THAI BASIC COLOR CATEGORIES AND MONOLEXEMIC COLOR TERMS

NISCHANADE CHITAPANYA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE
PROGRAM IN COLOR TECHNOLOGY AND DESIGN
FACULTY OF MASS COMMUNICATION OF TECHNOLOGY
RAJAMANGALA UNIVERSITY OF TECHNOLOGY THANYABURI
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Thesis Title	Thai Basic Color Categories and Monolexemic Color Terms
Name - Surname	Mrs. Nischanade Chitapanya
Program	Color Technology and Design
Thesis Advisor	Assistant Professor Chanprapha Phuangsuwan, Ph.D.
Thesis Co-advisor	Professor Mitsuo Ikeda, Ph.D.
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THESIS COMMITTEE

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(Associate Professor Pichayada Katemake, Ph.D.)

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(Assistant Professor Chanprapha Phuangsuwan, Ph.D.)

Mitsuo Ikeda .... Committee
(Professor Mitsuo Ikeda, Ph.D.)

Approved by the Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi in Partial Fulfillment of the Requirements for the Master's Degree

P. Dolkit ....Dean of Faculty of Mass Communication Technology
(Assistant Professor Prapaporn Dolkit, Ed.D.)

Date 1 Month November Years 2021

หัวข้อวิทยานิพนธ์	กลุ่มสีพื้นฐานของไทยและคำเรียกสีที่มีรูปศัพท์เดี่ยว
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สาขาวิชา	เทคโนโลยีสีและการออกแบบ
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อาจารย์ที่ปรึกษาร่วม	ศาสตราจารย์มิสึโอะ อิเคดะ, Ph.D.
ปีการศึกษา	2564

บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาจำนวนของกลุ่มสีพื้นฐานของไทยและที่มาของการใช้คำเรียกสีในภาษาไทย โดยทำการเก็บข้อมูลจากกลุ่มตัวอย่างชาวไทยจำนวน 161 คน โดยใช้แผ่นสีมันเซลล์ จำนวน 330 แผ่น ซึ่งเป็นชุดสีทดสอบดังกล่าวคล้ายกับชุดสีทดสอบที่ใช้ในโครงการสำรวจสีโลก (Word Color Survey) ผู้วิจัยขอให้กลุ่มตัวอย่างบอกชื่อสีสำหรับแต่ละแผ่นสี โดยกลุ่มตัวอย่างที่เข้าร่วมการศึกษานี้ทุกคนมีการมองเห็นสีปกติ ซึ่งทดสอบโดยใช้ the Farnsworth Munsell D-15 Color Vision Test

ผลการศึกษา พบว่า ค่าเฉลี่ยของจำนวนการใช้คำเรียกของกลุ่มตัวอย่างแต่ละคนอยู่ที่ 19.15 ± 5.21 โดยในจำนวนนี้พบว่ามีคำเรียกสี 12 คำ ที่ถูกใช้มากถึงร้อยละ 80 ของกลุ่มตัวอย่าง ประกอบด้วย คำเรียกสีที่มีความสอดคล้องกับ 11 สีพื้นฐานที่พบในการศึกษาของเบอร์ลินและเคย์ในปี 1969 และ สีฟ้า ซึ่งในการศึกษาของเบอร์ลินและเคย์นั้นได้จัดกลุ่มสีฟ้าและสีน้ำเงินให้อยู่ในกลุ่มเดียวกัน และผู้วิจัยยังพบว่ากลุ่มตัวอย่างในการศึกษานี้มักใช้คำเรียกสีส้มแทนสีแสด ต่างจากที่พบในการศึกษาของเบอร์ลินและเคย์และพบว่าสีเทาถูกใช้เรียกแผ่นสีทดสอบที่ไม่มีสี (achromatic) ที่มีความสว่างอยู่ระหว่างขาวและดำ นอกจากนี้ยังพบว่า มีคำเรียกสีไม่พื้นฐานที่ถูกใช้โดยกลุ่มตัวอย่างมากกว่าร้อยละ 50 เช่น สีขี้ม้า ที่มีการใช้ถึงร้อยละ 75 สีเลือดหมู ที่มีการใช้ถึงร้อยละ 68 และ สีบานเย็น ที่มีการใช้ถึงร้อยละ 50

จากการศึกษาที่มาของการใช้คำเรียกสีในภาษาไทย พบว่า คำเรียกสีส่วนใหญ่ที่ถูกใช้โดยกลุ่มตัวอย่างในการศึกษานี้มีแหล่งที่มาจากสีของพฤกษาถึงร้อยละ 31.72 โดยส่วนใหญ่เป็นชื่อของดอกไม้ รองลงมาคือวัตถุที่ไม่มีชีวิตตามธรรมชาติ โดยมีสัดส่วนที่ร้อยละ 17.54 ส่วนใหญ่เป็นชื่อของหินอัญมณี

คำสำคัญ: คำเรียกสีไทย การสำรวจคำเรียกสีโลก ที่มาของการใช้คำเรียกสี

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Name - Surname Mrs. Nischanade Chitapanya
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Thesis Co-advisor Professor Mitsuo Ikeda, Ph.D.
Academic Year 2021

ABSTRACT

The objectives of this study were to: 1) find the number of basic color categories used in Thailand and 2) investigate the derivation of Thai color names. There were 161 Thai native speakers participated, called subjects. The subjects were asked to provide color name for each of 330 Munsell color chips similar as used in the World Color Survey by using monolexemic color terms. All subjects were tested for their normal color vision by using the Farnsworth Munsell D-15 Color Vision Test, only subjects who pass the test could participate in the experiment.

The study results showed that the mean number of color terms used per subject was 19.15 ± 5.21. There were 12 color names used by ≥80% consensus of subjects, consisting of 11 colors which were corresponded to the basic color term (BCTs) as found by Berlin and Kay in 1969 plus *fa* ‘sky/light blue’. Notice that the result was changed from B&K studied for Thai BCTs. In this study, it was found that Thai subjects provided two categories for blues: *fa* and *nam-ngoen*. In addintion, *som* seems to be added to replace *saet*, and *thao* was added for achromatic. It was also found that three non-BCTs were used with ≥50% of the subjects; *khi-ma* ‘horse feces’ (75%), *lueat-mu* ‘pig blood’ (68%), and *ban-yen* ‘four o'clock flower/magenta’ (50%).

Regarding the derivation of color names, most color names used by Thai subjects were referred to objects in flora class (31.72%), followed by inanimate nature (17.54%). Which the flowers category and (semi-) precious stones category had the highest number of relevant color names in the flora and the inanimate nature classes, respectively.

Keywords: Thai color names, World Color Survey, derivation of color names

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Nischanade Chitapanya

Table of Contents

List of Tables

List of Figures

CHAPTER 1
INTRODUCTION

1.1 Background and Statement of the Problems

Color is important to our daily life because everything that surrounds us consists of colors and we use colors to characterize things in order to convey more specific and more accurate meaning for communication, for example, to identify the red apple, or specifying green curry. In addition, colors are also used as symbols to convey meaning, such as, in transportation, red, green, and yellow signals to tell drivers to stop, to go, or to leave traffic signal corner, and some cultures use white as a symbol for virtue, goodness, and freedom, or use black for wickedness, sobriety, and mystery.

People have invented color names to communicate about colors and there are various names of colors that are used in this world which are different according to the speaker's residence. In 1969, Berlin and Kay (B&K) [1] have investigated the color terminology systems of twenty languages and they proposed eleven basic color terms (11 BCTs) for a total universal list of color categories, though different languages used different numbers of basic color categories in their vocabularies, but in most languages have color terms drawn from theses 11 BCTs or fewer. The 11 BCTs are red, orange, yellow, green, blue, purple, pink, brown, gray, black, and white which are monolexemic used by the informants of those languages to communicate about the color of any type of object and that color name not covered by any other basic color terms. In addition, they also proposed an idea of an evolutionary of color terms that are associated with cultural complexity, a culture that is simple and not technologically sophisticated tends to have a low number of basic color terms, the evolution of BTCs is in the 1st, 2nd, or 3rd stage—there are 5 or fewer basic color terms. While the complex and technologically advanced cultures tend to use more BTCs, the evolution of BTCs may be in the 7th stage and the language has 8 or more BTCs. In their study, they concluded that the Thai language was in the 7th stage, they found 10 color terms in the Thai language namely: *khao* ‘white’, *dam* ‘black’, *daeng* ‘red’, *khiao* ‘green’, *lueang* ‘yellow’, *nam-tan* ‘brown’, *muang* ‘purple’, *chom-phu* ‘pink’, and *saet* ‘orange trumpet (at that time it was used to refer to orange)’.

Although the B&K results were supported by various ethnographic and experimental studies conducted after 1969 and were largely accepted by psychologists and vision researchers, there were immediately challenged, mainly by anthropologists. Number of test language samples is too small, too few informants per language, all native informants also spoke English, the data were collected in the San Francisco Bay area rather than in the homelands of the target languages, certain regions of the world and language families were underrepresented or overrepresented in the sample of twenty, and that the sample of twenty had too few unwritten languages of low technology cultures [2].

Therefore, the world color survey (WCS) [2] was introduced in 1976 to check and expand the findings of the B&K study. The WCS color naming data was collected from speakers of 110 unwritten languages. The WCS methodology coincided with that of the B&K study in the use of the Munsell color chips, consisting of 320 chromatic chips representing 40 equally spaced hues at 8 levels of lightness (Munsell Value), each at maximum available saturation (Munsell Chroma). One white chip was added in the WCS study that was whiter than any chip available at the time of the B&K study, making for a total of 10 achromatic chips and an overall total of 330 chips. The collected data have been compiled into an online data storage, available for researchers who are interested in using the data for a further analysis.

Color names are varied according to the color perception in different environments, experiences, also the language and culture of the speaker. Objects of the same color may have a different color name depending on speakers. We have learned how to call color names since childhood from our experiences that are inherited by our parents, our surroundings, and by being tought in kindergarten or elementary school. Due to the variety of color names, sometimes, there is a misunderstanding in color communication from using different color names between speakers and listeners or between customers and businesses, resulting delays in work and may lead to damage. Therefore, specifying the color categories and the representative of the color term clearly may help to reduce misunderstanding in color communication. I addition, studying color names also helps us to know the characteristics of the colors representing (by finding their representative color) each category. The data obtained can be applied for teaching about colors in the elementary school, and also can be applied to companies that manufacture colors or work related to colors in producing colors that are consistent with the basic color names.

In Thailand, there was also a comprehensive work from Pittayamatee [45] in creating the Thai color database for the standard Thai colors system and developed the knowledges under the name “Thai tone” to apply in an artwork. He has explored the Thai color names in the literature and dictionaries that existed in ancient Thai to the present and study the ancient methods of concocting Thai colors from both experts and textbooks of Thai painting, as well as textbooks on making masks. However, this database is quite a subjective and not scientific method but focuses on the artistic field.

Due to the diversity of Thai cultures, dialects, and environments that vary according to the topography, the use of color names varied. According to the color perception in different environments, experiences, and the dialect and culture of the speaker, we are led to questions about the color names in Thai. To explore the color names used by Thai-native speakers, this study will employ the categorical color-naming method, a similar method as used in the WCS, and using approximately same stimuli as WCS. To prevent the dialects bias, the data will be collected from Thai-native speakers from various areas of Thailand. The author expected to obtain a popular list of color names, the pattern of using color names, and the representative color of each basic color category. The author will also categorize color names according to meaning and type of source to investigate the derivation of color names base on the behavior of Thai people.

1.2 Purpose of the Study

There are two pursposes of this study,

1.2.1 To find the number of basic color categories used in Thailand.

1.2.2 To investigate the derivation of Thai color names.

1.3 Scope of the Study

To obtain data of Thai color names, this study will be conducted according to the WCS way. The author will employ color stimuli consisted of 330 Munsell color chips which are approximately used in WCS. These stimuli were kindly supplied to this study by the Research Institute of Electrical Communication, Tohoku University. Base on the limit time of lending color stimuli, the data will be collected from Thai-native speakers (called as subjects). The subjects will be derived by randomly sampled based on accidental sampling for at least 120 subjects as suggested by William S. Gosset [3]. The subject's age will be in a range between 20 to 40 years old (60 females and 60 males) and they all must be tested for their normal color vision before participate in the experiment. This study will be conducted under a controled experiment by using an experimental booth. Hence all subjects will provide their color names under the same experimental conditions.

1.4 Expected Contribution to the Knowledge about color names

1.4.1 To obtain the exact number of color categories and patterns of using color names for the 330 WCS color stimuli by Thai-native speakers.

1.4.2 To obtain the principles of thinking and behavior of using the color names of Thai people from the derivation of the names to called color.

1.4.3 The result of this study can be compared to the results of other countries that have been studied their own color name with the same set of color stimuli as used in the World Color Survey project to analyze the universality of color names.

1.4.4 The result can be applied for teaching about colors in the elementary school, and for companies that manufacture colors or work related to colors in producing colors that are consistent with the Thai basic color categories.

CHAPTER 2
LITERATURE REVIEW

2.1 Color

Color is one of the essential attributes of things that we can see in our daily life. In art color is one of the visual elements that is important and is used in the creation of works of art by making the work more beautiful, helping to create a more realistic and interesting. In science, color is defined as the wave of light or the intensity of light that the eye can see. The Dictionary of the Royal Institute of Thailand 2011 [4] has defined the word color as "the appearance of light in the eyes, visible in white, black, red, green, etc.; things that make the eyes see white, black, red, green, etc., such as house paint, fabric dye, painting color". Mark D. Fairchild [5] has defined the word of color in his book "Color Appearance Model" that "Color is an attribute of perception consisting of any combination of chromatic and achromatic content. This attribute can be described by chromatic color names such as yellow, orange, brown, red, pink, green, blue, purple, etc., or by achromatic color names such as white, gray, black, etc., and qualified by bright, dim, dark, etc., or by combinations of such names".

2.1.1 Physical of color

Colors that appear in nature are the result of the reflection of light on objects. Color is a type of wave of light that appears when light passes through a mist of water vapor in the air or a prism glass. The visible light that humans see as "white light", in fact it consists of many colors. As demonstrated by Newton the 17th century [43], the emitting sunlight through a triangular glass block called a prism can produced colored light. The shades of light refracted from the prism are separated into different colors, namely purple, indigo, blue, green, yellow, red as seen in the rainbow. Convesrly, when Newton taked another prism, passing a smaller part of the light through the prism again. This time, he noticed a smaller number of similar bands. This second refractive color looks more like a single light (monochromatic).

We see different colors from an object is caused by the fact that it reflects or absorbs different colors. We see yellow objects because they reflect more yellow than others, white objects reflect any color, and black objects absorb light (not reflecting any color). Newton's demontration have shown that if these different colored lights are mixed together, they can produce other colors. For example, if a red light is mixed with a yellow light on a white scene, we can see its orange, and if all the light colors are mixed in a balance, it will get white again.

2.1.2 Attributes of Color

When talking about color, there are several attributes of color to define certain characteristics. In this study, the author has summarized the attribute of color as following;

2.1.2.1 Hue; identified as the name of the color family to which color belongs such as red, green, purple. Hue is directly linked to the color's wavelength and denotes qualities that can be differentiated by color words such as red, yellow, green, blue, purple, etc. Fairchild [5] has defined the meaning of Hue as "an attribute of a visual sensation according to which an area appears to be similar to one of the perceived colors: red, yellow, green, and blue, or to a combination of them".

2.1.2.2 Brightness and lightness; are the shade (darkness) or tint (lightness) of a color. Areas of an evenly colored object in direct light have higher brightness than areas in shadow. Fairchild [5] also defined the meaning brightness separate from lightness that "brightness is an attribute of sensation according to which an area appears to emit more or less light, whereas lightness is the brightness of an area judge relative to the brightness of a similarly illuminated area appears to be white or highly transmitting".

2.1.2.3 Saturation; expresses the purity or the vividness of color or how sharp or dull the color appears. A vivid strong color has high saturation and a dull weak color a low saturation. Colors with even the slightest saturation are referred to as chromatic colors while white, grey, and black (colors with no saturation or hue) are called achromatic colors. Chromatic and achromatic colors both have dark and light colors.

In 1905, Munsell [6] proposed three psychological attributes. Base on the principle of equality of visual spacing. His three attributes were hue, value, and chroma, which have become generally accepted for object colors, which will be described in the topic 2.2.

2.1.3 Primary Colors

Primary colors are colors that are mixed together to produce a new color that looks different from the original color. There are 2 types of primary colors;

2.1.3.1 The primary colors of light, which are formed by refraction through a prism glass, have 3 colors; red, green, and blue in the form of radiation. Light properties can be used for photography, television, lighting and color lighting in various performances, etc.

2.1.3.2 The pigmentary primary color, it is a color that comes from both elementals in natural and chemical synthesis. There are 3 colors: red, yellow and blue. The pigmentary primary colors are widely used in art, industry, etc.

2.2 Munsell Color Notation

The Munsell color system was developed by Albert H. Munsell, in 1905 [6]. The goal of creating the Munsell color system was to have both a numerical system and a physical exemplification of color. The Atlas of Munsell Color, in the other word called Munsell Tree as shown in

Figure 2.1 was built to describe color based on the principle of perceived equidistance. Munsell divided three-dimensional color space into dimensions of hue, value, and chroma, their definitions were explained as follows.

2.2.1 Hue

The term hue is defined as an attribute of visual perception according to the property that classifies groups of colors. There were ten principal hues—five primary hues; red, yellow, green, blue, and purple, and five intermediates hues; yellow-red, green-yellow, blue-green, purple-blue, and red-purple—are arranged in a circle. Each principle hue can be further divided into 10 sub-hues; 1R, 2R, …, 10R, having 100 steps (Figure 2.2). Achromatic hues are notated with the prefix “N”, for example, N1, N2, …, N10.

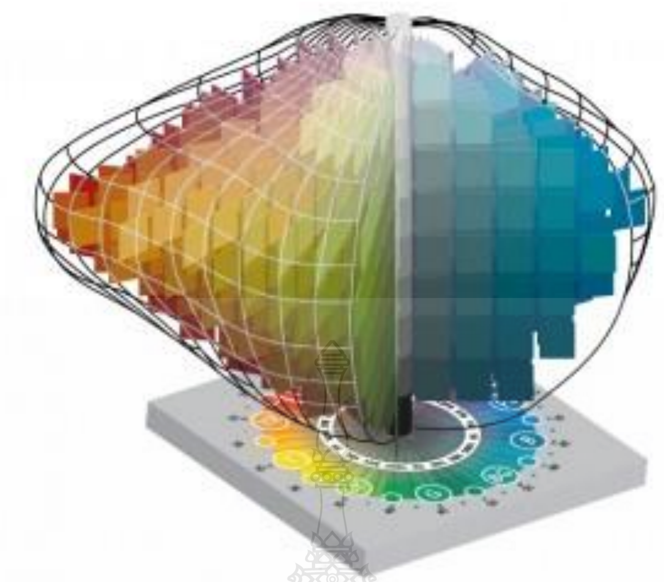


Figure 2.1 The atlas of Munsell Color.
SOURCE: Munsell color system. [Website]. Receive from https://munsell.com/about-munsell-color/how-color-notation-works/munsell-color-space-and-solid/

2.2.2 Value

The term value is defined as an attribute of lightness that provided the difference between bright and dark colors. Value varies in 10 steps between black (0) and white (10). The color between white and black is gray, which has an equal step of lightness difference.

2.2.1 Chroma

The term chroma is defined as an attribute of color saturation, how weak or strong color, indicated by a number, i.e., 2, 4, 6 and so on. Chroma was formed into scales of increasing with equal differences between neighboring chips and it is only one dimension that has unlimited scale. The length of the color chroma scale depends on the hue, such as red can provide more saturation than blue in the equal steps.

A Munsell notation is defined as H V/C, where H represents hue, V represents Value, and C represents chroma.

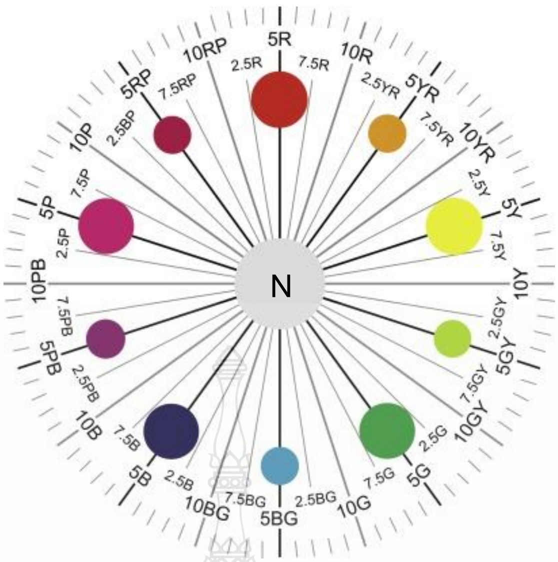


Figure 2.2 Munsell hues.

SOURCE: Munsell color system. [Website]. Receive from https://www.sciencedirect.com/topics/engineering/munsell-book

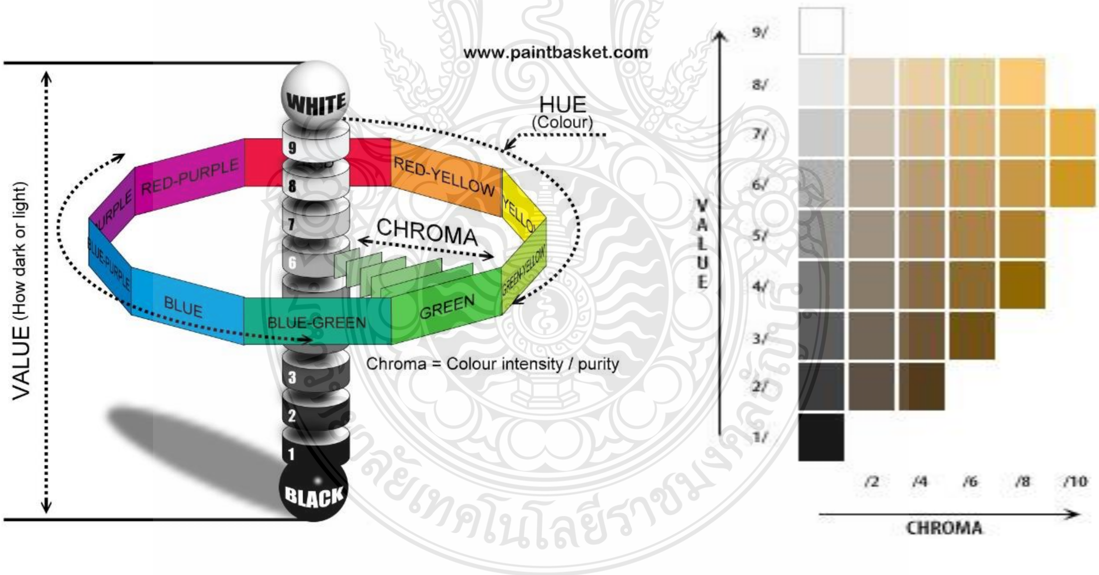


Figure 2.3 Munsell value and Munsell chroma.

SOURCE: Munsell color system. [Website]. Receive from https://s3.amazonaws.com/paintbas/wp-content/uploads/munsell_print.jpg and https://www.pinterest.com/pin/394416879835472933/

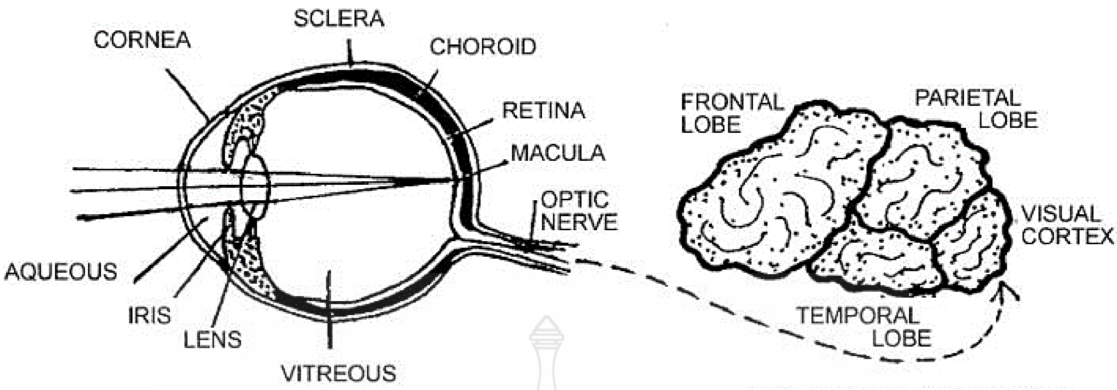


Figure 2.4 Visual system. The left side showing light (solid lines) entering to the eye and was absorbed by photoreceptors in the retina, then an electrical signal is passed through the optic nerve to the brain, visual cortex, on the right side. Here, the energy of light was interpreted to perceived color.

SOURCE: Virginia E. Bishop. (1991). How Does Vision Work. [Web site]. Receive from https://www.tsbvi.edu/curriculum-a-publications/3/1069-preschool-children-with-visual-impairments-by-virginia-bishop/

2.3 Human Color Perception

Color is a phenomenon of human perception, such as the perception that roses are red, leaves green, etc. The human color perception consists of three elements; light, object, and visual system. Light emitted from light sources is reflected by objects and enters the eye. Inside the eye has a part called the retina, which absorbed light by visual pigments of photoreceptors and converts the lights into nerve impulses. There are two types of photoreceptors in the retina; rod photoreceptor and cone photoreceptor. The rod photoreceptors work in low light, the cone photoreceptors work in high light and are the ones that cause color perception. There are three types of cone photoreceptors: light-sensitive cells of red (called L), green (called M), and blue (called S). When the three photoreceptors are exposed to light, they were stimulated in different ratios depending on the color and input of the incident light, and the brain will translate those different signals into different colors. As Figure 2.4 illustrates, the eye with the help of the nervous system and brain interpretation creates the sensations of color and vision for the interacting objects. The conversion from the energy of light to perceived color is the attribute of visual perception that can be described by color names such as red, yellow, orange, brown, blue, black, etc.

2.4 Categorical color naming

This is to categorize color to same color name, such as “Red”, “Orange”, and others. Although light energy can cause millions of colors, but for the color perception in the human visual system, the color can only be recognized at a wavelength of 400 - 700 nm. Humans classified color according to the characteristics of the colors that are similar to each other. Fugate Jennifer M. B. [7] and Crystal, D. [8], defined the term of categorical perception is “a phenomenon of perception of distinct categories when there is a gradual change in a variable along a continuum. It was originally observed for auditory stimuli but now found to be applicable to another perceptual modalities”.

Although humans look at the same objects, they may use different names. This relating to the speaker's language, experience, environment, culture and period, etc. This results in different languages having different words for the color names of things.

2.5 Berlin and Kay’s theory

In 1969, Berlin and Kay published a book “Basic Color Terms: Their Universality and Evolution” [1]. They investigated the color terminology systems of 20 languages including Arabic, Bulgarian, Catalan, Cantonese Chinese, Mandarin, English, Hebrew, Hungarian, Ibibio, Indonesian, Japanese, Korean, Pomo, Spanish, Swahili, Tagalog, Thai, Tzeltal, Urdu, and Vietnamese. They employed color stimuli consisted of 320 Munsell chips of 40 equally spaced hues and 8 levels of value at maximum chroma for each hue-value pair, and was supplemented by 9 Munsell achromatic chips (black through gray to white). In the first step of the study, a subject of the local language was asked by a designed questionnaire without the stimuli to find the smallest number of words that the speaker can name any color. Then the subject was asked to perform two tasks; naming task and focal task. In the naming task, the stimulus array was placed before the subject. For each color term, the transparent acetate was placed above the stimulus board and the subject was asked to specify all the chips that could call by that term with a grease pencil on all acetate chips. In the focus task, the stimulus array was shown again, and the subject was asked to indicate the best color chip of that color term. The results of the study were able to identify the boundaries of each type of color and found that all 20 languages had the focus 11 colors corresponding to black, white, red, orange, yellow, brown, green, cyan, purple, pink, and gray in English. B&K concluded that color is universal, and the center of color found in 11 places is considered to have universal. Therefore, colors are not unique in each language, but all languages in the world share the universal meaning of colors.

2.5.1 Evolution of basic color terms

After discovering 11 focus colors, B&K studied basic color terms from more other 78 languages and concluded that the colors of the world have a sequence of time and have a universal hierarchy order. B&K proposed the following seven basic chromatic evolution concepts:

Stage 1 there are two color terms: black and white.

Stage 2 there are 3 color terms: white, black, red.

Stage 3 there are 4 color terms: white, black, red, green or black white, red, yellow.

Stage 4 there are 5 color terms: white, black, red, green, yellow.

Stage 5 there are 6 color terms: white, black, red, green, yellow, blue.

Stage 6 there are 7 color terms: white, black, red, green, yellow, blue, brown.

Stage 7 there are 8 or more color terms: white, black, red, green, yellow, blue, brown, purple, pink, orange, gray

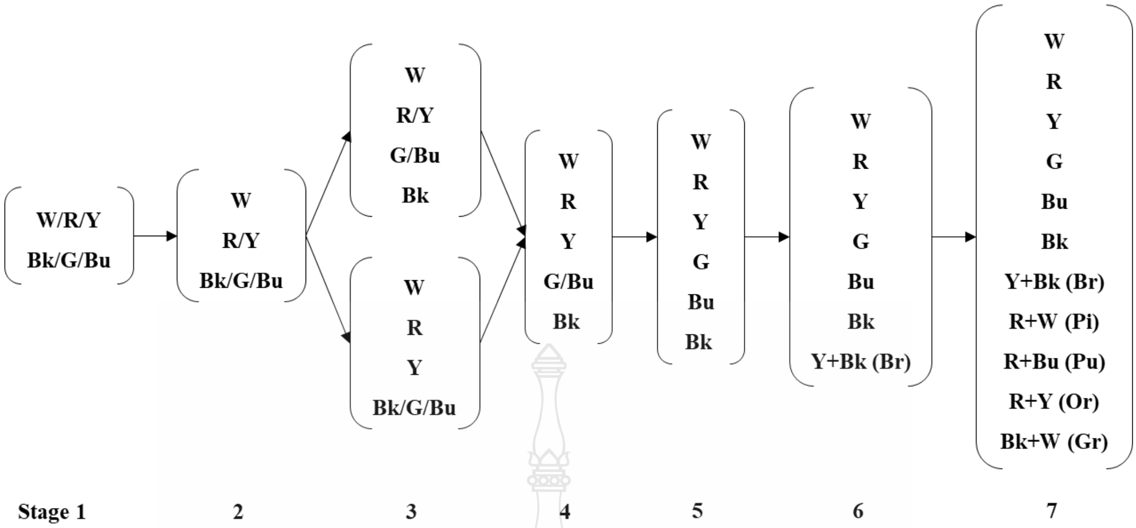


Figure 2.5 B&K's evolutionary sequence of color term development (adapted from B& K, 1969, p.4) [1]

Berlin and Kay also said that the number of BCTs is related to cultural complexity, that is, simple or not much use of technology culture has few BCTs (the evolution of BCTs is in the 1st, 2nd, 3rd stage.) In any culture that is more complex or technologically active, there will be a large number of BCTs (the evolution of BCTs is in the 7th stage). For example, Dani, spoken in the island of New Guinea, has 2 BCTs, as its speakers have a simple and non-technological lifestyle in their daily life. But in English there are 11 BCTs, indicating that English speakers' lifestyles are complex as they relate to technology in everyday life.

After B&K introduced the above idea in 1969, in 1975, Paul Kay [9] further studied the basic color term and published works in an article on "Synchronic Variability and Diachronic Change in Basic Color Terms". In this article, Kay has made some changes to the order of evolution of the BCTs because more evidence has been found that in many languages, the term green often includes blue, such as "ao" in Japanese, wiŋka in Aguaruna, yaš in Tzeltal, *tungu-* in Eskimo, *wiwi* in Futunese, etc. The new evolution of the BCTs that Kay has proposed is as follows;

Stage 1 contains the terms of white and black type: for the white including real white, all light colors, and hot colors such as red, pink, for the black including real black, dark brown, purple, and all other colors, except light green and blue.

Stage 2 contains the term of red type: all types of hot colors that develop from white.

Stage 3 there may be a combination of green and blue (3a), or yellow after red (3b).

Stage 4 there is a yellow type if following 3a, and a combination of green and blue if following 3b.

Stage 5 there are separate terms for green and blue types.

Stage 6 there is a type of brown.

Stage 7 there are categories for purple, pink, orange, and gray.

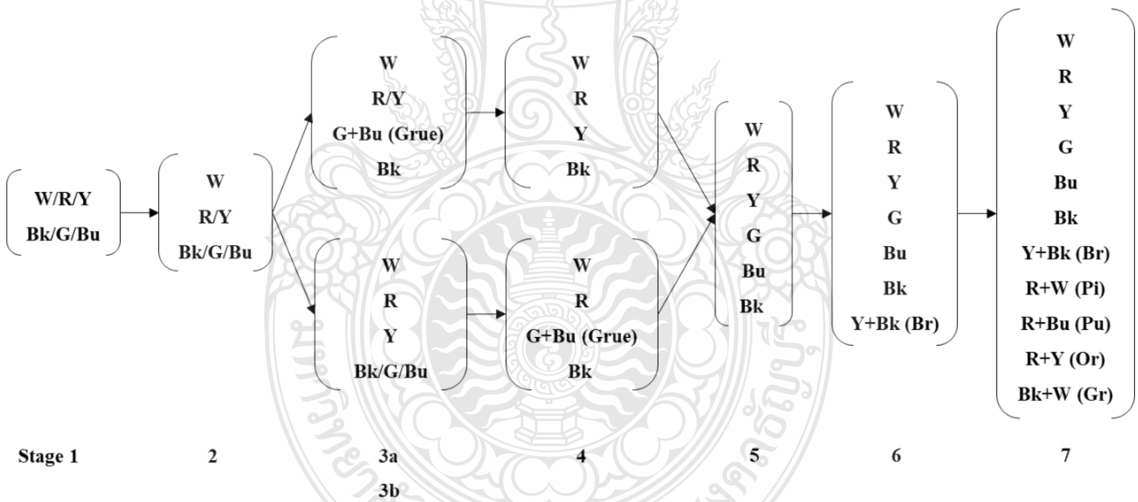


Figure 2.6 Kay's evolutionary sequence of color term development (adapted from Kay, 1975, p.4) [9]

2.5.2 Criteria for considering basic color terms

In the above study, B&K has defined basic color terms which requiring these 8 qualifications;

2.5.2.1 Basic color terms are single terms (monolexemic), it is a word whose meaning cannot be guessed from any part of the word. For example, the English word “green” is a basic color term, but “greenish” is not a basic color term because it can be guessed the meaning that comes from the word green.

2.5.2.2 The meanings of basic color terms must not overlap or combine their meanings with other colored terms. For example, “crimson” is not a basic color term in English because it is synonymous with “red” because it is a shade of red.

2.5.2.3 The basic color term must not be a narrow term for certain types of objects. For example, the English word “blond” is not a basic color term because it only applies to hair, skin, and furniture.

2.5.2.4 The basic color term must be a word that impresses (psychologically salient) a language speaker, it is a word that the speaker thinks before other words, appearing regularly and can be understood by other speakers who speak the same language.

2.5.2.5 In considering basic color terms, if wondering a word is a basic color term or not, consider its grammatical appearance. If the word is the same as other basic color terms, it can be considered a basic color term. For example, a basic color term in English can usually end in –ish, for example reddish, whitish, greenish, but anguish cannot end in –ish, so it is not a basic color term.

2.5.2.6 Color terms with the same name as the object, such as gold, silver, are not basic color terms (but this criterion does not include the word orange in English).

2.5.2.7 New loan words are not considered basic color terms.

2.5.2.8 Complex color names, such as blue-green, are not considered basic color terms.

2.6 Literature Review

B&K's work has motivated a widespread study of the color term. Based on researching previous the study for color naming, both from Thai and foreign researchers, the author has summarized as follows;

According to the World Color Survey, Kay and Regier (2003) [10] have analyzed data of the WCS to resolve the question of color naming universals. They tested on color naming data from languages of both industrialized and nonindustrialized societies whether there are universal tendencies in color naming and the result shows that strong universal tendencies in color naming exist across both sorts of language.

Linsey and Brown (2006) [11], also analyzed the WCS color-naming data set by using k-mean cluster analyses and gap statistics. The results show the average color-naming patterns of the clusters are composed of English patterns, and the structures of the k-means clusters spread out in a hierarchical manner way that was according to Berlin and Kay in the sequence of color category evolution theory. The result of gap statistical analysis showed that 8 optimal number of WCS chromatic categories; red, green, yellow-or-orange, blue, purple, brown, pink, and grue (green-or-blue). Considering the concordance analysis in color naming within WCS languages revealed boundary of color terms regions of statistically significantly low concordance. These boundary regions coincided with the boundaries associated with English "warm" and "cool". The results provide compelling evidence for similarities in the mechanisms that guide the lexical partitioning of color space among WCS languages and English.

Linsey and Brown (2009) [12] again analyzed the WCS color-naming data set by using the same k-mean cluster analyses and gap statistics to investigate universal motifs and their within-language diversity. The results show color naming patterns are composed of English patterns, and the structures of the k-means clusters spread out in a hierarchical manner, it is consistent with B&K in the sequence of color category evolution theory. The result of gap statistical analysis showed that 8 optimal number of WCS chromatic categories; red, green, yellow-or-orange, blue, purple, brown, pink, and grue (green-or-blue). Considering the concordance analysis in color naming within WCS languages, the result showed statistically significantly low concordance of color terms borders. These borders are according to English "warm" and "cool". Suggesting interesting evidence for the similarities in the use of color terms in WCS languages and English, and it is similar to that found in Kay and Regier [10].

Linsey and Brown (2014) [13], examined B&K's two conjectures; 1) the basic color terms and their universality, 2) the basic color terms and their universality, and examine the relationship between subject gender and color naming. They employed the stimuli approximately the same as used in World Color Survey, which had higher chroma, and added a whiter color chip than in the B&K (1969) study. The subject had to be done with two color-naming conditions; free-naming and constrained-naming. For the free-naming subjects named each color sample following 3 criteria; 1) The color name must be a single word, 2) The word must be a general color name, 3) The word must normally use to name the color of something in everyday life. The constrained-naming, subjects were allowed to use only 11 BCTs. The result obtained from 51 native English-speaking subjects shows a total of 122 color terms to name used for the 330 Munsell samples. There are 2 distinct motifs and 20 distinct color categories in American English. Women were statistically used more color terms and were more likely to use the green-teal-blue (GTB) motif than men. The examination of B&K's two conjectures shows that the first conjecture, there are at least 4 more glossed color categories that are commonly used and understood by many subjects. The second conjecture occurs as American English adds new color terms.

Kuriki et al. (2017) [14], investigated the number of Japanese basic color terms and their deployment across color space by using the same apparatus and procedure as Linsey and Brown's (2014) study. The cluster analysis results obtained from 57 native Japanese speaking shows two motifs in Japanese which little different, except for the extensions of the *mizu* (water) and *hada* (skin). The comparison between the present results with Uchikawa and Boynton (1987) has changed little from the last 30 years, *mizu* (light blue) is likely emerging as a new basic color term. The comparison between the Japanese and American English color lexicons was broadly similar, except for color categories in one language that were not present in the other; *mizu*, *kon*, teal, lavender, magenta, and beige.

Sun and Chen (2018) [15] studied the basic color terms used in Mandarin Chinese from 63 Taiwanese native Mandarin speakers. They used color samples of the Natural Color System (NCS) conforming to the Berlin and Kay survey. They selected Thirty-two single-character color-related Mandarin terms from a Chinese character database according to the frequency of use and asked subjects to select the color sample that matched the term. The result showed that the use of basic color categories among

Mandarin Chinese subjects are similar to those found in the World Color Survey (WCS), but they are represented by widespread and inconsistent color terms among subjects.

Paramei et al. (2017) [16] employed a psycholinguistic method on a web-based experiment to investigate Russian color naming by using 600 Munsell color samples. There were 713 native Russian speakers who participated in the study and they were asked to give color names in Russian with unconstrained color-naming. The result showed that among the 1422 color names obtained from the subjects, there were two blues categories were used with a high frequency; *sinij* 'dark blue', and *goluboj* 'light blue', embodied as 12 BCTs for Russian.

Paggetti et al. (2016) [17] investigated Italian basic color terms by using the monolexemic color-naming method. There were two Experiments, in Experiment 1, the sampling of 367 Munsell colors was presented on a CRT. Color names and reaction times of response were recorded to estimated naming consistency and consensus. In Experiment 2, consensus stimuli (N = 72) were presented again, and the subjects were asked to indicate the focal color ("best example") in an array of colors comprising a consensus category. There 16 subjects participated in both experiments. The result showed that naming of the red-purple area is highly refined, with consistent use of emergent non-BCTs, and *azzurro* and *blu* both perform as BCTs dividing the blue area along the lightness dimension, which is *azzurro* was designated to light blue and *blu* was designated to darker blue.

Siripant (1988) [18], have studied the Thai names of colors used in mural painting to produce traditional Thai color patches through photography and printing to assist future restoration work also to preserve Thai color by quantification of their characteristics by two established methods for describing color; by visual inspection to match with Munsell chips and by measure the CIE chromaticity coordinate (x, y) and luminance (Y) using a spectrophotometer. In the process of collected color names, he researched from four Thai dictionaries of arts, two Thai encyclopedias of arts, seven textbooks, seven volumes of archival correspondence, and one journal and yield 209 color names.

Engchuan (2000) [19], analyzed the basic color terms, the boundaries, and foci of basic color categories, the change in color categorization and concept, as well as the non-basic color terms in the Sukhothai period and at the present time. The study shows that there are five basic color terms; white, red, yellow, green, and black in Sukhothai Thai and 12 basic color terms; white, red, yellow, green, fa, blue, black, brown, pink, purple, orange, and gray in the present-day Thai. According to the theory of evolution of basic color terms proposed by Berlin and Kay (1969).

Phornthipphayaphanit (2014) [20], studied the evolution of basic color terms in Thai during the Thonburi and Rattanakosin Period from 690 pieces of literature composed during the two periods. There were 6 basic color terms in Thai during the Thonburi period; white, black, red, yellow, green, and purple. Rattanakosin period there were 12 basic color terms, which are white, black, red, yellow, green, purple, pink, orange, light blue, gray, dark blue, and brown. In the Thonburi period, colors were mostly compared to an animal, while in the Rattanakosin period colors were mostly compared to natural entities.

Rodsap (2013) [21], presented the Thai color terms that were collected in the Matichon Dictionary of the Thai language. It is found that the Thai color terms system consists of basic color terms, non-basic color terms, and modifiers color terms. Regarding the types of color terms, each color term is collected in thesaurus 2 characteristics such as Definition and Collection that is the main word, sub word or part of main-word and sub-word. However, when comparing all the dictionaries that he had studied, it was found that the previous version of the department from 1999 onwards (here is the year 1987) did not collect the color term *fa* ‘sky’ and orange in the basic color group. Also, in the 1999 version, there are still have not collected many words that contain *fa* as a component of basic words.

Phuchomsri (2018) [22], studied the color terms in northeastern Thai dialect (Thai-Isaan dialect) in terms of word building strategies and the relationships between these color terms and the environment. The study was conducted in a village of Khon Kaen Province used the concept of basic color terms described by Belin and Kay (1969). The result shows 12 basic color terms, including white, black, red, green, yellow, dark blue, light blue (Fa/sky), brown, purple, orange, pink, and grey. There were seven language devices were used in constructing non-basic color terms, including 1) mixing basic color terms with modifiers describing the darkness or lightness of the color; 2) mixing two different basic color terms; 3) mixing a basic color term with a non-basic color term; 4) mixing two different basic color terms with conjunction; 5) mixing a basic color term with an original term; 6) using terms normally used to refer to local plants, animals, or objects; and 7) using words from other languages. Considering the relationships between the color terms and the environment, it is shown that construction of the majority of non-basic color terms was accomplished through comparing the color with the color of various objects, such as objects in nature, plants, foods, animals, gems, and objects in daily life.

Honghengseng (2018) [23], studied the history of traditional Thai color terms in a case study of green color by a literature review through documents and related researches. He found that there were more than 150 words that were used to call color names in red, green, yellow, black, white, blue, purple, and brown. For only the green group, there are more than 30 ancient Thai color names were used. These names are related to lifestyle, nature, environment, political uniform, and trade exchange. For example, *khiao-tang-sae* represents trade relations between Thailand and China, which Thailand has imported consumer products and colors used in art from China. Another example of the color name is *khiao-ma-hat-thai* which comes from the government uniform color.

Tipkongka (2010) [24], studied color terms in Thai in the Ayutthaya period to investigate the appearance, structure, and strategies of creating basic and non-basic color terms, as well as studying the culture of Thai people in the Ayutthaya period reflected through the use of color terms. The data were collected from literature composed in the Ayutthaya period that still remains until the present. The results showed that there were 9 BCTs in the Ayutthaya period; *khao* ‘white’, *dam* ‘black’, *daeng* ‘red’, *lueang* ‘yellow’, *khiao* ‘green’, *chom-phu* ‘pink’, *som* ‘orange’, *fa* ‘sky/light blue’, *muang* ‘purple’. Regarding the structure of the basic color terms, they may appear with or without the word "color" and appeared in metaphorical phrases. The result of the culture reflected from the color terms revealed that Thai people in the Ayutthaya period had a way of life that was related to nature. Which the words used to call colors were mostly derived from minerals.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Experimental Booth

The experiment will be conducted in an experimental booth with the same specification as those of Kuriki et al.'s study [14] in Tohoku University. A view of the experimental booth and its structure are shown in Figures 3.1 and 3.2, respectively. A subject will investigate color chips in the booth of the size 150 cm wide, 90 cm high, and 60 cm deep. The luminance of the white walls was measured by Konica Minolta Chroma Meter CS-100A (Figure 3.3). The average luminance of the walls is 81 cd/m^2 and has the chromaticities, x = 0.3186 and y = 0.3384. The Spectrodensitometer is shown in Figure 3.3. The floor was covered with a gray paper, which is called a gray background, and its average luminance was 22 cd/m^2, and the chromaticities, x = 0.3117, y = 0.3255.

Figure 3.1 A view of experimental booth.

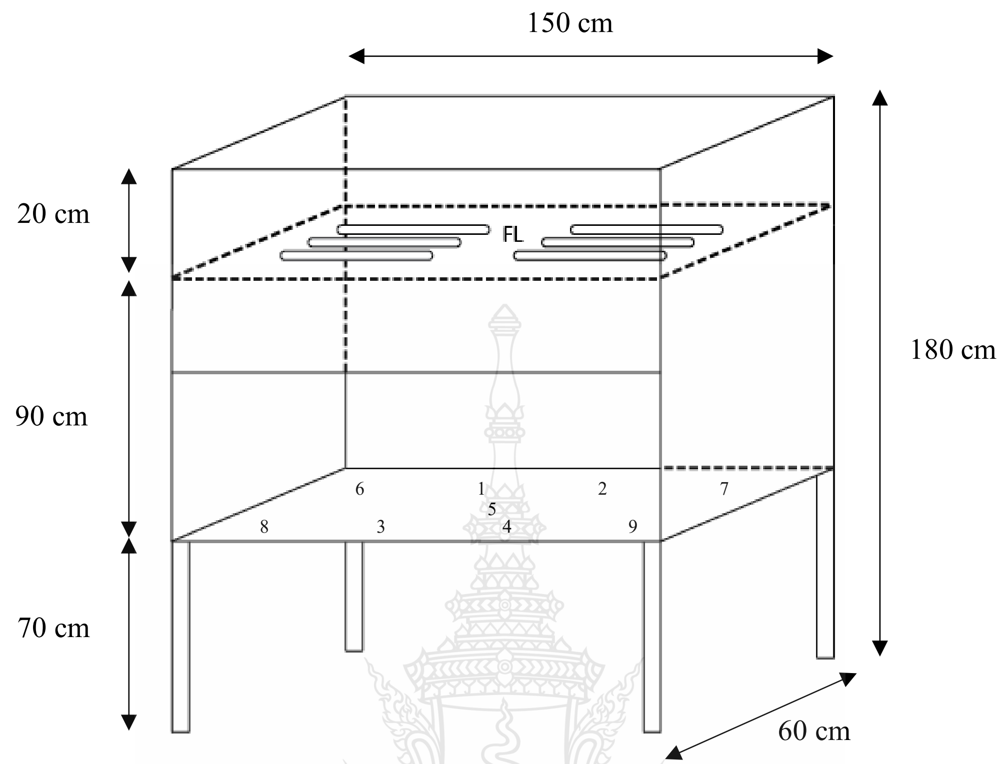


Figure 3.2 Structure of the experimental booth. The number 1 to 9 correspond to the position of the illumination were measured.

Figure 3.3 Konica Minolta Chroma Meter CS-100A.

3.2 Illumination

The booth was illuminated by 6 fluorescent lamps (TOSHIBA FL18W/T8/EX-D) which were hung below the ceiling by 20 cm and above the gray background by 90 cm. The illuminance was measured at 9 positions on the floor of the gray background as shown in Figure 3.2 by using Konica Minolta CL-500A Illuminance Spectrophotometer (Fig. 3.4). The averaged illuminance was 2,509 lx. The correlated color temperature was 5859 K, color rendering index (RI) was 97, and the chromaticity coordinates were x = 0.3233, y = 0.3593. The spectral power distribution of the lights and their CIEu'v' coordinates are shown in Figure 3.5. and 3.6 respectively.

Figure 3.4 Konica Minolta CL-500A Illuminance Spectrophotometer was used to measure the characteristic of experimental booth lighting.

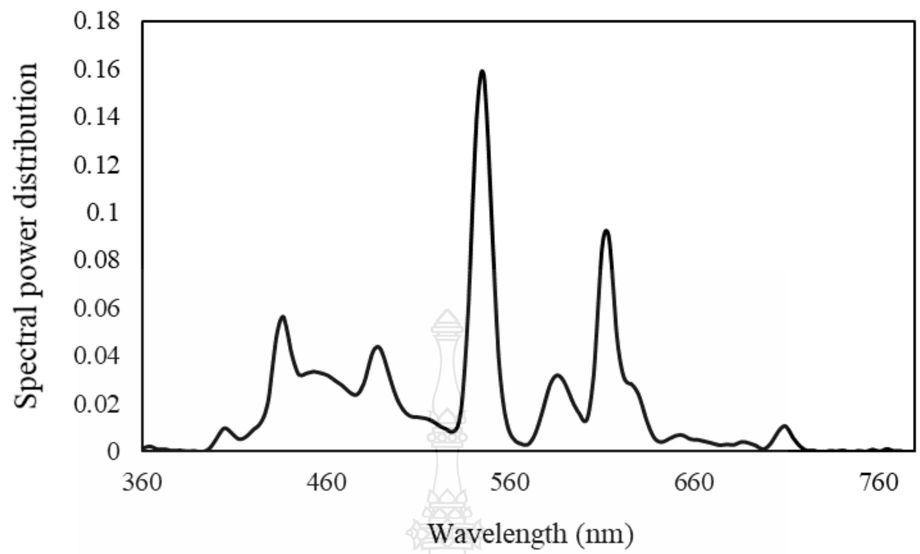


Figure 3.5 Spectral power distribution of experimental booth lighting.

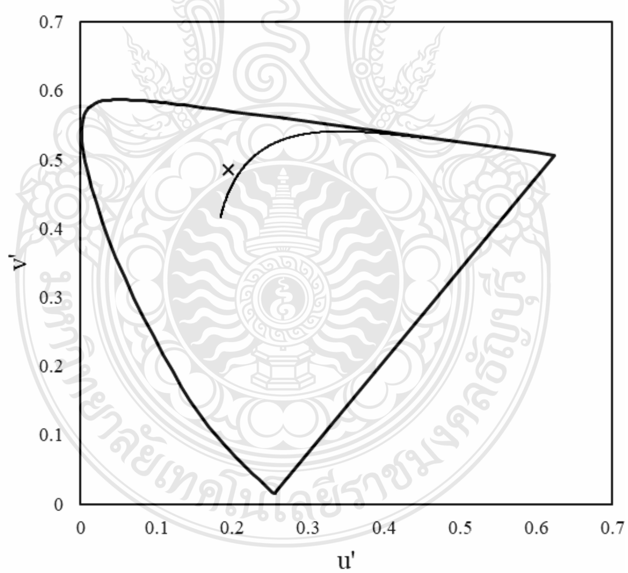


Figure 3.6 Chromaticity point of the experimental booth lighting is shown by × on u’ v’ diagram. The solid curve indicates the Black body locus.

3.3 Color stimuli

The color stimuli used were composed of 330 color chips taken from the Munsell Book of Color Glossy Edition. The color chips are almost the same as those used in the World Color Survey color chart. An example of the color chips is shown in Figure 3.7, of which size was 2 cm x 2.1 cm and was mounted on a gray mat square cardboard of the size 7x7 cm and of Munsell Value N5. On the back of each cardboard the color code of that color chip was written. The color stimulus was composted of 320 chromatic chips covering Value from 2 to 9 and 40, and equally spaced Munsell hue (2.5 R to 10 RP, in hue steps of 2.5) with the maximum chroma of each value in each hue as shown in Figure 3.8 and Figure 3.10. Besides the chromatic chips, there were 10 achromatic chips of Value from 1.5 to 9.5. The physical measurement of all color chips measured by Konika Minolta FD-7 Spectrodensitometer (Figure 3.9) is shown in Table I in Appendix A. Figure 3.11, 3.12, and 3.13 illustrate their CIEL*a*b*, u'v', and x y chromaticity respectively. The arrangement of these 330 color chips was mixed and created a new order with a pseudorandom order starting from number 1 to 330 to prevent the subject from guessing the color name in advance. All color chips were kept in 6 plastic boxes with the respective order.

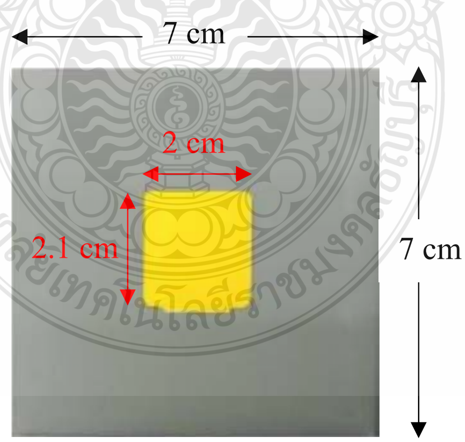
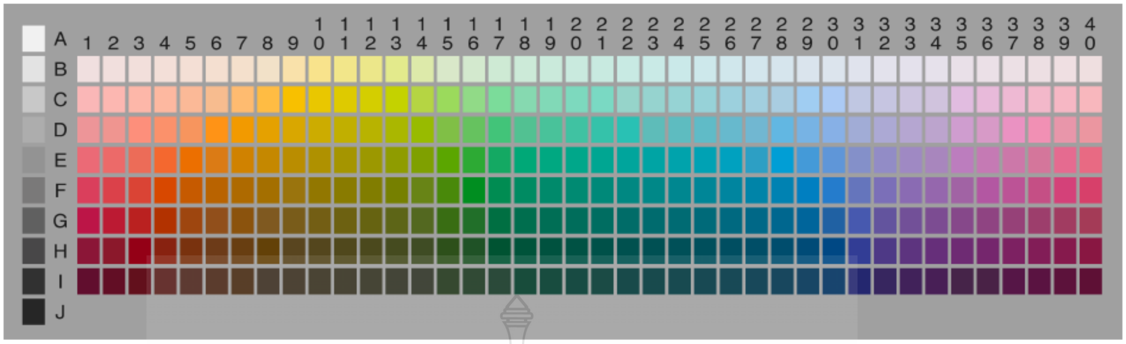


Figure 3.7 Examples of Munsell color chips.

(a)



(b)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
N9.5	A																																								
N9	B	2	2	2	2	2	2	2	2	4	6	6	6	6	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
N8	C	6	6	6	6	6	6	8	14	16	14	12	12	12	10	10	8	8	6	6	6	6	4	4	4	4	4	4	4	6	6	4	4	4	4	6	6	6	6	6	6
N7	D	8	8	10	10	10	14	14	14	12	12	12	12	12	12	10	10	10	8	8	8	8	8	6	6	6	6	6	8	8	8	6	6	6	6	8	8	10	10	8	8
N6	E	12	12	12	14	16	12	12	12	10	10	10	10	10	10	12	12	10	10	10	10	8	8	8	8	8	8	8	10	10	10	8	8	8	8	10	10	10	10	12	12
N5	F	14	14	14	16	14	12	10	10	8	8	8	8	8	8	10	12	12	10	10	10	10	8	8	8	8	8	8	10	12	12	10	10	10	10	10	12	12	12	14	14
N4	G	14	14	14	12	10	8	8	6	6	6	6	6	6	6	8	8	10	10	10	10	8	8	8	8	6	6	8	8	10	10	12	10	10	10	10	10	10	10	10	10
N3	H	10	10	12	10	8	6	6	6	4	4	4	4	4	4	6	6	8	8	8	8	6	6	6	6	6	6	6	8	10	10	12	10	10	10	10	10	10	10	10	10
N2	I	8	8	8	6	4	4	4	2	2	2	2	2	2	2	4	4	4	6	6	6	4	4	4	4	4	4	6	6	6	8	10	8	8	8	6	6	8	8	8	8
N1.5	J																																								
		2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10	2.5	5	7.5	10
		R				YR				Y				GY				G				BG				B				PB				P				RP			

Figure 3.8 World color survey chart (a). Munsell on WCS coordinates (b), horizontal rows show 40 hues with a step of 2.5 start from 2.5R to 10RP. The leftmost column shows Munsell Value start from 1.5 to 9.5. The numbers inside show maximum chroma of each value in each hue.

Figure 3.9 Konica Minolta FD-7 Spectrodensitometer.

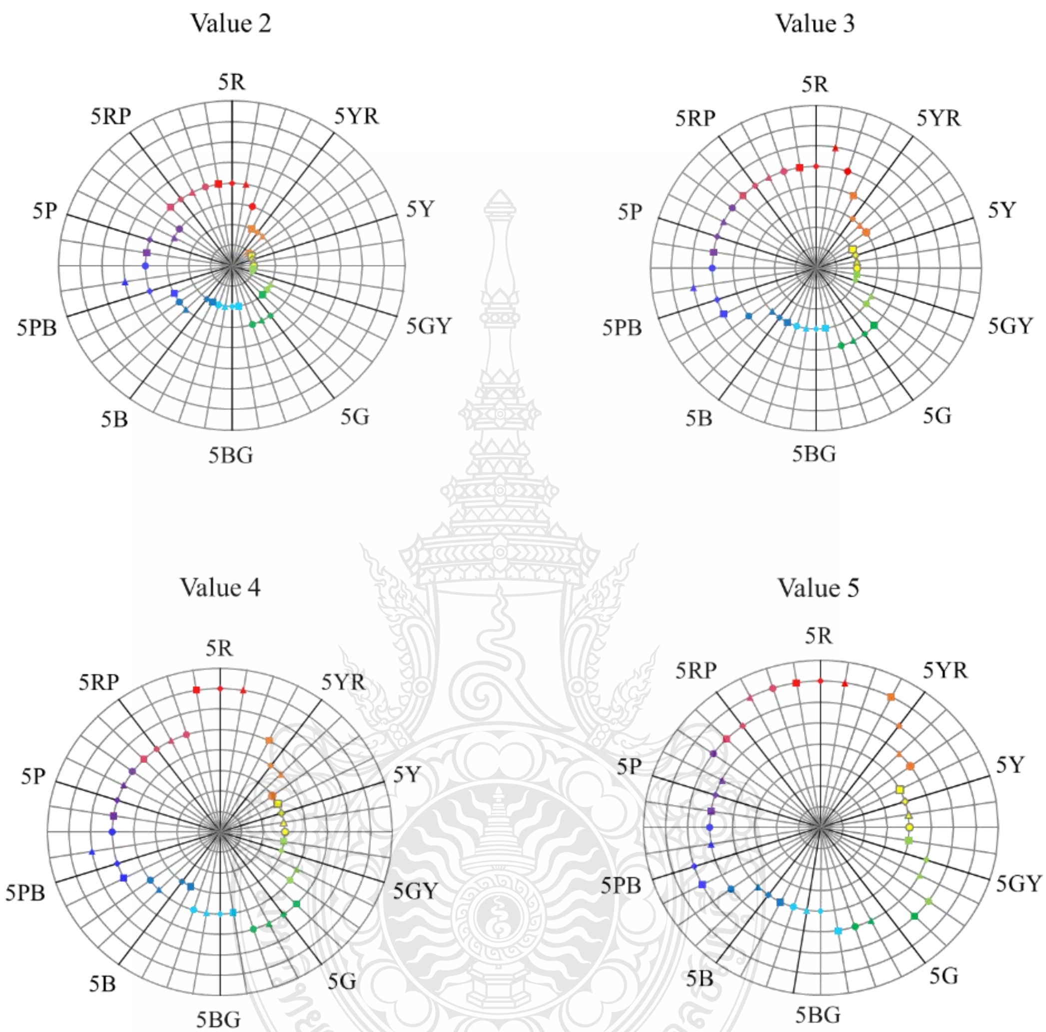


Figure 3.10 Color chips of different Munsell Chroma in Munsell Values 2 to 9. Chroma indicated by the circles, which the smallest circle indicated minimum chroma start form 2 and larger circle indicated higher chroma respectively. Hues indicated by the line connecting from the origin, ■ indicated Munsell hue is 2.5; ♦ is 5, ▲ is 7.5, and ● is 10. Each color indicated each Munsell primary hue.

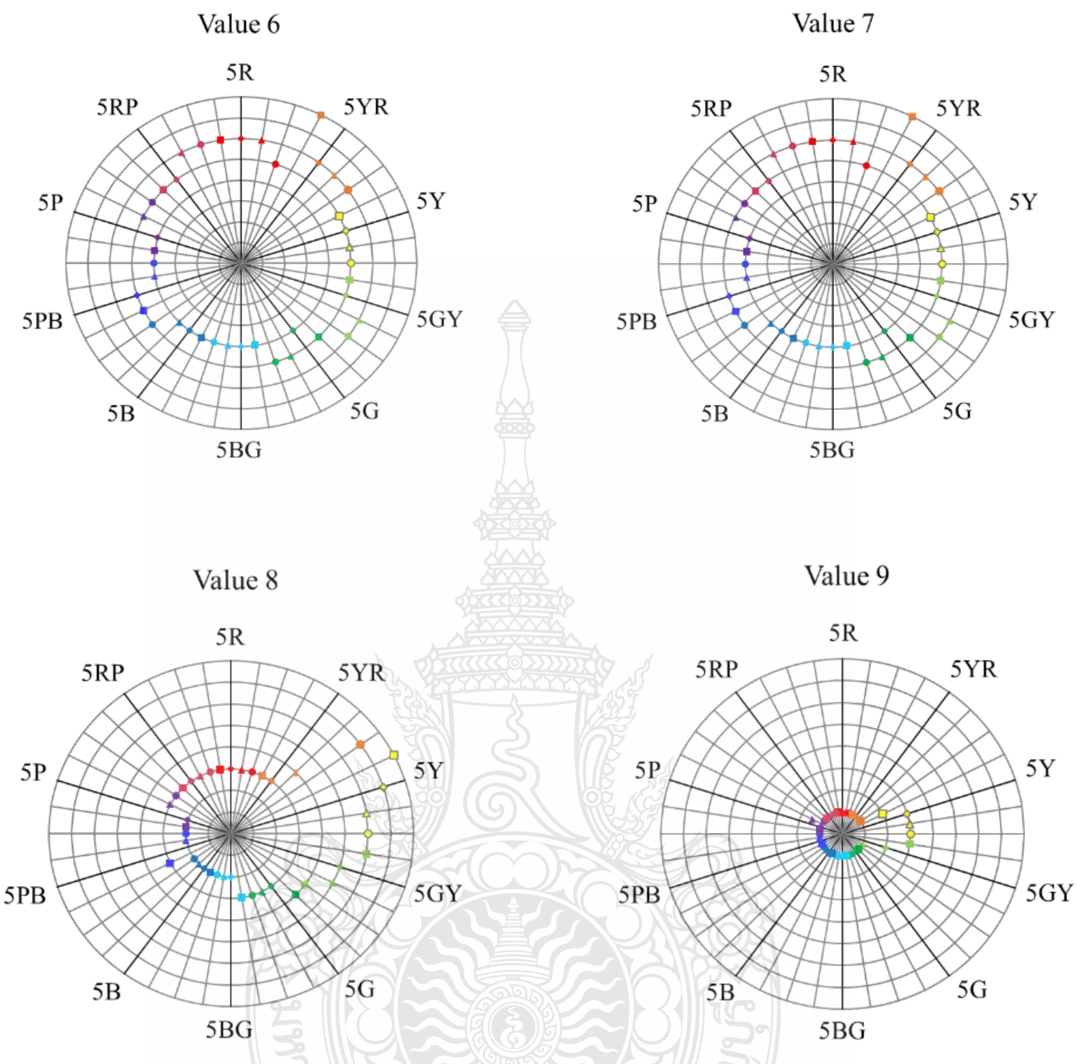


Figure 3.10 Color chips of different Munsell Chroma in Munsell Values 2 to 9. Chroma indicated by the circles, which the smallest circle indicated minimum chroma start form 2 and larger circle indicated higher chroma respectively. Hues indicated by the line connecting from the origin, ■ indicated Munsell hue is 2.5; ♦ is 5, ▲ is 7.5, and ● is 10. Each color indicated each Munsell primary hue (Cont.).

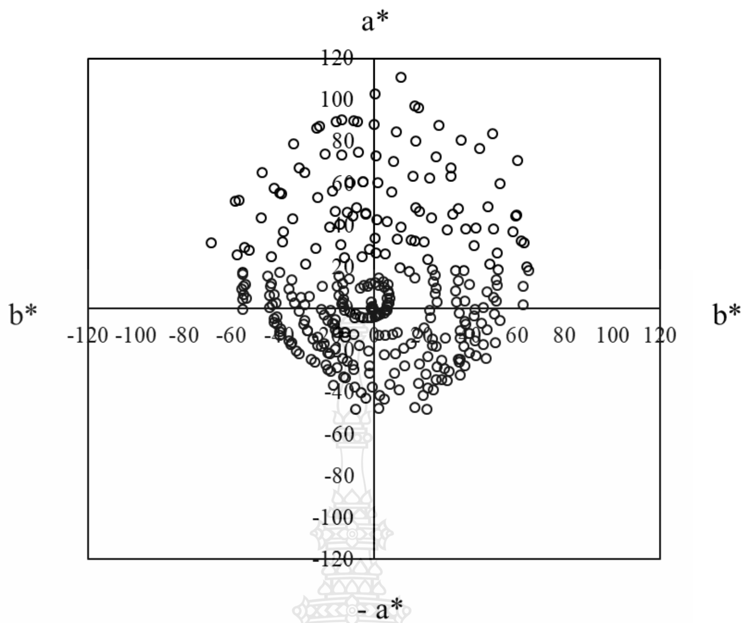


Figure 3.11 330 Color chips plotted on CIE L* a* b* color space.

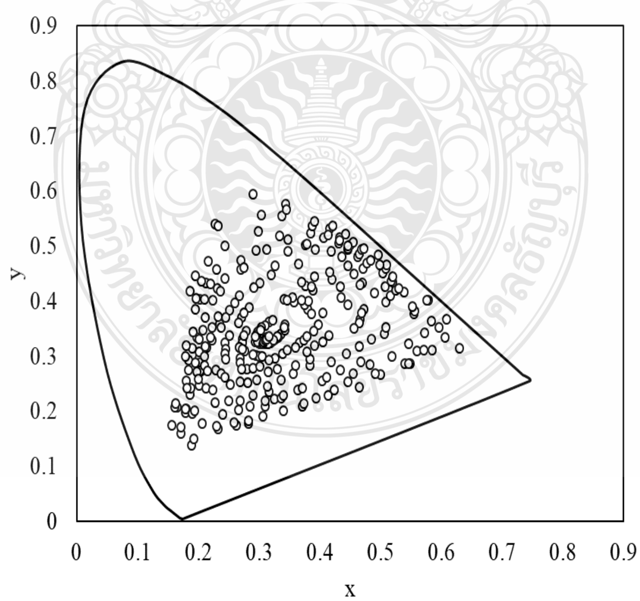


Figure 3.12 330 Color chips plotted on CIE x y chromaticity diagram.

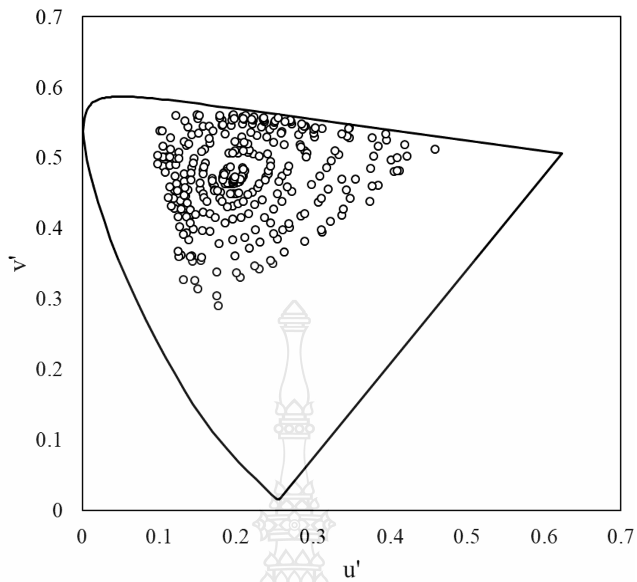


Figure 3.13 330 Color chips plotted on CIE u’ v’ color space.

3.4 Subjects

A hundred twenty subjects were randomly selected based on accidental sampling. They were all Thai-native speakers living in various areas of Thailand, which can be divided into four regions according to cultural characteristics, to avoid dialects bias. This study intended to obtain number of subjects at least 30 persons for each region following William S. Gosset’s suggestion [3] as the smallest number of samples that can give mean and standard deviation with the least tolerable expected deviations to be analyzed for any statistical analysis. All subjects were tested for their normal color vision by using the Farnsworth Munsell D-15 Color Vision Test (Figure 3.14) which was kindly supplied to the author by RIEC of Tohoku University, only subjects who passed the test could participate the experiment. An example of D-15 test data sheet is shown in Appendix B.

Figure 3.14 Farnsworth Munsell D-15 Color Vision Test.

3.5 Procedure

Before starting the experiment, subjects were asked to fill out questionnaires to provide their information including name, age, gender, education, occupation, salary, region, and dialect because Thailand has a different type or accent of spoken language that is used differently in each region. An example of the questionnaire was attached in Appendix B. Figure 3.15 shows a view of the experiment. A subject observed a color chip at a viewing distance of about 40 cm, the visual angle being 3 degrees, which was calculated by Eq. (3.1), and the geometry of Figure 3.16.

Figure 3.17 illustrated a flow chart of the experiment process. The 330 color chips of newly created order were presented to the subject one by one from number 1 to 330. The subject was asked to give color name for each color chip in two manners at the same time; Free-naming with some conditions and Forced-naming with only B&K's 11 BCTs as the following criteria.

3.5.1 The free-naming with 3 criteria.

1) The color name must be a single word (monolexemic color term), the subject was not allowed to use a compound color term such as *khiao-om-lueang* 'yellow-green' or modifiers words such as *khiao-khem* 'dark green'.

2) The word must be a general color name; the subject was allowed to use any word that was generally agreed to represent that color.

3) The word must be a normal use to name the color of any type of object or something in everyday life.

3.5.2 In the forced-naming, the subject could use only 11 BCTs proposed by B&K (1969).

However, subjects can use a name of objects or things that are found in their everyday life such as coffee or banana, etc. Initially, a subject could freely provide any color name that is in accordance with the conditions mentioned above (it can be either a BCT or an object name), if any of the color chips were given name in addition to the B&K 11 BCTs, (i.e., non-basic color terms, non-BCTs), the subject was asked to provide color name with only 11 BCTs for that color chip again. This process was done in one time, no repetition.

The data obtained from a subject will be recorded on data sheets as shown in Figure 3.18 (full version of the datasheet was attached in Appendix B). The leftmost 2 columns are the reorder of color chips and Munsell code, respectively, the next 11 columns are accordance with 11 BCTs, and the last column was created for recording the added of non-basic color terms (the additional information of 11 BCTs was recorded outside the last column for each of non-BCTs).

Figure 3.15 A view of experiment on data collection of color names.

$$\tan\theta = \frac{1.05}{40}$$

$$\theta = \tan^{-1}\left[\frac{1.05}{40}\right]$$

$$\theta = 1.50° \times 2$$

$$\theta = 3° \tag{3.1}$$

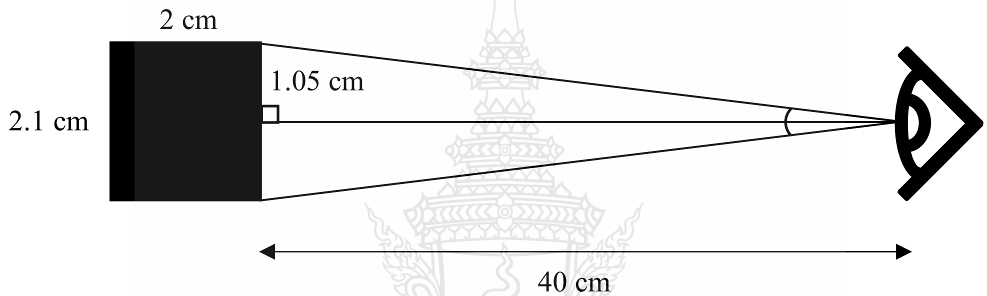


Figure 3.16 The visual angle from the observer's eye to the color chip.

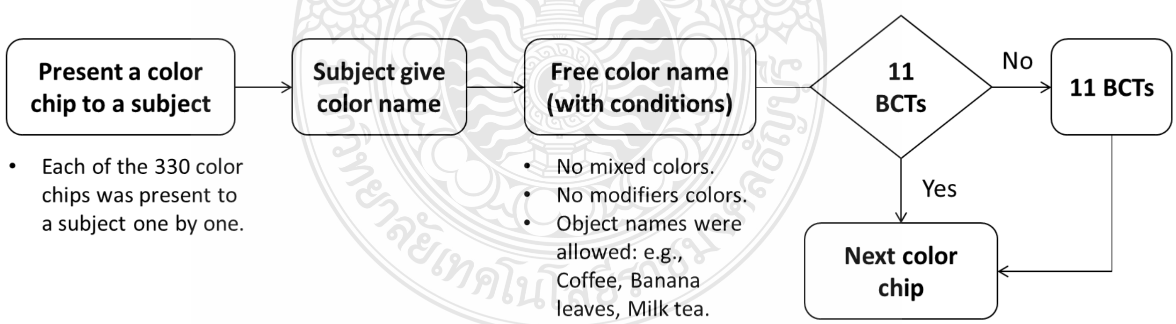


Figure 3.17 The process of collecting color-naming data from subjects. The experiments will be done in one time for both conditions, subjects could use free naming at the beginning, if they provided any non-BCTs, then they were asked again to give only the color term in the 11 BCTs.

Subject name: Box no: Date:

Order	Munsell hue	R แดง	Or ส้ม	Y เหลือง	G เขียว	Bu น้ำเงิน	Pu ม่วง	Pi ชมพู	Br น้ำตาล	Gy เทา	Bk ดำ	Wh ขาว	Others	
1	7.5PB 3/12					✓								
2	5P 6/8						✓							
3	7.5G 6/10				✓									
4	5Y 7/12			✓										
5	5GY 5/8				✓									
6	2.5RP 4/10						✓							
7	10R 7/10		✓											
8	5GY 4/6				✓									
9	7.5GY 8/10				✓									
10	2.5P 4/10						✓							
11	5G 2/6				✓									
12	5RP 6/10							✓						
13	7.5YR 4/8								✓					
14	7.5B 7/6												ฟ้า	Bu.
15	10YR 8/14			✓										
16	7.5P 3/10						✓							
17	7.5YR 3/6								✓					
18	2.5GY 2/2				✓									
19	7.5PB 8/4						✓							
20	10P 2/6						✓							
21	7.5YR 5/10		✓											
22	7.5Y 2/2				✓									
23	5Y 4/6				✓									
24	5Y 6/10				✓									
25	10G 3/8				✓									
26	5GY 2/2				✓									
27	5YR 6/12		✓											
28	10B 7/8												ฟ้า	Bu.
29	7.5R 3/12	✓												
30	5Y 2/2				✓									
31	2.5P 9/2											✓		
32	10BG 5/8												ฟ้า	G.
33	5Y 8/14			✓										
34	5PB 5/12					✓								
35	5Y 3/4				✓									
36	10R 2/6	✓												
37	2.5B 9/2				✓									
38	7.5B 8/4												ฟ้า.	Bu.
39	7.5R 8/6		✓											
40	5BG 6/8												ฟ้า	G.
41	7.5P 4/10						✓							
42	2.5BG 3/6				✓									
43	2.5R 3/10	✓												
44	7.5G 8/6												ฟ้า	G.
45	10RP 7/8							✓						
46	7.5R 9/2		✓											
47	2.5RP 5/12						✓							
48	7.5Y 3/4				✓									
49	7.5P 5/10						✓							
50	10BG 2/4					✓								
51	2.5PB 9/2				✓									
52	5Y 5/8				✓									
53	10GY 7/10				✓									
54	7.5PB 4/12					✓								
55	2.5G 5/12				✓									
56	N8											✓		

Color naming expt.

Figure 3.18 Examples of data collection. The 11 BCTs were recorded into 11 left columns according to each color name. The non-BCTs were recorded into the rightest of the table and the force-naming of 11 BCTs were recorded beside each non-BCTs color name row.

3.6 Data Analysis

Figure 3.19 shows the plan of data analysis. Firstly, the data obtained from subjects were analyzed to find general statistic values including the number of color names, frequency of use, the maximum, the minimum, and the mean number of color names used by Thai subject. Color names that were used with ≥ 30% of subjects will be considered as the frequently used of color names in Thai. In each color chip, if a color name was used by ≥ 80% of subjects, it will be considered as the Thai basic color name and it will be plotted on the WCS color space to investigate the color categories pattern used in Thai. Furthermore, the data will also be analyzed to find the centroids of color names, which will be considered as the representative color of each category. Firstly, the data will be analyzed for each category centroid by using Euclidean distance on CIEL*a*b* color space. A color chip called by a color name will be categorized as a member of that color category, each member will be calculated the location distance to the initial center of that category (the average CIEL*a*b* value of all members), a member that has the shortest distance will be considered as the representative (centroid) of that color category.

In parallel, the data of color names will also be classified according to the source of that color name (or object-referents) to investigate the behavior of Thai people in the use of color names base on the derivation of color names. For example, *chat ‘crimson’* is a kind of powder with a vivid red color derived from the smelting of the Cinnabar ore in Thailand and it is commonly used in art as the dye and pigment, so in this case, *chat* was classified into the dyes and pigments category. In addition, there is also an analysis of the new occurrences of the color name that are currently being used, compared to the color names used in the past that were found in the early literature to show the perception of colors for Thai people that change overtimes.

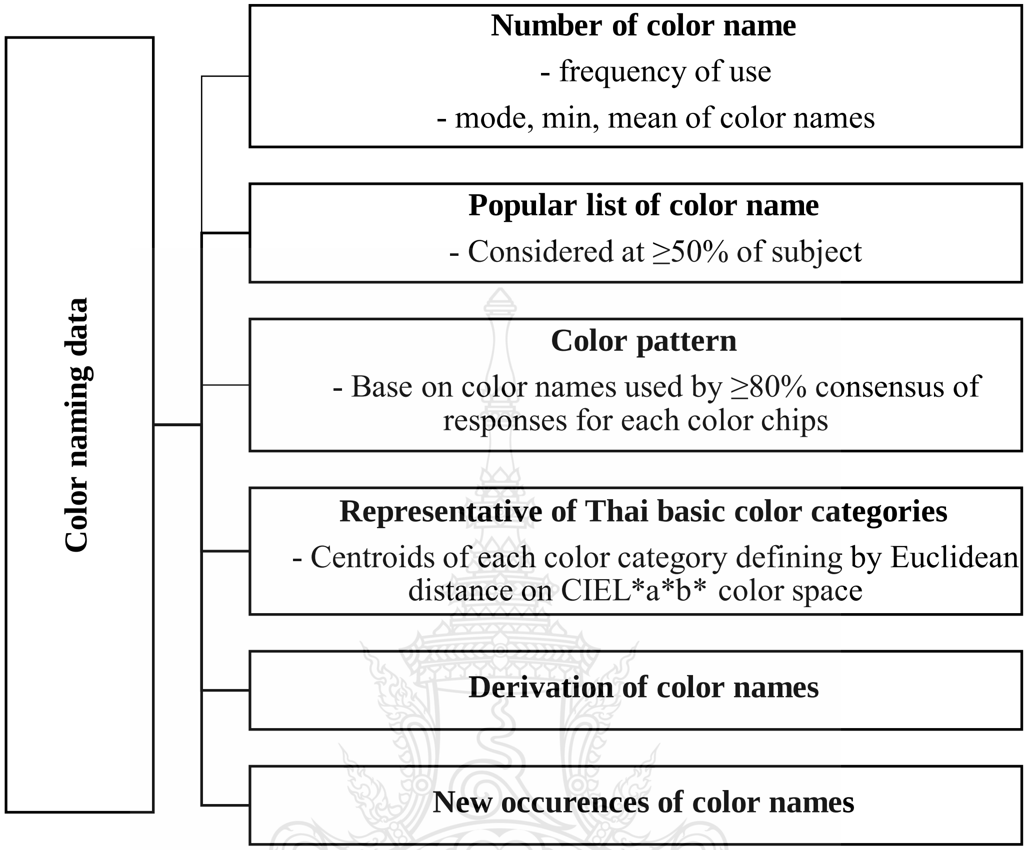


Figure 3.19 Plan for data analysis.

CHAPTER 4
RESULTS

4.1 Color term used by Thai speakers

We have collected daga from 161 Thai native speakers. Number of subjects and list of provinces in each region is provided in Table 4.1. The four regions are illustrated in Figure 4.1. Each region had more than 30 subjects to satisfy the condition given by Gosset [3].

Table 4.1 List of four regions with provinces,and the number of subjects in each region.

North	**Northeast**	**Central**	**South**
Nakhon Sawan	Loei	Bangkok	Surat Thani
Sukhothai	Nakhon Ratchasima	Rayong	Phatthalung
Phetchabun	Nong Khai	Pathum Thani	Prachuap Khiri Khan
Uthai Thani	Chaiyaphum	Saraburi	Yala
Tak	Mukdahan	Chai Nat	Nakhon Si Thammarat
Lampang	Nong Bua Lamphu	Chonburi	Phuket
Phichit	Surin	Ratchaburi	Chumphon
Phrae	Kalasin	Nonthaburi	Phetchaburi
Nan	Ubon Ratchathani	Phra Nakhon Si Ayutthaya	Krabi
Chiang Mai	Udon Thani	Nakhon Pathom	
Chiang Mai	Khon Kaen	Ang Thong	
Kamphaeng	Buriram	Samut Prakan	
Uttaradit	Sakon Nakhon	Samut Sakhon	
	Maha Sarakham	Chachoengsao	
42 subjects	**38 subjects**	**50 subjects**	**31 subjects**

Total number Color names given by 161 Thai native speakers in this study was 114. The counted number of color names used in each subject showed in Figure 4.1 indicating the mean number was 19.15 ± 5.21, the highest number (max number) of color names was 42, and the lowest number was 12. Note that no one in this study used less than 12 color names.

Frequencies of the color names corresponding to the B&K1969's 11 BCTs re shown in Figure 4.2. The frequency of non B&K 11 BCTs is also shown in the figure. The color name with the highest frequency was *khiao* 'green' (26.68%), followed by *muang* 'purple' (13.10%), *chom-phu* 'pink' (9.96%), and others. The overall frequency used for other color names than the11 BCTs (non-BCTs) was 18.36%.

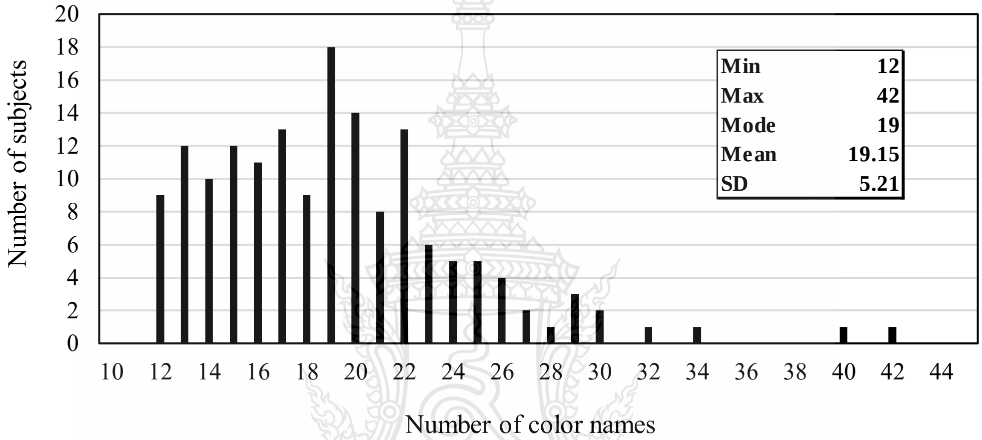


Figure 4.1 Frequencies of color names used by 161 Thai subjects.

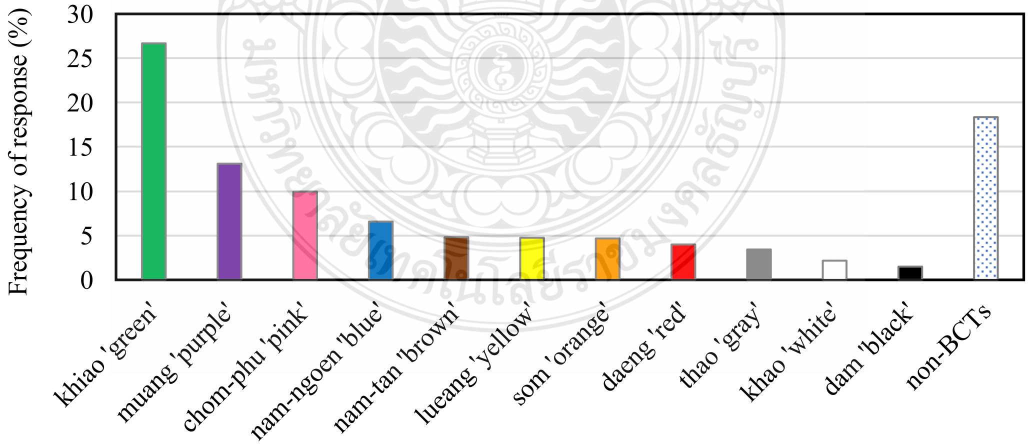


Figure 4.2 The frequency of using color terms; the color names corresponding to the B&K1969's 11 BCTs are represented by a colored bar, and beyond that (the non-BCTs) showed by the dots bar.

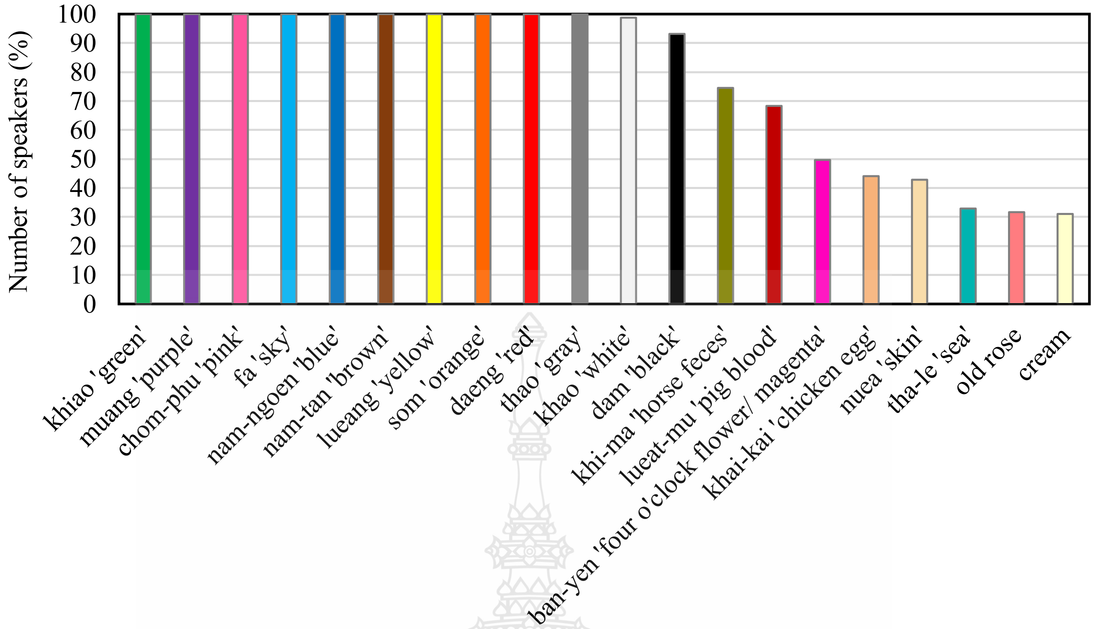


Figure 4.3 Twenty highly frequent color terms were used by Thai speakers. The order of color terms is sorted by the number of speaker's usage and the frequency of use from higher to lower (see Appendix C for more detail).

To see the color names most frequently used by Thai native speakers in this study, the author has extended the color names that were included in the non-BCTs's bar in Figure 4.2 which were used by ≥30% of subjects and illustrated them in Figure 4.3 as the twenty most frequently used color names. There were 12 color names that were used by more than 80% of subjects, consisting of the color names corresponding to the 11 BCTs proposed by B&K and *fa* 'sky'. All the color names of 11 BCTs as well as *fa* 'sky', and *thao* 'gray' were used by 100% of subjects. The two achromatic names, *khao* 'white' and *dam* 'black', were used by 98.76% and 93.17%, respectively. There were 2 non-BCTs namely *khi-ma* 'horse feces', and *lueat-mu* 'pig blood' that were used by more than 50% of the subjects; 74.53%, and 68.32%, respectively. In the case of *ban-yen* 'four o'clock flower/magenta' the number of subjects was almost 50%, i.e., 49.69%. More detail of all color names obtained from this study is provided in Appendix C.

4.2 Pattern of color categories

Based on the numerous of color names found in this study, the author has classified the categories of color names using the below criteria to see the pattern of basic color categories on WCS color space. Figure 4.4 shows the consistency of response from the subjects for each color chip at ≥80% (a), there are 12 color categories consisting of the color names corresponding to B&K's 11 BCTs and *fa* 'sky'. The colored areas represent each corresponding color name's and blank space indicates color chips whose consistency in using color names was lower than 80%, the area being called a confusing area. Elevating the criterion to 60% (b), there is still the similar result, but each color name has a larger area. However, there is still a lot of blank space which means we lost information of color names for many color chips, therefore, the author filled those empty spaces by using the highest proportion of respondents (c) to define the color names pattern for all color chips. Here, there are two more color names that occurred in the naming pattern (c) namely as *tueat-mu* 'pig blood' (with 46.58% and 37.27% of consistency) and *nuea* 'skin' (with 31.06% of consistency) which are located at the dark red and pale orange area, respectively. In addition, the subjects also used *dam* 'black' for the color samples located in dark green and brown areas.

It is worth noting that when the area of color names is enlarged, the *khiao* 'green' area was very huge, covering 30.61% of the total area of color space—to calculate the area of color space the author counted the number of color chips fall under the color category and divided by the total of 330 color chip. The subordinate areas are *muang* 'purple', *chom-phu* 'pink', and *fa* 'sky', which occupied 13.94%, 10.61%, and 10.61% of the color space, respectively. On the contrary, with the exception of *tueat-mu* 'pig blood' and *nuea* 'skin', the *daeng* 'red' category has the smallest area among those 12 color categories.

To see how the color pattern changes if the subjects respond with only 11 BCTs, the author, therefore, analyzed the patterns of color categories based on the data which the subjects were forced to respond with the B&K's 11 BCTs only, called a forced naming pattern. Similar to Figure 4.4, Fig 4.5(a) illustrates a pattern categorized based on ≥80% consensus of subjects' response in a particular color chip, (b) illustrates a pattern that has the consistency of response for a particular color chip ≥60%, and (c) illustrates a pattern categorized based on the highest proportion of respondents in each color chip. As expected, *khiao* 'green' has the largest area, it broadly swallowed up to the color samples that are in the Munsell hue of 7.5Y until 7.5BG at 80% consensus. When considering at

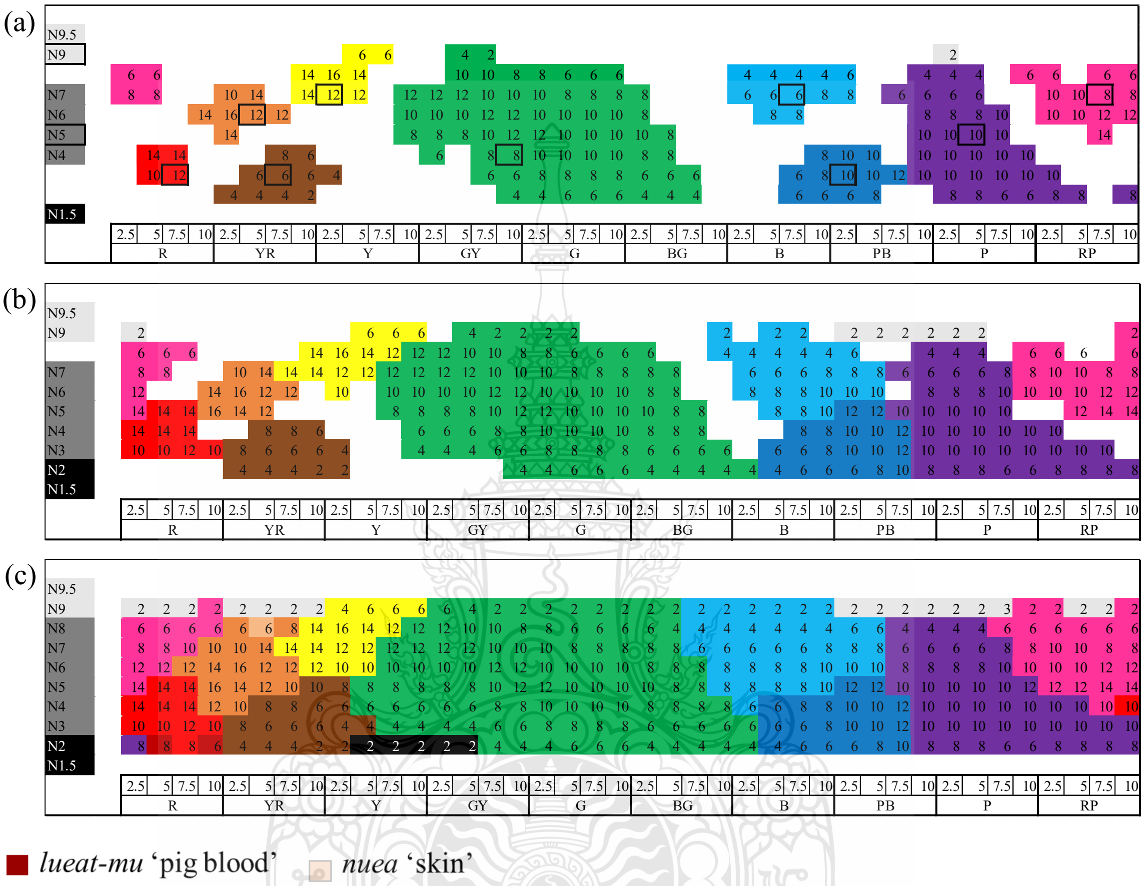


Figure 4.4 Color categories pattern obtained from free-naming plotted on WCS color chart. (a) The pattern of color names that have the consistency of response ≥80% for each color chip (the black rectangles indicated centroid of each color category), (b) the pattern of color names that have the consistency of response ≥60% for each color chip, and (c) the pattern of color names defined by the highest proportion of response for each color chip.

To see how the color pattern changes if the subjects respond with only 11 BCTs, the author, therefore, analyzed the patterns of color categories based on the data which the subjects were forced to respond with the B&K's 11 BCTs only, called a forced naming pattern. Similar to Figure 4.4, Fig 4.5(a) illustrates a pattern categorized based on ≥80% consensus of subjects' response in a particular color chip, (b) illustrates a pattern that has the consistency of response for a particular color chip ≥60%, and (c) illustrates a pattern categorized based on the highest proportion of respondents in each color chip. As expected, *khiao* 'green' has the largest area, it broadly swallowed up to the color samples that are in the Munsell hue of 7.5Y until 7.5BG at 80% consensus. When considering at 60% of consensus (b), it can be seen that the area of each color name has increased, especially the *khiao* 'green' that has swallowed the area from 5Y4/6 to 2.5B 2/4. After full filled the blank space with the color names that have the highest proportion of responses Fig. 4.5(c) was obtained. Here we can see that *khiao* 'green' is expanding more and more, devouring the area 33.94% of total color space. This implied perception of Thai subjects for green that they used the term *khiao* 'green' widely covering colored objects from greenish-yellow to greenish-blue. In addition, it can be noticed that *khao* 'white' has taken over the areas of light blue and light purple. As well as *dam* 'black' which has been used to refer to low-brightness color samples such as 5Y 2/2 through 5GY 2/2.

Considering the empirical 12 color categories, i.e. the categories were used with ≥80% consensus of subjects in Figure 4.4 (a), here, the boundaries of the *fa* 'sky' category from Figure 4.4 were superimposed on the patterns in Figure 4.5 as well to compare a color categories pattern between the two methods; free-naming and forced-naming. It can be seen that when the subjects were forced to use only the B&K's 11 BCTs instead of *fa* 'sky' the area that used to be *fa* 'sky' in the ≥80% consensus has been largely replaced by a blank area, Figure 4.5 (a). This blank area suggests that the use of names other than *fa* 'sky' causing confusion among the subjects, in another word, the subjects used a variety of color terms with different proportions because they were confused and could not make a decision when they were forced to use only 11BCTs without *fa* 'sky'. Considering the lower consensus, Figure 4.5 (b), the blank area was substituted by two color names, mostly by *nam-ngeon* 'blue' and some of *khao* 'white'. However, there was still some blank area left, indicating that there was still confusion among subjects in using color names other than *fa* 'sky' in the ≥60% consensus. When fully filled the pattern with the highest proportion of responses in each color chip, Figure 4.5 (c), many color names were used substituted for *fa* 'sky' consisting of *nam-ngoen* 'blue', *khao* 'white', *khiao* ‘green’, and *muang* ‘purple’. Using these color names with different proportions causing a low consistency in the use of color names and resulting in the blank area, the result shoud indicate that the term *fa* ‘sky’ is necessary for Thai speakers to identify colors. In another word, it is necessary to have two color categories of blue in Thai—*nam-ngoen* for blue, and *fa* for light blue—in addition to the 11 BCTs proposed by B&K in 1969.

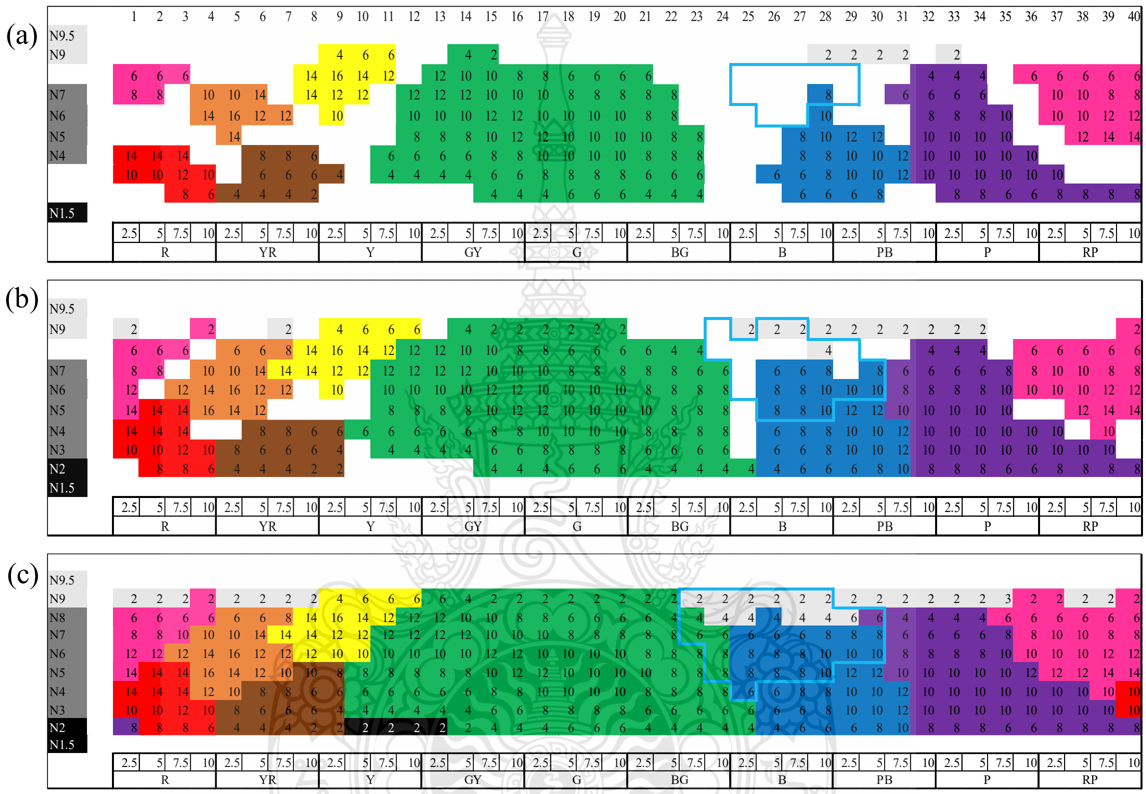


Figure 4.5 Color categories pattern obtained from forced-naming plotted on WCS color chart. (a) The pattern of color names that have the consistency of response ≥80% for each color chip, (b) the pattern of color names that have the consistency of response ≥60% for each color chip, and (c) the pattern of color names defined by the highest proportion of response for each color chip.

4.3 Representative of Thai basic color categories

To see the distribution of color categories on CIEL*a*b* color space, the colorimetric value of color chips fall under color categories illustrated in Figure 4.4(a) were plotted on the CIEa*b* plane as showed in Figure 4.6. Circles with different colors represented color chips that fall under those color categories and the centroid of each category is represented by a colored triangle that corresponds to that color category. Here, the centroid of each color category was calculated by using the equations 4.1.

$$C = min\ distance(Mm_n - Cm_n), \tag{4.1}$$

Where Cm_n is a category member, and Mm_n is the mean of all members. The centroid, *C*, or the center point of a color category derived from the minimum euclidean distance between the CIEL*a*b* coordinates of a particular color chip that fall under a color category (*Cmn*) and the mean coordinates of a category (*Mmn*). These centroids served as the representative of Thai basic color categories. Note that, there was no centroid for *dam* 'black' category since there was only one color chip with 80% consensus.

It is worth noting that *khaio* 'green' categories cover a large area in the CIEa*b* plane as seen in Figure 4.6 (a). It covers almost all of the ±a*-b* quadrants. This idicates that color semantic of *khaio* 'green' in Thai subject's perception covers yellowish green as well as bluish green objects. It was also noted that some categories were partially overlapped each other in their distribution—*fa* 'sky' and the *nam-ngoen* 'blue' category, and *chom-phu* 'pink' and *muang* 'purple' category. However, when considered together with the L* value (Figure 4.6 (b) and (c)), the centroid of *fa* 'sky' and *chom-phu* 'pink' categories has higher L* values than the *nam-ngoen* 'blue' and *muang* 'purple' categories, respectively.

In addition to calculating the centroids to define representative of each color category, the author also analyzed the color chip(s) with the highest subjects coherence in using color names, which is called focal color, and can be considered as the representative of each color category as well. The author compared the differences between the centroid of each category with the focal color chip of that category and showed them in Figure 4.7. Triangles represent the centroid of each category as presented in Figure 4.6, and circles represent the focal color chips. Some categories contain more than one color chip with the highest consistency, such as *chom-phu* 'pink' and *muang* 'purple. Considering Figure 4.7 (a), the centroids and the focal color chips correspond quite well with each other in most categories, except the *khiao* 'green', *lueang* 'yellow' and *chom-phu* ‘pink’ categories (indicated by black dashed ellipsoids). When considered together with the L* values in Figure 4.7 (b) and (c), only four color categories, *daeng* ‘red’, *som* ‘orange, *nam-ngoen* ‘blue’, and *fa* ‘sky’, still correspond well. This shows no systematic consistency between the centroid and the focal color of each color category as consistent as reported by Sturges and Whitfield’s finding [36]. The choice of centroids calculation was therefore taken into consideration in the designation for the representative of each color category in this study since even one color chip could be identified, unlike the focused color chips. The CIEL*a*b* coordinates of the centroids and focal colors are summarized in Table 4.1.

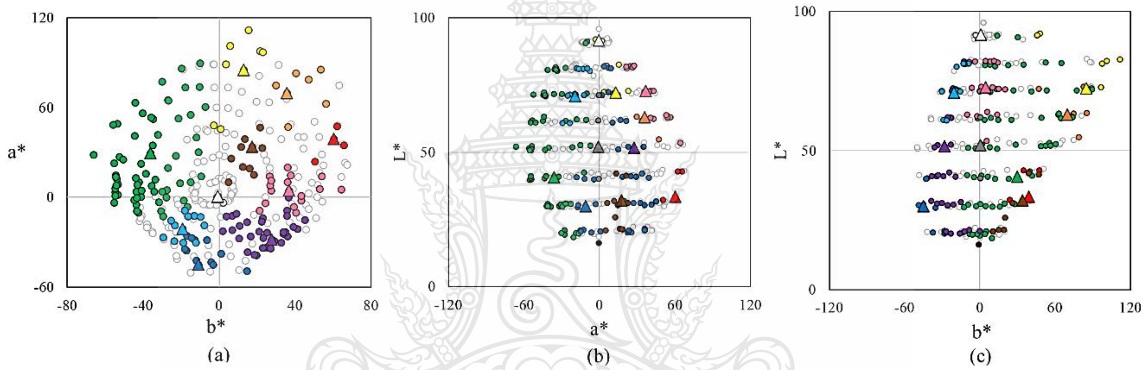


Figure 4.6 The distribution of 12 color categories on the CIEL*a*b* color space. (a) shows the difference in a*, b* dimensions, (b) shows the L*, a* dimensions, (c) shows the L*, b* dimensions. Circles with different colors represent color chips that fall under those color categories. Triangles represent the centroid of each category. Open circles represent color chips that have a consistency of use of lower than 80%.

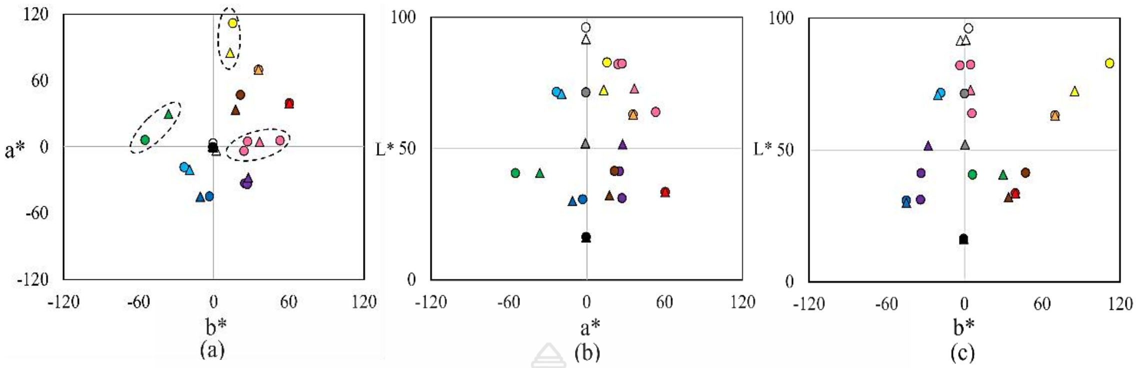


Figure 4.7 The centroid of each color category compared to the highest frequency color chip(s) in each category; (a) shows the difference in a* and b* dimensions, (b) shows the L* and a* dimensions, (c) shows the L* and b* dimensions. Circles with different colors represent color chips that have the highest frequency of use (focal color). Triangles with different colors represent the centroids of each category. The black dashed circles belong to the color categories mentioned in the text.

Table 4.2 CIEL*a*b* coordinates of the focal colors and the centroids

Category	**Focal color coordinates**			**Centroid coordinates**		
	L*	**a***	**b***	**L***	**a***	**b***
khiao 'green'	40.61	-54.82	6.2	40.68	-36.18	29.74
muang 'purple'	41.2	24.98	-33.39	51.68	27.65	-28.04
	31.08	27.06	-34.04			
chom-phu 'pink'	82.04	24.23	-3.59	72.82	36.69	4.68
	82.24	27.22	4.52			
	63.86	52.94	5.77			
fa 'sky'	71.5	-23.48	-18.48	70.84	-19.38	-20.81
nam-ngoen 'blue'	30.68	-3.29	-44.78	29.97	-10.9	-44.93
nam-tan 'brown'	41.32	21.39	46.98	32.08	17.44	33.87
lueang 'yellow'	82.73	15.47	111.89	72.34	12.95	84.94
som 'orange'	63.03	35.7	69.75	63.03	35.7	69.75
daeng 'red'	33.52	60.31	39.22	33.52	60.31	39.22
thao 'gray'	71.29	-0.71	-0.09	52.05	-1.08	0.29
khao 'white'	96.01	-0.61	3.17	91.7	-0.64	0.97
dam 'black'	16.27	-0.4	-0.76	16.27	-0.4	-0.76

4.4 Variation of the color terms

Regarding to the consistency analysis of the color names used by 161 Thai subjects it was found that no color chip has 100% consistency, implying that there is a variance in the use of color terms among subjects. For this reason, the author examined the proportion of color names that were used besides the 12 color names, *fa* ‘sky’ and the 11 color names corresponding to B&K’s 11BCTs. It is found that many color names (from 6 to 36 color names) were used besides these 12 color names. The number of color names depends on the number of color chips that fall under each category. For example, *daeng* ‘red’ category has four color chips and among these color chips there is a total of 15 color names were used besides *daeng* ‘red’ (e.g. lueat-mu, lueat-nok, saet), whereas the *khiao* ‘green’ category has 66 color chips and there were 36 color names used besides. However, those color names have a very low frequency of use compared to the use of the 12 color names. In Figure 4.8, the author has selected the five most often used color names in each of the 12 color categories, and show their frequency of use in percentage.

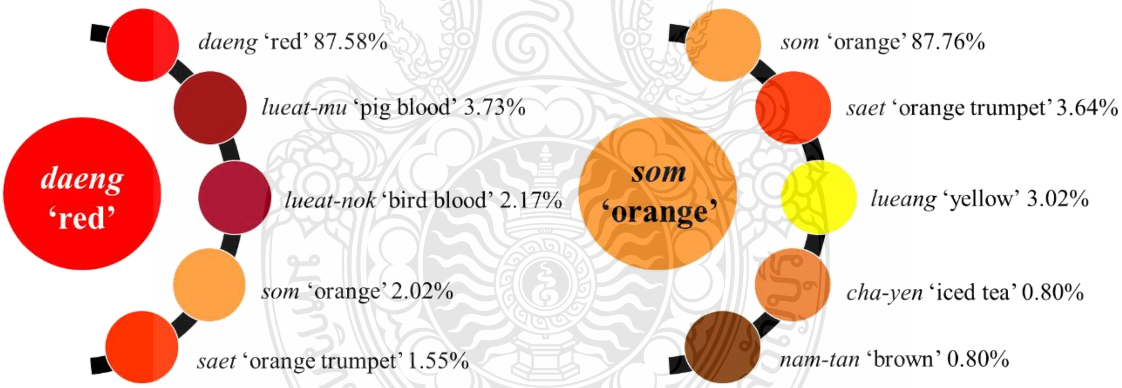


Figure 4.8. Variation of color names in each color category.

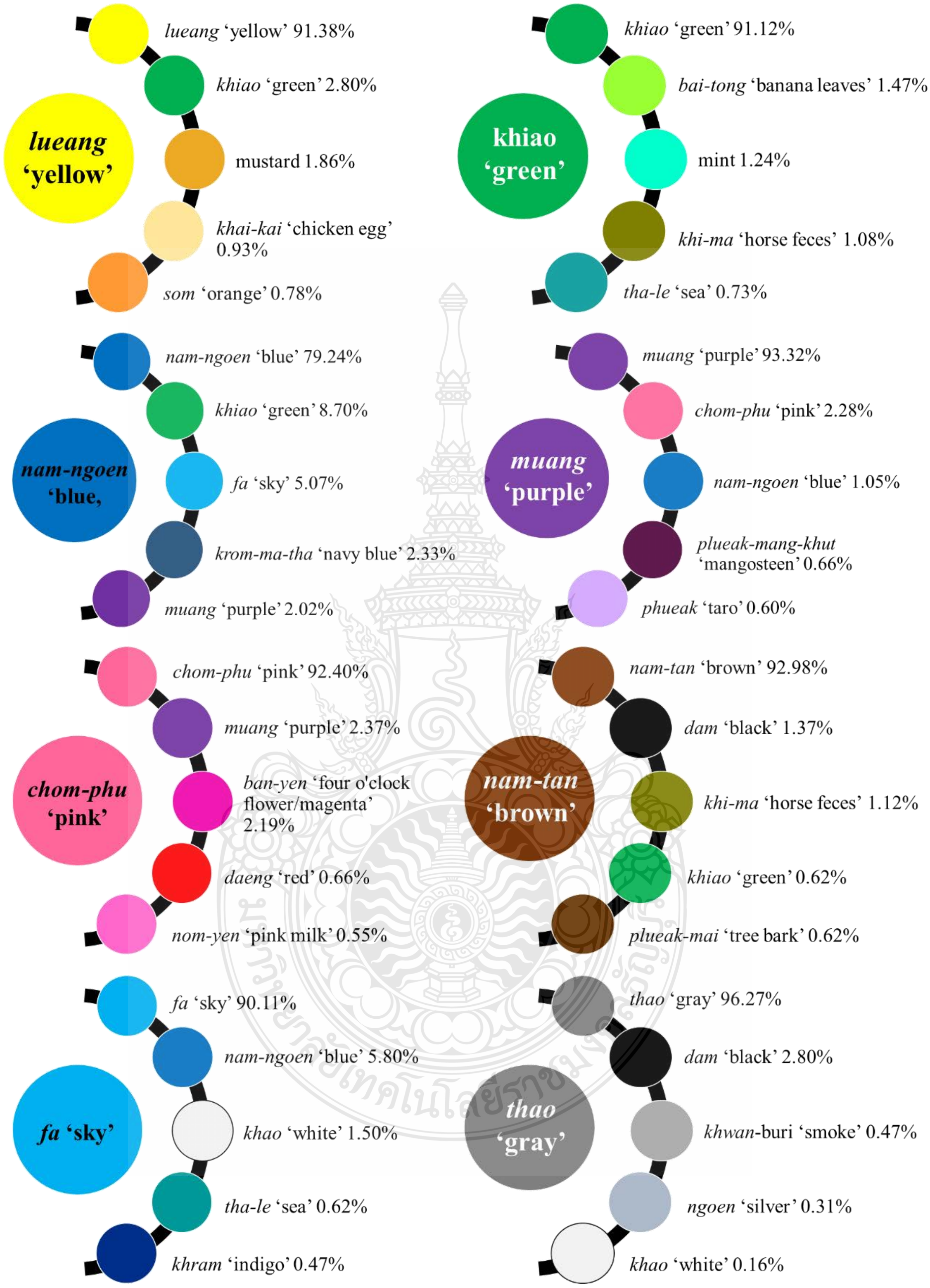


Figure 4.8. Variation of color names in each color category (Cont.).

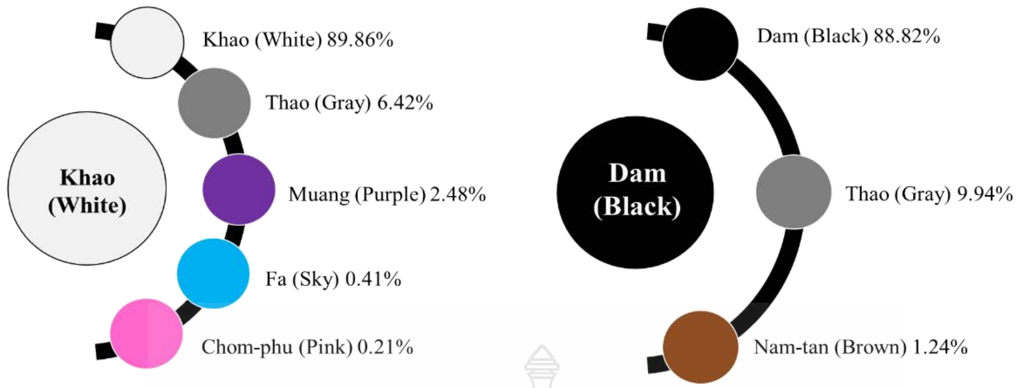


Figure 4.8. Variation of color names in each color category (Cont.).

4.5 Derivation of color names

As the data of color names obtained from 161 Thai subjects revealed 114 color names, the author has further analyzed the derivation of those color names based on the color semantic [40], [41], [42], in order to understand the perception and nature of the Thai people in using words to communicate about color. It is worth noting that numerous color names employed by Thai subjects in this study alluded to objects and the natural environment, such as flowers, leaves, food, or even feces. Implying that Thai subjects used those as the color referents to explain the qualities of other items' color, in color communication. This is consistent with the suggestion of some previous researches [30],[38],[39] that color terminologies used in Thai are regarded as people's experience how they found the natural environment and objects in their everyday life. They compared its colors to other items or objects that have the same color. In this study, the data of 114 color names were classified into 7 classes and 23 subclasses, called categories, following a comprehensive classification of object referents in Russian by Griber et al., [37]. The author counted the number of color names used referring to each category in percentage as showing in Figure 4.9 and 4.10, respectively. Note that, this study included basic color names in the classification of objects reference, in addition to Griber et al., as well as added one more class, "unknown", and three more categories, "herbs", "viands", and "bugs" into the flora, food and beverages, and fauna classes, respectively. Some categories have been excluded since there were no color names referred to those categories: nuts, advertisement, cosmetics, alcohol, and fish. Figure 4.9 shows that the flora has the highest number of relevant color names (37.72%), followed by inanimate nature (17.54%), food and beverages (13.16%), fauna (10.53%), unknown (8.77%), man-made objects (6.95%), and body and bodily products (2.63%), respectively.

Figure 4.10 shows the proportion of the number of color names derived from each category for the 5 classes. Note that, the class of unknown, and body and bodily products weren't shown here since they have no subclass. In the case of flora class, the categories with the highest number of color names are fruits (39.53%), followed by plants and flowers which have the same number of color names (20.93%). Note that, this study classified *phrik-yuak* 'bell pepper', *fak-thong* 'pumpkin', and *ma-khuea-thet* 'tomato' into the fruit category, different from Griber et al., which those were classified into the vegetable category. The fruit-derived color names used with a high number of subjects are *som* 'orange', peach, *ma-nao* 'lime', and *plueak-mang-khut* 'mangosteen peel', they were used by 161, 26, 20, and 20 subjects, respectively. The plant-derived color names that have a high number of subjects used are *bai-tong* 'banana leaves', mint, and *bai-mai* 'leaves', which were used by 44, 37, and 16 speakers, respectively. The color names which have a high number of subjects used referred to flowers are *ban-yen* 'four o'clock flower/magenta', old rose, and *saet* 'orange trumpet', used by 80, 51, and 43 subjects, respectively. In the class of the inanimate nature, most color names are referred to (semi-) precious stones (35%) and natural objects and substances (30%).

The color names that were found to have the highest number of speakers in the (semi-) precious stones category is *mo-ra-kot* 'emerald' (8 subjects) and in the natural objects and substances category is *tha-le* 'sea' (53 subjects). In the case of food and beverages class, the hot and soft drinks category was referred with the highest number of color names (46.67%), color names derived from hot and soft drinks that are often used among the subjects is *cha-yen* 'ice tea' (9 subjects). In the class of fauna, the category that has the highest number of object-derived color names is the birds' category (75%). The color name *khai-kai* 'chicken egg' is used with the highest number of subjects (71 subjects), followed by *lueat-nok* 'bird blood' which was used by 24 subjects. The last one, class of man-made objects, most of the color names are derived from the fabrics category (36.36%), followed by the dyes and pigments category (27.27%). The color names used with the highest number of subjects in the fabrics category is *krom-ma-tha* 'navy blue' (21 subjects), and in the dyes and pigments category is *khram* 'indigo' (36 subjects). Appendix C also provides more detail of object-referents classification for other color names.

This finding is consistent with Russian subjects in Griber et al. [37] that Russian subjects often used the color names derived from the flora and inanimate nature class. Although there is a slight difference in the number of color names due to different methods between both studies, the most of the color names refer to the name of plants, followed by flowers and then fruits in Griber et al., while most of the color names in this study refer to the name of fruits followed by plants and flowers with the same amount. However, numerous color names are consistent in both studies, for example, both Thai and Russian subjects used mint, rose, orange, lime, lemon, olive, peach, pumpkin, tomato, blueberry, and grape in the flora class, and used sea, mud, sun, turquoise, emerald, ivory, pearl, rust, bronze, and sky in the inanimate nature class.

Considering the derivation color names found in this study, it can be seen that the largest proportion of color names is referred to the flora class. This may reflect the nature of Thai people who are more related to green objects. Thai people are related to agriculture. The color names that they use to describe green color chips are more refined. This also suggests the behavior of Thai subjects that they are observant and pay attention to the small details of an environment and items around them, and applied those names communication about colors.

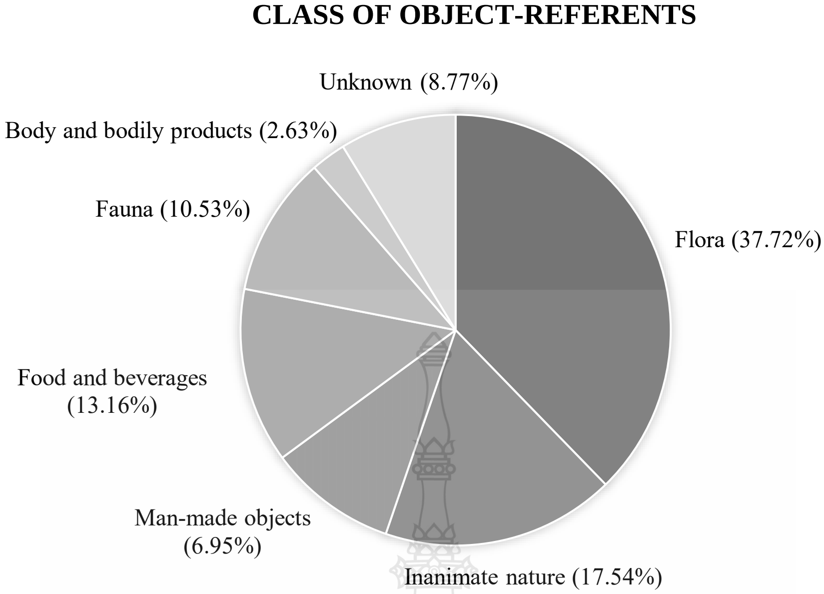
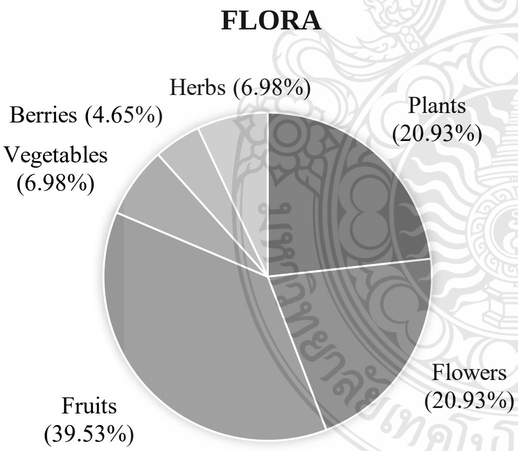


Figure 4.9 Object-derived of color names divided into seven classes, numbers in bracket indicated number of the color name found in that class in percent.



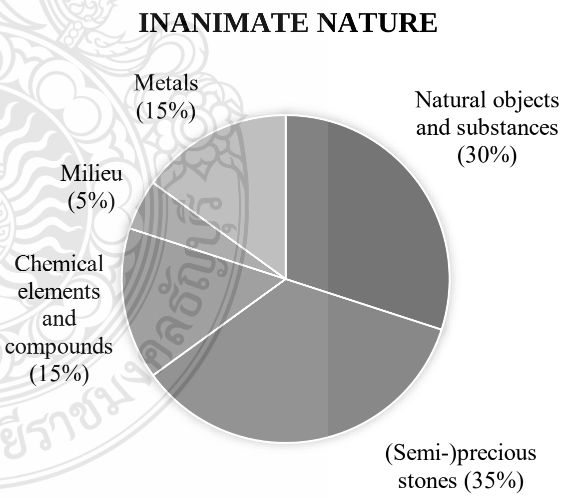
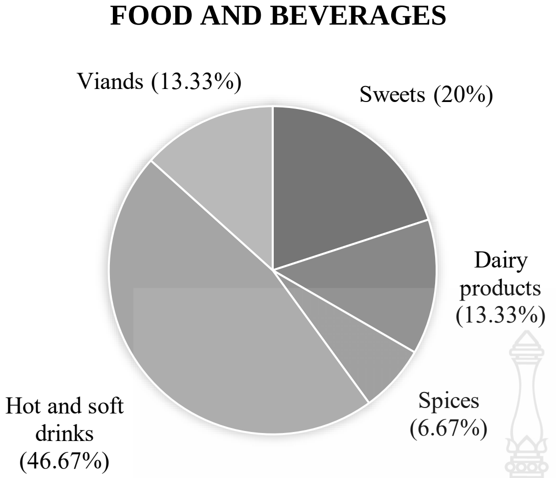
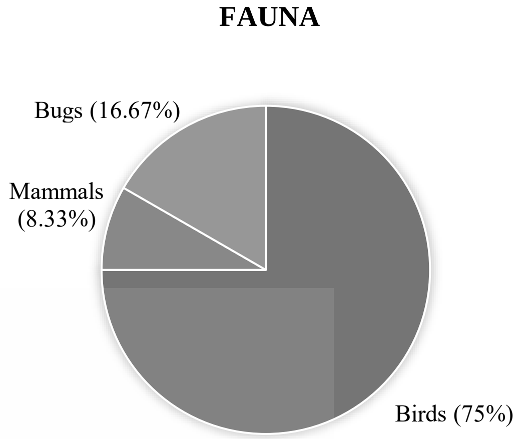


Figure 4.10 Subgroups in each class, categories, and percent of color terms used for each category. Note that this does not include 'unknown' and 'body and bodily products' classes.





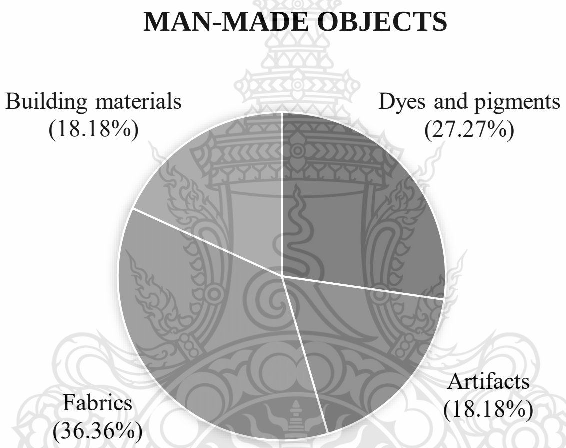


Figure 4.10 Subgroups in each class, categories, and percent of color terms used for each category. Note that this does not include 'unknown' and 'body and bodily products' classes (Cont.).

CHAPTER 5
DISCUSSION AND RECOMMENDATION

5.1 Two categories of BLUE by Thai subjects.

The data of color names obtained from Thai subjects revealed two categories of blue, *fa,* and *nam-ngoen*. These categories were clearly separated along the lightness dimension (see Figures 4.6 and 4.7), where *fa* was designed for light blue and *nam-ngoen* for dark blue. This finding corresponds to Phornthipphayaphanit (2014) [20] that 12 BCTs (including the two blues) were found from literature composed during the Rattanakosin period (nowaday). On the contrary, B&K 1969 [1], with a similar method of elicited color names to this study, the different results were found, there were 10 BCTs revealed from Thai subjects (only one Thai subject in their study). *som* and *thao* disappeared, and they found only one category for the blue area, *fa*. However, based on a higher number of native Thai subjects and all data were collected in the homeland rather than in the San Francisco Bay area, the present study should provide more reliable results.

The origin of *fa* and *nam-ngoen* is unclear, but the author assumed that in the case of *fa* it may be originated from comparing items' colors to the sky's since the sky is a universal symbol that everyone can easily see and understand, and in Thailand, a clear sky can be seen throughout the year. The meaning of the word *fa* in the Royal Institute Dictionary (1999) [28] is the areas that are visible above the earth. The word *fa* also refers to heaven and the sky color in sunny times. Moreover, Thai people tend to compare noble things with the sky, such as *sung-siat-fa* (high as the sky), *dok-fa* (a metaphor meaning a woman of higher status). *nam-ngoen*, due to the meaning of *nam-ngoen* in Siamese-English Dictionary (1907) [29] is the color of Nitrate of silver (color of water reacting with silver nitrate solution). The author assumes that this word has become more popular after being used for the silver nitrate for disinfection, silver coating, mirror making, and a process in photographs, in old days. In addition, there is also a connotation that means a king or royal family, blue blood, which is influenced by foreign cultures as well. The color name *fa* was probably known before *nam-ngoen*. As a result of color names in Thai history provided by other Thai researchers, it was found that *fa* was identified during the late Ayutthaya period around AD 1732–175813 [24], whereas *nam-ngoen* was found in Rattanakosin period AD 1782-present.

Both *fa* and *nam-ngoen* were used by 100% of subjects with a very high frequency of response compared to other color terms and their rank were fourth and fifth respectively in the twenty popular lists (Figure 4.3). Their areas are clearly separated from other color terms, also from each other. This result is consistent with the finding of many researchers in Thai color naming studies, [22], [24], [20], [30], [34] and also corresponds to other languages that were demonstrated to have two BCTs for 'blue': Japanese [14], Italian [17], Bolivian-Spanish [27], Russian and some other Slavic languages (e.g. Polish, Ukrainian, Belarusian) [16], [31], [32].

5.2 More refined color classification in warm tones

From the results of color categories pattern analysis, it can be seen that the warm colors (red, orange, yellow, yellow-green) are categorized more refined compared to the cool colors, as shown in Figure 4.4 (c). When considering the consensus of responses below 60% of subjects, two additional color categories have been revealed; *lueat-mu* 'pig blood' and *nuea* 'skin'. It was found that there were 35 color names in total in the warm color, excluding base color names. Color names with a number of subjects used ≥10% are *lueat-mu* 'pig blood' (68.32%), *ban-yen* 'four o'clock flower/ magenta' (49.69%), *khai-kai* 'chicken egg' (44.10%), *nuea* 'skin' (42.86%), old rose (31.68%), cream (31.06%), *bai-tong* 'banana leaves' (27.33%), *saet* 'orange trumpet' (26.71%), *it* 'brick' (20.50%), peach (16.15%), mustard (14.91%), *lueat-nok* 'bird blood' (14.91%), and *ma-nao* 'lime' (12.42%). These color names were used with varying frequencies in any color chips, causing a low consistency in the use of basic color categories in the warm tone area especially *daeng* 'red' category. It can be noticed that the area of the *daeng* 'red' category was much smaller compared to the other color categories. When considered together with Figure 4.2 and Figure 4.3 it can be seen that *daeng* 'red' has the lowest popularity and frequency of use among the chromatic names. This is because the population of the *daeng* 'red' category has many more non-BCTs, 15 color names, in which *lueat-mu* 'pig blood', *lueat-nok* 'bird blood' and *saet* 'orange trumpet' were also included.

The same phenomenon occurs with other warm colors as well, even if it's not as apparent as the *daeng* 'red' category. For instance, in *som* 'orange' category, there were *saet* 'orange trumpet', *nuea* 'skin', *old rose, it* 'brick', and peach included. As well as *lueang* 'yellow' category, it was found that mustard, lemon, *khai-kai* 'chicken egg', and cream were also included. This is consistent with earlier findings for other languages (Japanese [14], Mandarin Chinese [15], English [13], [27], Russian [16], Italian [17], Hungarian [33], Tsimane' and Bolivian-Spanish [27]) that warm color categories are more refined than the cool color categories.

5.3 Similarity in the use of color names for subjects in different regions

Due to the diversity of cultures and dialects in Thailand, this leads to the question about the differences in the use of color names in different regions. In this study, it was found that the total number of color names obtained from all subjects in North was 72, Northeast was 56, Central was 74, and South was 67 color names. Furthermore, the number of color names used by each subject in four regions were examined and the results were shown in Table 5.1. The North showed 42 color names, in Northeast was 30, Central was 32, and in the South was 40. Although the highest number of color names used in a particular subject in each region was different, the mean number was similar, e.g., there was no statistically significant difference in the number of color names used by each subject among the four regions tested by F-test.

Table 5.1 Number of color names in each region.

Region	Min	Max	Mean	SD	F-test
North	12	42	19.19	5.76	F = 0.246 p = 0.864
Northeast	12	30	18.58	4.14	
Central	12	32	19.50	5.19	
South	12	40	19.03	5.68	

Figure 5.1 illustrates the color categories pattern used by subjects in four regions with ≥80% consensus of response for each color chip. The categories patterns in the four regions were very similar. Although there is difference in the shape of the categories, the

location of those categories is same. Twenty most frequently used color names in each region are shown in Figure 5.2. It is seen here that most of the subjects used similar color names in all four regions, only *bai-tong* ‘banana leaves’, and *khram* ‘indigo’ that were found in the highly frequent list of color names in North, while *saet* ‘orange trumpet’ was found in the highly frequent list of color names in Northeast, and mint was found in the highly frequent list of color names in South, but none in the highly frequent list of other regions.

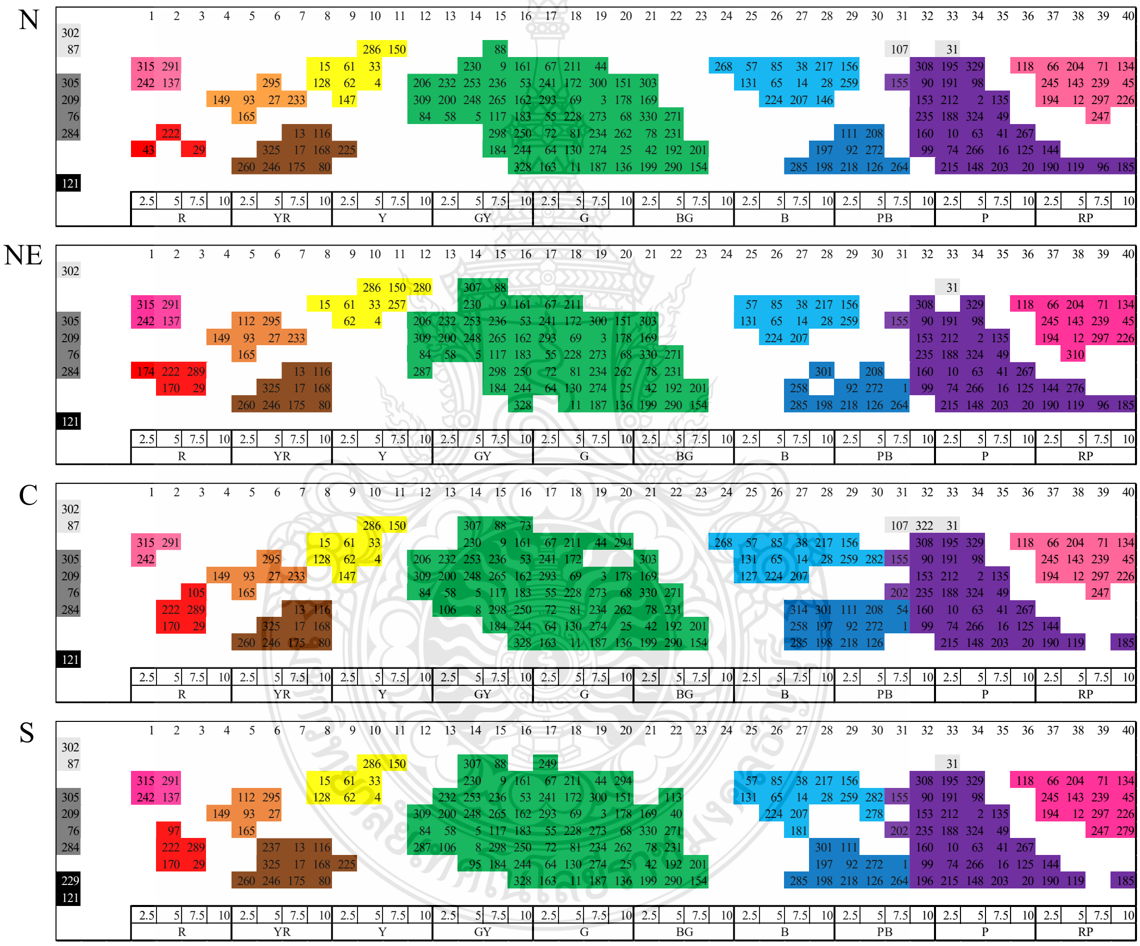


Figure 5.1 Color categories pattern for each region plotted on WCS color chart with the consistency of response ≥80% in each color chip, obtained from free-naming.

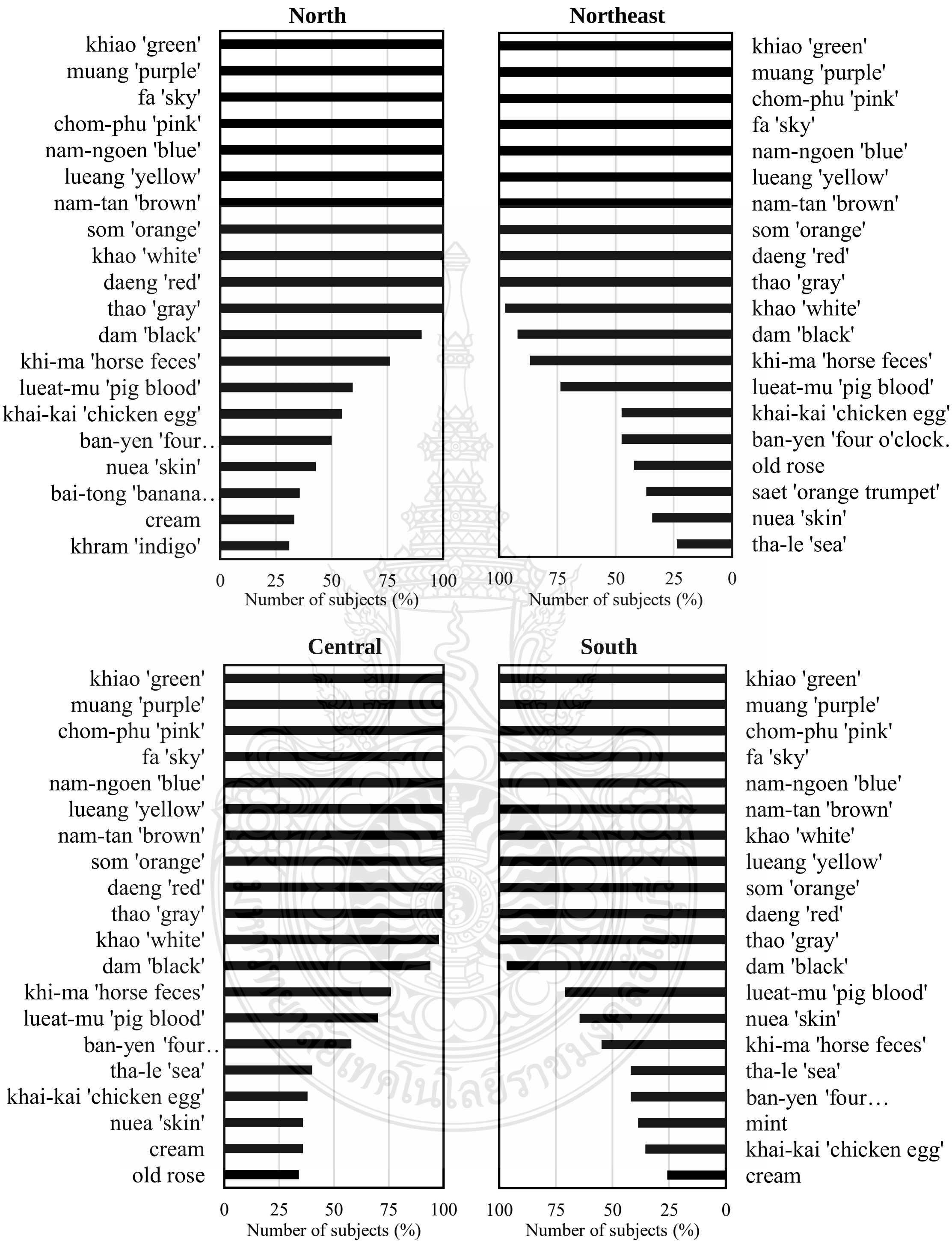


Figure 5.2 Twenty highly frequent color names used by subjects in each of four regions.

Regarding the derivation of color names in four regions, it was found that the subjects in all regions mainly used the color names related to flora class (see Figure 5.3). In North subjects used color names derived from flora class for 33.33%, followed by fauna and unknown class, with 13.89% in both classes. In the Northeast, the color names derived from the flora class were used with 33.93%, followed by the inanimate nature class and the unknown class with the same percentage, 16.07%. In Central, the color names referred to the flora class were used with 40.54%, followed by the food and beverages class 14.86% and then the man-made object class 10.81%. In South, subjects used color names derived from flora class for 29.85%, followed by the food and beverages class 16.42%, and then the inanimate nature class with 14.93%. In addition, interestingly, the category that has the highest proportion of object-derived color names in flora class for all regions was the same; the fruits category, followed by the plants, and then the flowers category (see Figures 5.4). The color name that most frequently used in the fruits category by subjects in the North, Northeast, and Central was the same—peach used by 17%, 13.16%, and 22% of subjects, respectively—whereas South is *ma-nao* 'lime', used by 19.35% of subjects. Note that, only Central subjects used color names referred to the baries category.

This suggests the similarity of using color names among subjects in different regions. Even though Thailand is made up of people from a variety of ethnic origins and cultural diversity, it seems that the subjects in this study revealed a uniformity in their use in terms of the use of color names. We should mention that the data of this study were mostly obtained from university students, all of whom can speak the official Thai language very well. However, it is difficult to collect data from a subject who cannot speak the official Thai language at all. This is because technology, social media, education, and trade exchanges in Thailand have evolved greatly and these are accessible to almost every area in Thailand today.

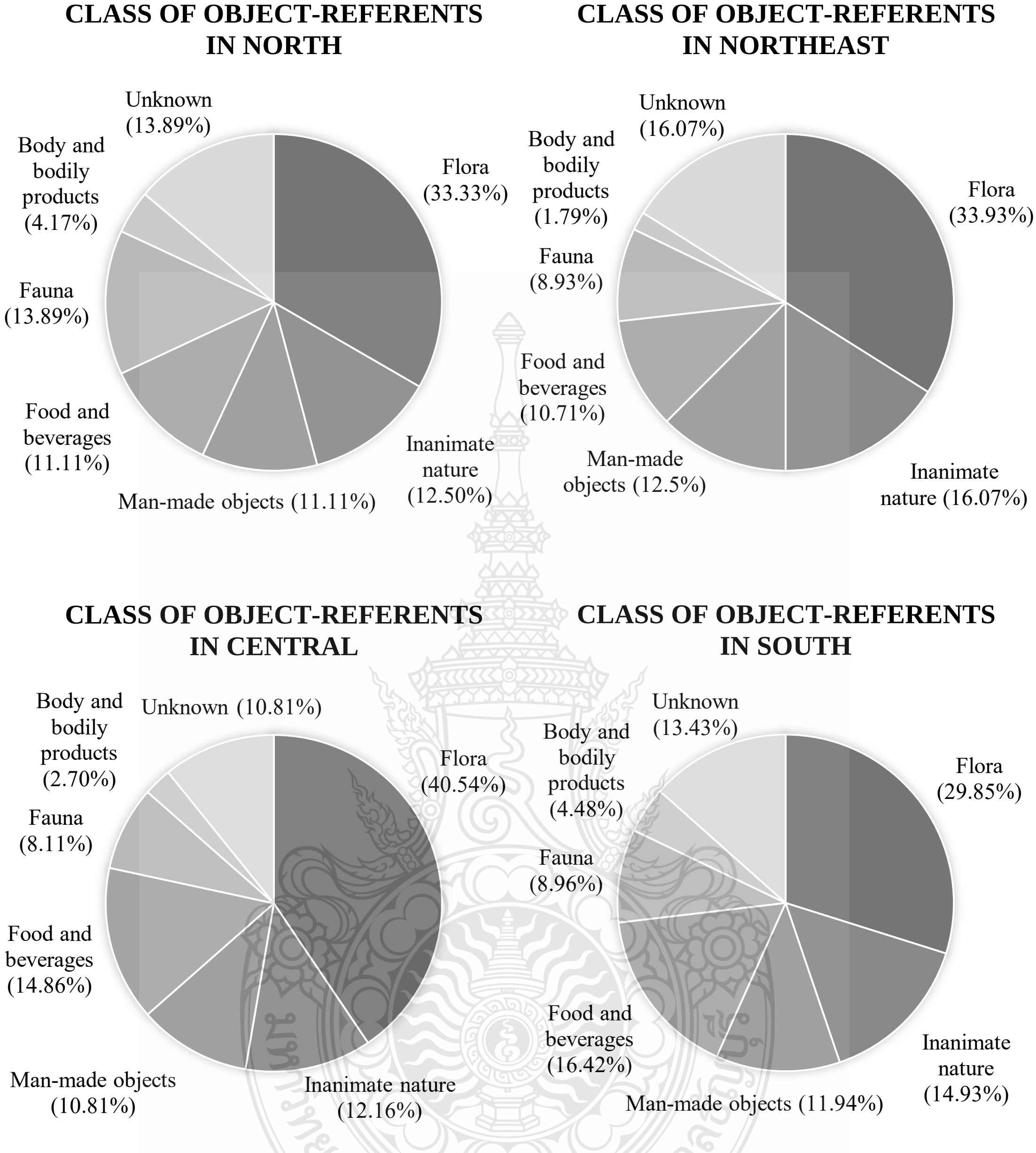


Figure 5.3 Proportion of object-derived color names in four regions.

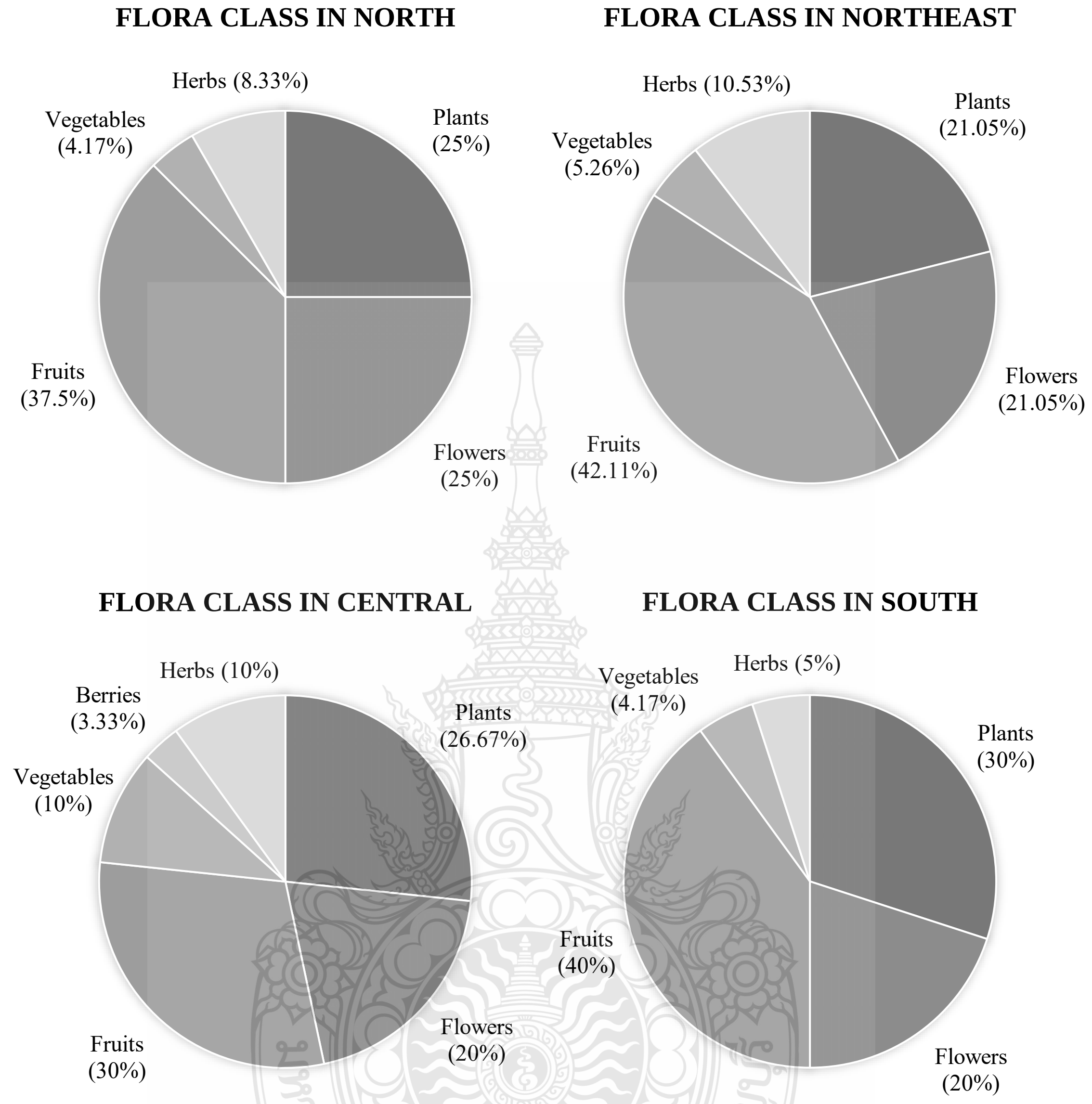


Figure 5.4 Proportion of use color names referred to categories of objects in flora class for four region. For other categories of each region, see the Appendix D.

5.4 Gender differences in color naming

As has been reported in previous studies of other languages [13], [16], [17], [35], there are differences in the use of color names in different gender. It was investigated the difference in color-naming between females and males—72 males and 89 females, in the age range of 18 to 60 years (Mean age = 21.95, SD ±5.93) and the color catergories patterns of male and female are shown in Figure 5.5. These categories patterns of females and males with ≥80% consensus of responses appear quite same, especially the shape of *lueang* ‘yellow’ category, and all categories were in the same location. However, there was a statistically significant difference in the number of color names used in each subject for the two genders, where females used non-BCTs slightly more than males (Table 5.2 and Figure 5.6). The total number of color names used by females’ subjects was 89 and that used by males was 80.

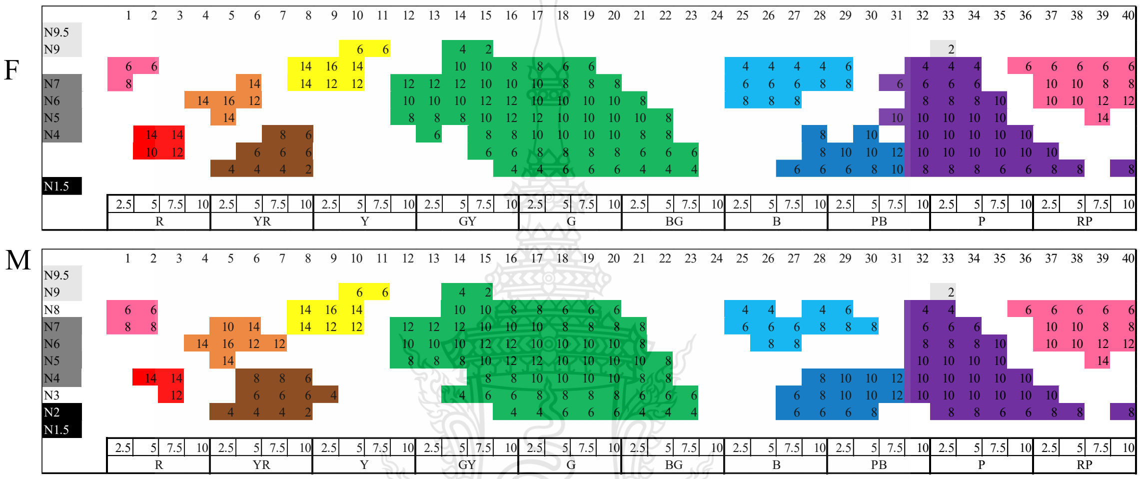


Figure 5.5 Color categories pattern for difference gender plotted on WCS color chart with the consistency of response ≥80% in each color chip, obtained from free-naming.

Table 5.2 Number of color names used in females and males.

Gender	Min	Max	Mean	S.D.	T-test
Females	12	42	20.11	5.45	t=2.65*
Males	12	32	17.88	4.58	p=0.004

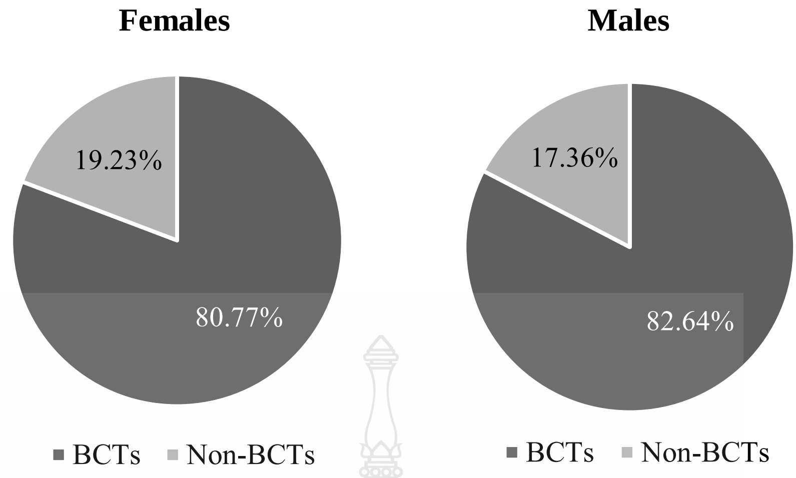


Figure 5.6 Proportion of use BCTs and non-BCTs in females and males.

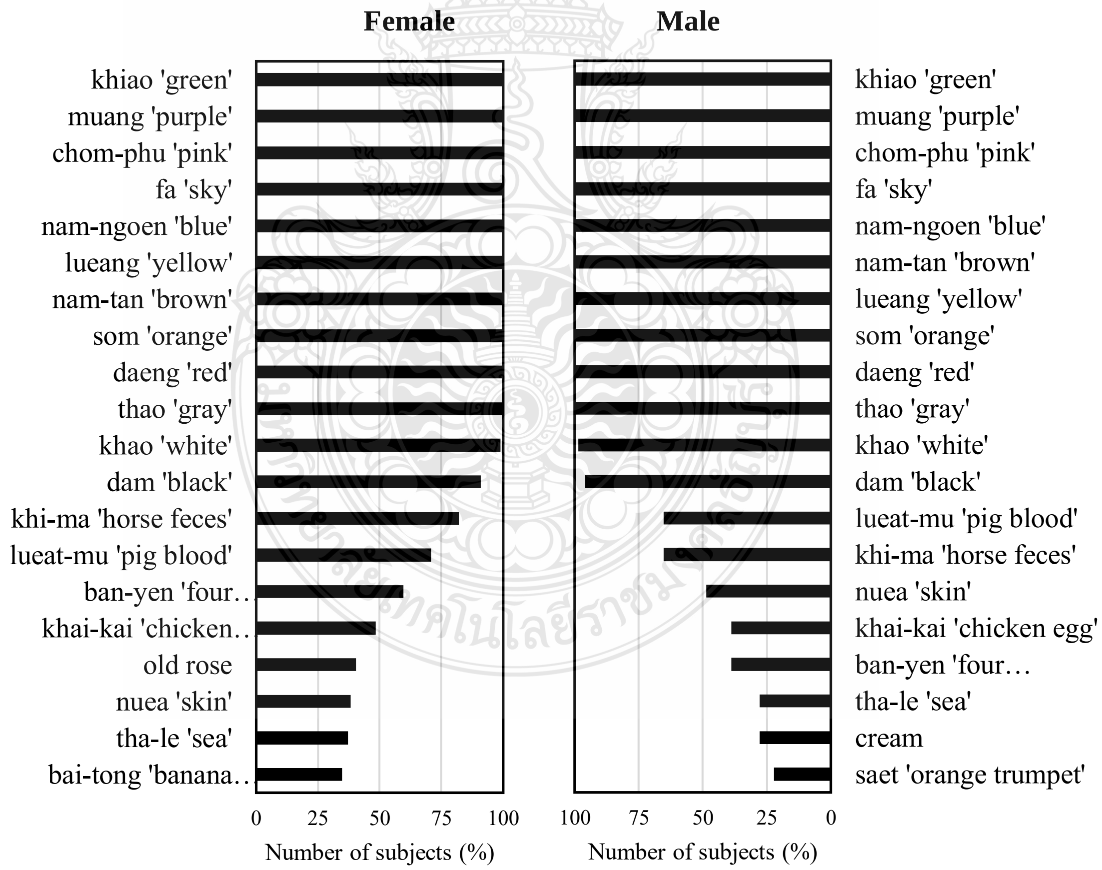


Figure 5.7 Twenty highly frequent color names used by females and males subjects.

Twenty mostly frequent used color names in males and females are shown in Figure 5.8 and they reveal a similar trend. Both females and males used the 12 color categories as well as *lueat-mu* ‘pig blood’ and *khi-ma* ‘horse feces’ with the same order, but different in percent of use for *lueat-mu* ‘pig blood’ and *khi-ma* ‘horse feces’. This also happened to ban-yen ‘four o'clock flower/magenta’, *khai-kai* ‘chicken egg’, *nuea* ‘skin’, and *tha-le* ‘sea’ that were found in the frequently used color names of both genders but differ in rank and percentage of use. It reveals also gender differences; two color names in females, old rose (rank 17) and *bai-tong* ‘banana leaves’ (rank 20) are not among the most frequently used by males. Whereas, two color names, cream, and *saet* ‘orange trumpet’ were frequently used for males (ranks 19 and 20, respectively), but did not occur among females' frequent names. In addition, it was found that females use more non-BCTs to identify warm colors than males, whereas males more refine in the use of color names in cool colors. This is consistent with the finding of Mylonas et al. [35]. The color names in warm colors that were given by females but not by males are *chi-won* ‘yellow robe of Buddhist monk’, *klip-bua* ‘petal of the lotus blossom’, *kha-min* ‘turmeric’, *phlai* ‘zingiber cassumunar’, *ma-miao* ‘pomerac’, *pun-haeng* ‘dry mortar’, cha-nom ‘milk tea’, *khlon* ‘mud’, *sa-nim* ‘rust’, *thian* ‘candle’, *khrang* ‘shellac’, *thap-thim* ‘ruby’, caramel, *chat* ‘crimson’, *dok-khun* ‘golden shower’, *dao-rueang* ‘marigold’, and *fak-thong* ‘pumpkin’. The color names in cool colors that were given by males but not by females are *tha-han* ‘military color’, *sa-rai* ‘seaweed’, turquoise, cantaloupe, *khi-pet* ‘duck feces’, *ton-kluai* ‘banana tree’, *ton-mai* ‘tree’, *phrik-yuak* ‘bell pepper’, *taeng-kwa* ‘cucumber’, *khi-nok* ‘bird feces’, and *fak* ‘winter melon’.

The derivation of color names was further analyzed with regard to gender differences. Both genders used color names of mostly referred to the flora class (33.71% in females and 36.25 for males) and followed by the inanimate nature class (16.85%), then the food and beverages class (14.61%) for females, or followed by the food and beverages class (13.75%), then the inanimate nature class (12.5%) for males, Figure 5.8. In the flora class, females mostly used color names referred to the fruits category (36.67%) followed by flowers (26.67%) and then plants (20%), while males mostly used color names referred to fruits (34.48%) followed by plants (31.03%) and then flowers (17.24%), Figures 5.9 and 5.10. The color names with the highly frequent of used in fruits category by females are *som* 'orange', peach, and *ma-nao* 'lime', and by males are *som* 'orange', *plueak-mang-khut* 'mangosteen peel', and peach. In addition, it was also found that females gave more refined color names in relation to (semi-)precious stone, e.g., *muk* 'pearl', *nga-chang* 'ivory', *thap-thim* 'ruby', and *phai-lin* 'sapphire' which were not given by males, whereas males gave more refined color names in relation to natural objects and substance, e.g., *phra-a-thit* 'sun' and *lava* which were not given by females. This is in accord with the finding of Griber et. al 2018 [37] that object-derived color names show certain categories are exclusively female or male.

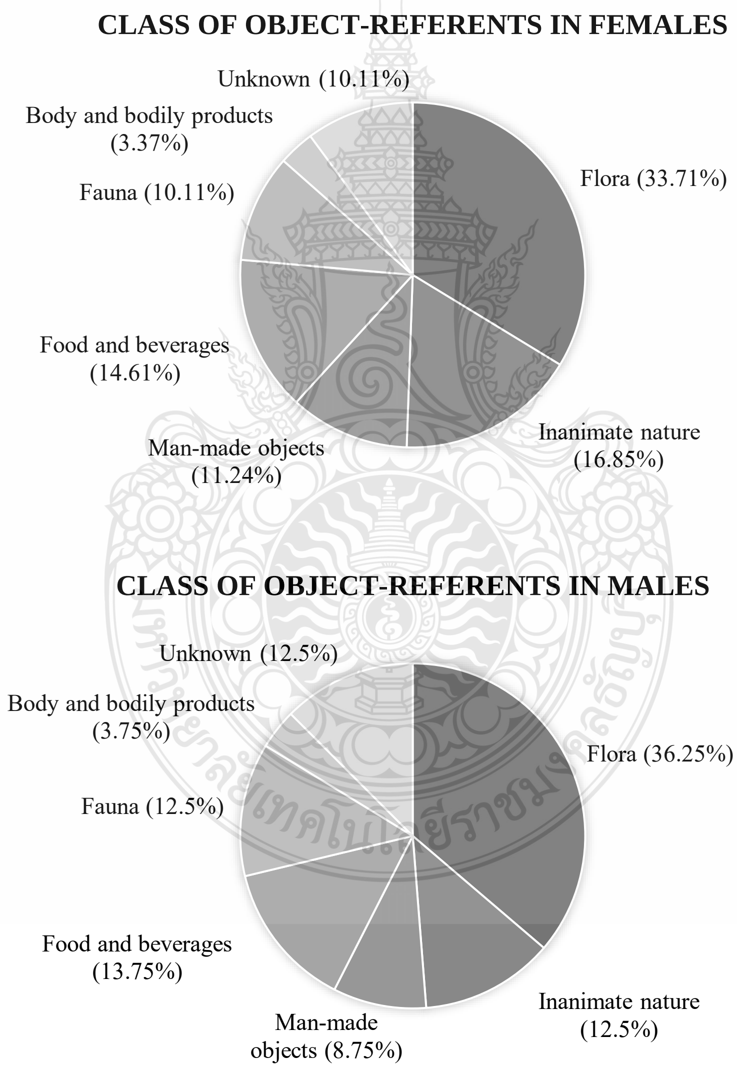


Figure 5.8 Proportion of object-derived color names in seven classes for females and males subjects.

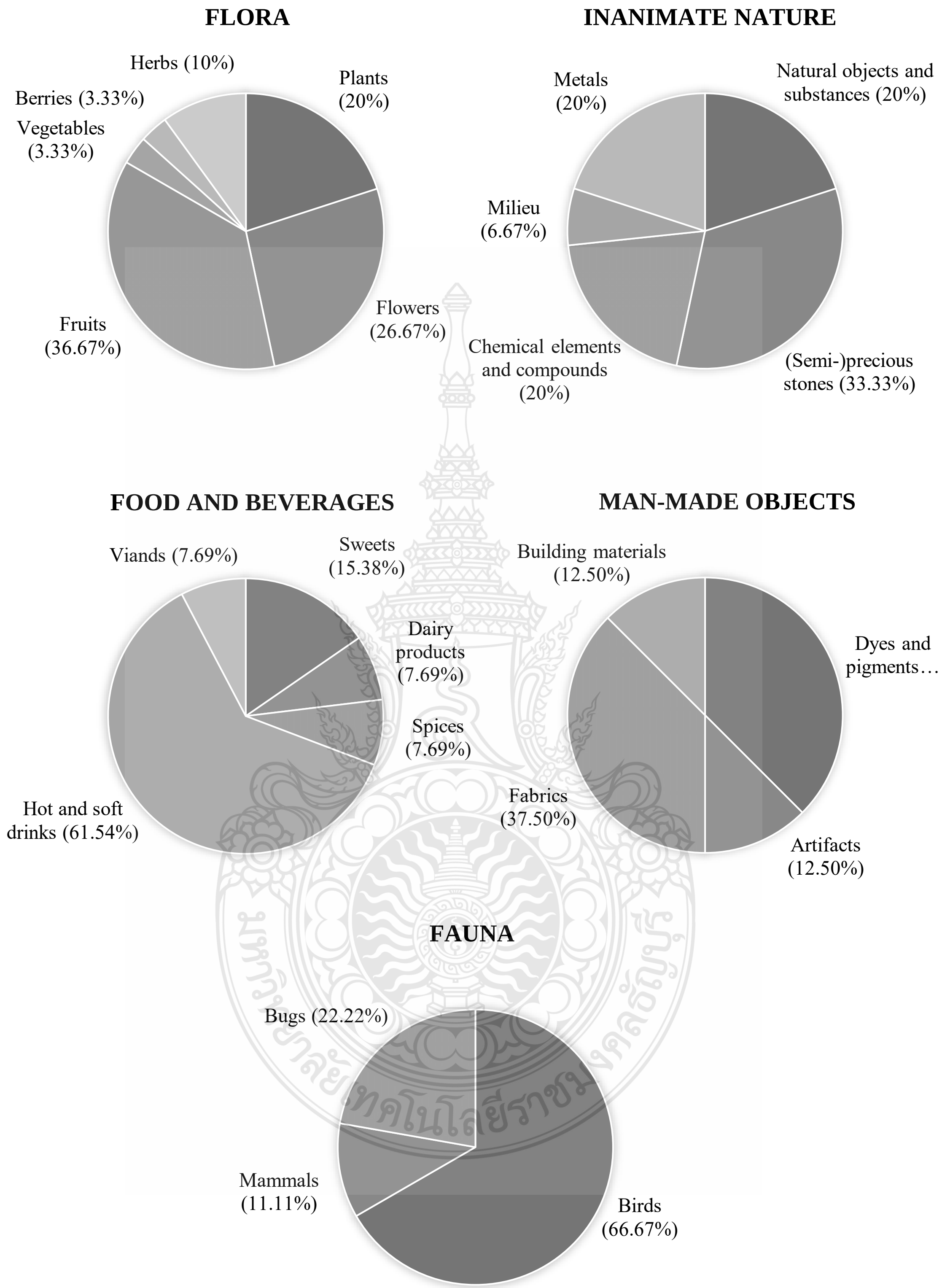


Figure 5.9 Proportion of object-derived color names for each category of five classes in females subjects.

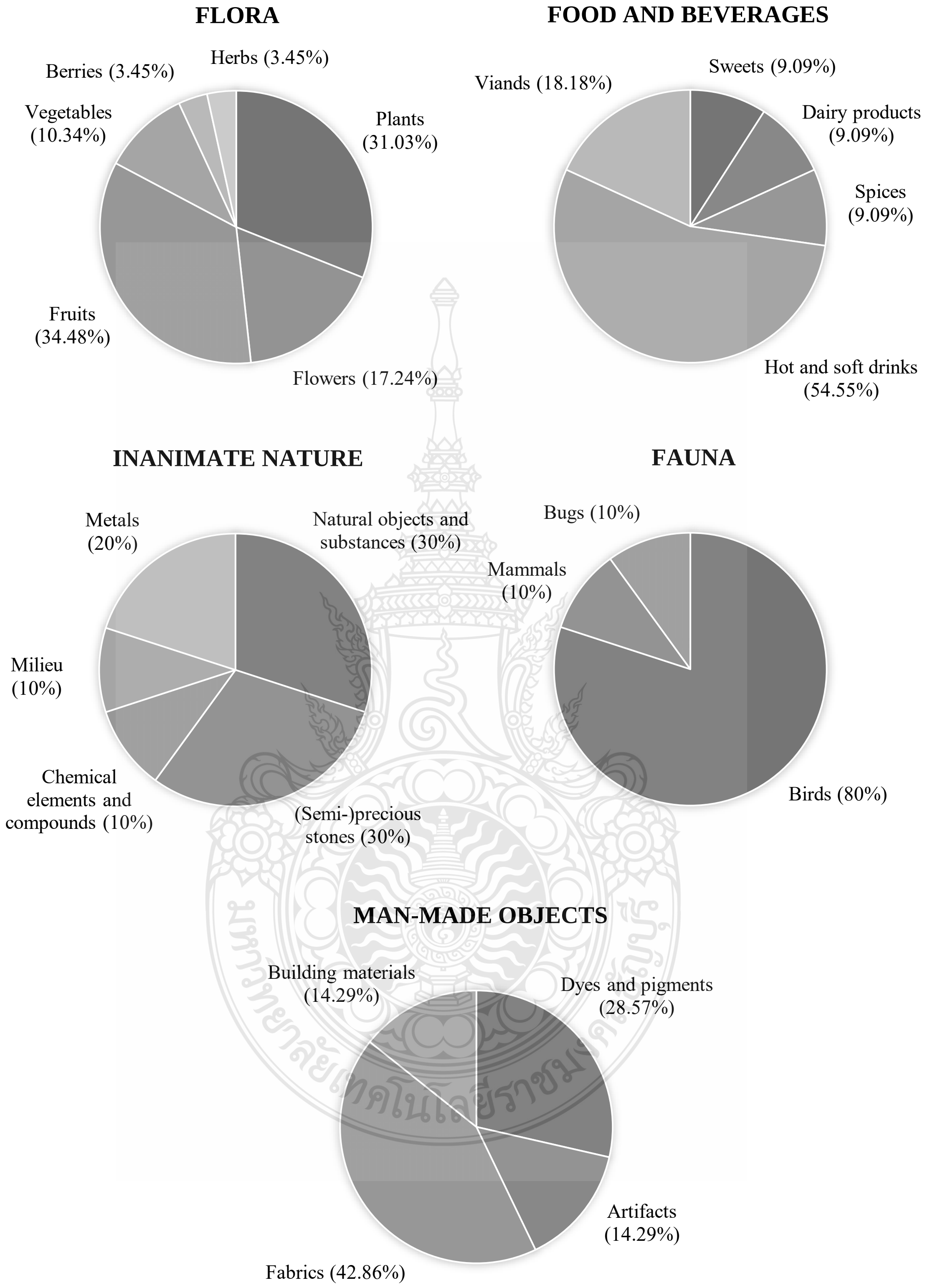


Figure 5.10 Proportion of object-derived color names for each category of five classes in males subjects.

5.5 New occurrence of the color names

Literature review for the color names in Thai [1], [18] – [24] reveals a change in the use of color names in time. Color names obtained from the subjects in this study were mostly derived from flora, while color names found in the Ayutthaya period [24] were mostly referred to as minerals. Moreover, numerous colors names were disappeared in this study, for example, *khab*, *sok*, *tang-sae*, *nam-rak*, *hong-sa-bat*, *dok-ta-baek*, *rong-thong, ho-ra-dan, ke-la-hum, ang-kap, fa-lap,* etc. [18], [23], [25], [44], [45].

As a comparison of color names found in this study with a comprehensive studies of traditional Thai color names used in Mural Paintings by Katemake and Preda [44] and the database of Thai colors used in Thai art work under the name “Thai tone” developed by Pittayamatee [45], there were many color names are consistent. For instance, *an-chan* 'butterfly pea', *fa* 'sky', *it* 'brick', *khaki*, *khram* 'indigo', *krom-ma-tha* 'navy blue', *ku-lap* 'rose', *met-ma-prang* 'marian plum seed', *nga-chang* 'ivory', *ngoen* 'silver', *nuea* 'skin', *phueak* 'taro', *plueak-mang-khut* 'mangosteen peel', *thong* 'gold', *ban-yen* 'four o'clock flower/ magenta', etc. Due to the objectives of Pittayamatee's stud y, it aims to develop a Thai color system to preserve the ancient coloring process for use in art. Therefore, the method of collecting data and presenting the results differs from this study, which is based on psychophysical and focusing on human color perception, the method of collecting data and illustrating results is somewhat more scientific. However, Katemake and Preda’s study has presented a scientific method for identifying a colorimetric of the traditional Thai colors used in mural paintings, the results could be served as a traditional Thai color name dictionary, and there are several color names correspond to those found in Pittayamatee. In this study, the author has matched the characteristic of color names that were found to be consistent in all three studies, i.e. matching of artistic color names elicited from literature, Thai art book, and art professionals [44], [45] with the spychophysic method based on human color perception elicited from general people who were the subjects in this study. The color matching table is shown in Appendix E.

In addition to 10 BTCs in Thai proposed by B&K’s 1969 [1], here, by using a similar method, there were found 3 more color names in this study with highly frequent use—*thao* ‘gray’, *som* ‘orange’, and *nam-ngoen* ‘blue’. In which *thao* ‘gray’ is used to refer to the color chips whose lightness is b etween white and black, *som* ‘orange’ seems to have been used as a replacement for *saet* 'orange trumpet'. Note that *som* is found to have been used since the Ayutthaya period [24]. In this study, it was found that *saet* was used more specifically for vivid orange and it has a lower number of speakers and frequency of use than *som*. Therefore, it was not considered as the BCT in this study. In addition, it was also found several color names to be used in addition to the previous time (see Table 5.3). This reflects the linguistic change over time, i.e., diachronic change in basic color names [12], [26] in Thai society.

Table 5.3 New occurrence color names

No.	Color names	Subjects (n)	Respones (n)
1	mint	37	295
2	peach	26	75
3	mustard	24	62
4	*cha-yen* 'iced tea'	9	26
5	lemon	8	23
6	*nom-yen* 'pink milk'	7	19
7	*cha-khiao* 'green tea'	3	5
8	*a-ngun* 'grape'	2	5
9	*cha-nom* 'milk tea'	2	4
10	turquoise	1	17
11	cantaloupe	1	11
12	*kaeng-som* 'thai sour soup made of tamarind paste'	1	2
13	*phrik-yuak* 'bell pepper'	1	2
14	*hom-daeng* 'shallot'	1	2
15	*taeng-kwa* 'cucumber'	1	1
16	cocoa	1	1
17	caramel	1	1
18	*thu-rian* 'durian'	1	1
19	*bron* 'bronze'	1	1
20	blueberry	1	1
21	*luk-kai* 'chick'	1	1
22	*lot-chong* 'pandan noodles with noconut milk/Thai dessert'	1	1

It is worth noting that Thai subjects in this study have given numerous color names that are a transliteration of English loanwords—old rose, cream, mint, peach, mustard, lemon, turquoise, cantaloupe, cocoa, caramel, blueberry, khaki, and lava—as well as an adopted form—*ka-fae* ‘coffee’, and *bron* 'bronze'. Moreover, many color names correspond to those found in other languages, e.g. Russian [16], Italian [17], English [26], magenta, turquoise, peach, lemon, blueberry, and bronze as exsamples. This finding suggests cross-cultural use of color names [12], [27], in another word, some color names are shared by Thai, Russian, Italian, and English speakers despite the cultural as well as natural environment differences. This may be due to the globalizational influence. The subjects in this study were young people and most of them were university students, they grew up in Thailand while technology, media, and commercial interactions with outsiders increased, allowing them to be affected by foreign languages and cultures.

5.6 Implication for Practice and Future Research

5.6.1 The result can be used as the data base of Thai color names in color communication.

5.6.2 Investigating on situation of educating about colors in schools as well as creating colors that adhere to the Thai fundamental color categories for color manufacturers.

5.6.3 The data of color names in this study were mostly obtained from young subjects and most of them were university students. In order to cover the Thai population, the subject number should be increased by increasing the number of the elderly. This will enable comparisons between color names used by subjects in different generations.

5.6.4 The results of this study revealed that Thai subjects used many transliterations of English loanwords to call color names, it would be interesting if further study investigates color naming with the factors of bilingual (or trilingual) subjects.

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APPENDICES

APPENDIX A

The physical measurement of 330 Munsell color chips

Table I The CIE L*a*b*, x y, and u’ v’ values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer.

No.	Munsell code	L*	a*	b*	x	y	u'	v'
1	7.5PB 3/12	30.43	14.46	-48.90	0.211	0.177	0.179	0.339
2	5P 6/8	61.73	21.03	-22.60	0.333	0.288	0.230	0.448
3	7.5G 6/10	61.89	-53.54	8.88	0.255	0.446	0.130	0.512
4	5Y 7/12	72.45	3.48	89.11	0.483	0.488	0.245	0.557
5	5GY 5/8	51.83	-21.39	52.68	0.403	0.525	0.190	0.556
6	2.5RP 4/10	41.92	42.34	-13.27	0.412	0.267	0.306	0.447
7	10R 7/10	72.65	41.42	40.35	0.497	0.379	0.304	0.520
8	5GY 4/6	41.53	-17.07	38.73	0.396	0.509	0.191	0.551
9	7.5GY 8/10	81.59	-34.98	52.56	0.370	0.497	0.180	0.544
10	2.5P 4/10	41.20	24.98	-33.39	0.302	0.234	0.232	0.405
11	5G 2/6	21.06	-27.68	4.91	0.248	0.456	0.125	0.514
12	5RP 6/10	62.40	43.11	-1.96	0.426	0.308	0.292	0.475
13	7.5YR 4/8	41.32	21.39	46.98	0.525	0.424	0.298	0.542
14	7.5B 7/6	70.84	-19.38	-20.81	0.270	0.329	0.169	0.462
15	10YR 8/14	81.35	21.44	97.58	0.514	0.459	0.275	0.552
16	7.5P 3/10	30.41	36.03	-25.74	0.353	0.223	0.284	0.404
17	7.5YR 3/6	32.08	17.44	33.87	0.512	0.417	0.294	0.538
18	2.5GY 2/2	19.64	-3.02	10.33	0.381	0.420	0.210	0.519
19	7.5PB 8/4	81.26	0.81	-12.91	0.323	0.333	0.204	0.472
20	10P 2/6	20.52	22.99	-13.41	0.370	0.255	0.278	0.431
21	7.5YR 5/10	52.15	26.18	63.75	0.536	0.430	0.302	0.546
22	7.5Y 2/2	20.12	-0.49	12.78	0.403	0.422	0.222	0.523
23	5Y 4/6	41.28	3.56	43.16	0.467	0.464	0.245	0.547
24	5Y 6/10	62.67	4.59	73.64	0.482	0.480	0.247	0.554
25	10G 3/8	30.80	-41.31	0.38	0.211	0.435	0.108	0.502
26	5GY 2/2	19.68	-4.97	9.67	0.369	0.422	0.201	0.519
27	5YR 6/12	63.03	35.70	69.75	0.543	0.417	0.314	0.543
28	10B 7/8	71.51	-19.14	-30.19	0.254	0.308	0.164	0.448

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
29	7.5R 3/12	33.52	60.31	39.22	0.643	0.316	0.467	0.517
30	5Y 2/2	20.66	1.29	12.87	0.411	0.416	0.229	0.522
31	2.5P 9/2	91.42	2.09	-3.31	0.343	0.351	0.210	0.484
32	10BG 5/8	51.61	-37.54	-18.72	0.218	0.342	0.131	0.461
33	5Y 8/14	82.30	5.77	101.15	0.488	0.486	0.248	0.557
34	5PB 5/12	50.66	-4.94	-49.44	0.211	0.231	0.158	0.389
35	5Y 3/4	30.99	2.5	27.53	0.447	0.447	0.239	0.539
36	10R 2/6	22.31	26.65	16.55	0.529	0.350	0.344	0.513
37	2.5B 9/2	91.39	-8.13	-3.25	0.328	0.359	0.197	0.486
38	7.5B 8/4	81.13	-13.1	-12.27	0.303	0.345	0.185	0.475
39	7.5R 8/6	81.55	26.45	19.89	0.425	0.367	0.259	0.504
40	5BG 6/8	61.14	-43.27	-7.62	0.243	0.383	0.137	0.485
41	7.5P 4/10	42.15	33.65	-24.19	0.353	0.251	0.266	0.426
42	2.5BG 3/6	30.06	-31.82	-2.95	0.229	0.401	0.124	0.491
43	2.5R 3/10	31.48	52.76	16.66	0.575	0.300	0.422	0.495
44	7.5G 8/6	80.96	-35.67	7.9	0.301	0.408	0.165	0.503
45	10RP 7/8	72.73	35.91	10.27	0.431	0.341	0.276	0.493
46	7.5R 9/2	91.7	6.34	5.45	0.364	0.363	0.220	0.493
47	2.5RP 5/12	52.34	50.83	-13.71	0.420	0.270	0.311	0.450
48	7.5Y 3/4	30.75	-0.22	28.57	0.440	0.458	0.231	0.541
49	7.5P 5/10	52.08	34.87	-22.98	0.359	0.266	0.262	0.437
50	10BG 2/4	19.07	-17.43	-10.89	0.221	0.331	0.135	0.456
51	2.5PB 9/2	91.4	-2.78	-4.56	0.334	0.353	0.204	0.484
52	5Y 5/8	52	4.63	59.75	0.480	0.474	0.248	0.552
53	10GY 7/10	71.3	-44.65	41.25	0.334	0.506	0.159	0.542
54	7.5PB 4/12	41.24	10.45	-48.31	0.227	0.208	0.180	0.371
55	2.5G 5/12	52.1	-66.3	28.69	0.248	0.555	0.108	0.545
56	N8	81.24	-0.7	1.08	0.347	0.361	0.209	0.489

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
57	2.5B 8/4	81.23	-18.08	-8.68	0.301	0.357	0.180	0.481
58	2.5GY 5/8	52.65	-15.19	55.29	0.423	0.513	0.203	0.556
59	10YR 6/12	62.52	20.95	81.27	0.523	0.453	0.283	0.552
60	N3	30.79	-0.53	-0.23	0.343	0.359	0.208	0.488
61	2.5Y 8/16	82.73	15.47	111.89	0.510	0.475	0.265	0.556
62	2.5Y 7/12	72.34	12.95	84.94	0.499	0.468	0.262	0.553
63	5P 4/10	40.89	28.97	-29.09	0.325	0.241	0.248	0.414
64	2.5G 3/8	29.87	-38.75	15.79	0.261	0.520	0.120	0.537
65	5B 7/6	71.5	-23.48	-18.48	0.268	0.338	0.165	0.466
66	2.5RP 8/6	82.04	24.23	-3.59	0.378	0.331	0.243	0.479
67	2.5G 8/8	80.69	-41.23	22.63	0.315	0.447	0.163	0.520
68	10G 5/10	52.23	-53.59	1.85	0.228	0.432	0.118	0.503
69	5G 6/10	61.06	-54.63	14.87	0.263	0.467	0.130	0.520
70	5B 2/4	21.06	-13.89	-14.42	0.226	0.307	0.144	0.443
71	7.5RP 8/6	82.24	27.22	4.52	0.398	0.342	0.252	0.488
72	2.5G 4/10	39.79	-55.51	22.96	0.243	0.555	0.106	0.544
73	10GY 9/2	91	-12.3	11.91	0.347	0.390	0.199	0.502
74	2.5P 3/10	31.08	27.06	-34.04	0.295	0.210	0.239	0.383
75	7.5Y 5/8	51.84	-1.51	59.99	0.464	0.489	0.234	0.554
76	N5	52.05	-1.08	0.29	0.344	0.361	0.207	0.489
77	2.5RP 9/2	90.81	5.6	-0.87	0.352	0.353	0.216	0.486
78	2.5BG 4/8	40.43	-43.79	-4.64	0.214	0.403	0.116	0.490
79	2.5GY 3/4	30.93	-8.18	24.32	0.399	0.469	0.204	0.539
80	10YR 2/2	21.01	4.86	10.4	0.416	0.394	0.241	0.514
81	5G 4/10	39.92	-54.14	12.35	0.225	0.501	0.105	0.527
82	10B 5/10	51.77	-22.4	-40.98	0.200	0.264	0.139	0.412
83	2.5YR 8/6	81.48	23.34	28.78	0.436	0.384	0.259	0.513
84	10Y 5/8	52.44	-7.44	60.59	0.449	0.503	0.221	0.556

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell hue	L*	a*	b*	x	y	u'	v'
85	5B 8/4	81.03	-16.6	-12.4	0.297	0.348	0.181	0.476
86	2.5Y 2/2	20.65	3.02	11.36	0.412	0.404	0.235	0.517
87	N9	91.7	-0.64	0.97	0.346	0.361	0.209	0.489
88	7.5GY 9/2	91.23	-9.69	14	0.354	0.391	0.203	0.504
89	7.5BG 6/8	61.82	-40.99	-12.26	0.239	0.367	0.138	0.477
90	10PB 7/6	72.42	6.89	-21.64	0.313	0.308	0.207	0.457
91	7.5BG 4/8	40.86	-41.99	-15.65	0.194	0.353	0.113	0.464
92	2.5PB 3/10	29.97	-10.9	-44.93	0.163	0.201	0.128	0.355
93	2.5YR 6/16	63.58	53.42	85.27	0.588	0.395	0.358	0.541
94	7.5Y 6/10	62.56	-2.71	73.47	0.466	0.495	0.233	0.556
95	5GY 3/4	30.45	-11.4	23.6	0.385	0.477	0.194	0.540
96	7.5RP 2/8	22.33	38.16	-3.92	0.476	0.265	0.364	0.456
97	5R 5/14	53.31	64.77	35.49	0.575	0.331	0.395	0.511
98	5P 7/6	71.4	14.46	-16.35	0.337	0.312	0.222	0.463
99	10PB 3/10	31.94	19.65	-38.56	0.260	0.205	0.210	0.374
100	10P 5/12	52.76	45.78	-21.34	0.386	0.260	0.289	0.438
101	2.5R 9/2	91.32	6.86	3.27	0.361	0.358	0.220	0.490
102	7.5PB 6/8	61.27	5.08	-31.07	0.284	0.281	0.195	0.436
103	7.5R 6/12	62.66	52.57	40.51	0.536	0.361	0.343	0.519
104	2.5B 2/4	20.02	-13.95	-12.32	0.231	0.318	0.146	0.450
105	7.5R 5/14	52.51	62.27	48.2	0.594	0.347	0.397	0.523
106	2.5GY 4/6	42.46	-12.2	40.1	0.413	0.497	0.203	0.550
107	7.5PB 9/2	90.95	0.22	-3.89	0.340	0.352	0.208	0.484
108	10RP 3/10	30.76	51.89	8.44	0.546	0.285	0.410	0.481
109	10BG 3/6	29.64	-27.9	-16.31	0.199	0.327	0.122	0.451
110	7.5P 7/8	71.9	25.37	-16.98	0.354	0.303	0.239	0.460
111	2.5PB 4/10	40.15	-12.07	-41.9	0.194	0.235	0.143	0.389
112	2.5YR 7/10	72.15	36.16	47.01	0.499	0.394	0.297	0.527

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
113	5BG 7/8	71.4	-41.91	-6.61	0.259	0.382	0.146	0.487
114	10BG 6/8	61	-38.23	-17.74	0.233	0.348	0.139	0.467
115	2.5B 4/6	41.2	-26.68	-19.74	0.220	0.322	0.137	0.451
116	10YR 4/6	42.05	13.39	39.13	0.487	0.432	0.270	0.539
117	7.5GY 5/10	51.73	-40.5	56.31	0.356	0.578	0.154	0.564
118	10P 8/6	81.81	21.19	-8.59	0.363	0.325	0.235	0.474
119	5RP 2/8	21.48	35.71	-8.57	0.444	0.253	0.345	0.442
120	5R 6/12	62.41	54.09	28.85	0.518	0.344	0.340	0.508
121	N1.5	16.27	-0.4	-0.76	0.340	0.355	0.207	0.485
122	5G 9/2	91.16	-14.23	5.53	0.334	0.380	0.194	0.496
123	10YR 9/2	91.85	3.53	14.95	0.375	0.381	0.220	0.502
124	7.5R 2/8	20.99	39.16	19.81	0.595	0.319	0.422	0.509
125	10P 3/10	30.55	41.36	-20.92	0.389	0.230	0.313	0.416
126	5PB 2/8	20.52	0.87	-37.6	0.184	0.187	0.150	0.345
127	2.5B 6/8	61.58	-35.29	-22.58	0.229	0.333	0.141	0.458
128	10YR 7/14	72.79	22.84	96.84	0.524	0.457	0.282	0.553
129	7.5YR 9/2	91.67	5.29	13.46	0.376	0.377	0.222	0.501
130	5G 3/8	29.95	-42.26	10.19	0.233	0.496	0.110	0.526
131	2.5B 7/6	71.17	-25.38	-15.46	0.271	0.346	0.164	0.471
132	10RP 9/2	91.68	7	2.93	0.361	0.358	0.220	0.490
133	10BG 9/2	90.7	-10.11	-2.43	0.327	0.362	0.195	0.487
134	10RP 8/6	82.1	26.69	8.32	0.404	0.349	0.253	0.492
135	7.5P 6/10	61.85	33.69	-23.09	0.356	0.277	0.254	0.444
136	10G 2/6	19.44	-27.98	0.14	0.224	0.426	0.117	0.500
137	5R 7/8	72.09	36.07	20.12	0.451	0.357	0.283	0.503
138	2.5YR 4/10	42.96	37.49	48.78	0.566	0.389	0.347	0.535
139	7.5G 9/2	91.23	-12.55	3.93	0.334	0.376	0.195	0.494
140	7.5BG 7/6	70.53	-30.19	-7.56	0.277	0.370	0.161	0.483

Table I The CIE L*a*b*, x y, and u’ v’ values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
141	2.5BG 9/2	90.88	-13.69	1.52	0.328	0.372	0.193	0.492
142	10P 9/2	91.14	4.84	-0.83	0.351	0.353	0.215	0.486
143	5RP 7/10	72.92	43.05	1.09	0.423	0.319	0.283	0.480
144	2.5RP 3/10	31.65	45.08	-14.96	0.425	0.243	0.336	0.432
145	7.5B 9/2	91.26	-5.96	-4.62	0.329	0.355	0.200	0.484
146	10B 6/10	61.25	-22.61	-38.97	0.219	0.281	0.148	0.426
147	2.5Y 6/10	62.26	11.66	70.66	0.495	0.464	0.261	0.551
148	5P 2/8	20.2	25.23	-23.33	0.325	0.215	0.263	0.393
149	10R 6/14	62.99	56.25	62.64	0.575	0.377	0.361	0.532
150	7.5Y 9/6	92.03	-3.03	48.05	0.414	0.438	0.223	0.531
151	10G 7/8	71.47	-43.81	3.96	0.274	0.412	0.148	0.501
152	7.5YR 8/8	81.88	20.93	49.42	0.463	0.416	0.263	0.530
153	10PB 6/8	61.1	10.29	-27.42	0.302	0.285	0.207	0.441
154	7.5BG 2/4	20.01	-18.2	-8.14	0.232	0.350	0.138	0.468
155	7.5PB 7/6	71.37	1.84	-22.47	0.303	0.310	0.198	0.456
156	2.5PB 8/6	80.22	-7.85	-18.33	0.300	0.329	0.189	0.466
157	7.5R 7/10	72.16	44.32	32.64	0.490	0.365	0.306	0.513
158	7.5YR 7/14	73.13	31.23	88.65	0.534	0.438	0.297	0.549
159	2.5B 3/6	30.88	-25.12	-19.73	0.200	0.309	0.127	0.441
160	10PB 4/10	40.86	18.38	-38.28	0.271	0.226	0.210	0.394
161	10GY 8/8	80.98	-35.15	34.97	0.345	0.465	0.175	0.530
162	10GY 6/12	61.73	-53.81	49.14	0.320	0.562	0.141	0.556
163	2.5G 2/4	18.49	-20.83	9.49	0.292	0.476	0.143	0.527
164	2.5R 5/14	52.82	66.23	23.38	0.553	0.313	0.391	0.499
165	2.5YR 5/14	54.76	47.19	78.93	0.589	0.397	0.358	0.542
166	2.5BG 8/6	80.82	-33.75	0.94	0.293	0.391	0.165	0.495
167	5PB 8/6	78.59	-4.65	-20.68	0.299	0.321	0.191	0.462
168	10YR 3/6	32.02	11.54	34	0.493	0.434	0.273	0.541

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
169	2.5BG 6/8	61.7	-44.85	-1.57	0.253	0.403	0.138	0.495
170	5R 3/10	32.24	50.45	24.03	0.588	0.318	0.417	0.507
171	7.5P 8/6	81.76	18.13	-11.36	0.353	0.323	0.229	0.471
172	5G 7/8	72.24	-43.99	13.08	0.290	0.435	0.152	0.513
173	10P 7/8	72.28	29.76	-13.06	0.370	0.306	0.249	0.464
174	2.5R 4/14	43.02	67.38	21.93	0.583	0.299	0.430	0.496
175	7.5YR 2/4	25.83	12.44	20.34	0.474	0.403	0.275	0.527
176	5R 9/2	91.41	7.62	5.11	0.365	0.361	0.221	0.492
177	2.5YR 3/8	31.67	32.54	39.17	0.573	0.382	0.356	0.534
178	10G 6/10	61.07	-54.72	3.66	0.242	0.431	0.126	0.505
179	5PB 9/2	91.15	-1.48	-4.79	0.336	0.351	0.205	0.483
180	7.5RP 4/10	42.64	47.01	2.95	0.478	0.297	0.341	0.477
181	7.5B 5/8	51.17	-24.1	-30.77	0.218	0.293	0.143	0.433
182	5YR 8/6	82.06	20.06	33.25	0.437	0.394	0.255	0.517
183	10GY 5/12	51.54	-56.02	48.72	0.304	0.599	0.127	0.563
184	7.5GY 3/6	30.86	-22.87	27.84	0.353	0.525	0.164	0.550
185	10RP 2/8	21.14	36.45	0.19	0.495	0.278	0.371	0.468
186	7.5Y 7/12	72.94	-3.33	89.01	0.470	0.500	0.233	0.558
187	7.5G 2/6	20.08	-30.15	3.98	0.232	0.458	0.115	0.513
188	2.5P 5/10	52.05	22.8	-33.73	0.304	0.252	0.225	0.419
189	2.5R 2/8	20.94	38.67	5.9	0.534	0.288	0.396	0.481
190	2.5RP 2/8	20.94	35.81	-12.16	0.425	0.240	0.338	0.430
191	2.5P 7/6	71.98	10.72	-18.93	0.325	0.310	0.214	0.460
192	5BG 3/6	30.62	-30.56	-9.12	0.216	0.367	0.124	0.473
193	10B 9/2	91.13	-4.98	-4.77	0.331	0.354	0.201	0.484
194	2.5RP 6/10	62.93	40.45	-9.98	0.401	0.297	0.278	0.464
195	2.5P 8/4	81.47	6.91	-12.03	0.334	0.330	0.213	0.472
196	10PB 2/8	20.72	17.48	-30.69	0.263	0.199	0.216	0.368

Table I The CIE L*a*b*, x y, and u’ v’ values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
197	10B 3/8	29.56	-17.46	-35.15	0.172	0.236	0.126	0.387
198	10B 2/6	21.25	-12.82	-28.22	0.178	0.237	0.130	0.389
199	2.5BG 2/4	19.99	-18.7	-2.08	0.256	0.390	0.143	0.490
200	2.5GY 6/10	62.25	-18.05	73.41	0.431	0.528	0.204	0.561
201	7.5BG 3/6	29.7	-29.53	-12.48	0.206	0.348	0.122	0.463
202	7.5PB 5/10	50.7	6.03	-39.25	0.255	0.249	0.187	0.409
203	7.5P 2/6	20.22	22.25	-16.16	0.352	0.245	0.269	0.421
204	5RP 8/6	82.04	24.18	0.31	0.385	0.338	0.245	0.484
205	5RP 9/2	91.33	5.96	1.29	0.357	0.356	0.218	0.488
206	10Y 7/12	71.95	-10.2	89.67	0.457	0.514	0.221	0.560
207	7.5B 6/8	61	-23.76	-28.88	0.237	0.307	0.153	0.445
208	5PB 4/10	39.92	-4.43	-42.87	0.207	0.227	0.156	0.385
209	N6	61.91	-1.19	0.25	0.344	0.360	0.207	0.489
210	5B 5/8	51.37	-29.2	-27.8	0.214	0.306	0.138	0.441
211	5G 8/6	80.28	-33.82	12.1	0.311	0.416	0.169	0.508
212	2.5P 6/8	62.03	16.54	-25.76	0.317	0.285	0.219	0.443
213	7.5Y 4/6	41.89	-1.06	44.82	0.456	0.479	0.233	0.550
214	7.5BG 5/8	50.75	-41.63	-13.48	0.219	0.363	0.127	0.472
215	2.5P 2/8	21.05	23.16	-27.07	0.300	0.207	0.246	0.382
216	7.5P 9/3	91.46	4.52	-2.2	0.349	0.351	0.214	0.485
217	10B 8/4	81.21	-9.81	-13	0.306	0.341	0.189	0.474
218	2.5PB 2/6	20.21	-6.59	-28.33	0.193	0.228	0.145	0.384
219	2.5R 6/12	62.9	54.79	21.54	0.503	0.333	0.336	0.500
220	2.5B 5/8	51.39	-35.24	-23.88	0.211	0.323	0.131	0.450
221	2.5GY 8/12	82.94	-19.11	85.42	0.433	0.515	0.208	0.557
222	5R 4/14	42.92	65.69	35.04	0.610	0.317	0.436	0.511
223	2.5Y 9/4	89.92	3.29	34.25	0.406	0.412	0.228	0.520
224	5B 6/8	60.93	-29.52	-26.69	0.231	0.317	0.146	0.450

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
223	2.5Y 9/4	89.92	3.29	34.25	0.406	0.412	0.228	0.520
224	5B 6/8	60.93	-29.52	-26.69	0.231	0.317	0.146	0.450
225	2.5Y 3/4	31.23	6.29	26.21	0.457	0.432	0.251	0.535
226	10RP 6/12	62.98	54.03	14.04	0.485	0.323	0.328	0.492
227	10BG 4/8	40.83	-38.16	-19.72	0.193	0.332	0.117	0.453
228	5GY 5/10	50.72	-54.62	13.79	0.247	0.482	0.119	0.523
229	N2	18.72	-0.41	0.01	0.344	0.360	0.208	0.488
230	5GY 8/10	81.51	-27.11	65.24	0.399	0.505	0.193	0.550
231	5BG 4/8	41.12	-42.5	-10.2	0.206	0.377	0.116	0.477
232	2.5GY 7/12	71.75	-19.81	86.15	0.435	0.530	0.205	0.562
233	7.5YR 6/12	63.24	29.76	75	0.535	0.432	0.301	0.547
234	7.5G 4/10	40.61	-54.82	6.2	0.211	0.470	0.103	0.515
235	10PB 5/10	51.21	14.96	-36.27	0.281	0.251	0.207	0.414
236	7.5GY 7/10	71.6	-36.03	53.42	0.369	0.516	0.174	0.549
237	5YR 4/8	41.47	26.51	44.81	0.535	0.409	0.313	0.538
238	5RP 4/10	41.9	45.69	-4.62	0.451	0.282	0.329	0.463
239	7.5RP 7/8	72.82	36.69	4.68	0.420	0.331	0.274	0.486
240	5YR 5/12	53.68	35.33	65.86	0.556	0.413	0.325	0.543
241	2.5G 7/10	71.58	-52.63	27.09	0.297	0.483	0.145	0.530
242	2.5R 7/8	72.26	37.69	15	0.444	0.347	0.283	0.497
243	10R 4/12	43.54	50.11	50.72	0.598	0.363	0.388	0.530
244	10GY 3/6	31.03	-27.15	19.92	0.316	0.505	0.150	0.539
245	2.5RP 7/10	72.62	39.28	-6.18	0.401	0.310	0.271	0.472
246	5YR 2/4	21.54	16.07	19.43	0.500	0.390	0.299	0.525
247	7.5RP 5/14	53.5	64.34	5.36	0.501	0.290	0.366	0.477
248	5GY 6/10	61.63	-26.83	64.61	0.402	0.536	0.187	0.559
249	2.5G 9/2	90.56	-11.81	8.02	0.341	0.383	0.198	0.498
250	10GY 4/8	40.68	-36.18	29.74	0.318	0.534	0.145	0.548
251	10Y 2/2	20.58	-1.99	10.56	0.386	0.416	0.214	0.519
252	10YR 5/10	52.78	19.49	64.08	0.519	0.445	0.284	0.549

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
253	5GY 7/12	71.62	-30.06	77.28	0.407	0.541	0.187	0.561
254	10R 5/16	53.9	63.12	74.91	0.620	0.364	0.405	0.534
255	5B 9/2	89.96	-8.4	-4.38	0.326	0.357	0.196	0.485
256	2.5PB 5/12	51.14	-15.23	-49.98	0.193	0.236	0.142	0.390
257	7.5Y 8/12	81.64	-3.01	88.94	0.465	0.493	0.233	0.555
258	7.5B 3/6	30.29	-17.07	-25.45	0.203	0.275	0.138	0.420
259	2.5PB 7/8	71.24	-12.26	-30.22	0.264	0.303	0.173	0.446
260	2.5YR 2/4	21.46	18.14	15.14	0.492	0.371	0.304	0.516
261	10P 6/10	62.01	37.09	-16.34	0.379	0.287	0.266	0.454
262	10G 4/10	41.06	-54.74	1.31	0.202	0.445	0.102	0.505
263	5R 2/8	20.97	41.61	13.85	0.581	0.300	0.427	0.497
264	7.5PB 2/10	20.85	13.86	-41.91	0.206	0.166	0.180	0.326
265	7.5GY 6/12	63.36	-44.32	63.16	0.360	0.567	0.159	0.562
266	5P 3/10	31.24	32.67	-30.23	0.325	0.216	0.263	0.393
267	10P 4/10	40.57	39.01	-19.41	0.383	0.255	0.290	0.433
268	10BG 8/4	82.52	-20.22	-7.09	0.301	0.362	0.179	0.483
269	2.5PB 6/10	61.81	-13.43	-39.05	0.235	0.276	0.161	0.425
270	7.5BG 9/2	91.31	-12.59	-1.6	0.325	0.366	0.193	0.488
271	5BG 5/8	50.95	-43.44	-9.13	0.225	0.381	0.126	0.481
272	5PB 3/10	30.68	-3.29	-44.78	0.183	0.199	0.145	0.356
273	7.5G 5/10	51.31	-54.35	8.16	0.237	0.459	0.118	0.514
274	7.5G 3/8	29.97	-41.05	4.64	0.222	0.461	0.110	0.513
275	7.5GY 2/4	19.84	-13.95	15.42	0.350	0.482	0.173	0.537
276	5RP 3/10	31.1	47.1	-7.65	0.464	0.258	0.360	0.449
277	2.5YR 9/2	91.72	6.8	8.81	0.370	0.368	0.222	0.496
278	5PB 6/10	61.24	-6.06	-38.51	0.248	0.272	0.172	0.424
279	10RP 5/14	54.02	64.33	13.98	0.523	0.304	0.374	0.488
280	10Y 9/6	91.36	-6.97	45.27	0.405	0.439	0.217	0.530

Table I The CIE L*a*b*, x y, and u’ v’ values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
281	2.5Y 5/8	52.02	10.51	56.16	0.490	0.457	0.261	0.548
282	5PB 7/8	70.98	-5.66	-31.87	0.272	0.295	0.181	0.443
283	5BG 9/2	91.32	-12.88	-0.18	0.327	0.369	0.193	0.490
284	N4	40.11	-0.75	0.5	0.345	0.361	0.208	0.489
285	7.5B 2/6	20.65	-14.66	-26.86	0.175	0.243	0.126	0.393
286	5Y 9/6	91.42	0.59	45.69	0.417	0.431	0.227	0.529
287	10Y 4/6	42.44	-6.36	44.48	0.438	0.491	0.219	0.551
288	5B 3/6	29.85	-22.59	-23.56	0.193	0.288	0.127	0.427
289	7.5R 4/14	42.81	62.05	47.51	0.623	0.335	0.432	0.522
290	5BG 2/4	19.84	-16.67	-6.04	0.247	0.360	0.144	0.475
291	5R 8/6	81.7	26.41	14.24	0.415	0.358	0.256	0.498
292	5B 4/6	41.32	-22.87	-22.62	0.222	0.308	0.142	0.443
293	2.5G 6/10	61.14	-50.75	25.37	0.290	0.494	0.139	0.533
294	10G 8/6	80.65	-34.32	4.09	0.297	0.398	0.165	0.499
295	5YR 7/14	72.87	40.53	82.83	0.547	0.420	0.315	0.544
296	10Y 3/4	31.37	-3.36	26.78	0.423	0.461	0.220	0.540
297	7.5RP 6/12	63.86	52.94	5.77	0.462	0.312	0.318	0.482
298	7.5GY 4/8	41.04	-32.41	41.76	0.353	0.559	0.157	0.559
299	2.5GY 9/6	91.27	-11.93	45.73	0.397	0.446	0.210	0.531
300	7.5G 7/8	70.99	-43.07	8.59	0.283	0.424	0.151	0.507
301	10B 4/8	40.75	-18.15	-34.36	0.201	0.263	0.140	0.412
302	N9.5	96.01	-0.61	3.17	0.350	0.364	0.210	0.491
303	2.5BG 7/8	71.38	-43.33	-0.2	0.268	0.401	0.147	0.496
304	10R 9/2	91.75	7.16	7.63	0.369	0.365	0.222	0.495
305	N7	71.29	-0.71	-0.09	0.344	0.359	0.208	0.488
306	10R 8/6	81.22	24.89	24.85	0.432	0.377	0.259	0.509
307	5GY 9/4	90.7	-11.02	30.15	0.377	0.420	0.207	0.519
308	10PB 8/4	81.97	3.75	-12.61	0.329	0.332	0.208	0.472

Table I The CIE L*a*b*, x y, and u' v' values of the 330 Munsell color chips measured by Konika Minolta FD-7 Spectrodensitometer (Cont.).

No.	Munsell code	L*	a*	b*	x	y	u'	v'
309	10Y 6/10	62.02	-10.43	73.77	0.449	0.512	0.218	0.559
310	5RP 5/12	51.85	54.17	-2.81	0.460	0.286	0.333	0.467
311	10RP 4/10	42.04	48.71	10.12	0.507	0.308	0.357	0.488
312	5YR 9/2	90.74	7.07	11.93	0.376	0.373	0.224	0.499
313	5BG 8/4	80.64	-22.3	-1.4	0.307	0.375	0.178	0.490
314	7.5B 4/8	40.74	-23.84	-31.92	0.195	0.275	0.132	0.419
315	2.5R 8/6	82.24	27.29	11.33	0.410	0.353	0.256	0.495
316	7.5RP 9/2	92.35	6.14	2.19	0.358	0.357	0.218	0.489
317	10BG 7/6	70.87	-29.75	-12.32	0.269	0.357	0.159	0.476
318	5P 9/2	90.92	2.94	-2.49	0.346	0.352	0.212	0.485
319	10Y 8/12	81.83	-10.66	87.74	0.450	0.504	0.221	0.557
320	10R 3/10	31.87	44.5	40.4	0.610	0.352	0.406	0.528
321	2.5Y 4/6	42.05	7.99	42.33	0.478	0.451	0.256	0.544
322	10PB 9/2	91.6	1.32	-3.39	0.342	0.352	0.209	0.484
323	7.5RP 3/10	29.93	51.43	0.42	0.516	0.267	0.398	0.465
324	5P 5/10	51.68	27.65	-28.04	0.330	0.261	0.241	0.429
325	5YR 3/6	31.2	22.55	33.11	0.530	0.401	0.314	0.534
326	7.5BG 8/4	81.83	-21.81	-4.28	0.303	0.369	0.178	0.487
327	10G 9/2	91.08	-12.97	2.93	0.331	0.374	0.194	0.493
328	10GY 2/4	20.91	-15.14	10.48	0.325	0.456	0.167	0.525
329	5P 8/4	81.22	9.08	-10.8	0.340	0.331	0.216	0.473
330	2.5BG 5/10	50.75	-55.47	-3.31	0.211	0.416	0.111	0.494

APPENDIX B

Data sheet for collecting data of color naming from Thai subjects

แบบสอบถามเพื่อสำรวจการใช้คำเรียกสีของคนไทย

คำชี้แจง: แบบสอบถามนี้จัดทำขึ้นเพื่อเก็บรวบรวมข้อมูลสำหรับการวิเคราะห์คำที่ใช้ในการเรียกชื่อสีต่างๆ ของคนไทย ข้อมูลของท่านจะถูกเก็บเป็นความลับและใช้ในการวิจัยเพื่อการศึกษาเท่านั้น

1. **ชื่อผู้ให้ข้อมูล**

   ....

2. **เพศ** ( ) ชาย ( ) หญิง ( ) อื่นๆ
3. **อายุ** ( ) ต่ำกว่า 20 ปี ( ) 20 - 40 ปี ( ) 41 - 60 ปี ( ) มากกว่า 60 ปี
4. **ระดับการศึกษา** ( ) ต่ำกว่ามัธยมปลาย ( ) มัธยมปลาย

   ( ) ปริญญาตรี ( ) สูงกว่าปริญญาตรี

5. **อาชีพ** ( ) นักเรียน / นักศึกษา ( ) ข้าราชการ / รัฐวิสาหกิจ ( ) ลูกจ้าง / พนักงานบริษัท

   ( ) ค้าขาย / ธุรกิจส่วนตัว ( ) ผู้ใช้แรงงาน / รับจ้างทั่วไป ( ) เกษตรกร

   ( ) แพทย์ ( ) นักออกแบบ ( ) เกษียณ / ว่างงาน

   ( ) อื่น ๆ โปรดระบุ ....

6. **รายได้ส่วนตัวเฉลี่ยต่อเดือน** .... บาท
7. **ที่อยู่ปัจจุบัน**

   5.1 ภูมิภาค .... **5.2 จังหวัด** ....

8. **ภูมิลำเนาเดิม / สถานที่เกิด**

   6.1 ภูมิภาค .... **6.2 จังหวัด** ....

9. **ภาษาที่ใช้ / จำนวนปี** ( ) ภาษาไทยกลาง / .... ปี ( ) ภาษาถิ่น โปรดระบุ .... /........ ปี

วันที่ให้ข้อมูล ..../............./................

โครงการนี้เป็นส่วนหนึ่งของการวิจัยเพื่อสำรวจการใช้คำเรียกสีของคนไทย

โดย นางณิศชเนตร์ ชิตะปัญญา นักศึกษาปริญญาโท สาขาเทคโนโลยีสีและการออกแบบ

คณะเทคโนโลยีสื่อสารมวลชน มหาวิทยาลัยเทคโนโลยีราชมงคลธัญบุรี

Order	Munsell hue	R แดง	Or ส้ม	Y เหลือง	G เขียว	Bu น้ำเงิน	Pu ม่วง	Pi ชมพู	Br น้ำตาล	Gy เทา	Bk ดำ	Wh ขาว	Others
1	7.5PB 3/12												
2	5P 6/8												
3	7.5G 6/10												
4	5Y 7/12												
5	5GY 5/8												
6	2.5RP 4/10												
7	10R 7/10												
8	5GY 4/6												
9	7.5GY 8/10												
10	2.5P 4/10												
11	5G 2/6												
12	5RP 6/10												
13	7.5YR 4/8												
14	7.5B 7/6												
15	10YR 8/14												
16	7.5P 3/10												
17	7.5YR 3/6												
18	2.5GY 2/2												
19	7.5PB 8/4												
20	10P 2/6												
21	7.5YR 5/10												
22	7.5Y 2/2												
23	5Y 4/6												
24	5Y 6/10												
25	10G 3/8												
26	5GY 2/2												
27	5YR 6/12												
28	10B 7/8												
29	7.5R 3/12												
30	5Y 2/2												
31	2.5P 9/2												
32	10BG 5/8												
33	5Y 8/14												
34	5PB 5/12												
35	5Y 3/4												
36	10R 2/6												
37	2.5B 9/2												
38	7.5B 8/4												
39	7.5R 8/6												
40	5BG 6/8												
41	7.5P 4/10												
42	2.5BG 3/6												
43	2.5R 3/10												
44	7.5G 8/6												
45	10RP 7/8												
46	7.5R 9/2												
47	2.5RP 5/12												
48	7.5Y 3/4												
49	7.5P 5/10												
50	10BG 2/4												
51	2.5PB 9/2												
52	5Y 5/8												
53	10GY 7/10												
54	7.5PB 4/12												
55	2.5G 5/12												
56	N8												

Color naming expt.

Order	Munsell hue	R	Or	Y	G	Bu	Pu	Pi	Br	Gy	Bk	Wh	Others
		แดง	ส้ม	เหลือง	เขียว	น้ำเงิน	ม่วง	ชมพู	น้ำตาล	เทา	ดำ	ขาว	
57	2.5B 8/4												
58	2.5GY 5/8												
59	10YR 6/12												
60	N3												
61	2.5Y 8/16												
62	2.5Y 7/12												
63	5P 4/10												
64	2.5G 3/8												
65	5B 7/6												
66	2.5RP 8/6												
67	2.5G 8/8												
68	10G 5/10												
69	5G 6/10												
70	5B 2/4												
71	7.5RP 8/6												
72	2.5G 4/10												
73	10GY 9/2												
74	2.5P 3/10												
75	7.5Y 5/8												
76	N5												
77	2.5RP 9/2												
78	2.5BG 4/8												
79	2.5GY 3/4												
80	10YR 2/2												
81	5G 4/10												
82	10B 5/10												
83	2.5YR 8/6												
84	10Y 5/8												
85	5B 8/4												
86	2.5Y 2/2												
87	N9												
88	7.5GY 9/2												
89	7.5BG 6/8												
90	10PB 7/6												
91	7.5BG 4/8												
92	2.5PB 3/10												
93	2.5YR 6/16												
94	7.5Y 6/10												
95	5GY 3/4												
96	7.5RP 2/8												
97	5R 5/14												
98	5P 7/6												
99	10PB 3/10												
100	10P 5/12												
101	2.5R 9/2												
102	7.5PB 6/8												
103	7.5R 6/12												
104	2.5B 2/4												
105	7.5R 5/14												
106	2.5GY 4/6												
107	7.5PB 9/2												
108	10RP 3/10												
109	10BG 3/6												
110	7.5P 7/8												
111	2.5PB 4/10												
112	2.5YR 7/10												

Color naming expt.

Order	Munsell hue	R	Or	Y	G	Bu	Pu	Pi	Br	Gy	Bk	Wh	Others
		แดง	ส้ม	เหลือง	เขียว	น้ำเงิน	ม่วง	ชมพู	น้ำตาล	เทา	ดำ	ขาว	
113	5BG 7/8												
114	10BG 6/8												
115	2.5B 4/6												
116	10YR 4/6												
117	7.5GY 5/10												
118	10P 8/6												
119	5RP 2/8												
120	5R 6/12												
121	N1.5												
122	5G 9/2												
123	10YR 9/2												
124	7.5R 2/8												
125	10P 3/10												
126	5PB 2/8												
127	2.5B 6/8												
128	10YR 7/14												
129	7.5YR 9/2												
130	5G 3/8												
131	2.5B 7/6												
132	10RP 9/2												
133	10BG 9/2												
134	10RP 8/6												
135	7.5P 6/10												
136	10G 2/6												
137	5R 7/8												
138	2.5YR 4/10												
139	7.5G 9/2												
140	7.5BG 7/6												
141	2.5BG 9/2												
142	10P 9/2												
143	5RP 7/10												
144	2.5RP 3/10												
145	7.5B 9/2												
146	10B 6/10												
147	2.5Y 6/10												
148	5P 2/8												
149	10R 6/14												
150	7.5Y 9/6												
151	10G 7/8												
152	7.5YR 8/8												
153	10PB 6/8												
154	7.5BG 2/4												
155	7.5PB 7/6												
156	2.5PB 8/6												
157	7.5R 7/10												
158	7.5YR 7/14												
159	2.5B 3/6												
160	10PB 4/10												
161	10GY 8/8												
162	10GY 6/12												
163	2.5G 2/4												
164	2.5R 5/14												
165	2.5YR 5/14												
166	2.5BG 8/6												
167	5P 8/6												
168	10YR 3/6												

Order	Munsell hue	R แดง	Or ส้ม	Y เหลือง	G เขียว	Bu น้ำเงิน	Pu ม่วง	Pi ชมพู	Br น้ำตาล	Gy เทา	Bk ดำ	Wh ขาว	Others
169	2.5BG 6/8												
170	5R 3/10												
171	7.5P 8/6												
172	5G 7/8												
173	10P 7/8												
174	2.5R 4/14												
175	7.5YR 2/4												
176	5R 9/2												
177	2.5YR 3/8												
178	10G 6/10												
179	5PB 9/2												
180	7.5RP 4/10												
181	7.5B 5/8												
182	5YR 8/6												
183	10GY 5/12												
184	7.5GY 3/6												
185	10RP 2/8												
186	7.5Y 7/12												
187	7.5G 2/6												
188	2.5P 5/10												
189	2.5R 2/8												
190	2.5RP 2/8												
191	2.5P 7/6												
192	5BG 3/6												
193	10B 9/2												
194	2.5RP 6/10												
195	2.5P 8/4												
196	10PB 2/8												
197	10B 3/8												
198	10B 2/6												
199	2.5BG 2/4												
200	2.5GY 6/10												
201	7.5BG 3/6												
202	7.5PB 5/10												
203	7.5P 2/6												
204	5RP 8/6												
205	5RP 9/2												
206	10Y 7/12												
207	7.5B 6/8												
208	5PB 4/10												
209	N6												
210	5B 5/8												
211	5G 8/6												
212	2.5P 6/8												
213	7.5Y 4/6												
214	7.5BG 5/8												
215	2.5P 2/8												
216	7.5P 9/3												
217	10B 8/4												
218	2.5PB 2/6												
219	2.5R 6/12												
220	2.5B 5/8												
221	2.5GY 8/12												
222	5R 4/14												
223	2.5Y 9/4												
224	5B 6/8												

Order	Munsell hue	R	Or	Y	G	Bu	Pu	Pi	Br	Gy	Bk	Wh	Others
		แดง	ส้ม	เหลือง	เขียว	น้ำเงิน	ม่วง	ชมพู	น้ำตาล	เทา	ดำ	ขาว	
225	2.5Y 3/4												
226	10RP 6/12												
227	10BG 4/8												
228	5GY 5/10												
229	N2												
230	5GY 8/10												
231	5BG 4/8												
232	2.5GY 7/12												
233	7.5YR 6/12												
234	7.5G 4/10												
235	10PB 5/10												
236	7.5GY 7/10												
237	5YR 4/8												
238	5RP 4/10												
239	7.5RP 7/8												
240	5YR 5/12												
241	2.5G 7/10												
242	2.5R 7/8												
243	10RP 4/12												
244	10GY 3/6												
245	2.5RP 7/10												
246	5YR 2/4												
247	7.5RP 5/14												
248	5GY 6/10												
249	2.5G 9/2												
250	10GY 4/8												
251	10Y 2/2												
252	10YR 5/10												
253	5GY 7/12												
254	10R 5/16												
255	5B 9/2												
256	2.5PB 5/12												
257	7.5Y 8/12												
258	7.5B 3/6												
259	2.5PB 7/8												
260	2.5YR 2/4												
261	10P 6/10												
262	10G 4/10												
263	5R 2/8												
264	7.5PB 2/10												
265	7.5GY 6/12												
266	5P 3/10												
267	10P 4/10												
268	10BG 8/4												
269	2.5PB 6/10												
270	7.5BG 9/2												
271	5BG 5/8												
272	5PB 3/10												
273	7.5G 5/10												
274	7.5G 3/8												
275	7.5GY 2/4												
276	5RP 3/10												
277	2.5YR 9/2												
278	5PB 6/10												
279	10RP 5/14												
280	10Y 9/6												

Order	Munsell hue	R แดง	Or ส้ม	Y เหลือง	G เขียว	Bu น้ำเงิน	Pu ม่วง	Pi ชมพู	Br น้ำตาล	Gy เทา	Bk ดำ	Wh ขาว	Others
281	2.5Y 5/8												
282	5PB 7/8												
283	5BG 9/2												
284	N4												
285	7.5B 2/6												
286	5Y 9/6												
287	10Y 4/6												
288	5B 3/6												
289	7.5R 4/14												
290	5BG 2/4												
291	5R 8/6												
292	5B 4/6												
293	2.5G 6/10												
294	10G 8/6												
295	5YR 7/14												
296	10Y 3/4												
297	7.5RP 6/12												
298	7.5GY 4/8												
299	2.5GY 9/6												
300	7.5G 7/8												
301	10B 4/8												
302	N9.5												
303	2.5BG 7/8												
304	10R 9/2												
305	N7												
306	10R 8/6												
307	5GY 9/4												
308	10PB 8/4												
309	10Y 6/10												
310	5RP 5/12												
311	10RP 4/10												
312	5YR 9/2												
313	5BG 8/4												
314	7.5B 4/8												
315	2.5R 8/6												
316	7.5RP 9/2												
317	10BG 7/6												
318	5P 9/2												
319	10Y 8/12												
320	10R 3/10												
321	2.5Y 4/6												
322	10PB 9/2												
323	7.5RP 3/10												
324	5P 5/10												
325	5YR 3/6												
326	7.5BG 8/4												
327	10G 9/2												
328	10GY 2/4												
329	5P 8/4												
330	2.5BG 5/10												

APPENDIX C

Data of the 114 color names and their object-derivation classification

No.	Color name	Number of subjects		Frequency of responses		Derivation of color terms	
		(n)	%	(n)	%	Class	Category
1	*khiao* 'green'	161	100	14177	26.68	Unknown	-
2	*muang* 'purple'	161	100	6962	13.10	Unknown	-
3	*chom-phu* 'pink'	161	100	5290	9.96	Unknown	-
4	*fa* 'sky'	161	100	5092	9.58	Inanimate nature	Milieu
5	*nam-ngoen* 'blue'	161	100	3493	6.57	Inanimate nature	Chemical elements and compounds
6	*nam-tan* 'brown'	161	100	2561	4.82	Food and beverages	Sweets
7	*lueang* 'yellow'	161	100	2521	4.74	Unknown	-
8	*som* 'orange'	161	100	2120	3.99	Flora	Fruits
9	*daeng* 'red'	161	100	1822	3.43	Unknown	-
10	*thao* 'gray'	161	100	1151	2.17	Unknown	-
11	*khao* 'white'	159	98.76	2484	4.68	Unknown	-
12	*dam* 'black'	150	93.17	792	1.49	Unknown	-
13	*khi-ma* 'horse feces'	120	74.53	759	1.43	Fauna	Mammals
14	*lueat-mu* 'pig blood'	110	68.32	348	0.65	Food and beverages	Viands
15	*ban-yen* 'four o'clock flower/ magenta'	80	49.69	306	0.58	Flora	Flowers
16	*khai-kai* 'chicken egg'	71	44.10	253	0.48	Fauna	Birds
17	*nuea* 'skin'	69	42.86	360	0.68	Body and bodily products	Body and bodily products
18	*tha-le* 'sea'	53	32.92	306	0.58	Inanimate nature	Natural objects and substances
19	old rose	51	31.68	166	0.31	Flora	Flowers
20	cream	50	31.06	231	0.43	Food and beverages	Dairy products
21	*bai-tong* 'banana leaves'	44	27.33	204	0.38	Flora	Plants
22	*saet* 'orange trumpet'	43	26.71	149	0.28	Flora	Flowers
23	mint	37	22.98	295	0.56	Flora	Plants
24	*khram* 'indigo'	36	22.36	122	0.23	Man-made objects	Dyes and pigments
25	*it* 'brick'	33	20.50	83	0.16	Man-made objects	Building materials
26	peach	26	16.15	75	0.14	Flora	Fruits
27	mustard	24	14.91	62	0.12	Food and beverages	Spices
28	*lueat-nok* 'bird blood'	24	14.91	57	0.11	Fauna	Birds

No.	Color name	Number of subjects		Frequency of responses		Derivation of color terms	
		(n)	%	(n)	%	Class	Category
29	*krom-ma-tha* 'navy blue'	21	13.04	75	0.14	Man-made objects	Fabrics
30	*ma-nao* 'lime'	20	12.42	82	0.15	Flora	Fruits
31	*plueak-mang-khut* 'mangosteen peel'	20	12.42	49	0.09	Flora	Fruits
32	*bai-mai* 'leaves'	16	9.94	61	0.11	Flora	Plants
33	khaki	11	6.83	23	0.04	Man-made objects	Fabrics
34	*phueak* 'taro'	9	5.59	50	0.09	Flora	Vegetables
35	*cha-yen* 'iced tea'	9	5.59	26	0.05	Food and beverages	Hot and soft drinks
36	*mo-ra-kot* 'emerald'	8	4.97	28	0.05	Inanimate nature	(Semi-)precious stones
37	lemon	8	4.97	23	0.04	Flora	Fruits
38	*khwan-buri* 'cigarette smoke'	8	4.97	16	0.03	Man-made objects	Artifacts
39	*khi* 'feces'	7	4.35	20	0.04	Body and bodily products	Body and bodily products
40	*nom-yen* 'pink milk'	7	4.35	19	0.04	Food and beverages	Hot and soft drinks
41	*plueak-mai* 'tree bark'	7	4.35	15	0.03	Flora	Plants
42	*met-ma-prang* 'marian plum seed'	6	3.73	27	0.05	Flora	Fruits
43	*chi-won* 'yellow robe of Buddhist monk'	6	3.73	10	0.02	Man-made objects	Fabrics
44	*bai-toei* 'pandan'	5	3.11	32	0.06	Flora	Herbs
45	*khai* 'egg'	5	3.11	19	0.04	Fauna	Birds
46	*khai-pet* 'duck egg'	5	3.11	11	0.02	Fauna	Birds
47	*lueat* 'blood'	5	3.11	9	0.02	Body and bodily products	Body and bodily products
48	*klip-bua* 'petal of the lotus blossom'	5	3.11	9	0.02	Flora	Flowers
49	*thong* 'gold'	4	2.48	14	0.03	Inanimate nature	Metals
50	*ka-fae* 'coffee'	4	2.48	10	0.02	Food and beverages	Hot and soft drinks
51	*an-chan* 'butterfly pea'	4	2.48	7	0.01	Flora	Flowers
52	*lae* 'dark bluish-green'	3	1.86	8	0.02	Unknown	-
53	*kha-min* 'turmeric'	3	1.86	7	0.01	Flora	Herbs
54	*ma-kok* 'olive'	3	1.86	7	0.01	Flora	Fruits

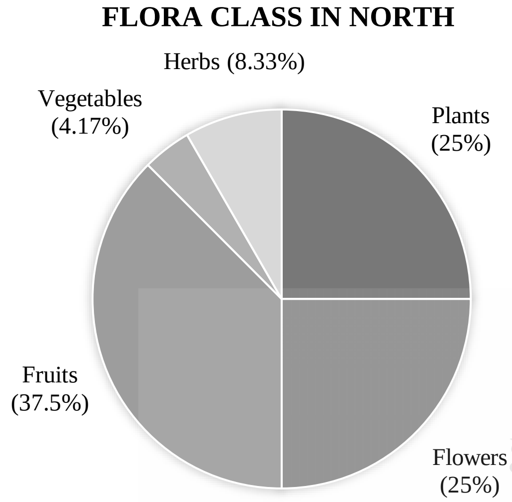
No.	Color name	Number of subjects		Frequency of responses		Derivation of color terms	
		(n)	%	(n)	%	Class	Category
55	*khi-kai* 'chicken feces'	3	1.86	6	0.01	Fauna	Birds
56	*cha-khiao* 'green tea'	3	1.86	5	0.01	Food and beverages	Hot and soft drinks
57	*pun-daeng* 'red lime' *for Thai betel chewing tradition	3	1.86	4	0.01	Man-made objects	Dyes and pigments
58	*muk* 'pearl'	3	1.86	4	0.01	Inanimate nature	(Semi-)precious stones
59	*hua-pet* 'duck head'	2	1.24	13	0.02	Fauna	Birds
60	*phlai* 'zingiber cassumunar'	2	1.24	12	0.02	Flora	Herbs
61	*tha-han* 'military color'	2	1.24	10	0.02	Man-made objects	Fabrics
62	*sa-nim* 'rust'	2	1.24	9	0.02	Inanimate nature	Chemical elements and compounds
63	*ngoen* 'silver'	2	1.24	7	0.01	Inanimate nature	Metals
64	*ma-miao* 'pomerac'	2	1.24	7	0.01	Flora	Fruits
65	*plik-ma-laeng-thap* 'jewel beetle's wings'	2	1.24	6	0.01	Fauna	Bugs
66	*ta-ni* 'musa balbisiana'	2	1.24	5	0.01	Flora	Plants
67	*pun-haeng* 'dry mortar'	2	1.24	5	0.01	Man-made objects	Building materials
68	*a-ngun* 'grape'	2	1.24	5	0.01	Flora	Berries
69	*ka-la* 'coconut shell'	2	1.24	4	0.01	Flora	Fruits
70	*nga-chang* 'ivory'	2	1.24	4	0.01	Inanimate nature	(Semi-)precious stones
71	*cha-nom* 'milk tea'	2	1.24	4	0.01	Food and beverages	Hot and soft drinks
72	*sa-rai* 'seaweed'	2	1.24	4	0.01	Flora	Plants
73	*khlon* 'mud'	2	1.24	3	0.01	Inanimate nature	Natural objects and substances
74	*nom* 'milk'	2	1.24	3	0.01	Food and beverages	Dairy products
75	turquoise	1	0.62	17	0.03	Inanimate nature	(Semi-)precious stones
76	cantaloupe	1	0.62	11	0.02	Flora	Fruits
77	*khi-pet* 'duck feces'	1	0.62	10	0.02	Fauna	Birds
78	*moi* 'tan skin'	1	0.62	9	0.02	Unknown	-
79	*ton-kluai* 'banana tree'	1	0.62	7	0.01	Flora	Plants

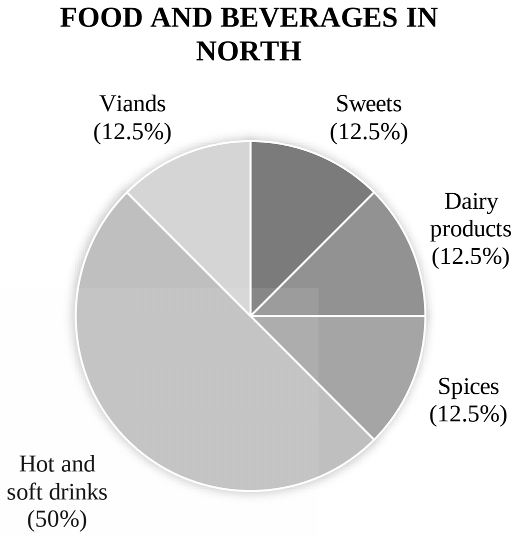
No.	Color name	Number of subjects		Frequency of responses		Derivation of color terms	
		(n)	%	(n)	%	Class	Category
80	*king-mai* 'tree branch'	1	0.62	5	0.01	Flora	Plants
81	*thian* 'candle'	1	0.62	4	0.01	Man-made objects	Artifacts
82	*khrang* 'shellac'	1	0.62	4	0.01	Fauna	Bugs
83	*ton-mai* 'tree'	1	0.62	3	0.01	Flora	Plants
84	*than* 'charcoal'	1	0.62	3	0.01	Inanimate nature	Natural objects and substances
85	*thap-thim* 'ruby'	1	0.62	3	0.01	Inanimate nature	(Semi-)precious stones
86	*kha-mao* 'soot'	1	0.62	2	0.00	Inanimate nature	Chemical elements and compounds
87	*plueak-kluai* 'banana peel'	1	0.62	2	0.00	Flora	Plants
88	*kaeng-som* 'thai sour soup made of tamarind paste'	1	0.62	2	0.00	Food and beverages	Viands
89	*phra-a-thit* 'sun'	1	0.62	2	0.00	Inanimate nature	Natural objects and substances
90	*phrik-yuak* 'bell pepper'	1	0.62	2	0.00	Flora	Fruits
91	*hom-daeng* 'shallot'	1	0.62	2	0.00	Flora	Vegetables
92	*am-phan* 'amber'	1	0.62	2	0.00	Inanimate nature	(Semi-)precious stones
93	*taeng-kwa* 'cucumber'	1	0.62	1	0.00	Flora	Fruits
94	cocoa	1	0.62	1	0.00	Food and beverages	Hot and soft drinks
95	*phai-lin* 'sapphire'	1	0.62	1	0.00	Inanimate nature	(Semi-)precious stones
96	*ku-lap* 'rose'	1	0.62	1	0.00	Flora	Flowers
97	*khi-nok* 'bird feces'	1	0.62	1	0.00	Fauna	Birds
98	caramel	1	0.62	1	0.00	Food and beverages	Sweets
99	*chat* 'crimson'	1	0.62	1	0.00	Man-made objects	Dyes and pigments
100	*dok-khun* 'golden shower'	1	0.62	1	0.00	Flora	Flowers
101	*dao-rueang* 'marigold'	1	0.62	1	0.00	Flora	Flowers
102	*din* 'soil'	1	0.62	1	0.00	Inanimate nature	Natural objects and substances
103	*thu-rian* 'durian'	1	0.62	1	0.00	Flora	Fruits
104	*nam-oi* 'molasses'	1	0.62	1	0.00	Food and beverages	Hot and soft drinks
105	*bron* 'bronze'	1	0.62	1	0.00	Inanimate nature	Metals
106	blueberry	1	0.62	1	0.00	Flora	Berries

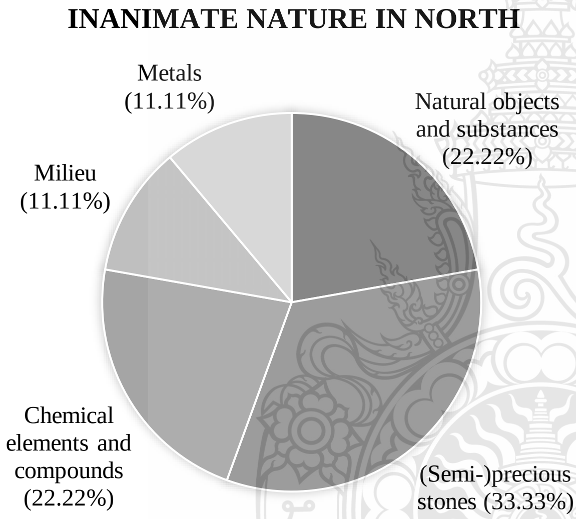
No.	Color name	Number of subjects		Frequency of responses		Derivation of color terms	
		(n)	**%**	**(n)**	**%**	**Class**	**Category**
107	*phut-tha-chat* 'star jasmine'	1	0.62	1	0.00	Flora	Flowers
108	*fak* 'winter melon'	1	0.62	1	0.00	Flora	Vegetables
109	*fak-thong* 'pumpkin'	1	0.62	1	0.00	Flora	Fruits
110	*ma-khuea-thet* 'tomato'	1	0.62	1	0.00	Flora	Fruits
111	*ma-phrao* 'coconut'	1	0.62	1	0.00	Flora	Fruits
112	*lot-chong* 'pandan noodles with noconut milk/Thai dessert'	1	0.62	1	0.00	Food and beverages	Sweets
113	lava	1	0.62	1	0.00	Inanimate nature	Natural objects and substances
114	*luk-kai* 'chick'	1	0.62	1	0.00	Fauna	Birds

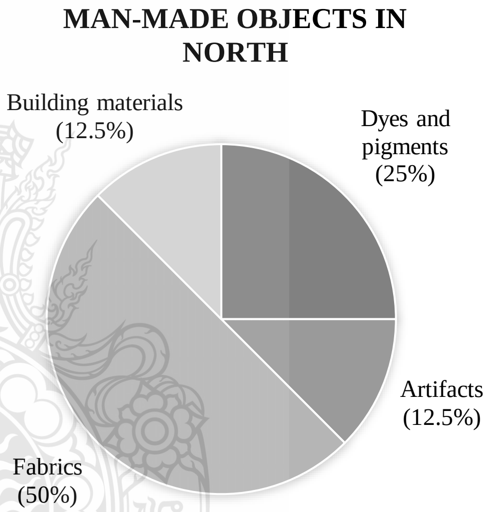
APPENDIX D

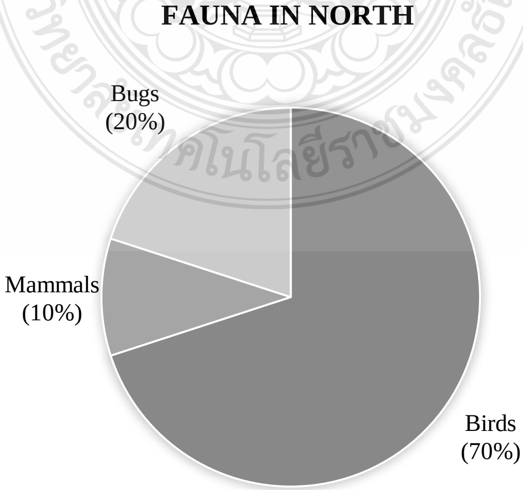
Categories of object-derived color names in four regions


FLORA CLASS IN NORTH
Herbs (8.33%)
Vegetables (4.17%)
Plants (25%)
Fruits (37.5%)
Flowers (25%)

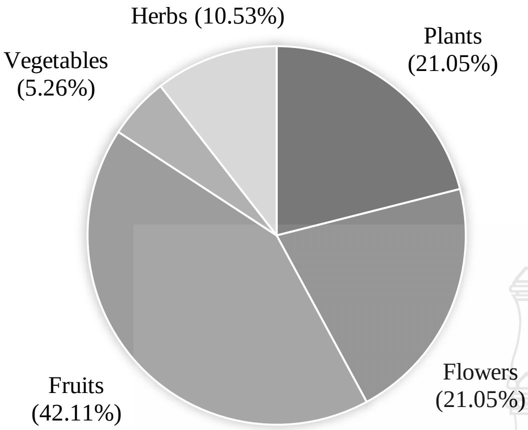

FOOD AND BEVERAGES IN NORTH
Viands (12.5%)
Sweets (12.5%)
Dairy products (12.5%)
Spices (12.5%)
Hot and soft drinks (50%)


INANIMATE NATURE IN NORTH
Metals (11.11%)
Natural objects and substances (22.22%)
Milieu (11.11%)
Chemical elements and compounds (22.22%)
(Semi-)precious stones (33.33%)

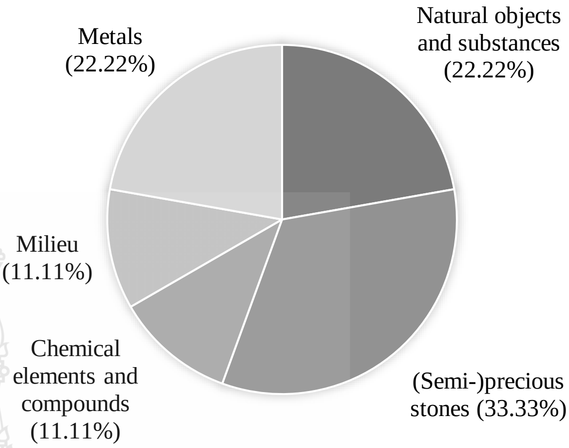

MAN-MADE OBJECTS IN NORTH
Building materials (12.5%)
Dyes and pigments (25%)
Artifacts (12.5%)
Fabrics (50%)


FAUNA IN NORTH
Bugs (20%)
Mammals (10%)
Birds (70%)

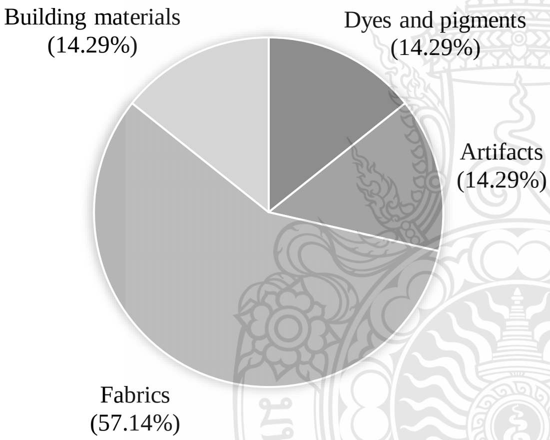
FLORA CLASS IN NORTHEAST



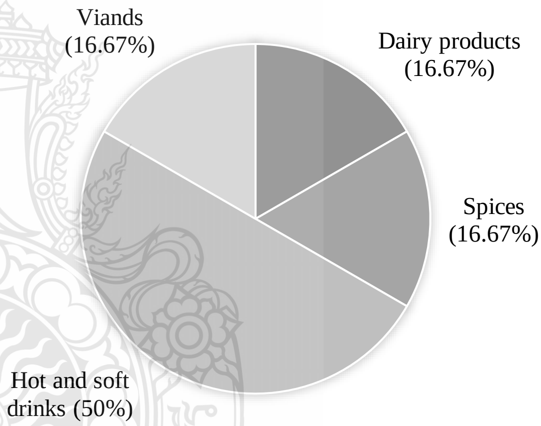
INANIMATE NATURE IN NORTHEAST



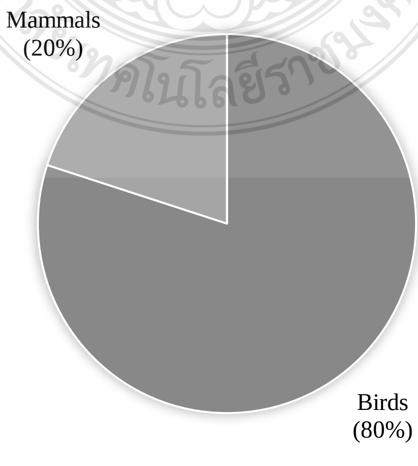
MAN-MADE OBJECTS IN NORTHEAST



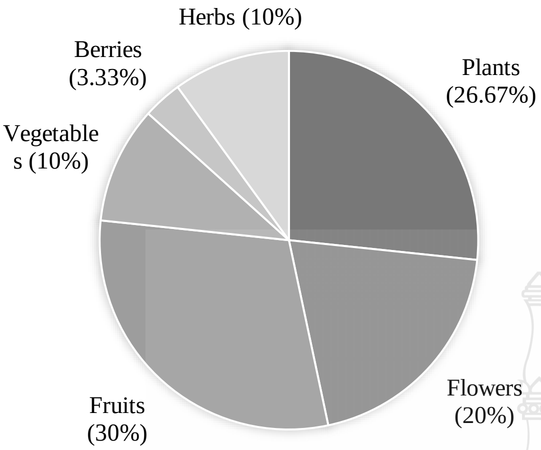
FOOD AND BEVERAGES IN NORTHEAST



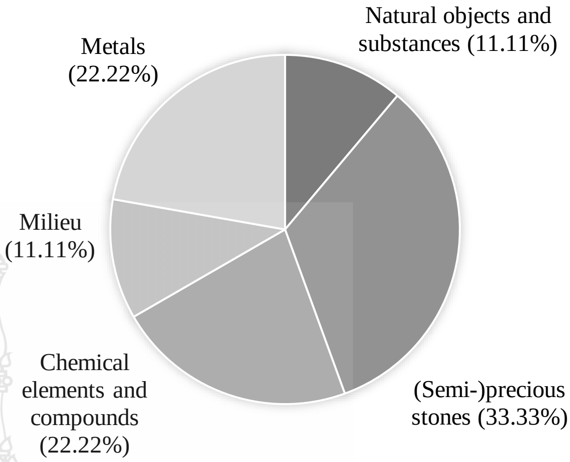
FAUNA IN NORTHEAST



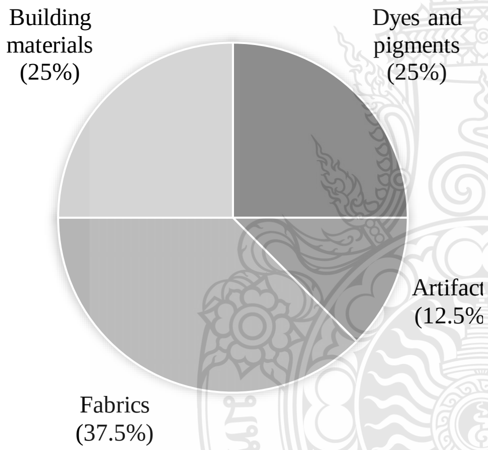
FLORA CLASS IN CENTRAL



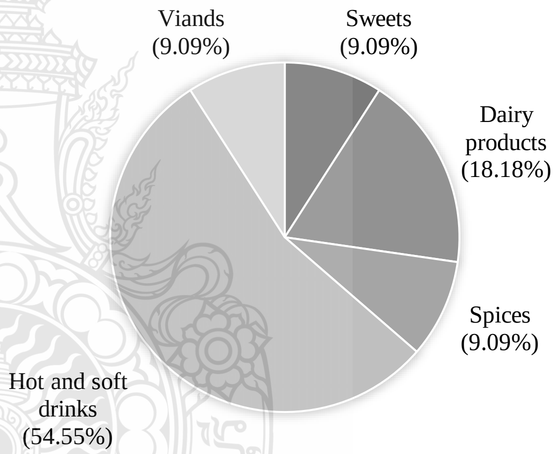
INANIMATE NATURE IN CENTRAL



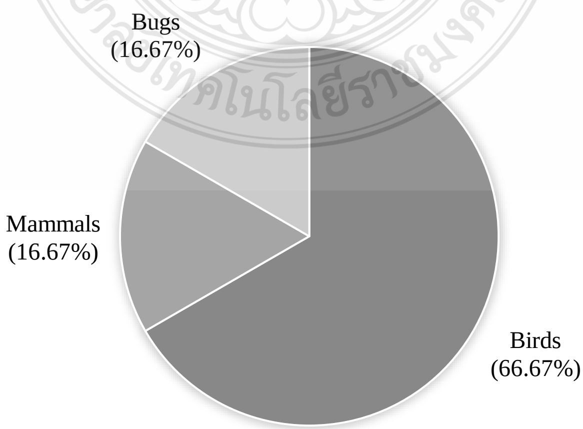
MAN-MADE OBJECTS IN CENTRAL



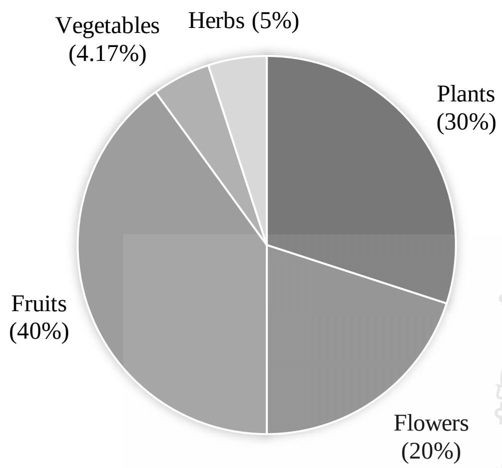
FOOD AND BEVERAGES IN CENTRAL



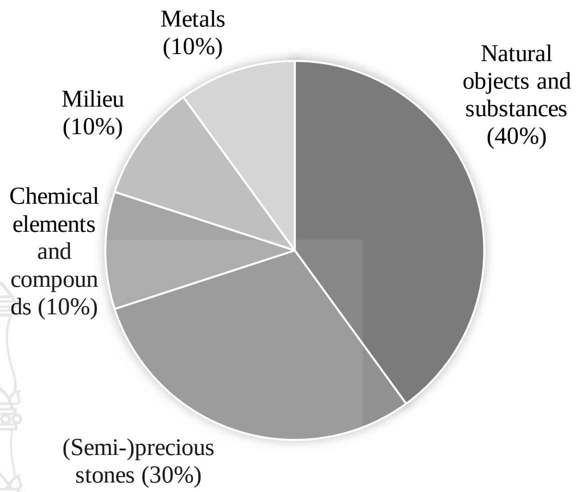
FAUNA IN CENTRAL



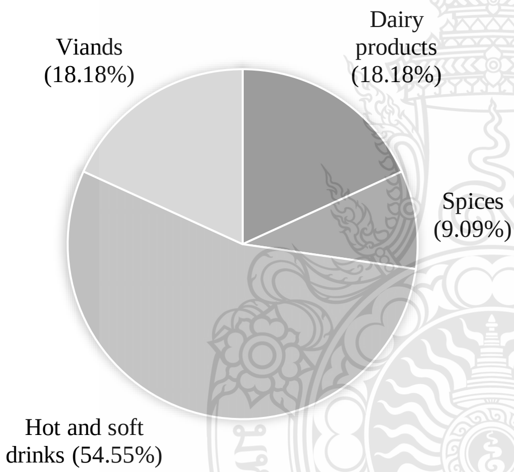
FLORA CLASS IN SOUTH



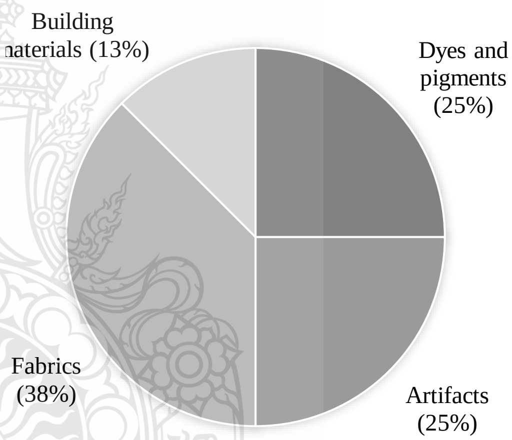
INANIMATE NATURE IN SOUTH



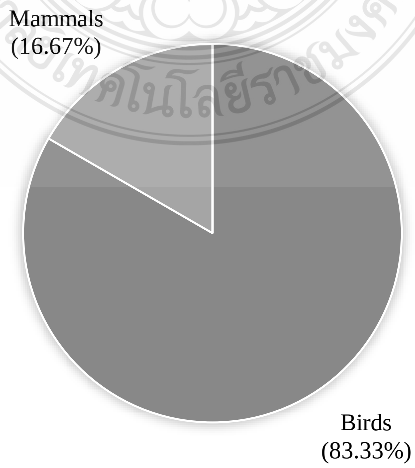
FOOD AND BEVERAGES IN SOUTH



MAN-MADE OBJECTS IN SOUTH



FAUNA IN SOUTH



APPENDIX E

Matching of color names to the traditional Thai color names used in Mural Paintings and the Thai tone colors.

Color names	Data of this study				Katemake and Preda (2014)				Pittayamatee (2016)
	Munsell	**L***	**a***	**b***	**Munsell/NCS**	**L***	**a***	**b***	**CMYK**
an-chan 'butterfly pea'	7.5PB 4/12	41.2	10.5	-48	S4040-R70B	42.45	10.84	-29.7	c70 m80 y10 k0
bai-tong 'banana leaves'	5GY 5/8	51.8	-21	52.7	S2040-G50Y	70.73	-17.6	34.22	c50 m30 y90 k0
ban-yen 'four o'clock flower/ magenta'	2.5R 5/14	52.8	66.2	23.4	5RP 5/10	50.96	43.32	-3.75	c0 m70 y20 k0
chat 'crimson'	5R 3/10	32.2	50.5	24	S1070-R	52.17	53.03	21.45	c20 m100 y100 k0
fa 'sky'	7.5B 7/6	70.8	-19	-21	7.5B 7/8	71.19	-19.6	-26.9	c80 m50 y10 k0
it 'brick'	2.5YR 4/10	43	37.5	48.8	2.5YR 6/8	61.36	27.3	35.01	c5 m65 y100 k20
khaki	2.5Y 4/6	42.1	7.99	42.3	S2030-Y30R	71.76	10.85	32.33	c25 m30 y45 k20
kha-mao 'soot'	7.5Y 2/2	20.1	-0.5	12.8	N2.5	25.1	0.74	-1.24	c90 m80 y70 k100
khram 'indigo'	5B 3/6	29.9	-23	-24	S4050-R80B	33.67	7.39	-36.1	c100 m80 y40 k10
krom-ma-tha 'navy blue'	7.5B 2/6	20.7	-15	-27	5B 3/2	30.95	-6.33	-6.68	c100 m90 y40 k30
ku-lap 'rose'	5R 3/10	32.2	50.5	24	2.5R 4/12	41.44	54.47	15.81	c0 m50 y20 k0
met-ma-prang 'marian plum seed'	2.5RP 3/10	31.7	45.1	-15	S2060-R30B	48.32	46.87	28.21	c70 m100 y20 k0
nam-tan 'brown'	7.5YR 3/6	32.1	17.4	33.9	7.5YR 6/4	61.49	9.51	22.37	c40 m70 y80 k30
nga-chang 'ivory'	2.5RP 9/2	90.8	5.6	-0.9	5Y 9/2	90.25	-1.67	17.12	c0 m0 y15 k0
plueak-mang-khut 'mangosteen peel'	10P 2/6	20.5	23	-13	S5030-R40B	38.88	19.18	-9.16	c50 m90 y45 k30

Biography

Name - Surname	Mrs. Nischanade Chitapanya
Date of Birth	November 04, 1994
Address	264/40 Baan Thammachad Village, Moo 1, Lam Phak Kut Subdistrict, Thanyaburi District, Pathum Thani, 12110
Education	Bachelor of Technology (Advertising and Public Relation Technology), 2016
Telephone Number	092-336-4482
Email Address	nischanade_p@mail.rmutt.ac.th, nischanade@gmail.com

วิทยานิพนธ์ฉบับนี้เป็นงานวิจัยที่เกิดจากการค้นคว้าและวิจัย ขณะที่ข้าพเจ้าศึกษาอยู่ในคณะเทคโนโลยีสื่อสารมวลชน มหาวิทยาลัยเทคโนโลยีราชมงคลธัญบุรี ดังนั้นงานวิจัยในวิทยานิพนธ์ฉบับนี้ถือเป็นลิขสิทธิ์ของมหาวิทยาลัยเทคโนโลยีราชมงคลธัญบุรี และข้อความต่างๆในวิทยานิพนธ์ฉบับนี้ ข้าพเจ้าขอรับรองว่าไม่มีการคัดลอกหรือนำงานวิจัยของผู้อื่นมานำเสนอในชื่อของข้าพเจ้า

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(Mrs. Nischanade Chitapanya)