

Youngin Kim, Yoonhee Choi

Abstract

The purpose of this study was to analyze the characteristics of the fashion color through color names and to examine the relationship between the color names and images of colors. For this research, 2,783 fashion colors forecasted in 12 fashion trend books from 1990 to 1999 were collected and analyzed.

The major results show as follows :

1) Color names were classified into 8 categories according to their origins ; A. plant, B. animal, C. mineral, D. natural phenomenon, E. living environment, F. man/region, G.. abstract expression, H. native color names

2) According to the categories, the distribution components of color showed differently. For example, color names in plant kingdom were mainly distributed in mid to dark tones such as g, sf, d, and in warm color ranges such as R, YR, Y, and RP while color names in mineral kingdom were mainly distributed in grayish tone and in cool color ranges such as PB and B.

3) The relationship between fashion color images and color names revealed that certain color names were used to convey certain fashion color images. For example, color names in plant kingdom were mainly used in a few fashion images such as abundant, fresh, ethnic, and exotic. To convey the image of fresh, color names such as leave olive, pine green and forest green were used and they were mainly distributed in GY and BG while flower based color names such as amaranth, tulip, orchid, lavender were used to convey the image of exotic and they were mainly distributed in R, Y, RP.

Keywords : color names, color image, forecast color

1. Introduction

Color is expressed by using color names which convey image of its own color in every day life.

The color names are defined as "a term of each color[1]" or "a term which designates color in order to distinguish from each other[2]" and they arise from a close connection between human and color. Color names are "images of colors". For example, we call color of YR as Beige in a light grayish tone. The image that we visualize is called the Pragmatic Image and the image that we name as colors is the Semantic Image. In order to get the proper knowledge about the colors, total images of two should be well coordinated and balanced. [3]

Kim, Young In : Dept. of Clothing and Textiles, Yonsei University, Seoul, Korea

Choi, yoon Hee : Dept. of Clothing and Textiles, Yonsei University, Seoul, Korea

The color names are images of colors which convey our thoughts and feelings about colors in simple and objective way. Therefore, the color names are not just a list of terms which indicate each color, but also represent its own image.

2. Aim

The objects of this study are to understand characteristics of colors in forecast colors through the color names and to examine a connection between the color names and images of colors.

3. Methods

For this research, 1731 fashion colors out of 2783(excluding colors with no suggested color names) were analyzed in order to understand characteristics of forecast colors. Those colors based on 12 fashion trend books were measured by using

Color Eye 1500 and those measured L*a*b values were converted into H V/C value of Munsell Color System and analyzed. The characteristics of colors were analyzed by 10 different colors of Munsell Color System, which are R(red), YR(yellow red), Y(yellow), GY(green yellow), G(green), BG(blue green), B(blue), PB(purple blue), and RP(red purple). The characteristics of tones were analyzed into 15 different tones, 12 tones by PCCS and 3 achromatic colors. The 12 tones are listed as p(pale), ltg(light grayish), g(grayish), dkg(dark grayish), lt(light), sf(soft), d(dull), dk(dark), b(bright), s(strong), dp(deep), v(vivid). The achromatic colors are W(white), Gy(gray) and Bk(black).

In order to find out how characteristics of colors, color names and theme in forecast colors are related to each other, 313 themes on fashion trend books were translated and grouped into similar images of color names. They were fallen into 58 groups and analyzed for relation between images of theme, characteristics of color and color names.

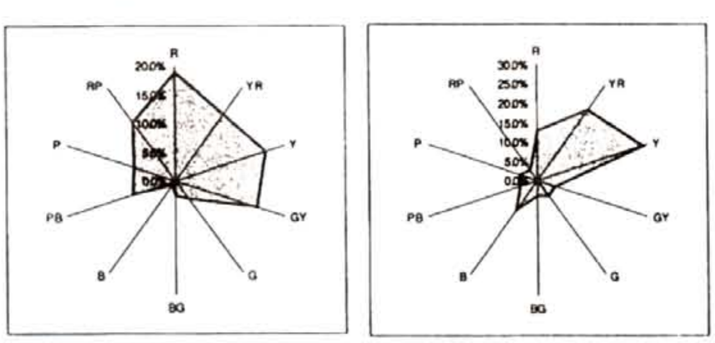
4. Characteristics of the Fashion Forecast-Color

4.1 Classification and Distribution of Frequency in Color Nnames

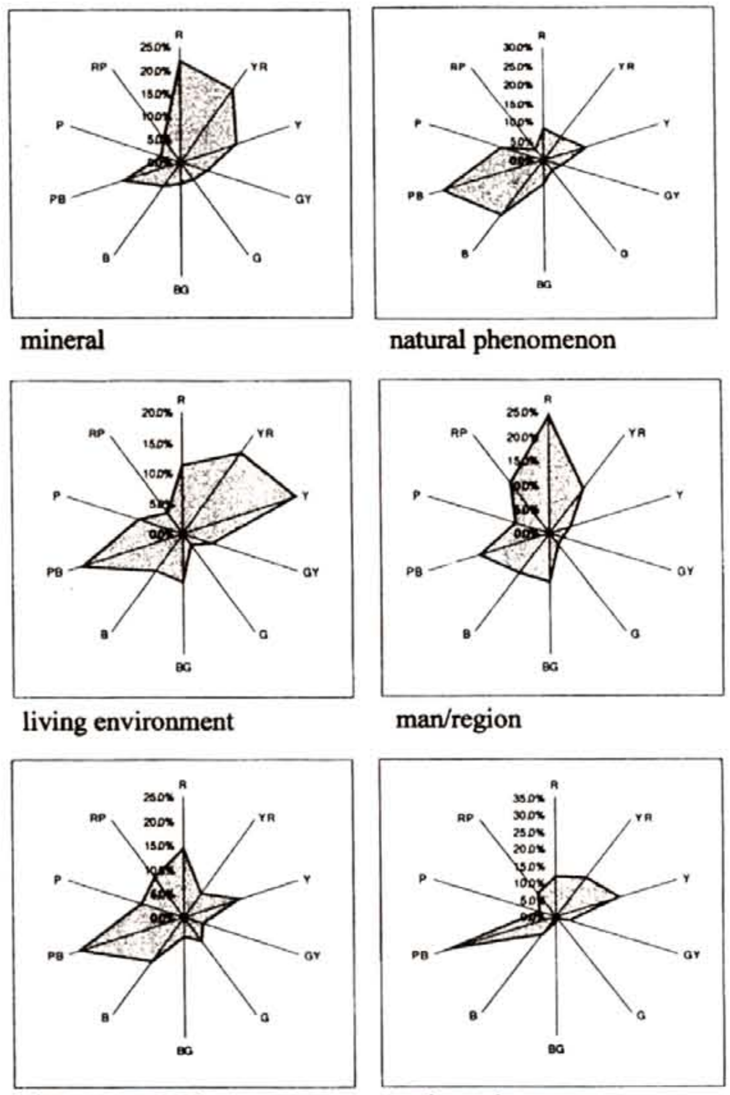
1731 color names fashion forecast-color mentioned above are classified into nature and man-made work. Nature is grouped into plant kingdom, animal kingdom, mineral kingdom, and natural phenomenon. Man-made work is grouped into living environment, man/region, abstract expression and native color names.

Distribution of frequency in 1731 color names of fashion forecast-colors are listed as; highest frequency is on the plant kingdom, 545 color names(32%), next is the living environment, 386 color names(22%), next, the mineral kingdom, 207 color names(12%), the natural phenomenon, 172(10%), the animal kingdom, 125(7%), the native color names, 98(6%) and man/region,70(4%).

4.2 Characteristics of Color by Hue



plant animal



mineral natural phenomenon

living environment man/region

abstract expression native color names

Figure 1. the distribution of hue

The distribution of hue of color names in 8 groups is shown on <Figure 1>. In the plant kingdom, warm colors such as R, YR, Y, and GY are on the highest distribution, RP(12.5%) is relatively high. B(0.9%) is rarely shown. The tendency of the distribution in the plant kingdom explains that most of the color names used in the plant kingdom originate from colors being seen as it is. In animal kingdom, YR(22.4%) and Y(29.9%) consist of 50% of distribution and RP(3.2%)is the least. The difference between the plant kingdom and the animal kingdom is distribution is that B is high in the animal kingdom and RP is high in the plant kingdom. The mineral kingdom also shows that Y(19.8%)and YR(16.5%) are high in distribution. PB(17.5%) is higher in the mineral kingdom than the animal or the plant kingdom. This explains that various PB colors are shown on gems and metals in the mineral kingdom. Cool colors such as PB(26.2%) and B(18.0%) are shown high in the natural phenomenon. In the living environment, R and YR are the highest, Y and PB are the middle, the rest of GY, G, BG, B, P, RP is low. The color names in man/region shows R(24%) as the highest. GY and G are 2.9% each, which is the lowest. The abstract expression and the native colors show PB(22.4% and 30.5% each) as the highest value. BG and B are the lowest.

4. 3 Characteristics of Color by Tone

The characteristics of tones of color names in 8 groups are shown on <Figure 2>. The dark area of the graph indicates high and the lined area indicates low in frequency. First, in the plant kingdom, g(14.1%), sf(14.7%), gray(13.6%), and d(13.2%) show high in frequency and they relatively look even. The dp, dk, and v show low in frequency, 1%. In the animal kingdom, gray(23.2%) and g(16%) are the highest. The v and s are 0.8% showing low in frequency. In the mineral kingdom, Gray(32.1%)is the highest, sf(12.3%) and d(10.4%)are the next, and v and dp are less than 1%. In case of the natural phenomenon, gray(29.7%) and sf(15.1%) are high, and dp. Dk and bk are seldom.

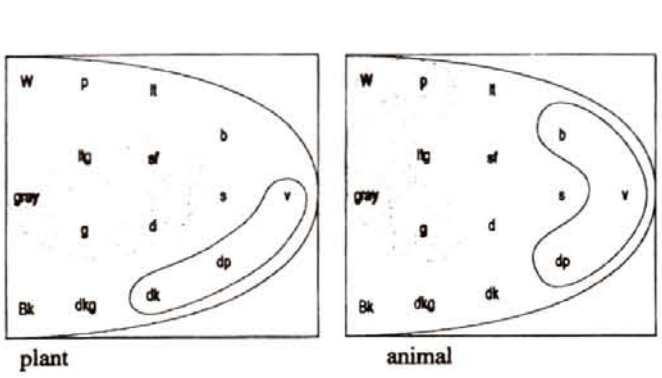
In the living environment, gray(18.4%), g(17.1%)and d(14.2%) are high. The v is the lowest in frequency. In man/region, gray shows the low in frequency. Which is not in case of other groups. The g(25.7%) is the highest, and sf and p are 10% each.

In the abstract expression, d(23.5%), g(15.3%), and gray(12.2%) ar high in frequency. The dp is not shown on the graph. Lastly, In native color, gray(21.9%) and g(20.3%) are the highest. The v and dp are the lowest.

The distribution of tones in 8 groups indicate that tones in the middle to low chroma range such as d and g and achromatic gray tones are more frequent in every group. But tones in high chroma range such as v and dp are less frequent.

4.4 Relationship between Fashion Theme and Color Names

In order to express the images of fashion theme which is suggested by forecast colors, the characteristics of color names are important. A group of color names are used to convey the images of the fashion themes. The images of the characteristics of tones are represented by the groups. Both hue and tone of the color names play role in conveying the images of fashion theme. But sometimes hue is more expressed than tone, and vice versa.



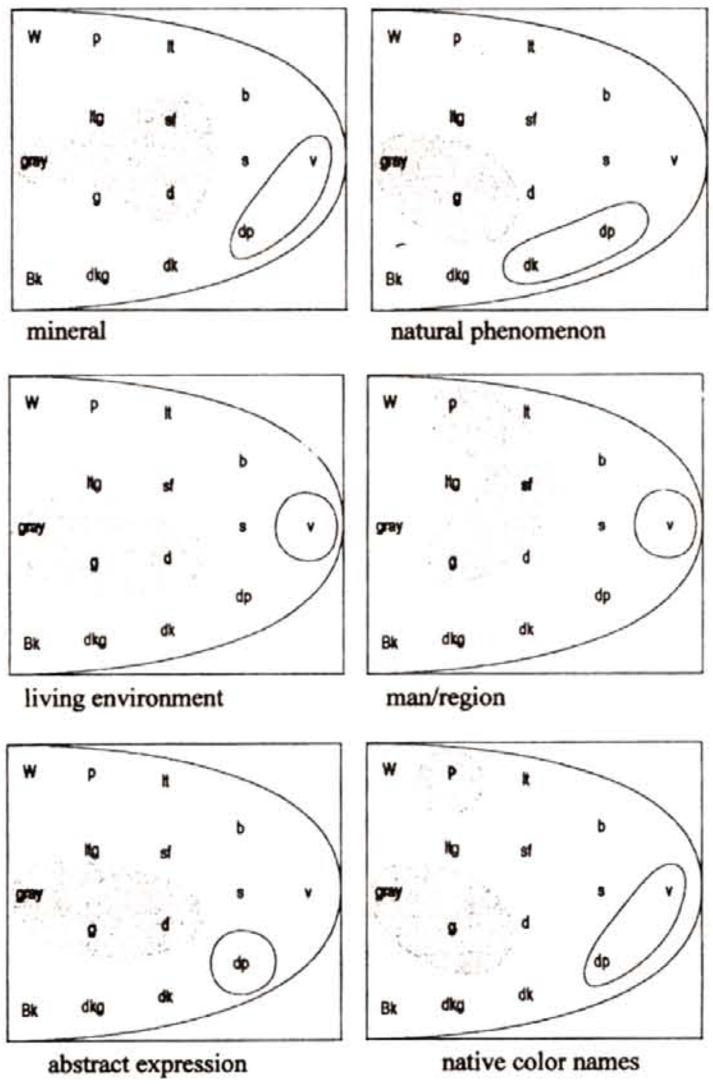


Figure 2. the distribution of tone.

The color names of the plant kingdom are the most used in expressing the images of fashion theme. The reason is that the color names of this group take the highest frequency(32%) in the fashion forecast-color. It also conveys images of color of nature which are easily found in any culture. The images which the plant kingdom conveys are richness, freshness, ethnic, exotic and passionate. Those images are concentrated on the hue of R(except freshness) and those images show differences in the characteristics of tone. The images of the mineral kingdom are modern and splendid. In modern image, gray is used mainly for color names of metal. In case of splendid image, color names of gems are used mostly.

The images of the natural phenomenon are peace and change. PB and B which are shown high in frequency on the graph for this group are used mostly to convey the images. The color names of man/region are used for image of journey.

The color names of the living environment give images of mixing and emotion and they convey concrete hue and tone.

5. Conclusion

The object of this study was to explain the characteristics of fashion forecast-color by color names of the 8 groups. The results of this study are as follows :

(1) Fashion forecast-colors are classified into 8 groups of color names; plant kingdom, animal kingdom, mineral kingdom, natural phenomenon, living environment, man/region, abstract expression, and native color.

(2) The characteristics of color names in the plant kingdom are warm color such as R, YR, Y, GY, and PR. Both animal and mineral kingdom is characterized by YR and Y. The color names of PB is more frequent in the mineral kingdom. The natural phenomenon has the highest frequency in PB and B. The living environment has the most similar color distribution to that of the forecast-colors. R, YR, Y and PB are the frequent colors, which reflect most of characteristics of forecast-color.

(3) Tone of color is less distinguished than hue, colors in the middle/low range of chroma such as g, d and achromatic chroma of gray show the highest frequency. In the plant and mineral kingdom, soft tone of sf shows the highest frequency. In man/region, bright tone of p shows the highest frequency.

(4) Relationships between name colors and fashion themes, characteristics of color names are important in expressing the images. In order to convey a certain image, color names of 8 groups are used and the characteristics of the groups represent images of colors.

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Colour Appearance of Flash Image on Computer Display

Kazuomi Gokuta, Tetsuya Sato, Yukitoshi Takahashi, Naomi Kondo

Abstract

Many children had been down with red and blue flash image of TV animation in Japan. To find a way for protecting children from the problem, our research group has carefully been trying to look for the cause under the permission of patient's parents and the ethical committee of a university.

We paid attention to visibility such as difficulty to see and speed of flash. We also tried to investigate the relationship between the visibility and flash colours with the viewpoint of kansei engineering. In this paper, we discussed about the influences of hue and chroma on two visibilities of midurasa (difficulty to see) and hayasa (speed of flash).

Keywords : flash image, photoparoxysmal response, epilepsy, TV animation, multimedia

1. Introduction

In December 1997, more than five hundred children were down with red and blue flash image of TV animation in Japan. To find a way for protecting children from the problem, our research group has carefully been trying to look for the cause under the permission of patientís parents and the ethical committee of a university. Takahashi et al found colours influence photoparoxysmal response caused by epilepsy [1-3].

As a recent investigation [4], they also found out that all of the downed children were not epileptics. This means that only epilepsy did not influence to induce the photoparoxysmal responses, but also some external factors did.

We thought we might take a hint to solve the problem from the relationship between psychological feelings induced by flash images and optical properties of flash images. Now, we are paying attention to two kinds of visibilities, midurasa (difficulty to see) and hayasa (speed of flash). In a previous study [5], we roughly analysed the relationships between the visibilities and flash colours with the viewpoint of kansei engineering (sensory engineering). In this paper, we discussed about the influences of hue and chroma on the visibilities.

Kazuomi Gokuta, Tetsuya Sato
Kyoto Institute of Technology
Goshokaido-cho, Matsugasaki, Sakyo-ku, Kyoto 606-8585, JAPAN
Phone/Fax: +81 75 724 7578, E-mail: tsato@ipc.kit.ac.jp
Yukitoshi Takahashi
Gifu Prefecture Hospital
4-6-1 Noishiki, Gifu 500-8717, JAPAN
Naomi Kondo
Gifu University
Tsukasa-cho, Gifu 500-8705, JAPAN

2. Experiment

2.1 Flash Image

To investigate the influences of hue and chroma on the visibilities, 29 colours for flash images were arranged. The standard colours used for the flash images were red (r), blue (b), green (g), yellow (y) and grey (n). And three middle colours between two standard colours were arranged. Figure 1 shows the colours used for flash images. A flash image continuously flashes two colours of a standard colour and a middle colour (or another standard colour) to the next standard colour. The frequency of a flash image was 15Hz, 15 colour returns per a second.

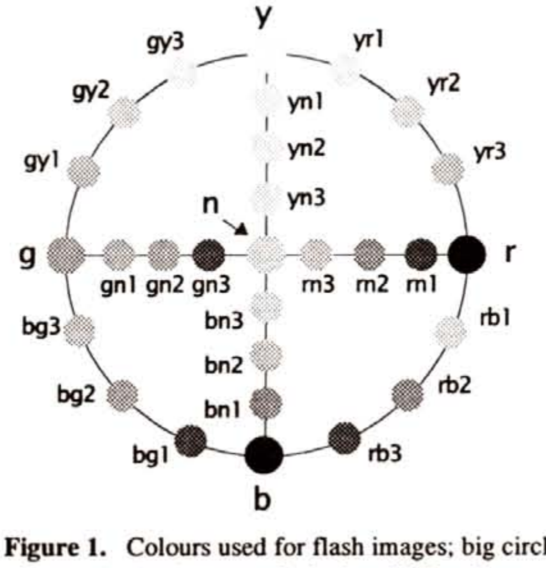


Figure 1. Colours used for flash images; big circle: standard colour, small circle: middle colour

2.2 Assessment

Two flash images were used for an assessment as shown in Figures 2. Assessments were carried out through Paired Comparison. Observers were requested answers about which flash image is hayai (or midurai) as show Figures 3. The total number of assessments was 2016; 96 Paired Comparison patterns and 21 observers.

Visual assessments were carried out as shown in Photo 1. The colorimetric properties of flash images were measured by Spectroradiometer SR-1 (Topcon Corp) as shown in Photo 2.

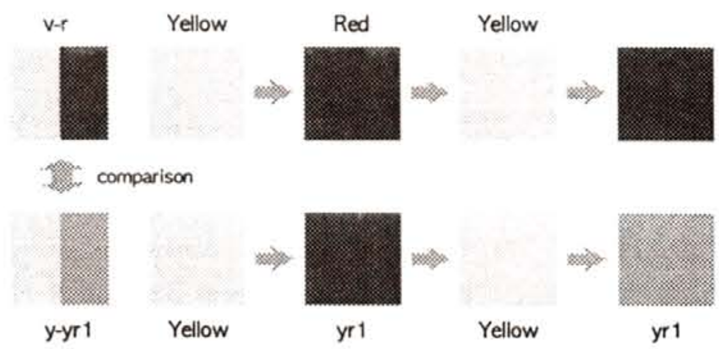


Figure 2. Flash images assessed through Paired Comparison

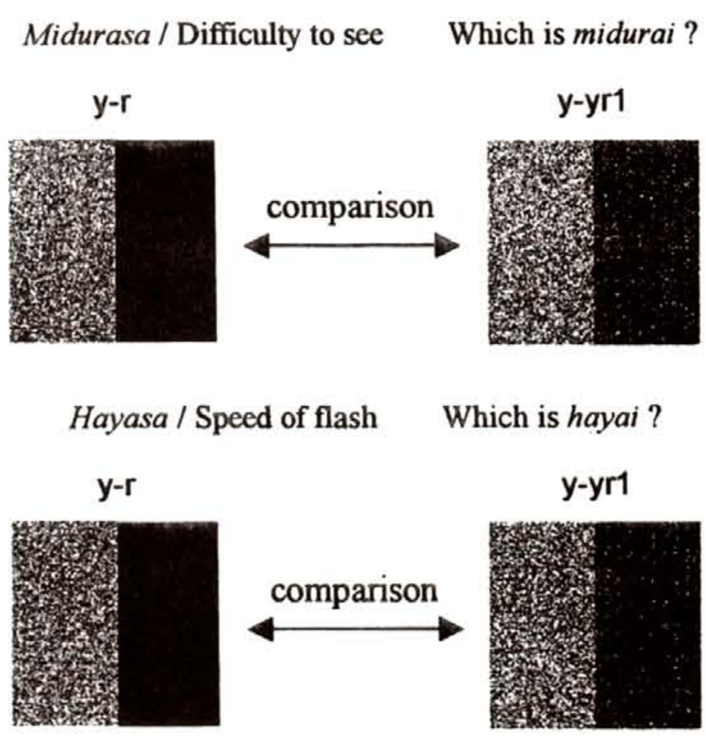
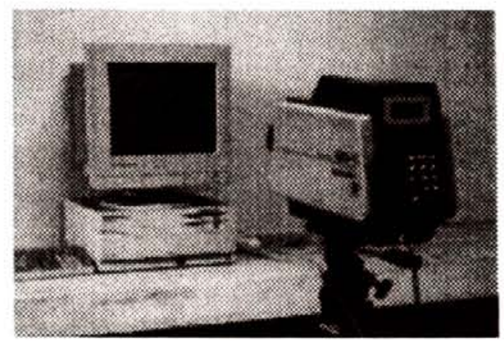


Figure 3. Midurasa and hayasa assessments through Paired Comparison

Observers:	21 students
Age:	from 19 to 25
Distance:	70cm – 1m
Frequency:	15Hz
Time:	2 seconds for a flash image
Size:	21 × 28cm
Order:	randomised
Lighting:	under fluorescent light such as a normal room lighting

Photo 1. Visual assessment and viewing codition



Spectroradiometer:	SR-1
Angle:	2 degree
Distance:	75cm
Measurement:	5 times

Maximum and minimum colourimetric values were excepted, and averages were computed

Photo 2. Instrumental assessment and measuring condition

3. Result

Confidence interval and hedonic scales were obtained from the assessments through Sheffeís method. By the confidence interval, we investigated about the difference between the feelings of two flash images. We also investigated about the relationship between the hedonic scale expressing the feelings and colorimetric property.

3.1 Confidence Interval

With the analysis through the confidence interval, we found that midurasa feelings on flash images mostly had confidence intervals larger than 95% confidence interval, Y0.05. As an example, Figure 4 shows the confidence interval on midurasa assessments on red-blue and blue-grey. The distance of allows in the figure shows Y0.05.

Hayasa feelings did not have lager confidence intervals excepting the case of large colour different flash images. Figure 5 shows hayasa assessments on yellow-red and green-grey.

Comparing between the distances of allows and flash images in the figures, we found that small hue and chroma contrasts of flash images influence to midurasa feeling, but not to hayasa feeling so much.

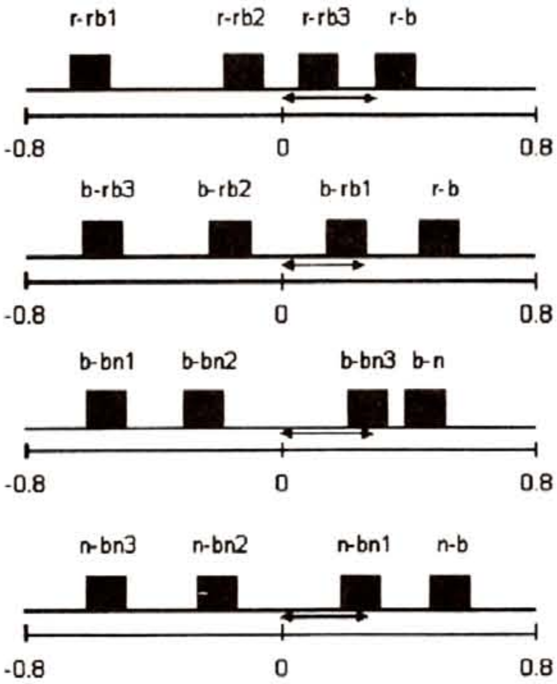


Figure 4. Confidence interval on *midurasa*

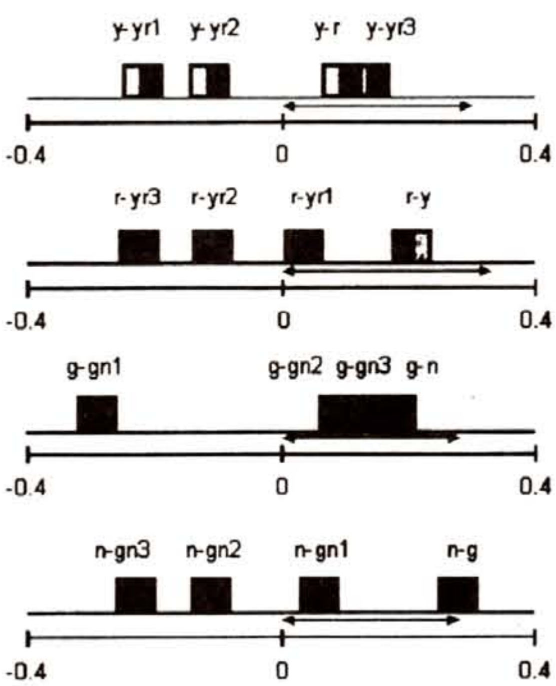


Figure 5. Confidence interval on *hayasa*

3.2 Relationship between Hedonic Scale and Luminance Difference

Hedonic scale was used as a sensational parameter corresponding to hayasa and midurasa feelings. In a previous study [5], we have already found that the relationship between hedonic scale and luminance difference is roughly linear.

Figure 6 shows the relationship between hedonic scale of midurasa and luminance difference. The relationship means that high contrast flash image is difficult to see (midurai). Figure 7 shows the relationship between hedonic scale of hayasa and luminance difference. Hayasa feelings on flash images used in this study were relevant to the luminance difference of flash colours. But hayasa feelings of some flash images were not influenced so much by colour as shown in Figure 7.

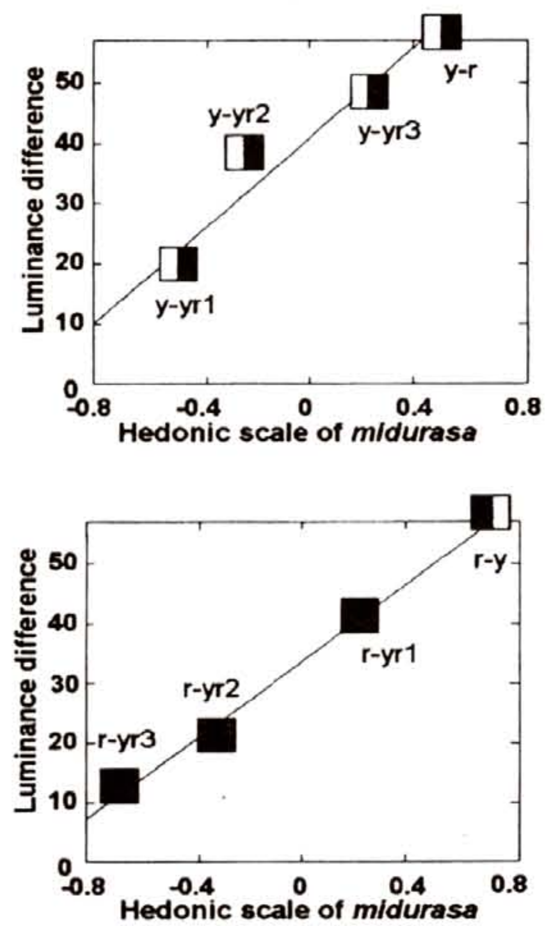


Figure 6. Relationship between midurasa and luminance difference, yellow-red, hue change

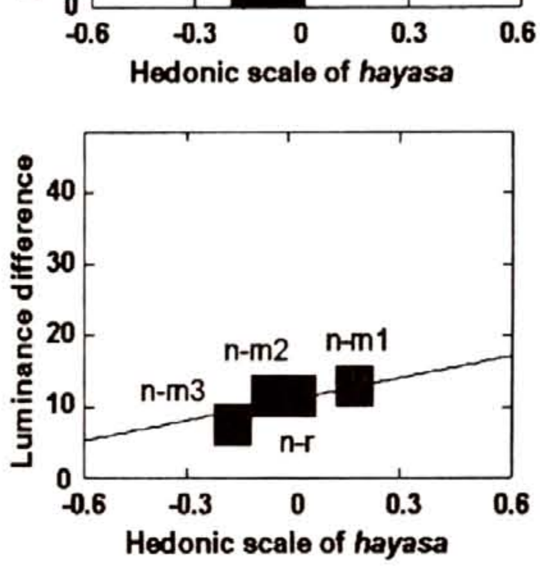


Figure 7. Relationship between hayasa and luminance difference, green-grey, chroma change

4. Summary

To investigate two kinds of visibility such as hayasa (speed) and midurasa (difficulty to see) feelings induced by a flash image, we tried to analyse the relationship between the visibilities and flash colours with the viewpoints of colour physics and sensory engineering. Comparing the luminance of colours with visual assessments of hayasa and midurasa, we found out the followings;

(1) *Hayasa* feeling was not the same, even though the frequencies of flash images were the same. This means that the magnitude of human sensation is different from physical one.
(2) *Midurasa* feelings on flash images mostly had confidence intervals larger than $Y_{0.05}$. But hayasa feelings did not have lager confidence intervals excepting the case of large colour different flash images.
(3) Hayasa and midurasa feelings were relevant to the luminance difference of flash colour. The relationships between the magnitude of the feelings and the luminance difference were in proportion.

The conclusions 1 and 3 were the same to the result in the previous study. In the case of the conclusion 2, we have already found in the previous study that large hue contrast of flash images influences to both of hayasa and midurasa feelings. But, with the results of this study, we found that small hue and chroma contrasts of flash images influence to midurasa feeling as well, but not to hayasa feeling so much.

Acknowledgement

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Workflow for Digital Photography and the Influence on Perception of the Printed Output Quality

Werner Sobotka

Abstract

The paper is explaining the different methods and technologies for digital photography. Especially the different image technologies will be described and the quality of colour accuracy will be pointed out. Using the IT8 colour test image for calibrating the systems and sending the compressed files to different viewers was investigated in respect of perceiving coloured images on different spots around the world for viewing and publishing. Important facts as different colour perception in different countries, and how to correct in advance these colour difference will be discussed. Digital colour photography is a global business on the other hand it has to take in consideration the different colour perception in different continents and different countries to get satisfying results. Proposals are made how to take care of this very important problem especially in future world of only digital colour photography.

Keywords : digital photography, perception, colour management

1. Introduction

The so called CCD-Chip (Charge Couple Device) is the heart of a digital camera. Digital cameras work with CCD- lines with RGB filters or one CCD chip. Very common are chips with filter wheels, CCD chips using a prism and CCDs with special filter coatings. CCD wheel types have only one chip, which can perceive only black and white, therefore three shuts have to be performed, CCD with prism use 3 chips two of the chips are green sensitive and one chip sensitive for red/blue. The filters are directly on the chip. Mainly chips with evaporated coatings as filters on the chip are used for amateur photography and One Shot technique. The photo will be taken with only one area sensor coated with filter layers for each colour. The best possibility to enlarge the information density is to enlarge the amount of sensor elements per pixel. Scanner cameras are working with CCD- lines. The line sensor is scanning the image line by line There are also a difference between three- pass scanning and one- pass scanning. There is also a four shot modus and cameras with this technology could be also used for one shot modus for moving objects.

Prof. Dr. Werner Sobotka
VFG (Institute for Research in Graphic Media)
A/1140, Leyserstrasse, Vienna, Austria
Phone 0043 / 1/9823914/121
Fax 0043/1/98 21 710
E/mail vfg@cybertron.at

2. Goals of Colour Management

To discuss colour management it is necessary to explain the problems about colour reproduction. The difference between conventional photography is, that the responsibility of the photographer stops with the production of the slide or print. The digital photographer is working directly in the field of prepress technology. The problems are occurring in the different colour spaces. Therefore to get satisfying results some important facts have to be taken in account for a perfect colour management.

2.1 Digital imaging should not influence the original

2.2 The colour output should be the same on all used hardware (monitor, print, proof)

2.3 The colour perception of the end-user should be put in consideration

The integration of different parts of the workflow process, especially input- and output- hardware and software programs for image handling should be working together in a workflow system.

In all digital photo-studios the image is running through different steps in production and therefore also through completely different colour spaces.

The human perception is the first most important factor of these workflow systems. The imaging process via a digital camera is the next step. The next point is the monitor, where the image will be judged for its reality in sense of image quality and colour accuracy. The colour space on the monitor allows 16,7 million colour shades, but still it is quite smaller as cameras or scanners can differentiate. The last step the output as colour photography or as printed product or as inkjet print should give the exact colour shades our customers wanted to get.

3. Problems of Colour Reproduction Versus Colour Perception

The first problems occurring for colour perception are as follows:

3.1 Green of the motive is different according to the green sensitivity of the CCD-sensor of the digital camera

3.2 The next step is that the phosphor pixels on the computer monitor are quite differently displaying the colour green as the human perception and the CCD sensitivity in the camera

3.3 The last important fact is the colour impression of the output the photographic print, a printed sheet or an ink jet print., where the colour green will be originated with YMCK colours Cyan and Yellow.

For the output which are used by different end users the colour accuracy of digital produced images is demanding:

1.Different viewers should see the same colours worldwide and also perceive colours in the same way

2. Colour management systems should also compensate between different colour perceptions and different hardware components.

3.The viewing conditions must be put in consideration ñ daylight or artificial light, direct or indirect illumination.

Colour Spaces

CIE Lab, CIE l*a*b*, CIE Luv, CIE L* u*v*. For digital photography CIE Lab is the common used colour space now.

Device Dependent Colour

Input devices and colour monitors are using RGB
Output devices are using CMYK

Device Independent Colours

The use of CIELAB colour space should be complete open systems device independent and usable for all hardware components.

Open colour- management systems have 2 important goals:

1. The reproducability of an image with the same results as a slide in Vienna and in two weeks as a print in Tokio

2. The possibility of a softproof in output quality with a monitor or as a hardproof with a colour printer

For transformation between different colour spaces are calculation methods available using with special transformation tables.

To standardise colour-management systems 1993 the ICC International Colour Consortium was established.

The ICC profiles are the main criteria to describe different characteristics of different hardware components like: Scanners, printer, digital cameras, RIPs. For the calculations a so called communication colour space will be established including all colours of all devices. Most systems are using therefore the CIELab- colour space.

4.The IT8- Chart Approach

The most used and imaged motive is now this IT8 chart. It is a basis for ICC profiles for digital cameras and also for viewing conditions in different countries and continents. It was tested that output in Europe, America and Asia is different. Also different standard colours are used for example EURO- Scale or SWAP colour scales or JAGAT defined colour scales in Japan. Therefore for output worldwide different profiles have to be established to be successful for global pictorial colour perception.

IT8- charts are mainly produced on light sensitive photo- material as slide or print available from Agfa, Fuji and Kodak .Beside standardised colour areas there is the possibility to put producer specific motives or country specific motives on a chart.

After digitalisation the profile software is comparing the existing values with the desired values, which are supplied as data set with a special chart. From the difference the ICC- profile will be calculated.

5. Use of Profiles

The use of such profiles for calculation for colour characteristics will be done by a so called CMM (Colour matching module). CMM can calculate each colour value for a given input colour space using the data of the profile, to calculate colour values for the output data.

Therefore CMM is a very important part for digital photography in future For example the manipulation of RGB data sets will be used to establish profiles of the input data for scanners , digital cameras and monitors and the output data set for all kind of printing processes. The output of an image is than without any manipulation of the user possible.

5.1 Colour Space Modification

The ICC/ standard can handle four different methods perceptual, saturation oriented, relative colorimetric and absolute colorimetric methods.

Perceptual accommodation of the natural colour space with the output colour space

Saturation/ brilliant high saturated colours with loss of colour accuracy.

Relative colorimetric, exact colorimetric colours in relation to the whiteness of paper.

Absolute colorimetric exact reproduction of the colours not reproducible colours will be shown as the next reproducible colour.

6. Summary

It id very important for exact colour reproduction to use a good working colour management system and different IT8 charts for the use in different countries and continents to get exact and accurate colour reproduction. Especially the perceptual quality id not a question of colour accuracy it is more or less a problem of the traditional colour perception in different countries and also in different user groups.

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The Validity on Evaluation of Interior Color by Scaled Model, Slide and Computer Graphic

Lee Jin-Sook, Jin Eun-Mi, Kim Won-Do, Jang So-Hyun, Han Sang-Pil

Abstract

The aim of this study is to compare the result of experiments by scaled model, slide and CG with that by mock-up, and to verify their validity.
This study was composed of four steps and was carried out as follows; 1) The object was determined to living room and variables of color were selected by representative orders that could explain evaluation characteristics of the living room. 2) Each evaluation object by experiment methods was manufactured under the same condition. 3) Through the evaluation experiment using SD Method(Semantic Differential Method), differences of tendency were analyzed. 4) The significant difference was verified by the Analysis of Variance.
The results of this study were as follows; 1) The evaluation experiments using scaled model and CG were valid and the P-values of scaled model were generally higher than that of CG. 2) The experiment by slide was partly valid, so it would be valid in case of being selected properly.

Keywords : Experiment Method, Validity, Mock-up, Scaled Model, Slide, CG(Computer Graphic)

1. Introduction

A color of all factors that compose the interior has great influence on the image of the space and affects interior. So systematic and analytic studies are needed for the comfortable interior environment. Because these studies must manage many visual object in short time, experiments by scaled model, slide and CG(Computer Graphic) are indispensable.

Recently, some studies on the validity of experiment methods using scaled model, slide and CG have been performed but the range of studies is narrow.

Therefore, the aim of this study is to verify the validity of experiment methods using scale model, slide and CG by comparing with mock up.

The flow of this study is as Fig. 1 and concrete contents are as follows. The step 1 is that of selecting the evaluation experiment condition. Scaled model, slide and CG being frequently used for evaluation of color environment were selected as evaluation object of experiment method. And the living room was selected as evaluation object of space and variables of color were selected by representative orders that could explain evaluation characteristics of the living room. The step 2, that of experiment under the fixed condition and experiment by evaluation methods were carried out. The step 3, that of verifying the validity of experiment methods by comparing the result of scaled model, slide and CG with that of mock up respectively.

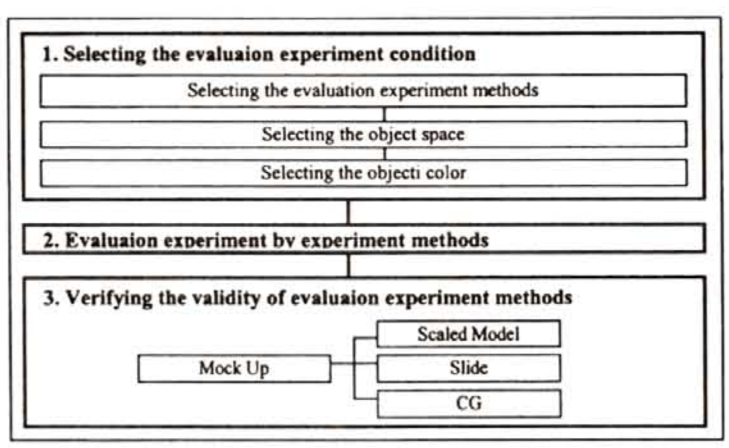

Figure 1. Flow Chart

2. Summary of Experiment

2.1 Selecting the Evaluation Experiment Methods

In this study, scaled model, slide and CG that were frequently used for evaluation of color environment were selected as experiment methods and those

Lee Jin-Sook, Jin Eun-Mi, Kim Won-Do, Jang So-Hyun, Han Sang-Pil, Chungnam National University
Dept of Architectural Engineering, College of Engineering
220 Kung Dong, Yosung-Ku, Taejon, 305-764, Korea
Phone : +82-42-821-7733
Fax : +82-42-823-9467
E-mail: js_lee@hanbat.chungnam.ac.kr

validity would be verified. Then mock up was to be standard and scaled model, slide and CG reappeared that to the highest degree.

2.2 Adjectives for Evaluation

Adjectives for the evaluation were selected out of adjectives that were judged that they could represent the image of living room effectively in the previous studies)), and included variously 3 factors, i.e. Evaluation, Potency and Activity Factor by the theory of Osgood). They were to 9 and as table 1.

Table 1. Adjectives

Stable	-	Unstable	Soft	-	Hard
Natural	-	Unnatural	Warm	-	Cool
Comfortable	-	Discomfortable	Lively	-	Calm
Open	-	Closed	Unique	-	Common
Bright	-	Dark			

2.3 The Color for Evaluation Object

The space for evaluation was determined to living room and hue was selected to N, 5R, 5Y, 5B by representative orders, i.e. neutral, warm and cool color. The value and chroma were fixed 9 and 2 respectively. They have been used mostly in the living room by the result of the previous studies). And in order to compare the result according to the change of value and chroma, N 7, N 8, 5Y 9/1 and 5Y 9/4 were added. Total colors were 8.

Ceiling and floor were fixed to N 9.5 and N 7.5 respectively. The color of furniture was 2.5Y 8/2.

2.4 Manufacturing the Space for Evaluation

Fig. 2 shows the plan of the experiment room and the layout of the furniture. The dimensions of the room are; width 2,760mm, length 5,870mm, ceiling height 2,700mm. The object of space is living room.

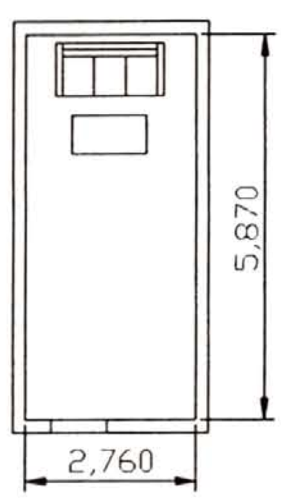

Figure 2. The Plan of The Experimental Room

The scaled model was manufactured to a scale of 1 to 10. Lighting was the daylight fluorescent lamp of the color temperature, 6000K(OSRAM, FL 40EX-D(11)).

The mean illumination was 250lx. The slide was manufactured by taking a photograph of the scene in mock up. The CG reappeared the color and lighting environment of mock up using the computer programs of AutoCAD, Phothshop and Lightscape 3.2 to the highest degree. The Fig. 3<"Fig. 5 show the example of evaluation objects.

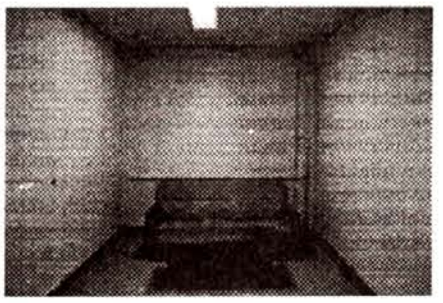

Figure 3. Mock Up (Slide)

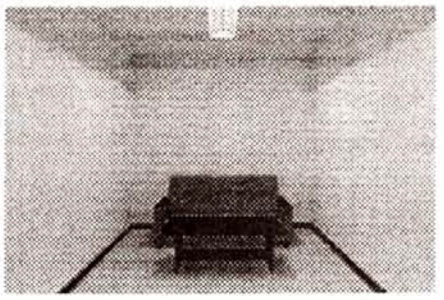

Figure 4. CG

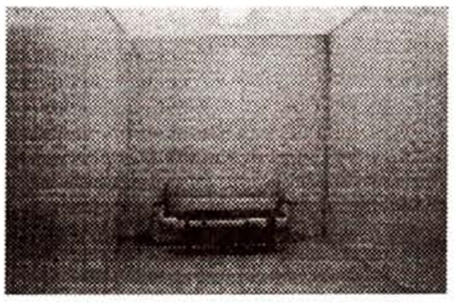

Figure 5. Scaled Model

2.5 Subjects

Subjects were composed of 31 graduated and senior students of the department of architecture who were accepted to have the ability of judgement for the colors of architecture. Because the aim of this study was to verify the validity of evaluation

1) Lee, Jin-Sook etc. 「Application of Repertory Grid Development Method to Extraction of Structural Model in Housing Environment」, Housing Research Journal of Korea, Vol. 2, No. 1, Jun. 1991.
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methods, the composition of subjects was the same in all experiments.

Table 2. The Group of Subjects

Sex	Male : 14, Female : 17
Position	Graduate Students : 11 Senior Students : 20
Total	31

2.6 Experiment Methods

Subjects eyes were fixed to the height 1.5m by evaluation of the scene through the observation window. Then in the experiment by slide, the ratio of the width of front wall on the screen and the distance from screen to the position of subject was the same as that of width and length in mock up. And in the experiment by CG, the ratio of the width of front wall on the monitor and the distance from monitor to the position of eyes was the same as that of width and length in mock up. Subjects evaluated the scene of mock up, scaled model, slide and CG after dark adaptation for 5 minutes. Objects were represented randomly not to be affected by the order.

The SD Method(Semantic Differential Method) was used for the evaluation.

2.7 Analysis Methods

In order to verify the validity of experiment methods using scaled model, slide and CG in the living room, Analysis of Variance by one-way layout(scaled model × mock up, slide × mock up, CG × mock up) was carried out. So each experiment methods were compared with mock up.

3. Verifying the Validity by Evaluation Experiment Methods

3.1 The Experiment by Scaled Model

The results of analysis are as the table 3. The P-values were above 0.05($P > 0.05$ (significant level 5%)) in all evaluaion adjectives. So the null hypothesis that there was no significant difference between experiment methods by scaled model and mock up was selected. In the case of 「Bright」 and 「Warm」, the P-values were relatively lower than that of the others. It was judged that the result was caused by the difference of texture between two experiments. These correspond to the result of previous studies[1)1)] on the texture.

Table 3. The Results of the ANOVA analysis (Scaled Model - Mock Up)

Adjective	P-value(P)	F-value
Stable	.713	0.136
Natural	.655	0.199
Comfortable	.417	0.661
Open	.731	0.119
Bright	.270	1.223
Soft	.384	0.761
Warm	.216	1.537
Lively	.941	0.006
Unique	.320	0.991

3.2 The Experiment by Slide

The results of analysis are as the table 4. The P-values of「Stable」, 「Natural」 and 「Comfortable」 that were Evaluation Factor were below 0.05($P < 0.05$(significant level 5%)). That yielded there was significant difference between experiment methods by slide and mock up in Evaluation Factor. The P-values of Potency and Activity Factor except for 「Bright」 were above 0.05($P > 0.05$(significant level 5%)), and that yielded there was no significant difference in Potency and Activity Factor. In the case of 「Bright」, it was judged because the slide could not represent the delicate difference of brightness from the characteristic point of the film.

Table 4. The Results of the ANOVA analysis (Slide - Mock Up)

Adjective	P-value(P)	F-value
Stable	.000	21.032
Natural	.005	7.913
Comfortable	.020	5.448
Open	.085	2.976
Bright	.001	10.522
Soft	.155	2.029
Warm	.526	.403
Lively	.370	.804
Unique	.037	4.383

Significant Level < 0.01 Significant Level < 0.05

3.3 The Experiment by CG

From the result of analysis, the P-values of all the evaluation adjectives except for 「Stable」 were above 0.05($P > 0.05$(significant level 5%)), so it could be yielded there was no significant difference between experiment methods by CG and mock up.

In the case of 「Stable」, it was judged that the reason was because subjects evaluated the scenes with not

5) SAWA Tomoe, etc., 「The Influence of Wall Color and Lighting and Material on the Evaluation of Interior Impression Part2」, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, 1997.

6) Kitamura, etc., 「Interpretation of the Evaluation Scales for Appearance, and a Quantitative Analysis of Appearance Using Simple Texture」, J. Archit. Plann. Environ. Eng, AIJ, No. 511, Dec. 1998

being in the room. And the evaluation values of the 「Stable」 in the CG were generally lower than that in mock up, but the flow of evaluation was nearly similar. The P-value of the 「Open」 was relatively lower than that of the others. It was judged that the reason was because the CG could not reappear well the binocular disparity and convergence angle that are related to the perception of depth.

Table 5. The Results of the ANOVA analysis (CG - Mock Up)

Adjective	P-value(P)	F-value
Stable	.002	9.454
Natural	.098	2.748
Comfortable	.360	.841
Open	.054	3.751
Brignt	.505	.445
Soft	.515	.425
Warm	.498	.460
Lively	.105	2.648
Unique	.081	3.067

Significant Level < 001 Significant Level < 005

4. Conclusion

The aim of this study is to verify the validity of evaluation methods in the color environment focussed on the scaled model, slide and CG.

(1) In the case of evaluaion experiment using scaled model, the P-values of all evaluation adjectives were above 0.05(P >0.05(significant level 5%). Therefore it was verified that the experiment by scaled model was valid. In the case of 「Bright」 and 「Warm」, P-values were relatively lower than that of the others. It was judged that the result was caused by the difference of texture between two experiments.

(2) In the case of evaluation experiment using slide, the P-values of 「Stable」,「Natural」 and 「Comfortable」 that were Evaluation Factor were below 0.05(P˘0.05(significant level 5%)). So there was no significant difference. But the P-values of Potency and Activity Factor except fro 「Bright」 were above 0.05(P˘0.05 significant level 5%)). So there was significant difference. In the case of 「Bright」, it was judged that the reason was because the slide could not represent the delicate difference of brightness from the characteristic point of the film.

(3) In the case of evaluaion experiment using CG, the P-values of all the evaluation adjectives except for 「Stable」 were above 0.05(P˘0.05(significant level 5%)). Therefore it was verified that the experiment by CG was valid. In the case of 「Stable」, it was judged that the reason was because subjects evaluated the scenes with not being in the room. And the evaluation values of the 「Stable」 in the CG were generally lower than that in mock up, but the flow of evaluation was nearly similar. The P-value of the 「Open」 was relatively lower than that of the others. It was judged because the CG could not reappear effectively the binocular disparity and convergence angle that are relate to the perception of depth.

As a result of this study, it was extracted that scaled model and CG were valid and the P-values of scaled model were generally higher than that of CG. The experiment by slide was partly valid, so it would be valid in case of being selected properly.

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1) Lee, Jin-Sook etc. 「Application of Repertory Grid Development Method to Extraction of Structural Model in Housing Environment」, Housing Research Journal of Korea, Vol. 2, No. 1, Jun. 1991.

2) Lee, Jin sook, etc. 「Analyzing and Extracting of the Color Evaluation Models of Interiors and Exteriors」, Proceeding Paper of the Architectural Institution of Korea, Vol. 20, No. 1, 2000.

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Determinant of the Size of Recognized Visual Space of Illumination in a Natural Environment

Hideki Yamaguchi, Hiroyuki Shinoda, Mitsuo Ikeda

Abstract

Understanding of illumination is necessary for the perception of color and brightness of object's surface. We call such understanding of illumination the recognized visual space of illumination, RVSI. In particular we use a term 'size' of RVSI to describe an observer's perception about intensity of illumination. When the luminance of an object's surface is increased by a spot-lighting, its surface is getting brighter as though it were being replaced by other surfaces of higher reflectance, and finally, at certain luminance, it begins to appear unnaturally bright as an object in the environment. This particular luminance, called border luminance, is a measure of the size of RVSI. The purpose of this study is to investigate what, in a complex environment, determines the size of RVSI. We measured the border luminance of the test patch (N5 gray, mat) to test three candidates for determinants of size of RVSI: illuminance (1), spatially averaged luminance across a visual field (2), and highest luminance in the field (3). The border luminance of RVSI was completely proportional to the illuminance. The effect of the averaged luminance or that of the highest luminance was almost negligible to that of the illuminance. Our results suggest that the illuminance is a major determinant of the size of RVSI.

Keywords : size of recognized visual space of illumination, color mode, natural environment, illumination

1. Introduction

When a person enters a room, s/he immediately understands how the space is illuminated, brightly or dimly, whitely or a little bit reddish, for example. This situation is expressed as that the recognized visual space of illumination, RVSI, for the room was constructed in her/his brain. Especially we use a term 'size' of RVSI to describe an observer's perception about intensity of illumination. When an observer recognizes a room is illuminated brightly (dimly), we say the size of RVSI is large (small). We use a circle to describe the RVSI schematically, as shown in Fig.1. The radius of circle indicates the size of RVSI. When we consider an object in the room it can be expressed by a certain point in the circle, as shown by a filled square in Fig.1. The apparent lightness of its surface is determined in relation to the size of RVSI. In other words, it is determined by the relative distance between that point and the center to the radius of the circle. When the luminance of an object's surface is increased by a spot-lighting, its surface is getting brighter as though it were being replaced by another surface with higher reflectance, and finally, at certain luminance, it begins to appear unnaturally bright as an object in this environment. This particular luminance is called 'border luminance'. This phenomenon can be described in the scheme as follows. As the luminance of the object's surface is increased by a spot-lighting, the filled square shifts outward along the radius and finally goes outside of the circle as shown by an open square in Fig.1. The border luminance corresponds to the radius of the circle, that is, the size of RVSI. Thus we can define the size of RVSI by the border luminance.

Hideki Yamaguchi, Hiroyuki Shinoda and Mitsuo Ikeda
Department of Photonics, Faculty of Science and Engineering, Ritsumeikan University
Nojihigashi, Kusatsu, Japan 525-8577
Phone : +81 77 566 1111 (ex 8552)
Fax : +81 77 561 2663
E-mail:ro012962@se.ritsumei.ac.jp

Let us consider what determines the size of RVSI. In the previous paper1, 2), the size of RVSI was studied with a Mondrian pattern or a miniature room. These results showed that the size of RVSI was proportional to the illuminance. In the present experiment we will prove it in a more naturalistic environment such as living room and also examine the effect of spatially averaged luminance across the visual field and the highest luminance in the field. We carried out two different experiments, where observers adjusted the intensity of a spot-lighting to get the border luminance in several conditions. The effect of the illuminance and the spatially averaged luminance were examined in experiment1, and the highest luminance in experiment2.

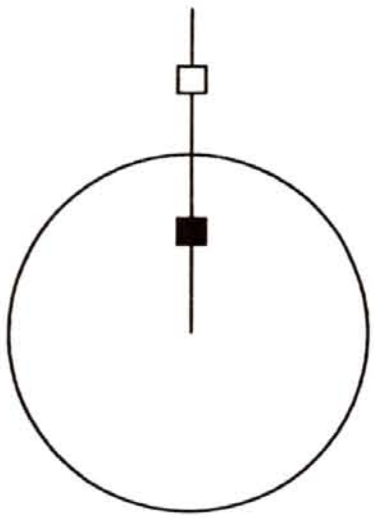


Figure 1. Schematic representation of RVSI and the border luminance

One of the most important and difficult tasks in evaluation of perceived brightness in everyday circumstances is to assess what level the visual system adapts to. Especially, this is an inevitable process when putting the new photometric system into practice3). We can assess the state of color adaptation easily, even in any complex environments, by measuring chromaticities of a stimulus that appears achromatic. On the other hand, we have neither definition nor measure of adaptation level with general consent that is usable for complex visual environments. We think the size of RVSI might be measure of adaptation level in everyday circumstances. For that issue, it is important to investigate what, in a complex environment, determines the size of RVSI.

2. Experiment1

2.1 Experimental Room

We run both experiments in an experimental room shown in Figure 2. The room was 3.6m wide, 2.7m deep, and 2.2m high. This room is arranged like a normal living room and illuminated by fluorescent lamps (daylight type, FL) on the ceiling. The intensity of FL was variable and the illuminance was measured with an illuminance meter placed on the table in the center of the room. We measured the border luminance with a target, a N5 gray patch of 6◊6cm that had a mat surface. The target was held by a pole 1.2m above the floor and spotlighted by a slide projector. The neutral density wedge filter was inserted in the light path that enabled us to control the luminance of the target. The highest luminance of the target was 170cd/m2. The distance between an observer and the target is 2.0m.

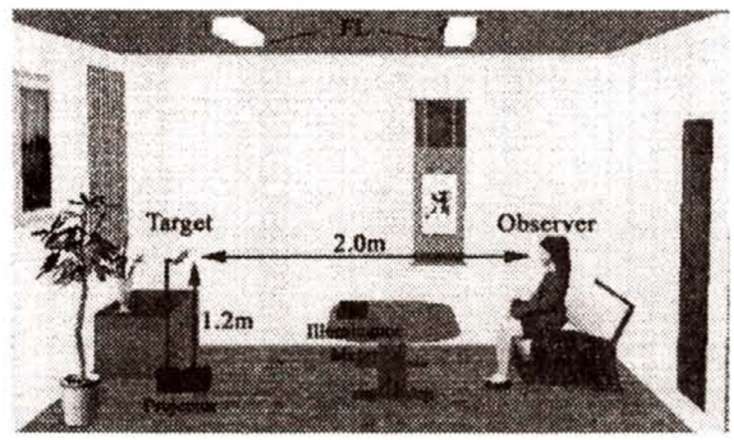


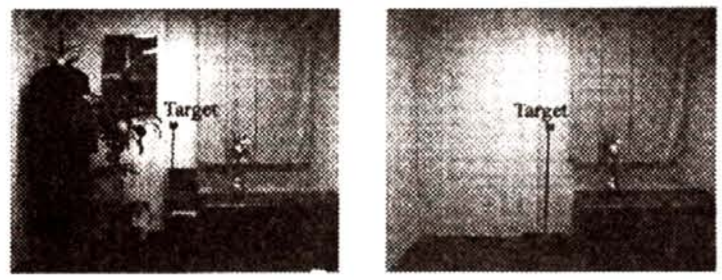
Figure 2. Side view of the exerimental room

2.2 Conditions

We manipulated the spatially averaged luminance by replacing objects in the room (Figure 3). Since the luminances of all objects introduced in setting (a) were lower than that of the front wall, the averaged luminance of setting (a) should be lower than that of setting (b). We denote setting (a) and (b) by L and H respectively. We measured border luminances at five different illuminance levels 3, 10, 30, 100 and 300lx, in both two settings.

2.3 Procedures

The observer's task was to adjust the luminance of the target where it starts to look unnatural as an object under the illumination. The observers were instructed to observe the entire room rather than only the target itself. One experimental session was composed of 25 adjustments (five successive adjustments for five illuminance levels). First five sessions were done in L condition, and then another five sessions were done in H condition. Five observers, HH (male), HS (male), HY (male), RY (female) and YM (male), participated in the experiment.



(a) (b)

Figure 3. Observer's view in two settings in expriment1:
(a) lower averaged luminance setting, L;
(b) higher averaged luminance setting, H

2.4 Results

The result from observer HH is shown in Figure 4 as an example since the results from other observers showed the same trend. The ordinate indicates the border luminance of the target and the abscissa indicates the illuminance of the room. Open circles show the averaged border luminance in L and filled circles in H. The error bars indicate the standard deviation across 25 adjustments. The border luminance of RVSI was proportional to the illuminance. The slope for both conditions was 0.9. The border luminance for H condition was slightly higher than that for L condition. We calculated the spatially averaged luminance for both setting to examine its contribution to the border luminance.

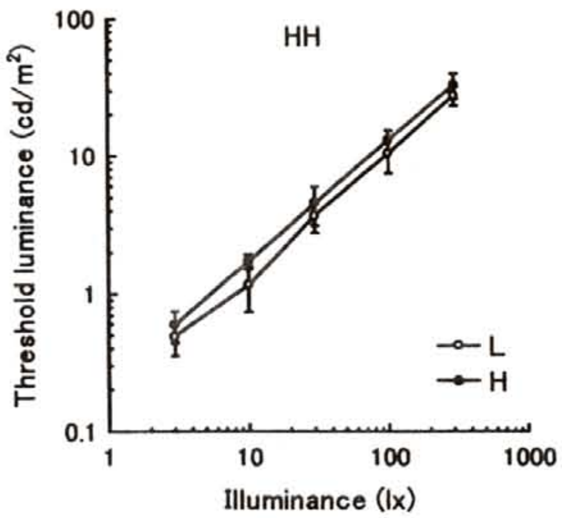


Figure 4. Border luminance as a function of illuminance from from observer HH

Although the averaged luminance in H was 1.6 times higher than that in L, the border luminance of H was just 1.2 times as high. In addition, the error bars almost overlapped each other. Thus, the effect of the averaged luminance, for the same illuminance level, was not significant. Replacing object in a room causes only small change in the averaged luminance.

In other words, the averaged luminance is mainly determined by the illuminance. Therefore, the illuminance, rather than the averaged luminance, may be more essential to the size of RVSI.

In the both settings, the highest luminance did not change; the white flower had higher luminance than any other objects, except the ceiling light FL, had. The small difference in the border luminance might be caused by the constancy in the highest luminance. We examined the effect of the highest luminance to the border luminance in experiment2.

3. Experiment2

3.1 Experimental Room

We carried out experiment2 in the same room as used in the experiment1.

3.2 Conditions

We introduced a small window on the front wall to manipulate the highest luminance in the scene (Figure 5). The window was made of white paper and illuminated by fluorescent lamps from behind. The illuminance of the room was set at three different levels (3, 30 and 300lx). In each illuminance levels, we set four different luminances of the window labeled by W1, W2, W3, and W4. The luminance of W1 was defined as having twice as high as that of the ceiling light, and that of W2 was set about ten times as high as that of the white flower. The luminance of W3 was set around the luminance where the appearance of its surface changes from surface color mode to light source color mode. Here we call this luminance 'transition luminance' to distinguish it from the 'border luminance'. The window without a backlight was labeled by W4. The luminances of each window states under each illuminance were shown in Table1. Since the lowest luminance of the window with a backlight was higher than 1cd/m2, W3 under illuminance of 3lx was unavailable.

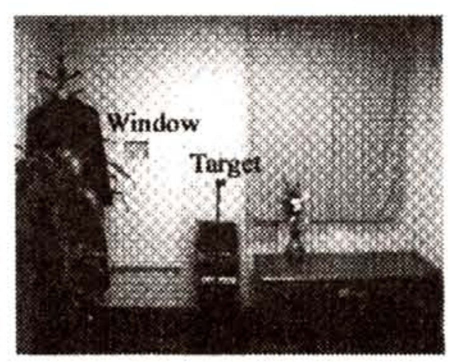


Figure 5. Observer's view in expriment2. The backlit window was introduced on the wall that enabled us to manipulate the highest luminance.

Table 1. The luminance of the window at each illuminance

Illuminance of the room (lx)	Luminance of the window (cd/m²)			
	W1	W2	W3	W4
3	30	5	----------	0.25
30	300	50	10	2.5
300	3000	500	100	25

3.3 Procedures

Observers were asked to set the luminance of the target where it starts to look unnatural (border luminance) and where it begins to appear a light source color mode (transition luminance). The observers were instructed to do adjustments observing the entire room, not only the target itself.

One experimental session was composed of 66 adjustments (three adjustments for the border luminance and then three adjustments for the transition luminance under 11 conditions shown in Table1). Each observer carried out five sessions of experiment. The same observers participated in this experiment.

3.4 Results

The result from observer HH is shown in Figure 6, since the results from other observers were almost the same. The ordinate indicates the border luminance and transition luminance. The abscissa indicates the luminance of the window. The open symbols show the transition luminance and the filled symbols show the border luminance. The circles show the illuminance of 300lx, the squares 30lx, and the upper triangles 3lx. The error bars indicate the standard deviation across 15 adjustments. For each illuminance levels, the border luminance was constant regardless of the window luminance. Rather it goes up with the illuminance, which agrees with the result of experiment1. The transition luminance co-varied with the border luminance and its value was 1.5 times higher than that of the border luminance.

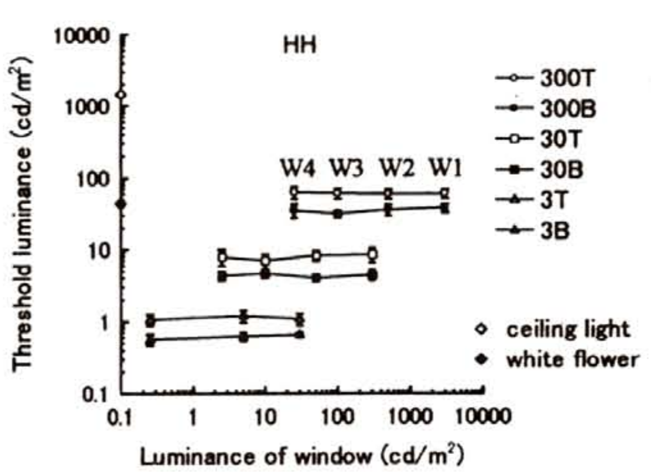


Figure 6. Result from observer HH. Filled symbols connected by lines indicate border luminance and open symbols transition luminance. The luminance of the ceiling light FL and that of the white flower at 300lx are shown by open and filled diamonds on the ordinate.

Let us take a close look at the data obtained at the illuminance of 300lx to examine the effect of the highest luminance on the border luminance. In condition W1, the luminance of the window was the highest and its value was 3000cd/m2. In other conditions, W2, W3, and W4, the highest luminance was the luminance of the ceiling light FL shown by an open diamond on the ordinate in Fig.6 and its value was 1500cd/m2. If the highest luminance in a scene determined the size of RVSI, the border luminance in W1 would differ from that in other conditions. In fact the border luminance was constant, which shows that the highest luminance does not determine the size of the RVSI. On the other hand, in all conditions, the luminance of the white flower was the highest among all the objects and its value was 45cd/m2 (a filled diamond on the ordinate). It should be noted that the border luminance was almost equal to the luminance of the white flower. The size of RVSI seems to be determined by the highest luminance of objects in the room. In a previous study4), it was suggested that the size of RVSI was determined by the highest lightness in the visual field, that is, the highest luminance of objects.

4. Discussion

We investigated three candidates as a determinant of the size of RVSI: illuminance, spatially averaged luminance, and highest luminance. In experiment1, the border luminance was proportional to the illuminance. The effect of the averaged luminance was small. Besides, replacing objects in a room caused only a small change in the averaged luminance, in other words, the averaged luminance was determined mainly by the illuminance.

Therefore, we can say that the illuminance is more important to the size of RVSI than the averaged luminance is. In experiment2, the border luminance was not affected at all by the presence of the small window, and it was equal to the highest luminance of objects. These results suggest that for the construction of RVSI we see only objects illuminated by the ceiling light and exclude other light sources. Since the highest luminance should be proportional to the illuminance, we can say that the illuminance is the most essential to the size of RVSI.

The border luminances from the both experiments were plotted against the illuminance in Fig.7. The filled symbols (L and H) show the averaged border luminance across all observers in experiment1 and the open symbols (W1, W2, W3 and W4) show that in experiment2. There is no difference among these averages and they are proportional to the illuminance. From these data we obtained a following formula.

LB=0.208E0.9

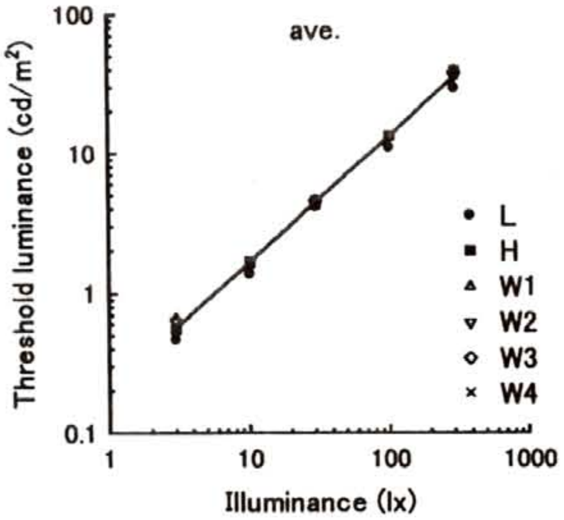


Figure 7. Averaged border luminances of all observers from all conditions

Where LB is the border luminance and E is the illuminance. The solid line in Figure 7 represents that formula. Using this formula we are able to predict the size of RVSI from the illuminance. For instance, when the illuminance on the table is 200lx, the border luminance is predicted to be 25cd/m2. Note that this formula is available to achromatic objects only, since a N5 patch used as a target in the experiment. In order to obtain a general formula we have to examine the border luminance for various chromatic objects.

5. Conclusion

The border luminance for a N5 patch was measured in a real space at various illuminances, averaged luminances, and the highest luminances. The border luminance was proportional to the illuminance (experiment1). The border luminance was equal to the highest luminance of 'objects' (experiment2). Since the highest luminance of objects is determined by the illuminance, we can conclude that the illuminance is a major determinant of the size of RVSI.

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Color Appearance Maintenance with Changes in Daylight Illuminants

Javier Romero, Javier Hern·ndez-AndrÈs, Juan L. Nieves, JosÈ A. GarcÌa.

Abstract

We have evaluated the variation in color when natural and artificial objects are illuminated with daylight of different days and hours of the same day. Chromaticity coordinates (x,y) and output magnitudes of the RLAB color appearance model were calculated for each of the illuminants and 27 objects of different hues. Although expected changes were found for (x,y) coordinates when light varies, no changes were account for lightness, hue, chroma and saturation both for the central hours of the day and different days. Only slight variations were found when sunrise and sunset light were considered. Results leads to the conclusion that adaptation color vision mechanisms act to maintain the appearance of the objects in nearly all conditions of photopic daylight illumination in the same location.

Keywords : daylight, color appearance, color differences

1. Introduction

The aim of this work is to know quantitatively the changes in the color of objects with the change on daylight all through a whole day and to compare, likewise, the results from different days with different atmospheric conditions. For this purpose we have made use of spectral reflectances drawn from a set of artificial and natural objects [1], and spectral power distributions (SPDs) of daylight measured and presented in a previous paper [2].

First we have obtained the chromaticity coordinates and luminances of objects and established the color-difference values associated with the variations on the spectral quality of daylight. Second we have evaluated the color attributes (lightness, hue, chroma and saturation) for different objects and daylight SPDs combinations as it is followed by an appearance color model. We try to see whether or not, no matter the purely colorimetric differences values are, the perceived color of objects (i.e. their color appearance) remain constant despite the variable quality. Due to the inclusion of adaptive transformation properties in the color appearance models, we check if chromatic adaptational changes are sufficient to achieved a perceived stability in the color appearance of objects despite of illuminant changes, that is, if color constancy is satisfied.

Javier Romero, Javier Hernández-Andres, Juan L.Nieves, José A.García
Departamento de Óptica. Facultad de Ciencias. Universidad de Granada.
18071 GRANADA. SPAIN.
Phone : 34-958-244241. Fax : 34-958-248533.
E-mail: jromero@ugr.es.

2. Results

Table 1 shows an example of the results derived from a single object under different phases of daylight corresponding to the same day. In this case an achromatic object and a completely clear day are chosen. We include in this table the daylightchromaticity coordinates as well as the objectchromaticity coordinates for each solar elevation at which a daylight measurement was taken. Also we have enclosed the L* value, which was calculated from the usual CIELUV and CIELAB formulas. This is considered as a first step in the evaluation of the color appearance attributes of the objects, because L* values are related with the object lightness.

Table 1. Chromaticity coordinates and L* values for a white object in a clear day (cl3). (xd,yd) are chromaticity coordinates of daylight at each solar elevation.

solar elev.(°)	x_d	y_d	x	y	L*
-1.2	0.2813	0.2987	0.2944	0.3145	72.63
1.1	0.2806	0.3017	0.2935	0.3176	72.63
3.1	0.2845	0.3057	0.2975	0.3215	72.65
9.9	0.3025	0.3215	0.3160	0.3368	72.72
14.2	0.3228	0.3388	0.3366	0.3528	72.78
25.9	0.3304	0.3441	0.3443	0.3577	72.81
36.8	0.3289	0.3437	0.3427	0.3573	72.80
48.2	0.3288	0.3414	0.3427	0.3552	72.81
55.6	0.3257	0.3377	0.3397	0.3518	72.80
58.7	0.3262	0.3377	0.3401	0.3518	72.80
37.9	0.3286	0.3394	0.3426	0.3533	72.81
28.0	0.3297	0.3402	0.3437	0.3539	72.81
16.3	0.3276	0.3384	0.3416	0.3523	72.80
4.9	0.2972	0.3138	0.3107	0.3292	72.70
2.7	0.2888	0.3073	0.3021	0.3229	72.67
0.7	0.2833	0.3029	0.2963	0.3187	72.64

Table 2. Chromaticity differences in MacAdam units for the 27 objects of figure 1 at the clear cl1 day. (x,y) are chromaticity coordinates of the objects at maximum solar elevation.

(x, y)	$(\Delta E)_1$	$(\Delta E)_2$
(0.3575, 0.3582)	33	9
(0.3404, 0.3522)	32	9
(0.3808, 0.3867)	32	9
(0.4646, 0.5010)	31	8
(0.4206, 0.5010)	27	7
(0.4458, 0.4343)	27	7
(0.4495, 0.4713)	33	9
(0.4594, 0.4572)	30	8
(0.3399, 0.4708)	30	9
(0.3331, 0.4280)	32	9
(0.3796, 0.4796)	37	11
(0.3668, 0.5329)	30	9
(0.3481, 0.4422)	34	10
(0.2682, 0.2801)	33	10
(0.2261, 0.2505)	35	11
(0.2027, 0.2040)	24	8
(0.2985, 0.3003)	33	10
(0.2878, 0.2271)	36	10
(0.4304, 0.3113)	35	8
(0.4519, 0.3645)	28	7
(0.5005, 0.3576)	22	5
(0.5843, 0.3417)	13	3
(0.5207, 0.4083)	18	4
(0.3577, 0.3316)	36	10
(0.3832, 0.3134)	41	10
(0.4402, 0.3893)	34	8
(0.3800, 0.2599)	38	9

It is noticeable (table 1) that colorimetric variations can be consider almost negligible when measurement near midday are considered, while significant differences are found between midday and twilight measurements. In the CIE 1931 system the variations on chromaticity coordinates of an object from the maximum solar elevation to the twilight follow, as expected, the same bias exhibited by the daylight, that is, a yellow-blue bias variation [2].

Next we calculate color differences on MacAdam units for the same object under different daylight SPDs. Table 2 shows the chromaticity-difference values derived from a completely clear day and each of the 27 selected objects that cover the chromatic variation of the objects measured by Vrhel [1]. The color difference ($\triangle$E)1 (see column 2 on table 2) has been calculated from the chromaticity coordinates of each object when it is illuminated with the two extreme conditions presented in table 1. For the color difference ($\triangle$E)2 (see column 3 on table 2) the illumination was respectively, the one for the maximum solar elevation and the one corresponding to the solar elevation closer to +5° (i.e. the beginning of the twilight).

We can see from table 2, that the ($\triangle$E)1 color-difference is significative; color variations are clearly greater than the tolerance values accepted in Colorimetry. Vrhel uses 3 CIELAB units (approximately 5.3 MacAdam units), based on object reproducibility recommendations. If we follow this recommendation and consider daylights but excluding twilights, the results are near within the colorimetric limits of color tolerances (third column of table 2).

Table 3. Chromaticity differences in MacAdam units for a red object at the different days. Second and third column show the chromaticity coordinates of the object at maximum and minimum solar elevation (the value of this parameter also specified) in each day.

day	(x,y)max, elev.	(x,y)min, elev.	$(\Delta E)_1$	$(\Delta E)_2$	$(\Delta E)_3$
cl1	(0.4303, 0.3113), 68.9°	(0.3651, 0.2653), -2.0°	35	9	5
cl2	(0.4345, 0.3129), 37.8°	(0.3634, 0.2641), -1.4°	37	17	6
cl3	(0.4300, 0.3109), 58.7°	(0.3785, 0.2747), -1.2°	28	16	2
ov1	(0.4270, 0.3093), 59.1°	(0.3224, 0.2375), -1.5°	53	7	1
ov2	(0.4227, 0.3070), 30.3°	(0.3351, 0.2441), -0.4°	46	27	5
mix	(0.4309, 0.3115), 52.9°	(0.3308, 0.2429), -2.3°	53	7	2

The question which arises from this analysis is whether or not these tendencies are keep constant for the entire set of the days? To study this possibility we show in table 3 the chromaticity differences for one object and six days with different atmospheric conditions. The chromaticity coordinates obtained with the maximum and minimum solar elevation and the solar elevation values are included in table 3. When only the twilights are excluded from the analysis the ((E)2 color differences are, in certain cases, also important from colorimetric considerations, so we can not conclude that these differences are always tolerable. The last column in table 3 shows the color-difference values ((E)3 when the object is illuminated with daylight at the maximum solar elevation and daylight with a solar elevation closer to 15∞, that is, trying to include only measurements taken in central hours of a day. In this case all the color differences are lower than the tolerable value, so we can conclude that on the central hours the color of objects does not change appreciably. This conclusion could be generalized to the different objects studied. Furthermore we claim that the chromaticity differences for an object under the central hour daylight conditions change very little through the day and through the different atmospheric conditions.

On the contrary, for twilights the results are the opposite because the chromaticity differences changes significantly during the same day, and are very sensible to the atmospheric conditions. Table 3 shows how these differences depending on the day. Nevertheless for central hours the object seems to maintain the color no matter the atmospheric condition.

Considering the appearance attributes, the lightness scarcely changes for different phases of daylight. The greatest differences, which are always not high, are found for the hue and, with little importance, for chroma and saturation. For this evaluation we used the RLAB color-appearance model [3] in order to calculate color-appearance attributes. Figure 1 shows the results when an extensive and representative set of objects is chosen. In this figure the differences in the aR and bR coordinates have been calculated for a clear day with the extreme conditions of illumination shown in table 1 and each of 28 objects. For each segment on figure 1 crosses represent the twilight condition of the illumination, and the opposite end of the segment represents the maximum solar-elevation condition of illumination.

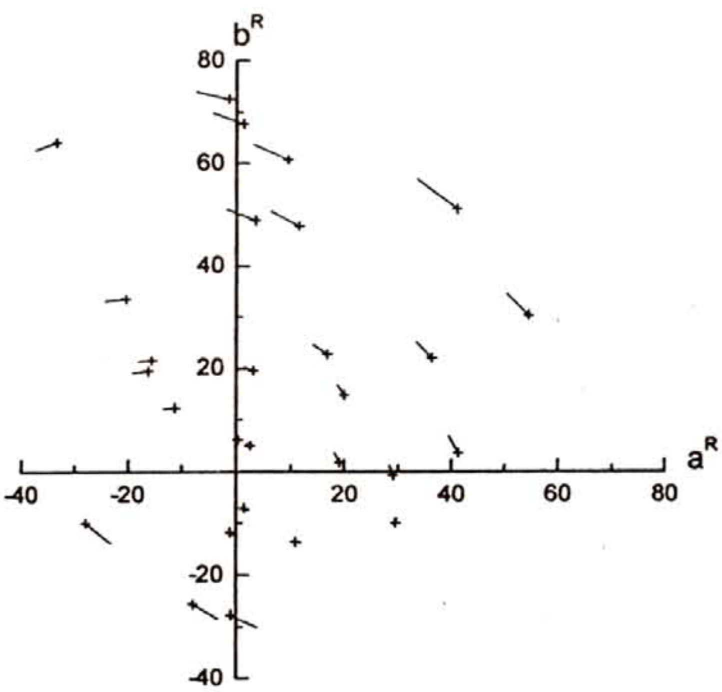

Figure 1.

The stimuli which were close to the reference white barely present variations. We observe that changes are appreciably major when the object is highly saturated. The conclusion pointed above is now also confirmed: the hue changes are more significant than the saturation changes are because the segments shown in figure 1 draw a circumference with center on the origin (except for certain objects: the ones on the second quadrant greens-).

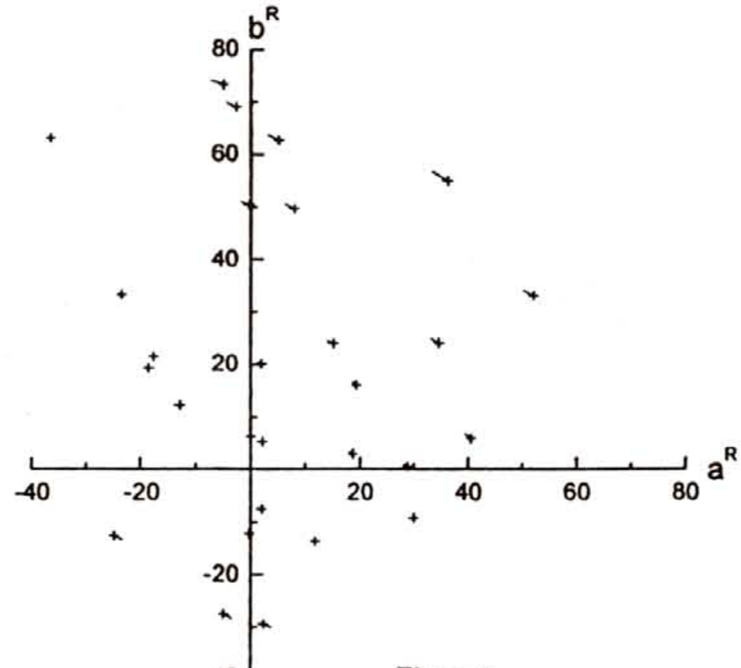

Figure 2.

A similar representation is presented in Figure 2, for the following extreme solar elevations: the maximum solar elevation and the closest to 5°, that is excluding twilights. The differences found are negligible, except for several objects with high chroma. The same behavior is obtained for the non-presented attribute: the lightness. This result leads us to conclude that for central hours of the day the objects appearance is practically constant.

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A Quantitative Study of the Area Effect of Colors

Lee Jin-Sook, Kim Chang-Soon, Yim Oh Yon, Lee Deok-Hyung

Abstract

The color selection of an architectural color design is carried out with color sample or sample book. So, occasionally, the finished color changed into different image to original color samples. By this reason, even though an architectural color designer who has a fluent experience can't predict exactly how the color sample will be changed in real finished color. This phenomenon is due to the color shift by the area effect of color. Such an area effect is experimentally known to color designer, but it doesn't have been precisely studied yet how much and to which direction the color is changed. So, in this study, we'd like to predict a color shift to propose a method to decrease an field implementation errors in architectural color planning.

Keywords : visual field, sensitive reaction, measurement on color shift, area effect

1. Introduction

In planning colors of the interior and exterior materials of the architecture, it is common to select appropriate color suited for the image by the color samples and sample book. But we frequently see the finished color of the architecture is brighter and showier than the color presented in a small sample book. This kind of unexpected change of a color can often be occurred after completing the architecture. No matter how skillful the architect is, it is not possible to predict exactly the change of colors when the architecture is finished. By experience, color designers know that the area effect happens because of the color shift. The purpose of the research is to estimate the amount of a color image reaction variation by changing areas in order to design the method to reduce an error about the color sample when it is applied in the real situation.

2. Experimental Design

2.1 Variables and Objects

The researcher selected three variables such as 2°, 10°viewview according to CIE to make a visible area changed and another 30° view. And we made the size of the observing window changed to 2°, 10°, 30° view (See 2.2.2.). The objects were the color panel. We chose the colors that included in the middle value and middle chroma of five basic colors-5R, 5Y, 5G, 5B, and 5P on Munsell System. In the case of 5Y, we selected the color involved in a high value and middle chroma considering the value of primary color (5Y 8/12) (Chart 1). We manufactured the color panel using the computer(MAC G3/400), printer(EPSON Stylus Photo EX) and color printing papers. The size of the color panel is 90cm ×60cm that can be seen from 1m's distance with 30°view.

5R 5/6	5Y 8/6	5G 5/6	5B 5/6	5P 5/6

Chart 1. Colors of objects

2.2 Apparatus

2.2.1 Light Sources

Two xenon lamps) which have the same daylight and spectral distribution were employed as the light sources. We observed the color panel and comparative color chart in the 45°viewposition from the central point. Illuminance in the experiment was 500lux.

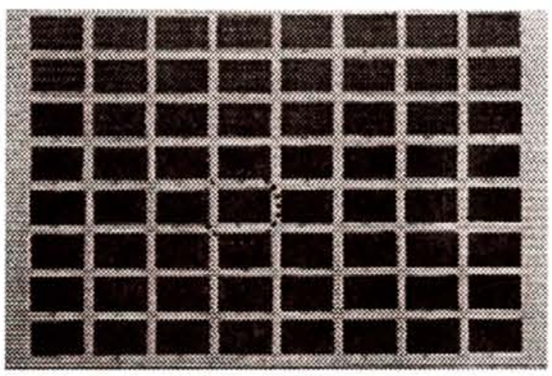
2.2.2 Observing Window

The researcher made three observing windows with an area of about 2°view, 10°view, and 30°viewview for the demonstration and one window for adaptation. And the observing windows can be made to change a size. For reduction of an exterior influence in estimating colors and color adaptation, we manufactured the observing windows using N5, neutral color.

Lee Jin-Sook, Kim Chang-Soon, Yim Oh Yon, Lee Deok-Hyung
Chungnam National University(CNU)
Dept. of Architectural Engineering, College of Engineering
220 Kung Dong, Yosung-Ku, Taejon, 305-764, Korea
Phone : +82-42-821-7733
Fax : +82-42-823-9467
E-mail: Js_lee@hanbat.chungnam.ac.kr

2.2.3 The Comparative Color Chart

The comparative color chart was producted with the same way as the color panel. We put the object colors in the central part of the comparative color chart and made colors changed. The comparative color chart that was 2.4cm × 1.8cm size was manufactured by connecting 64 pieces (Figure 1).



: The position of the object color

Figure 1. The example of the comparative color chart (5G 5/6)

2.3 Subjects

We selected six subjects (3 males and 3 females) who have experienced the delicate experiment of a color variation after 100-Hue test) and color-blindness test to examine whether they are dyschromatopsia.

2.4 Method

We let subjects estimate the amount of color variation seeing the color panel equipped vertically through the observing window in 1m's distance from the color panel after 10 minute's adaptation to N5 under a xenon lamp in windowless space. At that time, the area was presented in order-2°, 10°, 30° visual field. Subjects recorded a color of the comparative color chart using N5 mask(1.8cm × 1.2cm)

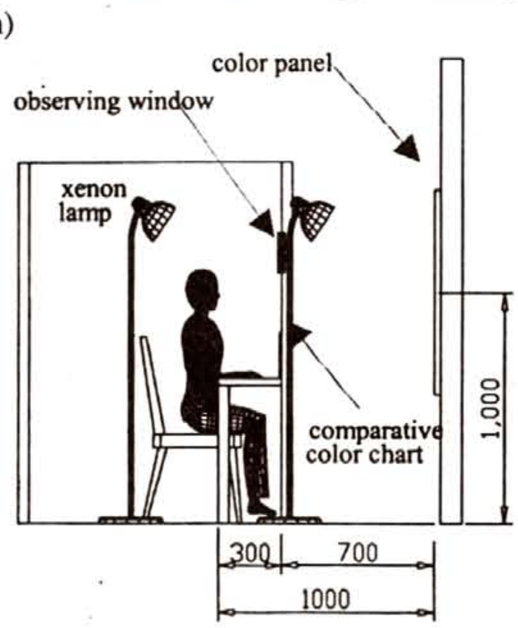


Figure 2. The view of experiment

which is the most similar to the color of the color panel seen through this observing window. If they couldn't find the exact color in the comparative color chart, they are allowed to respond interpolation. To prevent subjects' adaptation to the experiment, we observed time-limit less than 5 minutes. After finishing one experiment about the color panel, we made subjects adapted to N5, neutral color and performed an experiment about another color. I repeated the experiment three times each subject.

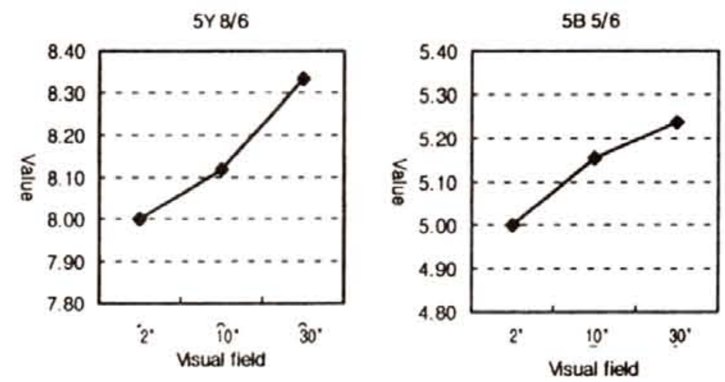


Figure 3. The tendency of the value variation.

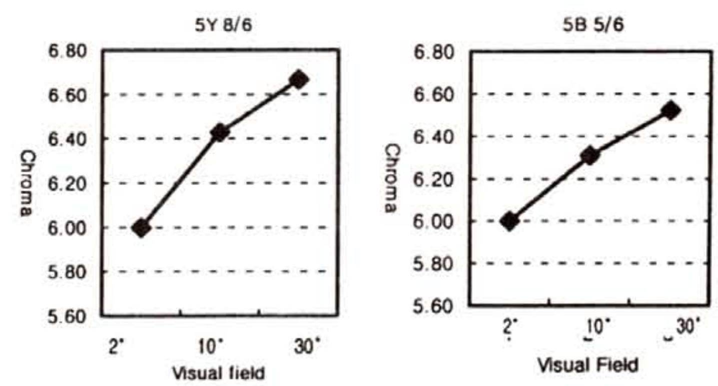


Figure 4. The tendency of chroma change

3. Result and analysis

The comparative color chart was producted with the same way as the color panel. We put the object colors in the central part of the comparative color chart and made colors changed. The comparative color chart that was 2.4cm × 1.8cm size was manufactured by connecting 64 pieces (Figure 1).

3.1 Change of the Value

For all object colors, the value was increasing as a view was higher from 2° and 10° to 30° view.

Especially, in the case of 5Y 8/6, there was a big change of value (0.32). We could identify that the

1)Xenon lamps are very similar light to daylight in spectral distribution. (color temperature: 5500K, color rendering index: 98 Ra)
2)100 Hue test was developed to grade and train people who examines a delicate color test. It selects 100 colors at the same interval in the color space of CIE 1964, value 6. And it can test an ability to identify colors as the unit of one level of CIE color difference.

realm of shade grows bigger as an area of shade variation.

3.2 Change of Chroma

For all colors, chroma was higher and clearer as a view was increased from 2°and 10° to 30°. When an area was increased from 2° to 30°, there was a similar change among 5R 5/6, 5Y 8/6, and 5P 5/6. And in the case of 5G 5/6, 5B 5/6, the amount of chroma change was 0.57 that is a similar level.

4. Conclusion

The researcher performed this experiment centered on an area from 2°, 10°and 30°view to investigate how colors was changed according to areas by a different view. The summary of the results acquired in this research is as followed.

(1) We observed that the value and chroma was higher as the area was increased to 2°, 10°, and 30° view each color object.

(2) In all the colors, the variation of a color reaction in chroma is higher than those in value.

(3) When the area became bigger, the subjects tended to feel that colors was bright and clear the increase of tone.

In future, we can observe the limit in applying to colors in the architecture by identifying the tendency of the color change according to the area change qualitatively.

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Visual Acuity Valid for Real Environment

Sook-Hee Kim, Mitsuo Ikeda, Hiroyuki Shinoda

Abstract

The visual acuity for a shade may be different from the lit place in the real environmental situations. We investigated the visual acuity for such situation. A subject adapted his/her eyes to the room with the illuminance 20, 100, 500 or 2000 lx and the visual acuity was measured when the eyes instantly moved to the place of shade of which illuminance was at one of the 8 different illuminance in the range from 0.1 to 100 lx. The result showed that the visual acuity of about 2.1 obtained for the room of 2000 lx reduced to only 0.4 at the shade illuminance of 2.5 lx. For the room illuminance of 20 lx on the other hand the visual acuity changed from 1.2 for the room to 0.9 for the shade showing less reduction compared to the brightly illuminated room. The effect of the luminance contrast of the test target was also investigated and the visual acuity became lower for lower contrast.

Keywords : visual acuity, luminance contrast, transient adaptation, shade illuminance, environmental illumination

1. Introduction

It is well known that the visual acuity changes depending on the illumination of environment. When the visual acuity is measured in a bright environment it shows a very high value, say 1.5, but when in a dark place it goes down to 0.5 for example. These acuities remain more or less stable as long as the person stays in a same environment and fix his/her eyes on one place. In our daily life, however, we move from one environment to the other and even if we stay in one place our eyes move to see various points in the place which is no longer uniform in illuminance. On a table the illuminance may be high but under the table it is low. We may not be able to assure the high visual acuity for such dark portion if the eyes move from bright portion to the dark. It is our experience that in a bright outdoors we sometime can not see objects in a shade if we instantly move our eyes to that area. If we are driving a car this disadvantage may cause a serious accident. It is important then to know how the visual acuity gets low when the eyes instantly look at a darker place while the person stays in a bright environment. We investigate here the visual acuity for such situation.

Sook-Hee Kim, Mitsuo Ikeda
Dept. of Photonics, Faculty of Science and Engineering, Ritsumeikan Univ.
Nojihigashi, Kusatsu, Shiga 525-8577, JAPAN
Phone : +81-77-566-1111 (x8552)
Fax : +81-77-561-2633
E-mail : shv99162@se.ritsumei.ac.jp

2. Methods

2.1 Apparatus

We built an apparatus by which the visual acuity could be measured for test targets placed in a shade while a subject could adapt his/her eyes to bright places. It is shown in Fig. 1. It is made of an experimental booth of the size 2m high, 1.8m wide and 1.8 m long. The booth simulated a study room and was decorated with artificial flowers, dolls, books, framed pictures and others. By this way we can measure the visual acuity to be exhibited in daily life.

Figure 1. Scheme of the experimental booth

For a subject to adapt at a bright environment six ceiling incandescent lamps were prepared at the ceiling. They were three 30 W lamps L3 and three 60 W lamps L6 as shown in the figure. Their intensities were controlled by light controllers. The horizontal illuminance of the room produced by the ceiling lights was measured with an illuminometer placed on the shelf of 67 cm high from the floor. A test target for which the visual acuity is measured should be placed in a shade. For that purpose an eaves was made on a shell in front of the subject as shown by B. It had the opening of 8 cm x 8 cm when viewed from the subject. To control the illuminance in the shade a slide projector P was used. The light coming from the projector passed through lenses and was reflected by mirrors so that it uniformly illuminated inside the eaves. A neutral density wedge filter W was inserted in front of the projector to adjust the illuminance.

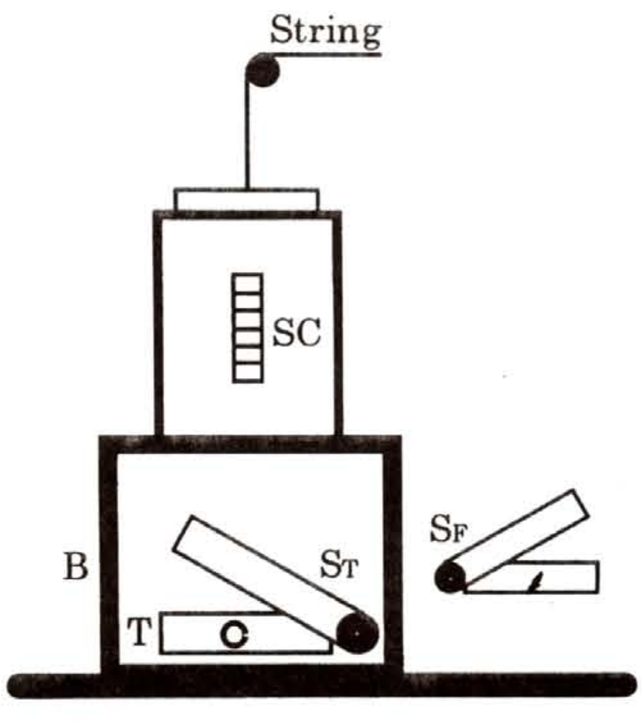

Figure 2. Arrangement to show text target presentation

The front view that the subject looked at binocularly is shown in Fig. 2. Inside the eaves a Landolt C letter T was presented for the measurement of the visual acuity. Its size can be changed by the subject by pulling a string up or down and fixing the position by reading the scale SC. The illuminance on the test target was adjusted by the experimenter. For the adaptation at a bright place a fixation picture F was placed on the wall and the subject was asked to look it at the measurement. Both the picture and the test target were closed by shutters S&ˇ and S4ˇ respectively and they were opened for 1 second by the subject by pushing a button. At the measurement the subject was asked to press the button and to look at the fixation picture first, and then to look at the test target. If the subject could see the test target of the Landolt C letter for a long time his/her eyes would adapt to the dark area inside the eaves and the visual acuity would increase. By this way the subject could see the target only for a short time with his/her eyes adapted to the bright room. The distance between the fixation picture and the test target was 30 cm. The subject viewed the test target at the distance 150 cm away.

Twenty seven Landol C letters were printed in black or gray on a white paper board so that the visual acuity was measured for the range of 0.1 to 2 at the distance 150 cm. The letter size was changed by an equal step of 0.05 in log acuity. Three different contrasts of letters were used, 35, 65 and 95 %.

2.2 Procedure

A subject adapted to the room lit at one of the illuminance 20, 100, 500 and 2000 lx for about 10 minutes. The method of adjustment was used to determine the visual acuity. The subjects set the Landolt C letter of an arbitrary size by adjusting the vertical position of a plate on which the Landolt C letters were printed by pulling the string up or down. Then the subject pressed the switch button to open the shutters to expose the fixation picture and the test target for one second. He/she judged whether the C can be read, and changed the size larger or smaller depending on his/her judgment. The operation was continued until the subject reached the threshold.

Three or four determinations of the threshold were successively conducted for any experimental condition. The experimenter then selected next illuminance for the test target randomly out of about four to eight levels depending on the room illuminance and the subject again conducted the threshold determination. When these determinations were carried out for the four room illuminance one session was completed. One session lasted for about 50 minutes. A subject engaged with three sessions to complete the experiment.

2.3 Experimental Conditions

Four illuminance levels were employed for the room, 20, 100, 500 and 2000 lx. Eight different illuminance were prepared for the test target, 0.1, 0.5, 1, 2.5, 6.5, 16, 40 and 100 x. The vertical illuminance on the wall where the test target was shown was always kept to these values by measuring it with a small sensor placed on the wall. It must be pointed out that there was a lower limit of illuminance in the shade because we could not eliminate the light coming from the ceiling lamps into the shaded area completely. Thus we could not set the test target illuminance below 2.5 lx for the environment illuminance 2000 lx. Three letter contrasts of the Landolt C were used, 35, 65 and 95 % as mentioned above.

2.4 Subject

Four subjects, HH (23 years old, male), HY (24 years old, female), TS (23 years old, male), AH (22 years old, male), and participated in the experiment. They all had normal color vision. They used contact lenses.

3. Results

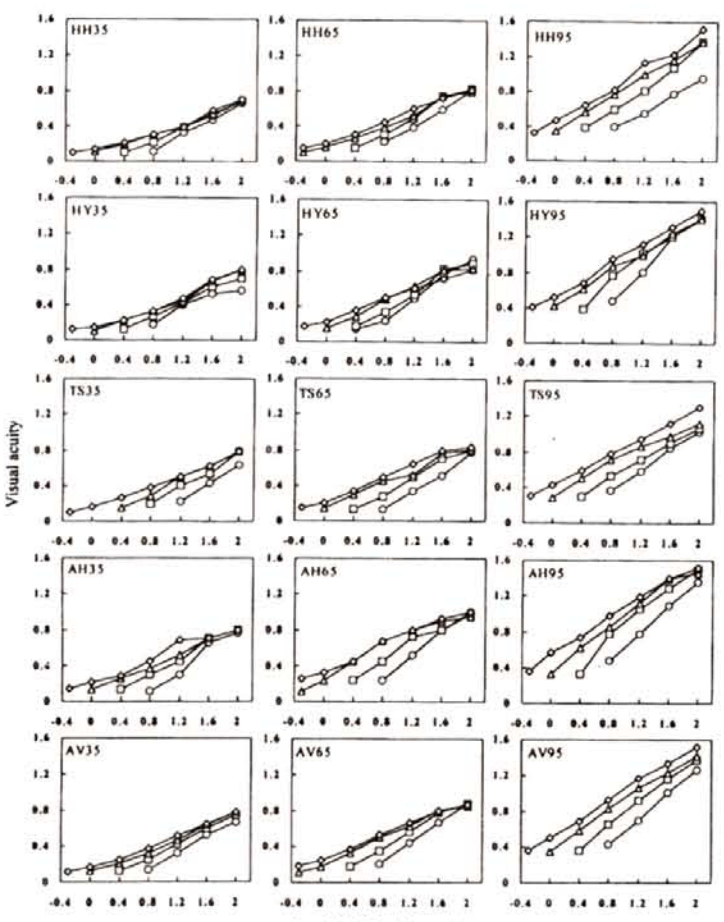

Figure 3. Experimental results to show the relationship between shade illuminance and the visual acuity. 2000 lx; ○, 500lx; □, 100lx; △, 20lx; ◇.

Results are shown in Fig. 3 for all the four subjects. Four rows represent the results from subjects, AH, HH, TS and HY respectively and the bottom the average of the four. The columns represent the letter contrast, 35, 65 and 95 %, respectively. Along the abscissa of each figure the illuminance of the test target is taken in log unit and the data points come either at 0.1, 0.5, 1, 2.5, 6.5, 6, 16, 40 and 100 lx. Along the ordinate the visual acuity is taken. In each figure four curves are drawn corresponding to the environment illuminance and the symbols diamond, triangle, square and circle indicate the illuminance 20, 100, 500 and 2000 lx, respectively. Each data point is the average of ten determinations of visual acuity. The data points are less than eight for some environment conditions as we could not set very low test target illuminance because of light leakage from the ceiling light as mentioned before.

It is clearly seen that every curve has a property of dropping down for lower target illuminance. In other words the visual acuity is lower when the eyes jump to a darker place within the shade from a bright environment. It is also seen that the curve goes down for higher environment illuminance. This implies that the visual acuity is lower when the observer stays in a brighter environment and his/her eyes jump to a shaded area. But this property is less observed for lower contrast of the test target. This happens because the visual acuity becomes low even when the eyes jump to the shade from a relatively low environment illumination.

4. Discussion

We pointed out a daily experience that we miss the objects under a tree in the outdoor of bright sunshine. To see the implication of the present results we measured in addition to the above experiment the visual acuity under a stable light environment with 20 lx and 2000 lx for the four subjects. The averaged results are shown in Fig. 4 by a horizontal dotted line of the visual acuity about 1.2 for 20 lx and a horizontal solid line of about 2.1 for 2000 lx. Those are the visual acuity measured while the subject adapted to the environment of 20 and 2000 lx. In the same figure the results obtained in the present experiment are shown for 20 and 2000 lx taken from the averaged data for the test target contrast 95 % in Fig. 3.

If an observer stays in an environment of 2000 lx his/her visual acuity is assured 2.1 as long as he/she see the bright portions in the environment. But if the observer looks instantly at a shade of illuminance 6.5 lx his/her visual acuity drops down to only 0.4. No wonder a taxi driver may miss a guest if he stands under a tree to avoid hot sunshine and raises a hand to stop the taxi. This kind of misconduct may happen less if the weather is cloudy. In Fig. 4 we see that the drop of the visual acuity is small, from 1.2 to 0.9, when the environment illuminance dropped less, from 20 lx to 6.5 lx.

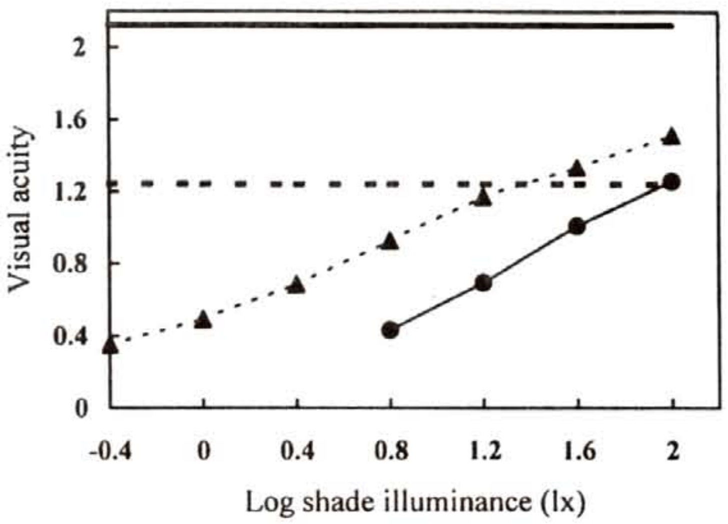

Figure 4. The comparison of visual acuity between at the environment and at the shade. 2000 lx; ●, 20 lx; ▲.

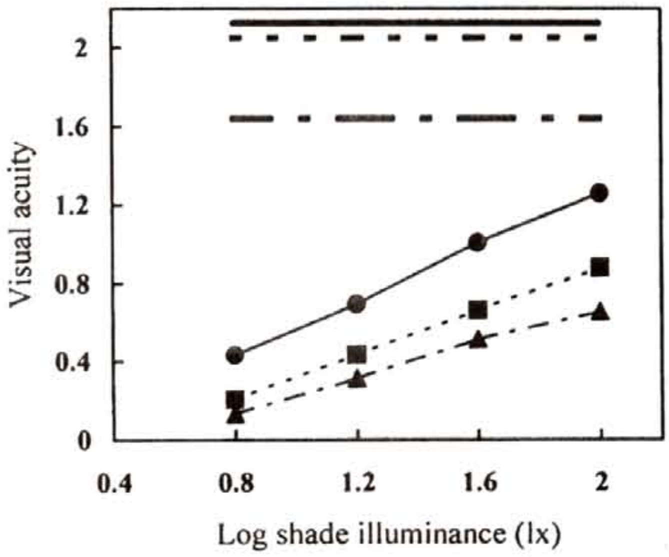

Figure 5. The plots t show the effect of luminance contrast of the test target. Solid line; 95%, dotted; 65%

Fig. 5 is prepared to show the effect of the letter contrast. Three curves are taken from the averaged data of 35, 65 and 95 % for the environment illuminance 2000 lx in Fig. 3. The visual acuity for the steady state of 2000 lx was also measured for the test target of different contrast from the same four subjects and their averaged results are shown by horizontal lines, a dashed line for 35 %, a dotted line for 65% and a solid line for 95 %. The visual acuity becomes lower for a lower environment illuminance as well known. It drops from 2.1 to 2 and finally to 1.6 when the target contrast drops from 95 % to 65 % and to 35 %. This property of dropping down in the visual acuity takes place also when the eyes jump from 2000 lx environment to a darker area if the contrast of the target in the shade becomes lower.

5. Conclusion

The visual acuity decreased significantly when a subject saw instantly a shaded place with his eyes adapted in a high illuminance environment. The decrease of the visual acuity became larger with increasing the difference of illuminance between the place where an observer stays and a shade in the place. We may suggest to raise the illuminance in shade with spotlight for example or to raise the luminance contrast of the object to be detected to avoid the acuity drop in the shade.

Acknowledgment

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Analyzing the Influence of the Lightsource Color on the Evaluation of the Interior Color

Eun-Mi Jin, Jin-Sook Lee

Abstract

The aim of this study is to measure the colorimetric shift by lightsources, analyze the characteristics of color evaluation by lightsources and analyze the influence of the lightsource color on the evaluation of the interior color.

The process of this study is composed of three steps ; 1) Selecting lightsources used in the office interior and measuring the colorimetric shift by physical characteristics of lightsources 2) Analyzing characteristics of color evaluation by lightsources through the evaluation experiment 3) Proposing the index of color design under characteristics of lightources by image types based on the analysis.

Keywords : Lightsource Color, Color, Color Temperature, Hue, Value, Chroma

1. Introduction

Thesedays, the usage of an office is variable and professionalized. So, it is necessary to consider the comfort as the residential space not the labor space. As the color is one of the most important elements of considering the comfort in the space. It is perceived differently by the characteristics of lightsources.

Therefore, the aim of this study is to measure the colorimetric shift by lightsources, analyze the characteristics of color evaluation by lightsources and analyze the influence of the lightsource color on the evaluation of the interior color.

The process of this study is composed of three steps ; 1) Selecting lightsources used in the office interior and measuring the colorimetric shift by physical characteristics of lightsources 2) Analyzing characteristics of color evaluation by lightsources through the evaluation experiment 3) Proposing the index of color design under characteristics of lightources by image types based on the analysis.

2. Measuring the colorimetric shift

2.1 The Selection of Objects

As the sample lightsource, four types of fluorescent lamp and two types of incandescent lamp were selected : like bulb color, warm-white color, daylight color, and cool-white color of fluorescent lamp, and halogen and krypton of incandescent lamp. These have color rendering index over 80 that can be used in the interior space.

Table 1. Lightsources

Kind of lamp	Fluorescent lamp				Incandescent lamp	
	bulb color	warm-white	cool-white	daylight	halogen	krypton
Color rendering index(R_a)	85	85	85	85	99	99
Color temperature (K)	2700	3000	4000	6000	2800	2750
Luminous flux (*lm*)	3350	3350	3350	3250	1450	1500

Among wall color in the interior space, each hue from ten group, R, YR, Y, GY, G, BG, B, PB, P, and RP, was adopted, which was given value 9 and chroma 2 used in general for the interior space in terms of preceded study[1]. Also, value 9,8, and 7 were chosen among neutral, and in the long run total 13 type colors were selected for the experiment. Table 2 shows the used color in the interior space.

Table 2. The Wall Color of Interior Space

5 R 9/2	5 YR 9/2	5 Y 9/2	5 GY 9/2	5 G 9/2
5 BG 9/2	5 B 9/2	5 PB 9/2	5 P 9/2	5 RP 9/2
N 9	N 8	N 7		

2.2 The Method of Measuring

For the purpose of leading to the distorted degree of lightsource colors, color stimuation measured through using colorimeter (CS-100, Minolta) was calculated by colorimetric shift. For measuring colorimetirc shift, D65 was employed as standard lightsource. Based on the wall color shift shown from the standard light, wall color shown from object lightsources was measured and calculated. Used

Jin Eun-Mi, Lee Jin-Sook
Dept. of Architecture, College of Engineering, ChungNam National University
KungDong220, YUSONGKU, TAEJON 305-764, KOREA
Phone : +82-42-821-7733
Fax : +82-42-823-9467
E-mail: jinem@dreamwiz.com

1) Lee Jin-Sook, etc., 「A Field Survey on the Interior Color in Office Building」, The Proceedings Paper of the Architectural Institution of Korea, 1996.4., pp.85~88

calculating method for it was the equations for CIE L*a*b* color space[2] defined by CIE.

2.3 Colorimetric Shift

Table 3 is the measuring and calculating result of variation of the colorimetric shift by lightsources.

As a result, the colorimetric shift of halogen and krypton of incandescent lamp shows over 80 at almost all color, which tells its higher distorted degree than at any other colorimetric shift. Less distortion of the color is rated, in order, at like bulb color and warm white color fluorescent lamp with 3000K color temperature, and at cool white fluorescent lamp with 4000K color temperature. The least distortion is marked at daylight fluorescent lamp with 6000K color temperature.

Table 3. The Colorimetric Shift of Color Samples by Lightsources

Lightsource / Color	Fluorescent lamp				Incandescent lamp	
	Bulb color	Warm-white	Cool-white	daylight	krypton	halogen
5 R 9/2	77.32	71.71	55.98	42.69	87.12	90.87
5 YR 9/2	74.32	70.97	53.05	64.58	84.10	86.85
5 Y 9/2	71.23	66.16	50.16	40.41	82.62	86.68
5 GY 9/2	73.24	68.31	52.93	42.20	84.22	88.52
5 G 9/2	76.39	71.69	55.84	38.61	88.65	92.19
5 BG 9/2	82.88	77.03	60.95	40.44	95.40	98.82
5 B 9/2	90.68	78.26	63.15	46.88	96.29	98.81
5 PB 9/2	84.16	78.49	62.73	43.12	96.39	99.45
5 P 9/2	81.99	76.28	59.76	42.55	93.57	95.55
5 RP 9/2	82.08	76.15	60.15	44.55	93.49	96.29
N 9	88.83	83.83	69.86	53.81	100.94	104.46
N 8	73.35	68.26	53.33	36.23	83.18	85.99
N 7	62.79	59.22	49.24	40.97	71.31	73.46

3. The Evaluation Experiment

3.1 The Outline of Experiment

3.1.1 Subjects

Subjects are consisted of graduate and graduated students in department of architecture who have perception of light and color, and their each reformed eye sight was over 1.0.

Table 4. The Composition of Subjects

Sex	Male : 13, Female : 17
Position	Graduate Students : 18, Senior Students : 12
Total	30

3.1.2 Evaluation Adjectives

Six pairs of color image from the preceded study[3] were selected as evaluation adjectives

Table 5. Evaluation Adjectives

Variable - Simple	Comfortable - Disturbed	Chic - Country
Clear - Dull	Warm - Cool	Soft - Hard

3.1.3 Evaluation Parameters and Objects

The parameters of the evaluation were value and chroma shown in case of changing both lightsources and wall color.

The lightsources for evaluation were four types of fluorescent lamp, warm-white color, daylight color, and cool-white color, and two types of incandescent lamp, halogen and krypton. Among wall color in the interior space, each hue from ten groups, R, YR, Y, GY, G, BG, B, PB, P and RP, was adopted, which was given value 9 and chroma 2 used in general for the interior space in terms of the preceded study[4]. Value 9, 8 and 7 were chosen among neutral as well. Therefore, totally 78 types objects were made by compounding of six type lightsources and 13type wall colors.

3.1.4 Manufacturing the Scaled Model

Scaled model for the experiment was inevitably built with the reason of peculiarity of the study estimating lots of evaluation objects within short time. As the scaled model experiment already proved its validity[5], this study was proceed by the 1/10 scaled model.

To be uniformly kept horizontal average illumination in the scaled model interior by the pencil of light of fluorescent and incandescent lamp, the number of lamp was adjusted. Thus one of fluorescent lamp and two of incandescent lamp were set. Horizontal average illumination by these lightsources was ranged around 700lx in the scaled model interior.

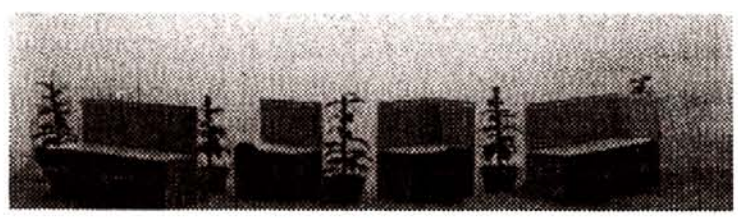

Figure 1. The interior of the scaled model

3.2 Experiment Method

First of all, subjects should not be influenced by other lightsources. Thus, first subjects had 5minutes adaptation in the darkroom and then 1minute adaptation by the lightsources through the observation

2) CIE L*a*b* color space was suggested by R.S.Hunter in 1948, and recommended by CIE in 1976. The equation is calculated by the following.

L*=116(Y/Yn)1/3-16
a*=500[(X/Xn)1/3-(Y/Yn)1/3]
b*=200[(Y/Yn)1/3-(Z/Zn)1/3]

Here Xn, Yn and Zn are the tristimulus values of the reference white under the standard lightsource. The colorimetric shift of the two color was calculated by the following.

⊿CIE(L*a*b*)=[⊿L*)2+(⊿a*)2+(⊿b*)2]1/2

3) Lee Jin-Sook, etc., 「The Analysis of the Characteristics and the Extraction of the Evaluation Construct Model in the Office Interior Color」, Journal of Korean Society of Color Studies, No. 7, 1996.12, pp.61~71

4) The former reference

5) Lee Jin-Sook, etc.,「Verifying the Validity of Experiments in the Scaled Model for Evaluating Colors」, Journal of Korean Society of Color Studies, No.13, 1999.12, PP.87~94

window. After that, the interior image rated from variation of wall color and lightsources was evaluated by the seven step semantic differential method.

4. Analysis

With the value and color by lightsources, which were evaluation parameters, multi-regression analysis was taken the extract color characteristics on the image types. Those each parameter was categorized into the ten colors of R~RP, 11 steps of neutral, and 3 steps of value 9, 8 and 7.

4.1 Analyzing the Characteristic of the Color by Lightsources

4.1.1 Characteristics of Color at the Warm-White Fluorescent Lamp

All the lightsources under 3000K color temperature had a similar tendency for image types. Table 6 shows the influence of color to the image types in the warm-white fluorescent lamp utilized extensively in the office.

Table 6. The Influence of Color by Image Types under the Warm-White Fluorescent Lamp

Adjective / parameter		Variable	Comfortable	Chic	Clear	Warm	Soft
Hue	R	[illegible]	-0.904	-0.788	-0.954	[illegible]	0.326
	YR	0.198	-0.704	-0.655	-1.054	1.430	[illegible]
	Y	-0.169	-0.038	-0.422	-0.220	0.130	0.726
	GY	0.655	0.096	-0.055	-0.220	-0.703	0.126
	G	0.231	0.129	-0.088	[illegible]	-0.703	-0.060
	BG	-0.102	0.529	0.112	0.146	-0.703	0.141
	B	-0.743	0.284	[illegible]	-0.028	-0.034	0.112
	PB	-0.433	0.062	-0.222	-0.720	[illegible]	0.559
	P	0.098	-0.504	-0.322	0.013	0.530	0.493
	RP	-0.169	-0.038	-0.322	-0.420	[illegible]	0.226
	N	-0.002	[illegible]	0.845	1.080	-1.703	-1.007
Value	9	0.099	[illegible]	0.194	0.278	-0.300	-0.152
	8	-0.601	-0.347	-1.073	-1.655	1.800	1.081
	7	-0.484	-0.601	-1.065	-1.410	[illegible]	[illegible]

▶ ■ : The highest value in the score of the categorie
▶ ▭ : Difference by 0.1 from the highest value

According to the Table6, the 「variable」 image is highly rated at the hues, GY, R, and YR, of the warm color and at the value 9, and the 「chic」and 「clear」 images was greatly rated at the hues, N, G, BG, and B, of the cool color and at the value 9, The 「soft」 image also had a similar effect at the Y and YR hues of the warm color and at the value 8, and so did the 「warm」 image at the huew, R, YR, and Y, of the warm color and at the value 8.

4.1.2 Characteristic of Color at the Cool-White Fluorescent Lamp

The influence of color to the image types in the cool-white with 4000K color temperature are as follows. The 「variable」 image is highly rated at most of chromatic color with the value 7 except the hue of YR and Y, and the 「comfortable」 image is highly evaluated at the hues, YR and Y, of the warm color with the value 9 and 8 ; The 「chic」 and 「clear」 images have high effect at the hues, B and PB, of the cool color with the value 9. Also, the 「soft」 and 「warm」 images is marked highly at the hues, R, YR, and Y, of the warm color with the value 9.

Table 7. The Influence of Color by Image Types under the Cool-White Fluorescent Lamp

Adjective / parameter		Variable	Comfortable	Chic	Clear	Warm	Soft
Hue	R	0.286	0.023	0.161	-0.093	[illegible]	0.484
	YR	-0.281	0.423	-0.105	-0.160	1.235	[illegible]
	Y	-0.047	[illegible]	0.061	0.140	[illegible]	0.684
	GY	0.953	-0.277	-0.372	-0.527	-0.165	-0.116
	G	0.619	-0.177	-0.205	.0140	-0.765	-0.150
	BG	0.186	-0.077	-0.505	-0.260	-0.632	-0.150
	B	0.269	0.156	[illegible]	[illegible]	-0.453	0.069
	PB	0.886	-0.443	0.261	[illegible]	-1.532	-1.416
	P	0.481	0.023	0.028	0.273	0.068	-0.083
	RP	0.447	0.057	[illegible]	0.040	0.468	-0.083
	N	-0.647	-0.010	0.061	0.007	-0.132	0.050
Value	9	-0.020	0.093	0.071	0.079	0.026	0.094
	8	[illegible]	0.023	-0.295	-0.155	-0.107	-0.439
	7	0.202	-0.270	-0.487	-0.714	-0.174	-0.601

▶ ■ : The highest value in the score of the categorie
▶ ▭ : Difference by 0.1 from the highest value

4.1.3 Analyzing the Characteristic of Color by the Daylight Fluorescent Lamp

The influence of color on image types under the daylight fluorescent lamp with 6000K are grasped through the score of categories. The influence are as table 8.

Table 8. The Influence of Color by Image Types under the Daylight Fluorescent Lamp

Adjective / parameter		Variable	Comfortable	Chic	Clear	Warm	Soft
Hue	R	-0.106	[illegible]	0.655	[illegible]	[illegible]	0.162
	YR	-0.506	0.525	0.388	0.241	0.766	[illegible]
	Y	0.060	[illegible]	0.321	0.274	[illegible]	0.396
	GY	0.627	-0.241	-0.212	-0.159	-0.167	-0.038
	G	[illegible]	-0.541	-0.712	-0.159	-0.567	-0.171
	BG	1.194	-0.975	-0.579	-0.159	-0.901	-0.771
	B	[illegible]	-0.611	-0.298	-0.290	-0.989	-0.481
	PB	-0.340	-0.141	-0.612	-0.859	-1.033	0.529
	P	0.194	0.259	[illegible]	0.641	-0.834	-0.671
	RP	-0.406	0.025	[illegible]	[illegible]	-0.234	-0.271
	N	-0.940	0.292	0.021	-0.092	0.366	[illegible]
Value	9	-0.145	0.104	0.035	0.045	0.146	0.193
	8	0.855	-0.396	-0.065	-0.255	-0.787	-1.104
	7	[illegible]	-0.751	-0.321	-0.243	-0.818	-1.058

▶ ■ : The highest value in the score of the categorie
▶ ▭ : Difference by 0.1 from the highest value

The 「variable」 image are estimated high in the hue, G, BG, and B of cool-color, and in the value 8, 7. The 「comfortable」, 「modern」 and 「clear」 image are marked high in the hue, P, R and RP of warm color, and in value 9. The 「soft」, 「warm」 image are estimated high in the hue, R, YR and Y of warm-color, and in the value 9.

4.2 Analyzing the Influence of the Lightsource Color on the Interior Color

The color which can present each image according to lightsources classified by the color temperature was analyzed as follows, based on the result, table 6 to 8, of multi-regression analysis.

In the case of 「variable」 image, the lightsource with 3000K color temperature is appropriate to high value, low chroma color and the hue of R and G groups, and the cool-white fluorescent lamp befitted value 7, chroma 2, and GY and P groups in the hue. Lastly, value 8, chroma 2, and the cool color of G and BG groups were matched well with the 「variable」 image.

In the case of 「comfortable」, 「chic」, and 「clear」 images, the lightsource with 3000K color temperature, was suitably adapted to high value, low chroma and cool-color groups. Under the circumstance of the 4000K lightsource, the 「comfortable」 image was apt for high value, low chroma and the warm-color of YR and Y groups, and also the 「chic」 and 「clear」 images befitted high value, low chroma and the cool-color group. High value, low chroma and the warm-color group were suitably matched with the daylight fluorescent lamp. In the 「soft」 and 「warm」 iamge's case, high value, low chroma and warm-color were fit for all colors.

5. Conclusion

In this study, the light sources which can be used in the interior space of an office were classified ; Variation of color by the lightsources was measured ; moreover, the characteristics of the color evaluation by the lightsources were analyzed, and the influence of lightsource colors on the evaluation of interior color. The results are as follows.

(1) Under the circumstance of the fluorescent lamps of the bulb color and warm-white color, krypton lamp, and halogen lamp with 3000K color temperature, warm color and value 8 and 9 are fitted with the 「variable」, 「soft」 and 「warm」 images. The cool color and value 9 are adapted for「comfortable」,「chic」 and 「clear」 images.

(2) In the case of the cool-white fluorescent lamp with the 4000K color temperature, it is highly effective to use the chromatic color and value 9 for the 「variable」 image and the warm color and value 9 for the 「soft」 and 「warm」 image. To apply the YR and Y groups and value 9 and 8 to the 「comfortable」 image is greatly suitable. Also, the cool color and value 9 are fit with the 「chic」 and 「clear」 image.

(3) Under the circumstance of the daylight fluorescent lamp with 6000K color temperature, the cool color of the G, BG and B group and value 8and 7 were highly fitted with the 「variable」 image ; the warm color of the P, R and RP group and value 9 showed good harmony with the 「comfortable」, 「chic」 and 「clear」images. Lastly, the warm color and value 9 were the most suitable to the 「soft」 and 「warm」 image.

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Assessment of Visual Harmony of a Room: Effect of Colors of Lighting and the Interior

Naohiro Toda, Taiichiro Ishida

Abstract

Visual harmony of a room must be influenced by various factors. Among all, colors used in the room and color of lighting may be the major factors. A large number of studies on color harmony have been done, however, a reliable theory for arranging colors with considering lighting has not been established. The aim of this study is to examine effects of colors of the lighting and the interior on visual harmony of the room. The subjects observed a pair of small model rooms that differed only in colors and judged which room was in better harmony. The results showed that the combination of the interior colors strongly affected the visual harmony of the room. In addition, the color of the light source did change the impression. In the additional experiment, the subjects judged the visual harmony of the color arrangements placed on the flat plane. The assessments for the simple arrangements of colors showed close correlation with those for the model rooms in ëincandescentí type lighting. Moreover, the results indicated that the perceived color of lighting may play a significant role in determining the visual harmony of the room.

Keywords : interior color, lighting, color harmony

1. Introduction

Colors in architecture have strong effects on our psychological states. To realize a reliable design process in architecture, we must elucidate the relations between colors and our psychological states. Especially visual harmony of colors is an important problem, and a large number of studies have been made on this issue[1, 2]. The most of these studies, however, dealt with simple color arrangements, it is not certain if the results from them can be applied to actual architectural environments.

In the actual architecture, surfaces and objects are constructed three dimensionally, not on flat plane. Also, there is light which is emitted to the space and fills there by the mutual reflection. We must consider how these factors affect the visual harmony of the architectural space. Sawa et al. found that wall colors and lighting patterns in a room are evaluated independently[3]. Little is known, however, how a color of a light source and colors of an interior affect the assessment of visual harmony of a room.

In this study, we examined effects of a color of lighting and colors of the interior on the visual harmony of a room.

TODA Naohiro, ISHIDA Taiichiro
Dept. of Architecture and Environmental Design, Graduate School of Engineering, Kyoto University
Yoshida-Honmachi, Sakyo-ku, Kyoto, 606-8501, JAPAN
Phone : +81-75-753-4766
Fax : +81-75-753-4766
E-mail: hm.toda@archi.kyoto-u.ac.jp, ishida@archi.kyoto-u.ac.jp

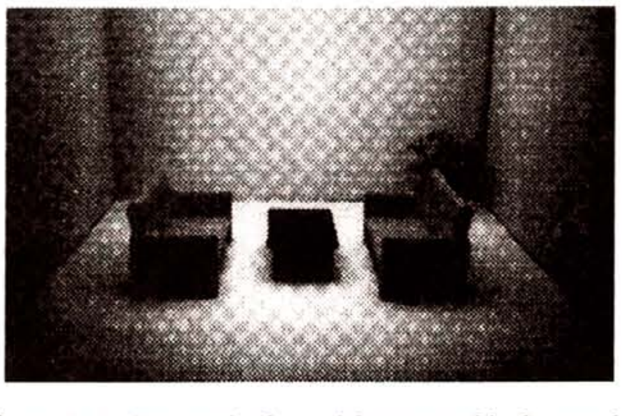

Figure 1. A photograph of a model room used in the exp. 1.

Table 1. The symbol and Munsell color notation of colors used in the experiments

	color
wall and floor	Y (5Y 9/2) or B (5B 9/2)
sofas	W (5Y 8/12) or C (5B 8/4)
table and plant pot	w (5Y 4/3.6) or c (5GY 7/2)

2 Experiment 1 : Assessment for the Model Room

2.1 Methods

In the experiment 1, we examined how colors of lighting and the interior influenced visual harmony of a room by using a pair of model rooms. The assessment was done by the method of pair comparisons.

We used a pair of model rooms that differed only in interior colors. A photograph of a model room was shown in Fig. 1. Subjects were asked to observe a pair of model rooms, and to answer which model was in better harmony. Observing time was 6 sec. The experiment was performed in a darkened room.

The size of the model was W45 x D54 x H30 cm. Two sofas, one table and one potted plant were placed in the model room as shown in Fig. 1. Each item in the model had two different colors as shown in Table 1. These colors were determined by referring 'cool' and 'warm' color classification4).

The selection of colors made 8 color combinations in the room, which made 28 pairs of the room comparisons in total.

Two lighting conditions were prepared. The one was 'daylight' type fluorescence lamp (Tc = 5000 K and Ra = 95), and the other was 'incandescent' type (2700 K, Ra = 95). In both lighting conditions, the horizontal illuminance at the center of the floor was set to 400 lx.

In one experimental session, the 28 pairs of the rooms were tested under one of two lighting conditions. Each subject devoted two experimental sessions. Eight subjects, 22-25 years of age, took part in this experiment. They all had normal color vision.

2.2 Results and Discussion

Table. 2 (a), (b) describes the summary of the results of The experiment 1. The value in Table.2 (a), (b) shows the probability that the color combination ai judged to be more harmonized than aj. The probability was obtained by combining judgements from all subjects.

Fig. 2 (a), (b) show the interval scale of the assessment of harmony transformed from the ordinal scale of Table. 2 (a), (b) using Thurstone's model5). The eight color combinations of the room are taken on the abscissa. The notation on this axis indicates the color combination using color abbreviations shown in Table. 2 (a), (b), in the order of the wall & the floor, the sofas, the table & the plant pot. The ordinate is the interval scale that is normalized so that 'YWw' in each lighting condition becomes zero.

It is clearly shown that visual harmony of the room strongly depends on the combination of the interior colors.

The assessment of each subject closely correlated with the average results shown in Fig. 2; the coefficients are more than 0.7 for five of the eight subjects, indicating their assenssments were based on some common characteristics of the interior colors.
In addition, we can see by comparing Fig.2 (a) and (b) that the color of lighting changes the assessment of visual harmony for some color combinations such as YWc, YCw, and BCc.

Table 2. The probability that the color combination pattern, ai, judged to be more harmonized than the aj. Table. 2 (a) is the result of 'Daylight' type, and Table. 2(b) is of 'incandescent color' type.

(a) neutral color-type

Pr(a_i>a_j)		Yww a_1	Ywc a_2	Ycw a_3	Ycc a_4	BWw a_5	BWc a_6	BCw a_7	BCc a_8
a_j	a_1		0.17	0.17	0.39	0.11	0.06	0.00	0.17
	a_2			0.33	0.67	0.28	0.28	0.22	0.39
	a_3				0.78	0.50	0.50	0.50	0.56
	a_4					0.33	0.33	0.44	0.50
	a_5						0.39	0.17	0.72
	a_6							0.39	0.61
	a_7								0.89
	a_8								

(b) incandecent color-type

Pr(a_i>a_j)		Yww a_1	Ywc a_2	Ycw a_3	Ycc a_4	BWw a_5	BWc a_6	BCw a_7	BCc a_8
a_j	a_1		0.50	0.13	0.44	0.25	0.31	0.31	0.44
	a_2			0.25	0.44	0.25	0.44	0.31	0.75
	a_3				0.69	0.56	0.31	0.63	0.63
	a_4					0.50	0.31	0.38	0.69
	a_5						0.44	0.31	0.63
	a_6							0.38	0.63
	a_7								0.81
	a_8								

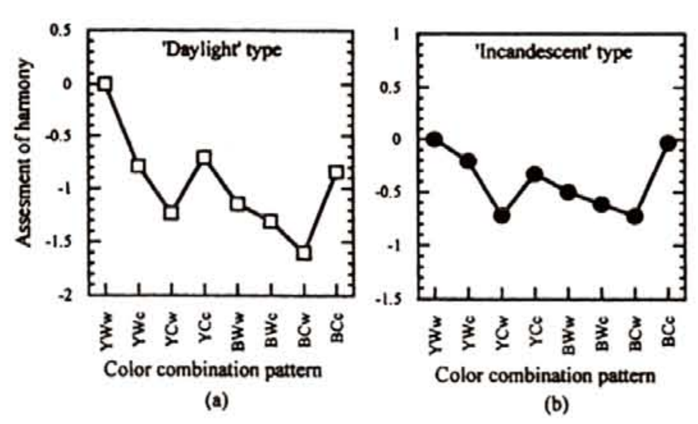

Figure 2. The interval scale of the assessment of harmony transformed from the ordinal scale of Table. 2 (a), (b). Fig. 2 (a) is the result of ëDaylightí type, and Fig. 2(b) is that of ëincandescent colorí type. The abscissa is color combination pattern, which notates the symbols shown in Table. 1, in the order of wall & floor, sofas, table & plant pot. The ordinate is the interval scale that is normalized so that ëYWwí in each lighting condition becomes zero. The point of zero is taken arbitarily, and only the relative differences are significant.

3. Experiment 2 : Assessment for Color Patches

3.1 Methods

The question we are concerned next is whether the visual harmony of the room can be explained by that of simple color arrangement. In the experiment 2, we examined the visual harmony of the color patches arranged on a flat plane. The experiment was designed referring to the study by Nayatani, et al.[2)]

In the experiment 2, the subjects judged the visual harmony of colors placed on the flat plane not on the three-dimensional room, otherwise the procedure and the selection of colors were the same as in the experiment 1. The experimental equipment is shown in Fig. 3. The sector-shaped color patches were prepared, and three patches were placed at the center of the background so that they made a circle of 8 cm in diameter as shown in Fig. 3. The background was a N5 gray paper of 40 cm square. The circular color arrangement subtended a visual angle of 6.5 deg for a subject at a viewing distance of 70 cm.

Two lighting conditions were employed as in the experiment 1; the one was 'daylight' type fluorescence lamp (Tc = 5000 K and Ra = 88), and the other was 'incandescent' type (Tc = 3000 K, Ra = 88). The horizontal illuminance at the location of the sample was set to 400 lx.

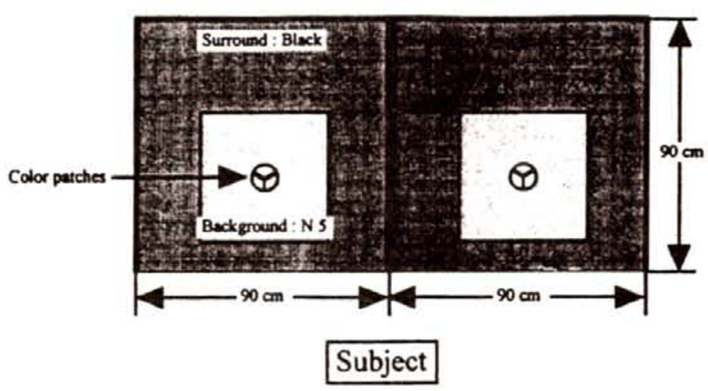

Figure 3. An experimental equipment used in the experiment 2. The sector-shaped color patches were prepared, and three patches were placed at the center of the background so that they made a circle of 8 cm in diameter as shown in Fig. 3. The background was a N5 gray paper of 40 cm square. The circular color arrangement subtended a visual angle of 6.5 deg for a subject at a viewing distance of 70 cm.

The experiment was performed in a dim room. Subjects were asked to compare two color arrangements, and to answer which arrangement was more harmonized. The observing time was 6 sec. In this experiment, each of the two color arrangements was illuminated separately, which made 120 possible combinations of the conditions. Each experimental session consisted of the 120 trials, and four sessions were carried out for a subject. The experiment 2 was carried out with 4 subjects of 23-26 years of age having normal color vision. Three of them took part in the experiment 1.

3.2 Results and Discussion

Fig. 4 Shows the interval scale of the assessment of the visual harmony obtained from the result of the experiment 2 plotted as in Fig. 2 (a), (b). The results from this experiment also shows that the arrangement of colors strongly affects the visual harmony. In addition, the 'incandescent' type tended to give the higher assessment score than 'daylight'type. Our main concern in the experiment 2 is to see if the assessments for the simple color arrangements correlates with those for the three-dimensional model room. Thus, the results of the experiment 1 are plotted against those of the experiment 2 in Fig. 5 (a), (b). In 'incandescent' type, the assessments from the two experiments closely correlate ($r = 0.90$) despite large difference in the spatial arrangement of colors. In 'daylight' type, however, the results from two experiments show poor correlation($r = 0.39$).

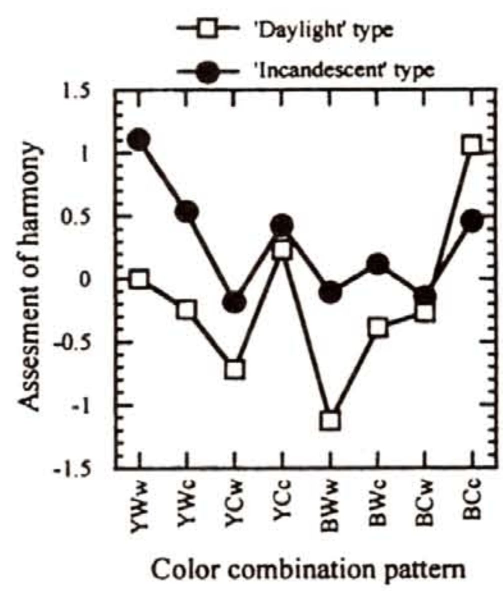

Figure 4. The interval scale of the assessment of the assessment of the visual harmony obtained from the result of Experiment 2 plotted as in Fig. 2 (a), (b).

We do not have enough information to understand why two lighting conditions showed different results. However, the effect of the mutual reflection of the light may be one possible cause. Since the inside of the equipment used in the experiment 2 was black or dark gray, the amount of the reflecting light was small and the shift in the color of lighting was little. On the other hand, in the experiment 1, the inside of the room had light bluish or yellowish color, thus there were large amount of reflecting light and the color of lighting shifted toward the color of the wall and floor. We measured the chromaticity of the light at the position of subjects eye under the two light source conditions in each equipment by MINOLTA CL-100. The results are presented in Fig. 6. The curve in the graph is the Planckian locus. Open symbols denoted the 'daylight' type light source and filled symbols 'incandescent' type. The plot symbol shown as 'Experiment 1 [Y]' represents the chromaticity when the color of wall and floor of the model in Experiment 1 was Y, and 'Experiment 1 [B]' represents the one when it was B, 'Experiment 2', represents the one of the light in Experiment 2.

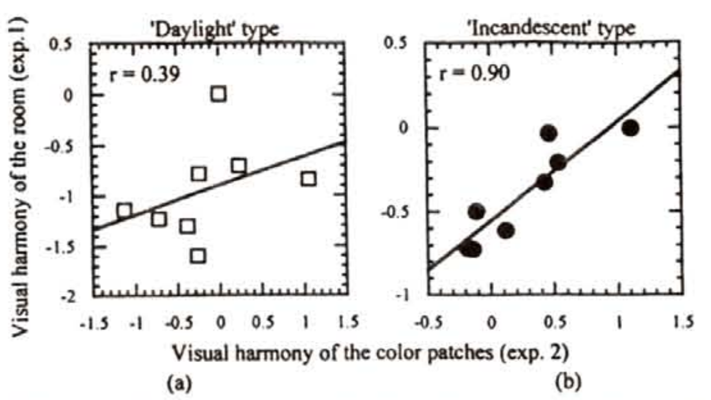

Figure 5. The correlation of between the visual harmony of the room and the color patches. Fig. 5 (a) shows the 'daylight' type, and Fig. 5 (b) results from the 'incandescent' type.

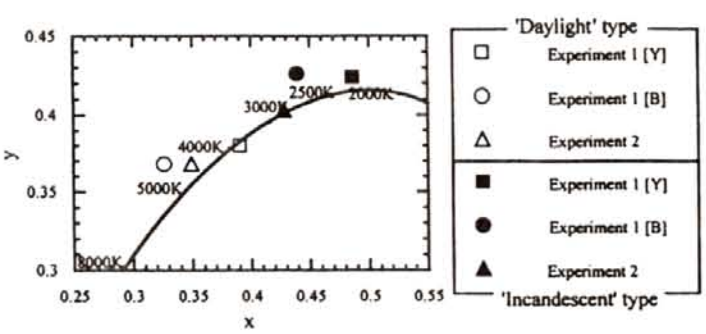

Figure 6. The chromaticity of the light at the position of subjectís eye under the two light source conditions in each equipment by MINOLTA CL-100. The curve in the graph is the Planckian locus. Open symbols denoted the 'daylight' type light source and filled symbols 'incandescent' type. The plot symbol shown as 'Experiment 1 [Y]' represents the chromaticity when the color of wall and floor of the model in Experiment 1 was Y, and 'Experiment 1 [B]'represents the one when it was B, 'Experiment 2', represents the one of the light in Experiment 2.

The chromaticities of the light at the subject's eye in the experiment 2 are almost the same as those of the light sources. On the other hand, the chromaticity of the light in the experiment 1 shifts toward the color of the interior. The chromaticities shown in the Fig.6 are physical changes which might be expected. The amount of the colorimetric shifts by the interior colors is almost equivalent in two lighting conditions. However, the shifts of the 'daylight' type and these of 'incandescent' type might give different effects on the subject's perception of the color of lighting. In 'incandescent' type conditions, the chromaticities of the light are in the region of 'warm white', indicating they are all perceived as reddish light. In 'daylight' type conditions, the shift of the color occurs between 'daylight' and 'cool white' regions, indicating they may be perceived as the color that contains bluish or yellowish tints depending on the interior conditions. Moreover, according to the introspective reports of the subjects, their recognized colors of the lighting were strongly affected by the color of the interior, implying that the effect of the color shift was more strong than that expected by the physical changes.

The changes in perceived color of lighting mentioned above may result in different assessments in the two experimental conditions under 'daylight' type lighting. If discounting this effect, the results in Fig.5(a) might also give close correlation, indicating the visual harmony of the room can be explained by that of the simple arrangement. Since the colors and their arrangements in the present study were limited, further intensive study is required to obtain a conclusion on this point.

4. Summary

It was shown in the experiment 1 that the selection and combination of the interior colors strongly affected the visual harmony of the room, and the color of lighting changed the assessment in some color combinations. We found from the results of the experiment 2 that the assessments for the simple color arrangements closely correlated with those for the model rooms in 'incandescent' type lighting. In addition, the results suggested that the mutual reflecting light and the perceived color of lighting must play a significant role in determining the visual harmony of the three-dimensional architectural space.

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The Treatment of Light with Matter

Research Group: Constitution and Interpretation of Artistic Images

Abstract

The workshop experience that is presented combines 3 fields. 1) Visual artists (Maribel DomÈnech and Margo Sawyer) 2) Students, mostly postgraduate level 3) Teachers/Researchers from the Research Group: Constitution and Interpretation of Artistic Images. It is carried out in the School of Fine Arts, University of Granada, Spain, in May of 2000.

Keywords: Art, education, light, material, appearance, image, language

1. Contents

The group provides the theoretical structure for working on the treatment of light with material. This particular project is part of one of the group's areas of investigation: appearance as a physical and allegorical phenomenon. Appearance acts as a macrosystem capable of bringing together the interraction of the elements and the constitutive phenomena of images in general, and of artistic images in particular. Appearance as spatial distribution of light becomes the descriptive nexus of the creation of the image. In this activity it is possible to experiment with open methodologies and interdisciplinary contents that are difficult to blend in the teaching of plastic and visual arts.

Technical knowledge of luminous media that can be used as constitutive elements of the work: the delimination of the same.

Artists invited to contribute to the research bring their own ways of working, which in themselves make up a methodology, revisiting the creation process of their works, in which special attention is given to light as a search for these new nodels of expression.

Teachers and researchers from the Group: ConstituciÛn e InterpretaciÛn de la imagen artÌstica. HUM 480 de la Junta de AndalucÌa:

M. PeÒa MÈndez, J. DÌaz Bucero, F. GarcÌa Gil, Professors from the Faculty of Fine Arts, University of Granada.

J. Casado de Amez·a, Professor at ETS Arquitectura University of Granada.

J. Lerma Pel·ez, J. Romero Torres, S. Cano TurriÛn, R. Cubillo Robles,

Universidad de Granada, Facultad de Artes. Avenida de AndalucÌa, S/N. Edificio Aynadamar. Granada 19071.

2. Introduction to the Workshop's Development

Lectures by the Artists on their artistic research.
After the lectures, working groups are formed.
Projects are generated by the students.
Discussion of the problematics of carrying out the projects.
The viable projects are carried out.
IMAGE ROOM. The nerve center containing projectors and light sources, as well as a variety of other materials. Using this room as a center, the whole faculty enclosure is involved in the work, including the gardens.
Information card used in the research:
Physical description of the piece.
Incidents during its creation.
Interpretation of what has been done.
Comparison of the technological aspects of light with purely linguistic points in the incorporation of light in art.

Purpose of the Research: to engage in a search for the linguistic fields, for expression and meaning, which are generated by the specific use of light technology and lightís relationship with material and other generic elements.

3. Conclusions

The novel element of the experience would be the phenomenon of appearance in art, and the combination of appearance with other typologies of creation and analytic processes of plastic and visual works. The first effect produced in the students by this confrontation of their artistic objectives, the new materials and different types of light sources is chaos. The surprise came when the students began to treat them, to handle them and, when they tried to understand them within the macrosystem of spatial distribution, the students began to come up with good ideas, and successful results were obtained.

The Conclusions May be Summarized as :

-Art-Science links: Metaphors derived from the physical aspects of light and materials. The physical appearance system articulated as an allegorical appearance system, and the latter as the most open and, in our opinion, the most correct, way to reach an understanding about the constitution of plastic images.

-Phenomonology and the creation process.

-Hermeneutics to give meaning and the means for reflection as regards interpretation.

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National Standard Traceable System for the Precise Color Measurement

Kim Chang-Soon

Abstract

Color is a very sensitive subject. Many factories have troubled to manage or control the color of their products. Primary standard of the color measurement is the spectral absolute diffused reflectance, which is measured in national standards institutes and compared each other to conform the accuracy of their measurements. The precise spectral absolute diffused reflectance is transferred to reference spectrophotometer, white standard reference plate, and standard color plates. Every color meter that is used in working field, can be calibrated with white standard reference plate and can be conform the data using the standard color plates.

Keywords : colorimetry, color measurement, white reference plate, traceability, color standard

1. Introduction

Nowadays the interests and the attentions to color are rapidly increased. Every company pays intensive attention to the color of its products. Because whatever their products may be, the color of those have very sensitive relation with the sale. To increase the sale they try to develop more attractive and more beautiful color and to manage the color more precisely to control the color of their products to be same. To do those they use color meters, which can objectively and easily measure color. But there are some problems that should be solved for the precise color measurements. One is that every color meter indicates not the same color values for the same object. Another one is if we got the color value for one object, how can we believe it.

To solve these problems, the values we have got by some measurements should have the standard traceability. To have the taceability the colormeter we have measured with should have calibrated with the CRM (Certified Reference Material). The CRM in colorimetry is the white standard reference plate, which has the certified data by a standards institute. Of cause, the standards institute has to maintain the traceability to the international standard. With these traceable system we can conform the measured color values.

Kim Chang-Soon
Korea Research Institute of Standards and Science (KRISS).
P.O.BOX 102, YUSONG, TAEJON 305-600, KOREA
Phone: +82-42-868-5201
Fax: +82-42-868-5022
E-mail: kcss@kriss.re.kr

Even a traceable system was constructed, the uncertainty can reduce the precision of the color measurements. To decrease the uncertainty, every standard institute is trying. Our national standard traceable system has constructed to decrease the uncertainties, which can come from the CRM materials and certifying systems.

In this paper we are going report the development of the national color standard traceable system.

2. The Primary Standard of Colorimetry

In 1931, CIE had recommended the color measuring method. According to this recommendation the real measuring quantity of the color sample is the spectral reflectance. The other data that are used to calculate the color, were precisely definded. To get the precise color value, the spectral reflectance should be precisely measured. (Eq. 1)$R(\lambda)$is the spectral reflectance of the test color sample. This is measured by spectrophotometer.

$$X = k\int_{380}^{780} S(\lambda)\cdot R(\lambda)\cdot \bar{x}(\lambda)d\lambda$$
$$Y = k\int_{380}^{780} S(\lambda)\cdot R(\lambda)\cdot \bar{y}(\lambda)d\lambda \qquad \text{(Eq. 1)}$$
$$Z = k\int_{380}^{780} S(\lambda)\cdot R(\lambda)\cdot \bar{z}(\lambda)d\lambda$$

here, $S(\lambda)$: relative spectral distribution of CIE standard illumination
$R(\lambda)$: spectral reflectance
$\bar{x}(\lambda), \bar{y}(\lambda), \bar{z}(\lambda)$: color matching functions of standard observer.
k : normalization factor as fallow

$$k = 100 / \int_{380}^{780} S(\lambda)\cdot \bar{y}(\lambda)d\lambda$$

$R(\lambda)$should be measured in the absolute scale which is based on the reflecting property of PRD(Perfect Reflecting Diffuser). PRD is a hypothetical material which has the Lambertian surface. Lambertian surface means that all over the 2π solid angle, the reflecting components obey the cosine law as fig.1.

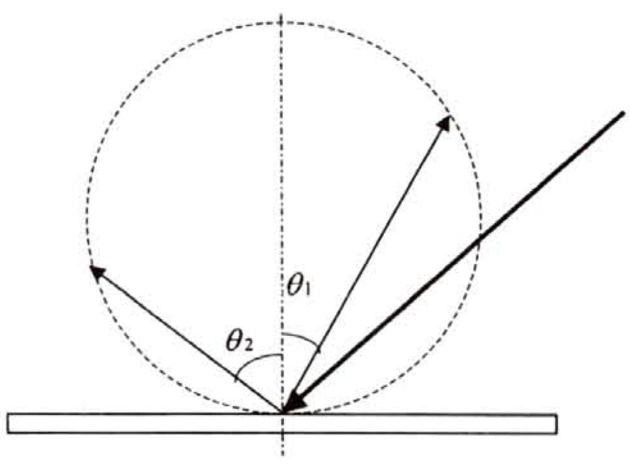

Figure 1. Reflection on Lambertian surface follows cosine law.

The absolute spectral diffused reflectances are measured in some national standard institutes. These institutes regularly compare the data each other. By doing these activities, the international standards are maintained. And these activities are performed under project of BIPM(Bureau of International des Poides et Mesures).

3. The Standard Traceable System

The traceability of the colorimetry is the same of the spectral reflectance measurements. Of course there is another type of color meters that do not measure spectral reflectance. This type of color meter ñ filter type color meter ñ read color (three-stimulus values) directly from the signals of filter combined detectors. For this type of colormeters, a white standard reference plate offers color values for every CIE standard illumination. Filter type colormeters are very useful and simple, so these are widely used in working fields as the 2nd level measuring instruments.

The data of the white standard reference plate are traceable to the reference spectrophotometer, which distribute the color and the reflectance standards. The reference spectrophotometer in KRISS which maintain the Korea national standard, has a 0/d geometry specula included and excluded possible. The data of this instrument are checked with more than 10 CMS. These CMS are checking the wavelength accuracy, detector linearity, and reflectance accuracy. For the reflectance accuracy, we compare the CMS from other standard institutes. And we also measure the absolute spectral diffused reflectance with our measuring system. The reflectance value from the absolute reflectance measuring system transfer to the reference spectrophotometer with white reference materials such as PTFE (polytetrafluorethylene) and barium sulfate. The traceable system of colorimetry standard is shown in Fig.2.

As seen in Fig. 2, we developed 3 type of standard transferring materials. Two of them are CRM, white standard reference plate and standard color plates. The other one is the color checker, which will be used in color image input and out put field. The development of the color checker is on processing. White standard reference plate can be used as the CRM of absolute spectral reflectance for spectro-colormeter and spectro-reflectometer. This plate has very few gloss component within measuring uncertainty. It makes possible to use this plate all over the geometry types.

Standard color plates are used for the filter type colormeter. Most filter type colormeter has some characters that it gives good measuring in some color region but some other region the measurements go out of accuracy. To compensate this, the standard color plates are used. Each standard color plate has its color coordinate for each standard illuminations, standard observer, and specula component included or excluded. The standard color plates should be persistent against many kinds of testing environments. Our standard color plates are made of ceramic tile. It is washable and strong to mechanical scratch or chemical contamination. Standard color plates consisted with 5 level gray scale and 7 vivid colors.

Color check are used to check the color in change of illumination circumstance or a monitor display. Now a days digital camera became to popular to everybody. And color printers are commonly distributed. Many company made many kinds of image input and output systems. The difference of color reproduction exists between the different imaging systems or even the same systems. Color reproduction in imaging system became the hot issue in industry and color science. Color checker will give many useable information for the suitable color reproduction. Development of our color check is on process.

But as a test version we made color checker which consisted with 24 colors. The data or opinion from user will be gathered to improve colors and checking skill.

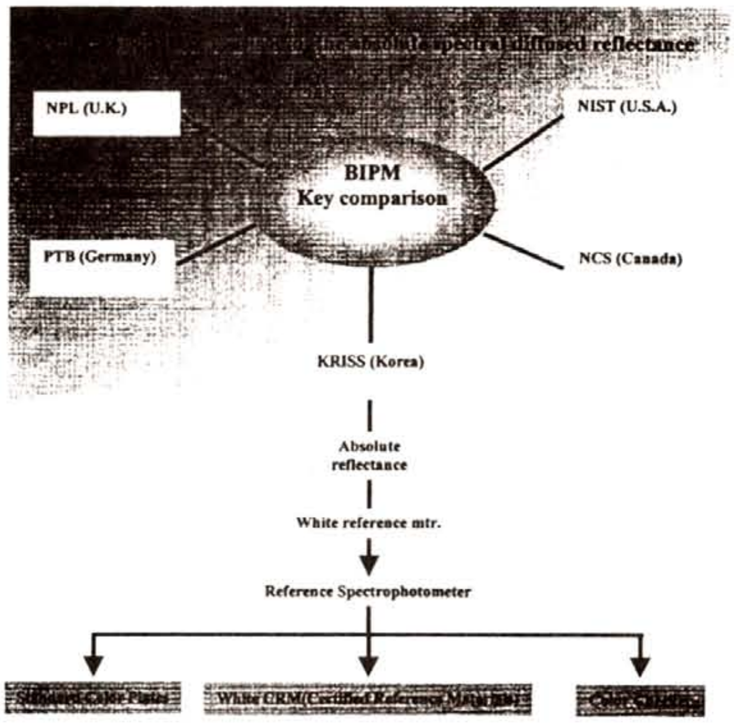

Figure 2. The national color standard traceable system.

4. The Results and the Uncertainty Analysis

The uncertainty of absolute reflectance traceability of the colorimetry is the same of the spectral reflectance measurements. Of course there are another types of color meters, which do not measure spectral reflectance. This type of color meter ñ filter type color meter ñ read color (three-stimulus values) directly from the signals of filter combined detectors.

For this type of colormeters, a white standard reference plate offers color values for every CIE illuminations and standard observers. The uncertainty of white standard reference plate is calculated from A type uncertainty by reference spectrophotometer and a systematic uncertainty of CRM that was used for calibration of the reference spectrophotometer. The uncertainty of reflectance data is less than 0.0018. And the uncertainty of color data is less than 0.0008 in CIE chromaticity coordinate(x, y).

The uncertainty of the standard color plates is lager than the white standard reference plate. The reason is the gloss components of the surfaces of color plates. Even if the gloss components exist, the uncertainty will be decreased for the surfaces those are perfect optical planes. For the limits of producing technology, our standard color plates have not optical planes. We expect someday there will be good improvements. The standard color plates carry many kinds of color coordinate data for every illuminations and standard observers. The color checker has mat surfaces to prevent the gloss, which comes from the various illumination conditions. The measured or calibrated data of each materials are reported in Table 1 and 2.

Table 1. Munsell value of standard color plates measured with KRISS reference spectrophotometer.
(2 degree observer, CIE-C illumination, 0/d geometry)

Color of STD plates	Munsell values (hue, value, chroma)	
	Specula included	Specula excluded
Red	5.6R 4.5/12.6	8.3R 3.8/16.2
Orange	0.6YR 6.4/12.6	1.4YR 6.0/14.9
Yellow	5.4Y 8.4/10.4	5.7Y 8.1/11.8
Green	1.7G 4.7/4.7	1.3G 4.0/6.2
Blue	9.3B 5.7/7.0	8.8B 5.3/7.6
Dark blue	7.2PB 3.1./6.6	6.3PB 1.5/10.9
Purple	3.8RP 5.0/8.1	4.2RP 4.4/9.5
White	N 9.0	N 8.8
L. Gray	N 8.1	N 7.8
M. Gray	N 6.3	N 5.6
D. Gray	N 4.5	N 3.9
Black	N 2.6	N 0.7

Table 2. Munsell value of color checker measured with KRISS reference spectrophotometer.(2 degree observer, CIE-C illumination, 0/d geometry specula excluded)

Color number	Munsell values	Color number	Munsell values
1	5.1YR 3.9/3.3	13	6.9PB 3.0/13.1
2	1.8YR 6.6/4.9	14	0.4G 5.9/7.8
3	4.3PB 5.7/5.9	15	6.9R 3.9/14.0
4	5.1GY 4.4/3.3	16	4.4Y 8.5/13.0
5	9.3PB 5.8/6.8	17	1.1RP 4.8/10.2
6	3.0BG 8.0/5.7	18	5.5B 5.5/8.5
7	4.2YR 6.5/13.8	19	N 9.2
8	7.3PB 4.2/9.8	20	N 7.9
9	2.6R 4.9/10.0	21	N 6.3
10	2.0P 3.2/7.0	22	N 5.1
11	5.5GY 8.0/8.9	23	N 3.9
12	4.4YR 7.6/12.3	24	N 2.2

5. Conclusion

The traceability is a very important conception in every measurement. The color value should be compatible all around the world. Now a days we can measure color in objective and quantitative way. Many kinds of colormeter help us to measure color. But the measured values have to be traceable. This means that the measured value have to be compatible all around the world and valuable to record.

The main purpose of constructing the national traceable system is to guarantee the measured value that was got with the calibrated instrument. We have constructed the color standard traceable system which is consisted with two systems — absolute spectral reflectance measuring system and reference spectrophotometer ñ and two kinds of CRM and one reference material. These CRM and material are purchasable in KRISS. And it will be helpful to measure color more precisely.

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Investigation of the Influence of Various D65 Daylight Simulators on Colour Matching

Yuk-Ming Lam, John H Xin, K-M Sin

Abstract

Two D65 simulators are used to investigate the influence of various D65 simulators on colour matching by using Davidson and Hemmendinger (D & H) Color Rule. These D65 simulators are categorized as A and B by CIE No.51 method, and both of them have colour rendering properties of about 90 Ra units by CIE No.13.3 methods. The colorimetric match point and average visual match point on D & H Color Rule for both D65 simulators are determined. The correlation between quantifying D65 simulator methods and visual assessment are evaluated.

Keywords : CIE Standard Illuminant D65, D65 Simulators, D & H Color Rule, Visible Range Metamerism Index and General Color Rendering Index

1. Introduction

International Commission on Illumination (CIE) recommended standard illuminant D65 by means of Spectral Power Distribution (SPD) and Correlated Colour Temperature (CCT) for colorimetric applications 30 years ago [1]. This recommendation is only a set of data, and CIE does not recommend any D65 simulator to be standard illuminant D65. Since the recommendation, many attempts have been made to simulate CIE standard illuminant D65.

Nevertheless, the simulations are still not close enough to represent the CIE standard illuminant D65. The diversity of D65 simulators results in the lack of precision in color evaluation. For this reason, CIE recommended No.51 method to assess the quality of daylight simulator in 1981 [2]. This method, however, is only based on theoretical colour difference calculation of metamers. The categorization of daylight simulator in the method seems without any visual assessment backing, and the chosen metamers are limited. The purpose of this study is to explore the influence of different categorized D65 simulators on colour matching using the Davidson and Hemmendinger (D & H) Color Rule.

Yuk-Ming Lam, John H Xin and Kwan-Moon Sin
Institute of Textiles and Clothing, The Hong Kong Polytechnic University
Hung Hom, Kowloon, Hong Kong.
Phone : (852) 2766 6521
Fax : (852) 2773 1432
E-mail : tcrslamym@inet.polyu.edu.hk

Quantifying D65 Simulators

CIE Publication No.51, A Method for Assessing The Quality of Daylight Simulators for Colorimetry was reported in 1981. The purpose of this method is to quantify the suitability of daylight simulators as practical reproductions of CIE standard daylight illuminants. The visible range metameric index MI(vis) and ultraviolet range metameric index MI(uv) are used to categorize daylight simulator into A to E grades according to average metamer colorimetric differences, CIELAB or CIELUV, in MI(vis) and MI(uv), seen from Table 1. In this study, only the MI(vis) is calculated for D65 simulators because the available measurement wavelength of the spectroradiometer is limited from 380nm to 780nm. On the other hand, the color rendering ability of D65 simulator is also determinated by using CIE Publication No. 13.3 "Method of Measuring and Specifying Color Rendering Properties of Light Sources" [3].

Table 1. Daylight Simulator Categorization

CIELAB MI(vis)	CIELAB MI(uv)	Category
<0.25	<0.32	A
0.25 to 0.50	0.32 to 0.65	B
0.50 to 1.00	0.65 to 1.30	C
1.00 to 2.00	1.30 to 2.60	D
>2.00	>2.60	E

2. Experimental

2.1 Spectroradiometeric Measurement

Two D65 simulators were obtained and measured using a Photo Research PR-704 spectroradiometer against a barium sulphate tile with a 0/45 illuminating/viewing geometry in colour viewing cabinet. The SPDs were recorded from 380 to 780nm at 2nm intervals [4]. For each D65 simulator, correlated colour temperature, visible range metamerism index, colour rendering index [3], lamp group and type [1] are given in Table 2. Figure 1 plotted SPD values against wavelength for the GretagMacbeth D65 simulator and VeriVide F20T12/D65 D65 simulator. They were selected to represent the typical D65 simulator used in this study. In the following discussion, the commercial names of these sources will be abbreviated to M and V. The word "illuminant" will be used only for those specified by the CIE, i.e. the CIE standard illuminant D65.

Table 2. Colorimetric Information for CIE Standard Illuminant D65 and 2 D65 Simulators

Illuminant/D65 Simulator	L(cd/m²)	CCT	MI(vis)	Ra	Type*	Group
CIE D65		6500	A	100		
GretagMacbeth - (M)	495	6350	A	95		
VeriVide - (V)	450	6276	B	97	F7	B

*CIE has divided the fluorescent sources into three groups: normal, broad and three bands and twelve types: F1 to F12 [2]

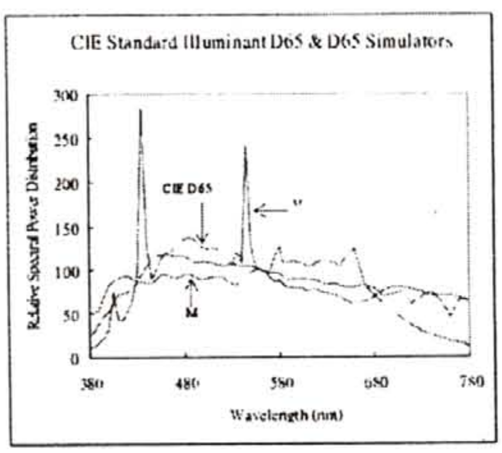

Figure 1. SPD curves of CIE Standard Illuminant D65 and 2 D65 Simulators

2.2 Spectrophotometeric Measurement

D & H Color Rule consists of two strips of printed colours, letter strip and number strip. 21 colours are presented on each strip. The reflectance factors of total 42 colours on two strips of the D & H Color Rule were measured by GretagMacbeth 7000A spectrophotometer using small aperture, specular and UV included mode from 400 to 700nm at 10nm intervals. The colorimetric specification of each colour under each D65 simulator and CIE standard illuminant D65 was calculated using weights and measured reflectance factors. The colorimetric match point for each D65 simulator and CIE standard illuminant D65 was determined by CIELAB colour difference equation. The point with the smallest CIELAB unit between colours on letter strip and number strip is regarded as colorimetric match point.

2.3 Visual Assessment for Determination Match Point

D & H Color Rule is made with paints, which provides a mean of testing how well one light source-observer combination compares with another [5]. In this study, the D & H Color Rule was used to test the difference of various D65 simulators on colour matching.

Totally 50 university students participated the visual assessment on determining visual match point in the D & H Color Rule under two D65 simulators. They passed the congenital colour vision deficiencies test and were rated as having ìsuperiorî colour discrimination ability in the Farnsworth Munsell-Hue 100 Test. In this visual assessment, each observer was asked to adapt the light source for 5 minutes prior to making any assessments. Observers were requested to match the colour samples, and reported the match point in terms of a letter-number combination for two D65 simulators separately. All the visual assessments were conducted in colour viewing cabinet. The average visual match point for each D65 simulator was computed.

3. Results and Discussion

The colorimetric match points of D & H Color Rule under CIE standard illuminant D65 and two D65 simulators are calculated and given in table 3. The colorimetric match point distribution was also plotted in Figure 2.

Table 3. D & H Color Rule Colorimetric Match Point of CIE standard illuminant D65 & 2 D65 Simulators

Illuminant/D65 Simulator	Match Point	CIELAB Units
CIE D65	H7	0.79
GretagMacbeth - (M)	H7	0.67
VeriVide - (V)	H8	0.45

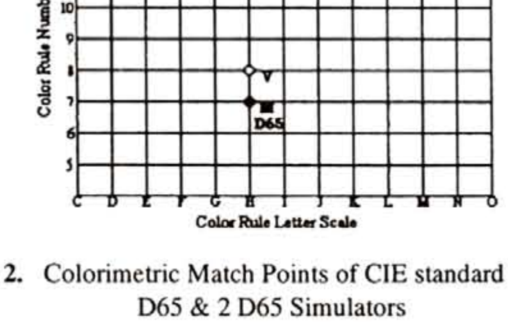

Figure 2. Colorimetric Match Points of CIE standard illuminant D65 & 2 D65 Simulators

According to table 3 and figure 2, two D65 simulators have different colorimetric match points. Only M has the identical colorimetric match point as CIE standard illuminant D65. V has one D & H Color Rule unit difference from CIE standard illuminant D65.

The visual match point was determined to investigate how the D65 simulators influence the colour matching judgement. The results are plotted in figure 3 & 4 for M and V D65 simulators respectively. The number next to the point indicates the number of observers who chose that point as a visual match point. The distribution of average visual match point for D65 simulators under investigation is plotted in figure 5.

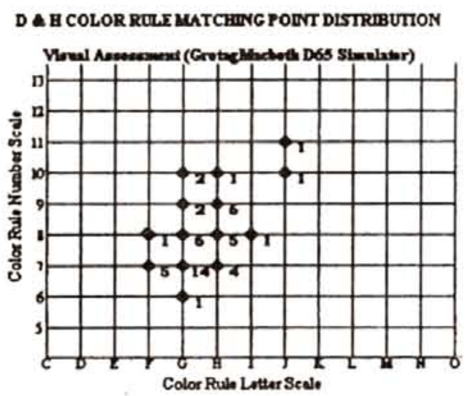

Figure 3. D & olor Rule Match Point Distribution for M D65 Simulator

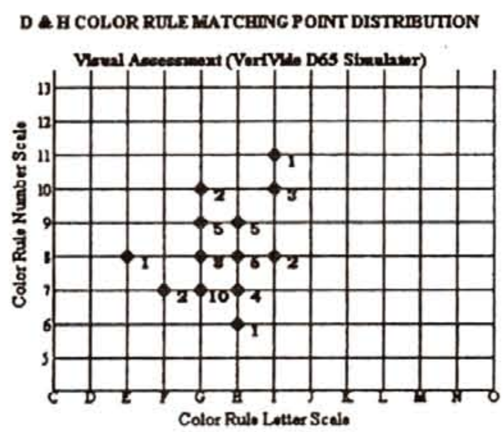

Figure 4. D & H Color Rule Match Point Distribution for V D65 Simulator

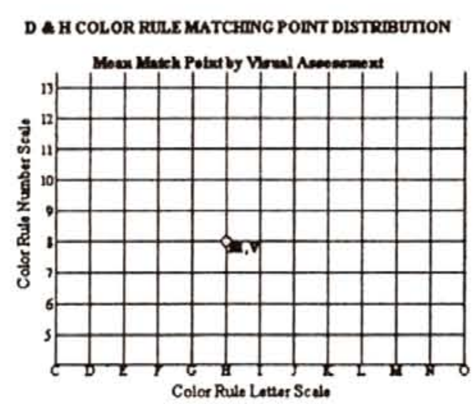

Figure 5. Average Visual Match Point for TwoD65 Simulators

With reference to figure 3 & 4, it can be noticed that the visual match point distribution under M and V D65 simulators are almost the same. And they have identical average visual match point which is plotted in figure 5. When comparing colorimetric match points (figure 2) to the average visual match points (figure 5) for two D65 simulators, V D65 simulator has the same result whereas M D65 simulator has the different result. None of the average visual match points under D65 simulators gives identical colorimetric match point with CIE standard illuminant D65.

5. Conclusion

The purpose of this study is to investigate the influence of various D65 simulators on colour matching. When considering the SPD of two D65 simulators, both of them cannot represent CIE standard illuminant D65 exactly. There is a difference of using SPD of CIE standard illuminant D65 and D65 simulators in determining colorimetric match point in D & H Color Rule. By means of average visual match point, there is no difference in using category A D65 simulator and category B D65 simulator in CIE No.51 method. Above all, it is difficult to make a conclusion whether CIE No.51 method is suitable or not to categorize D65 simulator. Since there is no daylight simulator can represent any CIE standard daylight illuminant, a method for categorizing daylight simulators based on visual assessment results rather than theoretical computation would considered to be a better method in order to reduce colour mis-matching.

Acknowledgment

One of the authors (Yuk-Ming Lam) wishes to acknowledge the studentship received from The Hong Kong Polytechnic University for the work reported here. Special thanks to 50 observers, who took part in this work.

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Ultraviolet Rays Shielding by Dyed Fabrics

Tomoko Mima, Masako Sato

Abstract

Effect of the chemical structure of direct dyes on ultraviolet ray shielding efficiency of the fabrics was studied. Fourteen direct dyes having different chemical structures (five reds, five blues and four yellows) were examined on (1) molar absorption coefficient at the regions of 700-400nm in wavelength (visible light region: VIS), 400-320nm(UVA) and 320-280nm(UVB) respectively, (2) dye exhaustion (%) and coloring on the cotton fabrics and (3) UV-rays shielding efficiency(%) of dyed fabrics. The functional effects of coloration by dye were discussed focussing on the protection of the human bodies from UV rays radiation.

Non-dyed fabrics were examined considerably absorption of UVA and UVB rays and high reflection of VIS rays. Even on the light colored fabrics, the dyes on the fabrics would be able to absorb not only the visible rays but also UV rays effectively and consequently shield the UV-rays. Even the light colored fabrics, the dyed fabrics were examined higher UV-rays shielding properties than non-dyed fabrics. The UV-rays shielding effects of fabrics increased with decreasing of the lightness of fabrics by dye uptake on the fabrics. The yellow colored fabrics were examined high luminance reflectance even at high uptake of dye on the fabrics. At the deep shade the dyed fabrics with red and blue showed effective UV-rays shielding, and at the light color the dyed fabrics with yellow showed higher level of UV-rays shielding than the other colors.

Keywords:ultraviolet rays shielding in UVA and UVB, absorption of electromagnetic wave, dye and dying, fabric

1. Introduction

As increasing of the environmental destruction, the radiation of electromagnetic wave, especially harmful ultraviolet wave, has been suspected to influence the human health [1]. Ultraviolet rays are categorized by three names divided on the basis of wavelength, 400-320nm as UVA, 320-280nm as UVB and shorter than 280nm as UVC. The shorter wave of UV has higher energy than the wave of longer visible light. As shorter UV rays arrive into the atmosphere recently, the human bodies should be in danger. It has been suggested that UVA and UVB might affect the sunburn and suntan on the skin, aging the skin and skin cancer by damaging the cellular gene.

Tomoko Mima*, Masako Sato**
* Seian College of Art and Design
1-25-1, Choshi, Nagaoka City, Kyoto, 617-0844, JAPAN
Phone : +81-75-953-1111 Fax : +81-75-953-1904
E-mail mima@std.life.osaka-cu.ac.jp
** Faculty of Human Life Science, Osaka City University
3-3-138, Sugimoto, Sumiyoshi-ku, Osaka City, 558-8585, JAPAN
Phone : +81-6-6605-2825 Fax : +81-6-6605-2824
E-mail: sato@life.osaka-cu.ac.jp

The clothing has been studied on the many functions such as aesthetic sense, hygiene performance and many other items for the end use. In the near future the ultraviolet shielding efficiency of clothing might be the most important function demanded for the protection of skin from the harmful

Table 1. Direct dyes used

Dye name	(C.I.No)	M.W
Red23	(C.I.29160)	814
Red28	(C.I.22120)	670
Red75	(C.I.25380)	991
Red80	(C.I.35780)	1373
Red81	(C.I.28160)	676
Blue1	(C.I.24410)	993
Blue14	(C.I.23850)	961
Blue53	(C.I.23860)	961
Blue71	(C.I.34140)	1030
Violet51	(C.I.27905)	720
Yellow4	(C.I.24890)	625
Yellow8	(C.I.13920)	519
Yellow50	(C.I.29025)	957
Yellow59	(C.I.49000)	476

ultraviolet rays. It is regarded that the clothes have

UV-rays shielding property essentially for the protection of human bodies by covering. UV-rays shielding by white fabrics has been available on the functions of fiber kinds and the construction parameters of textile, thickness of the textile and yarn numbers, numbers of yarn par cm of textile and so on [2,3]. However the mechanism of UV-ray shielding by dyes and dyed fabrics has not been studied sufficiently. The authors have reported the mechanism of UV-rays shielding using five different structured of direct red dyes [4].

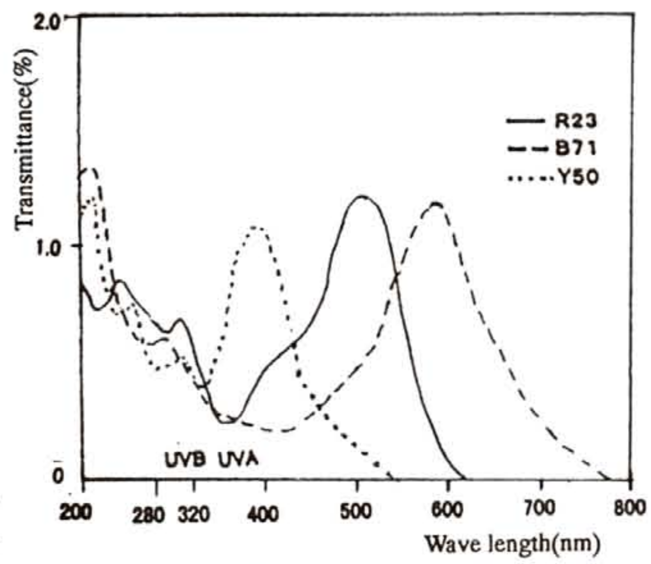

Figure 1. Spentral distribution curve of absorption with dye solution

Table 2. Monlar absorption coefficent

Dye	Molar absorption coefficent		UV/VIS
Red 23	UVA :	17460	0.292
	UVB :	32250	0.539
	VIS(507nm) :	59800	
Red 28	UVA :	26960	0.624
	UVB :	19560	0.456
	VIS(489nm) :	42940	
Red 80	UVA :	23630	0.216
	UVB :	35320	0.323
	VIS (526nm) :	109500	
Red 81	UVA :	13480	0.325
	UVB :	18730	0.452
	VIS (510nm) :	41400	
Red 75	UVA :	18840	0.346
	UVB :	27670	0.508
	VIS (521nm) :	54480	
Blue 1	UVA :	16810	0.190
	UVB :	25840	0.291
	VIS(621nm) :	88650	
Blue 14	UVA :	12829	0.176
	UVB :	21213	0.293
	VIS(590nm):	72276	
Blue 53	UVA :	14820	0.173
	UVB :	24570	0.286
	VIS(608nm):	85830	
Blue 71	UVA :	12880	0.220
	UVB :	24700	0.422
	VIS(586nm):	58540	
Violet 51	UVA :	10550	0.197
	UVB :	16110	0.301
	VIS(545nm):	53560	
Yellow 4	UVA :	29740	0.565
	UVB :	7590	0.144
	VIS(400nm) :	52680	
Yellow 8	UVA :	10800	0.593
	UVB :	9640	0.532
	VIS (400nm) :	18200	
Yellow 50	UVA :	35040	0.640
	UVB :	22110	0.404
	VIS (400nm) :	54780	
Yellow 59	UVA :	22100	2.434
	UVB :	14650	1.613
	VIS (400nm) :	9080	

The aim of this study is to examine the coloring effect of the dyes in expectation of UV-rays shielding material. Although the coloring by dye has been studied on the absorption of visible light, we would focus the new functions of dyes for the protection of the bodies from the harmful UV radiation.

2. Materials and Methods

2.1 Fabric and Dye Materials

Plain cotton fabric woven with 40^S yarns in thickness was used for the substrate of dyeing. Table 1 shows fourteen kinds of direct dyes (Red, Blue and Yellow colored) used. The sample dyes are reagent grade of Aldrich Chemical Company. The molar concentrations of dye solution were prepared by reducing purity with the dye content (%) indicated by Aldrich Chemical Company.

2.2 Examination of Molar Absorption Coefficient of Dyes at the Wavelengths of UVA, UVB and VIS

The spectral absorption curves of dye solution adjusted molar concentration were measured using UV-VIS SPECTRO PHOTO METER (UV-3000, SHIMAZU). The molar absorption coefficients were examined by established method using the maximum absorbance of the spectral absorption curve respectively in the regions of UVA, UVB and VIS and calculated UVA/VIS and UVB/VIS.

2.3 Dyeing and Measurement of Dye Uptake on the Fabric

Two pieces of fabric,7×7 cm², were dyed in the 100 ml dyeing liquor respectively controlled with seven different levels of molar concentration of dye from 0.01 to 1.00×10^{-4} mol /l. The dye uptakes, mol/g fabric, were determined by absorptiometry using before and after dyeing bath liquor. The coloring of dyed fabrics resulted in the color from light to deep shade in this dyeing condition.

2.4 Measurement of the Surface Color and the Spectral Transmittance of Dyed Fabrics

The surface colors of dyed fabric as parameters of CIE1931 Yx,y and CIE L*a*b* were measured using Color Measuring System Σ80 (NIHON DENSHOKU). The spectral transmittance and reflectance of dyed fabric were measured from 200 to 800 nm wavelength using UV-VIS SPECTRO RECORDING PHOTO METER UV-3200PC (SHIMADZU) and UV-rays shielding efficiency of dyes were calculated using the difference of transmittances between dyed and non-dyed fabric.

3. Results and Discussion

3.1 Specifications of Spectral Absorption and Molar Absorption Coefficient of Dyes

Fig.1 shows the spectral absorption curves of three colors, as typical models of Red23, Blue71 and Yellow 50 at the concentration of 0.2 × 10-4 mol/l.

The curves show the characteristic differences of dyes by the absorption of electric magnetic wave. In each region of UVA and UVB, Yellow50 and Red23 show the highest absorption in the three curves respectively. As the results, the specifications of the molar coefficients of dyes calculated from the absorption versus one molecule of dye were shown in Table2. The higher the absorption coefficient of dye at UVA and UBV, it might be more expected to be excellent on UV-rays shielding. The numbers of UV versus VIS are showing the coloring effect of the dye on the UV-rays shielding.

Fig.2 shows the relation between the dye concentration on the fabric and luminous reflection of the fabric as examples of Red23, Blue71 and Yellow50. The numbers in round brackets indicate the dye concentration in the liquor at dyeing, (1)(3), (5) and (7) respectively show the fabrics the light, the medium shade and the deep shade color dyed. As shown in the Fig.2 the Yellow50 resulted in the least uptake on the fabrics of the three colors at the same concentration of dyeing bath. By comparison with the same uptake on the fabrics, that is to say the same counts of dye molecule were on the same fabric weight, the fabrics dyed with Yellow50 were examined the highest luminance reflection of the other fabrics dyed with Red23 and Blue71. These results of colors were the same as the other dyes tested.

3.2 Ultraviolet Rays Shielding Property of Dyed Fabrics

Fig.3 shows the spectral transmittance curves of dyed fabric as examples of Red23, Blue71 and Yellow50. The UV-rays shielding efficiency (%) of dyes were examined using the area of transmittance curves in the regions of UVA, UVB and VIS respectively. The control data of the transmittance was adopted without fabrics (air) on the light pathway. Fig.4 shows the relations between luminous reflectance and UV-rays shielding of the fabric on Blue71. It is clear that the relations can be highly approximate by linear equation in all UVA, UVB and UVT.

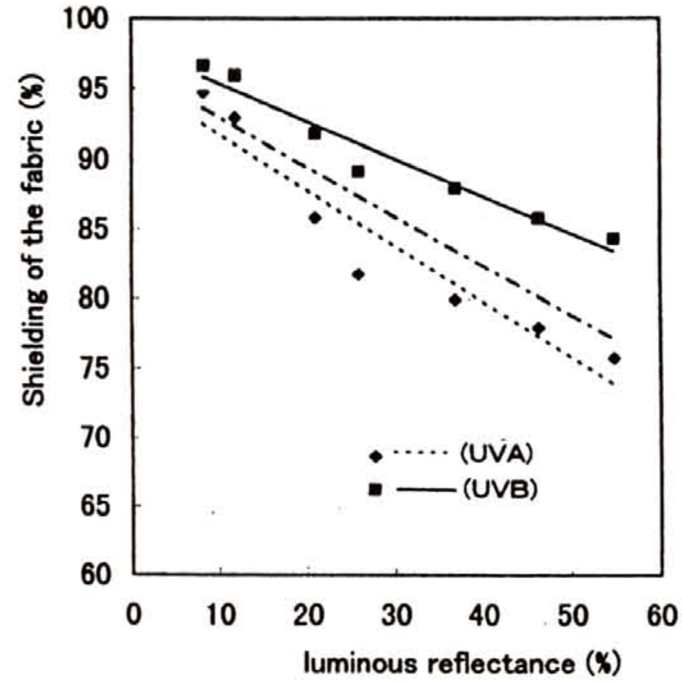

Figure 2. Relation between the dye uptake on the fabric and luminous reflectance of the fabric
The number in round bracket indicate the concentration of dye at dyeing

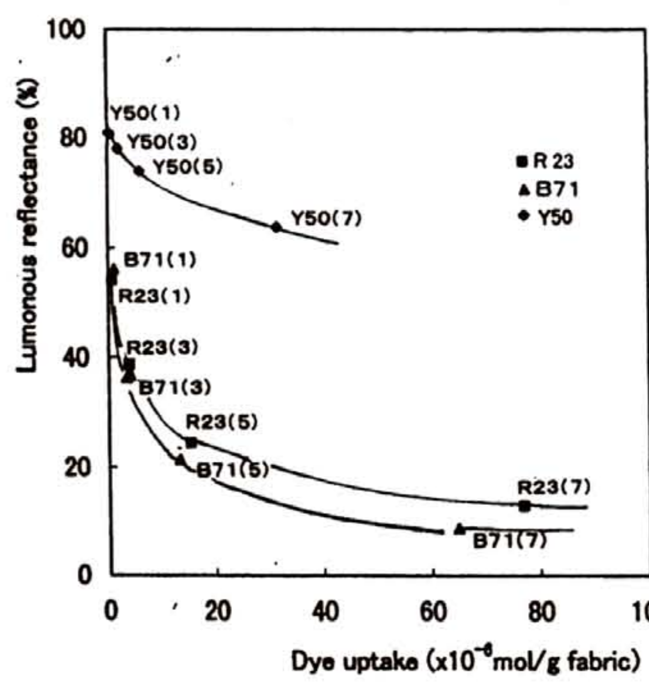

Figure 3. Spectral distribution curve of trasmittance with dyed fabrics

4. Conclusion

1) Even the light colored fabrics, the dyed fabrics were examined higher UV-rays shielding properties than non-dyed fabrics. The UV-ray shielding effects of fabrics increased with decreasing of the lightness of fabrics by dye uptake on the fabrics.

2) The yellow colored fabrics were examined high luminance reflectance even at the high uptake of dye on the fabrics.

3) The dyed fabrics with red and blue showed effective UV-ray shielding at the deep shade color,

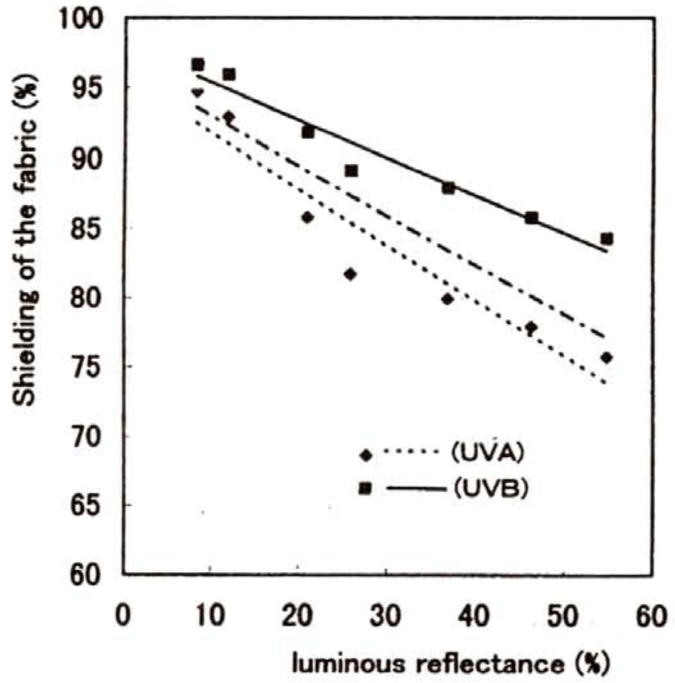

Figure 4. Relation between luminous reflectance and UV-rays shielding of the dyed fabric(Blue 71)

but the dyed fabrics with yellow showed high level of UV ray shielding even at the light color.

Acknowledgment

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A New Economic HF-AC-PowerSupply for Coloured Light Emitting Diodes and Coloured Neon-Tubes

Peter Marx

Abstract

A new electronic HF-powersupply to operate light emitting diodes (LED's) and simultaneously neon-tubes in series circuitry is described.

Keywords:electronic HF-powersupply, LED, neon-tube

1. Introduction

A new electronic AC-powersupply with a constant high-frequency AC-current to operate very economical a large number of coloured light emitting diodes will be presented. This HF-AC-powersupply has a very high internal output impedance and additional a special circuit for an excellent power-factor-correction to reduce the harmonic content, which indicates a low distortion factor of the line current and realize a high line-powerfactor of the device.

A large number of light emitting diodes are arranged in an antiparallel circuit-configuration and can be operated by this new powersupply.

Besides, coloured cold start tubular discharge lamps (so-called neon-tubes) can also be operated by this new powersupply. (See Fig. 1.....4, page 2)

2. Applications

General advertising illuminations, advertising signs, traffic-signals, emergency-lighting, illuminated architectural-lines for buildings, gas-service-stations, shops, ware-houses, railway-stations etc.

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Prof. Dr.-Ing. Peter Marx
TFH-Berlin, University of Applied Sciences
Fachbereich VII, Elektrotechnik
Luxemburger Straße 10
D-13353 Berlin
Germany
Phone : +49-30-4504-2310
F a x : +49-30-4504-2958
E-mail: marx@tfh-berlin.de

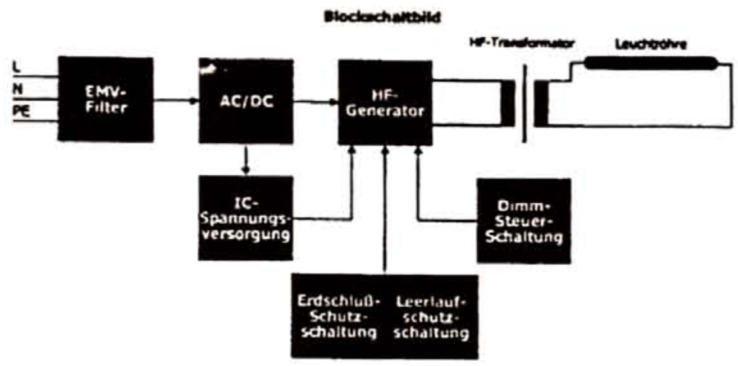

Figure 1. Dimmable HF-ballast for neon-tubes

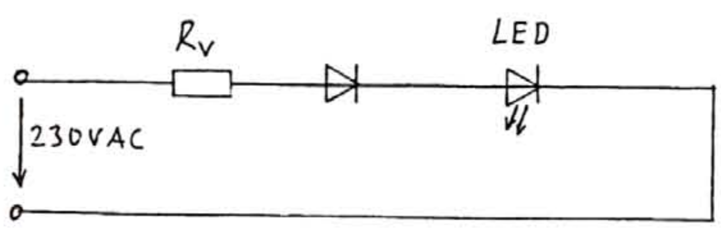

Figure 2. Standard circuit for LED

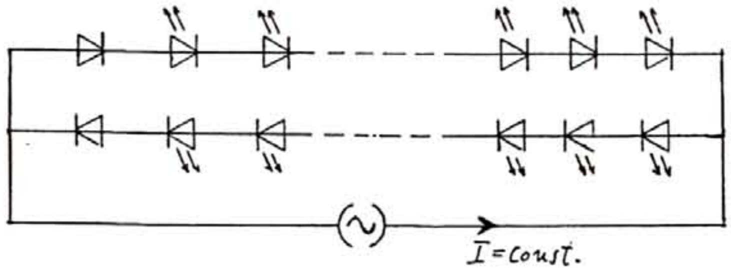

Figure 3. New powersupply for LED's with constant AC-current

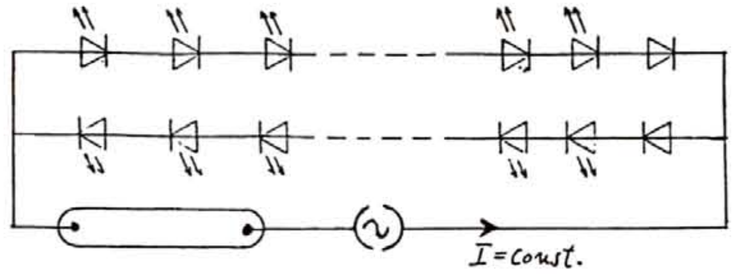

Figure 4. New powersupply with antiparallel configuration for LED's and neon-tubes in serial circuitry

Colorimetric Determination of Tartrazine in Some Soft Drinks

V. Tulyathan*, A. Hansuebsai**, K. Jitrukdee* , R. Toemklinchan*

Abstract

*Tartrazine (FD & C Yellow No.5) can cause an allergic type reaction in sensitive individuals. It is reported that some population is sensitive to this dye and most of those who are sensitive are allergic to aspirin. This dye has been used to mix with the soft drinks to make color of solutions. In this work, we shall report the application of colorimetry for determination the amount of tartrazine in some local soft drinks. Wool dyeing technique was used to extract the dye from standard, unknown solutions and soft drinks. After drying the wool, color values CIE-L*a*b* were measured. It is found that with appropriate concentration range and b* values, a highly correlated (R2>0.98) standard calibration curve was obtained. Percentage recovery of tartrazine from unknown was around 96 to 105%; but from soft drinks spiked with the dye, the percentage recovery was around 61 to 114. However, all the local soft drinks examined contained this dye less than the limit imposed by FDA (Thailand).*

Keywords : colorimetry, tartrazine, soft drink Introduction

1. Introduction

Tartrazine (FD&C yellow No.5) is one of the synthetic dyes used widely in soft drink industry. This dye can cause an allergic-type reaction in sensitive individuals. Most of those who are sensitive to this dye are allergic to aspirin (The American Dietetic Association, 1989). Many methods such as thin layer chromatography (Takeshita et al, 1972) and ion-pair formation and extraction followed by spectrophotometry (Lau et al, 1995) have been reported for the detection and quantitation of dyes in soft drinks and food. In most techniques, the dyes need to be extracted from the sample follow by quantitative measurement.

Complete extraction of the dyes is a crucial step and also time consuming. In this work, a simple wool thread dyeing of tartrazine from some soft drinks was measured colorimetrically. This work has been used for teaching undergraduates in basic colorimetry experiment. The purposes are to use safe chemicals and the students be able to connect colorimetry principle with analysis of everyday encountered chemicals.

V. Tulyathan*, A. Hansuebsai**, K. Jitrukdee* and R. Toemklinchan*

*Department of Food Technology, Faculty of Science, Chulalongkorn University.

**Department of Photographic Science & Printing Technology, Faculty of Science, Chulalongkorn University.

2. Experimental

2.1 Preparing Standard Calibration Curve

Tartrazine was prepared at the concentration of 0.1000 g per 100 ml and 1.0 ml of the solution was diluted to 100 ml (Working solution). It was from working solution that ten different dilutions (1.0x10-6 g dye/ml to 1.0x10-7 g dye/ml) were prepared for wool thread dyeing.

Each 100 ml of the standard were acidified with 2.0 ml diluted acetic acid (5%) and used for dyeing a fix length (about 2 feet or 0.290-0.299 g) of defatted wool thread, at the boiling for 3 minutes. The dyed wool thread was removed, washed in tap water, then air-dried and glued on a 2x2 cm paper. The CIE L* a* and b* values of the wool were measured with a colorimeter (MinoltaÆ CR300). Nine reading were taken with one set of wool. Samples were prepared in duplicate. Relationship of L* a* or b* values and tartrazine concentration were statistically analyzed using regression analysis.

2.2 Determination of Tartrazine in Some Soft Drinks

Some yellow color uncarbonated soft drinks were used in this work. There were two brands of electrolyte beverages and one lemon-lime flavor beverage. All were identified with paper chromatographic technique that the yellow dye was tartrazine. From each sample 5.0 ml was diluted with distilled water to 100 ml and used to dye the wool thread. Standard tartrazine was also added into each soft drink. The amount added was 2x10-5 g dye/ml.

3. Results and Discussion

The method presented was based on the classical wool dyeing qualitative method for food dyes (Maslowska,1996). Wool thread is used to extract the dye from food sample after proper pretreatment; however, to separate the dye out from the wool with dilute alkaline is incomplete and time consuming. Therefore, the dyed wool thread was directly measured colorimetrically. The amount of defatted wool thread used was 0.290-0.299 g/100 ml sample (Figure 1).

The CIE L* a* b* values of the standards and the linear relationship of b* values with concentration (R2=0.98) were shown in Table 1 and Figure 2, respectively. Determination of each added tartrazine in four unknown standards showed satisfactory recovery (rang 97 to 104%). However, recovery of the added dye in three soft drinks showed wide range of recovery (range 56 to 104.5%). One of the electrolyte beverage gave the lowest recoverage (56%). This beverage had opaque appearance as compared to the others. It was anticipated that some components, such as sugar and proteins, in the sample could interfere with the dye adsorption; hence, the recovery was decreased. With proper pretreatment of the sample for optimum food colorant extraction, this method can provide a rapid determination of the dye performed in student laboratory that do not posses sophisticated analytical instrument such as HPLC.

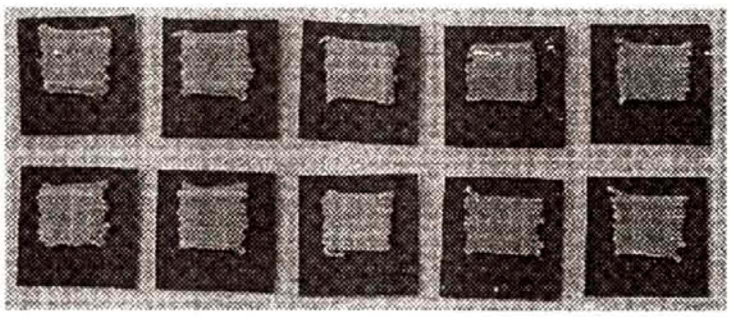

Figure 1. Standard dyed-wool thread.

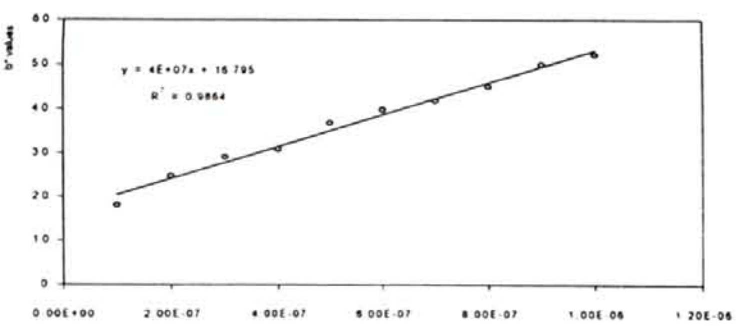

Figure 2. Relationship of tartrazine concentration and b* values.

Table 1. CIE L* a* b* values of standard tartrazine

Dye (g/ml)	L*	a*	b*
$1.0x10^{-7}$	87.16	-3.83	18.03
$2.0x10^{-7}$	87.18	-5.70	24.72
$3.0x10^{-7}$	86.93	-6.42	28.97
$4.0x10^{-7}$	87.33	-6.94	30.77
$5.0x10^{-7}$	87.22	-7.87	36.75
$6.0x10^{-7}$	86.51	-8.20	39.77
$7.0x10^{-7}$	86.58	-8.41	41.69
$8.0x10^{-7}$	87.06	-8.87	44.99
$9.0x10^{-7}$	86.99	-9.34	49.97
$1.0x10^{-6}$	86.56	-9.47	52.13

Table 2. Determination of tartrazine in samples

Sample	Tartrazine added (μg/ml)	Tartrazine found (μg/ml)	Tartrazine recovery	pH
Unknown 1	0.250	0.260	104%	
Unknown 2	0.450	0.450	100%	
Unknown 4	0.650	0.630	97%	
Unknown 5	0.550	0.540	98%	
Electrolyte beverage*	-	4.55		3.39
Electrolyte beverage*	4.00	8.73	104.5%	
Lemon-lime beverage*	-	11.45		3.32
Lemon-lime beverage*	4.00	14.29	71%	
Electrolyte beverage**	-	4.48		3.47
Electrolyte beverage**	4.00	6.70	56%	

* 5% sample was used.
** 10% sample was used.

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Effect of Ultraviolet Irradiation on the photodegradation of BPA polycarbonate

D.K. Hwang Y.G. Shul

Abstract

Bisphenol A polycarbonate(PC) is known to degrade upon exposure to UV light. Photolysis studies were carried out on PC film exposed to short wavelength radiation(254nm). To reduce the photodegradation of PC by UV, TiO2 has selected as an UV blocking material. This report describes the development of spectroscopic methods to demonstrate the effectiveness of UV blocker. A phenomenological study is presented demonstrating the change in color of transparent plastic material(PC) with the addition of TiO2 under the UV exposuring condition.

1. Introduction

Bisphenol A polycarbonate(PC) represents engineering thermoplastics of unique set of mechanical, thermal and electrical properties. It is widely applied in many industries but it is known to degrade upon exposure to UV light.

The photo-degradation of PC involves several distinctive reactions involving both direct photoytic pathways and photo-oxidative process. As aromatic polymers have intrinsic chromophoric units, the mechanism of their photochemical evolution can imply photoric reactions, which occur in the absence of oxygen and photo-oxidative pathways. On this, radical species oxidized direct photo scission processes, photo-induced oxidation implying hydroperoxidation of aliphatic carbon atoms of PC and oxidation of phenyl rings.

The various existing reactions involved in the photo-degradation are largely dependant upon the chemical structure of polymer and the spectral distribution of excitation light source. TiO_2 in photocatalysis is contained by potential barriers to small regions of space. Since photocatalysis usually consist of semiconductor particles, such quantization effects can utilize as an UV blocker. This report describes the change of PC with the addition of TiO_2 under the photo-oxidative process

2. Experimental

PC was supplied by Dow chemical(200-10). TiO_2 particles were used to Degusa P-25. PC film(10-13 μm) were obtained by evaporation of PC solutions in $CHCl_3$ Measurements of the photo-products distribution profiles in the irradiated films were performed on color and UV spectrophotometer. Color index was recorded on a Mecbeth color-eye 3100, UV spectra were used recorded on a Perkin-Elmer model 554,

3. Result

The photo-oxidation of PC at 254nm leads also to noticeable change of color difference irradiated films. Fig. 1 indicate that yellowness(color index) develop up to 7 at irradiation time[186hrs]. The color values of whiteness is lower[4times] than PC film at 0hr.

The color difference of PC films with TiO_2 has selected as an UV blocking material reported in Fig. 2 indicate that whiteness develop about 20 with the 4wt% TiO_2.

Under the irradiation of 254nm the photo induced oxidation route of PC has to be consider as a minor process compared to photo-fries rearrangement (scheme 1) [J.E. Pickett et al.]

3. Conclusion

To reduce the photodegradation of PC by UV light, TiO_2 has selected as an UV blocking material. A phenomenological study is presented demonstrating the change in color of transparent plastic material(PC) with the addition of TiO_2 under the UV exposuring condition.

TiO_2 seems to be effective to maintain whiteness of PC without losing optical transparency.

D. K. Hwang and Y. G. Shul
Department of Chemical Engineering,
Yonsei University, Seoul, Korea
e-mail : inorgcat@yonsei.ac.kr

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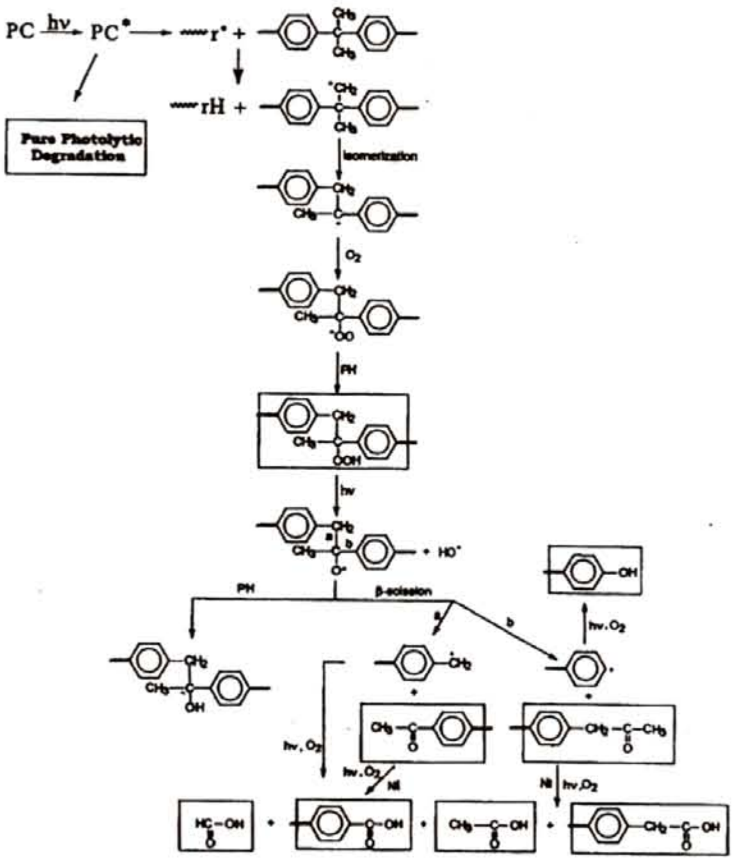

Scheme 1. Photo-oxidation of PC at 254nm
[J. E. Pickett, J. P. Barren and R. J. Oliver, Die. Angew. Makromole. Chemie, 247, 16, 1997]

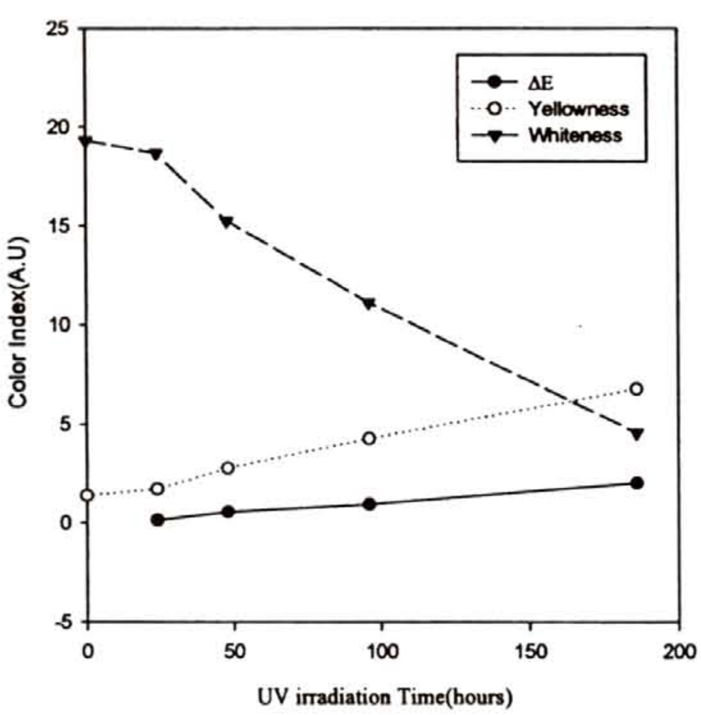

Figure 1. Change of Color index of PC film after UV irradiation

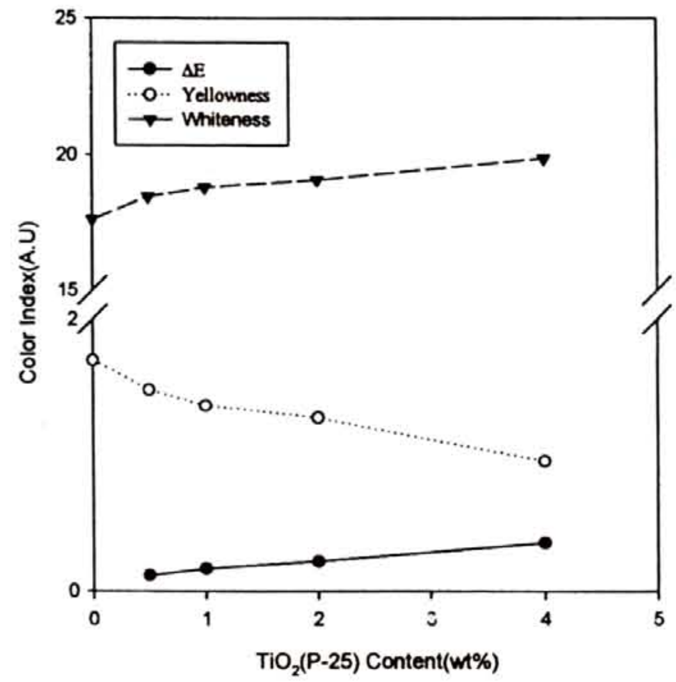

Figure 2. Change of Color index of PC film with Tio2(P-25) Particles

Study on Validity of TML (Target Marker Line) of the Catcher's Glove - Aimed at College Students -

Masanori Iwase

Abstract

This study has been focused upon validity of the TML glove, which is the catcher's black glove colored white around its mound. Comparisons have been made in the hitting ratio of the strike zone between the TML glove and the usual black glove. The subjects are right-handed and left-handed overhand pitchers. Both of them pitch twenty straight balls twice to the right and the left-positioned batters. The catcher sets his glove in the strike zone, and the pitcher throws the balls aimed at the strike zone. The mask, the chest protector, shin guards and knee pads are all black. Interesting and significant information has been obtained by means of questionnaire from the subjects after the experiment.

According to the results of statistics (x2) , the apparent distinction of the effect upon the TML glove has not been found. This would seem to depend upon different factors of the subject himself on a physical strength level as well as on a technical level. Several effects upon background colors should also be taken into consideration.

Keywords : TML of the catcher's glove, Sports and color.

1. Introduction

The purpose of this study is to investigate the validity of the TML (Target Marker Line) of a baseball catcher's glove. TML refers to a catcher's glove in which the main color of the glove is black and is colored white around its outer edge or mound (See Figure 1).

TML Glove Black Glove

Figure 1. TML Glove and Black Glove

2. Aim

Comparisons between the TML glove and an ordinary all black glove have been made in regards to the hitting ratio when a ball has been pitched in the strike zone.

3. Method

This study employs right-handed and left-handed pitchers as well as right and left-positioned batters.

Masanori Iwase
Science University of Tokyo

The pitchers throw 20 regular pitches (with no spin on the ball such as a curve or slider, etc.) two times each for a total of 40 pitches. The catcher holds his glove in the strike zone and the pitcher attempts to throw a strike (See Figure 2). An experiment was done June 22nd and June 25th, 1999. The subject (the pitchers) were college students with very little experience playing baseball. The catcher's involved was a member of a college baseball club and had extensive experience playing this position. The catcher equipment consists of a catcher's glove, mask, helmet, shin guards, a chest protector, and knee pads. These are all black in color with the exception of the special TML glove. The color of TML glove was expressed with Hue,Value,Chroma of A.H. Munsell (See Table 1).

A questionnaire completed by the pitchers and catcher reveals some interesting and significant data concerning among other things the use of= the TML glove (See Table 2).

Table 1. The catcher's glove of of A.H. Munsell

Color	Hue / Value / Chroma (A.H. Munsell)
White	9.74 PB 8.83 / 1.94
Black	6.15R 4.35 / 12.62

Table 2. Questionnaire

Question 1	Which is the easiest combination to pitch?
Question 2	Why do you think so?
Question 3	Which is the most difficult combination to pitch?
Question 4	Why do you think so?
Question 5	Which is the easiest combination to see the glove?
Question 6	Why do you think so?
Question 7	Which is the most difficult combination to see the glove?
Question 8	Why do you think so?
Question 9	Which glove do you think it easier to pitch?
Question 10	Do you think the TML glove is effective in pitching?

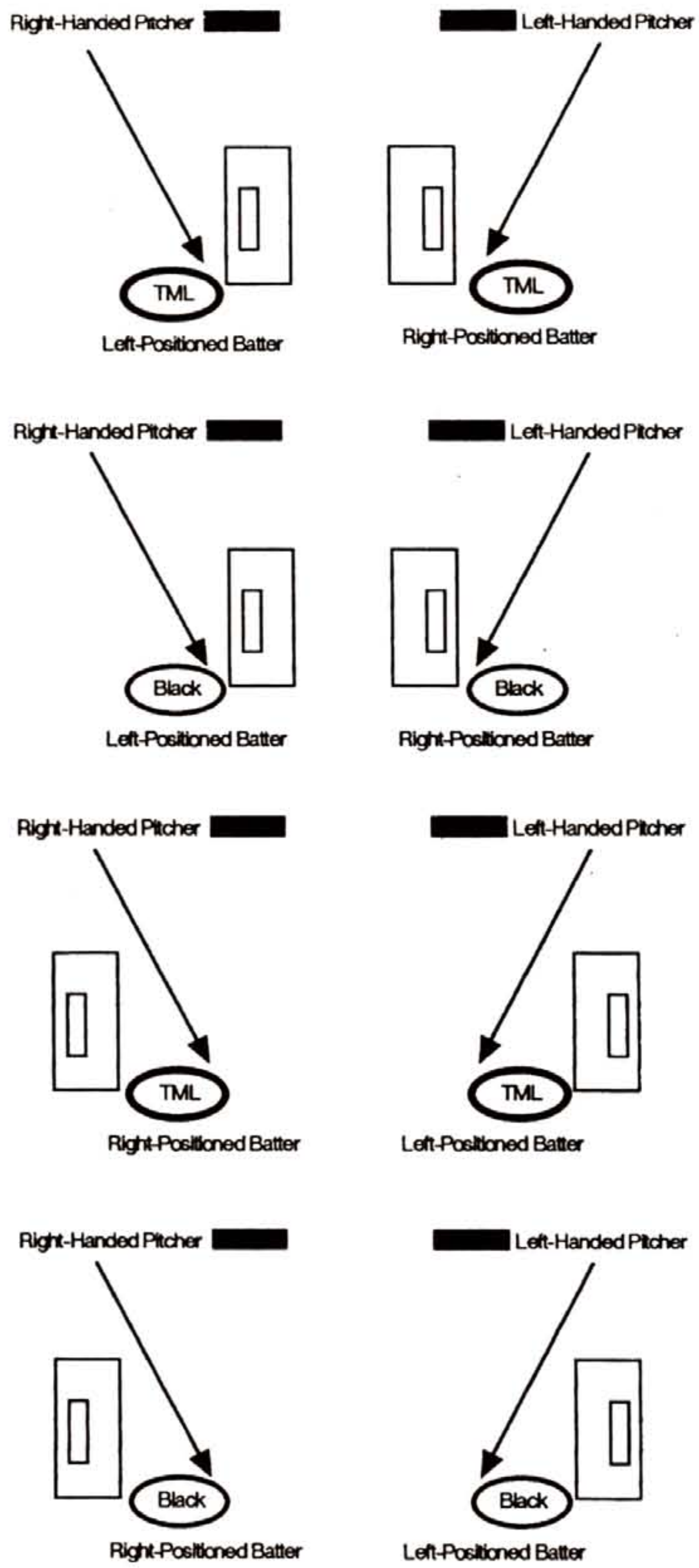

Figure 2. Pattern of Pitch

3. Result and Discussion

By analyzing the results of statistics (x2) , no apparent distinction can be made on the effect the TML glove has in terms of increasing a pitcher's strike throwing performance. The pie chart in Figure 3, represents the TML glove. The highest percentage of strikes thrown was 16.3% with a left-handed and a right-positioned batter. The lowest percentage of strikes thrown was 5.0% with a left-handed pitcher and a left-positioned batter. The pie chart in Figure 4, represents a black glove. The highest percentage of strikes thrown was 22.5% with a right-handed and a left-positioned batter. The lowest percentage of strikes thrown was 7.5% with a left-handed pitcher and a left-positioned batter. The black glove clearly has the best strike percentage in three out of four pitcher-batter combinations. The only exception is the left-handed pitcher vs. the right-positioned batter. In this case, the strike throwing results were in favor of the TML glove.

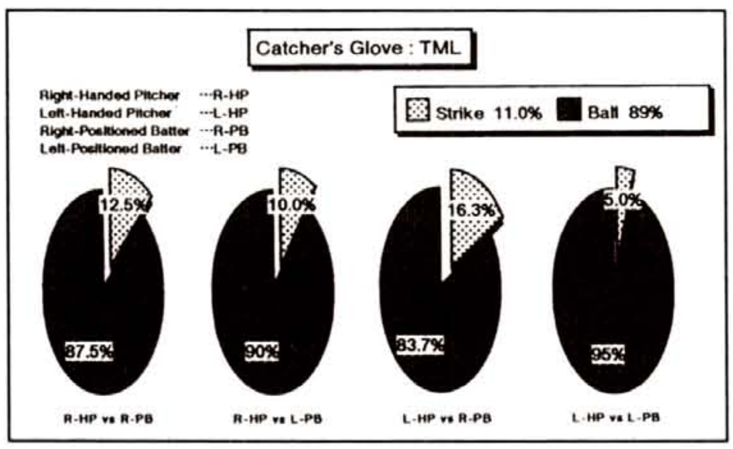

Figure 3. TML Glove Hitting Ratio of The Strike Zone

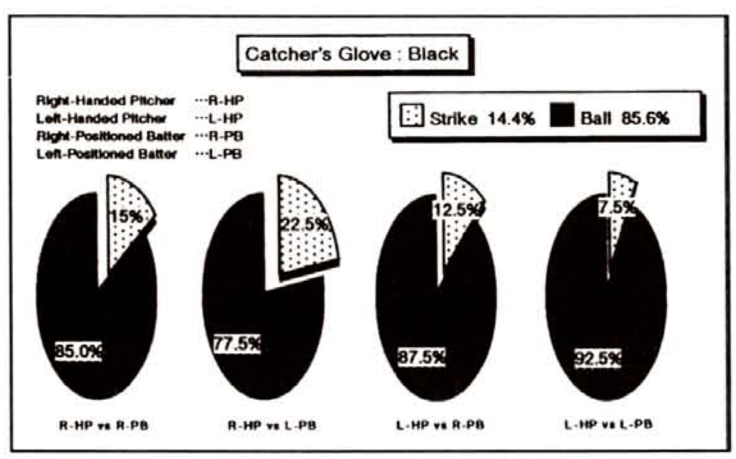

Figure 4. Black Glove Hitting Ratio of The Strike Zone

Several factors that come into play and must be considered are pitcher's physical strength, his endurance, and technical skill. All of these variables have a major role in determining whether a strike is thrown or not. Background colors that are present in the pitcher's field of vision must also be taken into account.

4. Conclusion

Although the TML glove is preferred by some pitchers, based on the results of this study it does not enhance a pitcher's strike throwing ability in a baseball game. In fact, the results from this study are astonishing. In most cases, the TML glove actually performed worse than the regular black glove. Colors have an important role in sports. Teams are readily identified by their team shirts color combinations and make it possible for players to easily distinguish teammates from opposing team members.

Background colors, such as the stand, fans, ground, team shirts, protective equipment, etc. must effect the pitcher's throw. Furthermore, the pitchers technique, strength, and experience all weigh heavily in influencing his pitching abilities. Although the TML glove's performance enhancing effects did not hold up in this study, the color of equipment used in sports is still of great importance. Future studies must be done to discover the relationships between athlete's performance and colors that surround them.

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Color Category in Free Classification of Color Chips

Young-Sun Kim*, Mahn-Young Lee**

Abstract

The subject were shown the color chips of the highest chromaticity in the color space and were told to categorize as will, and then, to reduce the number of categories, in order to search the property of color categories involved in color classification judgement. This procedure was repeated until they could reduce no more. As a result, 'ppalkahta(red)', 'nolahta(yellow)', 'noksayk(green)' and 'chungsayk(blue)' showed stable tendency as the basic color name category. When the classification order was low, 'phulunsayk' showed higher frequency of appearance with more stability than 'green' and 'blue'.

Keywords: Color Category, Color Classification, Color representation, Color naming, Basic Color name

1. Introduction

Various method have been applied to determine the basic color names in Korean(Lee & Kim, 1997). 'Yellow', 'red', 'blue' 'green', 'brown' and 'violet' were found to have the highest possibilities of the basic color names, 'youndoosayk(Chartreuse)', 'phukunsayk(pink)', 'bluish green'.., and 'purple' have also some possibilities. Their basicness are, however, not obvious. This study was to identify the basicness of those terms in a different way, free classification of color chips.

The basic color names have saliency and are expected to have a role of anker in color classification. It is expected that the color categories reflecting basic color names about themselves more frequently and consistently than those of none basic names. It is also expected that the composite color names are more likely to show themselves in the color categories when the number of categories is more reduced.

2. Method

2.1Subjects

Sixteen college students with normal color vision were used.

*Young-Sun Kim
Behavioral Science Research Centor, Korea University
5ka, Anam-dong, Sungbuk-ku, Seoul, Korea.
Office: 82-2-3290-1636 Fax:82-2-928-9203
E-mail:kalasun@korea.ac.kr
**Mahn-Young Lee
Dept. of Psychology, Korea University
1, 5ka, Anam-dong, Sungbuk-ku, Seoul, Korea.
Office: 82-2-923-9203 Fax:82-2-928-9203
E-mail:Mahn@korea.ac.kr

2.2 Materials

Five sets of 33 color chips were systematically selected from 324 chips of the highest chromaticity in Munsell Color Glossy Book. Each of them was mounted on a gray card(N7) of 13cm × 10cm.

2.3 Illumination: The color chips were observed in Macbeth color booth with daylight of D65.

2.4 Procedure

(1) The subjects were stayed more than 20 minutes in the room of D 65 illumination before involving experiment.

(2) Each of the subjects involved 5 consecutive sessions of color classification task individually.

(3) In each session, subjects were presented with a set of 33 color chips and asked to categorize at first, and then to name the categories he made. After completed, he was further asked to reduce the number of categories as will. The procedure was repeated until he could reduce no more.

3. Results

(1) The elemental color names, 'Red', 'Green', 'Yellow' and 'Blue' showed themselves most frequently when the number of categories was over 4, except 'Yellow'.

(2) When the number of categories was over 5, 'Borasayk(violet) was more frequent than 'Yellow'.

(3) When the number of categories was under 6, 'Phulunsayk' sometimes substituted both 'Blue' and 'Green', implying that 'Phulunsayk' is a typical composite color term in Korean.

(4) When the number of categories was 2, the

categories were frequently named as 'Warm and Cold' , 'Bright and Dark' or 'Red and Phulunsayk (Green and Blue)'.
(5) 'Jajusayk(purple)' was very low in frequency, implying that 'Borasayk' is basic but 'jajusayk' is not(Lee, 1983).
(6) 'Brown' and 'Pink' were relatively high in frequency when the number of categories was over 8.
(7) 'Juhwangsayk(Orange and Red-Yellow)' , 'Chungnoksayk(Blue-Green)', and 'Yondoosayk (Chartreuse or Yellow-Green)' were unexpectedly low in frequency, implying they are not basic.
(8) 'White' was relatived high as much as 'Bright' in frequency, however, 'Black' and 'Gray' responses did not appear.

4. Conclusion

(1) 'Red', 'Green', 'Yellow', 'Blue', 'Borasayk (violet)', 'Brown', and 'Pink' seem to be basic color terms in Korean.
(2) 'Jajusayk(purple)', 'Yondoosayk(Chartreuse)', and 'Chungnoksayk(Blue-Green)' seem not to be basic.
(3) 'Juhwangsayk(Orange)' is not obvious in basicness.
(4) 'White' is sometimes need as a composite color term, while 'Black' and 'Gray' is not.
(5) 'Phulunsayk' is a composite color term covering blue and green region. 'Red' is, however, sometimes used as a composite term covering red, orange and yellow region.

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