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เรืออากาศเอกเฉลิม โตสิริบัณฑิต

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

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QUANTITATIVE ANALYSIS OF THAI AND JAPANESE SENSATION ON COLOR COMBINATION

Flt.Lt. Chalerm Tosiribundit

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

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ร.อ.เฉลิม โตสิริบัณฑิต : การวิเคราะห์ความรู้สึกของคนไทยและคนญี่ปุ่นเชิงปริมาณต่อการรวมคู่สี. (QUANTITATIVE ANALYSIS OF THAI AND JAPANESE SENSATION ON COLOR COMBINATION) อ. ที่ปรึกษา : รศ. ดร.อรัญ หาญสืบสาย, อ. ที่ปรึกษาร่วม : รศ.ดร.เท็ตซึยะ ซาโตะ; 124 หน้า. ISBN 974-14-2035-8.

งานวิจัยนี้ศึกษาความรู้สึกของคนไทยและคนญี่ปุ่นเชิงปริมาณต่อการรวมคู่สี โดยอาศัยค่าสี CIE L*C*h ของคู่สีนั้น มาเป็นปัจจัยในการวิเคราะห์จากคำแสดงความรู้สึกสี 14 คู่ ให้ผู้สังเกตทั้งคนไทยและคนญี่ปุ่นแสดงความรู้สึก โดยแต่ละคู่คำความรู้สึกสีจะแบ่งออกเป็น 7 ระดับ ซึ่งข้อมูลของคนไทยได้ศึกษามาก่อนหน้านี้แล้ว คู่สีทั้งหมดที่ใช้ในการศึกษามี 253 คู่สี เลือกมาจากตัวอย่างสีในระบบสี PCCS กำหนดตัวอย่างสีดังนี้ สีแดง สีเหลือง สีเขียว สีน้ำเงิน และสีม่วง ตามลำดับ แต่ละสีแบ่งระดับน้ำหนักสีออกเป็น 4 ระดับได้แก่ สดใส หม่น สว่าง และมืด รวมกับสีขาว สีเทา และสีดำ ได้ระดับคะแนนการประเมิน (visual score) ของแต่ละคู่คำแสดงความรู้สึกต่อการรวมคู่สี นำไปหาความสัมพันธ์กับค่าสีของคู่สีตัวอย่างนั้น ๆ นอกจากนั้นนำระดับคะแนนการประเมินของคนไทยและคนญี่ปุ่นมาวิเคราะห์ทางสถิติ เพื่อเปรียบเทียบความเหมือนและแตกต่างของความรู้สึกของการรวมคู่สี ด้วยวิธีการทดสอบค่าเฉลี่ยแบบ Z-test กำหนดระดับนัยสำคัญที่ 0.05 พบว่าคู่คำแสดงความรู้สึกสี "Dark-Light" "Vague-Distinct" และ "Sombre-Vivid" ไม่มีความแตกต่างกันระหว่างคนทั้งสองประเทศ

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ภาควิชา วิทยาศาสตร์ทางภาพถ่ายและเทคโนโลยีการพิมพ์ ลายมือชื่อนิสิต..

สาขาวิชา เทคโนโลยีทางภาพ .... ลายมือชื่ออาจารย์ที่ปรึกษา..........................

ปีการศึกษา 2549 .... ลายมือชื่ออาจารย์ที่ปรึกษาร่วม..........................

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KEY WORD: COLOR SENSATION / COLOR COMBINATION / CROSS CULTURE

CHALERM TOSIRIBUNDIT: QUANTITATIVE ANALYSIS OF THAI AND JAPANESE SENSATION ON COLOR COMBINATION. THESIS ADVISOR : ASSOC. PROF.ARAN HANSUEBSAI, Ph.D., THESIS CO-ADVISOR : ASSOC. PROF. TETSUYA SATO, Ph.D., 124 pp. ISBN 974-14-2035-8.

This research aimed at investigating the Thai and Japanese sensation on color combinations and quantifying them relevant to CIE L*C*h color values. The experiment adopted a 7-point scale of 14 color sensation word pairs, based on prior thesis work, with 253 color pairs. These color samples were selected on the basis of PCCS color system. The color samples consisted of five hues (Red, Yellow, Green, Blue, and Purple) varied in four different tones (Vivid, Dull, Light and Dark) and three achromatic samples (White, Grey and Black). The experimental raw data were analyzed to derive the correlations coefficient between visual scores and colorimetric values. In addition, the cross-cultural comparison of the color combination sensation result was analyzed by statistic analysis; Paired Z- test was used to compare the similarity or difference in color sensations between the two cultures. The results showed that three pairs of opponent sensation words "Dark-Light", "Vague-Distinct", and "Sombre-Vivid" had no significant difference at a significant level of 0.05.

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CHAPTER 1

INTRODUCTION

Color is extremely important in our lives. There are tons of colors in the modern world. Color is everywhere: in the thousands of multimedia images we are exposed to every day uses, in the clothes we wear, and through the rooms we live in. Sometimes the colors are exciting, sometimes they are drab, but there is no escaping their ubiquity. Like music, poetry, and other art forms, color has the incandescent power to express our moods. It can inspire and move us in the same way a favorite song or poem does, just as great music depends on the right combination of notes, and poetry relies on precise word.

Colors are used in many ways to assert recognition because they are fairly easy to read and understand.

- Color is one of the most fulfilling elements in our lives. Color can attract our attention or change our mood. It can refer to who we are, how we feel and where we are going.

- Color is one of the first things we notice when we walk into a room. Is it any wonder that color, and how we use it, is one of the most important decorating decisions we will make in our home? Inside our home, the latest colors and the way they are applied let people know our personality and decor.

- Color can give information and is used to symbolic object, such as to stop when the traffic lights turn to red and to go on when they are green. Colors have a demonstrable psychological effect; as a result our automatic reaction to colors is so strong. The sight of red means warning and white means simplicity and respective of title. Military uniforms are intentionally colored to give statement and impose authority.

- Color is an important factor in the production of materials and is often vital to the commercial success of products, such as in fruit case, the color used to classify and judge the quality of materials or products. Also color and design of packaging are important to attract customers. (1)

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, etc. Because the emotions on color can be varied with the environment and human feeling, it is hard to organize and apply. (2)

Thus, it is necessary to carefully select color for the production because color always has its own meaning. The meaning of color depends on different things for different people and in different fields. There are many definitions of color from several special interests of people who deal with it. Color means pigment for artists, response of nervous system for physiologists, perception for psychologists, an attribute of radiant energy for physicists. The mechanism of human color perception is very complex and difficult to analyze. Color physicists are concerned with investigating the perception of light and color from a scientific point of view, while psychologists are investigating color from a perceptual and psychological slant. However, all these meanings of color make sense for those people who use them. Besides, all these meanings color is valueless if there is no color sensation. (3)

Color is a phenomenon of sensation, not an objective component or characteristic of a substance. Basically, the component of color sensation involves three basic factors; light sources, objects under illumination, human eyes and neutral responses of observers. Light is the energy radiated from light sources in form of the electromagnetic spectrum of various wavelengths. The perception of color is produced when radiant energy from light sources reflects the objects then enters to the eyes. The eye first records information without understanding, then the light passes through the lens of the eyes to the retina where light stimulates special photoreceptor cells, which are called rods and cones. Rod cells will only be sensitive to light at low illuminant. Cone cells will be sensitive to red, blue and green. A stimulus which is received by the eyes is not understood until the brain interprets them. At these cells, light is converted into electrical signals and then generates nerve impulse transmitting to the brain. The brain interprets and compares it with precious experiences based on culture, knowledge and personal preferences (4). It makes the act of seeing a perceptual process and taken place in the brain. It means that the color perception is produced by the reproduction of the object depending upon the physical composition of the light, the physiological state of adaptation of eyes and also any psychological effects that may have to the observers. The above mentioned shows that color is not only related to physic and physiology, but also related to psychology. However, the mechanism of human color perception system is very complex and difficult to analyze, particularly the mechanism related to the nervous system that is not well understood. As physicists study the color perception in terms of light from a scientific point of view, psychologists investigate the color from a perceptual and psychological point of view. (5)

In order to analyze the mechanism of color perception, it is necessary to make some quantitative scales. Words are the output of color perception and the most useful key to communicating information. There are many previous studies about color perception such as that of Sato et al. on the numerical expression of Japanese (6). Pungrassmee et al. studied Thai and Japanese color emotion words and their comparison (7). Kaya and Epps examined color emotion associations: past experience and personal preference (8). Ou and Luo investigated color emotion and color preference for single colors for British and Chinese observers (9). However, the above researches regarded only single colors. This applies limitation in color design of product.

At present, more interest goes beyond the investigation of color combination. Da Pos et al. studied pleasantness and frequency of some bi-color combinations for an Italian and Indian cross cultural study (10). Srimork studied the quantitative analysis of Thai sensation on color combination, where visual scores from observers were compared with those values obtained from equations (11). Ou et al. studied the effect of culture on color emotion and preference (12). They investigated the culture effect on both single color and combination color in six countries: British, France, Germany, Spain, Sweden and Taiwan. A total of 20 single colors and 190 color pairs were used as the stimuli. Four scales, “warm-cool”, “heavy-light”, “active-passive” and “like-dislike” were used in the experiment to measure color emotion and preference using the method of categorical judgment.

This research defined the color sensation induced by color combination using sensation words for Japanese observers. The objective is to quantify color sensation of two color combination.

Objective

To evaluate quantitatively the Thai and Japanese color preference and sensation induced by two color combination.

Scope of the Research

The dissertation covers the study on the cultural effects of the visual assessment of two color combinations to color sensation from the fourteen opponent word pairs. The comparison of the color combination sensation result between Thai and Japanese was analyzed and to investigate the similarity or difference in color sensations between two cultures.

Contents of the Thesis

Chapter 2 consists of an overview of the theoretical consideration and literature review relevant to this research. Chapter 3 describes materials under study and the experimental procedures and apparatuses. Chapter 4 discusses the results and discussion on the visual assessment, the characteristic of the color combination sensation on color difference in CIEL*C*h, then the values are compared in terms of the similarity or difference in color sensations between Thai and Japanese cultures. Finally, Chapter 5 presents the conclusion and some suggestions.

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CHAPTER 2

THEORETICAL CONSIDERATION AND LITERATURE REVIEW

2.1 Theoretical Considerations

2.1.1 The perception of color

Isaac Newton discovered in 1672 that light could be split into many colors by a prism, and used this experimental concept to analyze light. The colors produced by light passing through a prism are arranged in a precise array or spectrum from red through orange, yellow, green, blue, indigo and into violet. The students' memory trick is to recall the name "Roy G. Biv" where each letter represents a color. The order of colors is constant, and each color has a unique signature identifying its location in the spectrum. The signature of color is the wavelength of light.

The human visual system can detect the range of light spectrum from about 400 nanometers (violet) to about 700 nanometers (red) as shown in Figure 2-1. Our eyes are sensitive to a very narrow band of frequencies within the enormous range of frequencies of the electromagnetic spectrum. Our visual system perceives this range of light wave frequencies as a smoothly varying rainbow of colors. We call this range of light frequencies the visual spectrum. The following illustration shows the visual spectrum approximately as a typical human eye experiences it. (8, 13)

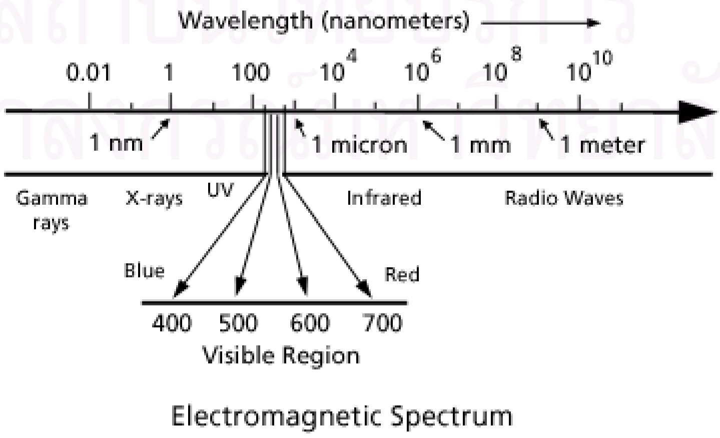

Figure 2-1 The electromagnetic spectrum

Our perception of color arises from the composition of three basic factors the source of light, objects under illumination, and the eyes and the neutral response of observers. The visual process begins when radiant energy from the source strikes the object and some of this energy is reflected and passes through the lens to strike the retina in the eye. The retina on the inner surface of the back of the eye contains photosensitive cells as shown in Figure 2-2. These cells contain pigments which absorb visible light. Two classes of photosensitive cells, rods and cones, it is the cones that allow us to distinguish between different colors. Cones are cells of three different types which respond to red, blue and green regions of light. The rods are effective in dim light and sense differences in light intensity. So in dim light we perceive colored objects as shades of gray, not shades of color

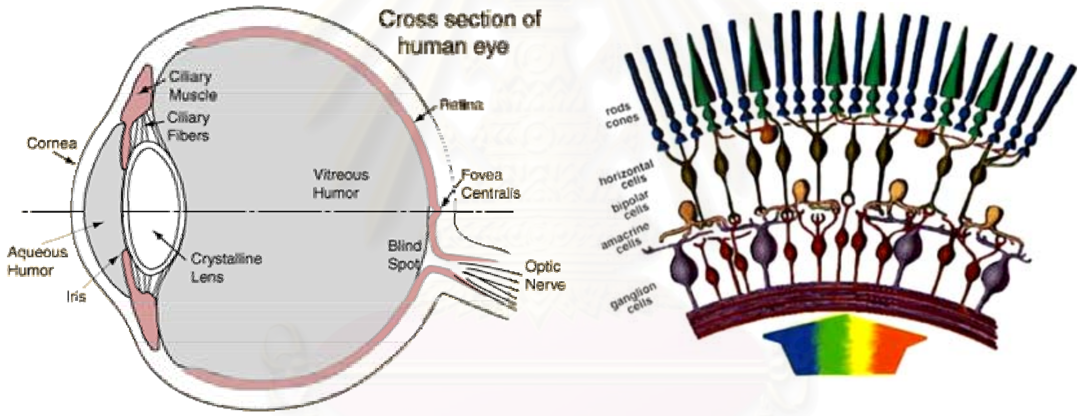

Figure 2-2 A cross section of human eye and photosensitive cells

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The human color vision process is very complex and is still not completely understood. Our Eyes and brain divide what we see into a right and left half. In the drawing below as shown in Figure 2-3, light gray represents the left half; dark gray represents the right half. The eyes invert the image and the left side of what we see ends up in the right side of our brain and converse. This all works out because the right side of our brain controls the left side of our bodies and converse.

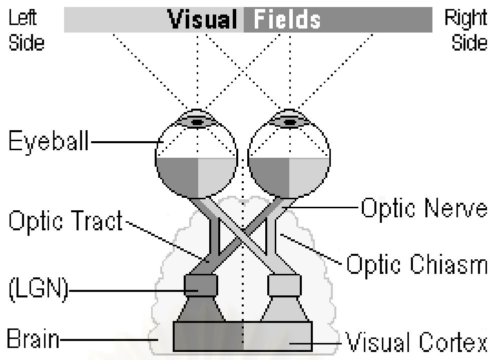

Figure 2-3 Diagrammatic process of the human perception

The opponent signals leave the retina via the optic nerve and eventually arrive at the brain. The brain signals are interpreted through a cognitive process that results in perception of color or color vision. (14, 15)

However, there is range of color vision in the human. The problems of color that involve person difference between two people are more difficult to deal with. It is possible that one or both have defective color vision, some people are often not aware of unless they have been tested. There are several testing devices available for detecting abnormal color vision. The best known of tests is the Ishihara test, where numbers composed of dots of varying sizes and colors are superimposed on backgrounds made up of similar dots. The ability to discern the numbers from the background is a measure of normal color vision. Another widely used test is the Farnsworth-Munsell 100 Hue test, where the observer is required to arrange a series of small color chips in consecutive order according to hue as shown in Figure 2-4. All tests must be carried out under daylight illumination. The tests are generally very reliable. (16)

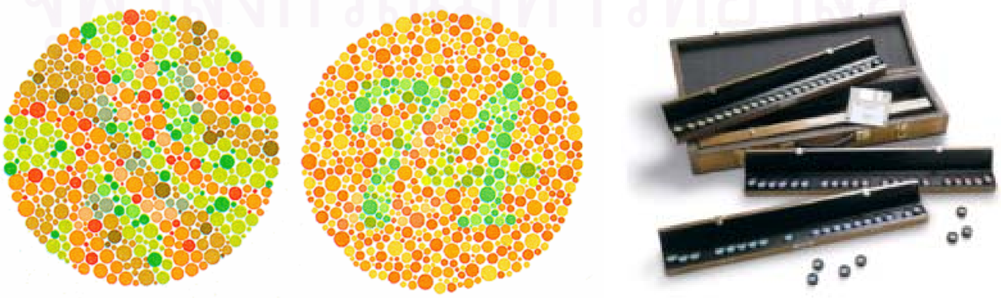

Figure 2-4 Ishihara Color Hue Blindness Test and Farnsworth-Munsell 100 test

2.1.2 PCCS (Practical Color Co-ordinate System) color system

PCCS stand for Practical Color Co-ordinate System made in 1964 by Japan Color Research Institute who developed it as a color system to put in practice its new color co-ordinate theory, derived from over 10 years of study and research on color harmony. This system is composed of three separate parameters of color perception, namely, hue, value and chroma, and is characterized by its capacity to be used functionally as a hue / tone, two-dimensional system. Both the Munsell Color System and the NCS are difficult to indicate because colors are represented three-dimensionally, adding further complexity to the study of colors. In the case of PCCS, it has the advantage of enabling the user to intuitively understand the representation of color, developed for statistic and research about color. It has another name “Colour Code for Research”. (17)

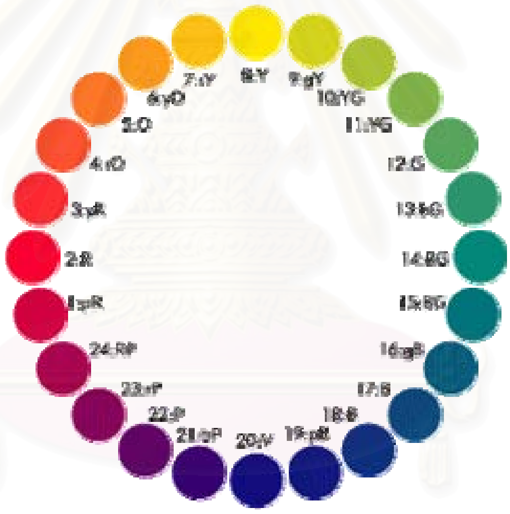

Figure 2-5 Color circle of PCCS color system

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PCCS is a color system that aimed at color harmony mainly. It includes the method of displaying the sign of three attributes and the method of the display in the system color name. But it also has distinguishing method. Brightness and the chroma are brought together by the concept "Tone",

Besides, tone is a compound concept of value and chroma, it indicates the tone of color such as bright or dark, strong or weak. By representing the tone of colors through the use of adjectives, systematic naming of colors is facilitated, thereby enabling the user to familiarize more easily as shown in Table 2-1.

Table 2-1 PCCS symbol relevant to 12 tone of PCCS color system

Symbol	Tone	Symbol	Tone
v	Vivid	sf	Soft
dp	Deep	d	Dull
dk	Dark	b	Bright
g	Grayish	s	Strong
lt	Light	p	Pale
ltg	light grayish	dkg	dark grayish

The uniting concept of brightness and the chroma is feature in the tone table of PCCS is to be arranged the hue circle brought together by the tone along the brightness axis of length and the chroma axis on side. Each tone and tone interrelation is understood well, such as 24 basically color hue of PCCS that compare with Munsell hue were shown in Table 2-2.

Table 2-2 PCCS hue indices relevant 24 colors hue circle

PCCS	Color	Munsell hue	PCCS	Color	Munsell hue
v1	Purplish red	10RP	v13	Bluish green	9G
v2	Red	4R	v14	Blue green	5BG
v3	Yellowish red	7R	v15	Blue green	10BG
v4	Reddish orange	10R	v16	Greenish blue	5B
v5	Orange	4YR	v17	Blue	10B
v6	Yellowish orange	8YR	v18	Blue	3PB
v7	Reddish yellow	2Y	v19	Purplish blue	6PB
v8	Yellow	5Y	v20	Violet	9PB
v9	Greenish yellow	8Y	v21	Bluish purple	3P
v10	Yellow Green	3GY	v22	Purple	7P
v11	Yellowish green	8GY	v23	Reddish purple	1RP
v12	Green	3G	v24	Red purple	6RP

Color in the PCCS is represented by combining the hue number from 1 to 24 and the tone in abbreviated letters, v2 (vivid red), dk16 (dark greenish blue), etc., are examples of the two-characteristic (hue/tone) representation as shown in Figure 2-6. In the world of color coordination, it is important that the combination of coloring is kept simple and can easily convey the image. While the Munsell Color System possesses an analogue continuity, PCCS is digital, which fact makes this representation system not only distinct, but also a more modern system suitable to the present age.

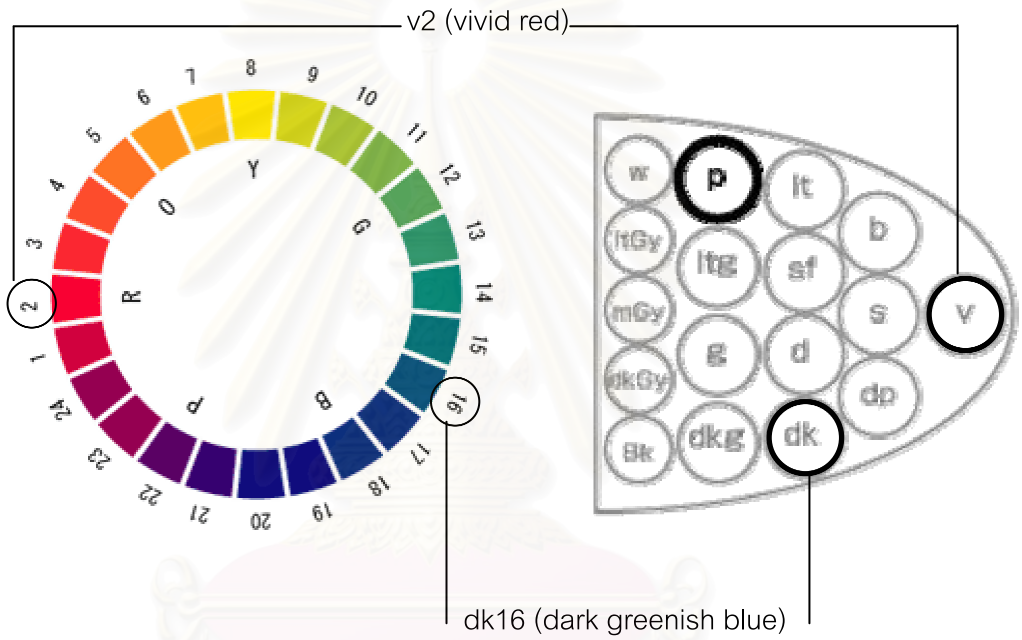
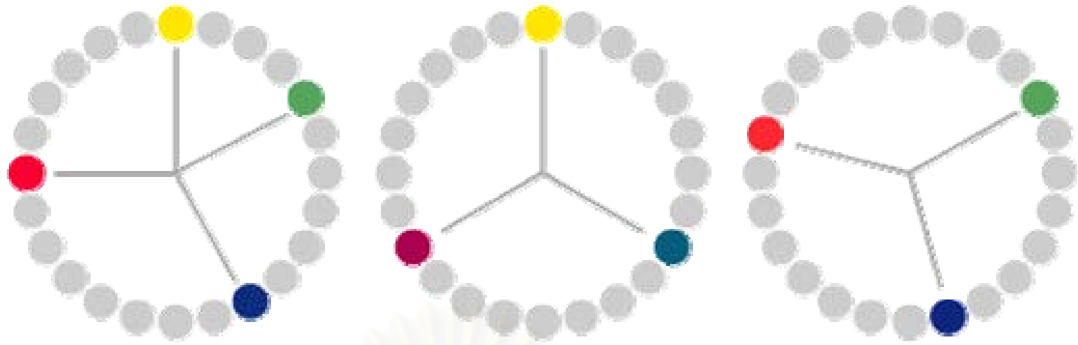


Figure 2-6 Combining name of PCCS color system

The hues in the PCCS are basically made of 8 colors including psychological four primary colors, red, yellow, green and blue, and their four complementary colors plus four in between colors with the same degree of difference. Between these 12 colors, further colors are added to compose a hue circle of a total of 24 colors. In this hue circle, the three optical primary colors and colors close to the three primary colors of color materials are included, as shown in Figure 2-7. (18)



Psychological 4 elementary, color (R, Y, G, B)	3 elementary color of dye, (C, M, Y)	3 elementary color of light (R, G, B)

Figure 2-7 Elementary color of PCCS color system

Achromatic colors (Black, Gray and White) are divided into perspective equivalent rate in the brightness stage. PCCS's brightness stage follows Munsell's brightness to connect to JIS's method of color representation. The brightest white assumed to be Munsell's 9.5 and the darkest color assumed to be 1.5, and it is divided into 9 levels. Added medium brightness and it become 17 levels. Tones are separated into 12 chromatic colors and 3 achromatic colors, which are codified. As indicated in the diagram as shown in Figure 2-8.

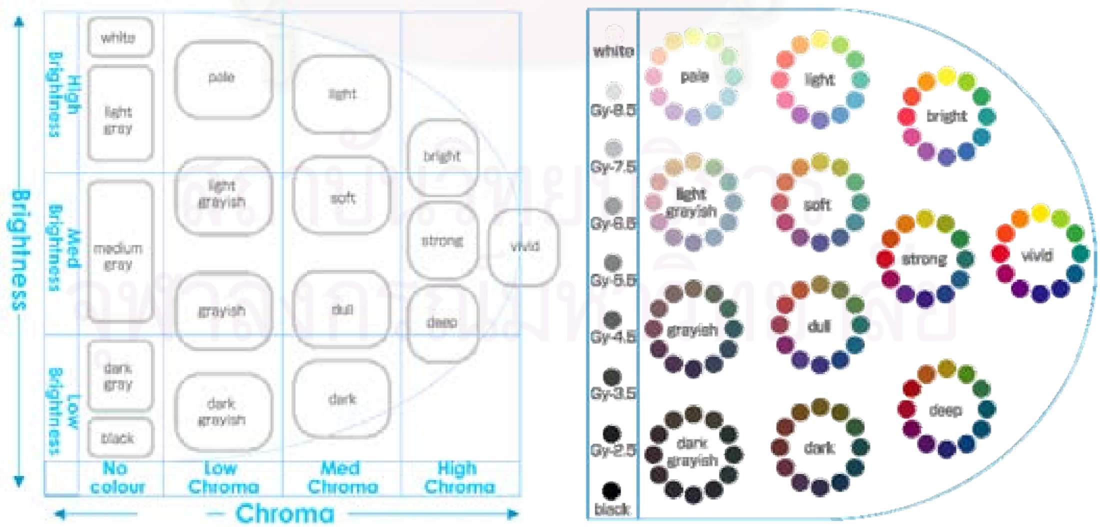


Figure 2-8 Tones of PCCS color system

2.1.3 The CIE color System

In 1931, the CIE system is also an important system which is usually employed in connection with instruments for color measurement. The CIE (Commission International de l'Eclairage or International Commission on Illumination) developed the standards of the colorimetric to be concerned with the relative spectral distribution of radiant flux emitted by the source and incident on the object. The CIE system developed on the human color perception process that stimulus for color is provided by the proper combination of a source of light an object and an observer. (19)

2.1.3.1 CIE standard sources and illuminants

The CIE has established a number of spectral power distributions as CIE illuminants for colorimetric. These distributions based on physical standards, such as blackbody radiators or Planckian radiator, or are based on statistical representations of measured light. Following are the standard light source:

- CIE illuminant A

The most common artificial light source is intended to represent typical, domestic, tungsten-filament lighting. Its relative spectral power distribution is that of a Planckian radiator at a temperature of approximately 2856 K. CIE standard illuminant A should be used in all applications of colorimetric involving the use of incandescent lighting, unless there are specific reasons for using a different illuminant. The standard recommends laboratory realizations of the CIE standard illuminant A.

- CIE illuminant C

An illuminant is the spectral power distribution of Illuminant A as modified by particular liquid filters defined by the CIE. It represents a daylight simulator with a correlated color temperature of about 6774 K.

- CIE illuminant D65 and D50 are part of the CIE D series

Illuminant has been statistically defined based upon a large number of measurements of nature daylight. Illuminant D65 and D50 represented an average daylight with a correlated color temperature of about 6500 K, and D50 represents an average daylight with a correlated color temperature of 5003 K. D65 is commonly used in colorimetric applications, such as, paint, plastics and textiles.

- CIE illuminant F series

Illuminant represents typical spectral power distributions for various types of fluorescent sources. Such as, CIE illuminant F2 represents cool white fluorescent with a correlated color temperature of 4230 K. CIE illuminant F8 represents a fluorescent D50 simulator with a correlated color temperature of 5000 K.

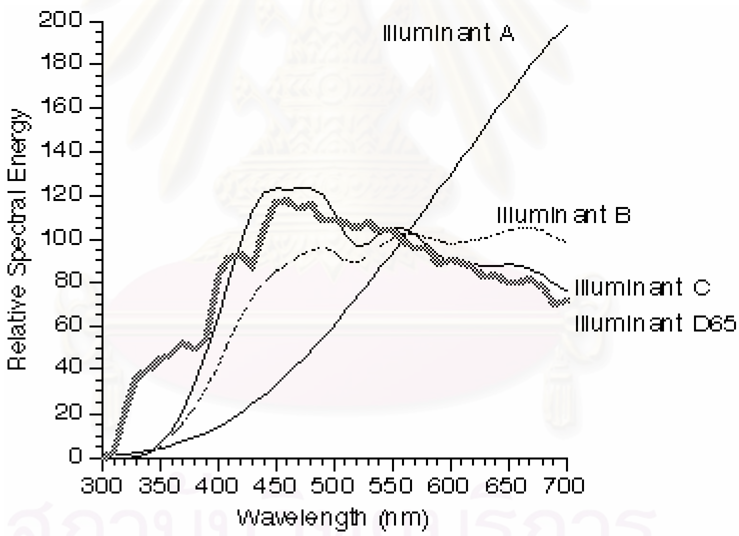


Figure 2-9 Relative spectral power distribution of CIE standard illuminant

In the past, the CIE published instructions on how to produce the light of a standard illuminant experimentally. These instructions were called standard sources. The CIE no longer publish any standard sources. Experimenters are left to measure to profiles of their sources and compare them to the published spectra of the standards. Although the standard illuminants are now simply tables of arbitrary numbers, many of them are chosen very carefully to be easily reproducible. The D series is a notable exception, as it is based on measurements of natural daylight. The D65 standard illuminant is very often used. It corresponds to the spectral composition of medium daylight. (20)

2.1.3.2 CIE Standard Observers

In 1931, experiments were performed to determine how a standard human observer perceives color. The experiments were done by projecting lights onto a screen and having an observer match one light using a combination of red, green, and blue lights. The observer changed the amounts of red, green, and blue light projected onto the screen so that the light spot created matched the single light. In a few cases, one of the three matching lights had to be projected on the light to be matched in order to achieve a match, which was, in essence, subtracting light from the matching lights. These experiments were done with the observer having a very small (2 degree) field of view. The curves generated from this data were mathematically manipulated so that all the curves were positive and the $\bar{y}$ was equal to the luminosity function (the way humans perceive brightness). The resulting curves, $\bar{x}$, $\bar{y}$, and $\bar{z}$ are referred to as the CIE 2 degree Standard Observer functions.

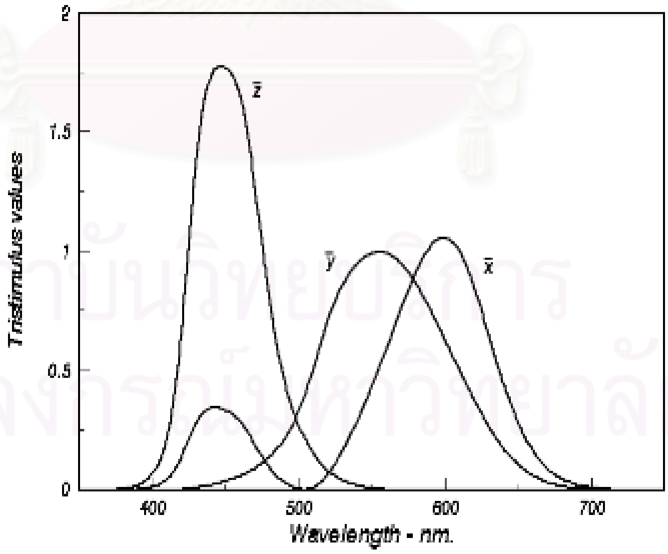


Figure 2-10 1931 CIE standard observer

In 1964, similar experiments were performed using a larger (10 degree) field of view. At that time, more was known about the anatomy and function of parts of the eye and it was determined that the 10 degrees field of view would be a better indicator of how color is actually perceived by humans than the two degree field of view. Thus, the CIE 10 degree Standard Observer functions were created. (21)

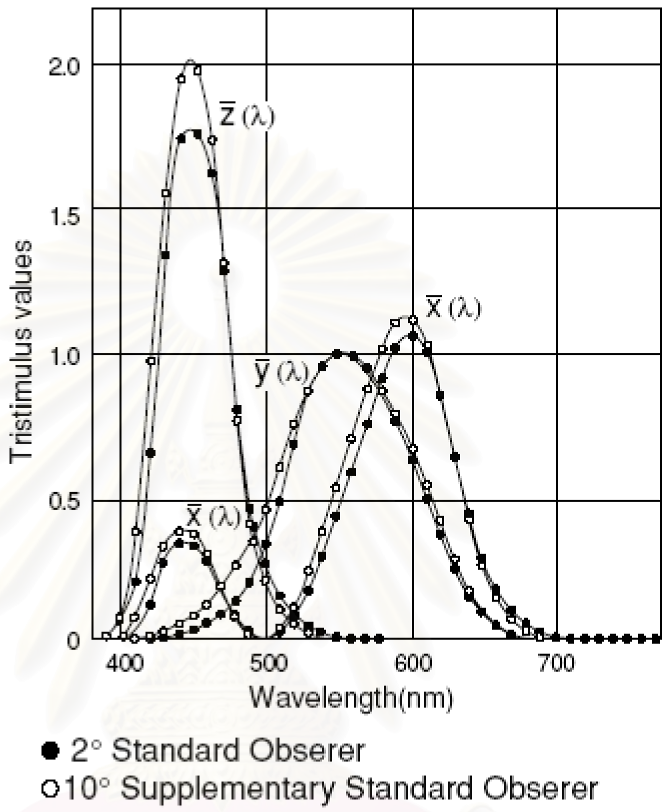


Figure 2-11 Comparison of 1931 and 1964 CIE standard observer

This is referred to as the 10 degrees supplementary Standard Observer. To give an idea of what a 2 degrees field of view is like compared to a 10 degrees field of view, at a viewing distance of 50 cm. 2 degrees field of view would be a φ1.7 cm. circle, while a 10 degrees field of view at the same distance would be φ 8.8 cm. circle. The 2 degrees Standard Observer should be used for viewing angles of 1 degree to 4 degrees; the 10 degrees Supplementary Standard Observer should be used for viewing angles of more than 4 degrees. (22)

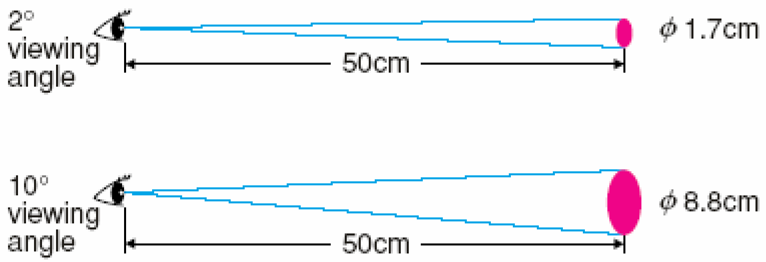


Figure 2-12 Comparison of 2^{O} and 10^{O} field of view

2.1.3.3 CIE XYZ Tristimulus Values

The CIE Tristimulus Values (XYZ) is calculated from these CIE Standard Observer functions by the equation 2.1, taking into account the type of illumination and reflectance of the sample.

$$X=K\int_{380}^{780} S(\lambda)\,\bar{x}(\lambda)R(\lambda)d\lambda$$

$$Y=K\int_{380}^{780} S(\lambda)\,\bar{y}(\lambda)R(\lambda)d\lambda$$

$$Y=K\int_{380}^{780} S(\lambda)\,\bar{z}(\lambda)R(\lambda)d\lambda$$

$$K=\frac{100}{\int_{380}^{780} S(\lambda)\,\bar{y}(\lambda)d\lambda} \qquad (2.1)$$

Where, $S(\lambda)$ is the relative spectral power distribution of the illuminant

$\bar{x}(\lambda)$, $\bar{y}(\lambda)$, and $\bar{z}(\lambda)$ are the color matching functions

$R(\lambda)$ is the spectral reflectance of specimen

K is the normalizing constant

At each wavelength $\bar{x}$, $\bar{y}$, and $\bar{z}$ are multiplied by the spectral energy emitted by the light source. Then that value is multiplied by the reflectance of the sample at each wavelength. The values for all the wavelengths are then summed. The XYZ values are calculated based on the luminosity of a perfect reflecting diffuser which has a reflectance of 100 at each wavelength. The sums are divided by the sum of the spectral energy time's $\bar{y}$ at

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each wavelength because Y for the perfect white must equal 100 by definition. CIE Publication 15.2 (1986) contains information on the XYZ color scale and CIE Standard Observer functions.

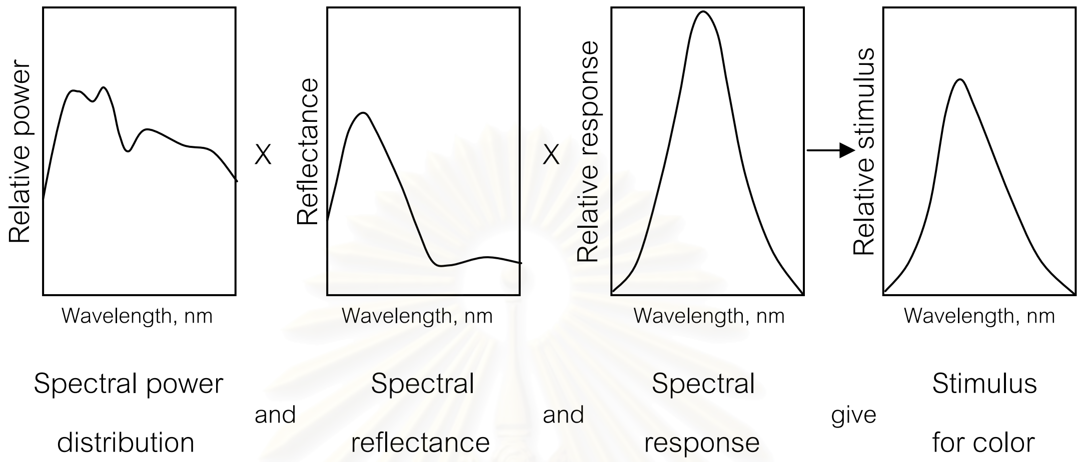


Figure 2-13 CIE trisitimulus values X, Y and Z of color.

The XYZ color scale may be used to quantify the color of an object. The reflectance curves of different colored objects are different so their XYZ values will also be different. However, the XYZ values do not fit into a color solid, so it is difficult to determine the actual color of an object based solely on its XYZ values. The XYZ values are most often used as a starting point for the calculation of other color values which fit into various color solids and, therefore, yield values from which the actual color of an object may be more easily determined based on the numbers alone. The colors of standard tiles are usually determined and listed in XYZ values. The Y value is also the luminous reflectance for the sample since $\bar{y}$ is equal to the luminosity function. Y is sometimes used to quantify the brightness of an object. (23)

2.1.4 The CIE L*a*b* Color Space and the CIE L*C*h* Color Space

The limitation of the CIE system due to non-uniformity of the changes in x, y or Y with the corresponding perceived color that is, equal change of x, y or Y, do not correspond to the same perceived difference. Many attempts were to find out a more uniform system. The

CIE L*a*b* 1976 color space, thus is established. This apace extends tristimulus colorimetric to three dimensional space with dimensions that approximately correlate with the perceived lightness, chroma and of a stimulus.

The variables used in the CIELAB system are L* as the correlate of lightness, a* as correlate of redness or greenness, and b* as the correlate of yellowness or blueness, as shown in Figure2-14. The L*, C*, h cylinder coordinates are another set of color difference equation that are widely used, are defined as following.

$$L^* = 116\,(Y/Y_n)^{1/3} - 16$$
$$a^* = 500[(X/X_n)^{1/3} - (Y/Y_n)^{1/3}]$$
$$b^* = 200[(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}]$$
$$C^* = (a^{*2} + b^{*2})^{1/2}$$
$$h = \tan^{-1}(a^* + b^*) \qquad (2.2)$$

Where, X/X_n, Y/Y_n, $Y/Y_n > 0.00885$

X, Y and Z are the tristimulus values of the stimulus

X_n, Y_n, and Y_n are the tristimulus values of the reference white

C* is chroma

h is hue angle

These values quantify the Munsell variables of hue, value and chroma, respectively. Value is quantified by L* on a scale such as a perfect black has on L* value of zero and the perfect reflection diffuser on L* value of 100. Chroma is denoted by C* and is measured on a scale such as a colorimetric neutral gray have C* value of zero. The hue angle is denoted in term of h. Four psychological primary colors are as red, yellow, green and blue having approximate hue angle of 27, 95, 162, and 260 degrees, respectively. (24)

2.1.5 Color- Difference on CIE L*a*b* Color Space and CIE L*C*h* Color Space

The differences in color between a standard and batch are defined by their difference in lightness (ΔL*), redness or greenness (Δa*) and yellowness or blueness (Δb*). The differences in color are also defined by difference in lightness (ΔL^*), chroma (ΔC^*_{ab}) and hue (ΔH^*_{ab}).

$$(\Delta E^*_{ab}) = [(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2]^{1/2} \quad (2.3)$$

$$(\Delta E^*_{ab}) = [(\Delta L^*)^2+(\Delta H^*_{ab})^2+(\Delta C^*_{ab})^2]^{1/2} \quad (2.4)$$

$$(\Delta H^*_{ab}) = [(\Delta E^*_{ab})^2-(\Delta L^*)^2-(\Delta C^*_{ab})^2]^{1/2} \quad (2.5)$$

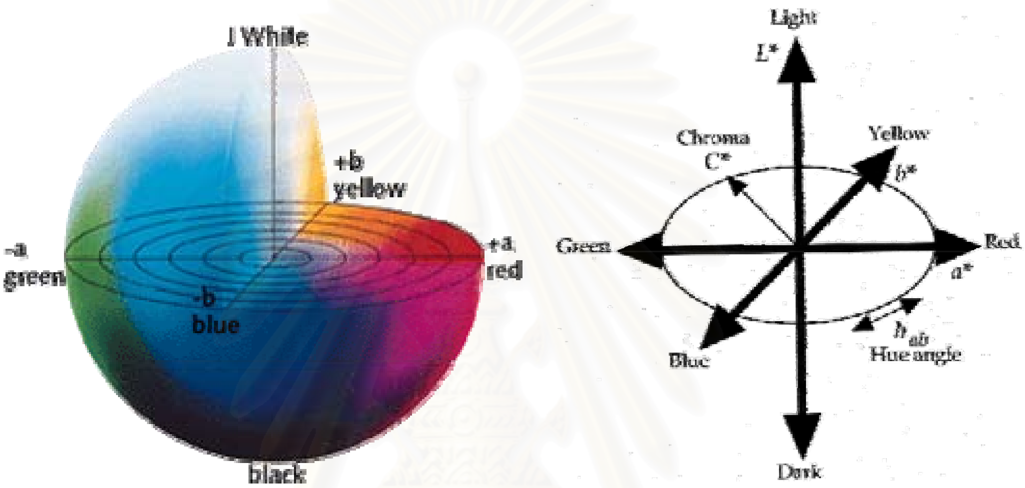


Figure 2-14 Diagrammatic of CIE L*a*b* color space and CIE L*C*h color space.

2.1.6 The Correlation Coefficient and Coefficient of Determination

The correlation coefficient, which is denoted by ρ (population correlation coefficient; rho), is a dimensionless quantity that measures the linear association between two random variables. The estimator of ρ is the sample correlation coefficient, r, that is following.

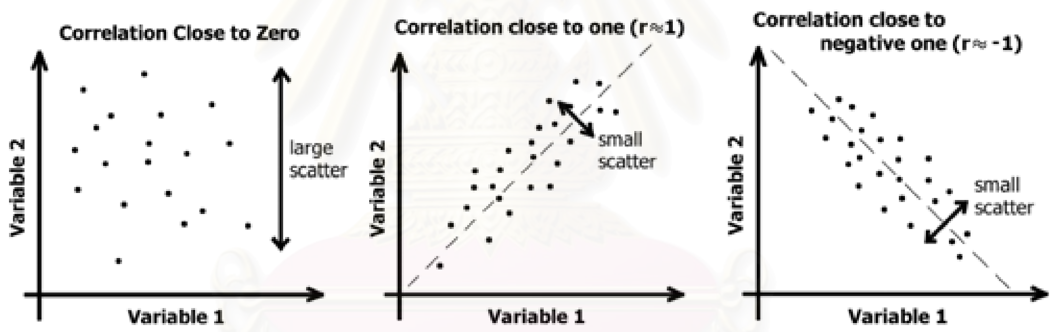
$$r_{XY} = \frac{n\sum XY-(\sum X)(\sum Y)}{\{[n\sum X^2-(\sum X)^2][n\sum Y^2-(\sum Y)^2]\}^{1/2}} \quad (2.6)$$

The sample correlation coefficient, r, measures the linear association between *Y* and *x* , while β_1 measure the predicted change in the mean of *Y* for a unit change in *x*.
The meaning of r is following.

The linear correlation coefficient (r) is a number between -1 and 1 which measures how close to a straight line a set of points falls. The closer to zero the correlation coefficient is, the less the points fall on a straight line

A measure of how much linear relationship exists between the values for the two variables.

- The correlation coefficient can range between +1 and -1.
- Positive values indicate a relationship between X and Y variables so that as X increases so does Y.
- Negative values mean the relationship between X and Y is such that as values for X increase, values for Y decrease.
- A value near zero means that there is a random, nonlinear relationship between the two variables.



No correlation Positive correlation Negative correlation

Figure 2-15 Scatter diagrams and correlation coefficient.

The correlation coefficient represents the strength of an association and is graded from zero to 1.00. It has no units, but may be positive or negative. The table 2-3 provides a rule of thumb scale for evaluating the correlation coefficient.

Coefficient of Determination, a statistic that was widely used to determine how well a regression fits is the coefficient of determination (or multiple correlation coefficient), R^2. R^2 represents the fraction of variability in y that can be explained by the variability in x. In other words, R^2 explains how much of the variability in the y's can be explained by the fact that they are related to x, i.e. (25)

Table 2-3 Strength of Correlation

Strength of Correlation	
Size of r	Interpretation
0.90 to 1.00	Very high correlation
0.70 to 0.89	High correlation
0.50 to 0.69	Moderate correlation
0.30 to 0.49	Low correlation
0.00 to 0.29	Little if any correlation

2.1.7 Factor Analysis

Factor analysis originated with psychologists in an attempt to discover the factor underlying intellectual ability. Charles Spearman is credited with originating, in 1904, the theory that a general factor (inherited intellectual ability) and specific factors (learning and experience) might be found to underlie the multitude of tests used to measure different intellectual abilities. He originated the idea that this might be done by analyzing a matrix of correlations of the various tests mathematically. Factor analysis has gone through several changes since then, but their basic objectives remind the same.

Factor analysis includes variable such as component analysis and common factor analysis. It is a statistical approach that can be used to analyze interrelationships among a large number of variables and to explain these variables in terms of their common underlying dimensions (factor). The objective is to find a way of condensing the information contained in a number of original variables into a smaller set of variants (factors) with a minimum loss of information. This is another saying that its objective is to try to make complex phenomena simpler and, by doing so, in crease our understanding of it.

The underlying assumption of factor analysis is that there exists a number of unobserved latent variables (or "factors") that account for the correlations among observed variables, such that if the latent variables are partialled out or held constant, the partial correlations among observed variables all become zero. In other words, the latent factors determine the values of the observed variables.

Each observed variable (y) can be expressed as a weighted composite of a set of latent variables (f's) such that

$$y_i = a_{i1}f_1 + a_{i2}f_2 + \ldots + a_{ik}f_k + e_i \tag{2.7}$$

Where, y_i is the i th observed variable on the factors

f is common factor or latent variance

a is common factor loading

e_i is the residual of y_i on the factors.

Given the assumption that the residuals are uncorrelated across the observed variables, the correlations among the observed variables are accounted for by the factors. The following is an example of a simple path diagram for a factor analysis model. This diagram is a schematic representation of the formula 2.7, as shown in Figure 2-16.

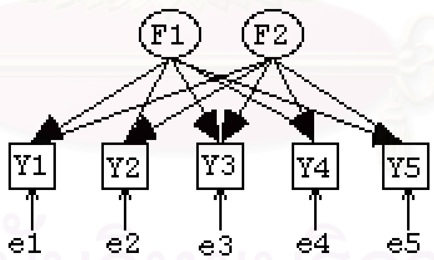


Figure 2-16 Diagram is a schematic representation of the factor analysis formula.

F1 and F2 are two common factors. Y1, Y2, Y3, Y4, and Y5 are observed variables, possibly 5 subtests or measures of other observations such as responses to items on a survey. e1, e2, e3, e4, and e5 represent residuals or unique factors, which are assumed to be uncorrelated with each other. Any correlation between a pair of the observed variables can be explained in terms of their relationships with the latent variables. (26)

2.1.8 Semantic Differential Method (SD Method)

The semantic differential originated from the work of Charles Osgood in the 1950s as a technique for scaling people on their responses to pairs of bipolar adjectives in relation to concepts. It is a technique for measuring meaning that grew out of research at Dartmouth College in the late 1930's. Typically, a single word (or short phrase) is the construct of interest, and individuals help the researcher differentiate the meaning of that construct by responding to several pairs of bipolar adjectives which are scored on a continuum running from +X to -X or from X to X + Y (Likert style). In theory, each bipolar pair ("scale") can be represented by a straight-line ("semantic space"); several such pairs or scales form a multidimensional geometric space. Thus, when individuals respond to a set of pairs or scales as they rate a concept, those individuals are, in effect, differentiating the meaning of that concept in intensity (degree from the origin along each semantic space) and direction (positive or negative along each semantic space). The larger and more representative the sample, the more thoroughly that space is defined as whole; determination of the minimum number of orthogonal dimensions (or axes) which exhausts the dimensionality of the semantic space allows maximum efficiency in defining that semantic space.

The Semantic Differential (SD) measures people's reactions to stimulus words and concepts in terms of ratings on bipolar scales defined with contrasting adjectives at each end. An example of an SD scale is:

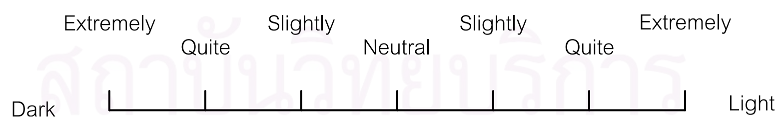


Figure 2-17 The example of a Semantic Differential (SD) scale.

Usually, the position marked 0 is labeled "neutral," the 1 positions are labeled "slightly," the 2 positions "quite," and the 3 positions "extremely." A scale like this is one measures directionality of a reaction (e.g., good versus bad) and also intensity (slight through extreme). Ratings are combined in various ways to describe and analyze the person's feelings. (27)

2.2 Literature Reviews

Harrington and Lechner (28) examined hypothesized existence of Color Language, one that anchored in color- emotion associations that carry specific meanings, is held by individuals and is used to communicate experience, brand images, new product positioning and so forth. US-based gender balanced subjects half of which were color professionals were given a questionnaire and asked for their associations. They found consistency of color-emotion associations across subjects with minor differences attributed to gender, age and professional background. Study results present initial yet promising support to the existence of Color Language and require a cross-culture expansion to determine the universality of this language.

Pos and Valentini (29) studied the colour association with seven basic emotions described by Ekman through an innovative procedure according to which 73 persons, young and aged had to paint, in a CRT monitor, the background of a face to visually fit the emotion it expressed. Result show a large 3D distributed of colours for each emotion. Happiness and surprise are significantly different from the other emotions on the basic of the L* a* b* attributes, being lighter, and happiness also yellower. Further significant differences are found, for instance between fear and the other dark emotions, being redder and bluer. Results, described as a function of the relative presence of the main hues and of the achromatic white gray and black in the chosen colours.

Nobbs et al. (30) studied about relationships between scales of emotion response and instrumental measures of colour. The results of studies of the “exciting-calming” emotion response from 54 observers to 42 simple, two-colour designs are reported. Studies of the response to designs with a central colour shape on a coloured background showed that the shape of the central colour area (circle, triangle and square) had only a slight influence on the number of “exciting” decisions. The colour of background had a strong influence on the number of “exciting” decisions. The relative area of the central shape to the background shape was found to have a modest influence on the observer responses. It is suggested that the visual contrast between the colour of the central shape and the colour of the background has a strong influence on the response of the observers.

Lee and Luo (31) studied on the mental image affected by colour and shape. A psychophysical experiment was carried out to assess 36 samples in terms of 20 image scales by a panel of 17 subjects All samples had three shapes (square, circle and triangle) and 12 colours. The principal component technique was used to categorize these scales into different components. It was found that many scales were categorized in the first component and is almost the same for all three shapes. The scales in each of the 3 components based upon square samples agreed exactly with the previous study. This implies the data are highly repeatable. The results also show that the preferred colours are highly associated with clean, round, modern and cool images. The subjects prefer light green and blue circle colours with a high contrast with background.

Cheng et al. (32) studied the corresponding feeling or emotion induced in the observers mind during the colour perception process is termed colour emotion. This study aims at evaluating the human colour emotion and quantifying the colour emotion with standard colour specifications. Since different culture 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 model using standard CIE colorimetric attributes. The similarity and difference towards colour emotion of male and female are studied and report in this study.

Sato et al. (33) performed a visual experiment to analysis quantitatively the feeling of color in term of colorimetric values. The visual experiment confirmed that the feeling was mainly affected by Munsell chroma and Munsell value. Finally, the empirical formulae were established to represent the feeling as following equation;

$$CI = [\{k_v(V-V_0)\}^2+\{k_c(C-C_0)\}^2]^{1/2}-k_s \qquad (2.8)$$

Where, CI is color image value

V is Munsell value

C is Munsell chroma

V_0 is Munsell value when the color image percent is minimum

C_0 is Munsell chroma when the color image percent is minimum

k_v is constant of the contribution of Munsell value for the color image

k_c is constant of the contribution of Munsell value for the color image

k_s is constant for the scaling of the color image

Sato et al. (34) tried to derive visual scales of psychological sensations described words, visual assessment tests against colour emotions express by twelve kinds of words pairs were carried out in Japan, Thailand, Hong Kong and UK. The numerical expression off each colour emotion has been tried as an equation with an ellipsoid-shape resembling that of a colour difference equation. The application of the empirical colour equation derived from sensory database was also tried.

Satake et al. (35) elucidate sensory words for describing automotive exterior colors in East Asia, the words chosen by about 300 observers were analyzed, The experiments were conducted at Kyoto Institute of Technology, Nippon paint Co., Hong Kong Polytechnic University, dong Hua University and Chulalongkorn University by using a set of questionnaire and 12 colors of painted panels. Prior to this experiment, they selected 31 words and 12 colors from 104b Color Chart producted by Japan Color Enterprise Co., Ltd., based on the results of like-dislike tests of 101 people in Hong Kong and Japan. These results were compiled from the subjects of from 19 to 67 years old. Distinctively, the emotion assessments that they conducted revealed that while “bright” and “light” are chosen in Japan as the sensory words of the impression induced by Light Green, “young” and “fresh” are selected in Hong Kong.

Yamaguchi et al. (36) investigated the use of kansei words for assessing colours of sportswear, and quantitatively analyzed colour emotion expressed by the kansei words. They also derived empirical formulae to express the colour emotions through an instrumental method. In this study they discussed about the application of the numerical expression, and also suggested an interface model for assisting the colour planning of the sportswear design assisted tool based on human colour emotion.

Ngampatipatpong (37) tried to link the gap between physical and perceptual color parameter by deriving the quantitative visual scale of the word which express human color perception which using the twelve opponent word pairs and relevant to colorimetric values. The derivation of the visual assessment and colorimetric values establishes the color perception equation as a general equation, which CP CIE L*, C*, h = [{k1(L*-L*0)}2 + {k2(C*-C*0)}2]1/2 - k3, where CP represents the color perception values. It can analyse the colorimetric characteristic of the visual scale in CIE L*, C*, h color space and then obtain the color perception map. This diagram determines the relationship between the twelve opponent word pairs. The results are found to divide the opponent word pairs into three groups which are dominated by chroma, lightness and hue, respectively. Moreover, it is possible to predict the color perception values using the empirical equation.

Stahre et al. (38) studied different of colour's appearance between a small colour chip and the same colour applied to a real room. The impression of the colour changes between these circumstances; e.g. on the chip it can be subdued, while it is perceived as striking in the room. The compare the results of a colour chip study, colour emotion, to Harleman's full-scale room study. In first study, textile chips were viewed against a gray background in a viewing cabinet. In the other study, two rooms were painted in 12 hues in two different nuances: NCS 1010 and NCS 1030. They correspond well to the hue areas and two of the studies. The two of the nuance categories used in the chip study. Semantic scaling was used in both studies. The two studies show a distinct difference between words associated to colours of the same nuance and colour category. A clear pattern could be seen. In the room, the colours were perceived as more distinct, stronger and they arouse much stronger emotions. Generally, a colour chip had to be much more colorful to give comparable associations.

Bangchokdee (39) studied the numerical expression of the color perception corresponding to twelve opponent words pairs through two-point and seven-point assessment carried out by Thai observers. The twelve color perception equations were derived from the relationship between the colorimetric values and visual assessments. The obtained visual results between methods and countries (Thailand-Japan) were compared by determining correlation coefficient and paired t-test I term of hue and tone.

There was a significant relationship between countries, with the exception of the “Deep-Pale”. Hue differences were found in “Warm-Cool”,”Deep-Pale” and “Striking-Subdued”. Tone differences tended to occur in all twelve tones.

Xin (40) evaluated the colour emotions, visual experiments were conducted in Hong Kong, Japan and Thailand using a set of 114 colour samples. The colour emotion results obtained from those regions were compared quantitatively to investigate the influence of cultural and geographical differences on them. In this study, twelve pairs of colour emotion described in opponent words. “warm-cool”, “light-dark”, “deep-pale”, “heavy-light”, “vivid-sombre”, “gaudy-plain”, ‘”strike-subdued”, “dynamic-passive”, “distinct-vague”, “transparent-turbid”, “soft-hard’ and ‘”strong-weak”. The influences of lightness and chorama were found to be much more important than that of the hue on the colour emotions studied.

Sueeprasan et al. (41) investigated color emotion of Thai on color combination. Thirty-four Thai observers assessed a set of 253 pairs color stimuli of PCCS made of two color combination by derived the quantitative visual scale using 14 opponent words pairs through the seven point method; “Dark-Light”, “Hard-Soft”, “Cool-Warm”, “Turbid-Transparent”, “Pale-Deep”, “Vague-Distinct”, “Light-Heavy”, “Sombre-Vivid”, “Weak-Strong”, “Passive-Dynamic”, “Plain-Gaudy”, “Subdued-Striking”, “Disharmony-Harmony” and “Dislike-like”. The experimental raw data were analyzed statistically to obtain visual scores for all of colour emotion scales investigated. The result was founded no simple correlation between colour sensations of two colour combinations and difference in lightness, chroma and hue. Additively relationship between single colour and two colour emotions was found and could be used to predict colour emotion for colour pair.

CHAPTER 3

METHODOLOGY

This section describes the material, apparatus and procedures used in the experiment.

3.1 Materials

3.1.1 PCCS color samples consisted of 5 hues, 4 tone and 3 achromatic colors. They were as follows;

5 hues : Red, Yellow, Green, Blue, Purple

4 tones : Vivid (v), Dull (d), Light (lt), Dark (dk)

3 achromatic : White, Medium Gray (5.5), Black

The dimension of color samples is 3 inches X 3 inches.

Figure3-1 PCCS color samples

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3.2 Apparatus

3.2.1 Standard light cabinet with illuminant D65 : GretagMacbeth The Judge III

3.2.2 Spectrophotometer: Minolta CM - 2600d (measurement apertures with Ø 8 mm, geometry d/8°, 360 to 740 nm wavelength range with 10 nm measurement intervals from xenon lamps, 10 degree observer conditions by performing SCE (Specular Excluded components) data simultaneously)

3.3 Observers

3.3.1 Japanese and Thai native speakers aged from 19 to 29.

(Visual assessment of Thais was investigated by Srimork (10), in 2003.)

3.3.2 The number of observers was 34 (male 17, female 17).

All observers passed pre-test using the Ishihara Test for detecting abnormal color vision to determine their qualification to participate in the visual assessment. (16)

3.4 Procedures

3.4.1 Measurement of color samples

These color samples were measured with the Minolta CM - 2600d under illuminant D65 with 10 degrees standard observer condition in terms of colorimetric values as L*, a*, b*, C^*_{ab} and h_{ab}. (see the data in Appendix A)

3.4.2 Arranging two color combination pairs from color samples

Twenty-three chips were combined for all possible combinations without repetition, when the order does not matter, but each object can be chosen only once. Therefore the total of two color combination pairs was 253 pairs.

3.4.3 Calculating color difference of color combination pairs

Each colorimetric value of two color combination were calculated in terms of color difference (ΔE^*_{ab}), lightness difference (ΔL^*), chroma difference (ΔC^*_{ab}) and hue difference (ΔH^*_{ab}). (see the data in Appendix A)

3.4.4 Visual assessment and analysis

3.4.4.1 Fourteen opponent word pairs translated in Japanese were "Dark-Light", "Hard-Soft", "Cool-Warm", "Turbid-Transparent", "Pale-Deep", "Vague-Distinct", "Light-Heavy", "Sombre-Vivid", "Weak-Strong", "Passive-Dynamic", "Plain-Gaudy", "Subdued-Striking", "Disharmony-Harmony" and "Dislike-like" (see Appendix C)

3.4.4.2 Each of the opponent ward pairs was divided into seven levels (+3 to -3), representing the magnitude of color sensation. The maximum value +3 was given to "Light", "Soft", "Warm", "Transparent", "Deep" ,"Distinct", "Heavy", "Vivid", "Strong", "Dynamic", "Gaudy", "Striking", "Harmony" and "Like". Each step was 1 point so that opposite numerical response was -3 for "Dark", "Hard", "Cool", "Turbid", "Pale", "Vague", "Light", "Sombre", "Weak", "Passive", "Plain", "Subdued", "Disharmony" and "Dislike", respectively, This process is called the seven-point method. (27)

3.4.4.3 The observers were asked to choose the magnitude of color sensation for each of the opponent word pairs when looking at the color samples under illuminant D65 in the light cabinet at approximated 45° to the normal with distance around 30 cm.

3.4.4.4 The visual scores were calculated from the answers of 34 observers as the percentage values ranging from +100% to -100% for each of the opponent word pairs. (see the data in Appendix B) The calculation percentage (VS%) is calculated as follows:

$$VS\% = \frac{a(-3)+b(-2)+c(-1)+d(0)+e(+1)+f(+2)+g(+3)}{3(a+b+c+d+e+f+g)} \times 100 \qquad (3.1)$$

Where a, b, c, d, e, f and g were the number of observers who chose -3, -2, -1, 0, 1, 2 and 3 respectively.

If all observers selects "very Vivid" (+3), VS% becomes equal to +100%. If all observers select "very Sombre" (-3), VS% becomes equal to -100%. If half of the observers select "very vivid" and the other half select "very Sombre" the percentage will be zero.

Similarly, the opponent word pairs of "Dark-Light", "Hard-Soft", "Cool-Warm", "Turbid-Transparent", "Pale-Deep", "Vague-Distinct", "Light-Heavy", "Sombre-Vivid", "Weak-Strong", "Passive-Dynamic", "Plain-Gaudy", "Subdued-Striking", "Disharmony-Harmony" and "Dislike-like" can be calculated.

3.4.4.5 Representing the relationship between the visual scores for each of fourteen opponent word pairs, and color difference (ΔE^*_{ab}), lightness difference (ΔL^*), chroma difference (ΔC^*_{ab}) and hue difference (ΔH^*_{ab}) respectively.

3.4.5 Extraction of Fourteen Opponent Word Pairs

Visual scores of fourteen opponent word pairs were extracted by the method of factor analysis with the extraction method of the principal component analysis and an orthogonal rotation. Factor analysis can be extracted by statistical software such as SPSS or SAS. This research used SPSS (Statistical Package for the Social Sciences) for the analysis.

3.4.6 Comparing the visual scores of fourteen opponent word pairs by Statistical Analysis

Visual assessment results from Thai and Japanese observers were compared by the Z-test and correlation coefficient to indicate the similarity or difference among them.

All the results from the visual assessment of fourteen opponent word pairs for Thai and Japanese observers were calculated and compared with one another to find out the relationship between two opponent word pairs.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Visual Assessment

Relationships between the visual results and the colorimetric values in based on color difference (ΔE^*_{ab}), lightness difference (ΔL^*), chroma difference (ΔC^*_{ab}) and hue difference (ΔH^*_{ab}) were established for "Dark-Light" (D-L), "Hard-Soft" (H-S), "Cool-Warm" (C-W), "Turbid-Transparent" (T-T), "Pale-Deep" (P-D), "Vague-Distinct" (V-D), "Light-Heavy" (L-H), "Sombre-Vivid" (S-V), "Weak-Strong" (W-S), "Passive-Dynamic" (P-Dy), "Plain-Gaudy" (P-G), "Subdued-Striking" (S-S), "Disharmony-Harmony" (DH-H) and "Dislike-like" (DL-L). The correlation coefficient values showed that there were no linear correlation between the visual scores and the colorimetric differences in a given pair. The results are shown in Table 4-1. The results from Japanese observers showed that "Vague-Distinct", "Sombre-Vivid", Passive-Dynamic", and "Plain-Gaudy" related to color difference values with moderate correlation coefficients of 0.56-0.68, and only "Subdued-Striking" related to color difference values with high correlation coefficient of 0.72. "Vague-Distinct" and "Subdued-Striking" related to lightness difference values with moderate correlation coefficients of 0.58 and 0.51 respectively. "Passive-Dynamic" related to hue difference values with moderate correlation coefficient of 0.51, while all opponent word sensation related to chroma difference values and hue differences with low correlation coefficients. This reveals that a colorimetric space between two color in a given pair cannot be used to predict color emotion for color combinations. The results from Thai observers showed that "Dark-Light", "Sombre-Vivid", "Subdued-Striking" and "Disharmony-Harmony" related to color difference with moderate correlation coefficients of 0.52-0.68. It was also found that color-sensation scales of Plain-Gaudy, Passive-Dynamic, and Vague-Distinct for Thai and "Subdued-Striking" for Japanese related to the color difference values with high correlation coefficients of 0.70-0.72.

Table 4-1 Correlation coefficients of visual assessment against colorimetric difference.

r	Japanese				Thai			
	deltaE*	deltaL*	deltaC*	deltaH*	deltaE*	deltaL*	deltaC*	deltaH*
D-L	0.48	0.18	0.29	0.33	0.53	0.37	0.36	0.23
H-S	0.04	-0.24	-0.01	0.19	-0.20	0.05	-0.16	-0.20
C-W	0.19	-0.13	0.08	0.27	0.42	0.04	0.41	0.29
T-T	0.48	0.29	0.28	0.26	0.41	0.28	0.31	0.18
P-D	0.14	0.24	0.08	-0.01	0.19	0.02	0.18	0.15
V-D	0.56	0.58	0.30	0.21	0.70	0.48	0.53	0.30
L-H	-0.21	0.02	-0.14	-0.19	0.01	-0.10	0.02	0.07
S-V	0.65	0.41	0.40	0.35	0.68	0.31	0.54	0.36
W-S	0.30	0.38	0.16	0.07	0.17	0.06	0.20	0.07
P-Dy	0.65	0.28	0.30	0.51	0.71	0.15	0.52	0.53
P-G	0.68	0.36	0.40	0.44	0.72	0.12	0.55	0.55
S-S	0.72	0.51	0.39	0.41	0.63	0.23	0.51	0.36
DH-H	-0.20	0.04	0.01	-0.32	-0.52	-0.02	-0.20	-0.57
DL-L	0.01	0.10	0.07	-0.10	-0.14	0.32	-0.05	-0.35

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In addition, it is interesting to classify the color combination pairs that have high visual score for each of sensation words from Thai and Japanese observers. The results are described and compared in Tables 4-2 to 4-15.

For "Dark-Light" (Table 4-2) it was found that color combination pairs that the observers judged as "Dark" can be divided into two groups. The first group contained pairs that were composed of black with dark, dull, or vivid tone color. It can be seen that only pairs combined from black and dark tone color were in this group for Thai results. The second group included pairs that were composed of dark tone color with dark, dull, or vivid tone color. The similar results between Thai and Japanese were found for pairs combined from dark with dark and dull with dark tone colors. On the other hand, color pairs that the observers judged as "Light" can be divided into three groups. The first group contained pairs that were composed of light tone color with vivid, or with light tone color. The second group included pairs that were composed of white with light, vivid, or dull tone color. The similar results between Thai and Japanese were found for pairs combined from white with light and vivid tone colors. The third group consisted of pairs that were composed of vivid tone color. The range of visual scores was from -73.53% to 86.27% and -85.29% to 83.33% for Japanese and Thai observers respectively.

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Table 4-2 The pair of tone color group from 15 color combination pairs that have high visual score of "Dark-Light"

Dark

Group	Tone pairs	JP	TH
1	dk-Bk	dk12-Bk	dk12-Bk
		dk18-Bk	dk18-Bk
		dk22-Bk	dk22-Bk
		dk2-Bk	dk2-Bk
		dk8-Bk	dk8-Bk
	d-Bk	d18-Bk	
		d22-Bk	
	v-Bk	v18-Bk	
		v22-Bk	
2	dk-dk	dk12-dk22	dk12-dk18
		dk18-dk22	dk12-dk22
		dk2-dk22	dk18-dk22
			dk2-dk18
			dk2-dk22
	d-dk	d18-dk18	d18-dk12
		d18-dk22	d18-dk18
			d22-dk12
			d22-dk18
			d22-dk22
	v-dk	v18-dk22	

Light

Group	Tone pairs	JP	TH
1	v-lt	v2-lt12	v12-lt8
		v2-lt18	v2-lt8
		v2-lt8	v8-lt2
		v8-lt12	v8-lt8
		v8-lt8	
	lt-lt	lt12-lt22	lt2-lt8
		lt2-lt8	lt8-lt12
		lt8-lt12	lt8-lt18
			lt8-lt22
2	lt-W	lt12-W	lt18-W
		lt8-W	lt22-W
			lt2-W
			lt8-W
	v-W	v2-W	v8-W
		v8-W	
	d-W	d12-W	
		d8-W	
3	v-v	v2-v8	v2-v8
			v8-v12

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For ”Hard-Soft” (Table 4-3) it was found that color combination pairs that the observers judged as “Hard” can be divided into four groups. The first group contained pairs that were composed of black with vivid, dark, dull, or light tone color. The similar results between Thai and Japanese were found for pairs combined from black with vivid and dark tone colors. The second group included pairs that were composed of dark tone color with vivid or with dark tone color. It can be seen that only pairs combined from black and vivid tone color were in this group for Japanese results. The third group consisted of pairs of vivid tone color with vivid, dull, or light tone color that only were in this group for Thai results. The forth group obtained pairs of achromatic colors that only were in this group for Japanese results. On the other hand, color pairs that the observers judged as “Soft” have only one group. The group contained pairs that were composed of light tone color with light, dull, vivid tone color, or white. The similar results between Thai and Japanese were found for pairs combined from light with light, dull tone colors and white. The range of visual scores obtained was from -57.84% to 73.53% and -61.76% to 79.41% for Japanese and Thai observers respectively.

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Table 4-3 The pair of tone color group from 15 color combination pairs that have high visual score of "Hard-Soft"

Hard			
Group	Tone pairs	JP	TH
1	v-Bk	v12-Bk	v22-Bk
		v18-Bk	v2-Bk
		v22-Bk	
		v2-Bk	
		v8-Bk	
	dk-Bk	dk18-Bk	dk2-Bk
		dk22-Bk	
	d-Bk	d12-Bk	
		d18-Bk	
		d8-Bk	
	lt-Bk	lt18-Bk	
		lt8-Bk	
2	v-dk	v18-dk22	v12-dk2
			v18-dk2
			v18-dk8
			v22-dk12
			v22-dk8
			v2-dk22
	dk-dk		dk2-dk22
3	v-v		v2-v18
			v2-v22
	v-d		v2-d12
			v2-d18
	v-lt		v2-lt18
4	achromatic	Gy5.5-Bk	
		W-Bk	

Soft			
Group	Tone pairs	JP	TH
1	lt-lt	lt12-lt18	lt12-lt18
		lt12-lt22	lt12-lt22
		lt18-lt22	lt18-lt22
		lt2-lt12	lt2-lt18
		lt2-lt18	lt2-lt8
		lt2-lt22	lt8-lt12
		lt2-lt8	lt8-lt18
		lt8-lt12	lt8-lt22
		lt8-lt22	
	lt-d	lt2-d12	lt12-d12
		lt8-d12	lt2-d2
			lt8-d8
	lt-W	lt2-W	lt12-W
			lt18-W
			lt22-W
			lt2-W
	v-lt	v2-lt2	
		v8-lt12	
		v8-lt2	

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For "Cool-Warm" (Table 4-4) it was found that color combination pairs that the observers judged as "Cool" can be divided into four groups. The first group contained pairs that were composed of dull tone color with dark, dull tone color, gray, or black. The similar results between Thai and Japanese were found for pairs combined from dull with dark tone color. The second group included pairs that were composed of dark tone color with gray, black, or white. It can be seen that only pairs combined from dark tone color with gray was in this group for Thai results. In opposite, only pairs combined from dark tone color with black and white were in this group for Japanese results. The third included pairs that were composed of vivid tone color with light, dull, dark tone color, black, or gray. The similar results between Thai and Japanese were found for pairs combined from vivid with light and dull tone color. The forth group was pairs that were composed of light tone color with light, dull, dark tone color, white, or black. The similar results between Thai and Japanese were found for pairs combined from light with dull and dark tone color. On the other hand, color pairs that the observers judged as "Warm" can be divided into three groups. The first group contained pairs that were composed of vivid tone color with light, vivid, dull, dark tone color, black, or gray. It can be seen that only pairs combined from vivid with light, vivid with vivid and dull tone color were in this group for Japanese results. The second group included pairs that were composed of light tone color with dull, light or dark tone color, and the third group consisted of pairs that were composed of dull tone color with dull or dark tone color that only were in this group for Japanese results. The range of visual scores was obtained from -60.78% to 70.59% and -69.61% to 79.41% for Japanese and Thai observers respectively.

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Table 4-4 The pair of tone color group from 15 color combination pairs that have high visual score of "Cool-Warm"

Cool

Group	Tone pairs	JP	TH
1	d-dk	d18-dk18	d12-dk12
		d18-dk22	d18-dk18
	d-d		d12-d18
	d-Gy	d18-Gy5.5	
	d-Bk	d18-Bk	
2	dk-Gy		dk12-Gy5.5
	dk-Bk	dk18-Bk	
	dk-W	dk18-W	
3	v-lt	v18-lt18	v18-lt18
	v-d	v18-d18	v12-d12
	v-dk	v18-dk18	
		v18-dk22	
	v-Bk	v18-Bk	
	v-Gy	v18-Gy5.5	
4	lt-lt		lt12-lt18
			lt18-lt22
			lt8-lt12
	lt-d	lt18-d18	lt12-d12
			lt18-d12
	lt-dk	lt18-dk18	lt12-dk12
	lt-W		lt12-W
			lt18-W
			lt22-W
	lt-Bk	lt18-Bk	

Warm

Group	Tone pairs	JP	TH
1	v-lt	v2-lt2	v2-lt18
		v2-lt8	v2-lt2
		v8-lt2	v2-lt22
			v2-lt8
	v-v	v2-v12	v2-v12
		v2-v8	v2-v18
			v2-v22
			v2-v8
	v-d	v2-d8	v2-d12
			v2-d2
			v2-d22
			v2-d8
	v-dk		v2-dk8
	v-Bk		v2-Bk
	v-Gy		v2-Gy5.5
2	lt-d	lt22-d2	
		lt2-d12	
		lt2-d2	
		lt2-d8	
	lt-lt	lt2-lt22	
		lt2-lt8	
	lt-dk	lt2-dk2	
3	d-d	d2-d8	
	d-dk	d2-dk2	

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For “Turbid-Transparent” (Table 4-5) it was found that color combination pairs that the observers judged as “Turbid” can be divided into two groups. The first group contained pairs that were composed of dull tone color with dark, dull tone color, black, or gray. The similar results between Thai and Japanese were found for pairs combined from dull with dark tone color. The second group included pairs that were composed of dark tone color with dark, black, or gray. The similar results between Thai and Japanese were found for pairs combined from dark with dark tone color and black. On the other hand, color pairs that the observers judged as “Transparent” can be divided into four groups. The first group contained pairs that were composed of vivid tone color with light, vivid tone color, or white. The similar results between Thai and Japanese were found for pairs combined from vivid with light tone color and white. The second group included pairs that were composed of light tone color with white or light tone color that all similar results between Thai and Japanese. The third and forth groups consisted of pairs that composed of dull tone color with white and pairs of achromatic colors respectively that only were in this group for Japanese results. The range of visual scores was obtained from -54.90% to 65.69% and -83.33% to 72.55% for Japanese and Thai observers respectively.

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Table 4-5 The pair of tone color group from 15 color combination pairs that have high visual score of "Turbid-Transparent"

Turbid			
Group	Tone pairs	JP	TH
1	d-dk	d18-dk2	d18-dk12
		d18-dk22	d18-dk18
		d18-dk8	d22-dk12
		d22-dk18	
		d22-dk8	
		d2-dk8	
		d8-dk22	
		d8-dk8	
	d-d	d18-d22	
	d-Bk		d22-Bk
	d-Gy		d18-Gy5.5
2			
	dk-dk	dk18-dk22	dk12-dk18
		dk2-dk22	dk12-dk22
		dk8-dk22	dk18-dk22
			dk2-dk18
			dk2-dk22
			dk8-dk22
	dk-Bk	dk2-Bk	dk12-Bk
		dk8-Bk	dk18-Bk
			dk22-Bk
			dk2-Bk
	dk-Gy	dk8-Gy5.5	

Transparent			
Group	Tone pairs	JP	TH
1	v-lt	v12-lt8	v8-lt12
		v2-lt18	v8-lt2
		v8-lt12	v8-lt8
		v8-lt18	
	v-W	v12-W	v12-W
		v18-W	v8-W
		v2-W	
		v8-W	
	v-v	v8-v18	
2			
	lt-W	lt18-W	lt12-W
		lt8-W	lt18-W
			lt2-W
			lt8-W
	lt-lt	lt8-lt18	lt12-lt18
			lt2-lt22
			lt2-lt8
			lt8-lt12
			lt8-lt18
			lt8-lt22
3			
	d-W	d12-W	
		d8-W	
4			
	achromatic	W-Bk	

For “Pale-Deep” (Table 4-6) it was found that color combination pairs that the observers judged as “Pale” have only one group. The group contained pairs that were composed of light tone color with light, dull, vivid tone color, gray, or white. The similar results between Thai and Japanese were found for pairs combined from light with light, dull tone color, and gray. On the other hand, color pairs that the observers judged as “Deep” can be divided into four groups. The first group contained pairs that were composed of dark with dark tone color or dark with black that all similar results between Thai and Japanese. The second group included pairs that were composed of vivid tone color with black, dull, dark, vivid tone color. The similar results between Thai and Japanese were found for pairs combined from vivid with vivid tone color and black. The third group consisted of pairs that were composed of dull tone color with black or dark tone color. It can be seen that only pairs combined from dull with dark tone color were in this group for Thai results. In opposite, only pairs combined from dull tone color with black were in this group for Japanese results. The forth group contained pairs of achromatic colors that only were in this group for Japanese results. The range of visual scores was obtained from -71.57% to 79.41% and -69.61% to 82.35% for Japanese and Thai observers respectively.

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Table 4-6 The pair of tone color group from 15 color combination pairs that have high visual score of "Pale-Deep"

Pale			
Group	Tone pairs	JP	TH
1	lt-lt	lt12-lt18	lt12-lt18
		lt12-lt22	lt12-lt22
		lt18-lt22	lt18-lt22
		lt2-lt12	lt2-lt18
		lt2-lt18	lt2-lt22
		lt2-lt22	lt8-lt12
		lt8-lt12	lt8-lt22
		lt8-lt22	
	lt-Gy	lt12-Gy5.5	lt18-Gy5.5
		lt18-Gy5.5	
		lt22-Gy5.5	
		lt2-Gy5.5	
	lt-d	lt18-d12	lt18-d8
		lt22-d12	lt22-d8
	lt-W		lt12-W
			lt18-W
			lt22-W
			lt8-W
	v-lt	v8-lt12	

Deep			
Group	Tone pairs	JP	TH
1	dk-Bk	dk12-Bk	dk18-Bk
		dk18-Bk	dk22-Bk
		dk22-Bk	dk2-Bk
		dk2-Bk	
	dk-dk	dk18-dk22	dk12-dk18
			dk18-dk22
			dk2-dk18
			dk2-dk22
2	v-Bk	v18-Bk	v18-Bk
		v22-Bk	v2-Bk
		v2-Bk	
		v8-Bk	
	v-d		v2-d22
	v-dk		v2-dk18
	v-v	v18-v22	v2-v18
		v2-v8	v2-v22
		v8-v18	
3	d-Bk	d12-Bk	
		d8-Bk	
	d-dk		d18-dk22
			d22-dk22
4	achromatic	W-Gy5.5	
		W-Bk	

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For “Vague-Distinct” (Table 4-7) it was found that color combination pairs that the observers judged as “Vague” can be divided into three groups. The first group contained pairs that were composed of light tone color with gray, light, or dull tone color. The similar results between Thai and Japanese were found for pairs combined from light with gray and light tone color. The second group included pairs that were composed of dull with dull, dark tone color, gray, or black. The similar results between Thai and Japanese were found for pairs combined from dull with dull, dark tone color, and gray. The third consisted of pairs that were composed of dark tone color with gray or dark tone color. The similar results between Thai and Japanese were found for pairs combined from dark tone color with gray. On the other hand, color pairs that the observers judged as “Distinct” can be divided into four groups. The first group contained pairs that were composed of vivid tone color with vivid, light, dark tone color, white, or black. The similar results between Thai and Japanese were found for pairs combined from vivid with vivid tone color, light tone color, white, and black. The second group included pairs that were composed of dull with white or black that only were in this group for Japanese results. The third group consisted of pair that was composed of dark tone color with white that only was in this group for Thai results. The forth group contained pair of achromatic that similar results between Thai and Japanese. The range of visual scores was obtained from -64.71% to 87.25% and -66.67% to 82.35% for Japanese and Thai observers respectively.

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Table 4-7 The pair of tone color group from 15 color combination pairs that have high visual score of "Vague-Distinct"

Vague			
Group	Tone pairs	JP	TH
1	lt-Gy	lt12-Gy5.5	lt22-Gy5.5
		lt18-Gy5.5	
		lt22-Gy5.5	
		lt2-Gy5.5	
		lt8-Gy5.5	
	lt-lt	lt18-lt22	lt12-lt22
		lt2-lt22	
	lt-d	lt18-d12	
		lt22-d12	
		lt22-d22	
		lt22-d8	
2	d-d	d8-d12	d18-d22
			d2-d12
			d2-d22
			d8-d12
	d-dk	d8-dk8	d18-dk12
			d22-dk12
			d22-dk8
	d-Gy	d2-Gy5.5	d12-Gy5.5
			d2-Gy5.5
			d8-Gy5.5
	d-Bk		d18-Bk
3	dk-Gy	dk8-Gy5.5	dk8-Gy5.5
	dk-dk		dk8-dk12

Distinct			
Group	Tone pairs	JP	TH
1	v-v	v2-v18	v2-v12
		v2-v8	v2-v18
		v8-v18	v2-v8
		v8-v22	v8-v12
			v8-v18
			v8-v22
	v-W	v12-W	v2-W
		v18-W	v8-W
		v22-W	
		v2-W	
	v-lt	v22-lt8	v12-lt8
		v2-lt8	v2-lt8
	v-Bk	v8-Bk	v12-Bk
			v8-Bk
	v-dk		v8-dk18
2	d-W	d12-W	
		d8-W	
	d-Bk	d12-Bk	
3	dk-W		dk2-W
4	achromatic	W-Bk	W-Bk

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For “Light-Heavy” (Table 4-8) it was found that color combination pairs that the observers judged as “Light” can be divided into two groups. The first group contained pairs that were composed of light tone color with light, dull, tone color, or white. The similar results between Thai and Japanese were found for pairs combined from light with light tone color, and white. The second group included pairs that were composed of vivid tone color with light tone color or white that only were in this group for Japanese results. On the other hand, color pairs that the observers judged as “Heavy” can be divided into five groups. The first group contained pairs that were composed of black with dark, vivid, or dull tone color. The similar results between Thai and Japanese were found for pairs combined from black with dark and vivid tone color. The second group included pairs that were composed of dark tone color with dark, dull, or vivid tone color that all similar results between Thai and Japanese. The third and forth groups contained pairs of dull tone color with gray and pairs of vivid tone color respectively that only were in this group for Thai results. The fifth group consisted of pair of achromatic colors that only was in this group for Japanese results. The range of visual scores was obtained from -70.59% to 85.29% and -73.53% to 75.49% for Japanese and Thai observers respectively.

Table 4-8 The pair of tone color group from 15 color combination pairs that have high visual score of "Light-Heavy"

Light			
Group	Tone pairs	JP	TH
1	lt-lt	lt12-lt18	lt12-lt18
		lt12-lt22	lt12-lt22
		lt18-lt22	lt18-lt22
		lt2-lt12	lt2-lt18
		lt2-lt22	lt2-lt22
		lt8-lt18	lt8-lt12
		lt8-lt22	lt8-lt18
			lt8-lt22
	lt-W	lt12-W	lt12-W
		lt8-W	lt18-W
			lt22-W
			lt2-W
			lt8-W
	lt-d		lt12-d12
			lt18-d8
2	v-lt	v8-lt12	
		v8-lt18	
		v8-lt2	
		v8-lt22	
		v8-lt8	
	v-W	v8-W	

Heavy			
Group	Tone pairs	JP	TH
1	dk-Bk	dk12-Bk	dk12-Bk
		dk18-Bk	dk18-Bk
		dk22-Bk	dk22-Bk
		dk2-Bk	dk2-Bk
		dk8-Bk	dk8-Bk
	v-Bk	v12-Bk	v18-Bk
		v18-Bk	v22-Bk
		v22-Bk	
	d-Bk	d18-Bk	
		d22-Bk	
2	dk-dk	dk18-dk22	dk18-dk22
		dk2-dk22	dk2-dk18
			dk2-dk22
			dk8-dk22
	d-dk	d18-dk22	d22-dk12
	v-dk	v22-dk18	v12-dk22
3	d-Gy		d18-Gy5.5
4	v-v		v2-v18
5	achromatic	Gy5.5-Bk	

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For “Sombre-Vivid” (Table 4-9) it was found that color combination pairs that the observers judged as “Sombre” can be divided into four groups. The first group contained pairs that were composed of dark tone color with dull, dark tone color, black, or gray. The similar results between Thai and Japanese were found for pairs combined from dark with dull, dark tone color, and black. The second group included pairs that were composed of dull tone color with dull tone color, gray, or black. The similar results between Thai and Japanese were found for pairs combined from dull with dull tone color and gray. The third group consisted of pairs that were composed of vivid tone color with dull tone that only were in this group for Japanese results. The forth group contained pair of achromatic that only was in this group for Thai results. On the other hand, color pairs that the observers judged as “Vivid” can be divided into three groups. The first group contained pairs that were composed of vivid tone color with vivid, light tone color, or white that all similar results between Thai and Japanese. The second group included pairs that were composed of white with dull tone color that only were in this group for Japanese results. The third group consisted of pair of light tone color with white that only was in this group for Thai results. The range of visual scores was obtained from -53.92% to 78.43% and -73.53% to 84.31% for Japanese and Thai observers respectively.

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Table 4-9 The pair of tone color group from 15 color combination pairs that have high visual score of "Sombre-Vivid"

Sombre			
Group	Tone pairs	JP	TH
1	d-dk	d12-dk8	d18-dk12
		d18-dk18	d22-dk12
		d18-dk8	d22-dk22
		d22-dk8	
		d2-dk8	
		d8-dk8	
	dk-dk	dk2-dk22	dk12-dk18
			dk18-dk22
			dk8-dk22
	dk-Bk	dk8-Bk	dk18-Bk
			dk22-Bk
			dk8-Bk
	dk-Gy	dk8-Gy5.5	
2	d-d	d18-d22	d2-d22
		d2-d22	d8-d12
	d-Gy	d18-Gy5.5	d12-Gy5.5
		d2-Gy5.5	d22-Gy5.5
	d-Bk		d18-Bk
3	v-d	v18-d22	
		v22-d22	
4	achromatic		Gy5.5-Bk

Vivid			
Group	Tone pairs	JP	TH
1	v-v	v2-v12	v2-v12
		v2-v18	v2-v8
		v2-v8	v8-v12
		v8-v12	v8-v18
		v8-v18	v8-v22
		v8-v22	
	v-lt	v2-lt18	v12-lt8
		v2-lt8	v2-lt2
			v2-lt8
			v8-lt18
			v8-lt2
			v8-lt8
	v-W	v12-W	v12-W
		v18-W	v2-W
		v22-W	v8-W
		v2-W	
		v8-W	
2	d-W	d12-W	
		d8-W	
3	lt-W		lt18-W

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For “Weak-Strong” (Table 4-10) it was found that color combination pairs that the observers judged as “Weak” can be divided into two groups. The first group contained pairs that were composed of light tone color with light, dull tone color, gray, or white. The similar results between Thai and Japanese were found for pairs combined from light with light, dull tone color, and gray. The second group included pair of vivid tone color with dull tone color that only was in this group for Japanese. On the other hand, color pairs that the observers judged as “Strong” can be divided into four groups. The first group contained pairs that were composed of vivid tone color with vivid, dark, dull, light tone color, black, or white. The similar results between Thai and Japanese were found for pairs combined from vivid with vivid, dark tone color, and black. The second group included pairs of dark tone color or dark tone color with black that only were in this group for Thai results. The third group consisted of pairs were composed of dull tone color with dark tone color, black, or gray. It can be seen that only pairs combined from dull with dark tone color and gray were in this group for Thai results. In opposite, only pair combined from dull with black was in this group for Japanese results. The forth group contained pair of light tone color with black that only was in this group for Japanese results. The range of visual scores was obtained from -49.02% to 81.37% and -64.71% to 73.53% for Japanese and Thai observers respectively.

Table 4-10 The pair of tone color group from 15 color combination pairs that have high visual score of "Weak-Strong"

Weak			
Group	Tone pairs	JP	TH
1	lt-lt	lt12-lt18	lt12-lt18
		lt12-lt22	lt12-lt22
		lt18-lt22	lt18-lt22
		lt2-lt22	lt2-lt12
			lt2-lt18
			lt8-lt12
			lt8-lt22
	lt-d	lt12-d12	lt2-d2
		lt12-d8	lt2-d22
		lt18-d12	
		lt18-d22	
		lt22-d12	
		lt2-d8	
	lt-Gy	lt12-Gy5.5	lt12-Gy5.5
		lt18-Gy5.5	lt18-Gy5.5
		lt22-Gy5.5	
		lt2-Gy5.5	
	lt-W		lt12-W
			lt22-W
			lt2-W
2			
	v-d	v12-d12	

Strong			
Group	Tone pairs	JP	TH
1	v-Bk	v18-Bk	v18-Bk
		v22-Bk	v22-Bk
		v8-Bk	v2-Bk
		v2-Bk	v8-Bk
	v-v	v2-v22	v2-v18
		v2-v8	v2-v8
		v8-v18	
		v8-v22	
	v-dk	v2-dk22	v22-dk18
			v2-dk18
	v-d		v2-d18
	v-lt	v2-lt8	
	v-W	v22-W	
2			
	dk-Bk		dk12-Bk
			dk18-Bk
			dk2-Bk
	dk-dk		dk2-dk18
3			
	d-dk		d18-dk18
	d-Bk	d12-Bk	
		d8-Bk	
	d-Gy		d18-Gy5.5
4			
	lt-Bk	lt8-Bk	

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For “Passive-Dynamic” (Table 4-11) it was found that color combination pairs that the observers judged as “Passive” can be divided into five groups. The first group contained pairs that were composed of dull tone color with dark, dull tone color, black, or gray. The similar results between Thai and Japanese were found for pairs combined from dull with dark tone color and gray. The second group included pairs that were composed of dark tone color with dark tone color, black, or gray that all similar results between Thai and Japanese. The third group consisted of pairs that were composed of achromatic colors. The forth group contained pairs that were composed of vivid tone color with dull, dark tone color or black that only were in this group for Japanese results. The fifth group included pairs that were composed of light tone color with dull, dark tone color or gray that only were in this group for Japanese results. On the other hand, color pairs that the observers judged as “Dynamic” can be divided into three groups. The first group contained pairs that were composed of vivid tone color with light, vivid, dull tone color or white that all similar results between Thai and Japanese. The second group included pairs that compose of white with dull tone color that only were in this group for Japanese results. The third group was pairs were composed of vivid tone color with dark tone color that only was in this group for Thai results. The range of visual scores was obtained from -57.84% to 77.45% and -69.61% to 80.39% for Japanese and Thai observers respectively.

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Table 4-11 The pair of tone color group from 15 color combination pairs that have high visual score of "Passive-Dynamic"

Passive			
Group	Tone pairs	JP	TH
1	d-dk	d18-dk18	d12-dk12
		d18-dk22	d18-dk18
			d18-dk22
			d22-dk18
	d-d	d18-d22	
	d-Bk	d18-Bk	
	d-Gy	d18-Gy5.5	d12-Gy5.5
			d22-Gy5.5
2	dk-Bk	dk18-Bk	dk12-Bk
		dk22-Bk	dk18-Bk
			dk22-Bk
			dk2-Bk
	dk-Gy		dk12-Gy5.5
			dk18-Gy5.5
	dk-dk		dk18-dk22
3	achromatic	W-Gy5.5	Gy5.5-Bk
			W-Gy5.5
4	v-Bk	v18-Bk	
		v22-Bk	
	v-d	v18-d18	
	v-dk	v18-dk18	
5	lt-d	lt18-d18	
	lt-dk	lt18-dk18	
	lt-Gy	lt18-Gy5.5	

Dynamic			
Group	Tone pairs	JP	TH
1	v-lt	v12-lt8	v12-lt8
		v18-lt8	v18-lt2
		v22-lt8	v2-lt18
		v2-lt12	v2-lt2
		v2-lt18	v2-lt22
		v2-lt8	v2-lt8
	v-v	v2-v12	v2-v12
		v2-v18	v2-v22
		v2-v8	v2-v8
		v8-v12	v8-v12
		v8-v22	v8-v18
			v8-v22
	v-d	v2-d12	v2-d22
	v-W	v2-W	v2-W
2	d-W	d12-W	
		d8-W	
3	v-dk		v8-dk2

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For “Plain-Gaudy” (Table 4-12) it was found that color combination pairs that the observers judged as “Plain” can be divided into three groups. The first group contained pairs that were composed of dull tone color with dark, dull, light tone color, gray, or black. The similar results between Thai and Japanese were found for pairs combined from dull with dark tone color, gray, and black. The second group included pairs that were composed of dark tone color with dark, vivid tone color, gray, or black. The similar results between Thai and Japanese were found for pairs combined from dark tone color with gray. The third consisted of pairs of achromatic colors that only were in this group for Thai results. On the other hand, color pairs that the observers judged as “Gaudy” can be divided into two groups. The first group contained pairs that were composed of vivid tone color with vivid, light, dark, dull tone color, white, or gray. The similar results between Thai and Japanese were found for pairs combined from vivid with vivid and light tone color. The second group included pairs of white with dull tone color that only were in this group for Japanese results. The range of visual scores was obtained from -63.73% to 87.25% and -67.65% to 88.24% for Japanese and Thai observers respectively.

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Table 4-12 The pair of tone color group from 15 color combination pairs that have high visual score of "Plain-Gaudy"

Plain			
Group	**Tone pairs**	**JP**	**TH**
1	d-dk	d12-dk8	d12-dk12
		d18-dk18	d18-dk12
		d18-dk22	d18-dk18
		d18-dk8	d18-dk22
		d8-dk8	
	d-Gy	d18-Gy5.5	d22-Gy5.5
		d2-Gy5.5	d8-Gy5.5
	d-Bk	d18-Bk	d18-Bk
		d22-dk8	
	d-d	d18-d22	
		d8-d22	
	lt-d		lt18-d18
			lt18-d8
2	dk-Gy	dk8-Gy5.5	dk12-Gy5.5
			dk18-Gy5.5
	dk-dk	dk18-dk22	
	dk-Bk		dk12-Bk
			dk18-Bk
	v-dk	v18-dk18	
		v18-dk22	
3	achromatic		Gy5.5-Bk
			W-Gy5.5

Gaudy			
Group	**Tone pairs**	**JP**	**TH**
1	v-v	v2-v12	v2-v12
		v2-v18	v2-v18
		v2-v22	v2-v22
		v2-v8	v2-v8
		v8-v12	v8-v12
		v8-v18	v8-v18
		v8-v22	v8-v22
	v-lt	v12-lt8	v12-lt8
		v22-lt8	v22-lt2
		v2-lt12	v2-lt22
		v2-lt18	v2-lt8
		v2-lt8	
	v-W	v2-W	
	v-dk		v2-dk12
			v2-dk8
	v-d		v2-d12
	v-Gy		v2-Gy5.5
2	d-W	d12-W	
		d8-W	

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For “Subdued-Striking” (Table 4-13) it was found that color combination pairs that the observers judged as “Subdued” can be divided into five groups. The first group contained pairs that were composed of dull tone color with dull tone color, gray, or black that all similar results between Thai and Japanese. The second group included pairs that were composed of dark tone color with dull, dark tone color, gray, or black that only were in this group for Japanese results. The third group consisted of pairs that were composed of light with light, dull tone color, gray, or white that only were in this group for Thai results. The forth group contained pairs that were composed of vivid tone color with dull tone color that only were in this group for Japanese results. The fifth group included pair of achromatic colors that only was in this group for Thai results. On the other hand, color pairs that the observers judged as “Striking” can be divided into four groups. The first group contained pairs that were composed of vivid tone color with vivid, light, dark, black, white, or gray. The similar results between Thai and Japanese were found for pairs combined from vivid with vivid, light tone color, black, and white. The second, third and forth groups included pairs that were composed of white with dull tone color, light tone color with black and achromatic colors respectively that only were in these group for Japanese results. The range of visual scores was obtained from -65.69% to 84.31% and -57.84% to 85.29% for Japanese and Thai observers respectively.

Table 4-13 The pair of tone color group from 15 color combination pairs that have high visual score of "Subdued-Striking"

Subdued			
Group	Tone pairs	JP	TH
1	d-Gy	d18-Gy5.5	d12-Gy5.5
		d2-Gy5.5	d22-Gy5.5
			d2-Gy5.5
			d8-Gy5.5
	d-d	d18-d22	d18-d22
			d8-d12
	d-Bk	d18-Bk	d18-Bk
2	d-dk	d12-dk8	
		d18-dk12	
		d18-dk18	
		d18-dk8	
		d22-dk18	
		d8-dk8	
	dk-dk	dk18-dk22	
	dk-Bk	dk18-Bk	
	dk-Gy	dk8-Gy5.5	
3	lt-lt		lt12-lt18
			lt12-lt22
	lt-Gy		lt12-Gy5.5
			lt22-Gy5.5
	lt-W		lt12-W
			lt22-W
	lt-d		lt18-d8
4	v-d	v18-d18	
		v18-d22	
5	achromatic		W-Gy5.5

Striking			
Group	Tone pairs	JP	TH
1	v-v	v2-v12	v2-v12
		v2-v18	v2-v18
		v2-v8	v2-v22
		v8-v18	v2-v8
		v8-v22	v8-v12
			v8-v18
			v8-v22
	v-lt	v12-lt8	v12-lt8
		v22-lt8	v22-lt2
		v2-lt18	v2-lt8
		v2-lt8	
	v-Bk	v8-Bk	v2-Bk
			v8-Bk
	v-W	v2-W	v2-W
	v-dk		v8-dk12
	v-Gy		v2-Gy5.5
2	d-W	d12-W	
		d8-W	
3	lt-Bk	lt8-Bk	
4	achromatic	W-Bk	

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For “Disharmony-Harmony” (Table 4-14) it was found that color combination pairs that the observers judged as “Disharmony” can be divided into two groups. The first group contained pairs that were composed of vivid tone color with dark, dull, light, vivid tone color, or black. The similar results between Thai and Japanese were found for pairs combined from vivid with dark and dull tone color. The second group included pairs that were composed of light tone color with dark or dull tone color. It can be seen that only pairs combined from light and dark tone color were in this group for Thai results. On the other hand, color pairs that the observers judged as “Harmony” can be divided into four groups. The first group contained pairs that were composed of vivid tone color with light tone color or with white. It can be seen that only pairs combined from vivid and dark tone color were in this group for Thai results. The second group included pairs that were composed of light tone color with dull, light, dark tone color, or white. The similar results between Thai and Japanese were found for pairs combined from light with dull, dark tone color, and white. The third group consisted of pairs were composed of dull tone color with dark tone color, and the forth group was pair of achromatic colors that similar results between Thai and Japanese. The range of visual scores was obtained from -41.18% to 73.53% and -68.63% to 82.35% for Japanese and Thai observers respectively.

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Table 4-14 The pair of tone color group from 15 color combination pairs that have high visual score of "Disharmony-Harmony"

Disharmony			
Group	Tone pairs	JP	TH
1	v-dk	v12-dk2	v18-dk2
		v12-dk8	v18-dk8
		v18-dk8	v22-dk8
		v22-dk8	v2-dk8
		v2-dk8	
	v-d	v12-d22	v2-d12
			v2-d18
			v2-d8
			v12-d2
			v12-d22
	v-lt		v12-lt22
			v2-lt12
	v-v		v2-v12
	v-Bk		v22-Bk
2	lt-dk	lt12-dk2	lt22-dk8
		lt12-dk8	lt2-dk8
		lt18-dk8	
		lt22-dk8	
		lt2-dk8	
	lt-d	lt12-d2	
		lt12-d8	
		lt18-d8	
		lt22-d8	

Harmony			
Group	Tone pairs	JP	TH
1	v-lt	v12-lt12	v18-lt18
		v18-lt18	v22-lt22
		v22-lt22	v8-lt8
		v2-lt2	
	v-W	v18-W	
2	lt-d	lt12-d12	lt12-d12
		lt18-d18	lt18-d18
		lt22-d22	lt22-d22
			lt2-d2
	lt-W	lt18-W	lt18-W
		lt2-W	
	lt-lt	lt2-lt22	
		lt8-lt12	
		lt8-lt18	
	lt-dk		lt18-dk18
			lt22-dk22
3	d-dk	d2-dk2	d12-dk12
			d18-dk18
			d22-dk22
			d8-dk8
4	achromatic	W-Bk	Gy5.5-Bk

For "Dislike-Like" (Table 4-15) it was found that color combination pairs that the observers judged as "Dislike" can be divided into three groups. The first group contained pairs that were composed of light with dark or dull tone color. It can be seen that only pairs combined from light and dark tone color were in this group for Thai results. The second group included pairs that were composed of vivid tone color with dark, dull, light tone color, black, or gray. The similar results between Thai and Japanese were found for pairs combined from vivid with dark and dull tone color. The third group consisted of pairs that were composed of dark tone color with dull tone color or white. It can be seen that only pairs combined from dull and dark tone color were in this group for Thai results. On the other hand, color pairs that the observers judged as "Like" can be divided into five groups. The first group contained pairs that were composed of light tone color with light, vivid, dull, dark tone color, or white that all similar between Thai and Japanese results. The second group included pair of vivid tone color with white. The third and forth groups consisted of pairs were composed of dull tone color with dark tone color and dark tone color with white respectively that have only Thai results. The fifth group was pair of achromatic colors that only was in this group for Japanese results. The range of visual scores was obtained from -36.27% to 48.04% and 67.65% to 77.45% for Japanese and Thai observers respectively.

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Table 4-15 The pair of tone color group from 15 color combination pairs that have high visual score of "Dislike-Like"

Dislike			
Group	Tone pairs	JP	TH
1	lt-dk	lt12-dk2	lt12-dk8
		lt12-dk8	lt2-dk8
		lt18-dk8	
		lt22-dk8	
		lt2-dk8	
	lt-d	lt12-d2	
		lt12-d8	
		lt22-d8	
2	v-dk	v12-dk8	v22-dk12
		v18-dk2	v22-dk8
		v22-dk8	v2-dk8
		v2-dk8	
	v-d	v12-d22	v12-d18
			v12-d2
			v12-d22
			v18-d2
			v2-d2
	v-lt		v12-lt22
			v2-lt12
	v-Bk		v22-Bk
	v-Gy		v12-Gy5.5
3	d-dk	d12-dk8	d18-dk8
	dk-W	dk8-W	

Like			
Group	Tone pairs	JP	TH
1	lt-lt	lt12-lt18	lt12-lt18
		lt18-lt22	lt2-lt18
		lt2-lt18	lt8-lt18
		lt8-lt12	lt8-lt22
		lt8-lt18	
	v-lt	v18-lt18	v18-lt18
		v22-lt22	v18-lt8
		v2-lt2	
	lt-d	lt18-d18	lt12-d12
		lt2-d12	lt18-d18
	lt-W	lt18-W	lt18-W
		lt2-W	lt22-W
	lt-dk	lt18-dk18	lt18-dk18
2	v-W	v18-W	v18-W
3	d-dk		d18-dk18
			d22-dk22
4	dk-W		dk18-W
5	achromatic	W-Bk	

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4.2 Comparison of the visual assessment of fourteen word pairs

The correlation coefficients of the relationship between the opponent words pairs were calculated (see the data in Appendix B). There are some cases that have high correlation between two sets of the visual scores of word pairs. The correlation coefficients for the relationship having the absolute value greater than 0.8 are shown in Table 4-16.

Table 4-16 The correlation coefficients of the relationship between the opponent word pairs which express absolute value of greater than 0.8.

Word pair	JP	TH
"Dark-Light" and "Turbid-Transparent"	0.84	0.92
"Dark-Light" and "Sombre-Vivid"		0.84
"Dark-Light" and "Light-Heavy"	-0.88	
"Hard-Soft" and "Light-Heavy"	-0.86	-0.85
"Hard-Soft" and "Pale-Deep"		-0.84
"Turbid-Transparent" and "Sombre-Vivid"	0.89	
"Turbid-Transparent" and "Plain-Gaudy"	0.83	
"Pale-Deep" and "Light-Heavy"	0.81	0.88
"Pale-Deep" and "Weak-Strong"	0.92	0.88
"Vague-Distinct" and "Weak-Strong"	0.87	
"Vague-Distinct" and "Sombre-Vivid"		0.86
"Light-Heavy" and "Weak-Strong"		0.86
"Sombre-Vivid" and "Plain-Gaudy"	0.92	
"Sombre-Vivid" and "Subdued-Striking"	0.91	0.82
"Passive-Dynamic" and "Plain-Gaudy"	0.89	0.91
"Passive-Dynamic" and "Subdued-Striking"	0.86	
"Plain-Gaudy" and "Subdued-Striking"	0.96	0.83
"Disharmony-Harmony" and "Dislike-Like"	0.90	

4.3 Extraction of Fourteen Opponent Word Pairs by Factor Analysis

In order to confirm the results from a correlation coefficient, Factor analysis was carried out to reduce a data set from a Factor of interrelated variables to a smaller number of not correlated factors. Factor analysis reveals underlying dimensions of all variables involved, and therefore more compact information can be achieved in the analysis and comparison. In this study, factor analysis was carried out to find such dimensions from the fourteen opponent word pairs for Japanese and Thai observers. The extraction method of principal factor analysis and a varimax rotation were used. The rotated factor loadings and communality for each variable for Japanese observers are shown in Table 4-17.

Table 4-17 Rotated Factor Loadings and Communalities of visual scores for Japanese observers.

Variable	Varimax Rotation				Communality
	Factor1	Factor2	Factor3	Factor4	
D-L	-0.89	-0.35	-0.07	0.19	0.96
H-S	-0.53	-0.80	-0.11	-0.18	0.96
C-W	-0.50	-0.41	-0.46	-0.59	0.97
T-T	-0.93	0.05	0.22	0.24	0.96
P-D	0.22	0.93	-0.09	-0.19	0.96
V-D	-0.43	0.87	-0.09	0.10	0.95
L-H	0.67	0.69	-0.06	-0.22	0.97
S-V	-0.88	0.39	0.05	0.18	0.96
W-S	-0.07	0.98	-0.05	-0.11	0.97
P-Dy	-0.82	0.20	-0.43	-0.24	0.95
P-G	-0.94	0.24	-0.18	0.02	0.96
S-S	-0.88	0.36	-0.19	0.07	0.95
DH-H	-0.41	0.07	0.81	-0.35	0.96
DL-L	-0.57	0.08	0.76	-0.21	0.95
Variance	6.47	4.37	1.79	0.83	13.47
% Var	0.46	0.31	0.13	0.06	0.96

The forth factor could be removed since it only represents 6% of total variance. The first three factors accounted for 90% of total variance, were considered to be sufficient in representing the 14 emotion variables with little information loss. The Factor1 and Factor2 were the most important ones, as accounted for 46% and 31% of total variance, respectively. Factor3 only accounted for 13%. Thus, the color sensation could be categorized as Factor 1, 2, and 3 respectively.

R-square or the correlation coefficients between visual score and factor score obtained from Japanese observers are shown in Table 4-18. Subdued-Striking, Sombre-Vivid, Plain-Gaudy, Turbid-Transparent, Passive-Dynamic, and Dark-Light color sensation were mostly influenced by Factor1 with the R^2 of 0.89, 0.88, 0.87, 0.72, 0.61 and 0.55 respectively. Factor2 related to Pale-Deep, Weak-Strong, Light-Heavy and Hard-Soft with the R^2 of 0.95, 0.85, 0.76 and 0.68 respectively. Vague-Distinct sensation equally related to the first two factors with the R^2 of 0.49 and 0.47 respectively. Factor3 influenced to Dislike-Like and Disharmony-Harmony color sensation with the R^2 of 0.85 and 0.95 respectively. Note that Cool-Warm color sensation showed no correlation with others.

Table 4-18 R-square values between visual scores and factor score for Japanese observers.

R-square	S-S	S-V	P-G	T-T	P-Dy	D-L	V-D
Factor 1	**0.89**	**0.88**	**0.87**	**0.72**	**0.61**	**0.55**	**0.49**
Factor 2	0.01	0.01	0.00	0.07	0.00	0.36	**0.47**
Factor 3	0.01	0.07	0.02	0.16	0.00	0.02	0.00

R-square	C-W	DH-H	DL-L	P-D	W-S	L-H	H-S
Factor 1	0.04	0.01	0.01	0.03	0.11	0.18	0.00
Factor 2	0.11	0.00	0.00	**0.95**	**0.85**	**0.76**	**0.68**
Factor 3	0.00	**0.95**	**0.85**	0.00	0.00	0.02	0.01

The extraction methods of principal factor analysis and a varimax rotation were used. The rotated factor loadings and communality for each variable for Thai observers are shown in Table 4-19. The forth factor could be removed since it only represents 1% of total variance.

The first three factors accounted for 84% of total variance, were considered to be sufficient in representing the 14 emotion variables with little information loss. The Factor1 and Factor2 were the most important ones, as accounted for 36% and 33% of total variance, respectively. Factor3 only accounted for 15%. Thus, the color sensation could be categorized as Factor 1, 2, and 3 respectively.

Table 4-19 Rotated Factor Loadings and Communalities of visual scores for Thai observers.

Variable	Varimax Rotation				
	Factor1	Factor2	Factor3	Factor4	Communality
D-L	0.77	-0.59	0.04	-0.06	0.94
H-S	-0.02	-0.85	0.39	0.16	0.90
C-W	0.39	0.23	-0.19	-0.83	0.94
T-T	0.68	-0.67	0.14	0.01	0.94
P-D	0.14	0.95	-0.09	-0.10	0.94
V-D	0.95	0.14	0.05	-0.03	0.93
L-H	-0.16	0.94	-0.15	-0.13	0.94
S-V	0.94	-0.20	0.08	-0.13	0.95
W-S	0.12	0.95	0.03	-0.01	0.91
P-Dy	0.78	-0.02	-0.22	-0.51	0.92
P-G	0.78	0.18	-0.28	-0.46	0.92
S-S	0.80	0.46	-0.11	-0.21	0.91
DH-H	-0.22	-0.12	0.93	0.03	0.93
DL-L	0.18	-0.19	0.89	0.22	0.92
Variance	4.99	4.60	2.05	1.34	12.99
% Var	0.36	0.33	0.15	0.10	0.93

R-square or the correlation coefficients between visual score and factor score obtained from Thai observers are shown in Table 4-20. Vague-Distinct, Sombre-Vivid, Subdued-Striking, Passive-Dynamic, Plain-Gaudy, and Dark-Light color sensation were mostly influenced by Factor1 with the R^2 of 0.90, 0.89, 0.64, 0.61, 0.60 and 0.59 respectively.

Factor2 related to Light-Heavy, Weak-Strong, Pale-Deep, and Hard-Soft equally related to the first two factors with the R^2 of 0.90, 0.90, 0.88 and 0.70 respectively. Turbid-Transparent color sensation equally related to the first two factors with the R^2 of 0.47 and 0.45 respectively. Factor3 influenced to Dislike-Like and Disharmony-Harmony color sensation with the R^2 of 0.85 and 0.95 respectively. Note that Cool-Warm color sensation showed no correlation with others same as result of Japanese observers.

Table 4-20 R-square values between visual scores and factor score for Thai observers.

R-square	V-D	S-V	S-S	P-Dy	P-G	D-L	T-T
Factor 1	**0.90**	**0.89**	**0.64**	**0.61**	**0.60**	**0.59**	**0.47**
Factor 2	0.02	0.04	0.21	0.00	0.03	0.35	**0.45**
Factor 3	0.00	0.00	0.45	0.05	0.08	0.00	0.02

R-square	C-W	DH-H	DL-L	W-S	P-D	L-H	H-S
Factor 1	0.15	0.05	0.03	0.02	0.02	0.02	0.00
Factor 2	0.05	0.01	0.04	**0.90**	**0.90**	**0.88**	**0.70**
Factor 3	0.04	**0.86**	**0.80**	0.00	0.00	0.02	0.15

The result of extraction by using the factor and R-square values showed that most color sensation between Japanese and Thai observers were based on the same factor. Sombre-Vivid, “Subdued-Striking”, “Plain-Gaudy”, “Passive-Dynamic”, “Vague-Distinct”, and “Dark-light” had high factor scores and R^2 values in Factor1 for both Thais and Japanese. “Vague-Distinct” sensations of Thai observers related to Factor1, but equally related to the first two factors for Japanese observers. “Pale-Deep”, “Weak-Strong”, “Hard-Soft”, “Light-Heavy” and ”Vague-Distinct” had high factor scores and R^2 values in Factor2, as well as Turbid-Transparent” sensations for Japanese observers related to in Factor1, but equally related to the first two factors for Thai observers. “Dislike-Like” and “Disharmony-Harmony” for Thai and Japanese observers had a high correlation with Factor 3. Likewise the result of Japanese observes “Cool-Warm” showed that no correlation with others as same as the result of Thai observers. From the extraction result seem that there was a little difference of color sensation among Thai and Japanese observers.

4.4 Comparison of the visual assessment of fourteen opponent word pairs by Statistical Analysis

The comparison of the color combination sensation results between Thai and Japanese was analyzed and compared the similarity or difference in color sensations between two cultures. This was done to evaluate quantitatively the Thai and Japanese color preference and sensation induced by two color combination.

In order to analyze these results from a statistical point of view, a paired Z-test for comparison of means was conducted. The paired Z-test (Paired-Sample t-test in case of n>100) was used to indicate the similarity or difference. The visual results among Thai and Japanese observers were compared by a paired t- test using SPSS. The hypotheses were

$H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

Where H_0 the population means are equal, H_1 the population means are different.

The null hypothesis, H_0 will be accepted at the 0.05 level of significance with a 95% confidence when -1.96 $\geq$ critical t-value $\leq$+1.96, or the calculated t-value is equal or lower than the critical t-value at the 0.05 level of significance, then the color sensation of two regions is considered as accept null hypothesis "no significant difference", while if the critical t-value is upper than the critical judged as reject null hypothesis and accept alternate hypothesis, or -1.96 >critical t-value <+1.96. It means that the difference is significant.

The results of hypothesis test by paired Z-test concerning mean are shown in Table 4-21. The table shows that "Hard-Soft", "Cool"-Warm", "Turbid-Transparent", "Weak-Strong", "Pale-Deep", "Subdued-Striking", "Light-Heavy", "Passive-Dynamic" "Disharmony-Harmony", "Plain-Gaudy" and "Dislike-Like" were found significant differences, while only three pairs of opponent sensation word "Dark-Light", "Vague-Distinct", and "Sombre-Vivid" have no significant difference, t-values were 1.166, -1.905 and 0.864 respectively.

Table 4.21 The results from a statistical analysis, a paired Z- test

Color sensation Pairs	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Dark-Light	1.65853	22.62113	1.42218	-1.14234	4.45940	1.166	252	0.245
Hard-Soft	12.23746	31.55264	1.98370	8.33073	16.14420	6.169	252	0.000
Cool-Warm	12.42194	31.36164	1.97169	8.53885	16.30503	6.300	252	0.000
Turbid-Transparent	7.17275	23.03952	1.44848	4.32008	10.02542	4.952	252	0.000
Pale-Deep	-12.02046	23.57531	1.48217	-14.93947	-9.10145	-8.110	252	0.000
Vague-Distinct	-3.45269	28.83004	1.81253	-7.02232	0.11695	-1.905	252	0.058
Light-Heavy	-4.28054	23.06931	1.45036	-7.13690	-1.42418	-2.951	252	0.003
Sombre-Vivid	1.24695	22.95691	1.44329	-1.59550	4.08939	0.864	252	0.388
Weak-Strong	6.65349	25.32947	1.59245	3.51728	9.78970	4.178	252	0.000
Passive-Dynamic	-5.04534	23.36557	1.46898	-7.93838	-2.15229	-3.435	252	0.001
Plain-Gaudy	-4.63458	29.00106	1.82328	-8.22539	-1.04377	-2.542	252	0.012
Subdued-Striking	-13.10548	31.60818	1.98719	-17.01909	-9.19186	-6.595	252	0.000
Disharmony-Harmony	13.08223	25.82210	1.62342	9.88503	16.27943	8.058	252	0.000
Dislike-Like	3.49919	22.55088	1.41776	0.70701	6.29136	2.468	252	0.014

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CHAPTER 5

CONCLUSION

The visual scores for each of the color-sensation scales from Japanese observers were plotted against the values of color difference (ΔE^*_{ab}), lightness difference (ΔL^*), chroma difference (ΔC^*_{ab}), and hue difference (ΔH^*_{ab}) between two colors of a given pair. It was found that "Vague-Distinct", "Sombre-Vivid", Passive-Dynamic", and "Plain-Gaudy" related to color difference values with moderate correlation coefficient of 0.56-0.68, and only "Subdued-Striking" related to color difference values with high correlation coefficient of 0.72. "Vague-Distinct" and "Subdued-Striking" related to lightness difference values with moderate correlation coefficients of 0.58 and 0.51 respectively. "Passive-Dynamic" related to hue difference values with moderate correlation coefficient of 0.51, while all opponent words sensation related to chroma difference values and hue difference with low correlation coefficient. These results signify that a colorimetric space between two color in a given pair cannot be used to predict color emotion on color combination. The results from Thai observers showed that "Dark-Light", "Sombre-Vivid", "Subdued-Striking" and "Disharmony-Harmony" related to color difference with moderate correlation coefficients of 0.52-0.68. However, it may be possible to predict the color-sensation scales of Plain-Gaudy, Passive-Dynamic, and Vague-Distinct for Thai and "Subdued-Striking" for Japanese from color difference values as it was found that they related to the color difference values with high correlation coefficients of 0.70-0.72.

The correlation coefficients of the relationship between the opponent word pairs were calculated. There are some cases that have high correlation between two sets of the visual scores of word pairs from the result of Thai and Japanese observers. The correlation coefficients have the absolute value of greater than 0.8. The results of factor analysis from the fourteen opponent word pairs for Japanese observers showed that the forth factor could be removed since it only represented 6% of total variance.The first three factors accounted for 90% of total variance. The Factor1 and Factor2 were the most important ones, as accounted for 46% and 31% of total variance, respectively. Factor3 only accounted for 13%. The results for Thai observers showed that the forth factor could be removed since it only represents 1% of total variance. The first three factors accounted for 84% of total variance. The Factor1 and Factor2 were the most important ones, as accounted for 36% and 33% of total variance, respectively. Factor3 only accounted for 15%. Thus, the color sensation of Thai and Japanese observers could be categorized as factor 1, 2, and 3 respectively.

R-square or the coefficient of determination confirmed the results of extraction by factor analysis. Sombre-Vivid, Subdued-Striking, Plain-Gaudy, Turbid-Transparent, Passive-Dynamic, and Dark-Light color sensation were mostly influenced by Factor1. Factor2 related to Pale-Deep, Weak-Strong, Light-Heavy and Hard-Soft. Vague-Distinct sensation equally related to the first two factors respectively. Factor3 influenced to Dislike-Like and Disharmony-Harmony color sensation. Cool-Warm color sensation showed no correlation with others for Japanese observers. The results for Thai observers; Vague-Distinct, Sombre-Vivid, Subdued-Striking, Passive-Dynamic, Plain-Gaudy, and Dark-Light color sensation were mostly influenced by Factor1. Factor2 related to Light-Heavy, Weak-Strong, Pale-Deep, and Hard-Soft. Turbid-Transparent color sensation equally related to the first two factors respectively. Factor3 influenced to Dislike-Like and Disharmony-Harmony color sensation. Note that Cool-Warm color sensation showed no correlation with others same as result of Japanese observers.

From the results of the paired Z- test with the critical t-value at the 0.05 level of significance, the visual scores between Thai and Japanese for “Hard-Soft”, “Cool”-Warm”, “Turbid-Transparent”, “Weak-Strong”, “Pale-Deep”, “Subdued-Striking”, “Light-Heavy”, “Passive-Dynamic” “Disharmony-Harmony”, “Plain-Gaudy” and “Dislike-Like” were found to be significantly different, while only three pairs of opponent sensation words “Dark-Light”, “Vague-Distinct”, and “Sombre-Vivid” had no significant difference. So, these three sensations on color combinations were similar between Thai and Japanese.

The Suggestion

This thesis reveals the relationships between Thai and Japanese sensation on color combinations. It should be investigated in a large amount of regions. Moreover, it is interesting to carry out further research on various conditions, for example, sample materials, light sources, color system, words or languages, observer's age, observers regions, and observer's education. It is interesting and very useful to investigate the difference and similarity between different regions on color emotion. The study may enable designers to easily select suitable colors for customers with different culture. In addition, the study should be extended to three or four color combinations and other color combination attributes and established to derive the color combination equations. At present, appropriate color selection is not only useful for color planning but also useful for color communication through network. So, the color emotion on color combination should be studied and transformed to represent on the monitor. The future research in this area should apply the obtained results to graphic design, interior architecture and packaging etc. These studies can be used as a basis for the determination of local consumers' emotion on color combination to support color planning in the industrial design field.

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APPENDICES

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APPENDIX A

COLORIMETRIC VALUES AND COLOR DIFFERENCE ON CIEL*a*b* AND CIEL*C*h COLOR SPACE, CORRELATION COEFFICIENTD OF VISUAL ASSESSMENT AGAINST COLORIMETRIC DIFFERENCE

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Table A-1 Colorimetric values of color samples in Japanese visual assessment.

Color Samples	Colorimetric				
	L*	a*	b*	C*	h
v2	51.61	61.88	17.65	64.35	10.92
v8	84.85	3.96	78.67	78.77	85.14
v12	58.79	-49.22	24.38	54.92	155.20
v18	45.80	-3.52	-38.15	38.31	266.17
v22	42.88	28.10	-28.56	40.07	310.87
lt2	73.22	32.70	12.63	35.05	17.59
lt8	87.89	1.47	52.59	52.61	87.74
lt12	77.15	-27.13	15.06	31.03	152.35
lt18	69.30	-8.01	-22.08	23.49	252.45
lt22	69.32	16.50	-14.23	21.79	318.66
d2	52.10	24.11	10.12	26.15	18.96
d8	61.81	4.56	35.20	35.50	79.91
d12	57.73	-18.98	10.20	21.55	152.97
d18	43.59	-4.13	-15.06	15.62	256.44
d22	45.22	12.68	-8.96	15.53	324.58
dk2	37.65	23.14	3.72	23.44	7.73
dk8	47.90	2.17	29.60	29.68	84.25
dk12	40.88	-17.35	8.11	19.15	155.87
dk18	35.14	-4.46	-15.37	16.01	256.09
dk22	32.91	11.05	-8.88	14.18	320.67
W	93.96	1.87	-1.37	2.32	324.60
Gy5.5	59.32	-1.18	2.05	2.37	120.93
Bk	28.41	0.15	-0.50	0.53	287.15

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Table A-2 Colorimetric values of color samples in Thai visual assessment.

Color samples	Colorimetric				
	L*	a*	b*	C*	h
v2	48.60	62.91	17.90	65.41	15.88
v8	82.68	6.28	83.92	84.15	85.72
v12	58.88	-50.20	25.74	56.41	152.85
v18	45.52	-3.71	-39.42	39.59	264.62
v22	42.04	26.05	-29.42	39.30	311.52
lt2	74.01	30.63	10.97	32.54	19.70
lt8	87.27	1.76	49.29	49.32	87.96
lt12	77.52	-25.40	15.39	29.70	148.79
lt18	68.44	-8.53	-21.76	23.37	248.59
lt22	69.55	15.84	-12.25	20.02	322.28
d2	52.11	23.53	9.36	25.32	21.69
d8	62.05	4.20	34.34	34.60	83.03
d12	53.62	-20.80	12.80	24.42	148.39
d18	39.37	-5.16	-14.85	15.72	250.84
d22	40.61	11.85	-9.77	15.36	320.50
dk2	33.08	22.93	3.87	23.25	9.58
dk8	46.53	2.20	32.26	32.33	86.10
dk12	38.95	-18.50	9.73	20.90	152.26
dk18	30.42	-5.29	-15.71	16.58	251.39
dk22	28.43	10.57	-9.54	14.24	317.93
W	93.25	1.10	-0.86	1.40	321.98
Gy5.5	55.85	-1.41	2.10	2.53	123.88
Bk	22.37	-0.68	-0.99	1.20	304.48

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Table A-3 Color difference of color combination pairs in Japanese visual assessment.

DE*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	90.47																						
v12	111.53	80.34																					
v18	86.17	123.41	78.53																				
v22	57.90	117.66	95.04	33.17																			
lt2	36.66	72.96	84.00	68.13	51.35																		
lt8	78.66	26.38	64.90	100.15	96.54	52.80																	
lt12	92.64	71.22	30.20	66.12	78.27	60.00	48.39																
lt18	82.32	102.65	62.98	28.82	45.21	53.64	77.53	42.50															
lt22	58.22	95.03	76.95	39.07	32.23	31.60	70.97	53.13	25.74														
d2	38.51	78.61	75.00	55.97	39.96	22.93	59.98	57.25	48.62	30.78													
d8	60.81	49.21	54.94	75.51	70.55	37.84	31.50	40.56	59.12	51.41	33.26												
d12	81.44	77.14	33.41	52.14	62.76	54.01	55.91	21.62	36.00	44.62	43.46	34.58											
d18	74.11	102.74	61.80	23.20	34.95	54.78	81.06	50.62	26.93	32.99	38.78	54.17	32.54										
d22	56.30	96.58	71.60	33.39	25.05	40.63	75.73	56.40	34.35	24.96	23.28	47.87	39.06	17.96									
dk2	43.47	90.63	78.16	50.30	33.08	37.89	73.36	64.93	51.36	37.01	15.83	43.82	47.11	33.64	18.10								
dk8	61.01	61.46	52.79	68.02	63.88	43.14	46.14	43.88	56.85	50.85	29.65	15.19	30.34	45.31	40.06	34.85							
dk12	80.52	85.83	40.01	48.53	58.43	59.75	67.40	38.20	42.50	49.54	43.00	40.64	17.05	26.82	34.82	40.86	29.86						
dk18	75.92	106.71	64.36	25.16	35.98	60.12	86.24	56.61	34.99	40.11	41.88	57.88	37.08	8.46	20.89	33.66	47.21	27.39					
dk22	60.30	102.04	73.54	35.15	27.88	50.55	83.02	63.15	43.14	37.20	29.99	53.10	43.38	19.56	12.42	18.09	42.24	34.04	16.97				
W	75.87	80.59	67.16	60.84	63.53	39.71	54.31	37.33	33.69	31.41	48.78	48.78	43.38	52.55	50.50	60.41	55.51	57.24	60.79	62.19			
Gy5.5	65.41	80.93	52.98	42.48	45.44	38.11	58.12	34.07	26.99	26.04	27.51	33.73	19.65	23.44	22.63	32.61	30.01	25.26	29.98	31.09	34.95		
Bk	68.40	97.31	63.09	41.63	42.16	56.92	79.75	57.99	46.95	46.15	35.33	49.09	36.61	21.47	22.61	25.13	35.92	23.16	16.97	14.46	65.58	31.05	

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Table A-4 Lightness difference of color combination pairs in Japanese visual assessment.

DL*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	33.24																						
v12	7.18	26.06																					
v18	5.81	39.06	13.00																				
v22	8.73	41.97	15.91	2.91																			
lt2	21.61	11.64	14.42	27.42	30.33																		
lt8	36.28	3.04	29.10	42.10	45.01	14.68																	
lt12	25.54	7.70	18.36	31.36	34.27	3.94	10.74																
lt18	17.69	15.56	10.50	23.50	26.41	3.92	18.60	7.86															
lt22	17.71	15.53	10.53	23.52	26.44	3.90	18.57	7.83	0.02														
d2	0.49	32.75	6.69	6.31	9.22	21.11	35.79	25.05	17.19	17.22													
d8	10.20	23.05	3.01	16.01	18.92	11.41	26.09	15.35	7.49	7.51	9.70												
d12	6.12	27.13	1.07	11.93	14.84	15.49	30.17	19.43	11.57	11.59	5.62	4.08											
d18	8.02	41.27	15.21	2.21	0.70	29.63	44.31	33.57	25.71	25.73	8.52	18.22	14.14										
d22	6.39	39.63	13.57	0.57	2.34	27.99	42.67	31.93	24.07	24.10	6.88	16.58	12.50	1.64									
dk2	13.96	47.20	21.14	8.15	5.23	35.57	50.24	39.50	31.65	31.67	14.45	24.16	20.08	5.94	7.57								
dk8	3.71	36.96	10.90	2.10	5.01	25.32	40.00	29.26	21.40	21.42	4.21	13.91	9.83	4.31	2.67	10.25							
dk12	10.73	43.97	17.91	4.91	2.00	32.33	47.01	36.27	28.41	28.44	11.22	20.92	16.84	2.70	4.34	3.23	7.01						
dk18	16.47	49.71	23.65	10.65	7.74	38.07	52.75	42.01	34.15	34.18	16.96	26.66	22.58	8.44	10.08	2.51	12.75	5.74					
dk22	18.70	51.94	25.88	12.88	9.97	40.30	54.98	44.24	36.38	36.41	19.19	28.89	24.81	10.67	12.31	4.74	14.98	7.97	2.23				
W	42.35	9.11	35.17	48.17	51.08	20.75	6.07	16.81	24.67	24.64	41.86	32.16	36.24	50.38	48.74	56.31	46.07	53.08	58.82	61.05			
Gy5.5	7.71	25.53	0.53	13.52	16.44	13.90	28.57	17.83	9.98	10.00	7.22	2.49	1.59	15.73	14.10	21.67	11.42	18.44	24.18	26.41	34.64		
Bk	23.20	56.45	30.39	17.39	14.48	44.81	59.49	48.75	40.89	40.91	23.70	33.40	29.32	15.18	16.82	9.24	19.49	12.48	6.74	4.51	65.56	30.91	

Table A-5 Chroma difference of color combination pairs in Japanese visual assessment.

DC*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	14.42																						
v12	9.43	23.85																					
v18	26.04	40.46	16.61																				
v22	24.28	38.71	14.86	1.75																			
lt2	29.30	43.72	19.87	3.26	5.02																		
lt8	11.74	26.16	2.31	14.30	12.54	17.56																	
lt12	33.32	47.75	23.90	7.29	9.04	4.02	21.59																
lt18	40.86	55.28	31.43	14.82	16.58	11.56	29.12	7.54															
lt22	42.55	56.98	33.13	16.52	18.27	13.26	30.82	9.23	1.69														
d2	38.20	52.62	28.77	12.16	13.92	8.90	26.46	4.88	2.66	4.36													
d8	28.85	43.28	19.43	2.82	4.57	0.45	17.11	4.47	12.01	13.70	9.35												
d12	42.80	57.22	33.37	16.76	18.52	13.50	31.06	9.48	1.94	0.24	4.60	13.95											
d18	48.73	63.15	39.30	22.69	24.45	19.43	36.99	15.41	7.87	6.17	10.53	19.88	5.93										
d22	48.82	63.24	39.39	22.78	24.54	19.52	37.08	15.50	7.96	6.27	10.62	19.97	6.02	0.09									
dk2	40.91	55.34	31.49	14.87	16.63	11.61	29.17	7.59	0.05	1.64	2.71	12.06	1.89	7.82	7.91								
dk8	34.67	49.09	25.24	8.63	10.39	5.37	22.93	1.35	6.19	7.89	3.53	5.82	8.13	14.06	14.15	6.24							
dk12	45.20	59.62	35.77	19.16	20.91	15.90	33.46	11.87	4.34	2.64	7.00	16.35	2.40	3.53	3.62	4.29	10.53						
dk18	48.34	62.76	38.91	22.30	24.06	19.04	36.60	15.02	7.48	5.79	10.14	19.49	5.54	0.39	0.48	7.43	13.67	3.14					
dk22	50.17	64.60	40.75	24.14	25.89	20.87	38.43	16.85	9.31	7.62	11.97	21.32	7.37	1.44	1.35	9.26	15.50	4.98	1.83				
W	62.03	76.45	52.60	35.99	37.75	32.73	50.29	28.71	21.17	19.47	23.83	33.18	19.23	13.30	13.21	21.12	27.36	16.83	13.69	11.86			
Gy5.5	61.98	76.41	52.56	35.95	37.70	32.68	50.24	28.66	21.12	19.43	23.78	33.13	19.18	13.25	13.16	21.07	27.31	16.79	13.64	11.81	0.05		
Bk	63.82	78.25	54.40	37.79	39.54	34.52	52.08	30.50	22.96	21.27	25.62	34.97	21.02	15.09	15.00	22.91	29.15	18.63	15.48	13.65	1.79	1.84	

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Table A-6 Hue difference of color combination pairs in Japanese visual assessment.

DH*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	82.89																						
v12	110.90	72.16																					
v18	81.93	109.85	75.64																				
v22	51.83	102.87	92.52	33.00																			
lt2	4.31	57.24	80.33	62.28	41.13																		
lt8	68.79	1.44	57.96	89.75	84.48	47.58																	
lt12	82.57	52.28	1.93	57.75	69.79	59.74	41.96																
lt18	69.24	85.08	53.55	7.66	32.73	52.23	69.41	41.08															
lt22	35.56	74.45	68.65	26.46	2.41	28.42	61.17	51.73	25.68														
d2	4.89	48.34	68.94	54.27	36.30	0.87	40.21	51.25	45.40	25.14													
d8	52.55	4.15	51.30	73.74	67.82	36.07	4.35	37.28	57.40	48.98	30.40												
d12	69.01	44.05	1.14	47.91	58.10	49.94	35.37	0.36	34.04	43.08	42.85	31.38											
d18	55.25	69.74	45.21	4.29	24.97	41.78	56.92	34.62	1.54	19.71	36.34	46.98	28.70										
d22	27.30	61.29	58.23	24.40	4.44	22.04	50.39	43.83	23.17	1.77	19.54	40.22	36.52	17.88									
dk2	4.59	54.07	68.34	47.36	28.11	5.98	44.79	50.97	40.45	19.07	5.87	34.51	42.58	32.18	14.42								
dk8	50.07	1.10	45.06	67.44	62.83	34.52	1.78	32.68	52.31	45.44	29.13	1.81	27.53	42.86	37.38	32.72							
dk12	65.77	43.34	0.73	44.32	54.53	47.67	34.83	1.69	31.30	40.48	40.92	30.77	1.13	26.44	34.35	40.50	27.05						
dk18	56.17	70.54	45.48	4.71	25.60	42.45	57.57	34.84	1.27	20.18	36.93	47.53	28.88	0.24	18.30	32.73	43.36	26.60					
dk22	27.75	59.52	55.48	22.06	2.78	22.25	48.92	41.79	21.24	0.62	19.70	39.12	34.81	16.33	0.91	14.80	36.32	32.72	16.72				
W	10.75	23.81	22.49	9.28	1.54	8.66	19.57	16.93	8.85	0.56	7.68	15.63	14.11	6.82	0.78	5.70	14.52	13.27	6.98	0.25			
Gy5.5	19.43	7.69	6.64	18.16	19.31	13.82	6.04	4.60	13.53	14.16	11.79	5.85	3.93	11.23	11.84	12.25	4.90	4.06	11.33	11.38	4.58		
Bk	8.16	12.68	9.87	1.73	2.19	6.29	10.39	7.49	2.22	1.88	5.51	8.45	6.23	1.59	1.85	4.62	7.77	5.80	1.65	1.61	0.70	2.22	

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Table A-7 Color difference of color combination pairs in Thai visual assessment.

DE*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	93.42																						
v12	113.85	84.51																					
v18	87.94	129.20	81.15																				
v22	60.34	122.02	95.60	31.59																			
lt2	41.66	77.39	83.55	67.31	51.71																		
lt8	78.87	35.22	63.72	98.20	93.97	49.78																	
lt12	92.96	75.67	32.70	67.07	76.90	56.31	44.52																
lt18	84.08	107.66	63.91	29.33	44.17	51.34	74.22	41.80															
lt22	59.70	97.53	76.93	41.21	34.00	27.89	65.57	50.28	26.18														
d2	40.45	82.41	75.83	56.26	40.15	23.08	57.49	55.46	47.57	28.81													
d8	62.43	53.74	55.17	76.00	70.31	37.25	29.42	38.40	57.88	48.60	33.11												
d12	84.02	81.46	32.55	55.54	64.12	55.35	54.52	24.48	39.55	47.16	44.49	34.06											
d18	76.10	108.45	63.69	25.37	34.55	56.10	80.35	52.72	30.07	36.86	39.64	54.97	34.82										
d22	58.62	102.85	73.79	33.84	24.29	43.57	75.94	58.16	36.52	29.32	25.19	49.64	41.77	17.80									
dk2	45.12	95.63	80.57	52.33	34.62	42.25	73.81	66.66	53.82	40.50	19.82	46.03	49.13	34.34	19.12								
dk8	62.42	63.18	54.23	71.93	66.28	44.91	44.16	44.80	59.27	51.93	31.79	15.79	30.95	48.22	43.53	37.64							
dk12	82.39	89.61	40.72	51.75	59.39	60.37	65.65	39.59	44.28	50.98	44.04	40.68	15.16	27.97	36.11	42.25	31.52						
dk18	78.18	113.10	67.42	28.15	36.13	62.47	86.64	59.92	38.63	44.60	43.93	59.96	39.90	8.99	20.81	34.45	51.15	29.91					
dk22	62.44	108.15	76.58	37.27	28.64	53.86	83.67	65.77	45.99	41.54	32.95	55.64	46.02	19.88	12.25	18.82	46.31	36.43	17.13				
W	78.52	85.59	67.24	61.55	63.72	37.18	50.51	34.84	33.84	30.14	47.96	47.14	47.29	56.02	54.46	64.18	57.28	58.69	64.88	66.08			
Gy5.5	66.63	86.45	54.30	42.85	44.03	37.88	56.78	34.95	27.90	26.29	26.24	33.31	22.26	23.94	23.43	33.38	31.77	25.22	31.29	32.11	37.60		
Bk	71.33	104.38	67.08	44.97	43.70	61.56	82.13	62.62	51.14	51.24	39.72	53.35	39.64	22.39	23.81	26.38	41.20	26.60	17.40	15.37	70.90	33.63	

Table A-8 Lightness difference of color combination pairs in Thai visual assessment.

DL*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	34.08																						
v12	10.28	23.80																					
v18	3.08	37.16	13.36																				
v22	6.56	40.64	16.84	3.48																			
lt2	25.41	8.67	15.13	28.49	31.97																		
lt8	38.67	4.59	28.39	41.75	45.23	13.26																	
lt12	28.92	5.16	18.64	32.00	35.48	3.51	9.75																
lt18	19.84	14.24	9.56	22.92	26.40	5.57	18.83	9.08															
lt22	20.95	13.13	10.67	24.03	27.51	4.46	17.72	7.97	1.11														
d2	3.51	30.57	6.77	6.59	10.07	21.90	35.16	25.41	16.33	17.44													
d8	13.45	20.63	3.17	16.53	20.01	11.96	25.22	15.47	6.39	7.50	9.94												
d12	5.02	29.06	5.26	8.10	11.58	20.39	33.65	23.90	14.82	15.93	1.51	8.43											
d18	9.23	43.31	19.51	6.15	2.67	34.64	47.90	38.15	29.07	30.18	12.74	22.68	14.25										
d22	7.99	42.07	18.27	4.91	1.43	33.40	46.66	36.91	27.83	28.94	11.50	21.44	13.01	1.24									
dk2	15.52	49.60	25.80	12.44	8.96	40.93	54.19	44.44	35.36	36.47	19.03	28.97	20.54	6.29	7.53								
dk8	2.07	36.15	12.35	1.01	4.49	27.48	40.74	30.99	21.91	23.02	5.58	15.52	7.09	7.16	5.92	13.45							
dk12	9.65	43.73	19.93	6.57	3.09	35.06	48.32	38.57	29.49	30.60	13.16	23.10	14.67	0.42	1.66	5.87	7.58						
dk18	18.18	52.26	28.46	15.10	11.62	43.59	56.85	47.10	38.02	39.13	21.69	31.63	23.20	8.95	10.19	2.66	16.11	8.53					
dk22	20.17	54.25	30.45	17.09	13.61	45.58	58.84	49.09	40.01	41.12	23.68	33.62	25.19	10.94	12.18	4.65	18.10	10.52	1.99				
W	44.65	10.57	34.37	47.73	51.21	19.24	5.98	15.73	24.81	23.70	41.14	31.20	39.63	53.88	52.64	60.17	46.72	54.30	62.83	64.82			
Gy5.5	7.25	26.83	3.03	10.33	13.81	18.16	31.42	21.67	12.59	13.70	3.74	6.20	2.23	16.48	15.24	22.77	9.32	16.90	25.43	27.42	37.40		
Bk	26.23	60.31	36.51	23.15	19.67	51.64	64.90	55.15	46.07	47.18	29.74	39.68	31.25	17.00	18.24	10.71	24.16	16.58	8.05	6.06	70.88	33.48	

Table A-9 Chroma difference of color combination pairs in Thai visual assessment.

DC*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	18.75																						
v12	8.99	27.74																					
v18	25.81	44.56	16.82																				
v22	26.11	44.86	17.12	0.30																			
lt2	32.87	51.62	23.88	7.06	6.76																		
lt8	16.09	34.83	7.09	9.73	10.03	16.79																	
lt12	35.71	54.46	26.72	9.90	9.60	2.84	19.62																
lt18	42.03	60.78	33.04	16.22	15.92	9.16	25.95	6.33															
lt22	45.38	64.13	36.39	19.57	19.27	12.51	29.30	9.67	3.35														
d2	40.08	58.83	31.09	14.27	13.97	7.21	24.00	4.38	1.95	5.30													
d8	30.81	49.56	21.82	5.00	4.70	2.06	14.73	4.90	11.22	14.57	9.27												
d12	40.98	59.73	31.99	15.17	14.87	8.11	24.90	5.28	1.05	4.40	0.90	10.17											
d18	49.69	68.43	40.69	23.87	23.57	16.81	33.60	13.98	7.65	4.30	9.60	18.87	8.70										
d22	50.05	68.80	41.06	24.24	23.94	17.18	33.96	14.34	8.01	4.67	9.97	19.24	9.06	0.36									
dk2	42.15	60.90	33.16	16.34	16.04	9.28	26.07	6.44	0.12	3.23	2.07	11.34	1.17	7.53	7.90								
dk8	33.07	51.82	24.08	7.26	6.96	0.20	16.99	2.64	8.96	12.31	7.01	2.26	7.91	16.61	16.98	9.08							
dk12	44.50	63.25	35.51	18.69	18.39	11.63	28.42	8.80	2.47	0.88	4.42	13.69	3.52	5.18	5.54	2.35	11.43						
dk18	48.83	67.58	39.84	23.02	22.72	15.96	32.74	13.12	6.80	3.45	8.75	18.02	7.85	0.86	1.22	6.68	15.76	4.33					
dk22	51.17	69.92	42.18	25.36	25.06	18.30	35.08	15.46	9.13	5.79	11.08	20.36	10.18	1.48	1.12	9.02	18.10	6.66	2.34				
W	64.01	82.76	55.02	38.20	37.90	31.14	47.93	28.30	21.98	18.63	23.93	33.20	23.03	14.32	13.96	21.86	30.94	19.51	15.18	12.84			
Gy5.5	62.88	81.63	53.88	37.06	36.77	30.01	46.79	27.17	20.84	17.49	22.79	32.07	21.89	13.19	12.83	20.72	29.81	18.37	14.05	11.71	1.13		
Bk	64.21	82.95	55.21	38.39	38.09	31.33	48.12	28.50	22.17	18.82	24.12	33.39	23.22	14.52	14.16	22.05	31.13	19.70	15.38	13.04	0.20	1.33	

Table A-10 Hue difference of color combination pairs in Thai visual assessment.

DH*ab	v2	v8	v12	v18	v22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy5.5	Bk
v2																							
v8	84.94																						
v12	113.02	76.19																					
v18	84.01	115.44	78.26																				
v22	54.00	105.95	92.54	31.39																			
lt2	3.08	57.01	78.62	60.57	40.08																		
lt8	66.83	2.51	56.61	88.34	81.76	44.95																	
lt12	80.81	52.29	2.90	58.11	67.55	56.13	38.75																
lt18	70.07	87.71	53.86	8.48	31.64	50.21	66.94	40.31															
lt22	32.63	72.30	66.93	27.16	5.26	24.52	55.92	48.69	25.94														
d2	4.12	48.95	68.83	54.02	36.26	1.00	38.63	49.11	44.64	22.32													
d8	52.61	2.54	50.57	74.01	67.24	35.22	3.55	34.80	56.42	45.76	30.19												
d12	73.17	47.15	2.89	52.81	61.29	50.82	34.94	0.19	36.66	44.17	44.45	31.39											
d18	56.90	72.13	44.95	5.99	25.11	40.80	55.07	33.60	0.75	20.72	36.29	46.38	30.55										
d22	29.46	63.84	58.53	23.11	3.84	22.09	49.36	42.60	22.25	0.55	20.08	40.42	38.64	17.75									
dk2	4.29	54.56	68.75	48.13	29.34	4.85	42.80	49.26	40.58	17.31	5.12	33.92	44.62	32.90	15.70								
dk8	52.90	0.34	46.99	71.56	65.76	35.52	1.29	32.24	54.34	44.90	30.50	1.79	29.07	44.69	39.64	33.96							
dk12	68.66	46.02	0.36	47.80	56.38	47.75	34.17	1.51	32.94	40.76	41.80	30.55	1.52	27.48	35.65	41.78	28.38						
dk18	58.28	74.12	46.35	5.90	25.57	41.80	56.59	34.63	0.96	21.13	37.18	47.65	31.49	0.16	18.10	33.69	45.92	28.34					
dk22	29.57	62.17	56.20	21.30	2.64	22.10	48.04	40.94	20.75	1.28	20.06	39.39	37.14	16.54	0.66	15.85	38.60	34.23	16.86				
W	8.66	19.12	17.67	7.14	1.35	6.51	14.79	12.86	6.83	0.03	5.92	12.10	11.66	5.45	0.12	4.60	11.87	10.76	5.56	0.32			
Gy5.5	20.81	9.54	5.98	18.85	19.90	14.31	6.89	3.74	13.62	14.05	12.46	6.53	3.34	11.28	12.33	12.89	5.86	3.56	11.62	11.91	3.71		
Bk	16.68	19.41	10.87	3.47	8.46	11.90	14.78	8.20	1.21	6.74	10.55	12.52	7.46	1.16	5.80	9.73	12.02	6.66	1.23	5.45	1.77	2.88	

APPENDIX B

VISUAL ASSESSMENT VALUES AND CORRELATION COEFFICIENT OF COLOR COMBINATION, VISUAL ASSESSMENT VALUES OF SINGLE COLOR

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Table B-1 Visual assessment values of color combination from Japanese observers.

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V2-W	77.45	21.57	30.39	62.75	62.75	79.41	-13.73	65.69	59.80	46.08	65.69	71.57	41.18	33.33
V2-Gy5.5	37.25	32.35	16.67	-4.90	-9.80	-20.59	-13.73	-11.76	-14.71	-10.78	0.00	-0.98	-6.86	-10.78
V2-Bk	-5.88	-37.25	0.98	-2.94	70.59	68.63	59.80	46.08	71.57	7.84	42.16	61.76	33.33	28.43
V2-V8	82.35	20.59	59.80	49.02	67.65	84.31	-20.59	78.43	65.69	77.45	87.25	84.31	35.29	10.78
V2-V12	71.57	31.37	52.94	46.08	46.08	64.71	-12.75	65.69	51.96	63.73	73.53	76.47	28.43	11.76
V2-V18	49.02	-1.96	-7.84	35.29	57.84	71.57	9.80	65.69	60.78	50.00	62.75	73.53	11.76	6.86
V2-V22	26.47	7.84	13.73	13.73	61.76	65.69	45.10	50.98	61.76	24.51	56.86	57.84	16.67	1.96
V2-lt2	51.96	61.76	70.59	26.47	2.94	14.71	-20.59	29.41	11.76	37.25	47.06	39.22	57.84	40.20
V2-lt8	78.43	32.35	57.84	53.92	43.14	75.49	-31.37	71.57	64.71	74.51	77.45	80.39	31.37	19.61
V2-lt12	71.57	42.16	45.10	52.94	4.90	45.10	-35.29	58.82	31.37	50.00	68.63	62.75	18.63	20.59
V2-lt18	71.57	40.20	14.71	63.73	7.84	50.00	-43.14	64.71	34.31	49.02	63.73	70.59	28.43	24.51
V2-lt22	69.61	40.20	42.16	44.12	-8.82	17.65	-33.33	51.96	16.67	45.10	49.02	48.04	36.27	19.61
V2-d2	17.65	37.25	43.14	-14.71	-0.98	-23.53	0.98	-10.78	-8.82	14.71	10.78	2.94	18.63	0.00
V2-d8	29.41	43.14	50.98	-15.69	-2.94	-4.90	-12.75	-4.90	0.98	15.69	14.71	21.57	-6.86	-5.88
V2-d12	55.88	44.12	46.08	14.71	1.96	4.90	-25.49	22.55	5.88	47.06	35.29	43.14	17.65	14.71
V2-d18	10.78	-11.76	-8.82	-15.69	24.51	18.63	13.73	2.94	31.37	21.57	25.49	29.41	-5.88	-2.94
V2-d22	38.24	33.33	28.43	-14.71	2.94	-6.86	-2.94	9.80	12.75	18.63	16.67	17.65	19.61	7.84
V2-dk2	0.00	22.55	42.16	-21.57	50.00	18.63	25.49	2.94	21.57	20.59	23.53	21.57	33.33	6.86
V2-dk8	21.57	19.61	39.22	-25.49	12.75	11.76	8.82	-0.98	13.73	11.76	18.63	24.51	-33.33	-29.41
V2-dk12	31.37	12.75	32.35	6.86	49.02	50.98	19.61	33.33	38.24	43.14	42.16	48.04	8.82	0.98
V2-dk18	16.67	-15.69	-0.98	-12.75	56.86	55.88	35.29	21.57	51.96	23.53	36.27	41.18	-8.82	-8.82

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V2-dk22	28.43	-16.67	15.69	-17.65	53.92	45.10	43.14	23.53	60.78	31.37	33.33	47.06	-17.65	-18.63
V8-W	86.27	33.33	19.61	65.69	24.51	61.76	-55.88	69.61	33.33	34.31	44.12	50.98	46.08	28.43
V8-Gy5.5	36.27	31.37	-3.92	-12.75	-29.41	-31.37	-27.45	-16.67	-25.49	-22.55	-17.65	-8.82	-1.96	-8.82
V8-Bk	17.65	-46.08	-20.59	12.75	69.61	82.35	52.94	38.24	76.47	28.43	50.98	75.49	19.61	8.82
V8-V12	66.67	25.49	33.33	50.00	46.08	59.80	-31.37	67.65	46.08	56.86	62.75	64.71	48.04	27.45
V8-V18	55.88	-7.84	-12.75	53.92	64.71	73.53	-11.76	62.75	62.75	45.10	59.80	73.53	41.18	35.29
V8-V22	43.14	-0.98	-1.96	23.53	63.73	73.53	22.55	61.76	62.75	51.96	68.63	72.55	25.49	13.73
V8-lt2	61.76	66.67	59.80	46.08	-35.29	-12.75	-54.55	39.22	-23.53	30.39	33.33	41.18	39.22	25.49
V8-lt8	81.37	50.98	46.08	47.06	-13.73	-11.76	-61.76	42.16	15.69	23.53	42.16	35.29	49.02	11.76
V8-lt12	75.49	63.73	36.27	53.92	-48.04	-9.80	-60.78	46.08	-19.61	17.65	31.37	31.37	38.24	27.45
V8-lt18	70.59	43.14	9.80	58.82	-24.51	18.63	-54.90	52.94	-13.73	17.65	31.37	43.14	36.27	27.45
V8-lt22	65.69	48.04	25.49	35.29	-40.20	-20.59	-56.86	34.31	-22.55	6.86	26.47	25.49	19.61	13.73
V8-d2	26.47	28.43	39.22	-5.88	-1.96	0.98	-8.82	2.94	-4.90	0.00	1.96	6.86	-2.94	-13.73
V8-d8	39.22	41.18	25.49	-15.69	-7.84	-18.63	-20.59	-8.82	-15.69	0.00	-7.84	-7.84	11.76	-11.76
V8-d12	53.92	48.04	36.27	29.41	-23.53	-10.78	-49.02	27.45	-12.75	8.82	17.65	28.43	43.14	30.39
V8-d18	15.69	-3.92	-24.51	-8.82	15.69	19.61	12.75	8.82	27.45	-2.94	0.98	24.51	12.75	0.00
V8-d22	24.51	24.51	25.49	-10.78	-11.76	-5.88	-18.63	13.73	-2.94	-2.94	6.86	18.63	-8.82	-7.84
V8-dk2	9.80	8.82	17.65	-12.75	37.25	31.37	21.57	14.71	30.39	22.55	23.53	33.33	-4.90	-3.92
V8-dk8	14.71	30.39	30.39	-32.35	-1.96	-20.59	-1.96	-21.57	-19.61	-16.67	-29.41	-10.78	5.88	-14.71
V8-dk12	29.41	13.73	24.51	0.98	42.16	42.16	4.90	35.29	35.29	24.51	26.47	37.25	33.33	24.51

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V8-dk18	13.73	-19.61	-20.59	-2.94	43.14	41.18	23.53	22.55	31.37	3.92	14.71	36.27	7.84	0.98
V8-dk22	15.69	-21.57	-0.98	-9.80	52.94	56.86	35.29	29.41	52.94	9.80	22.55	48.04	5.88	-1.96
V12-W	61.76	16.67	-2.94	64.71	50.98	77.45	-41.18	66.67	45.10	22.55	40.20	55.88	45.10	32.35
V12-Gy5.5	26.47	23.53	-8.82	-16.67	-37.25	-40.20	-28.43	-34.31	-28.43	-31.37	-34.31	-25.49	-10.78	-17.65
V12-Bk	-26.47	-42.16	-28.43	7.84	58.82	57.84	62.75	32.35	56.86	-16.67	-14.71	16.67	14.71	1.96
V12-V18	17.65	-5.88	-20.59	30.39	46.08	54.90	19.61	44.12	37.25	-12.75	5.88	11.76	26.47	2.94
V12-V22	2.94	-18.63	-11.76	11.76	61.76	59.80	38.24	51.96	57.84	16.67	27.45	39.22	7.84	6.86
V12-lt2	48.04	45.10	42.16	19.61	0.00	9.80	-16.67	37.25	16.67	39.22	39.22	45.10	6.86	7.84
V12-lt8	68.63	37.25	37.25	53.92	19.61	54.90	-34.31	57.84	37.25	45.10	59.80	64.71	39.22	22.55
V12-lt12	60.78	51.96	16.67	45.10	-12.75	0.98	-38.24	33.33	-5.88	-4.90	-2.94	2.94	52.94	35.29
V12-lt18	55.88	22.55	-9.80	48.04	-19.61	4.90	-39.22	34.31	-7.84	2.94	8.82	13.73	24.51	16.67
V12-lt22	55.88	41.18	16.67	24.51	-26.47	-0.98	-37.25	17.65	-3.92	13.73	17.65	22.55	-6.86	-4.90
V12-d2	18.63	25.49	31.37	-19.61	4.90	-16.67	13.73	-16.67	3.92	5.88	-4.90	-1.96	-15.69	-10.78
V12-d8	20.59	30.39	29.41	-26.47	-10.78	-22.55	-7.84	-24.51	-11.76	-12.75	-28.43	-17.65	-14.71	-11.76
V12-d12	27.45	42.16	20.59	5.88	-22.55	-40.20	-33.33	-12.75	-35.29	-27.45	-35.29	-41.18	33.33	11.76
V12-d18	-12.75	-10.78	-29.41	-32.35	25.49	-19.61	22.55	-19.61	0.98	-32.35	-38.24	-36.27	6.86	2.94
V12-d22	2.94	18.63	1.96	-21.57	6.86	-14.71	2.94	-26.47	-17.65	-18.63	-29.41	-13.73	-27.45	-27.45
V12-dk2	-6.86	-0.98	15.69	-30.39	38.24	27.45	41.18	-12.75	21.57	-9.80	-26.47	-8.82	-37.25	-19.61
V12-dk8	-3.92	17.65	13.73	-36.27	4.90	-31.37	4.90	-24.51	-6.86	-22.55	-31.37	-29.41	-21.57	-22.55
V12-dk12	-1.96	23.53	17.65	-0.98	15.69	0.00	17.65	-4.90	9.80	-18.63	-29.41	-34.31	43.14	27.45

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V12-dk18	-11.76	-19.61	-31.37	-15.69	49.02	15.69	42.16	3.92	32.35	-35.29	-28.43	-16.67	-1.96	-1.96
V12-dk22	-21.57	-30.39	-13.73	-20.59	53.92	47.06	59.80	5.88	41.18	-21.57	-17.65	-5.88	-15.69	-18.63
V18-W	57.84	-7.84	-40.20	58.82	51.96	75.49	-23.53	63.73	55.88	8.82	38.24	59.80	57.84	43.14
V18-Gy5.5	6.86	1.96	-44.12	-14.71	-25.49	-35.29	-11.76	-31.37	-22.55	-42.16	-40.20	-35.29	14.71	0.00
V18-Bk	-51.96	-57.84	-59.80	-2.94	68.63	50.98	71.57	22.55	60.78	-50.00	-29.41	-0.98	21.57	8.82
V18-V22	-22.55	-28.43	-36.27	0.98	64.71	25.49	59.80	22.55	52.94	-21.57	-3.92	-2.94	24.51	3.92
V18-lt2	33.33	23.53	14.71	10.78	4.90	25.49	-5.88	28.43	19.61	21.57	36.27	28.43	-12.75	-5.88
V18-lt8	53.92	2.94	-3.92	48.04	35.29	63.73	-6.86	58.82	46.08	47.06	51.96	57.84	34.31	20.59
V18-lt12	41.18	15.69	-16.67	41.18	-8.82	29.41	-28.43	45.10	24.51	2.94	24.51	36.27	11.76	15.69
V18-lt18	25.49	8.82	-58.82	50.00	-8.82	25.49	-29.41	38.24	15.69	-39.22	-6.86	2.94	63.73	48.04
V18-lt22	32.35	28.43	-12.75	18.63	-20.59	-9.80	-25.49	16.67	-4.90	-19.61	-2.94	2.94	15.69	8.82
V18-d2	-12.75	11.76	-0.98	-22.55	1.96	-9.80	20.59	-32.35	-2.94	-6.86	-17.65	-9.80	-10.78	-7.84
V18-d8	6.86	7.84	-8.82	-32.35	6.86	5.88	12.75	-28.43	12.75	-15.69	-33.33	-10.78	-5.88	-13.73
V18-d12	19.61	21.57	-12.75	-11.76	-8.82	-16.67	0.98	-15.69	-13.73	-24.51	-19.61	-15.69	18.63	15.69
V18-d18	-39.22	-22.55	-57.84	-30.39	25.49	-33.33	36.27	-37.25	5.88	-54.90	-44.12	-43.14	38.24	20.59
V18-d22	-14.71	-11.76	-33.33	-35.29	8.82	-33.33	26.47	-43.14	4.90	-42.16	-48.04	-44.12	-2.94	-11.76
V18-dk2	-32.35	-17.65	-21.57	-43.14	53.92	8.82	52.94	-25.49	24.51	-24.51	-32.35	-24.51	-12.75	-21.57
V18-dk8	-10.78	-9.80	-21.57	-40.20	29.41	-13.73	32.35	-35.29	3.92	-36.27	-46.08	-39.22	-25.49	-18.63
V18-dk12	-29.41	-17.65	-30.39	-29.41	42.16	1.96	49.02	-27.45	22.55	-39.22	-43.14	-43.14	1.96	-8.82
V18-dk18	-43.14	-36.27	-53.54	-33.33	48.04	-11.76	52.94	-31.37	26.47	-55.88	-49.02	-37.25	35.29	22.55

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V18-dk22	-50.98	-45.10	-46.08	-39.22	58.82	13.73	61.76	-20.59	37.25	-41.18	-49.02	-42.16	8.82	-13.73
V22-W	55.88	-1.96	-22.55	44.12	61.76	82.35	2.94	61.76	62.75	14.71	49.02	58.82	48.04	13.73
V22-Gy5.5	11.76	12.75	-14.71	-31.37	-21.57	-35.29	-5.88	-23.53	-9.80	-24.51	-36.27	-25.49	-1.96	-13.73
V22-Bk	-56.86	-44.12	-41.18	-19.61	73.53	53.92	79.41	2.94	64.71	-46.08	-17.65	10.78	32.35	7.84
V22-lt2	46.08	37.25	43.14	21.57	7.84	10.78	-6.86	25.49	9.80	13.73	29.41	31.37	20.59	8.82
V22-lt8	50.98	12.75	11.76	27.45	51.96	70.59	11.76	50.00	59.80	46.08	60.78	74.51	16.67	1.96
V22-lt12	44.12	20.59	-0.98	29.41	1.96	40.20	-13.73	40.20	34.31	23.53	40.20	47.06	-15.69	-5.88
V22-lt18	34.31	7.84	-33.33	21.57	6.86	26.47	-15.69	26.26	19.61	-5.88	13.73	29.41	-1.96	-1.96
V22-lt22	37.25	44.12	13.73	25.49	-23.53	-11.76	-22.55	21.57	-4.90	-5.88	5.88	6.86	73.53	36.27
V22-d2	-2.94	25.49	32.35	-27.45	6.86	-25.49	13.73	-33.33	-7.84	-12.75	-22.55	-19.61	4.90	-7.84
V22-d8	10.78	25.49	23.53	-32.35	9.80	2.94	10.78	-28.43	10.78	-8.82	-26.47	-3.92	-10.78	-18.63
V22-d12	10.78	23.53	1.96	-8.82	-6.86	0.00	0.00	-0.98	13.73	5.88	-1.96	12.75	16.67	10.78
V22-d18	-31.37	-20.59	-33.33	-42.16	28.43	-28.43	48.04	-33.33	15.69	-34.31	-40.20	-29.41	8.82	-1.96
V22-d22	-12.75	22.55	-5.88	-36.27	7.84	-36.27	26.47	-43.14	0.00	-28.43	-34.31	-27.45	22.55	-5.88
V22-dk2	-20.59	12.75	18.63	-43.14	36.27	-26.47	50.00	-32.35	22.55	-12.75	-32.35	-27.45	9.80	-5.88
V22-dk8	-8.82	17.65	16.67	-38.24	28.43	-16.67	26.47	-34.31	0.98	-15.69	-34.31	-6.86	-22.55	-35.29
V22-dk12	-23.53	0.00	0.98	-31.37	47.06	15.69	52.94	-6.86	31.37	-4.90	-23.53	3.92	-15.69	-4.90
V22-dk18	-45.10	-26.47	-28.43	-37.25	56.86	0.00	62.75	-30.39	35.29	-38.24	-38.24	-23.53	4.90	-4.90
V22-dk22	-41.18	1.96	-9.80	-41.18	54.90	4.90	59.80	-22.55	38.24	-24.51	-21.57	-10.78	47.06	15.69
lt2-W	70.59	56.86	38.24	50.00	-16.67	35.29	-50.98	35.29	8.82	14.71	35.29	47.06	55.88	44.12

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt2-Gy5.5	40.20	44.12	24.51	-3.92	-59.80	-52.94	-47.06	-22.55	-38.24	-14.71	-11.76	-7.84	9.80	4.90
lt2-Bk	-8.82	-14.71	1.96	-5.88	43.14	45.10	42.16	23.53	54.90	13.73	16.67	37.25	12.75	9.80
lt2-lt8	77.45	58.82	57.84	40.20	-28.43	1.96	-41.18	35.29	-0.98	43.14	51.96	54.90	26.47	23.53
lt2-lt12	70.59	64.71	46.08	46.08	-53.92	-12.75	-56.86	29.41	-22.55	23.53	41.18	47.06	38.24	33.33
lt2-lt18	60.78	55.88	23.53	48.04	-50.98	-12.75	-50.00	32.35	-30.39	5.88	32.35	32.35	46.08	38.24
lt2-lt22	69.61	73.53	48.04	43.14	-71.57	-57.84	-70.59	29.41	-44.12	-1.96	30.39	25.49	57.84	30.39
lt2-d2	26.47	50.00	54.90	-18.63	-28.43	-35.29	-17.65	-21.57	-17.65	11.76	-2.94	0.98	39.22	19.61
lt2-d8	36.27	45.10	46.08	-19.61	-35.29	-36.27	-20.59	-24.51	-36.27	3.92	-12.75	-10.78	2.94	-6.86
lt2-d12	49.02	58.82	47.06	27.45	-46.08	-35.29	-50.00	0.98	-32.35	11.76	13.73	20.59	40.20	38.24
lt2-d18	11.76	5.88	-2.94	-21.57	-10.78	-6.86	0.98	-9.80	7.84	-5.88	-9.80	1.96	0.98	8.82
lt2-d22	24.51	43.14	32.35	-16.67	-26.47	-22.55	-24.51	-12.75	-13.73	10.78	-1.96	14.71	39.22	23.53
lt2-dk2	13.73	32.35	52.94	-6.86	17.65	4.90	8.82	-8.82	8.82	12.75	10.78	23.53	41.18	25.49
lt2-dk8	15.69	37.25	43.14	-34.31	-8.82	-30.39	-9.80	-28.43	-29.41	2.94	-13.73	0.00	-19.61	-24.51
lt2-dk12	27.45	34.31	35.29	-2.94	7.84	18.63	0.98	8.82	8.82	18.63	12.75	21.57	5.88	10.78
lt2-dk18	2.94	5.88	-5.88	-15.69	30.39	12.75	14.71	-4.90	15.69	-10.78	-9.80	12.75	2.94	0.00
lt2-dk22	19.61	28.43	27.45	-12.75	22.55	19.61	20.59	2.94	19.61	10.78	3.92	12.75	17.65	5.88
lt8-W	72.55	39.22	27.45	55.88	-7.84	22.55	-58.82	52.94	13.73	19.61	43.14	49.02	48.04	33.33
lt8-Gy5.5	32.35	35.29	-2.94	-6.86	-37.25	-46.08	-35.29	-29.41	-32.35	-18.63	-21.57	-19.61	-3.92	-9.80
lt8-Bk	6.86	-46.08	-15.69	13.73	43.14	68.63	42.16	41.18	67.65	28.43	45.10	77.45	23.53	8.82
lt8-lt12	72.55	61.76	36.27	45.10	-58.82	-15.69	-49.02	33.33	-16.67	27.45	35.29	51.96	52.94	36.27

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
It8-It18	68.63	50.00	0.00	55.88	-43.14	12.75	-55.88	29.41	-11.76	3.92	32.35	45.10	52.94	42.16
It8-It22	62.75	57.84	33.33	30.39	-60.78	-30.39	-51.96	24.51	-27.45	3.92	30.39	30.39	23.53	13.73
It8-d2	33.33	43.14	44.12	-9.80	-14.71	-13.73	-14.71	-16.67	-4.90	15.69	2.94	15.69	8.82	-5.88
It8-d8	32.35	39.22	38.24	-22.55	-21.57	-34.31	-25.49	-27.45	-19.61	0.00	-17.65	-14.71	12.75	-12.75
It8-d12	48.04	51.96	37.25	20.59	-40.20	-17.65	-45.10	3.92	-8.82	5.88	19.61	28.43	48.04	29.41
It8-d18	10.78	-5.88	-16.67	-3.92	9.80	17.65	1.96	-2.94	19.61	-8.82	4.90	23.53	12.75	8.82
It8-d22	19.61	23.53	5.88	-9.80	-17.65	-1.96	-12.75	-2.94	6.86	2.94	15.69	30.39	9.80	-6.86
It8-dk2	16.67	3.92	19.61	-11.76	34.31	45.10	24.51	-1.96	31.37	28.43	19.61	41.18	-4.90	-6.86
It8-dk8	28.43	36.27	29.41	-25.49	-2.94	-30.39	-12.75	-24.51	-14.71	-3.92	-14.71	-3.92	1.96	-12.75
It8-dk12	24.51	21.57	15.69	14.71	22.55	42.16	-3.92	24.51	31.37	8.82	28.43	29.41	34.31	18.63
It8-dk18	6.86	-14.71	-20.59	2.94	40.20	46.08	30.39	5.88	32.35	-9.80	9.80	24.51	20.59	4.90
It8-dk22	5.88	-4.90	-1.96	7.84	36.27	56.86	25.49	31.37	46.08	9.80	35.29	48.04	9.80	-4.90
It12-W	74.51	46.08	1.96	50.98	-33.33	24.51	-51.96	48.04	11.76	0.98	34.31	40.20	49.02	28.43
It12-Gy5.5	47.06	45.10	-13.73	-12.75	-64.71	-58.82	-43.14	-41.18	-47.06	-31.37	-21.57	-19.61	0.98	-6.86
It12-Bk	-4.90	-32.35	-26.47	12.75	39.22	59.80	35.29	24.51	48.04	-6.86	2.94	21.57	-9.80	-7.84
It12-It18	60.78	60.78	-16.67	49.02	-61.76	-39.22	-64.71	16.67	-40.20	-32.35	-0.98	6.86	45.10	35.29
It12-It22	71.57	67.65	22.55	40.20	-61.76	-37.25	-61.76	12.75	-45.10	-12.75	17.65	25.49	20.59	11.76
It12-d2	19.61	29.41	29.41	-8.82	-23.53	-18.63	-8.82	-11.76	-7.84	12.75	-6.86	2.94	-26.47	-26.47
It12-d8	30.39	39.22	23.53	-10.78	-24.51	-37.25	-23.53	-36.27	-33.33	-18.63	-19.61	-6.86	-23.53	-22.55
It12-d12	39.22	49.02	27.45	17.65	-40.20	-40.20	-45.10	-13.73	-42.16	-23.53	-15.69	-11.76	56.86	22.55

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt12-d18	0.98	3.92	-32.35	-17.65	-12.75	-23.53	-3.92	-22.55	-9.80	-36.27	-36.27	-13.73	4.90	0.00
lt12-d22	13.73	27.45	-1.96	-17.65	-26.47	-26.47	-15.69	-25.49	-26.47	-16.67	-18.63	0.98	-10.78	-16.67
lt12-dk2	9.80	-1.96	13.73	-11.76	24.51	29.41	15.69	-2.94	28.43	11.76	7.84	18.63	-35.29	-35.29
lt12-dk8	15.69	27.45	6.86	-27.45	-19.61	-21.57	-9.80	-28.43	-32.35	-18.63	-26.47	-11.76	-41.18	-36.27
lt12-dk12	22.55	16.67	8.82	6.86	4.90	7.84	5.88	9.80	-0.98	-10.78	-17.65	-5.88	40.20	19.61
lt12-dk18	-9.80	-14.71	-33.33	-8.82	2.94	-5.88	14.71	-2.94	11.76	-26.47	-26.47	0.98	1.96	-5.88
lt12-dk22	2.94	-15.69	-17.65	-9.80	29.41	36.27	20.59	6.86	38.24	-13.73	-10.78	13.73	-14.71	-11.76
lt18-W	67.65	28.43	-39.22	59.80	-21.57	32.35	-43.14	38.24	13.73	-9.80	21.57	33.33	53.92	40.20
lt18-Gy5.5	35.29	34.31	-35.29	-4.90	-54.90	-43.14	-43.14	-26.47	-45.10	-50.98	-39.22	-36.27	21.57	15.69
lt18-Bk	-16.67	-47.06	-54.90	7.84	38.24	50.00	49.02	20.59	47.06	-17.65	-3.92	15.69	22.55	18.63
lt18-lt22	67.65	60.78	12.75	45.10	-69.61	-52.94	-61.76	9.80	-49.02	-25.49	5.88	5.88	49.02	35.29
lt18-d2	18.63	29.41	9.80	-14.71	-22.55	-18.63	-14.71	-25.49	-14.71	2.94	-0.98	-0.98	-6.86	-16.67
lt18-d8	30.39	34.31	7.84	-18.63	-38.24	-33.33	-28.43	-37.25	-28.43	-19.61	-30.39	-11.76	-25.49	-17.65
lt18-d12	44.12	47.06	-11.76	15.69	-55.88	-41.18	-48.04	-2.94	-39.22	-30.39	-12.75	-12.75	22.55	19.61
lt18-d18	-9.80	-12.75	-60.78	-8.82	-21.57	-21.57	3.92	-23.53	-18.63	-53.92	-42.16	-35.29	61.76	37.25
lt18-d22	8.82	32.35	-27.45	-14.71	-40.20	-39.22	-14.71	-23.53	-38.24	-33.33	-26.47	-22.55	13.73	-0.98
lt18-dk2	-5.88	-0.98	-14.71	-10.78	25.49	12.75	20.59	-0.98	19.61	-7.84	-18.63	5.88	-12.75	-12.75
lt18-dk8	3.92	14.71	-13.73	-30.39	-13.73	-17.65	-12.75	-38.24	-15.69	-28.43	-40.20	-14.71	-30.39	-29.41
lt18-dk12	11.76	7.84	-19.61	2.94	11.76	9.80	1.96	3.92	9.80	-24.51	-18.63	-10.78	4.90	10.78
lt18-dk18	-4.90	-28.43	-56.86	0.98	25.49	10.78	27.45	1.96	21.57	-48.04	-35.29	-12.75	46.08	35.29

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

Color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt18-dk22	-14.71	-24.51	-38.24	-11.76	28.43	25.49	34.31	-14.71	25.49	-33.33	-26.47	-7.84	-4.90	-3.92
lt22-W	61.76	38.24	7.84	32.35	-17.65	20.59	-45.10	30.39	-2.94	-6.86	7.84	21.57	38.24	21.57
lt22-Gy5.5	35.29	45.10	-3.92	-14.71	-55.88	-64.71	-46.08	-31.37	-44.12	-39.22	-35.29	-26.47	17.65	7.84
lt22-Bk	-9.80	-32.35	-21.57	-10.78	38.24	50.98	44.12	13.73	41.18	0.00	5.88	38.24	8.82	-7.84
lt22-d2	23.53	40.20	47.06	-4.90	-26.47	-26.47	-15.69	-20.59	-16.67	11.76	-5.88	-0.98	26.47	6.86
lt22-d8	26.47	38.24	30.39	-18.63	-46.08	-47.06	-23.53	-32.35	-27.45	0.98	-17.65	-21.57	-25.49	-25.49
lt22-d12	46.08	49.02	13.73	5.88	-49.02	-43.14	-46.08	-3.92	-34.31	-0.98	0.00	-4.90	21.57	12.75
lt22-d18	-6.86	0.00	-19.61	-18.63	-19.61	-14.71	6.86	-24.51	-7.84	-27.45	-33.33	-13.73	3.92	-17.65
lt22-d22	13.73	40.20	17.65	-8.82	-34.31	-46.08	-16.67	-28.43	-21.57	-26.47	-16.67	-8.82	52.94	28.43
lt22-dk2	7.84	22.55	30.39	-12.75	12.75	6.86	17.65	-2.94	8.82	14.71	-9.80	15.69	23.53	9.80
lt22-dk8	6.86	33.33	16.67	-34.31	-17.65	-22.55	-12.75	-38.24	-25.49	-15.69	-27.45	-12.75	-33.33	-31.37
lt22-dk12	6.86	13.73	13.73	-10.78	5.88	-0.98	10.78	-7.84	8.82	-8.82	-13.73	12.75	-14.71	-7.84
lt22-dk18	-13.73	-11.76	-24.51	-17.65	10.78	0.98	20.59	-10.78	19.61	-14.71	-24.51	-7.84	3.92	-3.92
lt22-dk22	-9.80	6.86	7.84	-10.78	20.59	10.78	26.47	10.78	25.49	-13.73	-3.92	12.75	48.04	22.55
d2-W	35.29	20.59	16.67	1.96	16.67	16.67	0.00	5.88	15.69	10.78	10.78	20.59	6.86	-15.69
d2-Gy5.5	3.92	26.47	20.59	-38.24	-38.24	-50.98	-15.69	-51.96	-30.39	-29.41	-54.90	-52.94	5.88	-14.71
d2-Bk	-44.12	-27.45	-4.90	-29.41	38.24	32.35	61.76	-17.65	39.22	-6.86	-35.29	-3.92	13.73	-2.94
d2-d8	16.67	36.27	46.08	-27.45	-0.98	-37.25	4.90	-40.20	-0.98	-13.73	-33.33	-17.65	29.41	6.86
d2-d12	21.57	39.22	38.24	-15.69	-12.75	-26.47	-10.78	-30.39	-6.86	-9.80	-18.63	-5.88	13.73	7.84
d2-d18	-16.67	2.94	-5.88	-37.25	0.98	-19.61	35.29	-37.25	4.90	-24.51	-40.20	-26.47	17.65	10.78

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

Color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
d2-d22	-11.76	19.61	27.45	-38.24	0.00	-35.29	15.69	-47.06	4.90	-13.73	-37.25	-28.43	14.71	7.84
d2-dk2	-14.71	26.47	50.00	-33.33	22.55	-21.57	44.12	-38.24	23.53	1.96	-24.51	-11.76	53.92	20.59
d2-dk8	-6.86	26.47	35.29	-47.06	8.82	-36.27	18.63	-47.06	-11.76	-11.76	-44.12	-35.29	0.00	-12.75
d2-dk12	-20.59	3.92	22.55	-33.33	35.29	3.92	46.08	-33.33	22.55	-0.98	-34.31	-11.76	10.78	9.80
d2-dk18	-38.24	-19.61	-20.59	-42.16	37.25	-7.84	51.96	-41.18	20.59	-24.51	-38.24	-12.75	1.96	2.94
d2-dk22	-44.12	-5.88	18.63	-43.14	45.10	-5.88	42.16	-38.24	31.37	-24.51	-44.12	-30.39	30.39	11.76
d8-W	35.29	19.61	11.76	-9.80	-2.94	14.71	-10.78	-11.76	8.82	-2.94	-12.75	17.65	-17.65	-26.47
d8-Gy5.5	8.82	36.27	7.84	-38.24	-45.10	-60.78	-28.43	-50.98	-39.22	-34.31	-59.80	-58.82	10.78	-19.61
d8-Bk	-42.16	-40.20	-15.69	-19.61	48.04	33.33	55.88	-22.55	33.33	-13.73	-31.37	-2.94	9.80	-7.84
d8-d12	30.39	40.20	34.31	-8.82	-38.24	-45.10	-33.33	-36.27	-29.41	-8.82	-25.49	-12.75	11.76	0.98
d8-d18	-20.59	-8.82	-12.75	-31.37	4.90	-13.73	20.59	-31.37	4.90	-29.41	-47.06	-24.51	10.78	4.90
d8-d22	-16.67	19.61	6.86	-34.31	-4.90	-26.47	14.71	-34.31	-5.88	-14.71	-49.02	-27.45	23.53	4.90
d8-dk2	-13.73	11.76	35.29	-38.24	26.47	0.98	38.24	-30.39	20.59	5.88	-26.47	-3.92	25.49	11.76
d8-dk8	-1.96	34.31	36.27	-50.00	-3.92	-48.04	4.90	-53.92	-10.78	-38.24	-52.94	-57.84	44.12	-1.96
d8-dk12	-12.75	11.76	11.76	-25.49	20.59	-8.82	22.55	-32.35	17.65	-25.49	-35.29	-12.75	27.45	6.86
d8-dk18	-36.27	-13.73	-27.45	-37.25	28.43	-1.96	34.31	-34.31	15.69	-30.39	-45.10	-19.61	17.65	1.96
d8-dk22	-40.20	-3.92	4.90	-46.08	33.33	6.86	51.96	-30.39	29.41	-12.75	-35.29	-17.65	14.71	-7.84
d12-W	42.16	23.53	-7.84	6.86	9.80	26.47	-15.69	10.78	14.71	-3.92	4.90	22.55	1.96	-7.84
d12-Gy5.5	17.65	44.12	-5.88	-22.55	-42.16	-57.84	-25.49	-45.10	-44.12	-34.31	-49.02	-50.00	18.63	-0.98
d12-Bk	-31.37	-28.43	-18.63	-17.65	39.22	37.25	50.98	-18.63	37.25	-8.82	-32.35	-10.78	15.69	-8.82

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values												
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
d12-d18	-13.73	1.96	-24.51	-30.39	-2.94	-22.55	14.71	-37.25	-3.92	-24.51	-42.16	-23.53	26.47	11.76
d12-d22	0.98	26.47	8.82	-27.45	-21.57	-36.27	-1.96	-41.18	-16.67	-20.59	-39.22	-33.33	-2.94	-0.98
d12-dk2	-15.69	8.82	16.67	-30.39	33.33	11.76	37.25	-33.33	23.53	9.80	-20.59	-3.92	-5.88	-0.98
d12-dk8	-1.96	22.55	13.73	-43.14	-7.84	-34.31	6.86	-48.04	-26.47	-22.55	-51.96	-48.04	-12.75	-31.37
d12-dk12	-2.94	29.41	2.94	-14.71	3.92	-7.84	3.92	-25.49	4.90	-24.51	-38.24	-41.18	44.12	24.51
d12-dk18	-25.49	-5.88	-35.29	-29.41	25.49	-2.94	44.12	-23.53	21.57	-31.37	-41.18	-26.47	25.49	10.78
d12-dk22	-29.41	-12.75	-26.47	-43.14	21.57	-0.98	41.18	-28.43	27.45	3.92	-22.55	-5.88	-7.84	-8.82
d18-W	22.55	-15.69	-42.16	11.76	37.25	42.16	15.69	8.82	44.12	-18.63	-10.78	22.55	27.45	23.53
d18-Gy5.5	-11.76	9.80	-43.14	-38.24	-17.65	-32.35	0.00	-49.02	-17.65	-44.12	-50.00	-52.94	26.47	12.75
d18-Bk	-68.63	-55.88	-53.92	-33.33	57.84	12.75	72.55	-35.29	43.14	-53.92	-56.86	-46.08	26.47	15.69
d18-d22	-34.31	0.00	-20.59	-44.12	5.88	-40.20	26.47	-49.02	-0.98	-44.12	-57.84	-48.04	27.45	-4.90
d18-dk2	-45.10	-18.63	-13.73	-46.08	50.98	-10.78	54.90	-39.22	35.29	-17.65	-38.24	-26.47	11.76	0.00
d18-dk8	-29.41	-4.90	-16.67	-54.90	26.47	-18.63	40.20	-52.94	2.94	-42.16	-57.84	-44.12	-1.96	-5.88
d18-dk12	-35.29	-15.69	-31.37	-37.25	43.14	-24.51	47.06	-36.27	19.61	-37.25	-48.04	-48.04	15.69	-5.88
d18-dk18	-50.98	-36.27	-59.60	-43.14	50.00	-29.41	55.88	-42.16	19.61	-57.84	-63.73	-65.69	42.16	-1.96
d18-dk22	-61.76	-30.39	-43.14	-46.08	59.80	1.96	65.69	-35.29	45.10	-45.10	-50.98	-43.14	26.47	1.96
d22-W	28.43	-6.86	-8.82	1.96	32.35	42.16	14.71	0.98	34.31	-1.96	3.92	27.45	4.90	-11.76
d22-Gy5.5	-1.96	20.59	-11.76	-29.41	-27.45	-34.31	-2.94	-42.16	-26.47	-33.33	-47.06	-38.24	25.49	3.92
d22-Bk	-58.82	-31.37	-18.63	-29.41	63.73	24.51	68.63	-27.45	46.08	-29.41	-43.14	-23.53	27.45	3.92
d22-dk2	-26.47	8.82	18.63	-40.20	34.31	-18.63	47.06	-29.41	20.59	-10.78	-30.39	-19.61	26.47	8.82

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
d22-dk8	-14.71	28.43	25.49	-46.08	0.00	-24.51	31.37	-43.14	3.92	-11.76	-51.96	-36.27	7.84	-12.75
d22-dk12	-25.49	1.96	2.94	-35.29	32.35	-8.82	31.37	-30.39	20.59	-9.80	-33.33	-14.71	-7.84	-14.71
d22-dk18	-49.02	-21.57	-29.41	-46.08	43.14	-14.71	50.00	-42.16	27.45	-38.24	-45.10	-46.08	13.73	-1.96
d22-dk22	-50.98	-0.98	0.00	-37.25	45.10	-18.63	49.02	-42.16	30.39	-24.51	-42.16	-34.31	42.16	-1.96
dk2-W	25.49	0.98	12.75	6.86	32.35	50.00	10.78	18.63	45.10	11.76	16.67	45.10	11.76	0.00
dk2-Gy5.5	-6.86	25.49	13.73	-36.27	-0.98	-14.71	17.65	-35.29	6.86	-23.53	-33.33	-15.69	3.92	-8.82
dk2-Bk	-60.78	-30.39	9.80	-44.12	72.55	16.67	74.51	-31.37	53.92	3.92	-26.47	-7.84	23.53	11.76
dk2-dk8	-8.82	26.47	41.18	-28.43	25.49	-10.78	39.22	-33.33	17.65	6.86	-31.37	-21.57	19.61	2.94
dk2-dk12	-34.31	4.90	21.57	-34.31	50.00	14.71	49.02	-23.53	35.29	0.98	-16.67	4.90	11.76	1.96
dk2-dk18	-47.06	-23.53	-10.78	-40.20	52.94	-1.96	55.88	-36.27	34.31	-5.88	-33.33	-17.65	18.63	-2.94
dk2-dk22	-54.90	1.96	10.78	-52.94	62.75	-1.96	65.69	-44.12	42.16	-21.57	-35.29	-31.37	20.59	-3.92
dk8-W	25.49	-0.98	-2.94	-15.69	18.63	34.31	-3.92	-10.78	14.71	-1.96	-21.57	14.71	0.98	-21.57
dk8-Gy5.5	-3.92	19.61	-10.78	-44.12	-30.39	-43.14	-13.73	-52.94	-24.51	-33.33	-50.98	-50.00	3.92	-19.61
dk8-Bk	-51.96	-27.45	-14.71	-44.12	63.73	27.45	64.71	-43.14	35.29	-31.37	-45.10	-17.65	22.55	-0.98
dk8-dk12	-9.80	15.69	9.80	-40.20	25.49	-11.76	33.33	-40.20	7.84	-11.76	-42.16	-22.55	20.59	6.86
dk8-dk18	-33.33	-7.84	-11.76	-41.18	33.33	5.88	43.14	-42.16	18.63	-32.35	-45.10	-31.37	5.88	-6.86
dk8-dk22	-37.25	14.71	11.76	-49.02	45.10	1.96	48.04	-40.20	32.35	-18.63	-47.06	-24.51	10.78	-4.90
dk12-W	19.61	-4.90	-2.94	7.84	40.20	50.98	11.76	25.49	36.27	-0.98	2.94	34.31	24.51	11.76
dk12-Gy5.5	-8.82	17.65	-0.98	-32.35	-8.82	-23.53	-1.96	-37.25	-11.76	-34.31	-44.12	-30.39	4.90	-7.84
dk12-Bk	-63.73	-29.41	-7.84	-25.49	65.69	38.24	69.61	-15.69	50.00	-28.43	-30.39	-23.53	20.59	7.84

Table B-1 Visual assessment values of color combination from Japanese observers. (cont.)

color combination	Visual Assessment Values													
	-40.20	-14.71	-32.35	-31.37	48.04	2.94	49.02	-24.51	30.39	-21.57	-38.24	-38.24	8.82	-7.84
	-55.88	-7.84	-2.94	-39.22	55.88	12.75	60.78	-16.67	32.35	-17.65	-28.43	-22.55	3.92	-9.80
dk12-dk18	16.67	-23.53	-45.10	12.75	50.00	64.71	19.61	31.37	44.12	-13.73	-0.98	31.37	36.27	22.55
dk12-dk22	-2.94	-9.80	-43.14	-29.41	-0.98	-16.67	5.88	-36.27	2.94	-30.39	-40.20	-33.33	20.59	11.76
dk18-W	-73.53	-50.98	-54.90	-39.22	72.55	11.76	85.29	-27.45	50.00	-51.96	-49.02	-48.04	38.24	8.82
dk18-Gy5.5	-66.67	-26.47	-36.27	-49.02	66.67	-2.94	70.59	-35.29	50.00	-37.25	-50.00	-46.08	21.57	0.00
dk18-Bk	11.76	-12.75	-8.82	4.90	53.92	66.67	23.53	28.43	48.04	7.84	9.80	47.06	17.65	6.86
dk18-dk22	-19.61	11.76	-23.53	-31.37	7.84	-7.84	33.33	-35.29	4.90	-28.43	-31.37	-23.53	13.73	2.94
dk22-W	-70.59	-38.24	-23.53	-28.43	79.41	16.67	80.39	-20.59	53.92	-44.12	-38.24	-34.31	21.57	-8.82
dk22-Gy5.5	49.02	19.61	-29.41	16.67	-33.33	-4.90	-42.16	-13.73	-12.75	-43.14	-28.43	-7.84	50.98	30.39
dk22-Bk	30.39	-50.00	-42.16	57.84	78.43	87.25	41.18	57.84	81.37	1.96	23.53	69.61	57.84	42.16
W-Gy5.5	-48.04	-43.14	-37.25	-20.59	44.12	32.35	64.71	-12.75	45.10	-41.18	-49.02	-25.49	46.08	28.43
W-Bk	-40.20	-14.71	-32.35	-31.37	48.04	2.94	49.02	-24.51	30.39	-21.57	-38.24	-38.24	8.82	-7.84
Gy5.5-Bk	-55.88	-7.84	-2.94	-39.22	55.88	12.75	60.78	-16.67	32.35	-17.65	-28.43	-22.55	3.92	-9.80

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Table B-2 Visual assessment values of color combination from Thai observers.

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V2-W	67.65	-18.63	50.00	36.27	48.04	71.57	22.55	67.65	34.31	70.59	59.80	78.43	18.63	8.82
V2-Gy5.5	59.80	-47.06	62.75	-3.92	60.78	60.78	55.88	52.94	42.16	55.88	68.63	71.57	-44.12	-30.39
V2-Bk	24.51	-61.76	58.82	-22.55	74.51	68.63	59.80	35.29	66.67	44.12	58.82	71.57	-18.63	15.69
V2-V8	78.43	-42.16	79.41	44.12	66.67	82.35	33.33	84.31	64.71	80.39	84.31	85.29	-11.76	10.78
V2-V12	46.08	-46.08	58.82	-19.61	68.63	76.47	63.73	75.49	38.24	76.47	88.24	82.35	-51.96	-22.55
V2-V18	48.04	-55.88	69.61	-16.67	78.43	73.53	64.71	66.67	62.75	58.82	78.43	76.47	-50.00	-26.47
V2-V22	29.41	-58.82	70.59	-25.49	72.55	65.69	57.84	51.96	10.78	71.57	80.39	77.45	-35.29	-26.47
V2-lt2	59.80	-15.69	52.94	39.22	33.33	61.76	18.63	66.67	-20.59	60.78	62.75	67.65	47.06	22.55
V2-lt8	83.33	-24.51	68.63	43.14	37.25	78.43	27.45	71.57	50.98	76.47	76.47	72.55	-13.73	11.76
V2-lt12	51.96	-26.47	30.39	31.37	31.37	47.06	-7.84	49.02	-17.65	52.94	60.78	61.76	-50.98	-41.18
V2-lt18	54.90	-49.02	56.86	35.29	56.86	68.63	-3.92	64.71	35.29	63.73	64.71	70.59	-41.18	-29.41
V2-lt22	63.73	-31.37	67.65	39.22	31.37	49.02	-11.76	59.80	-8.82	62.75	73.53	66.67	-19.61	-38.24
V2-d2	48.04	-37.25	72.55	-19.61	45.10	34.31	29.41	28.43	32.35	48.04	57.84	61.76	-33.33	-54.90
V2-d8	43.14	-37.25	63.73	-32.35	55.88	35.29	44.12	38.24	38.24	54.90	45.10	67.65	-62.75	-37.25
V2-d12	40.20	-48.04	56.86	-20.59	49.02	40.20	45.10	31.37	36.27	57.84	66.67	67.65	-66.67	-38.24
V2-d18	22.55	-52.94	51.96	-35.29	65.69	45.10	61.76	31.37	60.78	50.98	57.84	61.76	-51.96	-34.31
V2-d22	-4.90	-46.08	58.82	-33.33	73.53	24.51	55.88	-14.71	37.25	64.71	63.73	58.82	-41.18	-28.43
V2-dk2	39.22	-42.16	50.00	-28.43	60.78	38.24	45.10	50.00	37.25	43.14	54.90	63.73	39.22	5.88
V2-dk8	34.31	-47.06	56.86	-12.75	61.76	46.08	54.90	25.49	22.55	55.88	68.63	63.73	-68.63	-54.90
V2-dk12	29.41	-36.27	38.24	-33.33	64.71	52.94	53.92	41.18	53.92	58.82	72.55	63.73	-36.27	-11.76
V2-dk18	-12.75	-38.24	49.02	-21.57	73.53	61.76	55.88	9.80	55.88	32.35	58.82	52.94	-32.35	-12.75

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V2-dk22	-8.82	-53.92	48.04	-29.41	69.61	52.94	60.78	-4.90	50.98	41.18	65.69	62.75	11.76	-5.88
V8-W	83.33	28.43	37.25	72.55	25.49	73.53	-15.69	79.41	3.92	55.88	55.88	63.73	25.49	36.27
V8-Gy5.5	51.96	23.53	36.27	25.49	26.47	50.98	-5.88	50.00	-8.82	40.20	38.24	47.06	-15.69	-9.80
V8-Bk	45.10	-36.27	38.24	-26.47	69.61	74.51	61.76	53.92	63.73	54.90	59.80	84.31	-44.12	17.65
V8-V12	72.55	-30.39	21.57	46.08	53.92	78.43	-16.67	82.35	31.37	71.57	76.47	83.33	6.86	17.65
V8-V18	59.80	18.63	2.94	29.41	50.98	76.47	-5.88	80.39	22.55	63.73	76.47	73.53	-17.65	35.29
V8-V22	56.86	-22.55	49.02	18.63	70.59	79.41	50.00	77.45	31.37	66.67	79.41	77.45	4.90	18.63
V8-lt2	75.49	49.02	25.49	56.86	-18.63	37.25	-45.10	73.53	-33.33	54.90	52.94	53.92	-8.82	-1.96
V8-lt8	80.39	49.02	48.04	57.84	-15.69	56.86	-39.22	69.61	-15.69	50.98	34.31	49.02	64.71	22.55
V8-lt12	67.65	37.25	-8.82	60.78	-24.51	51.96	-35.29	64.71	-26.47	50.00	38.24	44.12	13.73	-20.59
V8-lt18	68.63	41.18	-11.76	53.92	-8.82	50.00	-45.10	72.55	-39.22	45.10	35.29	56.86	7.84	43.14
V8-lt22	70.59	37.25	15.69	53.92	-16.67	43.14	-44.12	64.71	-37.25	56.86	45.10	51.96	-33.33	-21.57
V8-d2	69.61	-33.33	41.18	22.55	36.27	48.04	-9.80	50.98	-8.82	45.10	61.76	61.76	-29.41	-13.73
V8-d8	69.61	23.53	32.35	40.20	14.71	39.22	-16.67	57.84	-12.75	41.18	40.20	47.06	56.86	-12.75
V8-d12	38.24	17.65	0.00	39.22	44.12	53.92	-4.90	52.94	-9.80	46.08	48.04	53.92	-15.69	3.92
V8-d18	46.08	-36.27	29.41	12.75	56.86	58.82	41.18	47.06	52.94	29.41	47.06	54.90	15.69	14.71
V8-d22	35.29	-21.57	34.31	-3.92	33.33	37.25	27.45	24.51	25.49	52.94	42.16	54.90	-18.63	-15.69
V8-dk2	47.06	-40.20	51.96	0.00	53.92	67.65	46.08	56.86	49.02	64.71	63.73	63.73	-19.61	-1.96
V8-dk8	40.20	-12.75	41.18	26.47	32.35	27.45	-19.61	33.33	-1.96	38.24	36.27	48.04	19.61	-3.92
V8-dk12	49.02	-16.67	19.61	17.65	54.90	65.69	19.61	64.71	31.37	55.88	59.80	71.57	4.90	6.86

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values												
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V8-dk18	46.08	-44.12	26.47	-0.98	62.75	74.51	57.84	60.78	54.90	57.84	58.82	66.67	7.84	7.84
V8-dk22	49.02	-18.63	36.27	19.61	63.73	66.67	29.41	55.88	40.20	48.04	48.04	59.80	-35.29	8.82
V12-W	65.69	38.24	-46.08	53.92	44.12	64.71	-41.18	66.67	2.94	9.80	27.45	61.76	0.98	19.61
V12-Gy5.5	2.94	-23.53	-12.75	-30.39	-11.76	-0.98	-11.76	-13.73	-10.78	-15.69	-17.65	24.51	-40.20	-49.02
V12-Bk	-11.76	-48.04	-36.27	-29.41	66.67	69.61	61.76	37.25	50.98	-5.88	28.43	46.08	-11.76	2.94
V12-V18	15.69	-5.88	-28.43	-16.67	50.00	35.29	43.14	53.92	42.16	20.59	46.08	48.04	24.51	16.67
V12-V22	20.59	-44.12	-5.88	-19.61	68.63	58.82	63.73	30.39	43.14	35.29	60.78	63.73	-17.65	3.92
V12-lt2	60.78	-15.69	2.94	35.29	31.37	56.86	-15.69	61.76	-12.75	47.06	58.82	57.84	-30.39	-25.49
V12-lt8	72.55	30.39	-7.84	47.06	32.35	69.61	-14.71	71.57	9.80	72.55	69.61	70.59	23.53	24.51
V12-lt12	54.90	40.20	-50.98	52.94	-14.71	53.92	-29.41	59.80	-2.94	21.57	25.49	41.18	53.92	26.47
V12-lt18	40.20	27.45	-49.02	25.49	23.53	14.71	-19.61	35.29	-18.63	-20.59	21.57	25.49	-11.76	-12.75
V12-lt22	58.82	22.55	-38.24	34.31	29.41	25.49	-40.20	29.41	-23.53	31.37	22.55	31.37	-61.76	-44.12
V12-d2	5.88	-26.47	-23.53	-25.49	21.57	-21.57	34.31	-21.57	21.57	25.49	-2.94	4.90	-50.98	-61.76
V12-d8	46.08	-28.43	-7.84	-2.94	25.49	-10.78	-17.65	-1.96	23.53	39.22	32.35	34.31	-40.20	-16.67
V12-d12	-17.65	2.94	-62.75	-41.18	51.96	-16.67	27.45	-24.51	17.65	-15.69	-23.53	41.18	50.98	-17.65
V12-d18	-18.63	-21.57	-28.43	-47.06	39.22	-17.65	33.33	-21.57	22.55	-12.75	12.75	19.61	-6.86	-42.16
V12-d22	-26.47	-29.41	-33.33	-48.04	30.39	-13.73	40.20	-26.47	18.63	-27.45	10.78	25.49	-57.84	-67.65
V12-dk2	-33.33	-50.98	-18.63	-39.22	51.96	29.41	45.10	-20.59	33.33	3.92	28.43	40.20	-42.16	-37.25
V12-dk8	-14.71	-21.57	-30.39	-20.59	42.16	-30.39	35.29	-31.37	-8.82	-8.82	-11.76	18.63	-28.43	-34.31
V12-dk12	29.41	-12.75	-44.12	-28.43	50.98	35.29	29.41	34.31	41.18	-0.98	-19.61	45.10	55.88	22.55

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V12-dk18	-14.71	-46.08	-27.45	-40.20	58.82	26.47	49.02	-12.75	35.29	-7.84	19.61	36.27	-18.63	-16.67
V12-dk22	-32.35	-46.08	-24.51	-49.02	62.75	47.06	65.69	-4.90	54.90	-9.80	42.16	45.10	-35.29	-35.29
V18-W	70.59	0.00	-43.14	43.14	32.35	67.65	-14.71	63.73	29.41	0.98	17.65	57.84	30.39	48.04
V18-Gy5.5	20.59	22.55	-43.14	-21.57	32.35	1.96	-18.63	-8.82	24.51	-19.61	-9.80	-10.78	0.00	15.69
V18-Bk	-42.16	-39.22	-39.22	-53.92	74.51	66.67	66.67	-10.78	71.57	-35.29	-30.39	52.94	17.65	38.24
V18-V22	-16.67	-39.22	-5.88	-25.49	56.86	36.27	50.00	0.00	37.25	22.55	48.04	48.04	19.61	-10.78
V18-lt2	48.04	28.43	8.82	22.55	18.63	50.98	-14.71	48.04	-28.43	59.80	54.90	56.86	-28.43	1.96
V18-lt8	70.59	53.92	-32.35	48.04	30.39	60.78	-21.57	50.00	-2.94	32.35	-13.73	48.04	35.29	48.04
V18-lt12	52.94	27.45	-33.33	16.67	27.45	46.08	-30.39	50.98	-14.71	-12.75	26.47	42.16	12.75	28.43
V18-lt18	45.10	54.90	-53.92	25.49	31.37	58.82	-26.47	36.27	24.51	-15.69	-15.69	50.98	68.63	68.63
V18-lt22	38.24	-7.84	-45.10	15.69	-10.78	12.75	-24.51	-6.86	-23.53	-15.69	-5.88	30.39	-23.53	-24.51
V18-d2	-18.63	-36.27	14.71	-35.29	40.20	-19.61	31.37	-28.43	24.51	29.41	-7.84	21.57	-48.04	-39.22
V18-d8	-4.90	-9.80	-27.45	-16.67	33.33	19.61	15.69	-22.55	22.55	-6.86	18.63	26.47	-27.45	-5.88
V18-d12	-3.92	-17.65	-39.22	-28.43	29.41	24.51	27.45	19.61	18.63	-18.63	-24.51	22.55	-26.47	-26.47
V18-d18	-48.04	-24.51	-28.43	-44.12	57.84	-14.71	56.86	-27.45	54.90	-28.43	-26.47	-1.96	50.00	7.84
V18-d22	-48.04	-30.39	-19.61	-64.71	61.76	-23.53	53.92	-53.92	27.45	-25.49	-19.61	25.49	-31.37	-33.33
V18-dk2	-52.94	-55.88	27.45	-59.80	67.65	35.29	57.84	-26.47	47.06	-3.92	37.25	39.22	-53.92	-33.33
V18-dk8	-41.18	-50.98	-20.59	-55.88	61.76	-33.33	53.92	-50.98	25.49	7.84	-8.82	47.06	-51.96	-35.29
V18-dk12	-38.24	-26.47	-50.00	-58.82	60.78	-12.75	63.73	-40.20	53.92	-38.24	-23.53	20.59	-4.90	-14.71
V18-dk18	-33.33	1.96	-41.18	-39.22	57.84	-3.92	50.98	-21.57	52.94	-31.37	-25.49	32.35	50.98	31.37

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
V18-dk22	-39.22	-31.37	-16.67	-63.73	65.69	-13.73	59.80	-35.29	50.98	11.76	4.90	32.35	-25.49	-19.61
V22-W	63.73	40.20	-23.53	39.22	26.47	63.73	-20.59	49.02	12.75	33.33	32.35	48.04	27.45	32.35
V22-Gy5.5	-16.67	-38.24	-0.98	-20.59	31.37	-23.53	16.67	-14.71	-25.49	2.94	11.76	28.43	-21.57	-29.41
V22-Bk	-36.27	-50.98	-13.73	-45.10	69.61	-8.82	66.67	-36.27	69.61	-31.37	5.88	26.47	-58.82	-46.08
V22-lt2	52.94	-32.35	49.02	1.96	42.16	63.73	32.35	50.98	-13.73	50.00	73.53	71.57	-27.45	-34.31
V22-lt8	58.82	0.98	40.20	25.49	37.25	47.06	-9.80	59.80	-8.82	45.10	45.10	50.00	-2.94	14.71
V22-lt12	47.06	-24.51	-17.65	25.49	27.45	45.10	-9.80	41.18	-10.78	34.31	47.06	51.96	-29.41	-19.61
V22-lt18	46.08	37.25	-36.27	32.35	24.51	31.37	-12.75	30.39	-2.94	-3.92	-20.59	33.33	30.39	32.35
V22-lt22	45.10	40.20	4.90	15.69	26.47	32.35	-7.84	39.22	-23.53	-13.73	22.55	40.20	66.67	47.06
V22-d2	-13.73	-18.63	25.49	-26.47	50.98	-20.59	30.39	-26.47	17.65	36.27	30.39	45.10	-28.43	-13.73
V22-d8	38.24	-25.49	33.33	-25.49	50.00	26.47	36.27	-12.75	20.59	35.29	35.29	34.31	-45.10	-39.22
V22-d12	-36.27	-24.51	-21.57	-53.92	35.29	-30.39	21.57	-41.18	22.55	-16.67	-20.59	0.98	-29.41	-35.29
V22-d18	-36.27	-24.51	-10.78	-56.86	69.61	-37.25	58.82	-57.84	31.37	-18.63	-40.20	22.55	-28.43	-31.37
V22-d22	-48.04	18.63	-19.61	-56.86	47.06	-35.29	46.08	-45.10	-12.75	-32.35	-19.61	-8.82	48.04	-21.57
V22-dk2	-26.47	-18.63	38.24	-50.00	70.59	-12.75	59.80	-30.39	7.84	22.55	31.37	39.22	15.69	-15.69
V22-dk8	-36.27	-50.98	21.57	-59.80	69.61	-8.82	54.90	-36.27	14.71	19.61	25.49	26.47	-58.82	-46.08
V22-dk12	-31.37	-54.90	-8.82	-62.75	65.69	-5.88	58.82	-34.31	44.12	22.55	49.02	45.10	-28.43	-42.16
V22-dk18	-56.86	-35.29	-11.76	-63.73	68.63	-15.69	57.84	-52.94	56.86	-34.31	-18.63	31.37	16.67	-3.92
V22-dk22	-37.25	-28.43	20.59	-53.92	64.71	30.39	62.75	-20.59	44.12	11.76	5.88	57.84	41.18	9.80
lt2-W	73.53	70.59	4.90	56.86	-32.35	45.10	-62.75	46.08	-58.82	-7.84	-30.39	33.33	50.00	42.16

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt2-Gy5.5	24.51	24.51	12.75	9.80	-31.37	-22.55	-27.45	-28.43	-42.16	-18.63	-23.53	1.96	-21.57	-8.82
lt2-Bk	17.65	-36.27	27.45	-16.67	39.22	50.00	26.47	25.49	39.22	33.33	34.31	51.96	-32.35	13.73
lt2-lt8	82.35	60.78	33.33	53.92	-28.43	39.22	-50.98	53.92	-36.27	50.98	44.12	35.29	20.59	17.65
lt2-lt12	53.92	50.98	-13.73	44.12	-25.49	28.43	-47.06	53.92	-50.98	33.33	29.41	27.45	-15.69	1.96
lt2-lt18	54.90	69.61	-30.39	44.12	-49.02	36.27	-60.78	53.92	-53.92	17.65	-18.63	1.96	17.65	47.06
lt2-lt22	63.73	56.86	-1.96	54.90	-45.10	-13.73	-52.94	43.14	-48.04	28.43	14.71	17.65	43.14	21.57
lt2-d2	27.45	59.80	13.73	-3.92	-27.45	-23.53	-35.29	-12.75	-49.02	-20.59	-26.47	-26.47	66.67	24.51
lt2-d8	32.35	46.08	13.73	22.55	-43.14	-20.59	-20.59	-5.88	-37.25	13.73	-9.80	12.75	-21.57	3.92
lt2-d12	18.63	32.35	-28.43	-15.69	-17.65	-13.73	-21.57	9.80	-27.45	19.61	21.57	23.53	-23.53	3.92
lt2-d18	28.43	34.31	-28.43	-16.67	-10.78	-14.71	-2.94	-20.59	-16.67	-9.80	-13.73	-6.86	-27.45	-10.78
lt2-d22	31.37	48.04	-15.69	21.57	-33.33	-28.43	-50.98	-14.71	-49.02	-14.71	-20.59	-18.63	28.43	17.65
lt2-dk2	30.39	37.25	22.55	-3.92	21.57	-8.82	-15.69	-20.59	-20.59	24.51	21.57	16.67	26.47	20.59
lt2-dk8	37.25	-27.45	41.18	-19.61	39.22	29.41	26.47	3.92	-6.86	27.45	37.25	42.16	-50.98	-50.00
lt2-dk12	20.59	-14.71	-17.65	-23.53	31.37	-10.78	32.35	-5.88	-6.86	17.65	25.49	27.45	-49.02	-32.35
lt2-dk18	22.55	37.25	7.84	-32.35	29.41	30.39	23.53	0.98	0.98	8.82	2.94	37.25	-29.41	13.73
lt2-dk22	32.35	-13.73	25.49	-17.65	33.33	44.12	23.53	13.73	6.86	38.24	37.25	53.92	11.76	15.69
lt8-W	80.39	58.82	-32.35	66.67	-53.92	-3.92	-64.71	45.10	-47.06	-17.65	-35.29	-20.59	38.24	26.47
lt8-Gy5.5	39.22	40.20	-30.39	23.53	-41.18	-18.63	-39.22	-20.59	-40.20	-14.71	-22.55	-11.76	-11.76	11.76
lt8-Bk	43.14	-17.65	20.59	-18.63	33.33	46.08	18.63	41.18	25.49	35.29	33.33	55.88	-12.75	16.67
lt8-lt12	74.51	78.43	-53.92	63.73	-64.71	-1.96	-70.59	45.10	-52.94	8.82	-34.31	-30.39	32.35	34.31

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt8-lt18	82.35	68.63	-45.10	64.71	-39.22	37.25	-61.76	56.86	-45.10	33.33	-9.80	18.63	33.33	51.96
lt8-lt22	73.53	76.47	-41.18	61.76	-57.84	-8.82	-66.67	27.45	-57.84	29.41	-8.82	-7.84	31.37	52.94
lt8-d2	45.10	30.39	26.47	11.76	-27.45	16.67	-30.39	18.63	-25.49	25.49	12.75	-8.82	16.67	-3.92
lt8-d8	54.90	66.67	-0.98	29.41	-39.22	1.96	-40.20	20.59	-48.04	-5.88	-25.49	-0.98	52.94	41.18
lt8-d12	63.73	42.16	-46.08	29.41	-28.43	-23.53	-33.33	26.47	-34.31	-19.61	-23.53	-16.67	27.45	10.78
lt8-d18	28.43	-9.80	-28.43	15.69	10.78	49.02	-16.67	12.75	6.86	21.57	12.75	16.67	9.80	18.63
lt8-d22	42.16	37.25	19.61	19.61	-8.82	25.49	-14.71	11.76	-21.57	26.47	-13.73	19.61	-7.84	-0.98
lt8-dk2	46.08	32.35	15.69	28.43	24.51	42.16	19.61	44.12	25.49	28.43	24.51	33.33	-2.94	27.45
lt8-dk8	37.25	1.96	30.39	17.65	15.69	30.39	-24.51	25.49	-17.65	22.55	-12.75	18.63	36.27	24.51
lt8-dk12	50.00	28.43	-27.45	9.80	47.06	55.88	13.73	39.22	-1.96	-15.69	16.67	49.02	19.61	39.22
lt8-dk18	19.61	-8.82	-19.61	-10.78	46.08	47.06	-0.98	33.33	25.49	26.47	26.47	34.31	-22.55	15.69
lt8-dk22	48.04	-22.55	27.45	13.73	44.12	57.84	41.18	27.45	30.39	31.37	36.27	44.12	-11.76	1.96
lt12-W	67.65	72.55	-66.67	71.57	-60.78	18.63	-70.59	23.53	-58.82	-46.08	-50.00	-43.14	53.92	44.12
lt12-Gy5.5	48.04	55.88	-44.12	15.69	-32.35	-36.27	-49.02	-32.35	-56.86	-26.47	-46.08	-56.86	7.84	11.76
lt12-Bk	36.27	5.88	-32.35	26.47	19.61	42.16	-7.84	18.63	31.37	-18.63	-13.73	37.25	-12.75	16.67
lt12-lt18	65.69	73.53	-69.61	65.69	-61.76	17.65	-59.80	51.96	-49.02	-20.59	-39.22	-44.12	55.88	56.86
lt12-lt22	69.61	75.49	-50.00	50.98	-66.67	-51.96	-62.75	-24.51	-64.71	-28.43	-36.27	-57.84	39.22	22.55
lt12-d2	39.22	31.37	-17.65	-3.92	-19.61	10.78	-19.61	-15.69	-41.18	-19.61	-17.65	-12.75	-48.04	-34.31
lt12-d8	52.94	44.12	-28.43	34.31	-28.43	-20.59	-35.29	-22.55	-34.31	-10.78	-26.47	-22.55	-25.49	-27.45
lt12-d12	50.00	67.65	-65.69	31.37	-19.61	-8.82	-55.88	21.57	-30.39	-48.04	-47.06	-12.75	75.49	60.78

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt12-d18	30.39	36.27	-49.02	3.92	-20.59	-16.67	-30.39	-28.43	-37.25	-33.33	-48.04	-36.27	18.63	16.67
lt12-d22	21.57	22.55	-32.35	-15.69	-22.55	-17.65	-29.41	-27.45	-19.61	-18.63	-17.65	-14.71	-8.82	-11.76
lt12-dk2	19.61	-36.27	-19.61	13.73	38.24	46.08	-7.84	14.71	-12.75	17.65	17.65	37.25	-34.31	-24.51
lt12-dk8	19.61	20.59	-26.47	3.92	-20.59	-19.61	-28.43	-20.59	-50.00	-29.41	-37.25	-32.35	-36.27	-43.14
lt12-dk12	42.16	37.25	-62.75	25.49	-5.88	38.24	-34.31	33.33	-13.73	-21.57	-33.33	21.57	46.08	38.24
lt12-dk18	39.22	21.57	-40.20	23.53	20.59	26.47	-4.90	21.57	-16.67	-20.59	-24.51	14.71	1.96	2.94
lt12-dk22	25.49	-14.71	-26.47	-29.41	38.24	30.39	18.63	-5.88	-9.80	10.78	-12.75	19.61	-49.02	-29.41
lt18-W	75.49	79.41	-68.63	67.65	-61.76	21.57	-71.57	66.67	-48.04	-19.61	-50.98	-24.51	69.61	77.45
lt18-Gy5.5	28.43	35.29	-50.98	25.49	-48.04	-28.43	-49.02	-28.43	-52.94	-34.31	-50.98	-24.51	29.41	34.31
lt18-Bk	14.71	-0.98	-31.37	-27.45	20.59	46.08	7.84	-6.86	8.82	-31.37	-32.35	-3.92	8.82	40.20
lt18-lt22	50.00	66.67	-56.86	47.06	-53.92	-26.47	-54.90	-14.71	-49.02	-28.43	-42.16	-32.35	37.25	32.35
lt18-d2	16.67	-14.71	13.73	-24.51	-19.61	-23.53	-20.59	-30.39	-27.45	-11.76	-22.55	-23.53	-28.43	-33.33
lt18-d8	32.35	47.06	-33.33	-19.61	-50.98	-34.31	-53.92	-35.29	-39.22	-49.02	-63.73	-45.10	25.49	12.75
lt18-d12	40.20	38.24	-53.92	31.37	-45.10	20.59	-36.27	-9.80	-36.27	-31.37	-40.20	-10.78	-14.71	15.69
lt18-d18	-16.67	43.14	-50.00	-28.43	-8.82	-26.47	-20.59	-30.39	12.75	-47.06	-55.88	-17.65	59.80	52.94
lt18-d22	39.22	40.20	-32.35	23.53	-18.63	-11.76	-26.47	-15.69	-33.33	-5.88	-21.57	-19.61	8.82	13.73
lt18-dk2	24.51	-16.67	-11.76	-19.61	31.37	30.39	25.49	-21.57	17.65	-5.88	-13.73	30.39	-45.10	-18.63
lt18-dk8	24.51	-3.92	-29.41	-1.96	-20.59	-19.61	-22.55	-17.65	-27.45	-8.82	-20.59	-26.47	-43.14	-34.31
lt18-dk12	15.69	0.00	-52.94	-18.63	18.63	26.47	-7.84	-16.67	-11.76	-19.61	-19.61	28.43	-13.73	-34.31
lt18-dk18	18.63	41.18	-44.12	-24.51	-13.73	-20.59	-18.63	-23.53	24.51	-36.27	-48.04	-28.43	64.71	50.00

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
lt18-dk22	27.45	21.57	-27.45	-16.67	38.24	27.45	21.57	-23.53	-17.65	-13.73	-13.73	21.57	12.75	14.71
lt22-W	77.45	79.41	-59.80	40.20	-69.61	-8.82	-73.53	-1.96	-58.82	-16.67	-44.12	-46.08	39.22	59.80
lt22-Gy5.5	-23.53	47.06	-32.35	-24.51	-40.20	-51.96	-23.53	-51.96	-43.14	-36.27	-50.98	-51.96	24.51	-11.76
lt22-Bk	6.86	-5.88	-22.55	-20.59	30.39	15.69	-11.76	-30.39	-22.55	-23.53	-39.22	7.84	-21.57	-8.82
lt22-d2	24.51	36.27	14.71	-13.73	-29.41	-35.29	-26.47	-32.35	-48.04	-20.59	-25.49	-31.37	25.49	18.63
lt22-d8	31.37	36.27	-22.55	-1.96	-49.02	-34.31	-37.25	-30.39	-49.02	-7.84	-31.37	-32.35	-27.45	7.84
lt22-d12	29.41	35.29	-35.29	-10.78	-36.27	-22.55	-39.22	-35.29	-44.12	-35.29	-28.43	-33.33	-20.59	-19.61
lt22-d18	-7.84	32.35	-35.29	-18.63	-11.76	-18.63	-21.57	-43.14	-35.29	-48.04	-51.96	-37.25	9.80	20.59
lt22-d22	14.71	42.16	-35.29	-13.73	-15.69	-26.47	-22.55	-41.18	-39.22	-19.61	-41.18	-13.73	64.71	21.57
lt22-dk2	23.53	26.47	27.45	-20.59	24.51	11.76	22.55	-15.69	19.61	11.76	-18.63	18.63	38.24	0.98
lt22-dk8	15.69	28.43	-20.59	-13.73	-24.51	-43.14	-30.39	-43.14	-44.12	-20.59	-21.57	-25.49	-51.96	-39.22
lt22-dk12	27.45	24.51	-20.59	-29.41	-12.75	7.84	6.86	-23.53	-29.41	-10.78	-14.71	22.55	-46.08	-37.25
lt22-dk18	23.53	-11.76	-31.37	-1.96	24.51	-20.59	21.57	-27.45	-11.76	-23.53	-28.43	-18.63	-28.43	-15.69
lt22-dk22	-5.88	39.22	-39.22	-23.53	-4.90	30.39	14.71	-5.88	-7.84	-25.49	-36.27	32.35	67.65	44.12
d2-W	51.96	-0.98	-11.76	-5.88	-16.67	37.25	-15.69	-2.94	-4.90	-16.67	-24.51	8.82	-11.76	-10.78
d2-Gy5.5	-18.63	35.29	-18.63	-29.41	-34.31	-49.02	-33.33	-55.88	-37.25	-38.24	-44.12	-52.94	-14.71	-21.57
d2-Bk	-29.41	-32.35	22.55	-56.86	44.12	-10.78	40.20	-39.22	37.25	-39.22	-41.18	-4.90	-0.98	-16.67
d2-d8	-25.49	35.29	9.80	-21.57	-15.69	-44.12	-13.73	-52.94	-14.71	12.75	-26.47	-28.43	9.80	-24.51
d2-d12	-31.37	28.43	-29.41	-50.00	-12.75	-57.84	19.61	-51.96	-26.47	-28.43	-29.41	-25.49	-7.84	-24.51
d2-d18	-42.16	-12.75	-14.71	-55.88	-6.86	-42.16	-6.86	-55.88	-9.80	-24.51	-25.49	-36.27	15.69	-21.57

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
d2-d22	-32.35	34.31	9.80	-46.08	-18.63	-57.84	-16.67	-58.82	-29.41	-24.51	-27.45	-34.31	22.55	-9.80
d2-dk2	-18.63	27.45	28.43	-19.61	24.51	-23.53	35.29	-21.57	22.55	10.78	-16.67	-6.86	57.84	33.33
d2-dk8	-35.29	-25.49	11.76	-47.06	25.49	-41.18	25.49	-52.94	-19.61	-20.59	-15.69	-20.59	-22.55	-39.22
d2-dk12	-25.49	-10.78	-14.71	-40.20	2.94	-43.14	26.47	-47.06	-28.43	-12.75	-12.75	-1.96	-32.35	-38.24
d2-dk18	-58.82	-26.47	-15.69	-60.78	50.98	-31.37	50.00	-43.14	32.35	-29.41	-26.47	-17.65	-7.84	1.96
d2-dk22	-48.04	-24.51	-8.82	-62.75	49.02	-23.53	48.04	-53.92	23.53	13.73	-7.84	4.90	22.55	-15.69
d8-W	66.67	30.39	-20.59	31.37	-15.69	33.33	-41.18	12.75	-27.45	-8.82	-24.51	19.61	-10.78	24.51
d8-Gy5.5	-0.98	42.16	-24.51	-37.25	-20.59	-50.00	-30.39	-53.92	-31.37	-31.37	-55.88	-41.18	36.27	14.71
d8-Bk	-54.90	-34.31	11.76	-59.80	60.78	21.57	51.96	-39.22	35.29	-29.41	-27.45	-5.88	14.71	18.63
d8-d12	-27.45	26.47	-35.29	-40.20	-26.47	-54.90	-22.55	-66.67	-37.25	-43.14	-51.96	-50.98	34.31	0.98
d8-d18	-17.65	30.39	-29.41	-27.45	-27.45	-49.02	-4.90	-49.02	-28.43	-24.51	-28.43	-31.37	11.76	7.84
d8-d22	-15.69	14.71	-12.75	-45.10	-7.84	-33.33	17.65	-54.90	-25.49	-31.37	-26.47	-17.65	-26.47	-12.75
d8-dk2	-49.02	-31.37	11.76	-53.92	41.18	-10.78	39.22	-45.10	35.29	-21.57	-19.61	-11.76	16.67	17.65
d8-dk8	19.61	34.31	0.98	-38.24	-8.82	-32.35	-19.61	-42.16	-2.94	-40.20	-30.39	-17.65	66.67	20.59
d8-dk12	19.61	5.88	-18.63	-19.61	23.53	-5.88	22.55	-26.47	22.55	-19.61	-19.61	-10.78	11.76	4.90
d8-dk18	-55.88	-25.49	-27.45	-48.04	41.18	-29.41	44.12	-51.96	36.27	-28.43	-28.43	10.78	-1.96	-19.61
d8-dk22	-41.18	-22.55	-15.69	-39.22	50.00	-24.51	52.94	-44.12	29.41	-8.82	-15.69	12.75	-29.41	4.90
d12-W	46.08	21.57	-48.04	19.61	-20.59	18.63	-33.33	-1.96	-26.47	16.67	-33.33	-18.63	31.37	31.37
d12-Gy5.5	-47.06	-3.92	-45.10	-55.88	-31.37	-66.67	-14.71	-64.71	-41.18	-52.94	-45.10	-52.94	20.59	-27.45
d12-Bk	-56.86	-36.27	-46.08	-54.90	52.94	-38.24	44.12	-37.25	40.20	-29.41	-33.33	-17.65	0.00	7.84

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
d12-d18	-56.86	-39.22	-56.86	-63.73	30.39	-41.18	23.53	-50.98	26.47	-48.04	-48.04	-32.35	16.67	-5.88
d12-d22	-49.02	-18.63	-38.24	-52.94	22.55	-42.16	44.12	-50.98	-9.80	-36.27	-39.22	-29.41	-11.76	-27.45
d12-dk2	-46.08	-14.71	-33.33	-57.84	40.20	-24.51	45.10	-46.08	25.49	-20.59	-18.63	-2.94	-29.41	-1.96
d12-dk8	-53.92	-36.27	-30.39	-50.98	18.63	-42.16	25.49	-53.92	-10.78	-14.71	-30.39	-15.69	-41.18	-31.37
d12-dk12	-38.24	43.14	-60.78	-50.98	44.12	-37.25	38.24	-34.31	13.73	-54.90	-56.86	-14.71	76.47	37.25
d12-dk18	-50.00	-17.65	-46.08	-56.86	44.12	-40.20	46.08	-45.10	32.35	-34.31	-43.14	-15.69	4.90	-0.98
d12-dk22	-52.94	-26.47	-34.31	-67.65	69.61	-33.33	62.75	-44.12	45.10	-43.14	-35.29	16.67	-30.39	-22.55
d18-W	23.53	31.37	-45.10	-17.65	-18.63	-25.49	-20.59	-28.43	-19.61	-38.24	-49.02	-33.33	39.22	32.35
d18-Gy5.5	-57.84	-25.49	-39.22	-72.55	61.76	-5.88	66.67	-53.92	59.80	-44.12	-51.96	-2.94	43.14	34.31
d18-Bk	-40.20	29.41	-44.12	-54.90	-8.82	-53.92	13.73	-59.80	-15.69	-43.14	-63.73	-50.00	50.98	20.59
d18-d22	-60.78	-3.92	-32.35	-67.65	28.43	-60.78	44.12	-58.82	13.73	-45.10	-44.12	-44.12	33.33	8.82
d18-dk2	-53.92	-13.73	-6.86	-58.82	48.04	-27.45	45.10	-49.02	42.16	-19.61	-23.53	12.75	14.71	-4.90
d18-dk8	-51.96	-17.65	-20.59	-66.67	48.04	-42.16	42.16	-57.84	25.49	-40.20	-48.04	-29.41	-27.45	-41.18
d18-dk12	-73.53	-23.53	-47.06	-78.43	59.80	-60.78	52.94	-67.65	31.37	-42.16	-54.90	-31.37	32.35	-8.82
d18-dk18	-64.71	0.98	-54.90	-71.57	65.69	-43.14	48.04	-56.86	64.71	-55.88	-57.84	-16.67	81.37	50.00
d18-dk22	-64.71	-22.55	-30.39	-61.76	73.53	-34.31	62.75	-57.84	45.10	-50.00	-54.90	38.24	26.47	13.73
d22-W	35.29	15.69	-31.37	18.63	-7.84	28.43	-20.59	-6.86	-21.57	-16.67	-24.51	-17.65	11.76	20.59
d22-Gy5.5	-44.12	32.35	-34.31	-52.94	-26.47	-48.04	-21.57	-71.57	-35.29	-51.96	-55.88	-47.06	23.53	0.00
d22-Bk	-56.86	-28.43	-33.33	-76.47	65.69	-19.61	59.80	-54.90	39.22	-44.12	-49.02	21.57	32.35	14.71
d22-dk2	-56.86	-39.22	34.31	-60.78	64.71	-39.22	62.75	-57.84	31.37	-27.45	10.78	31.37	21.57	-15.69

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
d22-dk8	-51.96	-19.61	-9.80	-60.78	41.18	-50.00	29.41	-58.82	-12.75	-26.47	-17.65	-20.59	-4.90	-25.49
d22-dk12	-70.59	-36.27	-35.29	-74.51	69.61	-55.88	64.71	-67.65	34.31	-47.06	-41.18	-20.59	14.71	-23.53
d22-dk18	-70.59	-22.55	-35.29	-67.65	34.31	-48.04	45.10	-57.84	28.43	-55.88	-50.98	-24.51	41.18	17.65
d22-dk22	-66.67	-10.78	-35.29	-59.80	74.51	-30.39	7.84	-61.76	-13.73	-43.14	-47.06	31.37	82.35	47.06
dk2-W	35.29	-18.63	-14.71	-22.55	52.94	69.61	29.41	18.63	50.00	-28.43	-36.27	50.00	21.57	33.33
dk2-Gy5.5	-43.14	-12.75	12.75	-55.88	41.18	-17.65	38.24	-51.96	31.37	-33.33	-40.20	-14.71	16.67	-11.76
dk2-Bk	-77.45	-50.00	16.67	-79.41	75.49	33.33	67.65	-49.02	73.53	-53.92	-46.08	33.33	50.98	22.55
dk2-dk8	-27.45	-29.41	27.45	-48.04	57.84	-31.37	48.04	-48.04	19.61	27.45	-18.63	-11.76	3.92	11.76
dk2-dk12	-54.90	-37.25	-16.67	-59.80	70.59	-14.71	61.76	-52.94	34.31	-25.49	-2.94	24.51	14.71	4.90
dk2-dk18	-67.65	-40.20	-16.67	-72.55	78.43	-9.80	72.55	-54.90	57.84	-34.31	-25.49	32.35	18.63	12.75
dk2-dk22	-80.39	-55.88	32.35	-75.49	73.53	-13.73	70.59	-54.90	53.92	-28.43	-1.96	28.43	39.22	3.92
dk8-W	39.22	9.80	-22.55	14.71	-3.92	34.31	-20.59	-12.75	-19.61	-13.73	-10.78	18.63	-10.78	3.92
dk8-Gy5.5	-17.65	25.49	-19.61	-40.20	-17.65	-50.00	-17.65	-50.98	-20.59	-28.43	-27.45	-26.47	12.75	-16.67
dk8-Bk	-68.63	-43.14	-21.57	-57.84	61.76	-27.45	70.59	-63.73	53.92	-49.02	-33.33	30.39	10.78	-11.76
dk8-dk12	-63.73	18.63	-21.57	-60.78	56.86	-50.98	50.98	-58.82	14.71	-36.27	-37.25	-29.41	20.59	-4.90
dk8-dk18	-45.10	-21.57	-29.41	-48.04	56.86	-27.45	49.02	-52.94	27.45	-37.25	-23.53	6.86	-17.65	-24.51
dk8-dk22	-63.73	-29.41	12.75	-68.63	63.73	-30.39	69.61	-63.73	35.29	-34.31	-43.14	35.29	-29.41	-38.24
dk12-W	35.29	21.57	-38.24	-18.63	34.31	52.94	-12.75	24.51	38.24	-13.73	-24.51	34.31	-0.98	1.96
dk12-Gy5.5	-58.82	-4.90	-55.88	-56.86	5.88	-41.18	39.22	-49.02	-22.55	-50.98	-55.88	-26.47	25.49	12.75
dk12-Bk	-76.47	-36.27	-47.06	-68.63	70.59	-16.67	71.57	-58.82	57.84	-56.86	-54.90	-2.94	43.14	21.57

Table B-2 Visual assessment values of color combination from Thai observers. (cont.)

color combination	Visual Assessment Values													
	dark-light	hard-soft	cool-warn	turbid-transparent	pale-deep	vague-distinct	light-heavy	sombre-vivid	weak-strong	passive-dynamic	plain-gaudy	subdued-striking	disharmony-harmony	dislike-like
dk12-dk18	-68.63	-30.39	-46.08	-68.63	70.59	-39.22	57.84	-61.76	53.92	-45.10	-45.10	-10.78	19.61	6.86
dk12-dk22	-67.65	-40.20	-30.39	-68.63	59.80	-34.31	50.98	-50.98	44.12	-29.41	-28.43	25.49	-0.98	-18.63
dk18-W	35.29	-8.82	-38.24	-17.65	37.25	48.04	21.57	-5.88	40.20	-36.27	-38.24	35.29	22.55	47.06
dk18-Gy5.5	-43.14	-10.78	-42.16	-46.08	41.18	-34.31	-4.90	-50.00	-4.90	-54.90	-55.88	-24.51	18.63	22.55
dk18-Bk	-84.31	-31.37	-34.31	-80.39	82.35	-25.49	75.49	-63.73	73.53	-69.61	-64.71	24.51	52.94	12.75
dk18-dk22	-78.43	-30.39	-38.24	-79.41	76.47	-19.61	75.49	-62.75	46.08	-50.00	-48.04	10.78	37.25	0.98
dk22-W	33.33	-21.57	-13.73	-1.96	45.10	48.04	42.16	-10.78	45.10	-11.76	-15.69	30.39	20.59	29.41
dk22-Gy5.5	-46.08	-20.59	-16.67	-39.22	23.53	-28.43	36.27	-50.98	-15.69	-28.43	-31.37	-15.69	13.73	-8.82
dk22-Bk	-85.29	-44.12	9.80	-83.33	71.57	-48.04	71.57	-73.53	53.92	-50.98	-47.06	-11.76	50.98	-15.69
W-Gy5.5	51.96	36.27	-53.92	30.39	-58.82	-33.33	-42.16	-49.02	-45.10	-57.84	-67.65	-49.02	36.27	30.39
W-Bk	28.43	-27.45	-20.59	-12.75	34.31	75.49	51.96	-19.61	45.10	-39.22	-40.20	61.76	-20.59	40.20
Gy5.5-Bk	-62.75	-26.47	-25.49	-62.75	42.16	-30.39	42.16	-64.71	39.22	-58.82	-66.67	-21.57	60.78	21.57

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Table B-3 Correlation coefficients between each of opponent word pairs in Japanese visual assessment.

r	D-L	H-S	C-W	T-T	P-D	V-D	L-H	S-V	W-S	P-Dy	P-G	S-S	DH-H	DL-L
D-L	1.00													
H-S	0.73	1.00												
C-W	0.52	0.74	1.00											
T-T	0.83	0.39	0.22	1.00										
P-D	-0.54	-0.80	-0.34	-0.21	1.00									
V-D	0.11	-0.47	-0.15	0.44	0.70	1.00								
L-H	-0.89	-0.86	-0.46	-0.65	0.82	0.28	1.00							
S-V	0.67	0.12	0.17	0.90	0.14	0.72	-0.36	1.00						
W-S	-0.29	-0.71	-0.28	0.08	0.92	0.87	0.64	0.42	1.00					
P-Dy	0.65	0.35	0.64	0.60	0.08	0.52	-0.34	0.72	0.29	1.00				
P-G	0.76	0.31	0.43	0.83	0.02	0.60	-0.45	0.91	0.30	0.89	1.00			
S-S	0.68	0.17	0.34	0.79	0.13	0.71	-0.34	0.91	0.41	0.86	0.96	1.00		
DH-H	0.23	0.14	0.01	0.48	-0.03	0.13	-0.21	0.36	0.10	0.09	0.26	0.21	1.00	
DL-L	0.38	0.19	0.03	0.64	-0.09	0.22	-0.32	0.52	0.10	0.22	0.42	0.39	0.89	1.00

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Table B-4 Correlation coefficients between each of opponent word pairs in Thai visual assessment.

r	D-L	H-S	C-W	T-T	P-D	V-D	L-H	S-V	W-S	P-Dy	P-G	S-S	DH-H	DL-L
D-L	1.00													
H-S	0.48	1.00												
C-W	0.23	-0.42	1.00											
T-T	0.92	0.60	0.08	1.00										
P-D	-0.45	-0.84	0.37	-0.54	1.00									
V-D	0.65	-0.14	0.46	0.54	0.25	1.00								
L-H	-0.66	-0.85	0.29	-0.76	0.88	-0.02	1.00							
S-V	0.84	0.16	0.40	0.78	-0.05	0.86	-0.32	1.00						
W-S	-0.44	-0.79	0.29	-0.54	0.88	0.24	0.86	-0.07	1.00					
P-Dy	0.62	-0.15	0.73	0.51	0.17	0.72	-0.03	0.79	0.09	1.00				
P-G	0.48	-0.34	0.74	0.36	0.36	0.74	0.15	0.74	0.25	0.91	1.00			
S-S	0.33	-0.45	0.61	0.21	0.59	0.82	0.34	0.66	0.50	0.74	0.83	1.00		
DH-H	-0.07	0.45	-0.35	0.07	-0.23	-0.19	-0.23	-0.09	-0.13	-0.39	-0.45	-0.32	1.00	
DL-L	0.27	0.53	-0.31	0.37	-0.27	0.18	-0.36	0.23	-0.14	-0.15	-0.25	-0.11	0.75	1.00

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Table B-5 Visual assessment values of single color form Japanese observers.

	V2	V8	V12	V18	V22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy	Bk
D-L	79.41	91.18	66.67	37.25	6.86	65.69	86.27	77.45	67.65	69.61	-3.92	11.76	39.22	-43.14	-38.24	-32.35	-17.65	-14.71	-36.27	-68.63	97.06	19.61	-76.47
H-S	12.75	26.47	33.33	-20.59	-7.84	66.67	51.96	63.73	40.20	68.63	27.45	33.33	39.22	-34.31	8.82	-3.92	15.69	14.71	-32.35	-34.31	28.43	21.57	-72.55
C-W	59.80	39.22	18.63	-40.20	-7.84	69.61	46.08	30.39	-23.53	30.39	49.02	36.27	24.51	-45.10	-2.94	31.37	14.71	11.76	-43.14	-28.43	-13.73	-35.29	-45.10
T-T	60.78	60.78	57.84	55.88	29.41	44.12	61.76	62.75	57.84	49.02	-28.43	-41.18	6.86	-50.98	-53.92	-41.18	-50.00	-13.73	-38.24	-23.53	88.24	-26.47	-21.57
P-D	74.51	72.55	29.41	57.84	68.63	-39.22	-10.78	-54.90	-49.02	-64.71	0.00	-13.73	-31.37	24.51	25.49	37.25	6.86	35.29	54.90	74.51	14.71	-47.06	78.43
V-D	88.24	91.18	67.65	62.75	73.53	2.94	43.14	8.82	0.98	-22.55	-20.59	-27.45	-37.25	-23.53	-29.41	7.84	-22.55	10.78	12.75	51.96	81.37	-46.08	78.43
L-H	3.92	-38.24	-27.45	7.84	33.33	-45.10	-55.88	-63.73	-57.84	-70.59	9.80	-8.82	-28.43	43.14	36.27	48.04	24.51	27.45	53.92	71.57	-64.71	-15.69	83.33
S-V	86.27	89.22	66.67	63.73	56.86	32.35	64.71	62.75	44.12	30.39	-25.49	-43.14	6.86	-42.16	-42.16	-23.53	-45.10	-19.61	-30.39	-8.82	72.55	-31.37	-0.98
W-S	77.45	68.63	45.10	62.75	63.73	-1.96	29.41	-13.73	-23.53	-42.16	13.73	-15.69	-31.37	2.94	11.76	38.24	-2.94	22.55	36.27	58.82	63.73	-29.41	69.61
P-Dy	73.53	71.57	26.47	-4.90	12.75	44.12	54.90	11.76	-11.76	12.75	22.55	-17.65	-15.69	-50.00	-39.22	10.78	-34.31	-13.73	-53.92	-45.10	-11.76	-46.08	-61.76
P-G	89.22	87.25	45.10	33.33	55.88	52.94	72.55	42.16	24.51	36.27	1.96	-42.16	-9.80	-55.88	-27.45	-10.78	-53.92	-21.57	-48.04	-26.47	31.37	-55.88	-34.31
S-S	89.22	89.22	50.00	37.25	60.78	54.90	81.37	44.12	37.25	35.29	11.76	-38.24	1.96	-45.10	-25.49	11.76	-40.20	-13.73	-32.35	2.94	60.78	-60.78	6.86

Table B-6 Visual assessment values of single color form Thai observers.

	V2	V8	V12	V18	V22	lt2	lt8	lt12	lt18	lt22	d2	d8	d12	d18	d22	dk2	dk8	dk12	dk18	dk22	W	Gy	Bk
D-L	79.41	91.18	66.67	37.25	6.86	65.69	86.27	77.45	67.65	69.61	-3.92	11.76	39.22	-43.14	-38.24	-32.35	-17.65	-14.71	-36.27	-68.63	97.06	19.61	-76.47
H-S	12.75	26.47	33.33	-20.59	-7.84	66.67	51.96	63.73	40.20	68.63	27.45	33.33	39.22	-34.31	8.82	-3.92	15.69	14.71	-32.35	-34.31	28.43	21.57	-72.55
C-W	59.80	39.22	18.63	-40.20	-7.84	69.61	46.08	30.39	-23.53	30.39	49.02	36.27	24.51	-45.10	-2.94	31.37	14.71	11.76	-43.14	-28.43	-13.73	-35.29	-45.10
T-T	60.78	60.78	57.84	55.88	29.41	44.12	61.76	62.75	57.84	49.02	-28.43	-41.18	6.86	-50.98	-53.92	-41.18	-50.00	-13.73	-38.24	-23.53	88.24	-26.47	-21.57
P-D	74.51	72.55	29.41	57.84	68.63	-39.22	-10.78	-54.90	-49.02	-64.71	0.00	-13.73	-31.37	24.51	25.49	37.25	6.86	35.29	54.90	74.51	14.71	-47.06	78.43
V-D	88.24	91.18	67.65	62.75	73.53	2.94	43.14	8.82	0.98	-22.55	-20.59	-27.45	-37.25	-23.53	-29.41	7.84	-22.55	10.78	12.75	51.96	81.37	-46.08	78.43
L-H	3.92	-38.24	-27.45	7.84	33.33	-45.10	-55.88	-63.73	-57.84	-70.59	9.80	-8.82	-28.43	43.14	36.27	48.04	24.51	27.45	53.92	71.57	-64.71	-15.69	83.33
S-V	86.27	89.22	66.67	63.73	56.86	32.35	64.71	62.75	44.12	30.39	-25.49	-43.14	6.86	-42.16	-42.16	-23.53	-45.10	-19.61	-30.39	-8.82	72.55	-31.37	-0.98
W-S	77.45	68.63	45.10	62.75	63.73	-1.96	29.41	-13.73	-23.53	-42.16	13.73	-15.69	-31.37	2.94	11.76	38.24	-2.94	22.55	36.27	58.82	63.73	-29.41	69.61
P-Dy	73.53	71.57	26.47	-4.90	12.75	44.12	54.90	11.76	-11.76	12.75	22.55	-17.65	-15.69	-50.00	-39.22	10.78	-34.31	-13.73	-53.92	-45.10	-11.76	-46.08	-61.76
P-G	89.22	87.25	45.10	33.33	55.88	52.94	72.55	42.16	24.51	36.27	1.96	-42.16	-9.80	-55.88	-27.45	-10.78	-53.92	-21.57	-48.04	-26.47	31.37	-55.88	-34.31
S-S	89.22	89.22	50.00	37.25	60.78	54.90	81.37	44.12	37.25	35.29	11.76	-38.24	1.96	-45.10	-25.49	11.76	-40.20	-13.73	-32.35	2.94	60.78	-60.78	6.86

APPENDIX C

OPPONENT WORD PAIRS AND QUESTIONNAIRE USED FOR THE VISUAL ASSESSMENTS

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Table C-1 The opponent word pairs used for the visual assessments. (5)

Symbol	Japanese	English	Thai
LD	Kurui - Akarai	Dark - Light	Mued - Sawang
HS	Katai - Yawarakai	Hard - Soft	Kangkradang - Numnual
CW	Tsumetai - Atatakai	Cool - Warm	Yen - Ron
TT	Nigoota - Sunda	Turbid - Transparent	Tueb - Prongsai
PD	Awai - Koi	Pale - Deep	Jang - Khem
VD	Bonyarishita - Hakkirishita	Vague - Distinct	Seed - Dodden
LH	Karui - Omoi	Light - Heavy	Bow - Nuck
SV	Kusunda - Azayakana	Sombre - Vivid	Mon - Sodsai
WS	Yowai - Tsuyoi	Weak - Strong	Oanaer - Khemkang
PDY	Seitekina - Doutekina	Passive - Dynamic	Sangobning - Kloenwai
PD	Jimina - Hadena	Plain - Gaudy	Reab - Choodchad
SS	Medatanai - Medatsu	Subdued - Striking	Kamukkamoe - Chadjan
DHH	Chowa - Fuchowana[1]	Harmony - Disharmony	
DLL	Suki - Kirai[1]	Like - Dislike	
Assessed in	Japan	UK	Thailand

[1]Word pairs that were translated by Mr.Satoshi Sakai, master degree student of Colour Science at the Department of Design Engineering and Management, Faculty of Textile Science, KIT, Japan.

アンケート

Quantitative Analysis of Thai and Japanese Sensation on Color Combination

名前 ____________________ 年齢 ______ 性別 ______

(Japanese/English)

所属 ______ 大学(会社) ______ 学科(部署) ______ 回生 ______

日時 ______ 月 ______ 日

Q. これから見せるカラーサンプルのペアについて、下記の回答例のようにその印象を答えてください。

回答例)

		非常に	かなり	やや	どちらでもない	やや	かなり	非常に		
1.	暗い						○		明るい	1. ☐

Color Combination

No.______

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サンプルペア（　　　）

No.____/__

		非常に	かなり	やや	どちらでもない	やや	かなり	非常に		
1.	暗い								明るい	1.
2.	硬い								柔らかい	2.
3.	冷たい								暖かい	3.
4.	濁った								澄んだ	4.
5.	淡い								濃い	5.
6.	ぼんやりした								はっきりした	6.
7.	軽い								重い	7.
8.	くすんだ								あざやかな	8.
9.	弱い								強い	9.
10.	静的な								動的な	10.
11.	地味な								派手な	11.
12.	目立たない								目立つ	12.
13.	不調和な								調和した	13.
14.	きらい								好き	14.

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VITA

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