2021

ANNUAL REPORT

COLOR RESEARCH CENTER

Mass Communication Technology, RMUTT

Preface

2021 is quite a slow movement similar with 2020 because of the pandemic, COVID-19. However, we were trying our best to achieve the goal as much as we can.

This annual report 2021 of Color Research Center aimed to present the academic activities and other activities which were happened in 2021 (Year budget from October 1st, 2020 – September 31st, 2021). There are many contents presented in this report such as CRC information, activities, cooperation, and research. These will be shown the achievement of Color Research Center all the year.

We extremely hope that this report will be advantages for the organization. Also, we would like to acknowledge everyone for the support. That made CRC achieved the target. We will try our best to develop our activities to make a huge advantage for students, staffs, and the faculty.

Director of Color Research Center

Content

Massage from CRC's Director

Color Research Center was established in 2013 which aim to promote the color science and technology. Also, we attempt to continuously push and promote CRC following RMUTT's strategy such as internationalization and research development. As the years passed, Color Research Center has done many researches and activities. We have collaborated with many international universities and experts to develop our research, laboratory, and other activities. Many scientific papers have been published by staffs of CRC on international journals.

In 2021, many countries still face with the COVID-19 situation. Although many of us got the vaccination, we still cannot organize the activities onsite. However, we did not give up developing our CRC. We continued doing the online activities as much as we can such as online exchange lecture, and online exchange activity. Also, we always prepare for the onsite activity if the circumstance gets better. Therefore, this annual report will present the achievements and activities that were happened in 2021.

Chanprapha Phuangsuwan

Director of Color Research Center

General Information

A Briefly History

Color Research Center (CRC) is a highly regarded research and development in color science in field of science, engineering and design. CRC is an integral part of the Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi. With international professional scholar's support researchers, students, living society and industries. Therefore, CRC have set of high-performance equipment for serving all teaching and research activities. This report contains CRC's equipment and research activities in past fiscal year.

The CRC was formally established in August and the open ceremony was held in December 2013. We intend to promote color science and its application in this country and join and cooperate with color scientists in the world.

CRC Logo

CRC
Color Research Center

The logo represents the hue ring of the opponent colors theory composed of four unique colors, red, yellow, green, and blue.

General Information

Location

Color Research Center is located on 4th floor in Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi.

Address: *Faculty of Mass Communication Technology, RMUTT*
39 moo 1 Klong Hok, Klong Luang, Patumthani 12110, Thailand

Contact information

Tel: +66 2 5494538

Email: crc@rmutt.ac.th

Website: www.crc.rmutt.ac.th

CRC Members

Dr. Chanprapha Phuangsuwan, Director of CRC

Assistant Professor

Field to cover: Color vision and color appearance

Dr. Mitsuo Ikeda

Professor

Field to cover: Color vision, Visual information processing

Dr. Kitirochna Rattanakasamsuk

Assistant Professor

Field to cover: Elderly vision and universal color design

Dr. Uravis Tangkijviwat

Assistant Professor

Field to cover: Color preference and color psychology

Dr. Waiyawut Wuthiastasarn

Assistant Professor

Field to cover: Media Accessibility

Pappim Chuenjai

Technical Assistant

International Advisors

Dr. Hirohisa Yaguchi

Emeritus Professor, *Chiba University, Japan*

Dr. Hiroyuki Shinoda

Professor, Department of Information and Computer Intelligence

College of Information Science and Engineering,

Ristumeikan University, Japan

Dr. Yasuki Yamauchi

Professor, Faculty of Engineering

Yamagata University, Japan

Dr. Mikiko Kawasumi

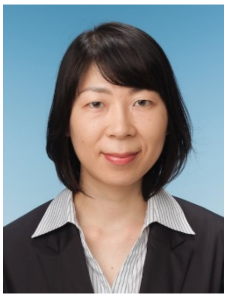
Associate Professor, Department of Information Engineering,

Faculty of Science and Technology

Meiji University, Japan

Visiting researcher, Rajamangala University of Technology Thanyaburi

International Advisors



Dr. Yoko Mizokami

Professor, Department of Imaging Sciences,
Graduate School of Engineering

Chiba University, Japan

Dr. Miyoshi Ayama

A former Dean of the Graduate School of Engineering and School of

Engineering and a Professor Emeritus of *Utsunomiya University*.

Dr. Miho Saito

The Executive Vice president and a Professor Emeritus of *Waseda University, Japan*.

Instruments

No.	Instruments	Amount
1	Spectroradiometer: Konica Minolta CS2000	1
2	Spectrophotometer (360-740 nm.): CM-3700d	1
3	Spectrophotometer: Konica Minolta CM-512m3A	1
4	Spectrophotometer: Konica Minolta FD-7	1
5	Illuminance Meter: Konica Minolta CL-200A	3
6	Illuminance Meter: Konica Minolta T-10A	1
7	Illuminance Meter: Konica Minolta T-10MA	1
8	Illuminance Spectrophotometer: Konica Minolta CL-500 A	1
9	Luminance Meter: Konica Minolta CS100A	2
10	Haze Meter: HM-150	1
11	Farnsworth-Munsell: 100 Hue Test	1
12	The Munsell Book of Color Glossy Collection	1
13	Eyes Tracking: ASL The EYES-TRACKING*7	1
14	Program ASL Result Plus	1
15	Laptop HP	1
16	Laptop DELL	1
17	White Calibration Plate	1
18	Haze Standard Plate for HM-150	4

Instruments

Spectroradiometer:

Konica Minolta CS2000

Spectrophotometer (360-740 nm.):

CM-3700d

Spectrophotometer:

Konica Minolta CM-512m3A

Spectrophotometer:

Konica Minolta FD-7

Illuminance Meter:

Konica Minolta CL-200A

Illuminance Meter:

Konica Minolta T-10A

Instruments

Illuminance Meter:

Konica Minolta T-10MA

Illuminance Spectrophotometer:

Konica Minolta CL-500 A

Haze Meter: HM-150

Luminance Meter:

Konica Minolta CS100A

Farnsworth-Munsell: 100 Hue Test

The Munsell Book of Color

Glossy Collection

Instruments

Laptop HP

Laptop DELL

White Calibration Plate

Haze Standard Plate for HM-150

Online Borrowing and return system

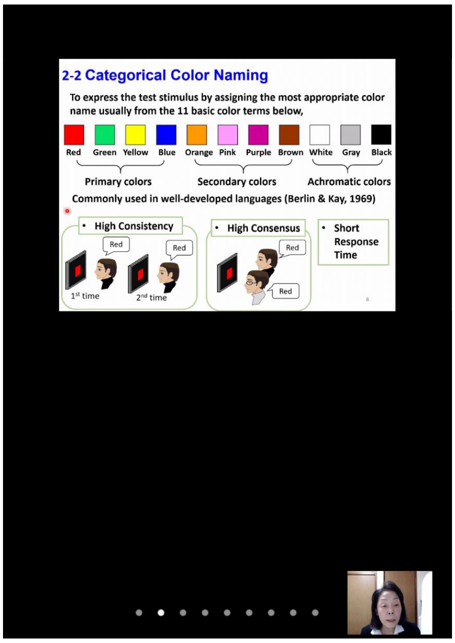
There is the online system for borrowing and returning the instrument of Color Research Center. People who would like to borrow and return instrument can scan QR code and submit the google form. QR code can be found in CRC website - http://www.crc.rmutt.ac.th/ or CRC office.

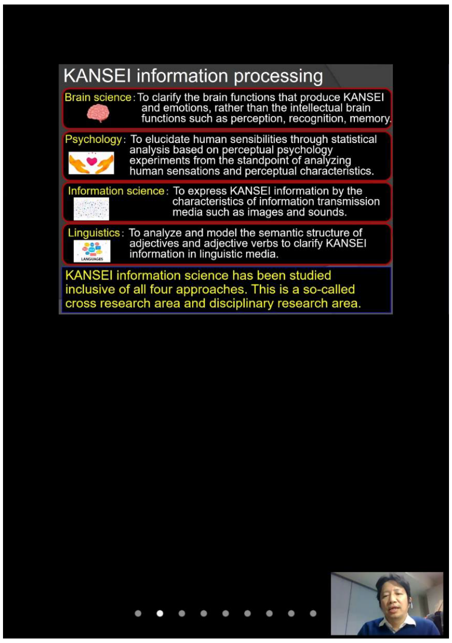
Activities

1. Online International Exchange Lecture between CRC, RMUTT and Utsunomiya University

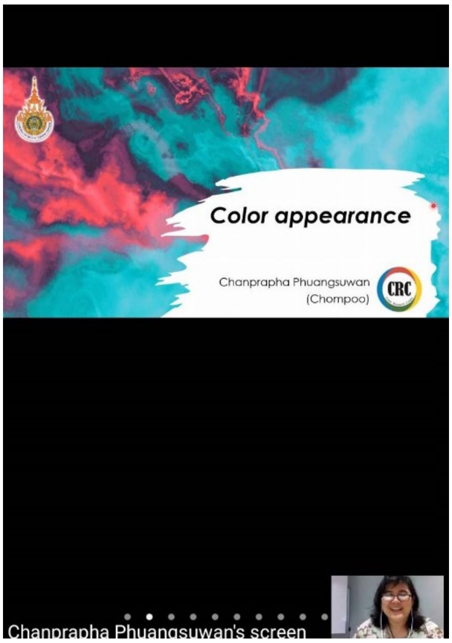
This activity was held on December 2nd and 16th, 2020 at 1:00 p.m. (Thailand time). Utsunomiya University was a host of the first lecture on December 2nd, 2020. The main topic is **"Kansei Informatics and Color Science".**

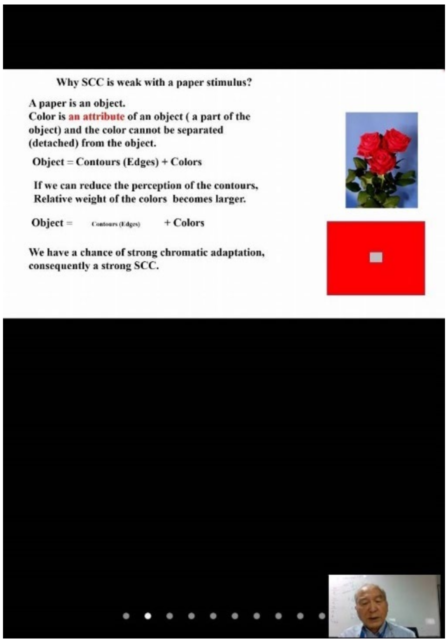
CRC team and students in CRC's laboratory were participating the lecture





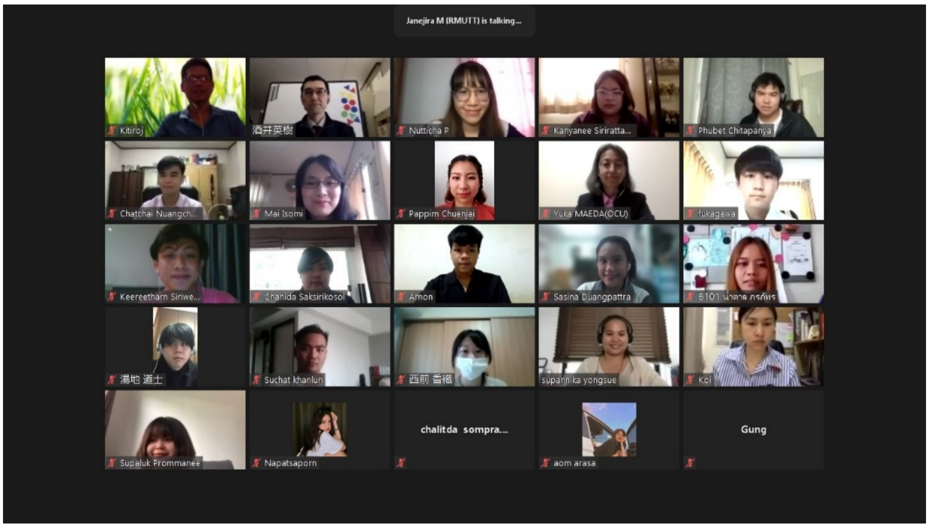
There were 2 research topics talked in the lecture: ***Color Appearance of Small Stimuli presented in Central and Peripheral Visual Field*** by Prof. Miyoshi Ayama and ***Kansei Informatics and Color Science*** by Assoc. Prof. Tomoharu Ishikawa. In this lecture, there are totally 17 people participated.





The second lecture was held on December 16th, 2020, by Color Research Center. The topic is ***"Chromatic Adaptation to Illumination"***. Prof. Mitsuo Ikeda and Assist. Prof. Chaprapha Phuangsuwan presented the topic. There are totally 12 people participated in the lecture.

2. Online international exchange between RMUTT and Osaka City University



Color Research Center and Osaka City University, Japan organized ***"Online international exchange between RMUTT and Osaka City University"*** on February 23rd, 2021, at 1 p.m. (Thailand time) through Zoom Application.

Prof. Sakai talked

There were 13 projects from MCT students and 2 projects from Osaka City University presented in the activity. This activity gave an opportunity to students to present their project in international session as an oral presentation in English and exchanged knowledge between two universities.

Presentation topics

Osaka City University, Japan

1. Development of Colorimetric and Gloss Measurement System in a Temperature/Humidity Control Using a Digital Camera.

Presenter: Shimpei Fukagawa, Graduate School of Engineering.

2. Measurement of Wet Colors of Bricks and Gravels by Using a Non-Contact Colorimetric System.

Presenter: Tsugumichi Watanabe, Graduate School of Human Life Science.

Faculty of Mass Communication and Technology, RMUTT

1. Beauty Photography for cosmetic advertising

Presenter: Miss Supaluk Prommanee, Department of Photography and Cinematography Technology

2. User interface Design and developing prototype: The information event website of media and design contest for undergraduate student

Presenter: Mr. Keereetharn Siriwech, Department of Multimedia Technology.

3. PCA the Development Individual's of Identify Application by Applying Principal Component Analysis (PCA) Algorithm

Presenter: Mr.Watcharawit Sama, Miss Arasa Menlaem, Miss Chalitda Somprasong, Department of Digital Media Technology.

4. The Production of Music Video Using by Low Angle Shot, High Angle Shot, Fast Motion and out of Pucus Technique to Covey the Opposite Meaning.

Presenter: Miss Sasina Duangpattra, Depaerment of Radio and Television Broadcasting Technolog.

5. Effect of lighting on lipstick texture for advertising photography

Presenter: Miss Supakarn Wongpinit, Department of Advertising and Public Relations Technolog.

6. The development of branding and package for value added of rice product Phorak kasikam Community Enterprise at Lumlukka District Phathum Thani Province

Presenter: Miss Natnaree Khonkaew, Miss Panjaporn Sa-nguanpong, Miss Phorntiwa Prangklang, Department of Digital Printing and Packaging Technology.

7. Creating of color chips from water lilies

Presenter: Miss Kanyanee Sirirattanakun, Color Research Center, RMUTT.

8. The creating of color control stripe for standard of dried water lilies

Presenter: Mr. Arnon Khamwong, Color Research Center, RMUTT.

9. Chromatic adaptation of color chips under various illuminations

Presenter: Mr. Sucaht Khanlun, Color Research Center, RMUTT.

10. The color names indicated to Thai flower's aroma

Presenter: Miss Napatsaporn Pookathamma, Color Research Center, RMUTT.

11. Investigation of the effect between room illuminance and display luminance for simultaneous color contrast

Presenter: Miss Janejira Mepean, Color Research Center, RMUTT.

12. Color and lightness of Thai skin tone

Presenter: Miss Natticha Pattarasoponkun, Color Research Center, RMUTT.

13. Color appearance under vivid LEDs light

Presenter: Mr. Phubet Chitapanya, Color Research Center, RMUTT.

3. Online Asia Student Workshop on Image Science 2021 (ASW 2021)

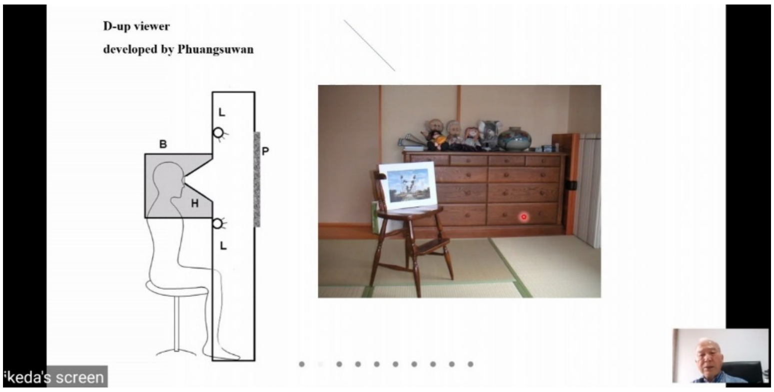
There are totally 7 students divided into 4 undergraduate students and 3 graduated students from MCT participated in Online Asia Student Workshop on Image Science 2021(ASW 2021) from 15 - 19 March 2021.

List of MCT students

No.	Name	Department
1	Mr. Arnon Khamwong	Digital Printing and Packaging Technology
2	Ms. Kanyanee Sirirattanakun	Digital Printing and Packaging Technology
3	Ms. Napatsaporn Pookathamma	Digital Printing and Packaging Technology
4	Mr. Suchat Khanlun	Digital Printing and Packaging Technology
5	Janejira Mepean	Color Technology and Design
6	Nutticha Pattarasoponkun	Color Technology and Design
7	Chatchai Nuangcharoenporn	Color Technology and Design

The International Symposium

The activity began on 15 March 2021 with ***the International Symposium***. There are more 60 people in many universities and countries participated in the event.

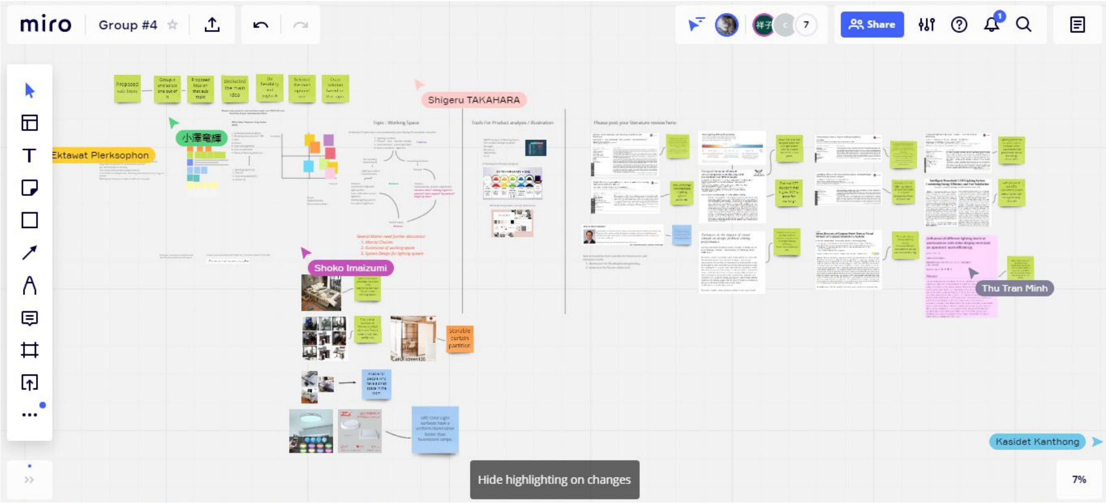


Prof. Ikeda talked

Asst. Prof. Chanprapha talked

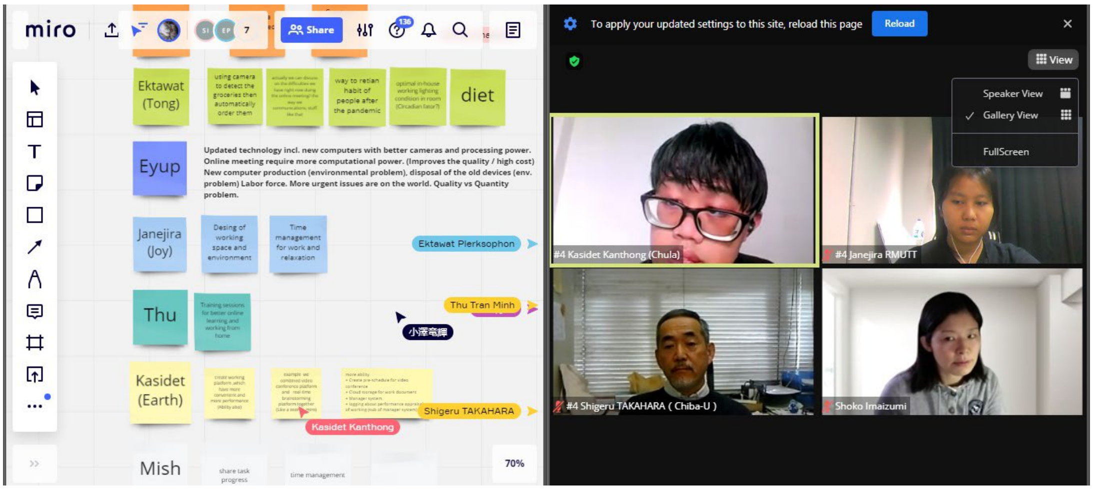
There are 10 topics presented. Prof. Mitsuo Ikeda was invited to be *a Keynote speaker.* He talked in the topic ***"Chromatic adaptation to illumination".*** Moreover, Asst. Prof. Dr. Chanprapha Phuangsuwan, a director of color research center was invited to talk as *invited speaker.* She talked in the topic ***"Device dependent simultaneous color contrast".***

Workshop days



Miro website's appearance.

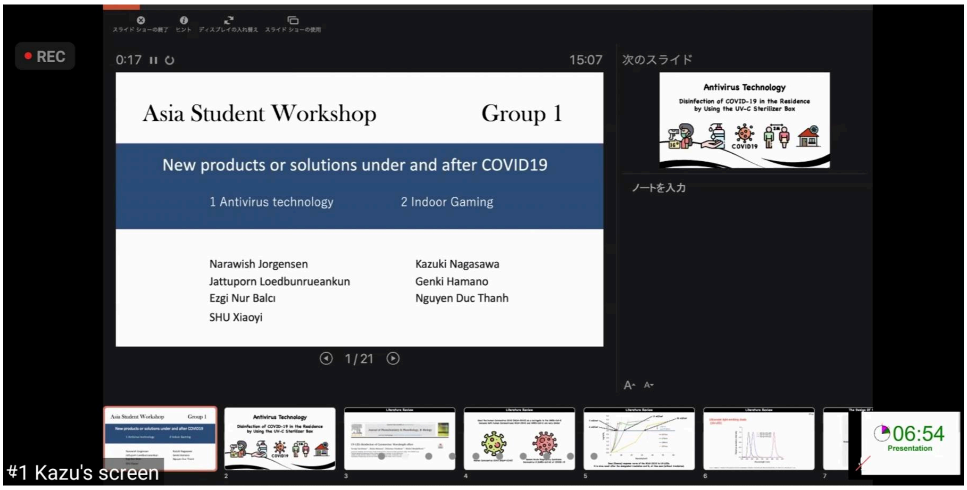
For workshop on 16-18 of March, all students will be divided into 10 groups. They were assigned to work in the topic "*New products or solutions under and after COVID19 on anything (students can propose)*" The application used for workshop and discussion was Miro website and Zoom application. MCT students exchanged knowledge and idea with other students from many countries.



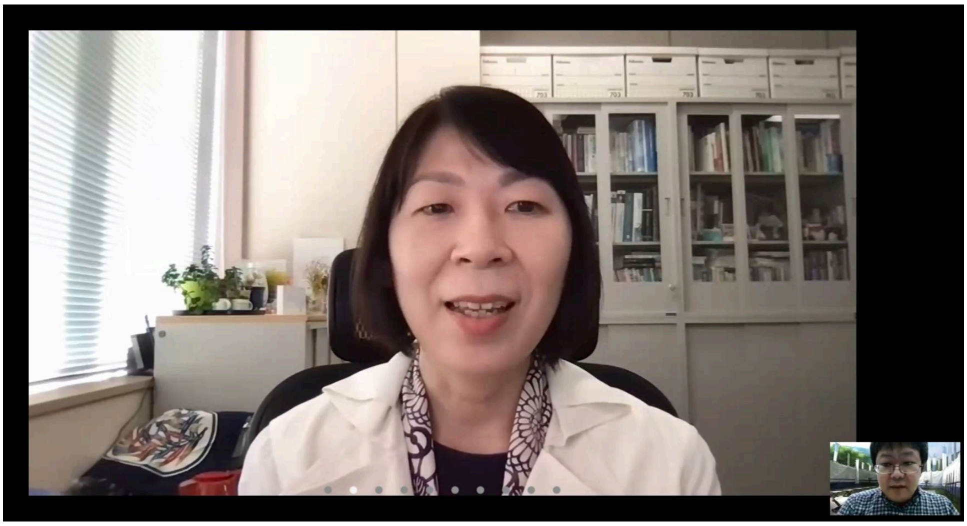
Students were discussing the ideas.

Presentation day

On 19 March 2021, each group presented their project through Zoom application. They got advice and discussed with experts and professors for the project.



Students' presentation



Prof. Yoko Mizokami from Chiba University gave the closing speech.

Cooperation

Local Cooperation

Color Research Center have participated the color group named "Color Society of Thailand" or CST. This group distributes the academic activities in the field of color. CRC members play an important role in the group.

Soon, Color Society of Thailand is going to arrange the 1st CST Annual Conference on 24th – 25th February 2022 as an online conference, and International Colour Association 2023 (AIC 2023) in Chiang Rai, Thailand.

Cooperation

International Cooperation

Chiba University

Color Research Center extended the cooperation with ***Chiba University***, Japan

Therefore, we continue the academic exchange together.

All cooperation

CRC brought the international cooperation with many universities as following.

Year	University	Country
2011	Ristumeikan University	Japan
2013	Meijo University	Japan
2015	Chiba University	Japan
2017	Yamagata University	Japan
2018	Osaka City University	Japan
2019	Huafan University	Taiwan
2020	Utsunomiya University	Japan
2021	Kyushu University	Japan

Research

Name	Research name	Publish	Year
Chanprapha Phuangsuwan and Mitsuo Ikeda	Ikeda, M. and Phuangsuwan, C. (2020). The effect of tissue paper on the color appearance of colored papers. Journal of the Optical Society of America A. 37(4), A114-A121. https://doi.org/10.1364/JOSAA.381611	Journal of the Optical Society of America A.	2563
	Mepean, M., Ikeda, M., and Phuangsuwan, C. (2020). Effect of room illuminance and display luminance on simultaneous color contrast viewed through a tissue paper. Proceeding of Color Science Association of Japan KENTAI2020 Conference, Japan, Supplement in Journal of the Color Science Association of Japan, 44 (6), 12-13 December 2020, 29-32.	*Journal of the Color Science Association of Japan, 44(6) Supplement, 29-32.*	2563
	Pattarasoponkun, N., Phuangsuwan, C. and Ikeda, M. (2021). Color and lightness of Thai skin tone. Proceeding of Color Science Association of Japan 2021 Conference, Japan, Supplement in Journal of the Color Science Association of Japan, 45 (3), 26-27 June 2021 Nagoya, 18-21.	*Journal of the Color Science Association of Japan, 45(3) Supplement, 18-21.*	2564

	Mepean, J., Ikeda, M. and Phuangsuwan, C. (2021). Effect of tissue on the simultaneous color contrast on an electric display. Proceeding of Color Science Association of Japan 2021 Conference, Japan, Supplement in Journal of the Color Science Association of Japan, 45 (3), 26-27 June 2021 Nagoya, 22-25.	*Journal of the Color Science Association of Japan, 45(3) Supplement, 22-25.*	2564
	Chitapanya, N., Phuangsuwan, C. and Ikeda, M. (2021). Thai basic color categories and monolexemic color terms. Proceeding of Color Science Association of Japan 2021 Conference, Japan, Supplement in Journal of the Color Science Association of Japan, 45 (3), 26-27 June 2021 Nagoya, 26-28.	*Journal of the Color Science Association of Japan, 45(3) Supplement, 26-28.*	2564
	Chitapanya, P., Phuangsuwan, C. and Ikeda, M. (2021). Color appearance of color chips under light-emitting diodes lamps. *Color Research and Application*. Accepted 24 Sept, 1-20. DOI: 10.1002/col.22744	Color Research and Application, Accepted 24 Sept. (2021).	2564

Appendix

Effect of room illuminance and display luminance on simultaneous color contrast viewed through a tissue paper

Janejira Mepean Graduate School, Faculty of Mass Communication Technology, RMUTT, Thailand
Mitsuo Ikeda Color Research Center, RMUTT, Thailand
Chanprapha Phuangsuwan Color Research Center, RMUTT, Thailand

Keywords: Simultaneous color contrast, Display, Tissue paper, Elementary color naming.

1. Introduction

The simultaneous color contrast SCC is a well-known phenomenon of color appearance. The stimulus is composed of a colored surround with a gray test patch at the center. The test patch appears cyan if the surround is red, for example. When the stimulus is made of a paper, the phenomenon is not strong and the cyan color is not vivid, if any. It was shown, however, that if the entire stimulus is covered by a white tissue the phenomenon is much enhanced and the cyan appears very vivid[1]. According to the theory of the recognized visual space of illumination RVSI[2], the SCC phenomenon was explained by the chromatic adaptation to the surrounding color. A subject adapts to the color of illumination of a space constructed over the surrounding surface[2]. When a paper stimulus is employed in the SCC experiment, a subject strongly recognizes an object for the stimulus and the color is a mere attribute of the object, consequently the construction of an illuminated space over the surrounding surface becomes weak to weaken the SCC phenomenon. By putting a tissue over the stimulus, the edges of the test patch at the center becomes blurred and the object recognition is weakened. The test patch is composed of edges (contours) plus colors. Thus,

Test patch = Edges + Colors [1]

If perception of edges disappears with a tissue we are left mostly with colors and the color alone should behave as light. Thus,

Stimulus = Colors (Light) [2]

A strong chromatic adaptation should occur and the test stimulus appears vivid.

In this paper we will investigate if this tissue effect takes place in other devices, particularly in an electric display that has been used nowadays by many researchers in the color appearance experiment.

2. Experiment

Four surrounding colors, red, yellow, green and blue were employed, each surround being varied at five steps of luminance by adjusting the amount of RGB (50, 100, 150, 200 and 255) in the power point. A gray patch at the center of the surround was set at three different luminance, which we called a dark gray (DGr) (21 cd/m²), middle gray (MdGr) (41 cd/m²) and light gray (LGr) (61 cd/m²), respectively. Their chromaticities are shown in Fig.1a, b, a for

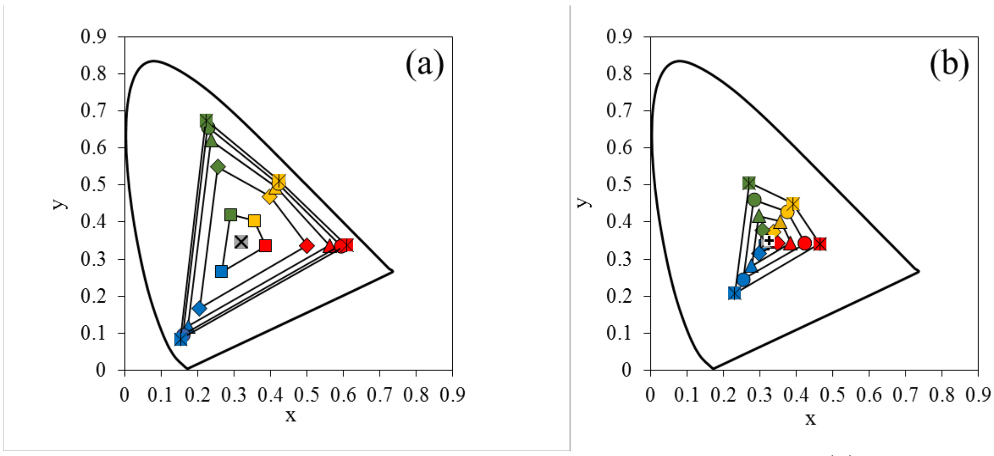


Figure 1. Five steps of colors for the surrounding without-tissue (a), with-tissue (b) (□ 50, ◇ 100, △ 150, ○ 200, ✱ 255), and gray patches (✕).

without-tissue and b for with-tissue.

One sheet of commercially available white tissue was used. A tissue was stretched flat on the frame of white foam and the size of the tissues in the frame was 13x14 centimeters. The haze value of the tissue paper was 80 and the transmittance was flat at 56 % for visible wavelength.

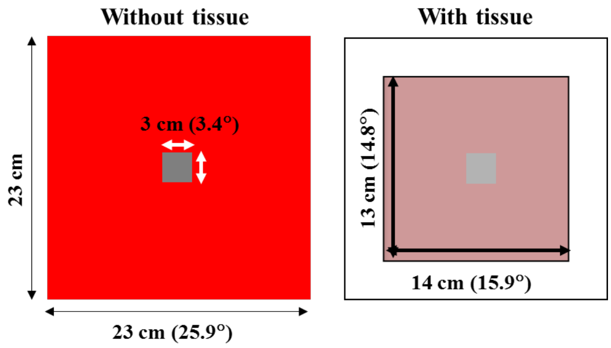


Figure 2. Stimuli of the without-tissue and the with-tissue.

A 24.1" of EIZO LCD display was used to present a SCC stimulus. The display was placed horizontally on a table and was masked with a black cardboard. Sizes of the stimulus is shown in Fig. 2 with the visual angle when viewed at 50 cm apart. The room was lit with one ceiling fluorescent lamp and the illuminance was kept at 200 lx on the display.

Subjects were asked to judge the color appearance both of surround and gray patch by the elementary color naming method, namely, the amounts of chromaticness, whiteness, and blackness totaling 100 percentage, and unique hues, red, yellow, green, and blue, totaling 100 percentage also.

Five subjects with normal color vision participated in the experiment and the judgment was repeated for three times at different days.

3. Results

Examples of results are shown in Fig. 3 taken from the subject CP. The upper figures (a) show the data in polar diagram that is normally used in the opponent-colors theory. The color of the green surround is shown by a solid square and the color of test patch by open symbols for three different luminance. The amount of chromaticness is given by the radial distance to the data point from the origin. It is bigger without the tissue than with tissue both for surround and for test patch. The colors of three test patches almost overlap. As already known the color of the test patch is magenta for this green surround[3]. The apparent hue of the test patch is expressed by the angle of the test patch point from the red axis and both apparent hues of without- and with-tissue are almost same as the angles, -24° and -23°, indicate.

We are mostly interested in the amount of chromaticness for different amount of color and it is shown in the bottom figure of Fig. 3 for the subject CP, where the amount of color is taken along the abscissa and the amount of chromaticness along the ordinate in the case of green surround. Three figures correspond to test patch, DGr (left), MdGr (middle), and LGr

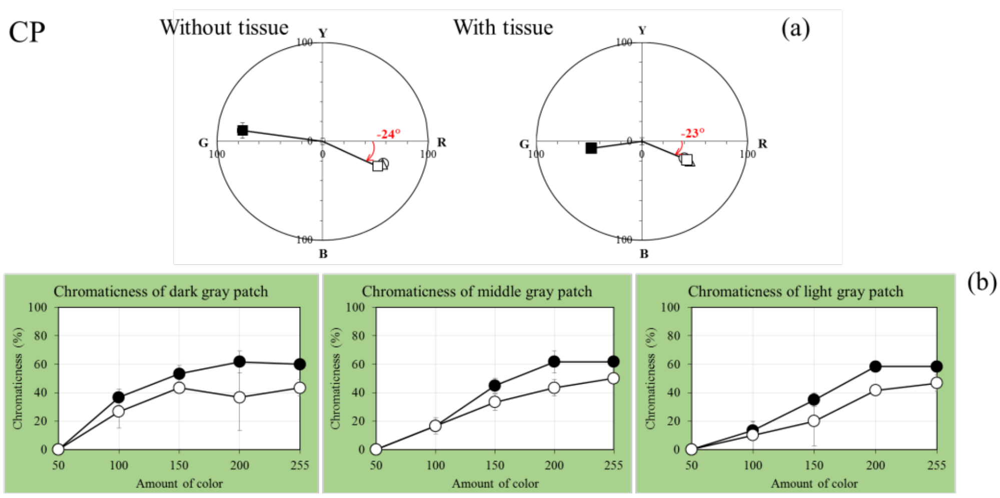


Figure 3. (a), Color appearance of the most vivid green surround (■) and of test patches; DGr (□), MdGr (△) and LGr (○). (b), Results of chromaticness without-tissue (●) and with-tissue (○).

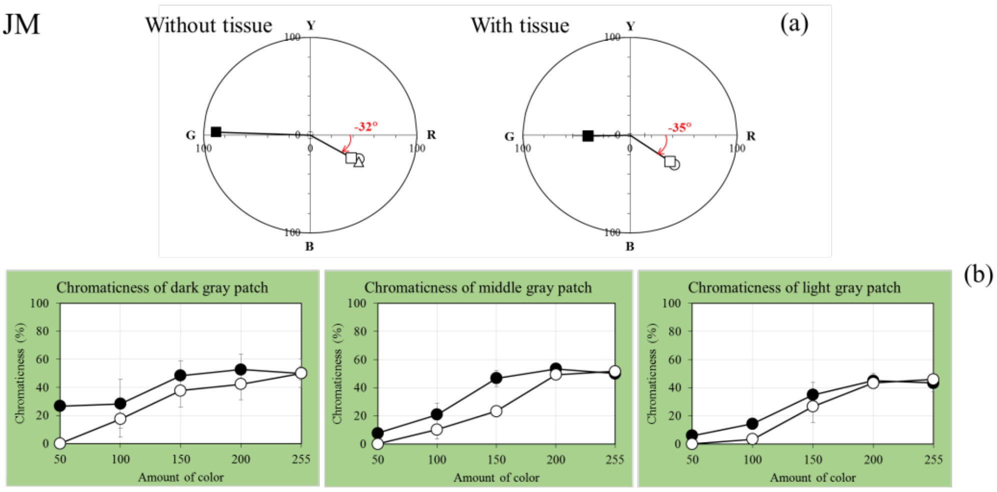


Figure 4. (a), Color appearance of the most vivid green surround (■) and of test patches; DGr (□), MdGr (△) and LGr (○). (b), Results of chromaticness without-tissue (●) and with-tissue (○).

(right). Filled symbols are from the without-tissue and open symbols from the with-tissue.

Similar results from the subject JM are shown in Fig. 4 and the tendency of the apparent hue and the amount of chromatiness is very similar to that from the subject CP.

We took average of amount of chromaticness of all five subjects for different color of surround and the results are shown in Fig. 5, the uppermost line for the test patch of DGr, the middle for MdGr, and the bottom for LGr. Columns correspond to the color of surround, red, yellow, green, and blue from the left.

Finally, we took average of all four colors of surround and the results are shown in Fig. 6 for different gray of test patch. Solid circles represent amount of chromaticness without-tissue and open circles the amount of chromaticness with-tissue.

4. Discussion and Conclusion

It is clearly seen in Fig. 6 that there is no difference between the without-tissue and the with-tissue for any luminance of test patch contrary to the expectation that a tissue blurs edges of test patch and surrounding color is

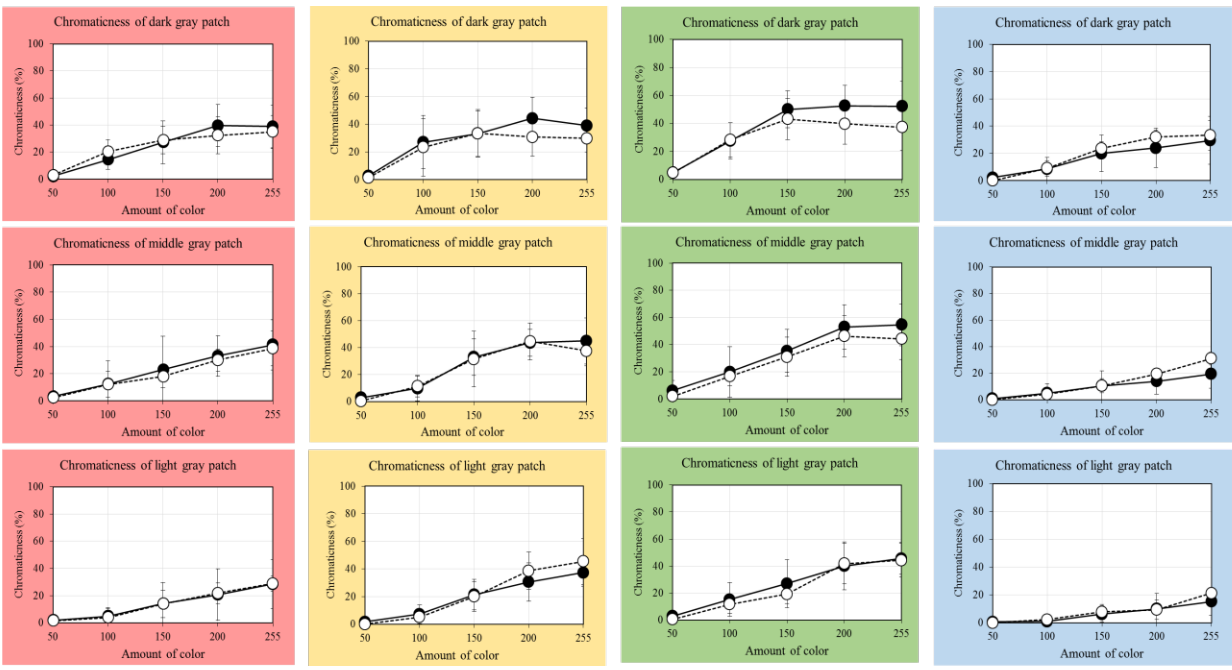


Figure 5. Averaged results of chromaticness from five subjects compared between without tissue (●) and with tissue (○).

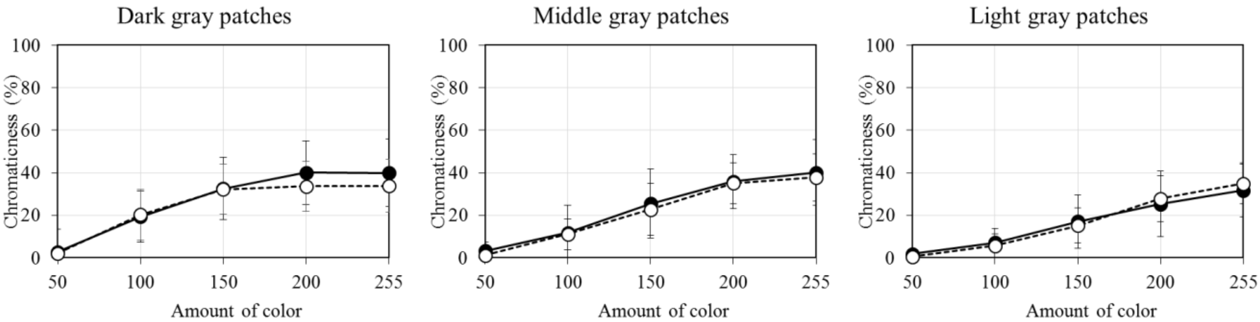


Figure 6. Averaged results of chromaticness from four surrounding colors compared between without tissue (●) and with tissue (○) for each difference gray patches.

more emphasized to yield stronger chromatic adaptation to the color. Eqs. [1] and [2] seem not to hold.

Phuangsuwan reported that the simutaneous color contrast phenomenon is device dependent[4]. The amount of chromaticness was observed largest with an electric display, and then a projector, a paper with a tissue and a paper without a tissue in this order. She reasoned that the display is a self-luminous device and a subject recognizes light from the surround enough to have a strong chromatic adaptation without a tissue.

To relate her assertion to the present result, the display caused enough chromatic adaptation and the effect of a tissue was too small to show enhancement of simultaneous color contrast.

It would be interested to find that blurred edges of test patch on a display will not show an enhancement of SCC.

References

1) Ikeda, M. and Phuangsuwan, C. The effect of tissue paper on the color appearance of colored papers, Journal of the Optical Society of America A, 2020, 37 (4), pp. A114–A121.

2) Ikeda, M. Color Appearance Explained, Predicted and Confirmed by the Concept of Recognized Visual Space of Illumination, Optical Review, 2004, 11 (4), pp. 217–225.

3) Phuangsuwan, C. and Ikeda, M. Chromatic adaptation to illumination investigated with adapting and adapted color, Color Research and application, 2017, 42, pp. 571–579.

4) Phuangsuwan, C. Chromatic adaptation to illumination, Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, pp. 238–243.

Color and lightness of Thai skin tone

Nutticha Pattarasoponkun — Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand
Chanprapha Phuangsuwan — Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand
Mitsuo Ikeda — Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand

Keywords: Skin color, Skin measurement, Thai skin color, Thai skin tone, Skin color difference

1. Introduction

The skin is one of the components of the body. It consists of Hemoglobin and Melanin[1]. The production of Hemoglobin and Melanin is more or less dependent on the individual. As a result, humans have different skin colors. In addition, there are other factors that can make the color and brightness of the skin different. For example, ethnic differences affect human skin color as shown by research by K. Xiao et al[2]. Even the time period, can change the color of the skin, according to research by Kumiko Kikuchi et al[3].

Even though, the same ethnic but the skin color may differ by individual factors, especially gender differences. As a research by Kihwan Han et al. that has examined the skin color of Koreans and found that gender differences are one of the factors that affect the color difference[4].

However, in daily activities including work It is inevitable to be exposed to the sunlight. High exposure to sunlight, as well as the duration of exposure to sunlight, affect melanin production[5], which directly affects the brightness of the skin. Thus, the skin color of each person is different, as research by Kihwan Han et al., who found that workplace differences between people working outdoors and people working indoors causing different skin color[4].

In this study, we investigate Thai skin color; to collect the data of Thai skin color and to investigate factors affecting the color and lightness from the point of view of different gender and different working place, namely, different genders and different of workplace of outdoor and indoor.

2. Methodology

Total number of subjects were 123 Thai nationals, 54 males and 69 females, ranging in the age from 24 to 70 years old. They had a variety of occupations, such as farmers, gardeners, teachers, officers, etc. The working group was classified into two categories: 84 people who work outdoor (mostly under direct sunlight) and 39 people who work indoor (mostly work in the buildings).

Five positions of the body: left and right cheeks, forehead and chin, which are the face area to represent area most frequently exposed to the sunlight and inner arm that represents areas less exposed to the sunlight. These represent actual skin color of subjects (Fig.1).

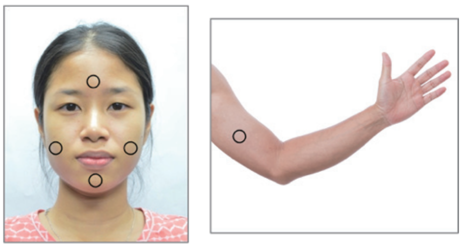


Figure 1 Positions of skin measurement

The Konica Minolta Chroma Meter CS-100A was used to measures the color and lightness, providing XYZ tristimulus value and xy chromaticity coordinates. It is a non-contact instrument. There was no need to worry about the pressure on the skin that may affect skin color. A standard white was used to convert XYZ tristimulus and to CIELAB.

As the measurement was to be made under various lighting conditions indoor and outdoor, Konica Minolta Chroma Meter CL-200A used to measure the illuminance and xy value. The illuminance during the experiment was in the range of 239 -2750 lx.

Subjects were asked to provide their own personal information in the questionnaire such as gender, age, province of birth, occupation, workplace characteristic, etc. At the skin color measurement, subjects were asked not use cosmetics or skin care products. If subjects used cosmetics or skincare products, they were asked to wash the skin.

The measurement was first done for the standard white. Subjects held the white standard at the same position as the five positions of skin measurements, and real skins of their positions were measured for the color and lightness. The CIELAB and lightness of the skin at each position were calculated.

3. Result and discussion

Result from 123 Thai subjects are shown in Fig.2 plotted on a*-b* diagram. Both cheeks were averaged to represent the cheeks as they were almost same. The range of redness value (a*) in cheeks, forehead, chin and inner arm were from 9.34 to 21.154, 6.81 to 21.77, 6.94 to 22.26 and 6.65 to 18.12, respectively. That of yellowness (b*) in cheeks, forehead, chin and inner arm were from 12.46 to 24.32, 12.98 to 23.16, 12.59 to 22.93 and 10.96 to 24.21, respectively. The inner arm showed the lowest value of redness and yellowness. This portion is an area rarely exposed to sunlight and showed lower redness than portions of the face. Chin had the highest value of redness and cheeks had the highest of yellowness. The average of a* and b* at respective portion were cheeks (14.80, 18.68), forehead (14.46, 18.37), chin (15.57, 18.18) and inner arm (11.76, 18.54).

Figure 3 and Fig. 4 show plots of L*-a* and L*-b*. The range of lightness values in cheeks, forehead, chin and inner arm were from 42.22 to 77.34, 42.48 to 76.68, 38.54 to 70.90 and 31.94 to 82.13 respectively. The inner arm gave the highest and lowest value of lightness as compared with other positions. For the lowest lightness the subject reported that while he was working, he usually did not protect sunlight. The lightness of his inner area was low.

Two types of statistical analysis were applied; the independent t-test for testing mean difference in gender and workplace and One-way ANOVA and Post hoc Dunnett T3 for testing mean difference in the positions of the body. Both of them set the P-value less than 0.05.

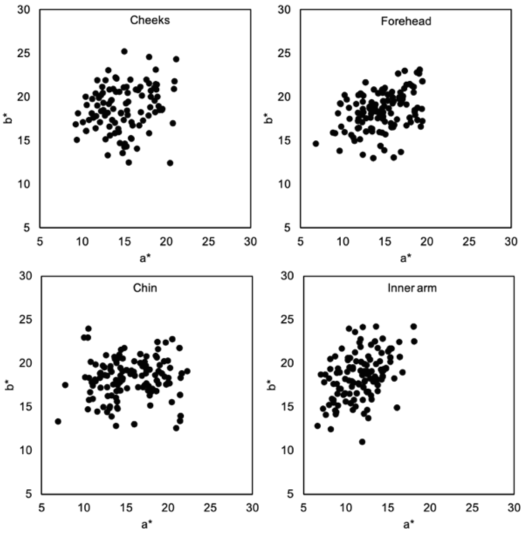


Figure 2 The distribution of Thai skin measurement in each position plotted on a*-b* diagram.

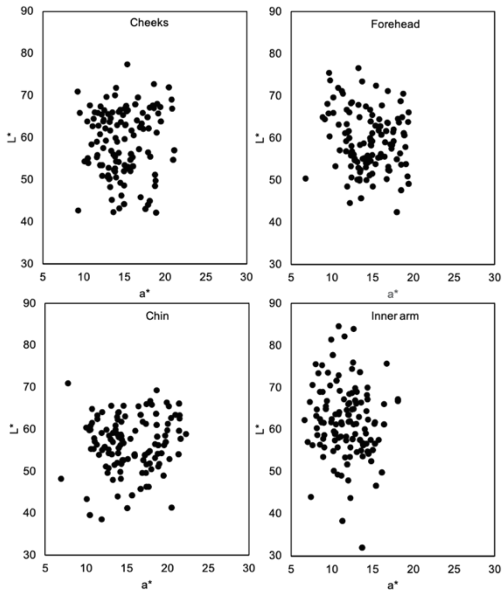


Figure 3 The distribution of Thai skin measurement in each position plotted on L*-a* diagram.

The averaged lightness of cheeks, forehead, chin and inner arm were 58.77, 57.30, 56.60 and 61.95, respectively, as shown in Fig. 5A. It is seen that the inner arm is significantly different from positions of the face (inner arm vs cheek: P-value = 0.016, inner arm vs forehead: P-value = 0.05 and inner arm vs chin: P-value = 0.000). Comparison of the facial position, only the forehead and chin had significant differences (P-value = 0.013). Figure. 5B shows the average of redness (a*) of the cheeks, forehead, chin and inner arm. They were 14.80, 14.46, 15.57 and 11.76, respectively. The redness of inner arm was also significantly different from other positions (inner arm vs cheeks, forehead, chin; P-value = 0.000). For the positions of the face, only forehead and chin were significant (P-value = 0.043). It can see that inner arm is the lowest of redness value. It noticed that when the lightness increases, the redness decreases. On the contrary, the average of yellowness of all positions (18.68, 18.37, 18.18 and 18.54 respectively) showed no significant difference as shown in Fig.5C.

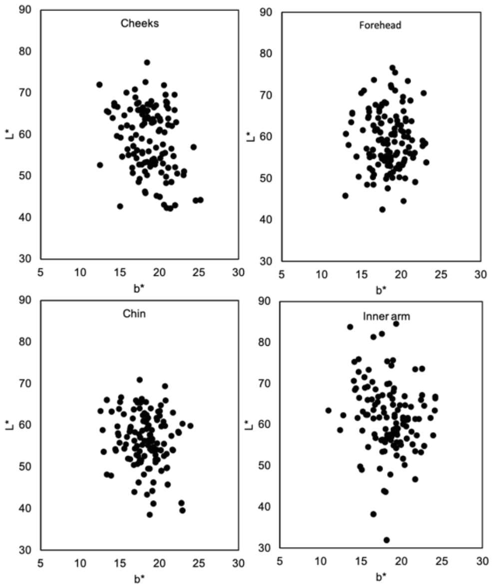


Figure 4 The distribution of Thai skin measurement in each position plotted on L*-b* diagram.

Figure 6 shows the chroma vs lightness. The range of chromatic in cheeks, forehead, chin and inner arm were from 17.72 to 32.24, 16.17 to 30.02, 15.03 to 30.63 and 14.43 to 30.21, respectively. Cheeks is the highest value of chroma than those tree position. On the contrary, the lowest value of chroma is inner arm.

Figure 7 indicates results of males and females separately. it is clearly seen that the average lightness of skin in females was significantly higher than males. The average lightness of cheek between male and female had P-value = 0.001, that forehead had P-value = 0.027 and that chin had P-value = 0.000. Inner arm did not show significance. In addition, the redness of female was significantly redder than males (cheeks: P-value = 0.009, chin: P-value = 0.001 and inner arms: P-value = 0.001) except forehead. On the contrary, the yellowness values did not show significant difference in all positions.

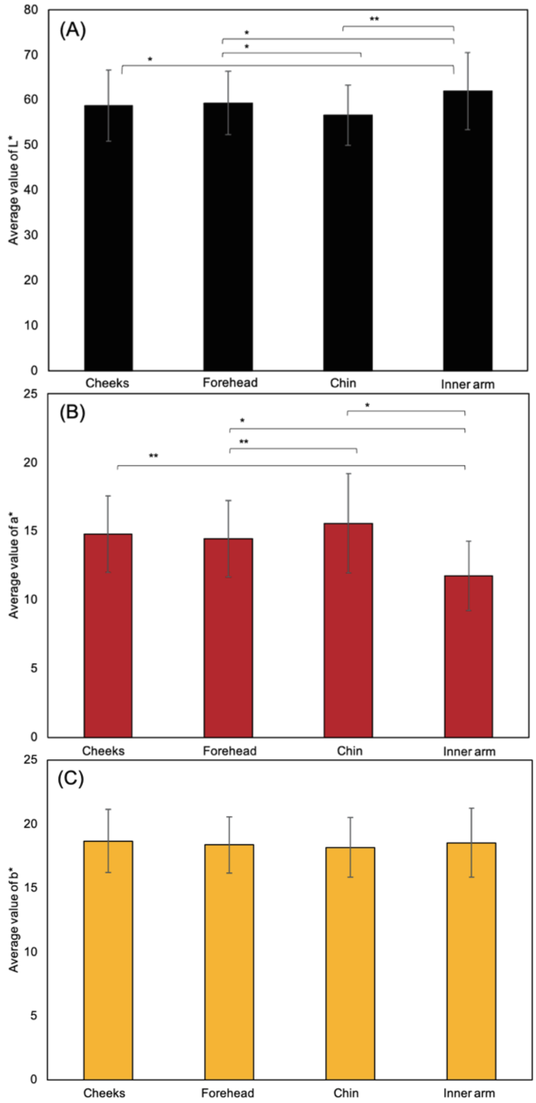


Figure 5 The average value in each position of Thai skin measurement. (A), (B) and (C) showed the average of lightness, redness and yellowness, respectively. * indicate significant difference less than 0.05, ** indicate significant difference less than 0.01.

Figure 8 shows the workplace characteristic. It is seen that the subjects who work outdoor had significantly lower lightness than indoor (cheeks; P-value = 0.000, forehead; P-value = 0.000, chin; P-value = 0.000 and inner arm, P-value = 0.000). Those people who work outdoors have higher yellowness than indoors. It may be due to the sun's exposure to increase the number of melanin pigment, which result with lower lightness value and higher yellowness value.

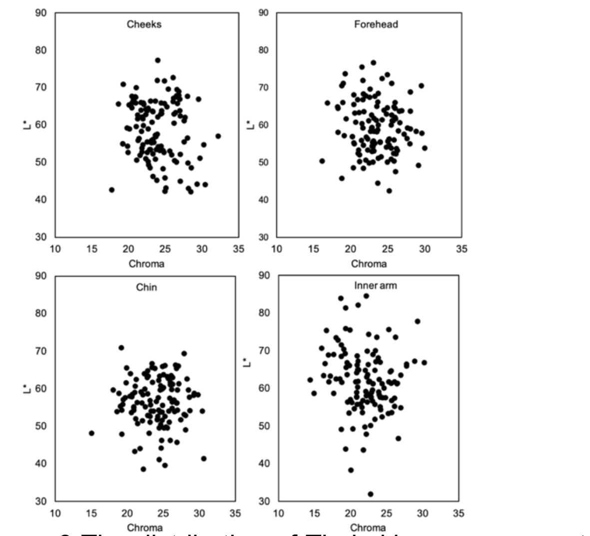


Figure 6 The distribution of Thai skin measurement in each position plotted on L*-chroma diagram.

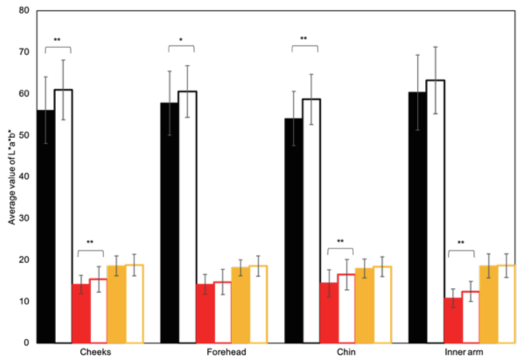


Figure 7 The average value in genders difference of Thai skin measurement. The solid bar showed the value of male and transparent bar indicated the value of female. Black, red and yellow color indicated the value of lightness, redness and yellowness, respectively. * indicate significant difference less than 0.05, ** indicate significant difference less than 0.01.

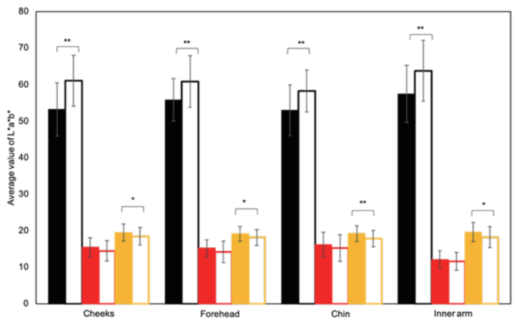


Figure 8 The average value in workplaces characteristic difference of Thai skin measurement. The solid bar showed the value of male and transparent bar indicated the value of female. Black, red and yellow color indicated the value of lightness, redness and yellowness, respectively. * indicate significant difference less than 0.05, ** indicate significant difference less than 0.01.

4. Conclusion

Different between body positions and gender had different lightness and redness of the skin. On the contrary, the workplace characteristics had affected to lightness and yellowness of the skin. Gender and workplace characteristics are factor that affect different skin color of Thai.

References

1) Takanori Igarashi, Ko Nishino และ Shree K. Nayar, “The Appearance of Human Skin: A Survey”, Foundation and Trend in Computer Graphic and vision, vol. 2 (2007), pp. 1-95.

2) K. Xiao, J. M. Yates, F. Zardawi, S. Sueeprasan, N. Liao, L. Gill, C. Li and S. Wuerger, “ Characterising the variations in ethnic skin colours: a new calibrated data base for human skin”, Skin Research and Technology (2016), pp. 1-9.

3) Kumiko Kikuchi, Chika Katagiri, Hironobu Yoshikawa, Yoko Mizokami and Hirohisa Yaguchi, “Long-term changes in Japanese women’s facial skin color”, Color Res Appl, vol. 43 (2017), pp. 119-129.

4) Kihwan Han, Taehyun Choi and Daegu Son, “Skin color of Koreans: statistical evaluation of affecting factors”, Skin Research and Technology, vol. 12 (2006), pp. 170-177.

5) Nina G. Jablonski and George Chaplin, “Human skin pigmentation as an adaptation to UV radiation”, PNAS, vol. 107 (2010), pp. 8962-8968.

Effect of tissue on the simultaneous color contrast on an electric display

Janejira Mepean Graduate School, Faculty of Mass Communication Technology, RMUTT, Thailand
Mitsuo Ikeda Color Research Center, RMUTT, Thailand
Chanprapha Phuangsuwan Color Research Center, RMUTT, Thailand

Keywords: Simultaneous color contrast, Tissue paper, Display, Illuminance, Elementary color naming.

1. Introduction

The simultaneous color contrast or SCC is a well-known phenomenon of color appearance. The stimulus is composed of a colored surround with a small gray test patch at the center. The test patch appears cyan if the surround is red, for example. When the stimulus is made of a paper, the phenomenon is not strong and the gray patch does not give vivid of cyan color. However, that if the entire stimulus is covered by a white tissue the phenomenon is much enhanced and the cyan appears very vivid[1]. The SCC phenomenon was explained by the chromatic adaptation to the surrounding color based on the recognized visual space of illumination RVSI theory[2]. A subject adapts to the color of illumination of a space constructed over the surrounding surface[3, 4]. When a paper stimulus is employed in the SCC experiment, a subject strongly recognizes an object for the stimulus and the construction of an illuminated space over the surrounding surface becomes weak and consequently a weak phenomenon of SCC. By putting a tissue over the stimulus the edges of the test stimulus at the center become blurred and the object recognition becomes weak. The test stimulus is composed of edges plus colors. Thus,

Stimulus = Edges + Colors (1)

If perception of edges disappear we have only colors left and the color alone should behave as light. Thus,

Stimulus = Colors (Light) (2)

A strong chromatic adaptation should occur and the test stimulus appears vivid. Blurred image can be produced in after image and the enhancement of SCC was observed.

In this paper, we will investigate if this tissue effect occurs in an electric display, by changing display luminance and room illuminance.

.

2. Experiment 1

2.1 Experiment

In experiment 1, we investigate the effect of display luminance for four surrounding colors, red, yellow, green, and blue. Luminance of surrounds were varied at five steps of luminance by adjusting the amount of RGB (50, 100, 150, 200, and 255). A gray patch at the center of the surround was set at 41 cd/m². Their chromaticities are shown in Fig. 1(a), (b); (a) for without-tissue and (b) for with-tissue.

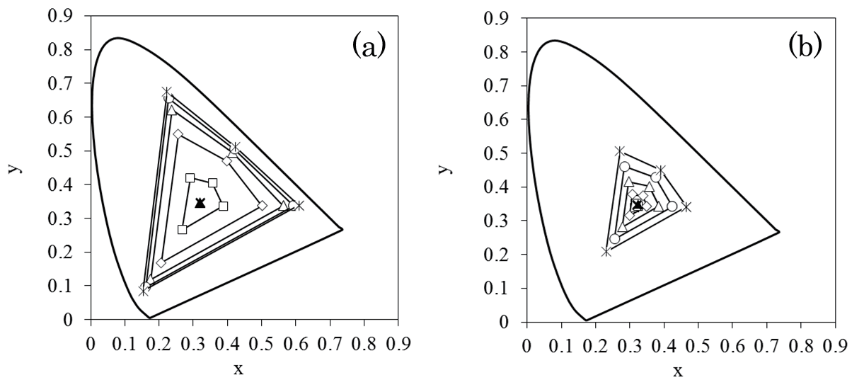


Figure 1. Five steps of colors for the surrounding without-tissue (a), with-tissue (b) in Experiment 1 (□ 50, ◇ 100, △ 150, ○ 200, ✱ 255), ▲ white, and gray patches (✕).

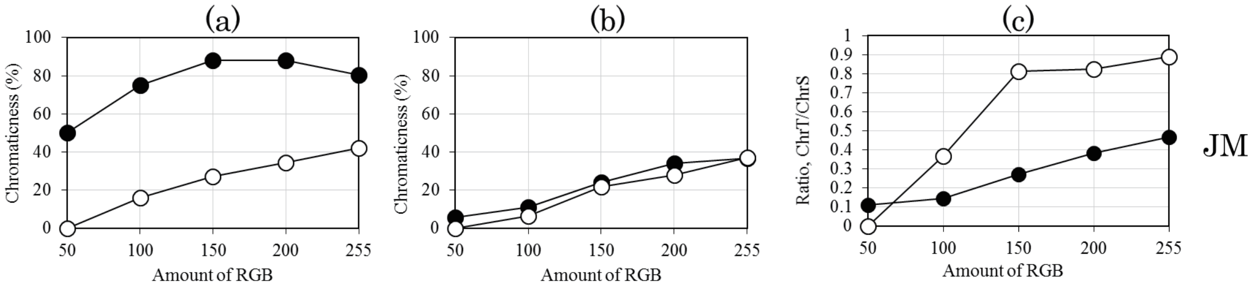


Figure 2. Amount of chromaticness of red surrounding with five steps of luminance (a) surrounding, (b) gray patch. The chromaticness ratio red stimulus (c), compared between without tissue (●) and with tissue (○)

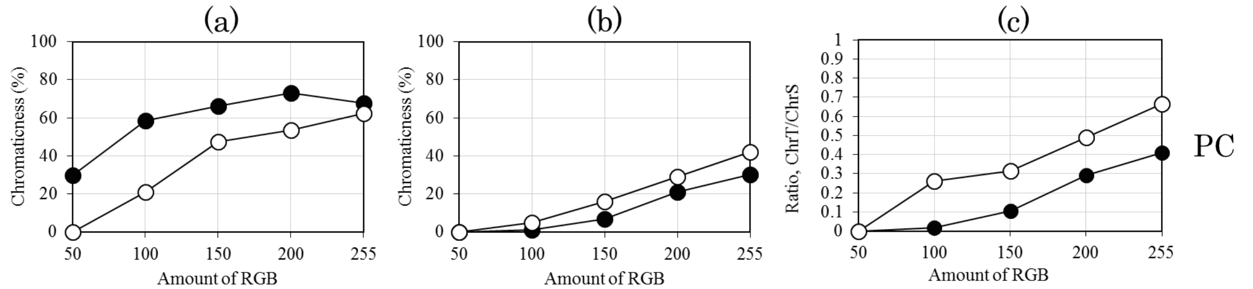


Figure 3. Amount of chromaticness of red surrounding with five steps of luminance (a) surrounding, (b) gray patch. The chromaticness ratio red stimulus (c), compared between without tissue (●) and with tissue (○)

One sheet of commercially available white tissue was used. A tissue was stretched flat on the white frame and the size of the tissues within the frame was 13x14 cm^2. The transmittance was constant at 56 % for visible wavelength and the haze value of the tissue paper was 80 %. The physical effect of a tissue is 1) to reflect the white ceiling light toward a subject reducing the contrast of the image and desaturating color of the image on the display and 2) to blur the image.

A 24.1" EIZO LCD display was used to present the SCC stimulus. The display was placed horizontally on a table and was masked with black cardboard. The size of the surround was 23x23 cm^2 and the gray patch was 3x3 cm^2 (25.9° and 3.4° of visual angle, respectively when viewed at 50 cm apart). The horizontal plane illuminance was kept at 200 lx on the display by using one ceiling fluorescent lamp

Ten subjects with normal color vision participated in the experiment and the judgment was repeated five times on different days. Subjects were asked to judge the color appearance of surround and gray patch by the elementary color naming method, namely, to estimate chromaticness, whiteness and blackness in percentage and unique hues, red, yellow, green, and blue in percentage also.

2.2. Results of experiment 1

Examples of results are shown in Fig. 2 taken from the subject JM for red surround. The amount of chromaticness at five steps of amount of RGB are shown for the surround in (a) and for the gray test patch in (b). The abscissa is the amount of RGB and the ordinate amount of chromaticness. Figure 2(a) clearly shows difference of the chromaticness between without-tissue (●) and with-tissue (○). Chromaticness reduced quite much with tissue. Although the subject JM perceived the chromaticness of the surround weaker with-tissue than without-tissue, she could perceive chromaticness of both gray patches with or without the tissue quite similar with each other at every step of the amount of RGB and saturation gradually increased We are interested in the power of surround to induce color at the test patch, and we took ratio of chromaticness of test patch to the chromaticness of surround. The ratio is shown in Fig. 2(c). It increased at all steps of the surround and shows clearly the difference between no tissue and with tissue.

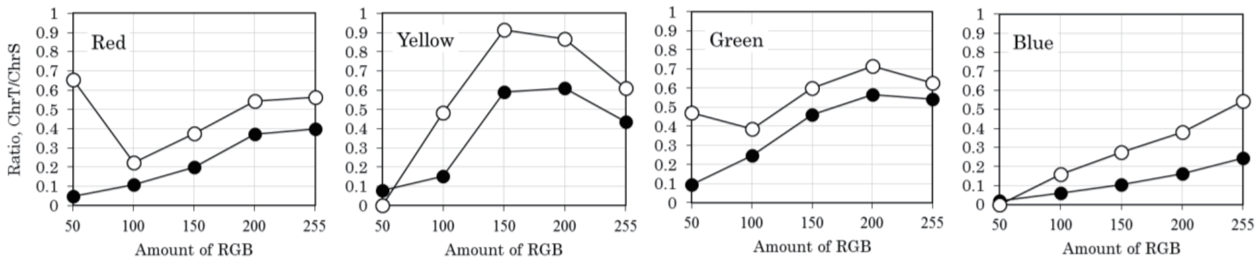


Figure 4. Chromaticness ratio of four surrounding colors with five steps of luminance compared between without-tissue (●) and with-tissue (○)

Figure 3 shows similar results from another subject PC. The results show the same tendency as the subject JM.

We took average of the chromaticness ratio of all ten subjects and the results are shown in Fig. 4 for four surrounding colors for without-tissue (●) and with-tissue (○). The ratio increases for all steps of the surround.

3. Experiment 2

3.1 Experiment

Here we investigate the effect of room illuminances. The surrounding luminance was kept constant for all the colors of surrounding red, yellow, green, and blue at 41.3, 124, 83.5, and 9.5 cd/m^2, respectively, a gray patch at 41 cd/m^2. The room illuminance was changed by ceiling lamps at ten levels, 3, 6, 13, 25, 50, 100, 200, 400, 800, and 1600 lx on the display. Their chromaticities are shown in Fig. 5 (a) for without-tissue and (b) for with-tissue. The procedure of experiment 2 was the same as experiment 1 and the same observers participated as subject.

3.2 Results of experiment 2

We averaged the results of ten subjects and obtained the chromaticness ratio for all four surrounding colors, which are shown in Fig. 6. The abscissa gives the room illuminance. The ratios of both "without-tissue" and "with-tissue" were fairly constant under room illumination level from 3-100 lx, but at the illuminance around 200 lx it started to increase for higher illuminance, except for the green surround which is quite constant at all illuminance levels.

Finally, we took average of all four colors of surround as shown in Fig. 7.

4. Discussion and Conclusion

Figure 4 from experiment 1 suggests that the effect of tissue exhibited by the chromaticness ratio increased for larger amount of RGB or luminance of the surround. And in the experiment 2, Fig. 7 clearly showed the ratio increase beyond the room illuminance 200 lx.

We can understand these results by taking account of the tissue effect of the image blurring and the reflection of white light. The image blurring effect reduced an object recognition of

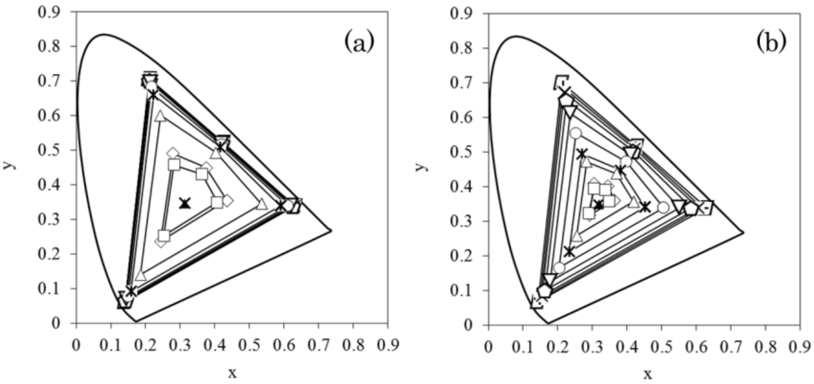


Figure 5. The surrounding colors under ten levels of illuminance without-tissue (a), with-tissue (b) in Experiment 2 (▱3 lx, + 6 lx, × 13 lx, ⬠ 25 lx, ▽ 50, ○ 100, ∗ 200 lx, △ 400 lx, ◇ 800 lx, □ 1600 lx), ▲ white, and gray patches (✕).

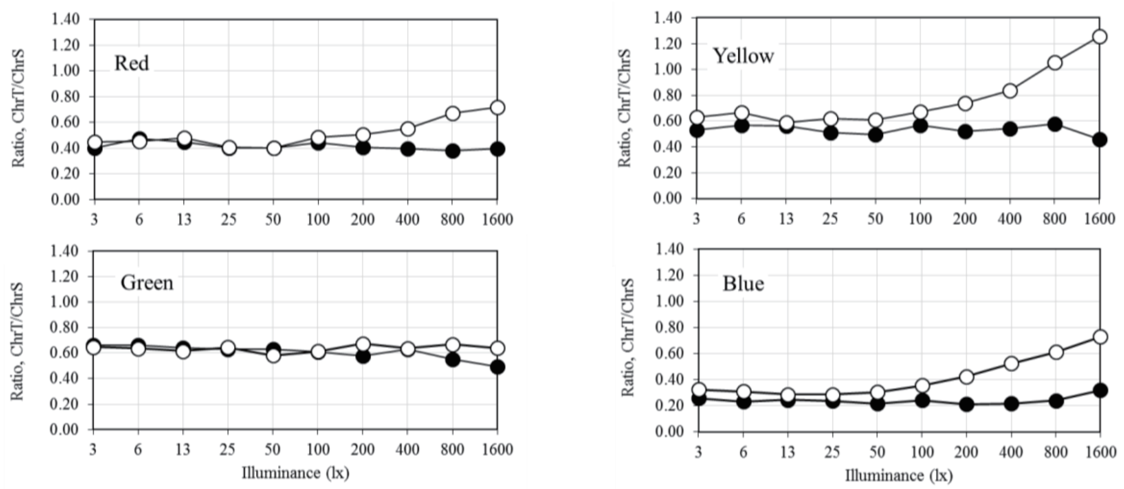


Figure 6. Chromaticness ratio of four surrounding colors with ten levels of illuminance compared between without-tissue (●) and with-tissue (○)

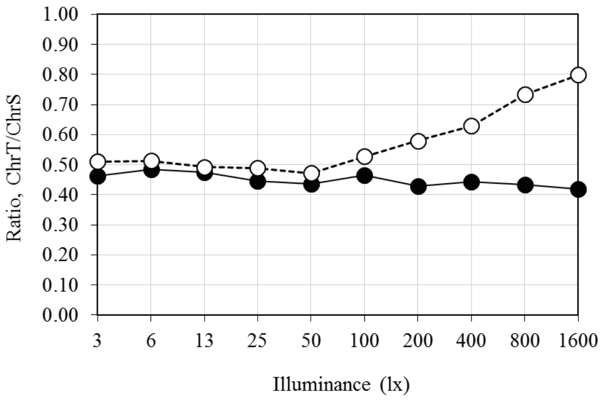


Figure 7. Averaged results from four surrounding colors compared between without-tissue (●) and with-tissue (○)

the test patch remaining only color or light giving the situation shown by Eq.(2), which caused the test patch to appear more vivid color of the gray patch[3]). A more reflection of the ceiling light reduced the image contrast to reduce the sharpness perception of the edges of the test patch and increased the color induction by the same token as the image blurring effect.

References

1) M. Ikeda. and C. Phuangsuwan: The effect of tissue paper on the color appearance of colored papers, Journal of the Optical Society of America A. 37(4) (2020), pp. A114–A121
2) M. Ikeda: Color Appearance Explained, Predicted and Confirmed by the Concept of Recognized Visual Space of Illumination, Optical Review. 11(4) (2004) , pp. 217–225
3) Phuangsuwan, C. and Ikeda, M. Chromatic adaptation to illumination investigated with adapting and adapted color, Color Research and application. 42 (2017) , pp. 571–579
4) Phuangsuwan, C., Ikeda, M., and Mepean, J. Color appearance of afterimages compared to the chromatic adaptation to illumination, Color Research and Application. 43(3) (2018) , pp. 349–357

THAI BASIC COLOR CATEGORIES AND MONOLEXEMIC COLOR TERMS

Nischanade Chitapanya — Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand
Chanprapha Phangsuwan — Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand
Mitsuo Ikeda — Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand

Keywords: Thai color names, Color categories, World color survey, Source of color names, Color chips.

1. Introduction

Color is very important to our way of life. From ancient times to the present day, color has been utilized as a symbol to convey a certain meaning. Therefore, color is should be studied in order to benefit our way of life because all the things that surround us are made up of color.

Due to the World Color Survey (WCS)[1)], in our previous study[2)], we investigated color name usage from 161 Thai-native speakers by using similar color samples as used in the WCS. We found 114 color names were used by Thai subjects. In this number there were 12 color names used by more than 80% of subjects which correspond to the eleven basic color terms (11BCTs) as found in Berlin and Kay (B&K, 1969)[3)] plus “Fa” (Sky/light blue). In this study, we further investigated that where these 114 color names were derived from? We have classified those color names into different groups base on their meaning to understand the source of those color names and understand how Thai subjects communicate about color.

2. Experiment

2.1 Subjects

Data of Thai color names were obtained from 161 Thai-native speakers (subjects). All subjects were tested to ensure that they had a normal color vision by using the Farnsworth Munsell D-15 Color Vision Test before starting the experiment.

2.2 Apparatus

The 330 color chips taken from the Munsell Book of Color Glossy Edition were almost the same as was used in the World Color Survey color chart which compost of 320 chromatic chips, values from 2 to 9 with 40 equally spaced Munsell hue (2.5 R to 10 RP, in hue steps of 2.5) at the maximum chroma of each value in each hue. Besides chromatic chips, there were 10 achromatic chips of values from 1.5 to 9.5. Each color chip (of the size 2x2.1 cm^2) was mounted on square cardboard of the size 7x7 cm^2 covered by a gray matte paper approximately N5, the color chart and example of color chips showing in Figure 1.

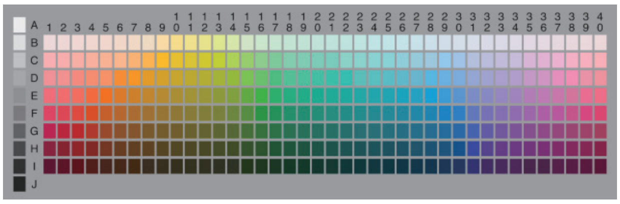


Figure 1. Color stimuli used in the World Color Survey.

2.3 Procedure

(1) Collecting color naming data

After tested the color vision, a subject was presented the color chip one by one and he/she was asked to provide a color name for each color chip by free-naming with conditions; the color name without mixed colors (no combination of two or more colors, such as yellow-green) or modified colors (no word that specifies the darkness or brightness, such as dark green). However, the subject can use the name of objects or things that are found in their everyday life such as coffee or banana, etc. A subject could freely tell any color term that he/she uses in daily life by using a monolexemic color term that incorporates the B&K’s 11BCTs. One subject conducted only one session, no repetition.

(2) Classifying color names baes on the source of color name

After we got color naming data, we have classified all the color names into categories

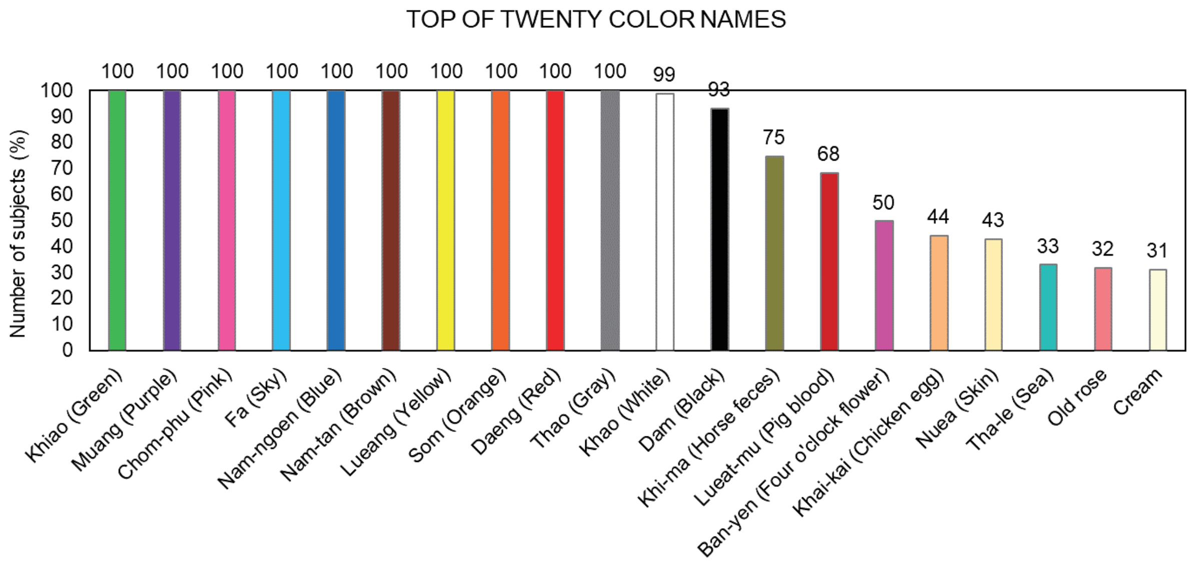


Figure 2. Twenty popular color terms used by Thai subjects. The order of color terms is sorted by the number of subject's usage and frequency of use from higher to lower.

according to their meaning to determine the source of those color names. For example, Ban-yen (Four o'clock flower/Magenta) is the name of a flower in Thailand. Therefore, we classify it as a plant group; a color name derived from a plant's name, meaning that Thai people use the name of the plant instead of the color name. Notice that, since the group of plants is quite broad, we have further divided the sub-groups of plants according to the type of plant[4], such as flowers, fruits, etc. names, and understand how Thai subjects communicate about color.

4. Result and discussion

From our previous work of surveying Thai color names from 161 Thai-native speakers[2], we have found a total number of color names is 114 and there were 12 color names used by more than 80% of subjects including the 11BCTs as found in Berlin and Kay (1969) plus "Fa" (Sky/light blue). It was also found that there are three non-basic color terms (non-BCTs) used by ≥50% of subjects; Khi-ma (Horse feces), Lueat-mu (Pig blood), and Ban-yen (Four o'clock flower/Magenta), which were used by 75% and 68% and 50% of subjects, respectively. Figure 2 shows Twenty popular color names used by Thai subjects. The order of color names is sorted by the number of subject's usage and frequency of use from higher to lower, of these names, there are two derived words from the English language: Old rose and Cream used by 32% and 31% of subject, respectively.

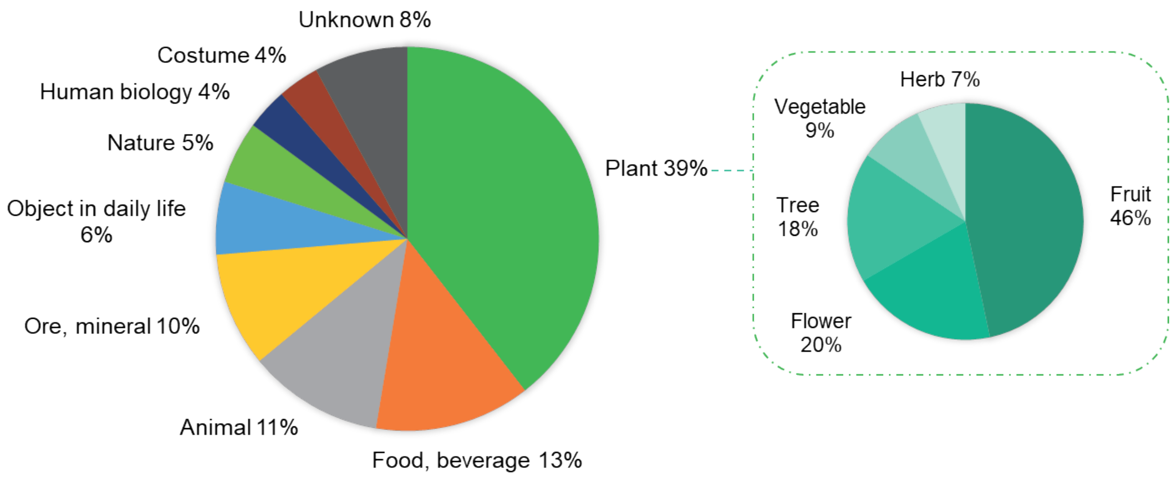


Figure 3. Source of color names categorized base on color name's meaning.

Table 1. Three ranks of color names in each category of sources are most used by Thai subjects.

Source of color name	Rank	Color name	Number of subject
Animal	1	Khi-ma (Horse feces)	120
	2	Khai-kai (Chicken egg)	71
	3	Lueat-nok (Bird blood)	24
Costume	1	Krom-ma-tha (Navy blue)	21
	2	Ka-ki (Khaki)	11
	3	Chi-won (Yellow robe of Buddhist monk)	6
Food, beverage	1	Nam-tan (Brown)	161
	2	Lueat-mu (Pig blood)	110
	3	Cream	50
Human biology	1	Nuea (Skin)	69
	2	Khi (Feces)	7
	3	Lueat (Blood)	5
Nature	1	Fa (Sky)	161
	2	Tha-le (Ocean)	53
	3	Khlon (Mud)	2
Object in daily life	1	It (Brick)	33
	2	Khwan-buri (Smoke)	8
	3	Pun-daeng (Red cement)	3
Ore, mineral	1	Nam-ngoen (Blue)	161
	2	Mo-ra-kot (Emerald)	8
	3	Thong (Gold)	4
Plant	1	Som (Orange)	161
	2	Ban-yen (Four o'clock flower/Magenta)	80
	3	Old rose	51
Unknown	1	Khiao (Green)	161
	2	Muang (Purple)	161
	3	Chom-phu (Pink)	161
	4	Lueang (Yellow)	161
	5	Daeng (Red)	161
	6	Thao (Gray)	161
	7	Khao (White)	159
	8	Dam (Black)	150
	9	Lae (Dark bluish-green)	3

The next question is, where did those color names come from? To understand the nature of Thai subjects in the use of the color name. We, therefore, checked those color name's meaning and classified them into different categories according to their meaning to investigate the behavior of Thai people in the use of color names base on the derivation of color names. Figure 3 on the left shows nine categories of the source of color names including the color names that come from plants 39% which occupies the highest proportion. The category that has the second-highest proportion of the number of color names is food/beverage, accounting for 13%. The third highest proportion is the color names that are derived from animals which account for 11%. Then followed by the color names that derived from ore/mineral 10%, object in daily life 6%, nature 5%, human biology 4%, costume 4%, and unknown 8%.

Due to the variety of color names that come from plants we, therefore, divided sub-groups further into categories of plants, including fruit, flower, tree, vegetable, and herb. From the sub-graph on the right in Figure 3, it can be seen that the highest proportion is the color names derived from fruit's name which accounts for 46%. Sub-groups of plants that have the second proportion is flower's name, 20%. The third proportion is the color names that come from the tree category, accounting for 18%. Then followed by vegetable and herb which account for 9% and 7%, respectively. Table 1 shows 3 ranks of color names in each category that are most used by Thai subjects. For the unknown category, most of them consist of basic color names except “Lea” which is a term used in the Isan region or Northeast of Thailand, meaning dark greenish-blue and referring to dark skin people.

Considering the color names and the source of color names found in this study, various color names obtained from Thai subjects are related to things or the environment that they have seen in daily life. It can indicate the nature of Thai subjects that they pay attention to small details of things around them and use those to describe the characteristics of color in color communication.

Acknowledgment

We would like to thank Prof. Ichiro Kuriki, Asst. Prof. Rumi Tokunaga, the RIEC of Tohoku University, and Chiba University for kindly supplying us the Munsell color chips and the experimental equipment as well as the valuable comments in doing the experiment.

References

1) R. S. Cook, P. Kay, T. Regier. The World Color Survey database: History and use. In Cohen, Henri, & Claire Lefebvre (Eds.), Handbook of Categorisation in the Cognitive Sciences, Amsterdam: Elsevier. (2005). pp. 224– 241.

2) B. Berlin and P. Kay. Basic color terms: Their universality and evolution. Berkeley, CA: University of California Press. (1969).

3) N. Panitanang, C. Phuangsuwan, I. Kuriki, R. Tokunaga, M. Ikeda. Thai basic color terms and new candidate nomination. The 5th Asia Color Association (ACA) Proceedings. (2019). pp. 164-169.

4) R. A. Lewis. CRC Dictionary of Agricultural Sciences. CRC Press. (2002). ISBN 978-0-8493-2327-0.