# COLOR RESEARCH CENTER

## ANNUAL REPORT

# 2020

MASS COMMUNICATION AND TECHNOLOGY, RMUTT

# Preface

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

This annual report 2020 of Color Research Center aimed to present the academic activities and others that happened in 2020 (Year budget from October 1st, 2019 – September 31st, 2020). There are many contents shown in this report such as CRC information, student exchange, international conference, cooperation of CRC, and researches. These will show 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 and staffs.

Director of Color Research Center

# Content

## Message from CRC's Director

Color Research Center CRC was established in 2013 to promote the color science and technology. Beside the main aim of CRC we made continuously effort to push and promote RMUTT's strategy such as internationalization. As years passed, CRC carried out many researches and activities. Many scientific papers have been published by staffs of CRC on international journals such Color Research and Application, Jr. of Optical Society of America, A, and Jr. of Color Science Association of Japan. We started collaboration with many international universities by exchanging MOU, such as Huafan University, Taiwan, Yonsei University, Korea, Chiba University, Japan, Ritsumeikan University, Japan, Meijo University, Japan, Utsunomiya University, Japan, and Yamagata University, Japan. Many Japanese scientists helps CRC by becoming international advisors, Prof. Yaguchi and Mizokami of Chiba University, Prof. Yamauchi of Yamagata University, Prof. Shinoda of Ritsmeikan University, Assoc. Prof. Kawasumi of Meijo University, Prof. Ayama of Utsunomiya University and Prof. Saito of Waseda University, Japan. Some of them are serving co-supervisors to graduate students in CRC.

In 2020, we faced with a trouble situation, pandemic of COVID-19 and many activities were forced to stop or speed down. We lost opportunities of staff and students to attend at international conferences and to go abroad as exchange students. But, because of this troubled situation we could start a new program of online international exchange lecture with Utsunomiya University.

We can assure that our activities will continue this coming year also.

Chanprapha Phuangsuwan, PhD

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

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:*** *39 moo 1 Klonghok Thanyaburi 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**

Professor Emeritus, *Chiba University, Japan*

Field to cover: Color appearance model

**Dr. Hiroyuki Shinoda**

Professor, Department of Information and Computer Intelligence

College of Information Science and Engineering,

*Ritsumeikan University, Japan*

Field to cover: Visual information processing

**Dr. Yasuki Yamauchi**

Professor, Faculty of Engineering

*Yamagata University, Japan*

*Supervisor to Phubet, Ph.D student*

Field to cover: Organic LED

**Dr. Mikiko Kawasumi**

Associate Professor, Department of Information Engineering,

Faculty of Science and Technology

*Meijo University, Japan*

Visiting researcher, Rajamangala University of Technology Thanyaburi

Field to cover: Human interface

## International Advisors

**Dr. Yoko Mizokami**

Professor, Department of Imaging Sciences, Graduate School of Engineering

*Chiba University, Japan*

Field to cover: Color vision and visual information processing

**Dr. Miyoshi Ayama**

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

Engineering and a Professor Emeritus of *Utsunomiya University*.

Field to cover: Visual ergonomic and Kansei

**Dr. Miho Saito**

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

Field to cover: Cross-cultural study of color preference

# 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 |

# 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

## Research

| Researcher | Name of the research project | 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), 114-121. | Journal of the Optical Society of America A | 2020 |
| | Sukontee, P., Phuangsuwan, C., Iyota, H., Sakai, H., and Ikeda, M. (2019). Color of Cooked rice to Improve Appetite for Elderly. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 39-43. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Chitapanya, P., Phuangsuwan, C., and Ikeda, M. (2019). Color appearance of objects in the environment lit with LED lamps. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 56-61. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Pattarasoponkun, N., Phuangsuwan, C., and Ikeda, M. (2019). Skin color of Thai people. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 143-148. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Somdang, K., Phuangsuwan, C., Tsuji, N., Kawasumi, M., and Ikeda, M. (2019). Color of Lipstick to Make Thai Girls Healthier. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 149-153. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Panitanang, N., Phuangsuwan, C., Kuriki, I., Tokunaga, R., and Ikeda, M. (2019). Thai Basic Color Terms and New Candidate Nomination. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 164-169. | Proceedings of the 5th Asia Color Association Conference | 2019 |

## Research

| Researcher | Name of the research project | Publish | Year |
|---|---|---|---|
| Chanprapha Phuangsuwan and Mitsuo Ikeda | Mepean, J., Ikeda, M., and Phuangsuwan, C. (2019). Simultaneous Color Contrast on a Display Determined by Different Viewing Distances. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 175-180. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Chantra, S., Ikeda, M., Sakai, H., Iyota, H., and Phuangsuwan, C. (2019). Device Independent Simultaneous Lightness Contrast. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 181-185. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Pumila, W., Phuangsuwan, C., Mizokami, Y., and Ikeda, M. (2019). Colors for Female and Male Image by Thai and Japanese People. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 204-209. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Jinphol S., Ikeda M., Phuangsuwan C., and Mizokami Y. (2019). Effect of Haze Value and Materials on the Color Appearance in the Tissue Experiment of the Simultaneous Color Contrast. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 226-231. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Nguensawat P., Ikeda M., Phuangsuwan C., and Mizokami Y. (2019). Effect of Viewing Distance to the Simultaneous. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 232-237. | Proceedings of the 5th Asia Color Association Conference | 2019 |

## Research

| Researcher | Name of the research project | Publish | Year |
|---|---|---|---|
| Chanprapha Phuangsuwan and Mitsuo Ikeda | Phuangsuwan C. (2019). Choromatic Adaptation to Illumination. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 238-243. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Upakit, O., Phuangsuwan, C., and Ikeda, M. (2019). Size Constancy Demonstrated on Photograph. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 385-388. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Phuangsuwan C., Ikeda M., and Pumila W. (2020). Dectectability of Color-Code Toilet Signs. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement, June 27-28, 2020, Kyoto, Japan. pp. 3-6. | Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement | 2020 |
| | Phuangsuwan C., Ikeda M., and Nguensawat P. (2020). Simultaneous Color Contrast with a Large Surrounding Field. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement, June 27-28, 2020, Kyoto, Japan. pp. 7-10. | Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement | 2020 |
| | Phuangsuwan C., Rattanakasamsuk K., Saksirikosol C., and Jarernros J. (2020). Does Rainboe Color Truly Represent Alternative Gender?. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement, June 27-28, 2020, Kyoto, Japan. pp. 177-179. | Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement | 2020 |
| Kitirichna Rattanakasamsuk | Jankeaw, K., Rattanakasamsuk, K., Kihara, R., and Kawasumi, M. (2019). Representative Colors of Grapes. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 283-288. | Proceedings of the 5th Asia Color Association Conference | 2019 |

# Research

| Researcher | Name of the research project | Publish | Year |
|---|---|---|---|
| Kitirichna Rattanakasamsuk | Rattanakasamsuk K., and Kawasumi M. (2019). Comparison of Color Interference in Gender Identification Between Thai and Japanese. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 442-446. | Proceedings of the 5th Asia Color Association Conference | 2020 |
| | Puenpa S., Rattanakasamsuk[2] K., and Srisuro P. (2019). Relationship Between Proper Contrast and Image Satisfaction. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 573-575. | Proceedings of the 5th Asia Color Association Conference | 2019 |
| | Rattanakasamsuk K., Nontawongsa C., Srisuro P., and Phuangsuwan C. (2020). Does Rainboe Color Truly Represent Alternative Gender?. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement, June 27-28, 2020, Kyoto, Japan. pp. 177-179. | Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement | 2020 |
| | Rattanakasamsuk K., Saksirikosol C., Phuangsuwan C., and Jarernros J. (2020). Color of Thai Iced Tea. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement, June 27-28, 2020, Kyoto, Japan. pp. 180-181. | Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement | 2020 |
| Waiyawut Wuthiastasarn | Wuthiastasarn W. (2019). Study of How the First - Time Voters Memorize the Color of Political Parties. Proceedings of the 5th Asia Color Association Conference, November 29-December 2, 2019, Nagoya, Japan, 198-203. | Proceedings of the 5th Asia Color Association Conference | 2019 |

# Activities

## Asia Student Workshop on Science Image (ASW 2019)

There are totally 6 students from MCT who participated in Asia Student Workshop on Science Image (ASW 2019) at Chiba University, Japan from November 21 to December 14, 2019. There are 4 undergraduate students joined in D2D program and 2 graduated students joined in L2L program.

**List of students**

| No. | Name | Department |
|---|---|---|
| | | ***D2D Program*** |
| 1 | Supaluk Prommanee | Photography and Cinematography Technology |
| 2 | Sopita Sinpaldee | Advertising and Public Relations |
| 3 | Tanapat Piriyapanpong | Photography and Cinematography Technology |
| 4 | Chatchai Nuangcharoenporn | Photography and Cinematography Technology |
| | | ***L2L Program*** |
| 5 | Janejira Mepean | Color Technology and Design |
| 6 | Nutticha Pattarasoponkun | Color Technology and Design |

# Activities

## Asia Color Association Conference (ACA 2019)

**The Third Asia Color Association Conference (ACA 2019)**

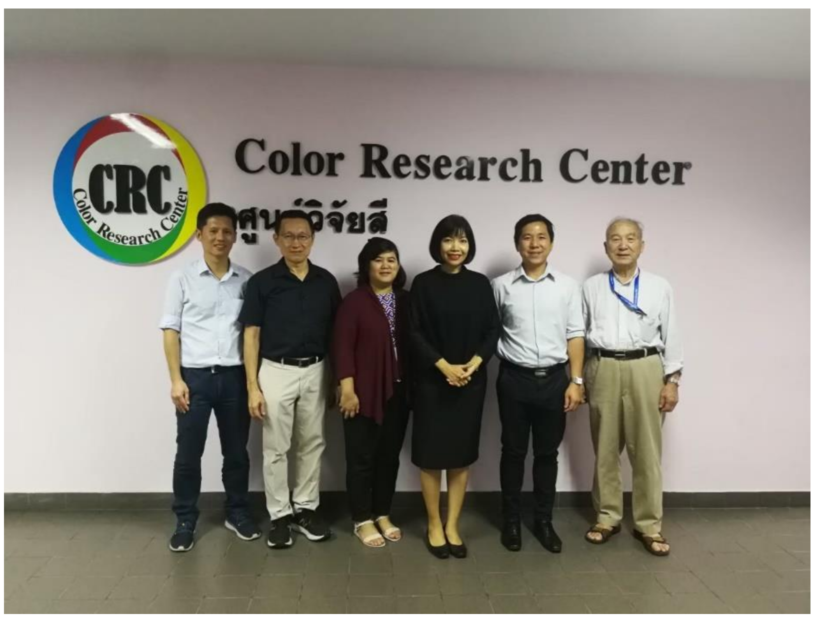
There are 9 undergraduate students and 4 graduated students of faculty of Mass Communication and Technology participated in Asia Color Association Conference (ACA2019 Nagoya): Color Communications from November 29 – December 1, 2019 in Nagoya, Japan.

In the conference, MCT students presented their academic works in English as an oral presentation. In this participation, students gained many experiences such as oral presentation in international stage.

# Cooperation

## Local Cooperation

Color Research Center has 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 the important role in the group.




Soon, CST plans to arrange the local seminar and international conference, AIC - International Color Association Conference 2023.

# Cooperation

## International Cooperation

Color Research Center has brought ***Utsunomiya University***, University of Japan, to be a partner of academic exchange.

宇都宮大学
UTSUNOMIYA UNIVERSITY

On February 13, 2020, Professor Miyoshi Ayama and Associate Professor Tomoharu Ishikawa visited Faculty of Mass Communication and Technology to sign the MOU between School of Engineering, Utsunomiya University and Faculty of Mass Communication and Technology, RMUTT.


This agreement will be significance and advantage in research filed. Also, students of MCT will have an opportunity to participate an exchange program.

# Cooperation

## International Cooperation

***Huafan University***, Taiwan has become a partner of academic exchange. The agreement was signed by two universities on December 1, 2019.

On December 1, 2019, Color Research Center's staffs and MCT staffs met Professor Tien-Rein Lee, the president of Huafan University to sign the MOU between Haufan University and RMUTT. This agreement is a great opportunity for MCT students, researchers, and staffs to cooperate with the top University of Taiwan.

In addition, Mr. Teiji Tachibana, the board chairman of Meijo University *(Second person from the left)* was a witness of this signing.

# Appendix

# COLOR OF COOKED RICE TO IMPROVE APPETITE FOR ELDERLY

Pantakan Sukontee[1*] Chanprapha Phuangsuwan[1], Hiroyuki Iyota[2], Hideki Sakai[3], Mitsuo Ikeda[1].

[1] *Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2] *Graduate School of Engineering, Osaka city University, Japan*
[3] *Graduate School of Human Life Science, Osaka city University, Japan*

*Corresponding author: Pantakan Sukontee,1159108020127@mail.rmutt.ac.th, 453opolopol@gmail.com

**Keywords**: Color of cooked rice, Thai herb, elderly, appetite.

## ABSTRACT

In the next few years, we will step into the aging society completely and many changes will take place with aging. The most common problem in the elderly is anorexia, they get bored to eat any foods. To improve this situation we hypothesized that if we change the color of rice changes from white to some other color by herbs such as butterfly pea, yellow by turmeric, red by roselle, green by pandanus leaf. Four chromatic colors and plus white rice were prepared to be presented by LCD display. In each of color rice, we changed the saturation by using Adobe Photoshop from the original color that was measured directly from real rice. Three steps of higher saturation were added to the original color and three steps of lower saturation were added to the original color. Finally, the total stimuli were 25 pictures. The preference questionnaire was "like" and "dislike" with scale 3 to -3, meaning like or dislike. We found that Thai elderlies preferred no vivid color of rice in red, yellow, green and blue. Japanese elderlies mostly preferred white color of rice and showed a small preference for red and yellow color by the reason that Japanese are familiar with the red and yellow rice for their daily life.

## INTRODUCTION

Population of elderly people is increasing rapidly in Thailand. The United Nations [1] predicted that in the years 2001-2100 would be the century of the elderly, in which Europe has the highest number of elderly people in the world and Asia has the 4th highest number of elderly people in the world. Thailand is the country with the 4th highest proportion of elderly people in Asia and the 2nd in ASEAN. Department of Older Persons (DOP) of the Foundation of Thai Gerontology Research and Development Institute (TGRI) reported [2] the status of Thai elderly population in 2017 that there are 11 million elderly people aged 60 years or over in Thailand which counted as 17% of the total population of 65.5 million. Thailand is rapidly aging and it is expected that in not over than 4 years Thailand will become a completely aging society. When we step into the aging society many changes will take place with aging. One of them is a decrease of appetite for food, which decreases with age and often they get bored to eat any foods. To improve this situation rice may be colored. In Thailand, colored rice stained by herbs is common on market as it is thought some colored rice is good for health. In this report, we will investigate the effect of color of rice for appetite for elderly people.

## EXPERIMENT

### Subjects

There were 4 groups of subjects participated in this study, 30 Thai elderly people (age range from 61 to 80 years old), 100 Thai young people (age range from 18 to 25 years old) , 15 Japanese elder people (age range from 61 to 82 years old), and 21 Japanese young people (age range from 21 to 25 years old), totally 166 people.

### Preparing stimuli

Five rice colors stained by herbs; purple by butterfly pea, green by pandanus leaf, red by roselle, yellow by turmeric, and white without stain as shown in Fig. 1 (d). The rice was cooked by a normal rice cooker (Sharp KSH-Q18) with standard water. After the cooking we measured the colors of rice by using Konica Minolta Luminometer CS-100A (Fig. 1 (b)) and we took photographs for each cooked rice on dishes under controlled illumination of experimental booth by using DSLR camera Canon EOS kiss x7i (Fig. 1 (c)). The booth was built to have the size of 150 cm in width, 60 cm in depth, and 180 cm height. It was illuminated by 8 daylight fluorescent lamps (TOSHIBA FL18W/T8/EX-D); 6 lamps were hanged on the ceiling and the others two lamps were set at the beside the dish of rice as you can see in Fig.1 (a). The illuminance of the booth was 3,194 lx, color temperature was 6,500 K.

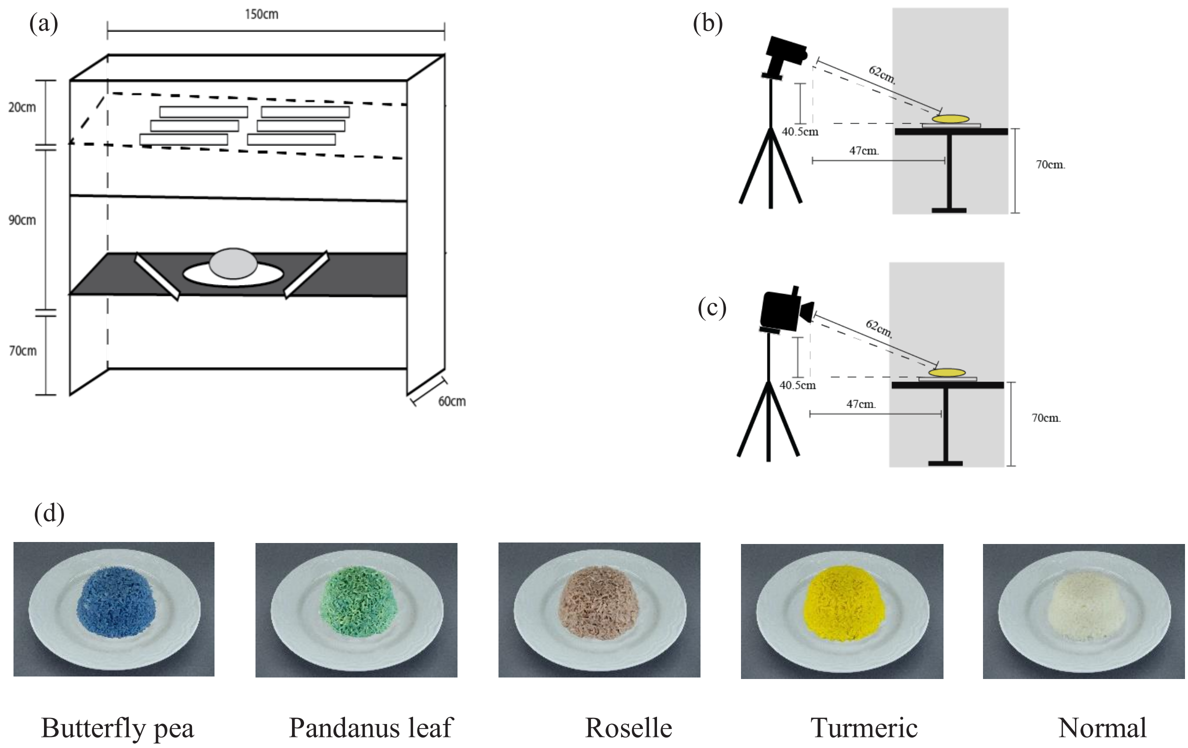



**Figure 1. Preparing stimuli. (a) structure of experimental booth used for measuring rice colors and taking photos. (b) Measuring color of rice by using luminometer CS100A, (c) Taking photos of colored rice. (d) Photographs of colored rice.**

Five colored rice photographs were then adjusted for temperature and tint by using the Adobe LightRoom on the LDC display (Eizo Cs2420) to make the color of photographs to match the real rice. The matched colors are shown in Fig. 2 (a) by open symbols. The colored filled symbols represent the color of real rice. After that, we adjusted the saturation of the photograph by using the Adobe Photoshop CC to decrease and increase saturation by 5 steps; two photographs of higher saturation than the original photograph (2, 1) and two photographs of lower saturation than the original photograph (-2, -1). The saturation of the original color was coded as 0. The results are shown in Fig. 2b with black filled triangles for the original. It was not possible to make saturation higher for the bellow photographs. There were 25 photographs as shown in Fig. 2 (b).

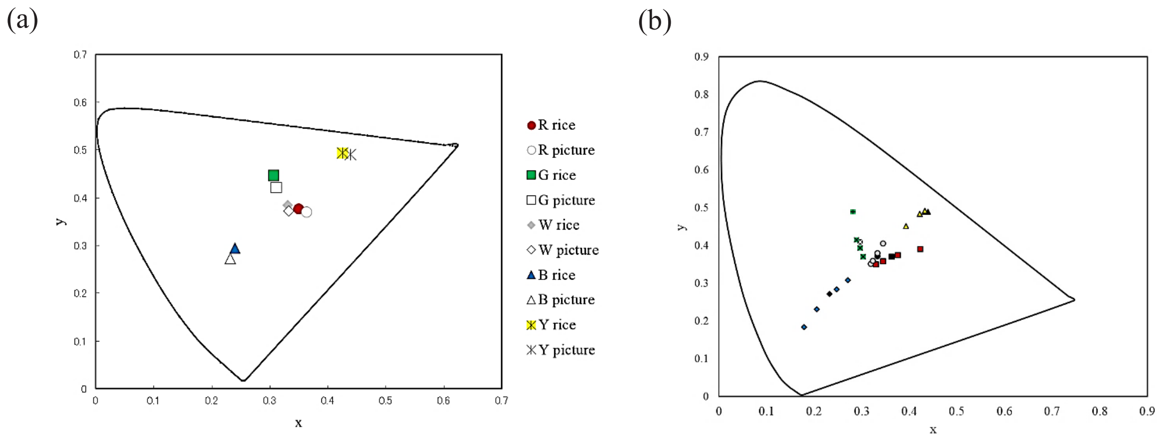



**Figure 2. Rice colors. (a) Matching colors of rice photographs. (b) Adjusting saturation of rice photographs.**

## Procedure

For the convenience of moving experimental equipment to collect data from the elderly subject outside, we created an experimental box made of black board as shown in Fig. 3(a), of the size 45 cm in width, 91.2 cm in depth, and 30 cm height, to prevent light from outside keeping the inside the box dark. A subject looked at the 25 rice photographs which were presented one by one on the 14-inch labtop display (Asus A45V) through an aperture of the size 7.5 cm x 10 cm (Fig. 3(b)). The visual angle of a picture on the display was 12.4° high. The subject was asked to rank the picture by 7-point scale, from "like" down to "dislike"; -3 (dislike at all), -2 (dislike), -1 (rather dislike), 0 (so so), 1 (quite like), 2 (like), 3 (really like).

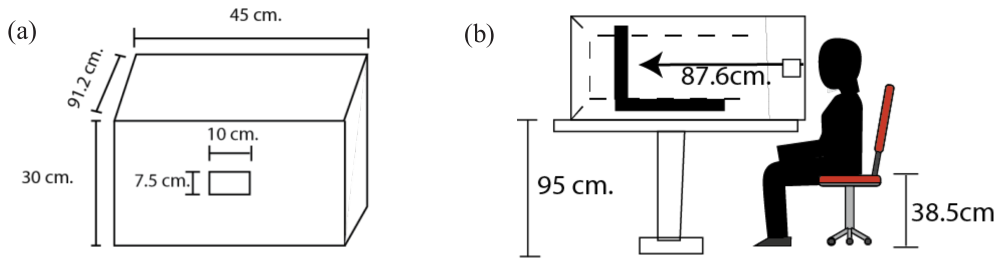



**Figure 3. (a) An experimental box. (b) View of doing experiment.**

## RESULTS AND DISCUSSION

The scores to show saturation effect from 30 Thai elderlies are shown in Figure 4 for difference colors. The score did not change for saturation except the yellow rice. They did not like very vivid yellow rice. We averaged score of subject of each group for each color and the results are shown in Figure 5. Here, the scores of different saturation were averaged. The left above figure shows the score rated by Thai elderly subjects, we can see that red rice has the highest score of 1.67. White rice gave score 1.47, they like but not much. Other rice colors have the score less than 1 but all positive, which means they feel so so. For the Thai young subjects (right top figure), it seems that they like rice in every color, but there is no rice with a distinctive preference score than other colors, in which every rice color has less than 1.5, the highest score is 1.38. The averaged score of Japanese subjects shown at the bottom (both elderly and young groups) shows similar results for elderly and young people. The highest is white rice and the second is red and then yellow, but the green and blue rice gave minus score which means they dislike.

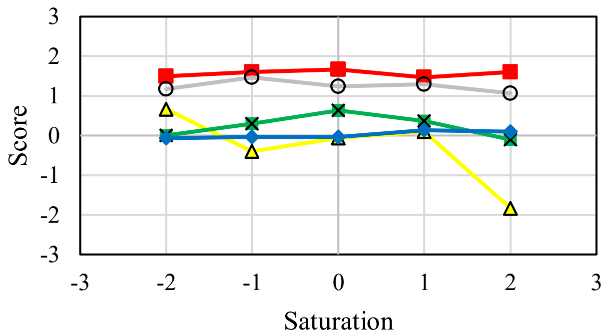



**Figure 4.Score for different saturation of four colour of rice. Subjects Thai elderlies.**

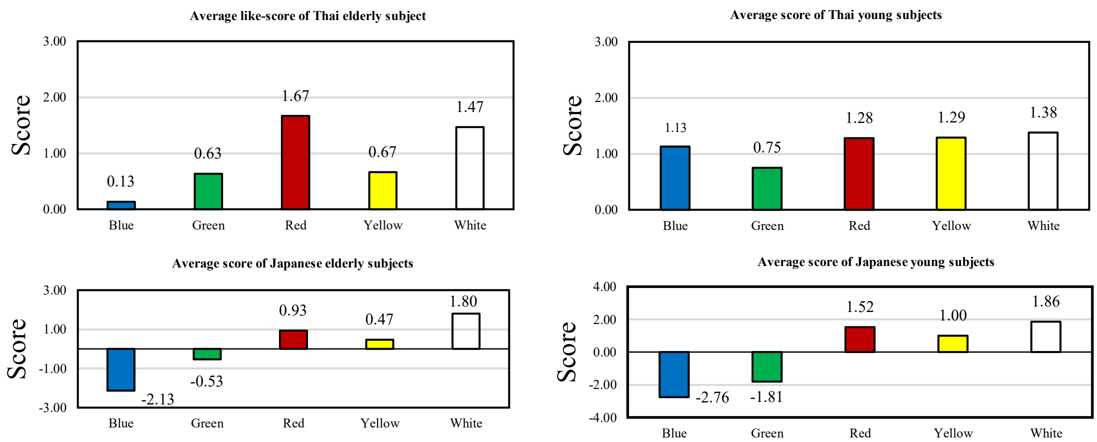



**Figure 5. The averaged score of subjects. The left top shows Thai elderly subjects score, the right top shows Thai young subjects score, the left bottom shows Japanese elderly subjects score, and right bottom shows Japanese young subjects score.**

If we compare Thai elderly subjects with Japanese elderly subjects in Figure 5, both Thai and Japanese elderly prefer white rice and red rice. Thai elderly subjects prefer red rice the most, secondly white rice, while the Japanese elderly subjects like white rice the most and the second red rice but they dislike blue rice and green rice. When we compare the results of Thai elderly subjects and Thai young subjects Thai young subjects like all the colors but the Thai elderly subjects like red and white, but so so for blue, green, and yellow rice. The comparison between Thai young subjects and Japanese young subjects shows clearly difference in blue rice and green rice, Thai young subjects like all the colors but Japanese young subjects dislike blue and green rice, they prefer white rice. Japanese subjects, both young and elderly subjects prefer white rice the most, like red rice, and they feel "so so" for yellow rice. But all Japanese subjects dislike blue and green.

When we look at the overall result we can conclude that the four groups of subjects prefer white rice and red rice, but do not like blue rice nore green rice. We also interviewed some subjects for voting reason and they pointed out that they prefered the white rice because it is a normal color that they always found in daily life, and the red rice looks like red bean in Japan and looks like Thai food named "Khao khluk kapi, Rice Mixed with Shrimp paste". It influenced subjects to feel want to taste. Whereas, the blue rice and green rice remind them the fungus and chemicals that may be toxic. To ensure the results of the experiment, we should repeat the experiment by controlling the color of the blue and green rice not to have too much saturation.

## ACKNOWLEDGEMENT

Pantakan Sukontee thanks RMUTT for providing him with scholarships Co - operative education Rajamangala University of Technology Thanyaburi that made Pantakan to do internship abroad. He also thanks students of Professors Iyota and Sakai laboratories to be a good friends to Pantakan and for serving as subjects for this experiment.

## REFERENCES

1. Vapattanawong, P. (2019). *Station of the Thai elderly 2017: Foundation of Thai Gerontology Research and Development Institute.*,from http://thaitgri.org/?wpdmpro=situation-of-the-thai-elderly-2017
2. United Nations. (2015). World Population Ageing 2015. Retrieved September 26, 2019, from https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf.

# Color appearance of objects in the environment lit with LED lamps

Phubet Chitapanya[1]*, Chanprapha Phuangsuwan [2] and Mitsuo Ikeda[2]

[1]*Graduate School, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2]*Color Research Center, Rajamangala Uiversity of Technology Thanyaburi, Thailand.*

*Corresponding author: Phubet Chitapanya, phubet_c@mail.rmutt.ac.th

**Keywords**: Color appearance, color constancy, LED, color chip, elementary color naming, RVSI

## ABSTRACT

LED (Light-Emitting Diode) is a narrow band of wavelengths lamp becoming to be all around us which is able to produce various colored illumination with less electric consumption. The one problem of LED is a poor property of CRI (Color rendering index) and it might affect the ability to see color of objects safely. To know color appearance of objects, 26 color chips which size is 6 × 6 inch covered 8 hues and Test color sample (R1-R15) were printed. The chips were placed one by one as a test stimulus on a table under experimental room which only illuminated by LED controlling lamp connected to a computer outside the room. The size of the room was 210 cm long, 110 cm wide, and 200 cm, and was decorated with various to simulate a normal room. There were thirteen illuminations which covered also 6 hues on u'v' color space and two saturation steps. The room illumination was fixed to be about 100 lx under all illuminations. 30 subjects including experience subjects and naïve subject were participated in this experiment by judging color of the chips by the elementary color naming method. There was 2-minute adaptation before doing experiment. The result showed the relative area was decreased under green illumination more than the other when increasing saturation.

## INTRODUCTION

The ability to stably see color under various colored illumination called color constancy had been investigating all the time. Many researchers used an experiment methodology working with 2-dimensional test patch on a monitor. Chanprapa and Ikeda's experiment[1)] showed that when a subject could perceive a test patch as a three-dimensional, he or she could get higher color constancy perception. It's not only the dimensional space affecting to color perception. The difference of spectral power distribution of LEDs can influence the effect from the other light type. There has been some research where color appearance of objects was investigated under LED light but not under vivid colored light. Ruiqing's experiment[2,3)] showed the result of color constancy index was low on some color categories under blue and yellow illuminations. In this study, we try to determine the limit of color constancy under various illuminations by elementary naming method working on a real object represented by color stimulus in a realistic room in which subject has to judge each of color chip with their absolute judgement. By doing experiment by the method, area of color perception under each colored illumination could be compare to under white light as a ratio.

## EXPERIMENT

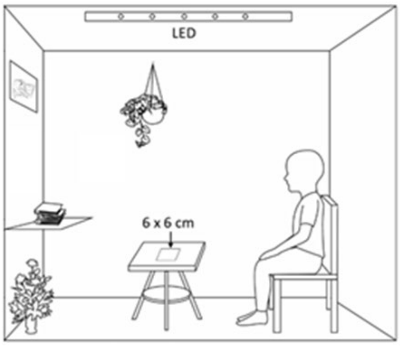



**Figure 1. Experimental booth.**

### Apparatus

This experiment was done inside a booth which illuminated by LED light of RGB type (Philips color kinetics). the room is decorated by books, flowers, fruit model, and picture, giving a daily life situation to a subject as shown in figure 1. The size of the booth is 135 cm long, 82cm wide, and 172cm high. A stool of the height 52 cm was placed in front of a subject and a test stimulus object which size is 6 cm × 6 cm was placed at the center of a gray paper on the stool.

### Illuminations

In the figure 2. shows spectral power distributions of the red, green, and blue lights of the LEDs, as measured by Konica Minolta CL-500A Illuminance Spectrophotometer. By mixing the three of each colored light, thirteen illuminations were prepared as shown in figure 3. The square symbol indicated neutral illumination following D65 chromaticity ordinates defined by CIE. Twelve hues, (R)red, (Y)yellow, (G)green, (C)cyan, (B)blue, and (M)magenta were investigated in this experiment. Red, green, and blue hue were the maximum intensity of red LED, green LED, and blue LED respectively. The other hues were designed by half distance of u'v' chromaticity diagram between each pair of colored LEDs. The twelves hues were connected by the red line indicating the gamut of our LEDs such as R2, Y2, …G2. In each hue, different saturation was also prepared by the half distance of u'v' diagram between neutral ordinates and their points on the red line. The less saturations were connected by the blue line such as R1, Y1, …G1. All of illuminations was fixed at 100lx on the table which test stimulus placed over there.

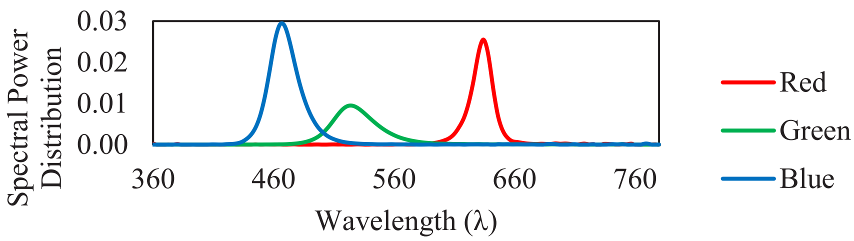



**Figure 2. Spectral power distribution of red, green, and blue LED light.**

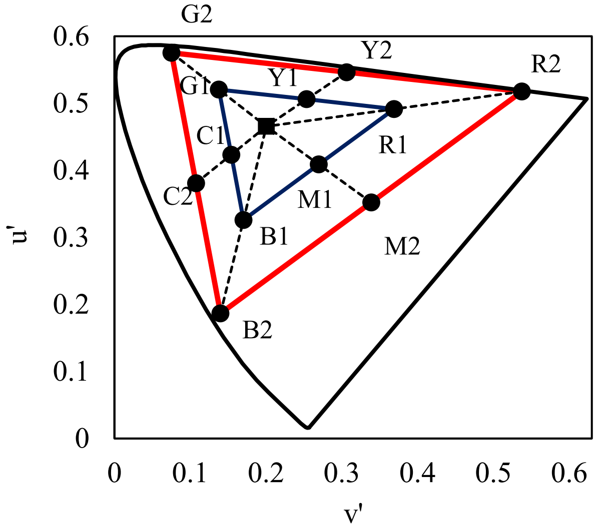



**Figure 3. Illumination conditions.**

**Stimuli**

Following CIE test color sample, fifteen color chips as TCS01-TCS15 were reproduced (ΔE≈4) by Konica Minolta Accurio press C83HC digital printer which is designed for nearly stimulated color as a monitor as shown by open square in figure 4. The solid circle indicates eight color chips which is covered 8 hues around achromatic point representing as saturation color chips. The difference angle of each hue was 45°. Three achromatic color chip, black, gray, and white were shown in figure 4 as solid square symbols. Totally, twenty-six color stimuli were used in this experiment.

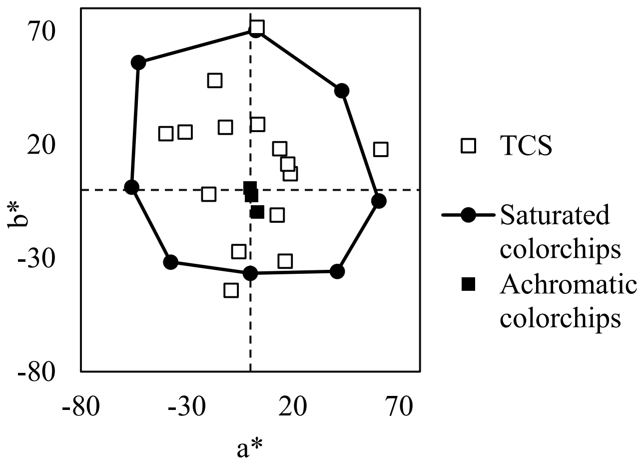



**Figure 4. Color stimuli.**

## PROCEDURE

Thirty subjects were participated in this experiment. All of them have normal color vision tested by Farnsworth–Munsell 100 Hue Test. Twenty-five subjects were naïve. They were university students taking color vision class and they all got a score credit for doing this experiment. Five subjects were experience subjects who had a chance to do similar procedure.

In the beginning of each colored illumination, a subject had to adapt to the light for 2 minutes then each color stimuli would be placed on a table one by one. A subject had to judge color chip by using elementary color naming method. A subject had to judge an element as 100% composed of chromaticness, whiteness, and blackness. If a subject named at least percentages of chromaticness, he or she had to judge which color that he or she saw as another 100% hue element composed of red, green, blue, and yellow in which could mix to produce this color chip. As elementary color naming relating to opponent color theory, a subject couldn't judge red and green, or blue and yellow mixing together.

## RESULT

The result can be transferred color naming result in each color judgement to polar diagram as shown in figure 5. In each circle plot represents the result from subject PC's perception. The colored on each plot shows the physical chromaticity of each stimulus under D65 illumination measured by Konica Minolta FD-7. The result is connected by the black line indicating the area of color perception.

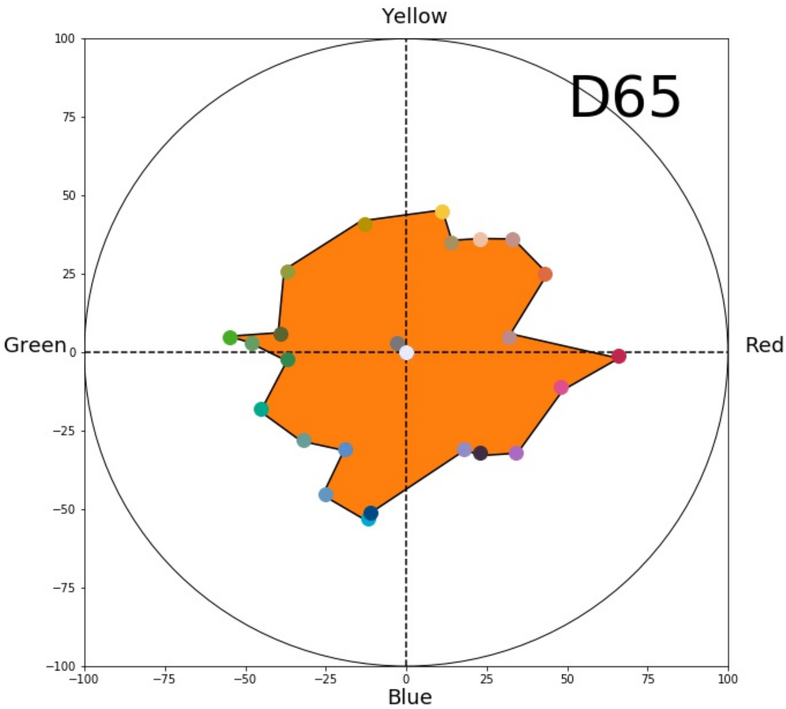



**Figure 5. Example of average result of all subject under D65 illumination. The orange area shows the area perception. Each color of each plot was the chromaticity of each color under D65 light.**

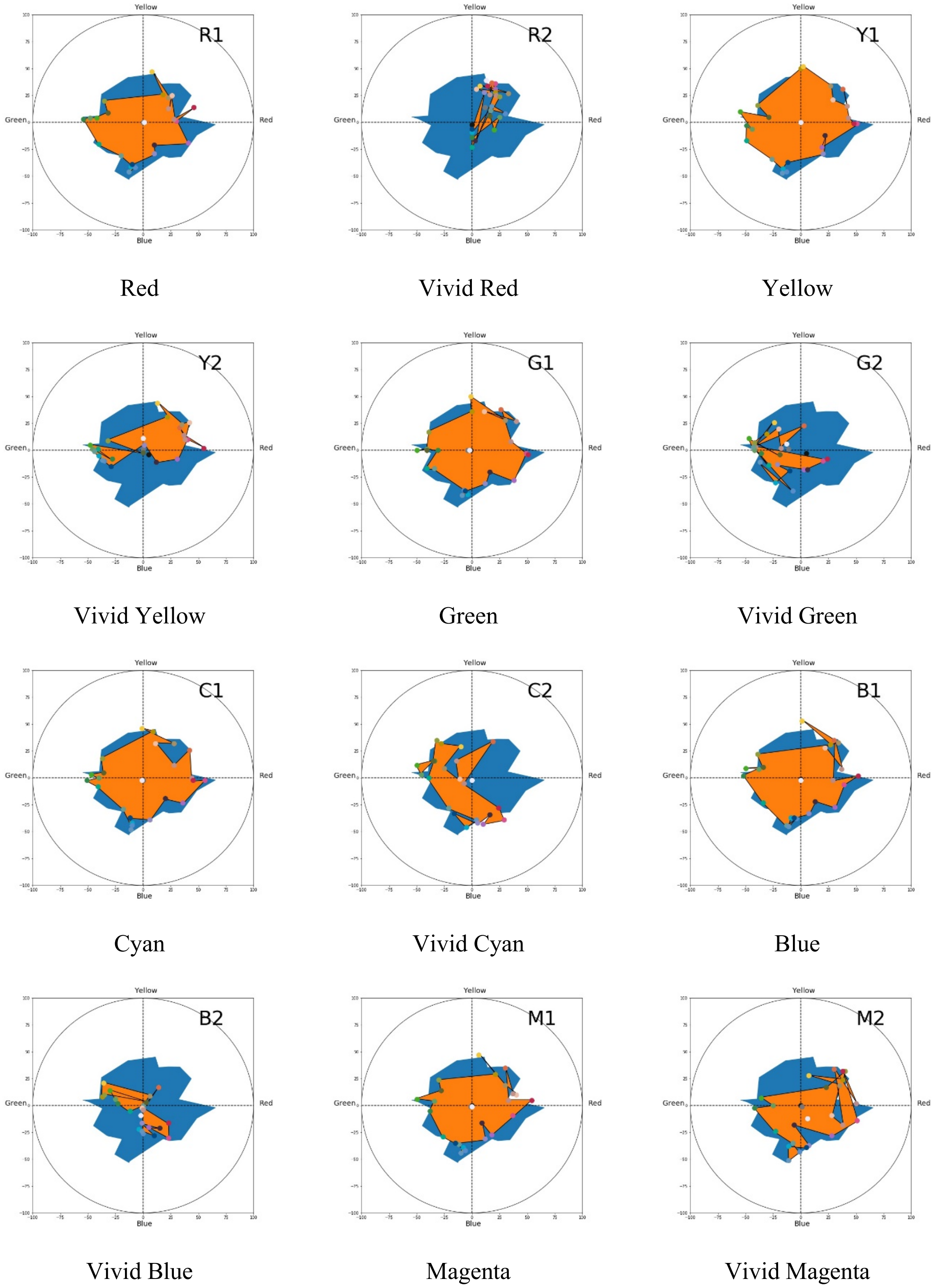



**Figure 6. Average result of all subjects. The orange area indicates the result under each test illumination, while the blue area is the area under D65.**

Figure 6 shows the average result of all subject in each colored illumination from R1, R2, …, M2. The orange surfaces are the area of color perception based on how it shifts from color perception under D65. Blue surfaces are the color perception area under white illumination.

An area inside the orange shape can be calculated by Eq. (1). Then, take area ratio under test illumination by area under D65 to investigate how much area quantitative is changed compared to the normal light. The result of area comparison is showed in figure 7. Perfect color constancy is perfect when area ratio equals to 1. To compare result under various illumination, a slope (m) of any colored direction was measured by fixed curve shown that under green illumination, area ratio was decreased as m = -5.2, then yellow, cyan, blue, red, and magenta as m = -5.0, -4.7, -2.9, -2.9, and 2.8 respectively.

$$Area = \left| \frac{(x1y2 - y1x2) + (x2y3 - y2x3) \ldots\ldots + (xny1 - ynx1)}{2} \right| \quad (1)$$

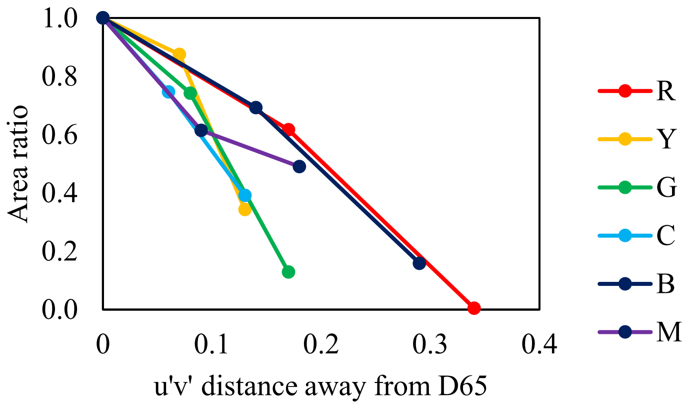



**Figure 7. Area ratio comparison**

## ACKNOWLEDGEMENT

I'd like to thank Thai research and researchers for industries (RRI), and Konica Minolta's printing solution co., ltd. for supporting.

## REFERENCES


1. Phuangsuwan, C., Ikeda, M., & Katemake, P. (2013). Color constancy demonstrated in a photographic picture by means of a D-up viewer. Optical Review, 20(1), 74–81. doi: 10.1007/s10043-013-0012-7
2. Ma, R., Liao, N., Yan, P., & Shinomori, K. (2018). Categorical color constancy under RGB-LED light sources. *Color Research & Application*, *43*(5), 655–674. doi: 10.1002/col.22241
3. Ma, R., Liao, N., Yan, P., & Shinomori, K. (2019). Influences of lighting time course and background on categorical colour constancy with RGB-LED light sources. *Color Research & Application*, *44*(5), 694–708. doi: 10.1002/col.22392

# SKIN COLOR OF THAI PEOPLE

Nutticha Pattarasoponkun[1], Chanprapha Phuangsuwan[2] and Mitsuo Ikeda[2]

[1]*Graduate School, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2]*Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand.*

*Corresponding author: Nutticha Pattarasoponkun, nootoon2538@gmail.com

**Keywords**: Thai skin color, young Thai people, skin tone, skin color scale

## ABSTRACT

To do a proper cosmetic treatment for faces statistics of skin color is important. Color of cheek, forehead, chin, and inner arm were measured for 107 Thai subjects and compared with Garnier skin color scale which is popular among Thai young girls. It was found that Thai skin color is mostly characterized by L* value. Thai skin color is not properly expressed by Garnier skin color scale to imply a need of development of skin color scale proper to Thai people.

## INTRODUCTION

Garnier skin color scale is very popular among young girls in Thailand. It is used to judge face skin color so that cosmetics is properly chosen to make the face more charming. Atitaya Sangngiew et al.1) measured skin color of young Thai people and compared the results with the Garnier skin color scale. It was found that the Garnier skin color scale did not express the skin color of young Thai people properly and it was pointed out that it is important to collect more data of Thai skin color to see if the Garnier skin color scale cannot be applied to Thai people. If not, a new skin color scale may be developed to suit Thai girls. The measurement by Sangngiew, however, was limited only to teenagers of Thai university and it is necessary to obtain skin color of larger number of Thai people and of wide range of age. In the present paper the measurement was carried out for Thai people of the age covering 18 to 82 years old and for farmers who get strong tan.

## EXPERIMENT

Color of left and right cheeks, forehead, chin and inner arm of subjects were measured with Konica Minolta CR-20, a colorimeter of contact type. At the same time the experimenter judged the subject's face to categorize them into three tones, white skin tone, tan skin tone and dark skin tone by the visual inspection following Garnier's classification. 107 subjects participated in the measurement as summarized in Table 1. Subjects of the age 19 to 30 years old were all students or staffs of Rajamangala University of Technology Thanyaburi and the students were given credit of workshop by becoming the subjects. Fifteen subjects of over 31 years old were people living in Saraburi, a northern city near Ayuttaya of Thailand.

**Table 1: Subject distribution**

| Rank of age | Males | Females |
|---|---|---|
| 19-30 years old | 48 | 44 |
| 31-40 years old | 2 | 2 |
| 41-50 years old | - | 1 |
| 51-60 years old | 1 | 2 |
| 61-70 years old | 2 | 4 |
| 71-87 years old | - | 1 |

Two examples of Garnier skin color are shown in Fig.1. They were purchased at different time and specified old (a) and new (b). They are different in size. The scale has 16 colors and their L*, a*, and b* were measured with Konica Minolta spectrodensitometer FD-7.

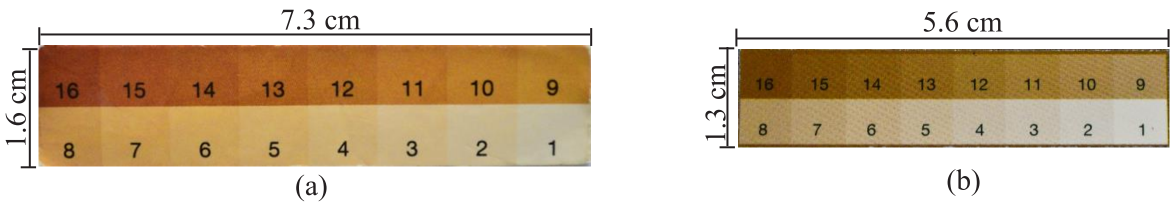



**Figure 1 Pictures of Garnier skin color scales available in Thailand, a, old, b, new.**

## RESULTS

Color of two Garnier skin color scales were measured and their values are given in Table 2 and plotted on L*-a* graph in Fig. 2, by xes for the old one and crosses for the new one. Color patches for white, tan, and dark are indicated for both scales. The two scales are quite different and a proper and accurate reproduction of color is desired.

**Table 2: Color specification of old and new Garnier skin color scales.**

| Data Name | L* | a* | b* |
|---|---|---|---|
| Garnier 1 | 83.92 | 2.47 | 16.03 |
| Garnier 2 | 82.02 | 3.9 | 20.54 |
| Garnier 3 | 80.85 | 5.36 | 24.41 |
| Garnier 4 | 77.33 | 6.57 | 28.2 |
| Garnier 5 | 75.73 | 7.51 | 31.91 |
| Garnier 6 | 72.75 | 9.49 | 34.96 |
| Garnier 7 | 70.62 | 11.15 | 37.1 |
| Garnier 8 | 65.92 | 12.37 | 36.34 |
| Garnier 9 | 62.99 | 12.36 | 41.6 |
| Garnier 10 | 59.03 | 13.78 | 41.08 |
| Garnier 11 | 55.04 | 16.25 | 42.42 |
| Garnier 12 | 53.55 | 15.35 | 35.04 |
| Garnier 13 | 48.81 | 17.94 | 37.37 |
| Garnier 14 | 45.21 | 19.74 | 36.38 |
| Garnier 15 | 43.07 | 22.02 | 33.84 |
| Garnier 16 | 40.33 | 23.46 | 31.17 |

(a) : Old scale

| Data Name | L* | a* | b* |
|---|---|---|---|
| Garnier 1 | 88.74 | 0.08 | 8.14 |
| Garnier 2 | 86.69 | 1.6 | 9.91 |
| Garnier 3 | 82.87 | 2.11 | 12.66 |
| Garnier 4 | 77.80 | 2.80 | 14.05 |
| Garnier 5 | 78.90 | 4.35 | 19.39 |
| Garnier 6 | 74.59 | 5.15 | 22.14 |
| Garnier 7 | 71.16 | 5.68 | 23.55 |
| Garnier 8 | 64.27 | 5.86 | 24.55 |
| Garnier 9 | 67.05 | 6.77 | 26.71 |
| Garnier 10 | 64.00 | 7.89 | 29.04 |
| Garnier 11 | 62.05 | 8.38 | 32.11 |
| Garnier 12 | 59.16 | 8.32 | 32.86 |
| Garnier 13 | 55 | 9.65 | 33.62 |
| Garnier 14 | 52.00 | 8.67 | 34.81 |
| Garnier 15 | 48.86 | 8.73 | 34.63 |
| Garnier 16 | 45.95 | 9.72 | 34.88 |

(b) : New scale

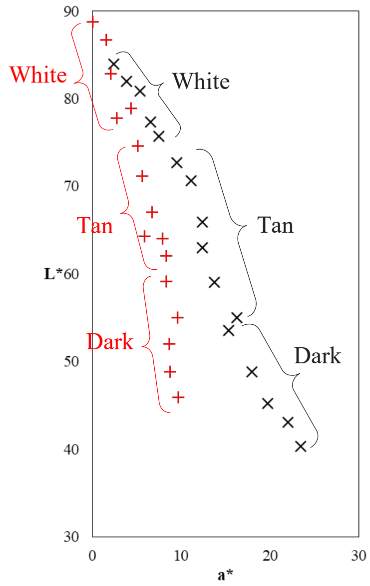



**Figure 2 Plot of old and new Garnier skin color scale with regions of white, tan, and dark tone. Xes, old, +. New.**

Skin colors of left and right cheeks were measured and were averaged. The results of cheek, chin, forehead, and inner arm are plotted on a*-b*, L*-a*, and L*-b*, graphs for all 107 subjects in Fig. 3, 4, and 5. The old Garnier skin color scale is shown by xes. Open circles are the colors of subjects judged "white" by the experimenter, gray circles are for "tan" and filled circles for "dark". Difference of skin color appears mostly in L* as a wide distribution in direction of L*. The graph of cheek in Fig. 4 is reproduced as Fig. 6. Data of Saraburi people are shown by open triangles and they overlap with data taken at RMUTT, which implies that this widely spread aggregation along L* direction fairly well represents Thai skin color. It is quite clear that old Garnier skin color scale does not represent Thai skin color as it locates far from Thai skin color aggregation. The upper people in the aggregation have white face tone, the bottom dark tone, and the middle people the tan tone. The new Garnier color scale shown by crosses passes Thai skin color but the tone ranges does not agree with tons of Thai skin.

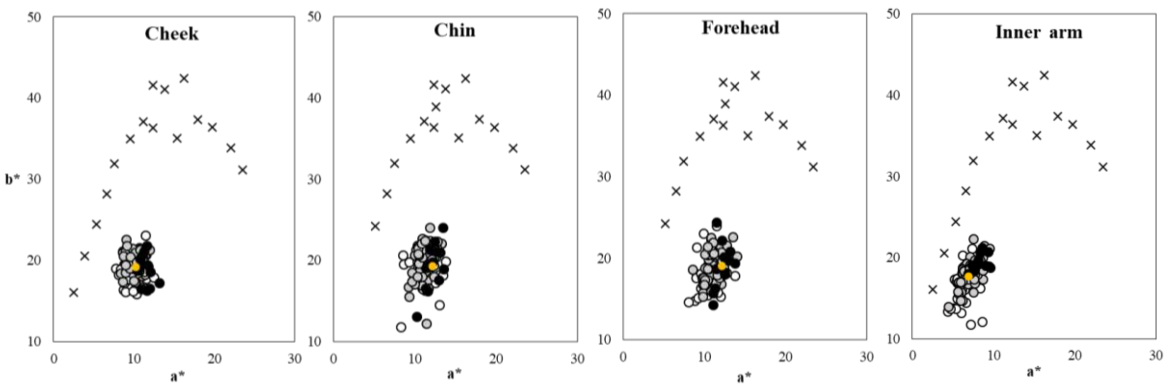



**Figure 3 Skin colors of cheek, chin, forehead, and inner arm plotted on a*-b* graphs.**

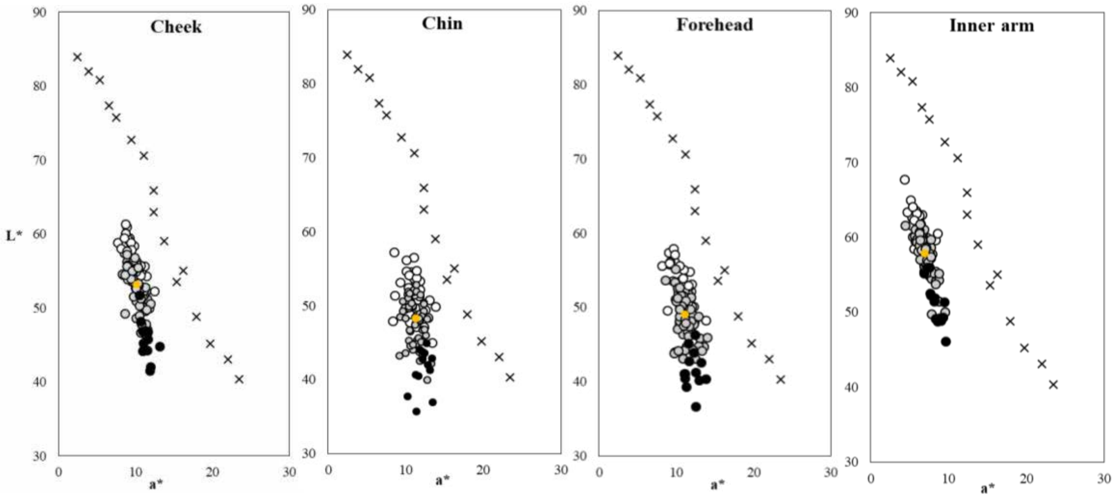



**Figure 4 Skin colors of cheek, chin, forehead, and inner arm plotted on L*-a* graphs.**

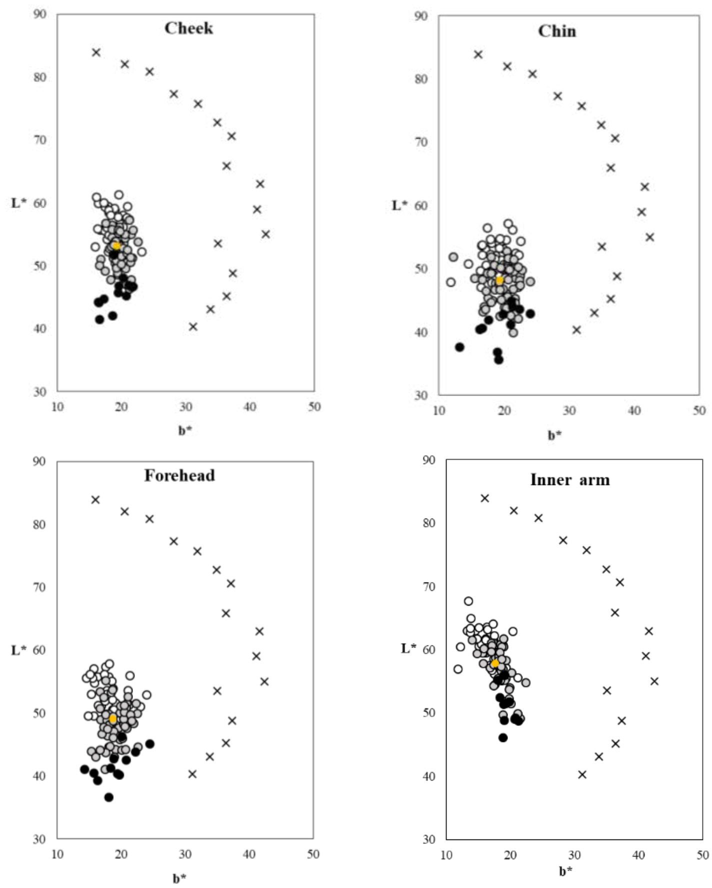



**Figure 5 Skin colors of cheek, chin, forehead, and inner arm plotted on L*-b* graphs.**

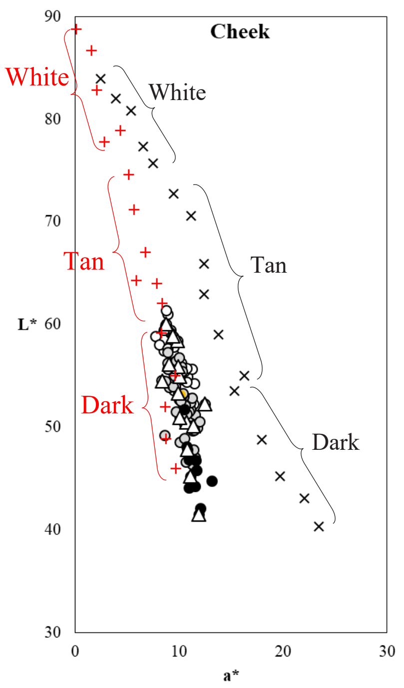



**Figure 6 Skin colors of cheek plotted on L*-a* graph. Open circles, white tone skin; gray circles, tan; filled circles, dark tone skin; open triangles, Saraburi people.**

In Fig. 7 colors of cheek and inner arm are plotted for Saraburi people. L* of cheek is lower than that of inner arm to imply their cheeks got tanned for many years of living. There was one female farmer of the age 66. Her cheek and inner arm colors are shown by a filled triangle and an open triangle, respectively. Her cheek is very dark, the lowest among people measured but inner arm is same as other people.

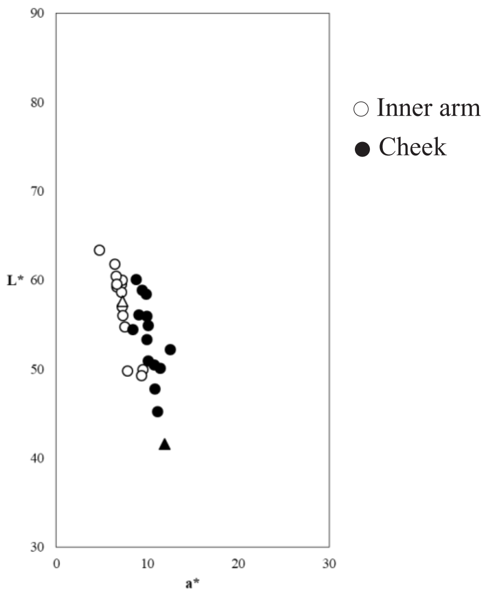



**Figure 7 Comparison between cheek and inner arm for Saraburi people. A filled tringle shows cheek color of a female farmer and a open triangle inner arm of the same person.**

## CONCLUSION AND DISCUSSION

Thai skin colors were mostly characterized by L* which distributed from 40 to 60. On the other hand they did not differ among people in a* and b*. A female farmer showed the lowest L* value among all the 107 subjects measured. Her face was tanned because of many years of field work. This suggests importance of collecting data from different professions.

Garnier skin color scale did not represent Thai skin color. It is important to develop a scale to match with Thai skin color, which is our future work.

## ACKNOWLEDGMENT

We acknowledge Centasia Co., a Bangkok distributer of Konica Minolta Sensing Co. for providing us Konica Minolta CR-20 for many months. Without the instrument the present experiment must have become difficult.

## REFERENCES

1.Atitaya Sangngiew, Chanprapha Phuangwsuwan, Mitsuo Ikeda. Skin color of Thai people. Proc. *Conference of the Color Science Association of Japan*, 2019.

# COLOR OF LIPSTICK TO MAKE THAI GIRLS HEALTHIER

Kanokwan Somdang[1*], Chanprapha Phuangsuwan[1], Natsuki Tsuji[2], Mikiko Kawasumi[2] and Mitsuo Ikeda[1]

[1] *Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2] *Faculty Science and Technology, Meijo University, Japan.*
*Corresponding author: Kanokwan Somdang, 1159108020788@mail.ac.th, Sooskaaksah@gmail.com

**Keywords**: Lipstick color, Healthier, Thai, Japanese

## ABSTRACT

Color of lipstick changes impression of a girl to a great extent and it is useful to investigate what color gives a certain impression. In this present work we classified skin color of Thai young girls to three groups, white, tan, and dark, and their skin color were measured by Konica Minolta CM-512m3A. For Japanese girls, the color data skin was taken from Yoshikawa (2005) and they classified color skin by two groups as reddish and yellowish tones. Six colors of lipstick were selected by matching with Munsell color book which was showed by Munsell hues as 10RP, 5R and 10R and kept Value at 5 and Chroma at 8 and 14. Facial stimuli of six colors skin tone were created by a Photoshop. The colors of lipstick were stained by the same software. The six facial images were presented on a display EIZO LCD type by one type of skin color tone (with 6 colors of lipstick) and subjects assessed of impression with four categories "healthy" , "Unhealthy", "Bright", "Dark" and another impression, "like" and "dislike" to find out the individual favorite color of lipstick. The lipstick colors showed "healthy" impression at 10RP 5/14 for white and dark skin tones, 10R 5/8 for tan. The selected color lipsticks for "unhealthy" impression were showed 10R 5/14 for white and dark. For tan skin tone showed 5R 5/14 for unhealthy impression. The color lipsticks were selected for "bright" impression 10R 5/14 for white and tan, 10RP 5/8 for dark skin tone. The impression of "dark showed at the color lipsticks 5R 5/8 for white and 10R 5/8 for tan and dark skin tones. But for the popular like impression showed the color of lipstick at 5R 5/14, 10RP 5/14 and 10R 5/8 respectively, without considering to the skin color tone.

## INTRODUCTION

Many researches have studied about the color appearance of the face skin in term of clothing colors [1], effect of facial redness [2] and so on. We can easily detect the healthiness and attractiveness by looking at the face. It has various factor to make a criterion of healthiness and attractiveness such as skin color tone, color of lip, color of hair, color of clothes and the style of making up. Lip is becoming the importance role for every gender, without adding color to lip it causes less confident to go outside or to meet other people. Our hypothesis was to use the right color of lip it can give a good looking such as healthiness and attractiveness. We employed the graphic of woman facial images and simulated 3 types of skin tone for Thai peoples and 2 types skin tone for Japanese people. We employed six colors of lipstick to simulate facial images lip. The experiment was carried out on a display. We asked the observers with the adjectives "healthy, unhealthy, bright and dark".

## EXPERIMENT

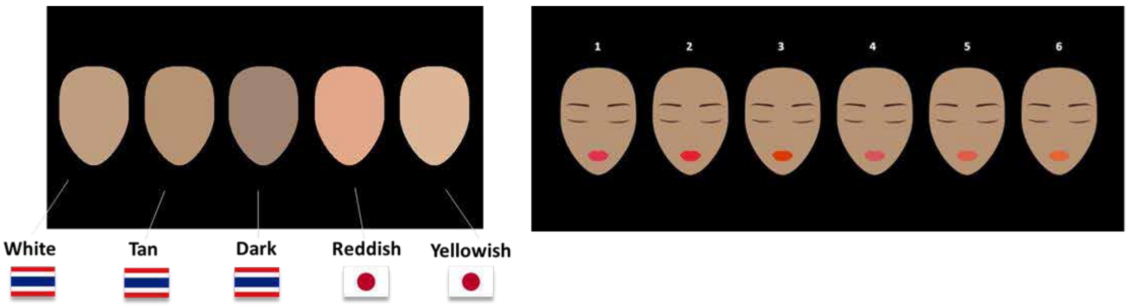
### Stimuli

The color of the facial image stimuli was set to the average skin color of Thai and Japanese females (the average of Thai color skin measured from 39 females by Spectrophotometer Konica Minolta CM-512m3A and for the average Japanese color skin we took values from Yoshikawa [3]).

Categories of Thai color skin tone were white, tan and dark and Japanese skin colors tone were yellowish and reddish. The physical color measurement data are shown in Table 1. We were control the color of facial images based on the color Yxy value which was measured from the cheeks of participants. Figure 1 (a) showed the stimuli represented to 5 skin tones.

**Table 1: Yxy chromaticity valuces of skin color and of facial images on display.**

| Coutries | Skin color tone | Real face | | | Monitor | | |
|---|---|---|---|---|---|---|---|
| | | Y | x | y | Y | x | y |
| Thailand | White | 25.606 | 0.369 | 0.362 | 25.992 | 0.366 | 0.363 |
| | Tan | 22.835 | 0.378 | 0.366 | 22.723 | 0.376 | 0.366 |
| | Dark | 20.803 | 0.385 | 0371 | 18.700 | 0.385 | 0.371 |
| Japan | Reddish white | 32.080 | 0.388 | 0.361 | 31.877 | 0.388 | 0.360 |
| | Yellowish white | 39.730 | 0.370 | 0.363 | 39.870 | 0.370 | 0.365 |




(a) (b)

**Figure 1. (a), Skin color tone on facial images. (b), Facial images with the 6 selected color lipsticks.**

Six popular colors of lipstick were employed to investigate the healthy and brigthness impression. Those colors of lipstick were matched with the Munsell color system shown in Fig. 2. They were three hueds; 10RP, 5R and 10R of which value was fixed at 5 and Chroma at 8, th represented dull color and those with Chroma 14 and Value 5 vivid color. We adopted six colors of lipstick to lip on the facial images stimuli (five colors tone) as shown in Fig. 1 (b). Total stimuli were 30 facial images (6 colors of sipstick x 5 skin colors tone). Fig. 1 (b) shows 6 facial images with different colors of lipstick for a color skin tone.

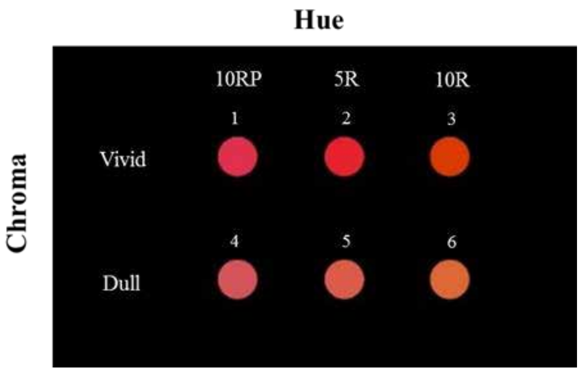



**Figure 2. Six popular colors of lipstick expressed by Munsell color system.**

**Procedure**

The facial images stimuli were shown on the display with the randomly skin color tone. The questionnaire was prepared by the Google form so that subjects can be select the color of lipstick which gave the impression of "healthy", unhealthy", "bright" and "dark". And the last question was "What is your favorite color of lipstick among 6 colors?". Subject selected under the experimental booth which was a dark room. No repetition in this experiment.

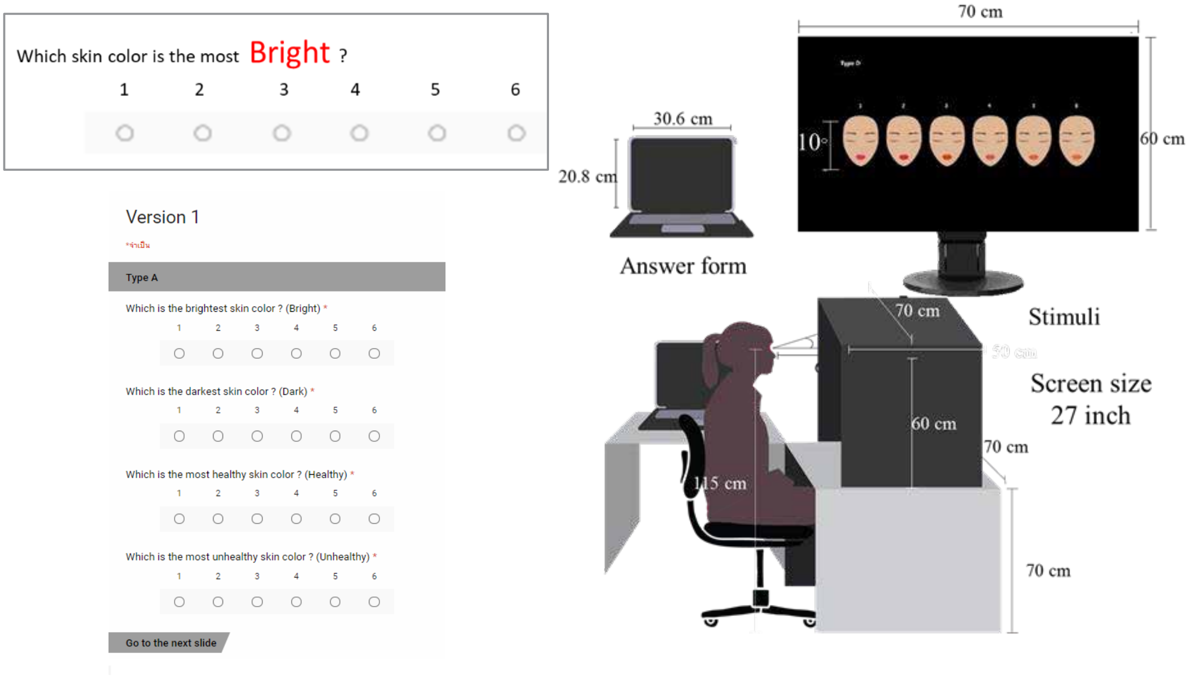



**Figure 3. Data sheet, experimental booth and stimuli on the display.**

**Subjects**

Thirty three Japanese and thirty eight Thai served as subjects. Their age ranged from 19 to 50 years old for Japanese and 18 to 44 years old for Thai. They were checked for normal color vision by Ishihara test.

## RESULTS

Fig. 4 showed the results of color lipsticks that gave the impression as healthy, unhealthy, bright and dark for white, tan and dark skin tones of Thai and for reddish and yellowish for Japanese. The abscissa showed three hues of lipsticks and ordinate showed Chroma values at 8 for dull and at 14 for vivid color. The results of selected color of lipstick in four categories; healthy, unhealthy, bright and dark of Thai subjects' impression were showed in the Fig. 4. The lipstick colors showed the "healthy" impression for 10RP 5/8 for white and dark skin tone, 10R 5/14 for tan skin tone respectively. The selected color of lipsticks for "unhealthy" impression were 10R 5/8 for white and dark. For tan skin tone it was 5R 5/8 for unhealthy impression. The color lipsticks for "bright" impression was 10RP 5/8 for white and tan, 10RP 5/14 for dark skin. The impression of "dark" was color lipsticks 5R 5/14 for white, 10R 5/14 for dark skin and for tan skin, the impression of "dark" was two color of lipstick as 5R 5/14 and 10R 5/14.

The selected color of lipsticks from Japanese subjects agreed with Thai results. Reddish skin color showed 10R 5/14 but for yellowish skin showed 10RP 5/8 for the "healthy" impression. "Unhealthy" impression was given by 5R 5/8 for reddish and 10R 5/8 for yellowish skin. "Bright" showed 10RP 5/8 both reddish and yellowish skin. "Dark" impression was 5R 5/8 for reddish and 10R 5/14 for yellowish skin.

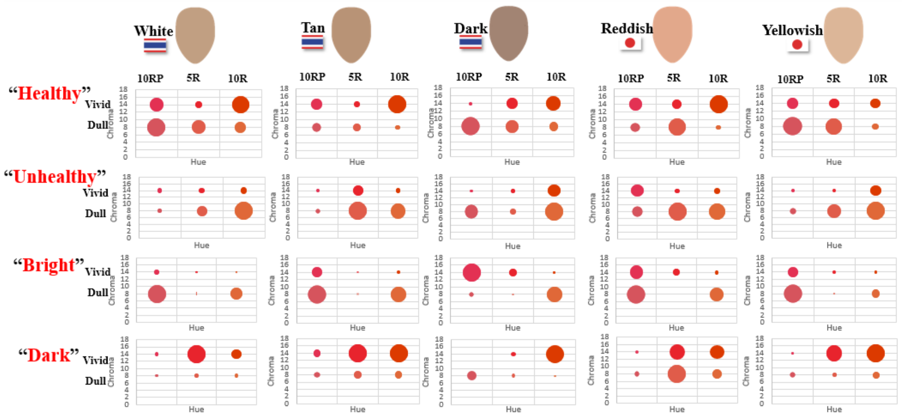
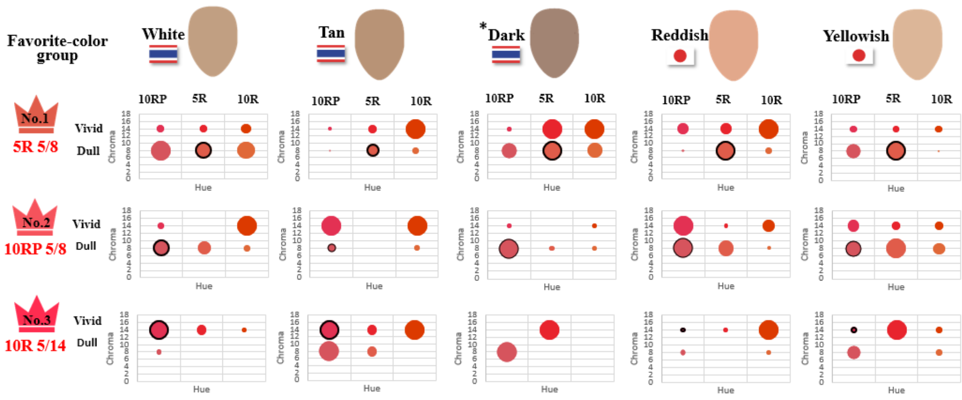



**Figure 4. Results of color lipstick for healthy, unhealthy, bright and dark.**

## CONCLUSION

The color of lipsticks affected to the impression of the face. The individual preference of color lipsticks did not relate to the impression, which was found in the last question "what is favorite your color lipstick?" The most favorite color of lipstick was 5R 5/8, 10RP 5/8 and 10RP 5/14 respectively as shown in Fig. 5. In this experiment we could not find out the systematic preference of lipstick color with different color skin tones. We need a further experiment to investigate on this topic.




*The result of dark skin type just only Thai subject

**Figure 5. Three ranking of favorite color of lipstick compared with the healthy impression results, the bubble with black line indicate favorite color of lipstick.**

## ACKNOWLEDGEMENT

Kanokwan somdang thanks RMUTT for providing her with the Student development foundation of RMUTT scholarship for her transportation to do an internship at Meijo University for 3 months. Also thanks students at Associate Professor Kawasumi's laboratory at Meijo University who helped her experiment and for serving subjects.

## REFERENCES

1. Nakajima, Y., He, S., & Fuchida, T. (2018). Effects of adjacent chromatic clothing colours on facial skin colour appearance. *AILISBOA 2018 colour & human comfort*.
2. Re, D. E., Whitehead, R. D., Xiao, D., & Perrett, D. I. (2011). Oxygenated-Blood Colour Change Thresholds for Perceived Facial Redness, Health, and Attractiveness. *PLoS ONE*, 6(3). doi: 10.1371/journal.pone.0017859
3. Yoshikawa, H. (2005). Colorimetric Approach to the Skin Color. *Journal of the Color Science Association of Japan*, 29(2).

# THAI BASIC COLOR TERMS AND NEW CANDIDATE NOMINATION

Nischanade Panitanang[1]* Chanprapha Phuangsuwan[2], Ichiro Kuriki[3], Rumi Tokunaga[4], and Mitsuo Ikeda[2].

[1]*Graduated School, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*

[2] *Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand.*

[3] *Research Institute of Electrical Communication, Tohoku University, Japan*

[4] *College of Liberal Arts and Sciences, Chiba University, Japan.*

*Corresponding author: Nischanade Panitanang, nischanade_p@mail.rmutt.ac.th

**Keywords**: Thai color names, Color categories, World color survey, Elementary color naming, Basic color term.

## ABSTRACT

Due to a variety color names used in the world which is different depending on the speaker's habitat and it raises questions about the universality cross-linguistic of the color name. We conducted a survey of Thai color names from 161 Thai native speakers. 330 Munsell color chips taken from the Munsell Book of Color Glossy Edition, 320 chromatic chips, Munsell Value ranging 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, and 10 achromatic chips of Value from 1.5 to 9.5. Subjects were asked to name the color chips using monolexemic color term. The results showed mean number of color terms used per subject was 18.94 ± 5.02 (Mode = 19). There were 12 color terms used by more than 80% of subjects including the eleven basic color term as found in Berlin and Kay (1969) plus “Fa” (Sky/light blue), Notice that, “Fa” was used by 100% of subjects, more than some BCTs such as white and black which were used by 98.76% and 93.17% of subjects, respectively. In order to examine the quantity of perception for “Fa” and the neighboring colors, we took the color chips that are located on their border to re-examine by elementary color naming method. The result of experiment 2 showed that Thai subjects perceive “Fa” (Sky/light blue) as distinct from other colors. This might be evident for promoting “Fa” to be a candidate of 12th Thai basic color terms.

## INTRODUCTION

Color terminology varies according to the speakers in different social environments. To define the number of universal color categories, Brent Berlin and Paul Kay (B&K, 1969) [1] 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 which most languages share all or fewer color terms drawn from theses 11BCTs; red, orange, yellow, green, blue, purple, pink, brown, gray, black, and white. Shortly after their work was published, there were largely accepted by psychologists and vision researchers. However, there were also arguments, mainly by anthropologists, regarding the number of language and number of subjects in each language they explored. Therefore, World Color Survey (WCS) was established in 1976 to examine and expand the finding of Berlin and Key. There were recently works as according to the WCS project, Linsey and brown (L&B, 2014) [2] they obtained data from 51 American English subjects who are American English native speakers and found that there are 20 distinct color categories composed of 11 BCTs as fond in B&K, 1969 plus 9 non-basic color terms (non-BCTa). In the modern Japanese color lexicon, Kuriki et al. (2017) found

16 statistically distinct Japanese chromatic categories from 57 native Japanese subjects. They found that “mizu” is a strong candidate as the 12th Japanese basic color term which was used by 98% of subjects. Due to the diversity of Thai cultures, dialects, and environments that vary according to the speaker residence, we employed similar method and stimuli as used in the WCS to investigate Thai basic color terms.

## METHODOLOGY

We conducted two experiments; Experiment 1 and Experiment 2. Experiment 1 using the color categorical method to define number of color categories used by Thai people. Experiment 2 using the elementary color naming method to examine the quantities of the new candidate for Thai basic color term and its neighboring colors in term of the subject's perception.

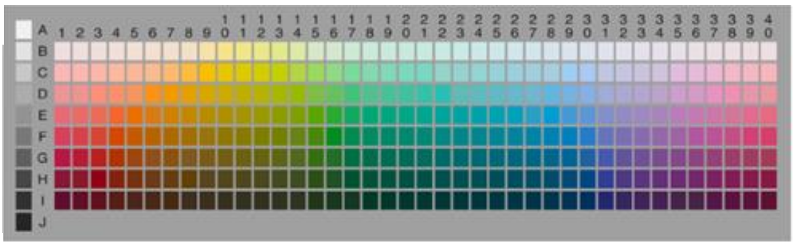
### Subjects

There were 161 Thai native speakers participated in the Experiment 1, subject’s age ranges from 18 to 60 years-old, the average age is 21.93. The Experiment 2 there were 30 Thai native speakers participated, they were random selected from Experiment 1. 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 can attend the experiment.

### Color stimuli

We employed the color chips taken from the Munsell Book of Color Glossy Edition which was kindly supplied to us by Research Institute of Electrical Communication, Tohoku University and College of Liberal Arts and Sciences, Chiba University. There were 330 color chips; 320 chromatic chips, Munsell Value ranging 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, and 10 achromatic chips of Value from 1.5 to 9.5 (Fig. 1). The color chips have the size of 2 cm x 2.1 cm, each chip was mounted on a square cardboard of the size 7 cm by 7 cm covered by gray matte paper of approximately N5. All color chips were re-arranged in mixed order and kept in 6 plastic boxes.

(a)



(b)

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| N8 | C | 6 | 6 | 6 | 6 | 6 | 6 | 8 | 14 | 16 | 14 | 12 | 12 | 12 | 10 | 10 | 8 | 8 | 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 |
| N6 | E | 12 | 12 | 12 | 14 | 16 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 10 | 10 | 10 | 10 |
| N5 | F | 14 | 14 | 14 | 16 | 14 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 12 | 12 | 10 | 10 | 10 |
| N4 | G | 14 | 14 | 14 | 12 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 8 | 8 | 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 |
| N2 | I | 8 | 8 | 8 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 4 | 4 | 4 | 6 | 6 | 6 |
| 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 |
| | | R | | | | YR | | | | Y | | | | GY | | | | G | | | |

| | | 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 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| N8 | C | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 | 6 | 4 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 | 6 |
| N7 | D | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 8 | 8 | 10 | 10 | 8 | 8 |
| N6 | E | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 10 | 12 | 12 |
| N5 | F | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 14 | 14 |
| N4 | G | 8 | 8 | 8 | 8 | 6 | 6 | 8 | 8 | 10 | 10 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| N3 | H | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 8 | 10 | 10 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| N2 | I | 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 |
| | | BG | | | | B | | | | PB | | | | P | | | | RP | | | |

**Figure 1. (a) World color survey color space. (b) Attribute of the Munsell color chips, two lowest horizontal rows indicated 40 hues with a step of 2.5 start from 2.5R on the left graph to 10RP on the right graph. The left most vertical columns show values start form 1.5 on the bottom to 9.5 on the top. Number inside the graph shows Munsell chroma of each chip.**

**Experimental booth and illumination**

Both Experiments were conducted under controlled experiment by using then same experimental booth as shown in Fig 2. The booth has the size of 150 cm (L) x 90 cm (H) x 60 cm (W) illuminated by 6 daylight fluorescent lamps (TOSHIBA FL18W/T8/EX-D) which hung overhead from the ceiling provided illuminance of 2,509 lx measured by using Konica Minolta CL-500A Illuminance Spectrophotometer, the correlated color temperature (CCT) was 5,859 Kelvin, color rendering index (RI) was 97. The color chips were presented on the gray background, luminance was 22 $cd/m^2$, surrounded by white wall, luminance was 81 $cd/m^2$.

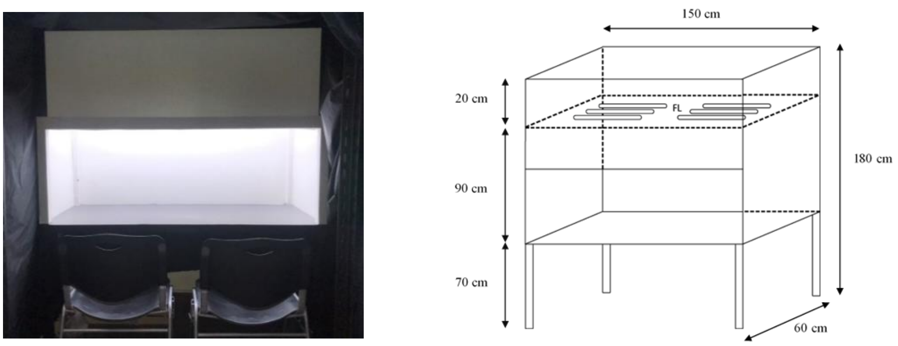



**Figure 2. The experimental booth and its specification.**

**Procedure**

*Experiment 1.* After tested the color vision, a subject was presented the color chip one by one and he/she was asked to provided color name for a color chip by free-naming with some conditions; 1) the color name must be single word, 2) the word must be a general color name, 3) the word must normally use to name the color of any type of object or something in everyday life. In the same time, if he/she provided any non-basic color terms (non-BCTs) then he/she was asked to provide additional information of only the color name in 11 BCTs, forced naming. Subjects conducted the experiment only one session.

*Experiment 2.* We re-examine the color chips located along the boundary of the Thai-BCTs candidate by using elementary color naming method to obtained quantities of subject's perception for the new candidate of Thai basic color term and its neighboring colors. Subjects assessed the amounts of chromaticness, whiteness, and blackness in percentage (a total is 100), and assessed the apparent hue by unique red, yellow, green, and blue in percentage (a total is 100). Subjects can provide only one or two hue which is not an opponent color (can't response red plus green or yellow plus blue). Each subject performed only one session for this experiment.

## RESULTS AND DISCUSSION

Color terms obtained form 161 subjects show a total of 114 color terms. Figure 3 shows mean number of color terms used by 161 Thai native speakers is 18.94 ± 5.04, maximum is 41, minimum is 12 and mode is 19 color terms. Here we can see that all Thai subjects used at least 12 color terms.

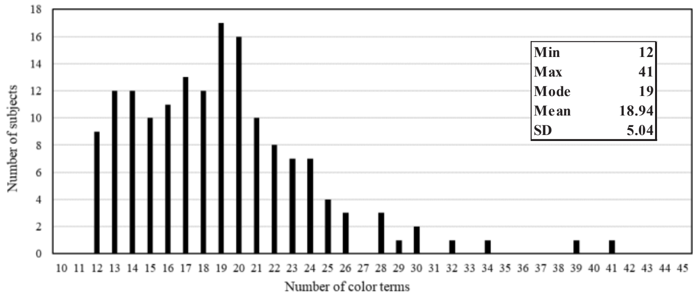



**Figure 3. Number of color terms.**

Figure 4 illustrated top of twenty popular list used by Thai subjects includes 11-BCTs as found in B&K 1969 and 8 non-basic color terms; Fa (Sky/light blue), Khi-ma (Horse feces/dark yellow-green), Lueat-mu (Pig blood/dark red), Ban-yen (Four o'clock flower/Magenta), Khai-kai (Chicken egg/pale brown), Nuea (Skin), Tha-le (Ocean), Old rose, and Cream. It is worth noting that, there is a non-BCTs, Fa (Sky/light blue), used by 100% of subjects (Figure 4a) and it has the 4th highest frequency of use (Figure 4b), representing 9.58%, which is higher than many basic color terms including blue, representing 6.57%. Considering other non-BCTs, it is found that there are 2 colors that are used by more than 50% of the subjects, namely (Horse feces/dark yellow-green) and Lueat-mu (Pig blood/dark red), representing 74.53% and 68.32 respectively. Both of these color names are the names of specific colors that are commonly used among Thai people but might rarely found in other countries.

(a)

(b)

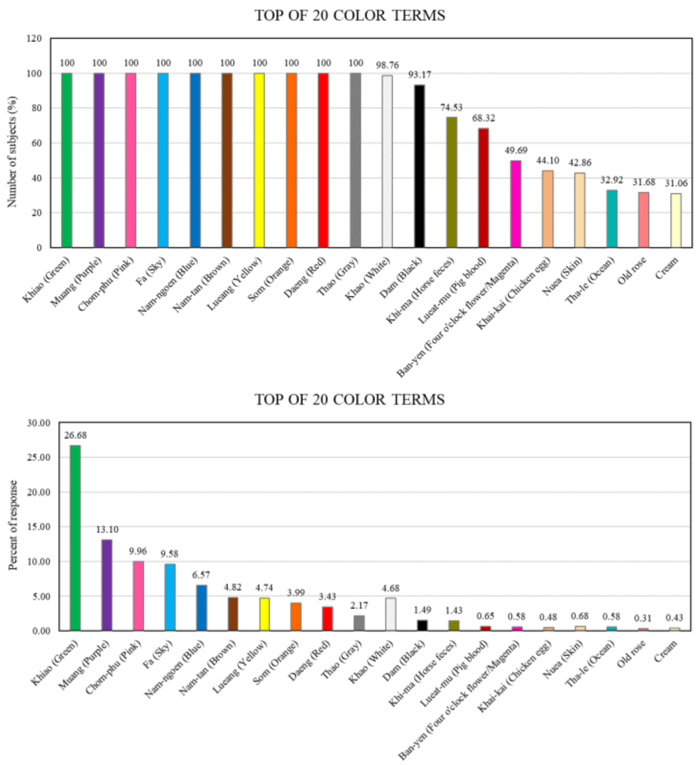



**Figure 4. Twenty popular lists. (a) Number of subjects who used the color terms.**
**(b) Percent of response for each color term.**

Figure 5 shows color terms pattern plotted on the WCS color chart by using the highest proportion of color names used for each color chips, (a) the result of forced naming and (b) the result of free-naming. In the free-naming there are 14 color terms illustrated; 11BCTs plus Fa (Sky), Lueat-mu (Pig blood), and Nuea (Skin). It is interesting "Fa" area is quite large, which is larger than many basic colors. This indicates the Thai subjects perceived blue and light blue as different colors and they thought it should be classified in different categories.

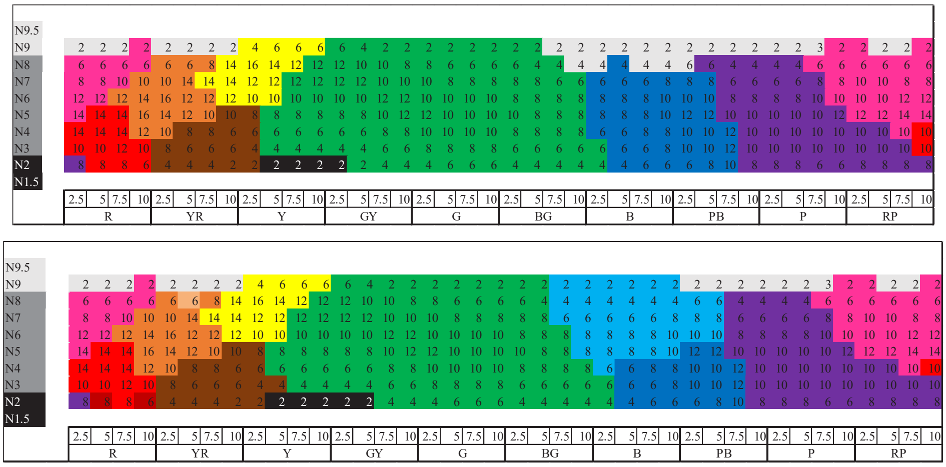



**Figure 5. Color terms pattern of Free-naming (a) and Forced naming (b). The false colors represent each color name.**

Due to the color term "Fa" has vary high frequency of use  Due to the attractiveness of the color blue used by 100% of observers and has a very high frequency of use when compared to other color names Therefore, we have enumerated the frequency of color terms used in forced-naming instead of "Fa" as shown in Figure 6. We can see that the color terms are vary, which caused by the difficulty of the decision because the subjects thought that "Fa" is a unique color and they didn't know should they classified into which group.

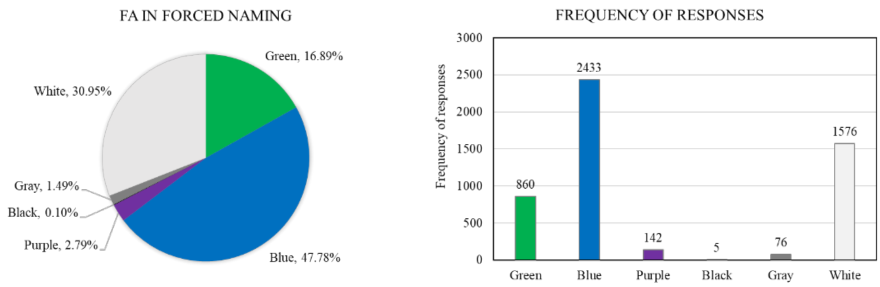



**Figure 6. Forced-naming of Fa. Left figure illustrates color terms in 11BCTs and their proportion of used and the right figure illustrates their frequency of responses.**

In order to examine the difference between "Fa" and its neighboring colors in term of subjects' perception, we took the color chips along the edge of "Fa" and its neighboring to re-examine by using elementary color naming method as mentioned in the Experiment 2. Figure 7 shows the area of perception for the color chips along the boundary of "Fa" and its neighboring colors. Here, we can see some difference for "Fa" and "Purple" borders, there are no area, but the position is clearly separated, also for “White”. In the case of “Fa” and “Green” they overlap in some parts which “Fa” is shifted to “Blue” axis side, and they almost overlap in “Fa” and “Blue”, implying that there is not much difference in hues. However, when considered in terms of chromaticness there are some difference, subjects perceived “Fa” is less chromaticness than “Blue”. Note that, most subjects who participated in the Experiment 2 are naïve and they were trained before starting the experiment, so there may be some variability in the response. However, the advantage of using this method is getting the absolute value in subjects’ perception.

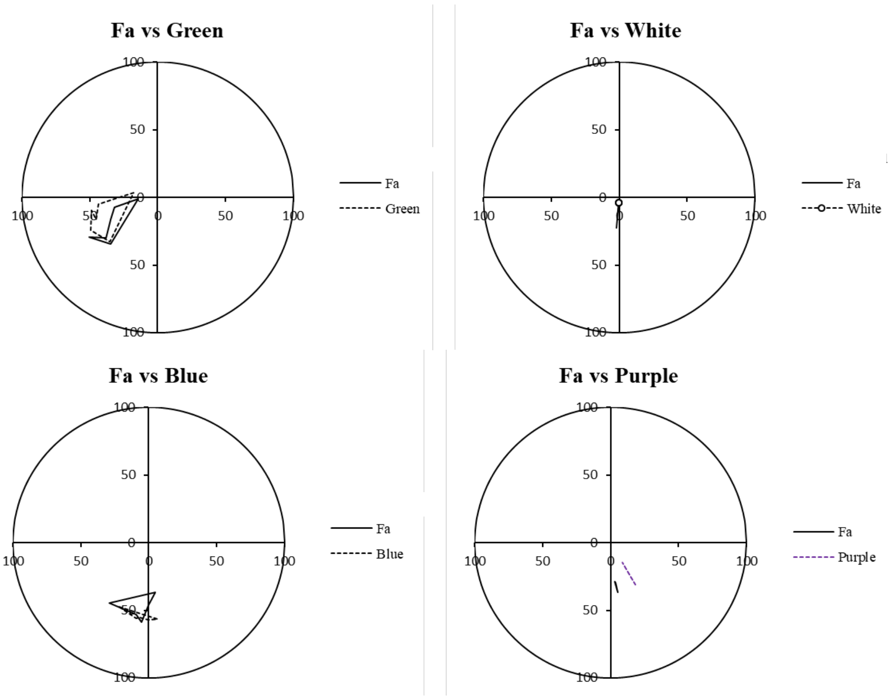



**Figure 7. Area of color perception on polar diagrams for the color chips located on border. Fa is shown by solid line, the other colors show by dotted lines separate into each color.**

## ACKNOWLEDGEMENT

We would like to thank the Research Institute of Electrical Communication of Tohoku University and the College of Liberal Arts and Sciences of Chiba University for kindly supplying us the Munsell color chips and the experimental equipment.

## REFERENCES


1. Berlin, B., & Kay, P. (1969). Basic color terms: Their universality and evolution. Berkeley, CA: University of California Press.
2. Cook, R. S., Kay, P., Regier, T. (2005). The World Color Survey database: History and use. In Cohen, Henri, & Claire Lefebvre (Eds.), Handbook of Categorization in the Cognitive Sciences (pp. 224– 241). Amsterdam: Elsevier.
3. Lindsey, D. T., Brown, A. M. (2014). The color lexicon of American English. Journal of Vision, 14(2), 1-25.
4. Kuriki, I., Fukuda, K., Tokunaga R., Lindse D. T., Uchikawa K., Shioiri S. (2017). The modern Japanese color lexicon. Journal of Vision, 17(3), 1–18.

# SIMULTANEOUS COLOR CONTRAST ON A DISPLAY DETERMINED BY DIFFERENT VIEWING DISTANCES

Janejira Mepean[1]*, Mitsuo Ikeda[2] and Chanprapha Phuangsuwan [2]

[1] *Faculty of Mass Communication Technology, Rajamangala Uiversity of Technology Thanyaburi, Thailand.*
[2] *Color Research Center Rajamangala Uiversity of Technology Thanyaburi, Thailand.*

*Corresponding author: Janejira Mepean, janjira672@gmail.com

**Keywords**: Chromatic adaptation, Color appearance, Elementary color naming, Simultaneous color contrast, Viewing distance.

## ABSTRACT

The simultaneous color contrast phenomenon is considered as the effect of chromatic adaptation to the color initiated by the surrounding color of the stimulus. If the stimulus is seen at an extremely short viewing distance the subject's recognition of the stimulus as an object may be reduced because the stimulus becomes very large not to recognize the edges. The vividness of the color appearance of the central gray patch may become large at the viewing distance. The color appearance of the test patch was measured as a function of the viewing distance when the stimulus was presented on a TV display. In general the vividness increased for shorter viewing distance with some subjects but an opposite results were obtained from other subjects. An explanation was given as that the display is a self-luminous display and some subjects felt or recognized colored light of surround even at a far distance of 5 meter and eyes adapted to the color and saw a vivid color at the test stimulus.

## INTRODUCTION

It is known that the simultaneous color contrast SCC is a phenomenon to show the chromatic adaptation. Stimulus pattern of SCC is a large colored field with a small achromatic patch at the center. It was pointed out that the large colored surrounding field works as an adapting color and the color appearance of the central gray patch is a result of the chromatic adaptation to the surrounding color [1, 2, 3]. If one observes the pattern from a far distance the pattern appears a mere object and no strong chromatic adaptation should take place. But if the view distance becomes short so that the surrounding field occupies a large area of the retina, it becomes hard to recognize the pattern an object and the surrounding is recognized as just a shining field, which should cause the visual system to adapt to the illumination, thus a strong chromatic adaptation takes place. The present research is to investigate if this hypothesis is correct by using a display to present the SCC stimulus.

## EXPERIMENT

A Samsung 55" television display UA55H6340TK was used to present a SCC stimulus. The stimulus was a rectangle of 68 cm high and 121 cm wide as a surround having a gray test patch of 11.5 x 11.5 $cm^2$ at the center. Five colors, red, yellow, green, blue and whitewere employed for .the surround. Their chromaticies are listed in Table 1 and shown in Fig 1

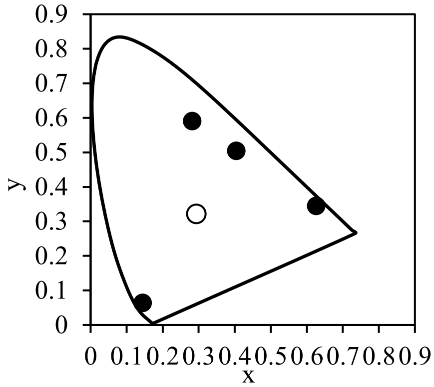



**Figure. 1 Chromaticity points of surrounds, red, yellow, green, blue and white.**

The bottom line in Table 1 gives specifications of the central test patch. The lumianance of .the surrounds and the test patch are also given in the table

**Table 1: Color specifications of surrounds.**

| Color | Y (cd/m$^2$) | x | y |
|---|---|---|---|
| R | 43.6 | 0.626 | 0.345 |
| Y | 185 | 0.404 | 0.504 |
| G | 140 | 0.282 | 0.591 |
| B | 16.4 | 0.144 | 0.064 |
| W | 209 | 0.294 | 0.321 |

To change the visual angle of the SCC pattern the viewing distance was changed to 5, 3, 1.5, 0.3 and 0.15 meters and their visual angles varied from 13.8°to 152.2° as shown in Table 2.The subjects were asked to judge the colors of the central patch by the elementary color naming method. Six subjects of normal color vision participated in the experiment and the judgement was repeated for five times for each condition. The experiment was carried out in a room illuminated at 236 lx at the subject's eye level.

**Table 2: Visual angle of the test patch and the surrounds at different viewing distance.**

| Distance (cm) | Visual angle (width) | |
|---|---|---|
| | Test patch (°) | Surround (°) |
| 15 | 42 | 152.2 |
| 30 | 22 | 127.3 |
| 150 | 4.4 | 44 |
| 300 | 2.2 | 22.8 |
| 500 | 1.3 | 13.8 |

## RESULTS

The color appearance of the surrounds is shown in Fig. 2 on a polar diagram normally used in the opponent colors theory. The apparent hue is shown by the angle for Red axis in the anticlockwise direction. Unique hues of red, yellow, green, and blue are shown at 0°, 90°, 180°, and 270°.

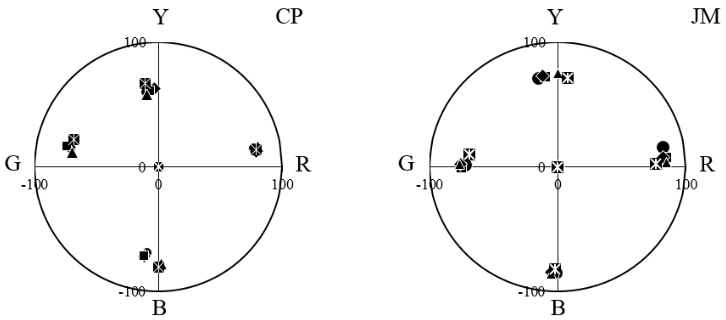



**Figure. 2 Color appearance of surrounds plotted on a polar diagram for two subjects. Viewing distance, ✳, 15 cm, ▲, 30 cm, ◆, 150 cm, ■, 300 cm, ● 500 cm.**

The amount of chromaticness is taken along the radius direction starting at the origin as 0 and ending at the circumference as 100. Figure 2 shows results of two subjects, CP and JM. At each group there are five points corresponding to five viewing distances. Each point is the average of five repetitions. Four surrounds appeared to them almost unique hues.

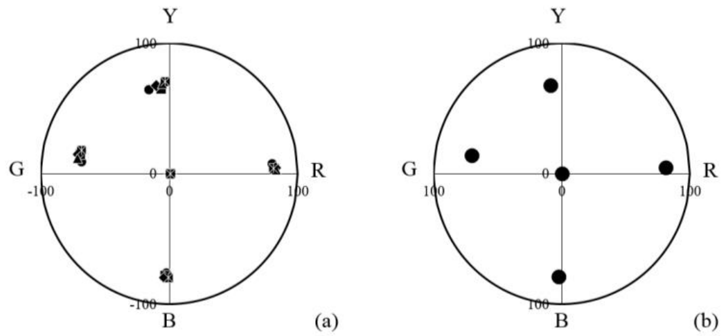



**Figure. 3 Left, Color appearance of surrounds obtained by 6 subjects. Right, Averaged color appearance of 6 subjects for surrounds.**

In Fig. 3 the averages of six subjects are plotted for different viewing distance in (a) and for the averages of different viewing distance in (b). As we see in (a) there seems to be no difference among different viewing distance. In Fig. 4 the amount of chromaticness is plotted for different viewing distance for different surround. Color appearance of surround did not change for viewing distance.

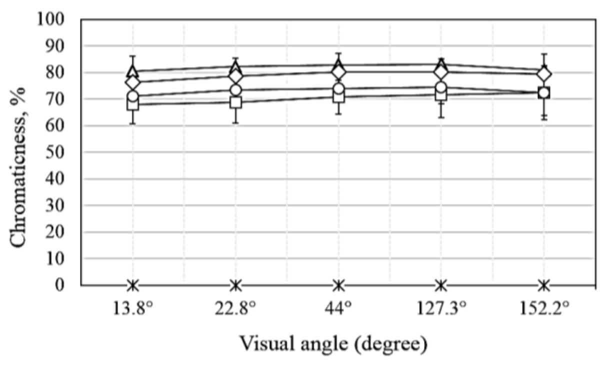



**Figure. 4 Amount of chromaticness of surrounds for different viewing angle. △, red surround; □, yellow; ○, green; ◇, blue, ✳, white.**

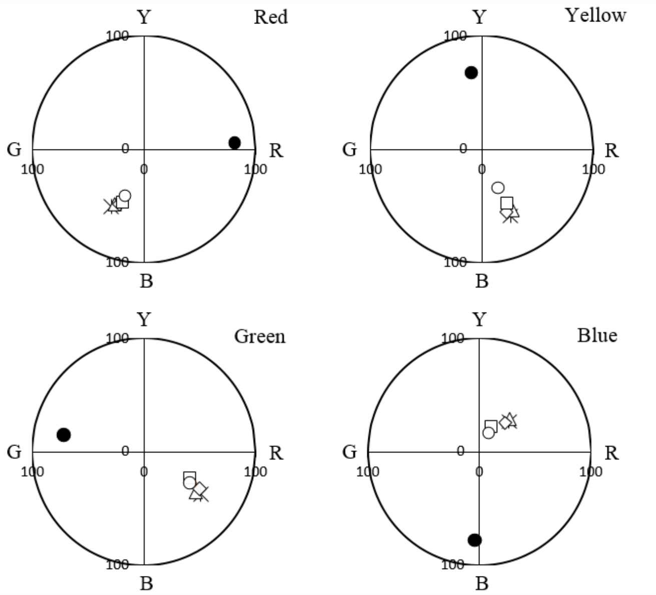



**Figure. 5 Color appearance of surround and test patch shown on polar diagrams for four surrounding colors.**

The average of color appearance of test patch is also shown on polar diagram in Fig. 5. Different figures give results of different surrounding colors. Filled circles show the color appearance of surround as appeared in Fig. 3. Other symbols correspond to the viewing distance; ○, 5 m, □, 3 m, ◇, 1.5 m, △, 0.3 m, ✳, 0.15 m. There is a tendency of the amount of chromaticness increased for shorter distance, which is particularly evident with yellow surround.

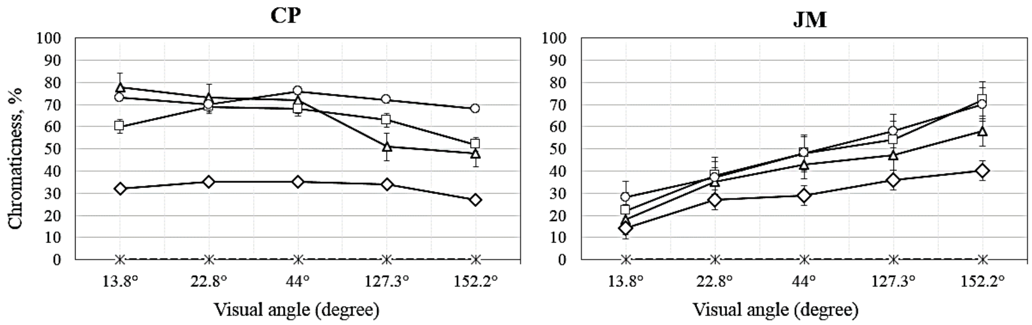



**Figure. 6 Amount of chromaticness of test patch for viewing angle from two subjects. Symbols represent colors of surround. △, red surround; □, yellow; ○, green; ◇, blue, ✳, white.**

To see the change of amount of chromaticness more clearly Fig. 6 is prepared for subjects CP and JM. Along the abscissa the viewing distance is taken and along the ordinate the amount of chromaticness. There is difference in the amount among surrounding color, the largest with green, and then yellow, red, and blue, the blue the smallest in both subjects. But the trend of change differs. While JM showed increase for shorter viewing distance or larger visual angle, CP did not show such trend, rather opposite. The amount slightly decreased for larger visual angle. The subject expressed that she can see a vivid color for the test patch even at the 5 m viewing distance.

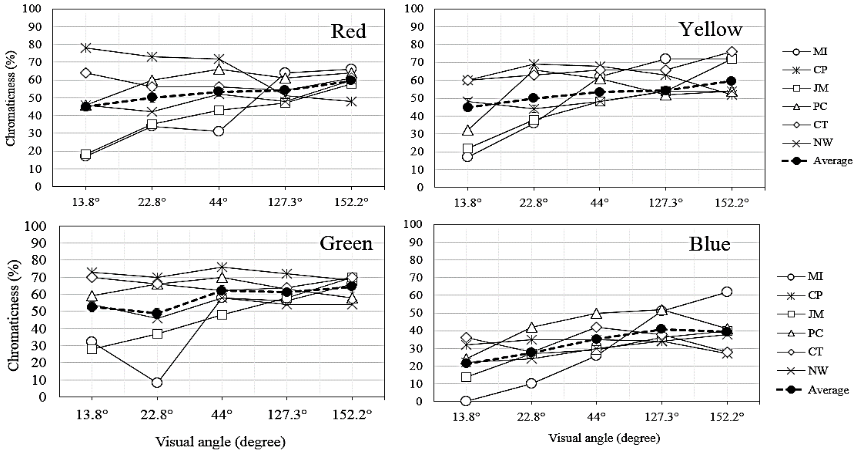



**Figure. 7 Amount of chromaticness of test patch for viewing angle for six subjects. Symbols represent subjects.**

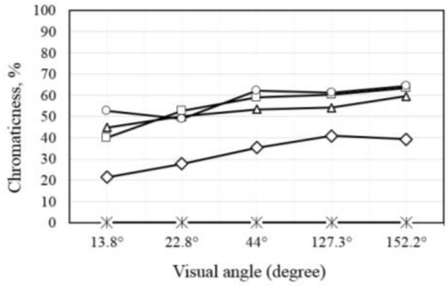



**Figure. 8 Averaged amount of chromaticness of test patch for viewing angle. Symbols represent color of surround, △, red surround; □, yellow; ○, green; ◇, blue, ✳, white.**

Figure 7 shows the individual difference by different symbols. With red, yellow, and green surrounds the value diverges greatly at the longest viewing distance but they converge at shortest distance. Thick dashed lines show the average of six subjects. Although there is variance among subjects the dashed lines show a gradual increase for shorter viewing distance. Those dashed curves are summarized in Fig. 8. The blue curve locates separately at the low level indicating that the blue surrounding is weak to induce color at the test patch.

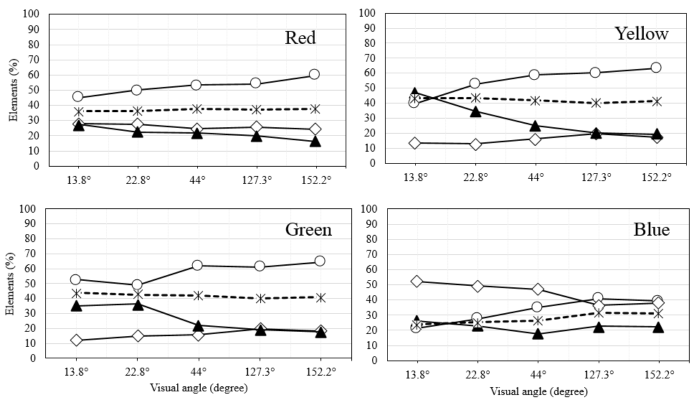



**Figure. 9 Amounts of elements plotted for viewing angle. ○, chromticness; ▲, blackness; ◇, whiteness. Dashed lines is the average of the chromaticness and blackness.**

In the experiment whiteness and blackness were also measured beside chromaticness. They are shown in Fig. 9 with different symbols; ○, chromaticness, ◇, whiteness, ▲, blackness. It is interesting to note, particularly in the green surround, that the chromaticness curve and the blackness curve show symmetric relation. Dashed lines are average of chromaticness and blackness and they are almost straight lines suggesting chromaticness and blackness are symmetrical. In other words, the increase of chromaticness for shorter viewing distance was given by the reduction of blackness amount.

## CONCLUSION AND DISCUSSION

The simultaneous color contrast was investigated for different viewing distance which changed the visual angle for the stimulus. It was anticipated that increase of visual angle or decrease of viewing distance increases the vividness of the color appearance of the central test patch because the recognition of the stimulus as an object reduces for short distance. The expectation was found in some subjects but opposite result was found by other subjects. We can think of some reasons for this unexpected result. A display is a self-luminous display. The surround gave light impression already at 5 m viewing distance, which gave strong chromatic adaptation and caused vivid color of the test patch. When the viewing distance was short as 15 cm, subjects could see color dots of the television display that was used in this experiment, which bothered the subjects to judge the color appearance of the test patch. An author of this paper observed the same SCC stimulus presented on an EIZO display which did not give color dots t 15 cm, She reported the color appearance of the test patch became more vivid. The SCC stimulus was composed of a central small gray patch and a large surround. Both had clear edges to give an object recognition to subjects. But if the subject saw light impression even at 5 m distance the chromatic adaptation must be strong to give vivid color for the test patch. It is needed to do a similar experiment by using EIZO in the future to clarify questions raised in this experiment.

## ACKNOWLEDGEMENT

Janejira Mepean, the senior author, acknowledges Dr. Fusako Ikeda for giving Mepean the Fusako Scholarship to study at graduate school of Rajamangala University of Technology Thanyaburi.

## REFERENCES

1. Ikeda, M. (2004) Color appearance explained, predicted and confirmed by the concept of recognized visual space of illumination. Opt. Rev., 11, 217-225.
2. Srirat, P., Phuangsuwan, P., & Ikeda, M. (2014) Chromatic adaptation to illumination investigated with two rooms technique. *Jr. Col. Assoc. Jpn,* 38(3), 176-177.
3. Phuangsuwan, C., Ikeda, M., & Mepean, J. (2018). Learning to de-escalate: Color appearance of afterimages compared to the chromatic adaptation to illumination. *Color Research and Application*, *43*(3), 349-357. doi: 10.1002/col.22207

# DEVICE INDEPENDENT SIMULTANEOUS LIGHTNESS CONTRAST

Saran Chantra[1]*, Mitsuo Ikeda[1], Hideki Sakai[2], Hiroyuki Iyota[3] Chanprapha Phuangsuwan[1]

[1]*Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2]*Graduate School of Human Life Science, Osaka City University, Japan.*
[3]*Graduate School of Engineering, Osaka City University, Japan.*

*Corresponding author: Saran Chantra, 1159108020192@mail.rmutt.ac.th, Saranchantra@gmail.com

**Keywords**: Simultaneous lightness contrast, Devices, Projector, Paper stimulus, Two - rooms arrangement

## ABSTRACT

The simultaneous lightness contrast phenomenon was investigated with four different devices; a paper stimulus, a two - rooms arrangement, a display, and a projector. Luminances of the central gray patch and surround were made equal among the devices. Except the paper stimulus the strength of SLC was about same among other devices to imply device independent SLC.

## INTRODUCTION

There are two kinds of simultaneous contrast phenomenon, simultaneous color contrast SCC and simultaneous lightness contrast SLC. The pattern for the phenomenon is usually a large area surrounding a small gray patch at the center. When the surround is made of a color the gray patch appears colored complementally to the surrounding color, which is SCC phenomenon, while the surround is achromatic the gray patch appears also achromatic but darker or brighter depending on the lightness of the surround, which is called SLC phenomenon. Those patterns are often shown in textbooks. But if they are demonstrated on printed paper the SLC shows a clear effect, while the SCC does not. A concept of recognized visual space of illumination RVSI proposed by Ikeda explains the SCC by the chromatic adaptation [1]. The concept asserts that the chromatic adaptation takes place to the illumination in a space where the observer stays and not to the color of objects that the observer is looking at. The simultaneous color contrast phenomenon is explained by this concept in a way that the color of the surrounding is transferred to the illumination color in the observer's recognition and he/she adapts to the illumination. Difference between the results of SCC and SLC is interpreted as that to an observer it is easier to recognize the illumination level than the illumination color on the printed simultaneous contrast pattern. The degree of the easiness greatly differs in the SCL among devices to demonstrate the phenomenon, such as printed paper, a display, a projector, or a two - rooms technique [2]. If the recognition of illumination level is easy for any devices the SLC effect should not differ among devices on the contrary to the SCC which is quite dependent on devices [3]. In this paper the SLC was measured for four different devices, a printed paper, a display, a projector, and a two - rooms technique Fig. 1. Two kinds of SLC stimuli were prepared, one with a white surround and the other with a black surround. Both surrounds had a same gray central patch. The luminance of the surround and that of the central test patch were made equal for difference devices and the visual size of the pattern was also made about same. The experiment was done in a room without the ceiling lamps. Subjects were asked to judge the appearance of the central test patch by the elementary color naming method, namely the amounts of whiteness and blackness in percentage. Experiments were carried out at Rajamangala University of Technology Thanyaburi, Thailand and at Osaka City University, Japan, where the senior author spent for three months for internship under supervision of Professors Iyota and Sakai.

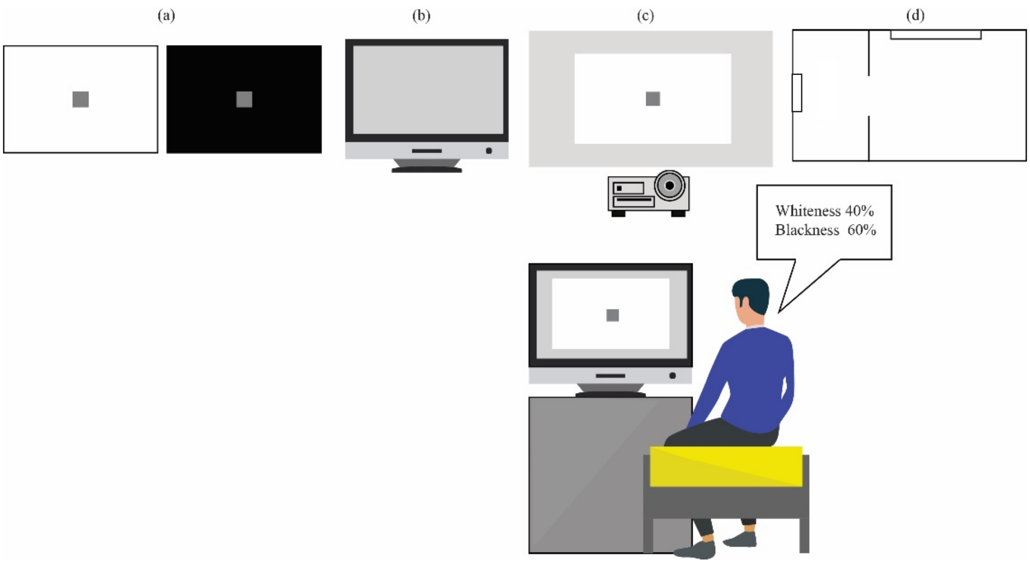



**Figure. 1. Four devices used for the simultaneous lightness contrast experiment.**

## EXPERIMENT

Stimuli we used was a small square gray patch placed at the center of a large surround of black or white. They were presented as papers, a display, a projector and in a two-rooms arrangement [2]. Their dimensions and luminance are summarized in Table 1. In spite of different devices they were made equal as much as possible. Y shows the luminance when the paper stimulus was measured in a room of the illuminance 890 lx. L*values of black surround was 26 at OCU and 22 at RMUTT and that of white surround was 95 at OCU and 93 at RMUTT. Except the paper stimuli all the devices were observed in a dark room. Fourteen subjects participated in the experiments, 7 at OCU and 7 at RMUTT. They observed devices in a pseudo - random order.

**Table 1: Experimental condition**

| Device | S (cm) | T (cm) | Dist. (cm) | Visual angle (°) | | Test patch | | | White surround | | | Black surround | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | S (°) | T (°) | Y | x | y | Y | x | y | Y | x | y |
| Obj. | 21x30 | 2x2 | 70 | 17x24 | 1.63 | 89.4 | 0.31 | 0.44 | 231 | 0.31 | 0.45 | 25.4 | 0.31 | 0.44 |
| Disp. | 53x35 | 3x3 | 110 | 27x18 | 1.63 | 89.4 | 0.31 | 0.45 | 231 | 0.31 | 0.45 | 25.5 | 0.31 | 0.46 |
| Proj. | 60x92 | 4x4 | 135 | 25x38 | 1.63 | 88.4 | 0.29 | 0.46 | 231 | 0.29 | 0.46 | 24.3 | 0.29 | 0.46 |
| Two-rms. | 37x24 | 3x 3 | 120 | 18x11 | 1.62 | 88.6 | 0.31 | 0.45 | 232 | 0.31 | 0.45 | 25.5 | 0.31 | 0.44 |

## RESULTS

Results of two subjects, AH of OCU and SJ of RMUTT are shown in Fig. 2 and 3 for surround and gray test patch, respectively. The amount of whiteness was very high for the white surround (○) in the all the devices, but for the black surround (●) it varied for different devices. While it was 0 and 5 with the paper stimulus from AH and SJ, respectively, it was 75 and 26 with the two rooms arrangement and 63 and 34 with display. This is understandable if we notice that the paper stimulus appeared really black but the front wall of the two - rooms arrangement was white. Even the room illuminance was set at a low level to give the same luminance as for the paper the white wall appeared dark but still white as the color constancy tells us. The left figure of Fig. 4 gives the amount of whiteness of test patch with white surround (○) and with black surround (●). The amount of whiteness with black surround is much higher than the amount of whiteness with white surround. There is seen a large difference between the object stimulus and the two rooms stimulus, but the amount of whiteness remained about the same among other devices, two-rooms, display, and projector, implying the device independent.

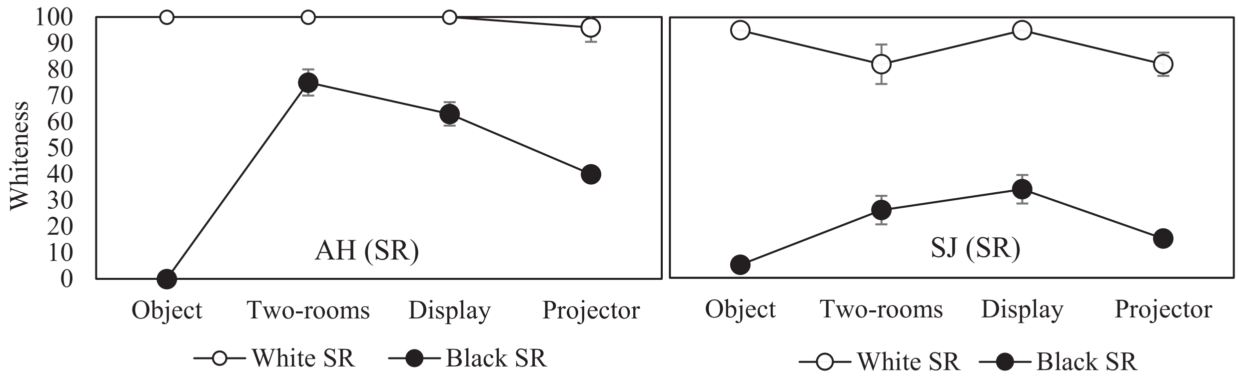



**Figure. 2. The amount of whiteness of white surround (○) and of black surround (●).**

**Subject AH (left) and SJ (right).**

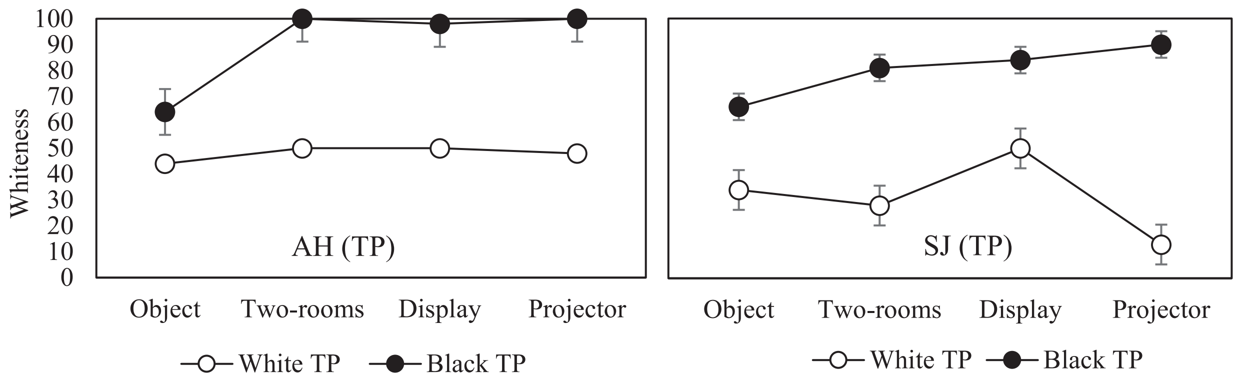



**Figure. 3. The amount of whiteness of test patch with white surround (○) and with black surround (●). Subject AH (left) and SJ (right)**

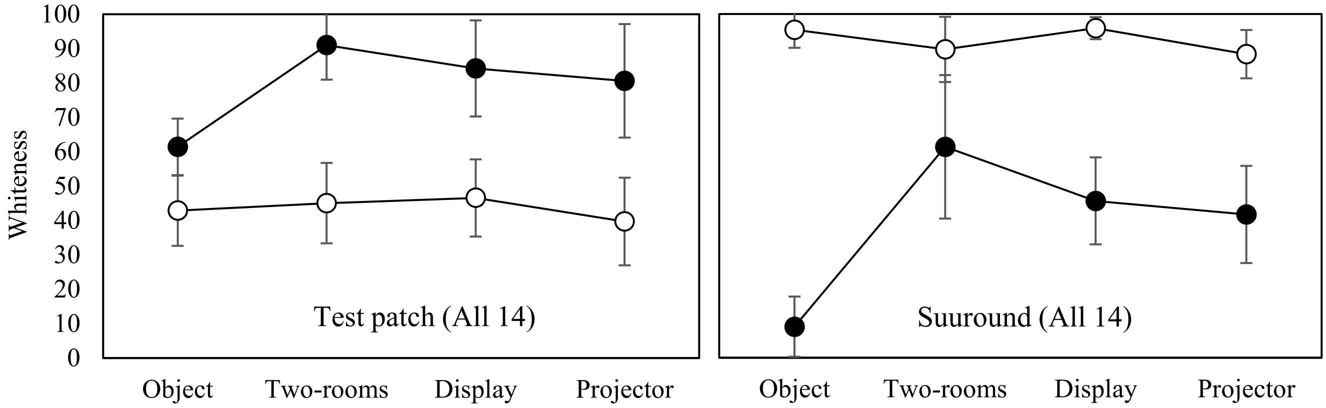



**Figure. 4. Averaged results of 14 subjects for the amount of whiteness of test patch (left) and of surround (right). (●), black surround, (○), white surround.**

## DISCUSSION AND CONCLUSION

Although we found the device independent SLC for two - rooms arrangement, a display, and a projector, the amount of whiteness with black surround in the object stimulus was smaller than other devices. With white surround the amount of whiteness was about the same for all the four devices (○) in the left figure of Fig. 4. We noticed that the white surround appeared white in all the four devices, but the black surround appeared different. That of object stimulus appeared really black as shown by only 9 of the whiteness amount as seen in the right figure of Fig. 4 but the other stimuli appeared gray although the luminance was made same as shown in Table 1. We calculated a ratio of whiteness amount of test patch to that of surround. The results are shown in Fig. 5 for the black surround (●) and for the white surround (○). The ratio of the object stimulus is much higher than other devices. The effect of surround to the test patch appearance is significantly large in the object stimulus. This might be caused by a really black surround in the object stimulus.

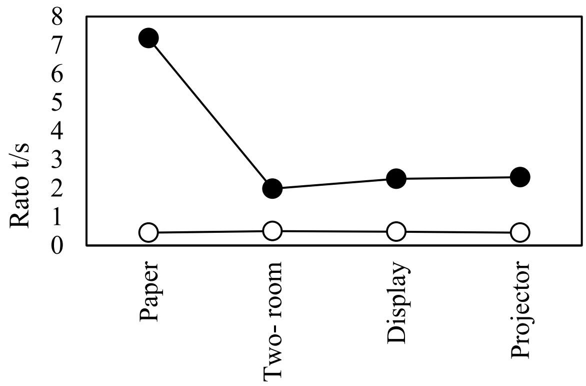



**Figure. 5. Ratio of whiteness amount of test patch to surround. (●), black surround, (○), white surround.**

## ACKNOWLEDGEMENT

Saran Chantra thanks RMUTT for providing him with scholarships Co - operative education Rajamangala University of Technology Thanyaburi that made Saran to do internship abroad. He thanks students at Iyota and Sakai laboratories to be a good friends to Saran and for serving as subjects of this experiment.


## REFERENCES


1. Ikeda, M. (2004). Color Appearance Explained, Predicted and Confirmed by the Concept of Recognized Visual Space of Illumination. *Optical Review*, 11(4), 217–225. doi: 10.1007/s10043-004-0217-x
2. Phuangsuwan, C., & Ikeda, M. (2017). Chromatic adaptation to illumination investigated with adapting and adapted color. *Color Research & Application*, 42(5), 571–579. doi: 10.1002/col.22117
3. Phuangsuwan, C., & Ikeda, M. (2019). Device dependent simultaneous color contrast. *Proc of Col. Sc. Assoc. Jpn.*

# THE STUDY OF HOW THE FIRST - TIME VOTERS MEMORIZE THE COLOR OF POLITICAL PARTIES

Waiyawut Wuthiastasarn[1]*

*(39 Rangsit – Nakornnayok Rajamangala University of Technology Thanyaburi)*
*[1]Color Research Centre, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand*

*Corresponding author: Waiyawut Wuthiastasarn, e-mail waiyawut_w@rmutt.ac.th

**Keywords:** colors of political parties, color code, memorize of color, first-time voters

## ABSTRACT

Because of coup d'etat, the last general election voted in Thailand was 3rd of July, 2011. Thais have waited for 8 years for the next election voting. In 2019 the waiting had over. The election was on 24 of March 2019. The election commissions informed that the new voters were 6.4 million peoples. More than 100 political parties were registered. One of the simple strategies among the parties was to select the representative color for the political parties. They proposed the term "Color of Political Party" to be memorized for voting. In this paper, we aimed to study the factors of the memorable color of the political party for the new voter. From 132 parties, the researcher selected 2 political parties that were well-known which were Future Forward Party (orange color) and Democrat Party (blue sky color). New voters or first-time voters who participated in this survey were 419 students from the Rajamangala University of Technology Thanyaburi, Pathum Thani Province. The result showed that the new voters tended to memorize the wrong color code of the sample political parties. Most of the new voters couldn't memorize the colors of the political parties, except these two parties.

## INTRODUCTION

In political campaign communication, the colors are used in elections to memorize of the voters. Each political party use representative colors that are different from the rival party. Luigi Marini (2017) found that right wing political parties tend to use color in the blue range. On the other hand, left wing political parties tend to use red color. The new political parties would not use the color that political parties have been used previously. However, the colors of political parties are vary according to the context of local areas. (Marini, L., 2017) [1]

Rifka Sibarani (2018) studied another theory of Roland Barthes in Indonesia president election campaign. She found that the parties uses color to create an ideology of political parties. The yellow symbolizes the authority of the Golongan Karya Party. The red color represents the labor history of the communist ideology of the political party PDI Perjuangan. Blue represents a new liberal concept with the patriotism of Susilo Bambang Yudhoyono. While the political parties of Joko Widodo use a combination of red-white-black to show the aggressiveness of his political party. (Sibarani, R., 2018) [3] In addition, the colors of political parties are used in the campaign in other countries as well. For example, in Taiwan, the New Party uses yellow to represent the party while the Democratic Progressive Party uses green. In Canada, the New Democrat uses orange, while the Liberal Party uses red, and the Conservative of Canada uses blue. Most U.S. political parties use red, white and blue together. However, television broadcasting often uses red for Republican and blue for Democrat. There are still political parties that use other colors, for example, green for the Green party and yellow for the Libertarian Party.

On the other hand, according to the Ecological Valence Theory (EVT's), Palmer and Schloss (2010) studied effects of the color preferences and found that the voters closely associated red with the Republican Party and blue with the Democratic Party especially on the election date. They suggested that mass media has an effect on the color preferences of the voters. The color satisfaction of the voters depends on their experiences toward the political party. (Palmer, S. E.& Schloee, K.B., 2010)[2]

In Thailand, the coup d'etat happened on 22nd of May, 2014 by General Prayut Chan-o-cha. Thais waited for 8 years for the general election. The election was on 24 of March 2019. The Election Commissions of Thailand informed that new voters were 6.4 million peoples while there were 132 political parties. Therefore, the new voters must know and remember every political party. One of the simple strategies among the parties was to select the representative color for the political parties. According to the survey of the color usage of political parties in Thailand conducted by SALMON LAB,[4] found that blue colors were used by up to 30 political parties (36.59 percent). For example, the elder political party which is Democratic Party (no.2) as shown in Figure 1,


**Figure 1 Political Parties that use blue color.**

SALMON LAB,[4] survey found that followed by green 12 political parties (14.63 percent). For example, Dee Power Party (no.1), Green Party (no.3), Thai Teachers for People Party (no.11) as shown in Figure 2.


**Figure 2 Political Parties that use green color.**

And multi-colors. As shown in Figure 3, 12 parties (14.63 percent) used multi colors for their logos. For example, Thai Local Power Party (no.7) used green, red, and blue. The Kasikornthai Party (no.6) uses orange, purple, green, sky blue, and blue. The Prachachat Party (no. 12) uses yellow, brown, purple, green, orange, blue, violet, and red.


**Figure 3. Political Parties that use more than one color.**

## RESEACH DESIGN

The research question was to find the memorable colors of the Political Party and other factors associated with the color from new voters. This was an online study in Google form. A logo of political parties edited by Photoshop CS6 in black and white, 2 x 2 inches was placed on the top of the questionnaire. And then, the participants were asked to select the color name of red, blue, green, yellow, pink, orange, and brown that represent the color of 27 political parties from the parties that had party-list members of the House of Representatives. The participants were 419 voters who were students of the faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Pathum Thani, Thailand.

## RESULT AND DISCUSSION

The 419 participants was 100 persons for 18 years old, 182 for 19 years old, 97 for 20 years old, 30 foe 21 years old, 4 for 22 years old, 2 for 23 years old, and 4 for 24 years old. They selected color representative the political parties shown in the Figure 4

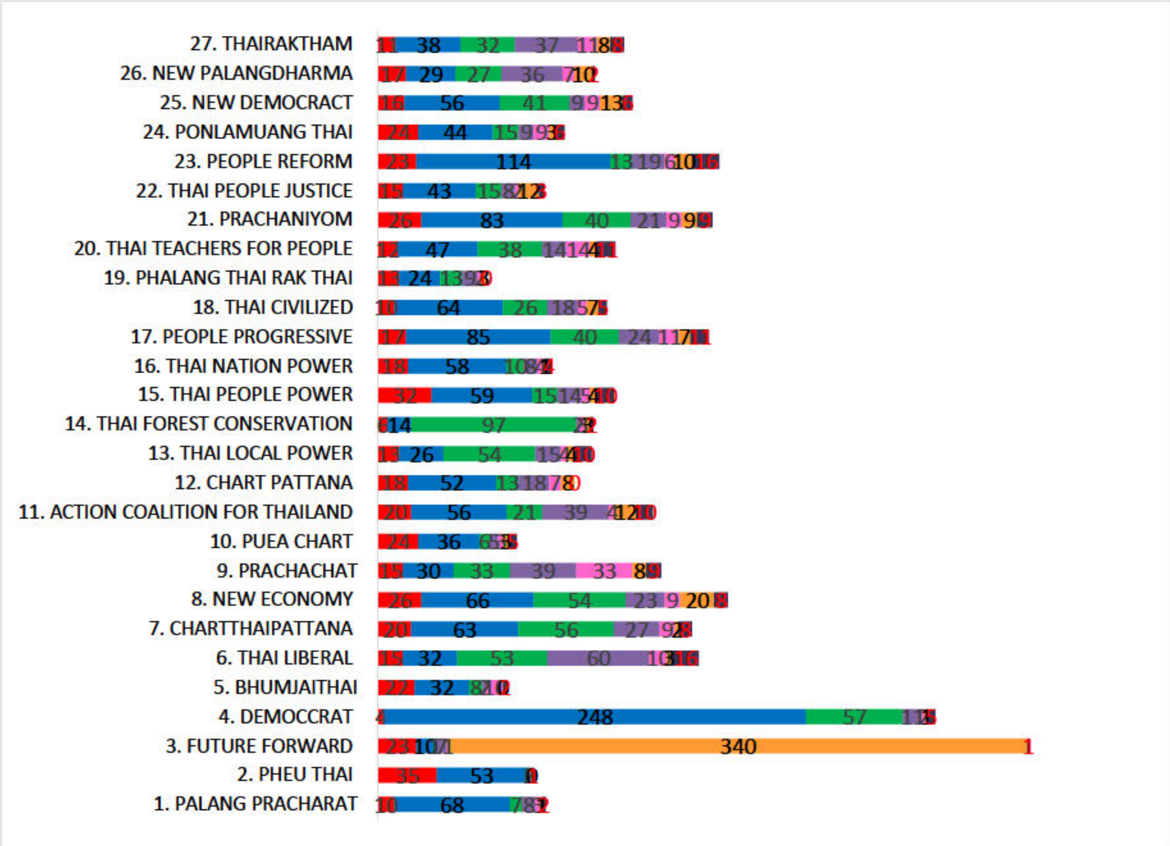



**Figure 4. The memorable colors of the Political Party**

The result shown that the new voters memorized orange color as the Future Forward Party (no.3) according to the Ecological Valence Theory (EVT's) that effects of the color preferences. (Palmer, S. E.& Schloee, K.B., 2010)[2] The younger voters preferred the Future Forward Party because of 6,330,617 votes from number of the new comer were 6.4 million peoples (The Election Commissions of Thailand,2019)[5]. The blue color as Democrat Party (no.4) because this party was the oldest political party established in 1946. The colors of others of political parties was distribution. They used blue color, which was a color in the blue range that represents the conservative while Future Forward Party a new liberal political party, used the opposite color (orange). It was similar to the study of previous study found that political parties with the right wing parties tend to use color in the blue range as the party's color and political parties with left wing parties tend to use red color instead. (Marini, L., 2017)[1]

## ACKNOWLEDGEMENT

This acknowledgment for Miss Ploy Srisuro, and my colleagues and the freshman and sophomore students of Mass Communication Technology, Rajamangala University of Technology Thanyaburi they were a good participants in this research.

## REFERENCES


1. Marini, L.(2017) *Red parties and blue parties, the political of party colours: Use and percrption of non-verbal Cues of Ideology*. Paper presented at Political Studied Association (PSA) Conference, University of Stratchlyde, Glasgow, Scotland, 10-12 April 2017.
2. Palmer, S. E.& Schloee, K.B.(2010) *An ecological valence theory of color preferences.* Paper presented at Proceedings of the National Academy of Science, United State of America, 107(19):8877-82, May 2010
3. Sibarani, R.(2018) *Indonesia's Political Colourd: From the New Oder to Joko Widodo*. ILMU KOMUNIKASI, 15(2),189-202.
4. SALMON LAB, [online], https://lab.sal.mn/2019/03/political-parties-colors/61824/
5. The Election Commissions of Thailand, [online], https://www.ect.go.th/ect_th/

# COLORS FOR FEMALE AND MALE IMAGE BY THAI AND JAPANESE PEOPLE

Wipada Pumila[1]*, Chanprapha Phuangsuwan[1], Yoko Mizokami[2], and Mitsuo Ikeda[1]

[1]*Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2]*Graduate School of Engineering, Chiba University, Japan*.
*Corresponding author: Wipada Pumila, 1159108020382@mail.rmutt.ac.th, vipada.pumila@gmail.com

**Keywords**: Color, Female image, Male image, Thai, Japanese

## ABSTRACT

We can put meaning to color, which is called color coding. In Thailand, the color codes are not so much utilized. One example is toilet sign. In many countries a male toilet is coded by blue or black while a female by red. But in Thailand such color code is not used and, in some cases, both female and male toilets are shown by red. In order to utilize the color code in public society it is necessary to investigate what color has what image to the people. The present paper investigated the colors for female image and for male image latent in Thai people. 72 color chips covering hues and saturation taken from Munsell Book of Color were arranged in two rings and female subjects were asked to choose representative hue that matches with their impression for female by ranking 1-3, the second they asked to select color chip from the hue that they chose one color. The same experiment was done for male subjects also. We obtained the color chip that female subjects chose, and that male subject chose. The result showed that the first choice for female image was 2.5R7/8 and for male image was 10B 6/10. For Japanese subjects' color choice of female was 7.5RP6/12 and male image 5PB 4/12. Results of color choice represented to female and male images from Thai and Japanese people showed slightly different. However, those colors appeared same tone as male was blue tone and female was pink tone.

## INTRODUCTION

Pink and blue colors are common color when we think about the color code that represents to females and males. For example, the product of Hello-Kitty also use pink for girl and blue for boy [1]. In many countries their coded the color for female by red or pink and blue or black for male. In Thailand the color codes used for female and male are not specified. We surveyed the color of toilet sign around university, supermarket and department store and found that no systematic used of color. Sometime both female and male used the same black color and just using a difference of pictograms to discriminate or sometimes they use red color for male toilet and blue for female toilet as shown in Fig. 1 (a). In Japan, Male's toilet is shown by blue or black while female's toilet by red as shown in Fig. 1 (b). It is easy to find out where toilet is in a clouded place like in the department store. In advance, there is also a movement to introduce gender-neutral toilets that can be used by anyone. In Tokyo's Shibuya, one of the first municipalities to issue same-sex partnership certificates providing some of the same rights as a marriage certificate, the municipal office annex toilets have rainbow colored signage reminiscent of the LGBT movement's multicolored flag. New gender-free toilet signage depicting a figure wearing pants on one side and a skirt on the other can be found at places like the Mega Don Quijote discount shop in Shibuya, as well as in hotels in Kyoto catering to ever-increasing numbers of foreign tourists[2].


(a) (b)

**Figure 1. (a) Used of toilet color sign in Thailand. (b) Used of toilet color in Japan.**

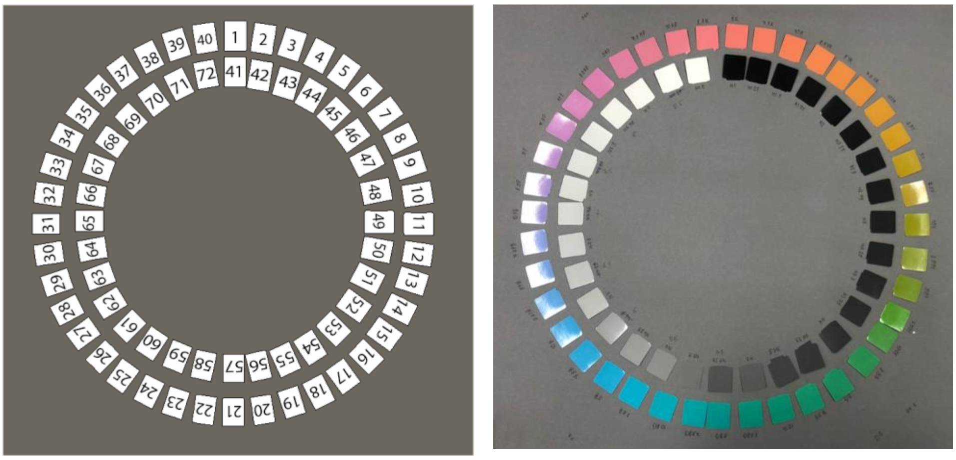

**Figure 2. A new gender-free toilet signage.**

Thailand is now aging society. More than 10 million elderly people were increasing for 10 percent of the total population since the year 2014. The prediction shows that in 2031 we will be "aged society". To prepare the environment suitable for elderly is necessary. Color code is one idea to help the elderly this paper we aimed to utilize the color for female and male and propose to apply for the toilet sign.

## EXPERIMENT

### Stimuli

Seventy-two color chips from glossy Munsell color book were used to make the hue ring as shown in Fig. 3. Those color chips were pasted on the gray paper about N5 and it contained 40 hues. The color chips were kept the value 6 and chroma 8 and for achromatic chips ranged from N1 to N9 with interval 0.25 (for example N1, N 1.25, N1.50, N1.75) except N4, N5 and N6 had no value at step 0.75.



(a) (b)

**Figure 3. (a) Scheme of hue ring. (b) Hue ring.**

**Procedure**

Subject asked to think about the color image for female and male under the normal daily life environment. Illuminance was ranged from 500 -3000 lx. The subjects were asked to select the 3 ranking of hues first. After getting three representative hues the experimenter will be opened the Munsell book into the corresponding hue that he/she chose in each ranking and then subject looked around the color chips which were showed in many values and chromas then selected one of color chip that imaged to female or male to the subject. Subjects continue selected the color chips for the second and third ranks respectively. The experiment duration was 3-5 minutes for each subject, and no repetition on this experiment.

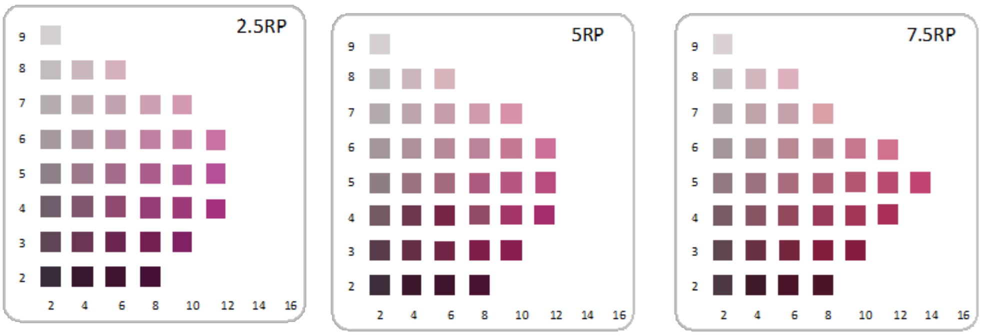



**Figure 4. Example of Munsell sheet in the book.**

**Subjects**

One hundred Japanese subjects (age ranged from 17-47-year-old) participated in this experiment and those subjects were divided into 50 females and 50 males. For Thai people was also the same number as Japanese and age ranged from 18-44-year-old.

## RESULTS AND DISCUSSION

The results of selected hue for the first rank of male image from Thai and Japanese people are showed in the Fig. 5. The abcissa indicates Munsell hue and ordinate indicates number of subjects that selected in each hue. The munsell hue 10B was high frequency selected by Thai people and 5PB for Japanese choice. Figure 6 showed the result of munsell hue represented to female image. Munsell hue 2.5R was showed high frequency selected female image for Thai people and 7.5RP for Japanese people. In addition, the selected hues were varied distribution into 32 hues.

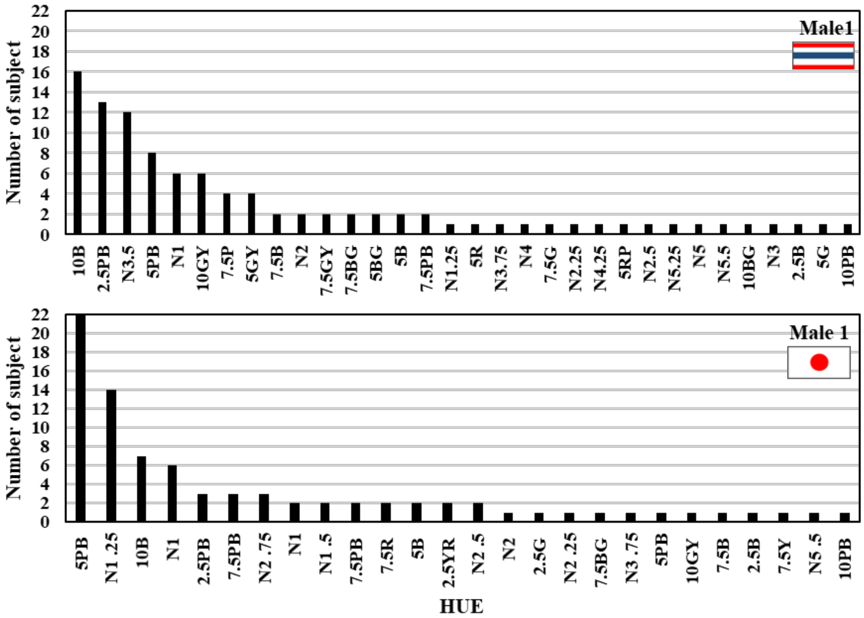



**Figure 5. Result of selecting hue represented to male image of Thai and Japanese.**

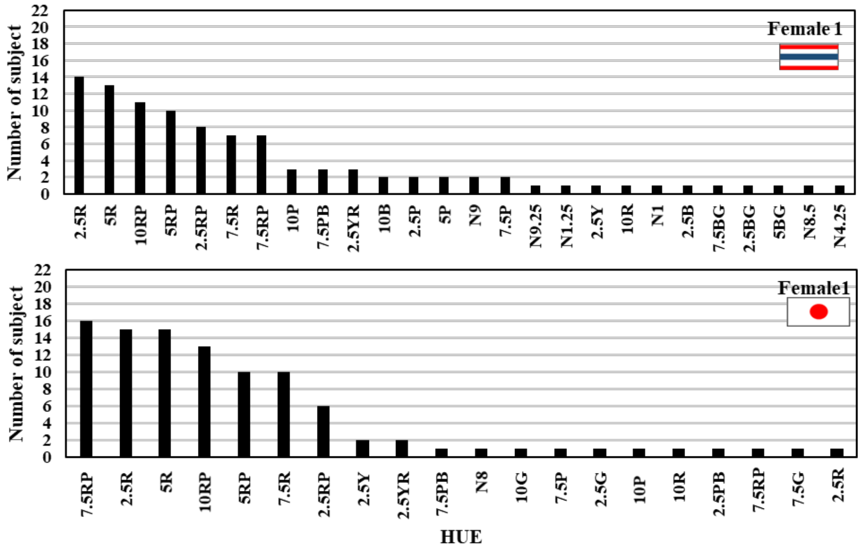



**Figure 6. Result of selecting hue represented to female image of Thai and Japanese.**

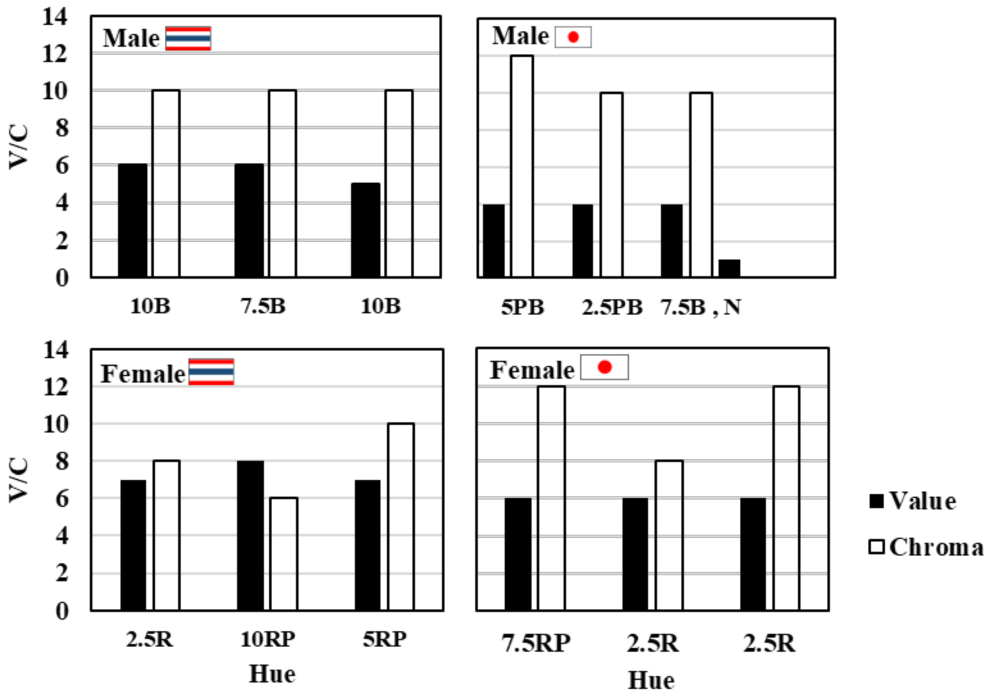



**Figure 7. Results of hue/vale/chroma in three ranking from Thai and Japanese.**

Three ranks of color selected by Thai and Japanese are shown in Fig. 7. The abscissa indicates Munsell hue from rank 1 to 3 and ordinate indicates value and chroma. Left column was the result of Thai and Japanese on the right column. Solid bars represent to value and chroma. The colors representative male image of Thai people was 10B 6/10, 7.5B 6/10 and 10B 5/10 respectively. Color representative male image from Japanese was showed 5PB 4/12, 2.5 4/10 and 7.5B 4/10 plus N1 respectively. In the two bottoms graph are the results of female image which 2.5R 7/8, 10RP 8/6 and 5RP 7/10 respectively. For Japanese, the female image was showed 7.5RP 6/12, 2.5R 6/8 and 2.5R 6/12 respectively. In figure 8 is comparison of only first rank of selecting color that represented male and female image of Thai and Japanese. 10B 5/10 was high frequency selected for male image for Thai people and its color was lighter than Japanese selected color 5PB 4/12 which was lower value and higher chroma. In the point of view of author in Japanese selected color for male image it might be caused by their get used to with the color code which normally seen at the toilet sign. In the case of Thai people selected color for male image it may come from their organized image or experience from other products color that normally use blue color tone for male.

The result of color representing to female image was showed high selected at 2.5R 7/8 for Thai. The color appearance for 2.5R 7/8 was pink slightly red. And for Japanese showed 7.5RP 6/12, it's colored quite pink slightly blue which is similarly to the female toilet sign in Japan. This finding is agreed with Anya C. Hurlbert et. al. that showed the color preference difference between male and female by using CRT display and using forced- choice 'color-picking' task with colorimetrically controlled stimuli separating the relative contributions of hue, saturation and lightness. Their results showed average color for female preference at reddish-purple region and male preference showed at blue-green region.  In addition, color preference of male and female slightly differed by counties such as UK preferred reddish purple for female and bluish green for male. However, China preferred reddish yellow for female and reddish purple for male.

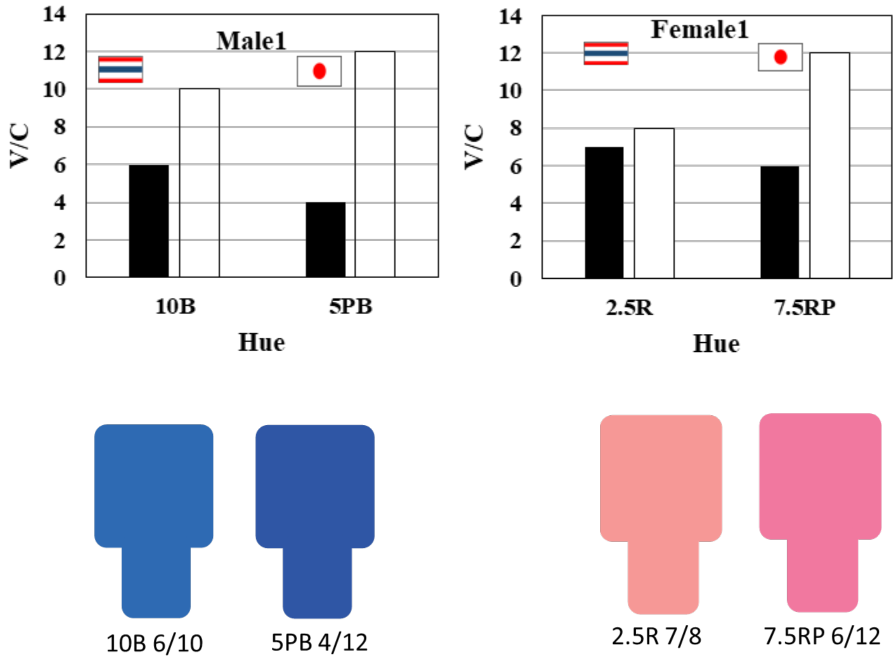



**Figure 8. Comparison of color that representative to male and female image of Thai and Japanese. Solid bars indicate value and opened bars indicate chroma.**

## ACKNOWLEDGEMENT

Wipada Pumila thanks RMUTT for giving her the Co-operative Education, Rajamangala University of Technology Thanyaburi scholarship that made her to spend at Chiba University for 3 months to carry out internship. Also thanks students at Prof Mizokami's laboratory at Chiba University who helped her experiment and for serving subjects.

## REFERENCES

1. Rost, L.C. (2018). An alternative to pink &blue: Colors for gender data. Retrieved September 22, 2019. https://blog.datawrapper.de/gendercolor/.
2. Maritomo. (2019). Japan's Toilet Signage Goes Global. Retrieved September 22, 2019, from https://www.nippon.com/en/guide-to-japan/gu006004/japan's-toilet-signage-goes-global.html.
3. Hurlbert, A. C., & Ling, Y. (2007). Biological components of sex differences in color preference. *Current Biology*, 17(16), 623–625. doi: 10.1016/j.cub.2007.06.022

# EFFECT OF HAZE VALUE AND MATERIALS ON THE COLOR APPEARANCE IN THE TISSUE EXPERIMENT OF THE SIMULTANEOUS COLOR CONTRAST

Supattra Jinphol[1]*, Mitsuo Ikeda[1], Chanprapha Phuangsuwan[1], Yoko Mizokami[2]

[1]*Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2]*Graduate School of Engineering, Chiba University, Japan.*

*Corresponding author: Supattra Jinphol, 11591080200077@mail.rmutt.ac.th, supattra4762@gmail.com

**Keywords**: Simultaneous color contrast, paper stimuli, display stimuli, tissue, chromatic adaptation

## ABSTRACT

A stimulus of the simultaneous color contrast is a small gray patch surrounded by a color. When the stimulus is made by a paper the gray patch does not give a vivid color. But when we observe the stimulus through a paper tissue the phenomenon is enhanced and the gray patch presents a vivid complementary color to the surrounding color. In this report various materials such as a tissue, ground glass and fabrics were employed and the effect to the simultaneous color contrast was investigated. There was found no effect of materials. The effect increased for higher haze value of the cover sheet to HV 80, beyond which it started to decrease. The effect was measured for display stimuli. When the stimulus on a display was observed through a tissue the color of the gray patch became more vivid than the color seen on paper stimuli through a tissue.

## INTRODUCTION

When a gray patch is surrounded by a color, the patch appears roughly opposite color of the surrounding color, which is called the simultaneous color contrast SCC phenomenon. When the pattern is made of printed papers the phenomenon is not strong and the central gray remains gray if not colored. It was pointed out in text books [1][2] that if the pattern is covered by a white tissue the phenomenon becomes evident and the color of the gray patch appears vivid. No quantitative description is not given in these text books and we though it worthwhile to investigate quantitatively the effect of tissue by using the elementary color naming method. It is considered that the effect of tissue is the effect of scattering light from the surface. The properties expressed by the haze value. If the haze value of the tissue is changed the effect of SCC is expected to change. In this report the haze value of the tissue is changed by adopting umber of sheets and the SCC is measured for them. We are interested if different materials beside tissue may give different effect and some appropriate materials will be investigated for the SCC.

## STIMULI

To obtain different haze value of cover sheets, commercially available sheets of various materials were collected, tissue papers of 5 different brands, 4 different fabrics including silk, and a ground glass of 5 mm thickness. Tissues of different brands did not show difference in HV and we employed only one of them in the experiment. Fig. 1 shows HV of different materials. Along the abscissa number of sheets of tissue and silk fabric is taken and along the ordinate the HV. A tissue had HV of over 80 with one sheet, much higher than HV of a silk fabric. It became equivalent to that of one tissue when 5 sheets were overlaid. Other materials, a ground glass, a Toray fabric, and a lining fabric gave a similar HV as one sheet of tissue as shown by symbols, ◇, * and Δ, respectively.

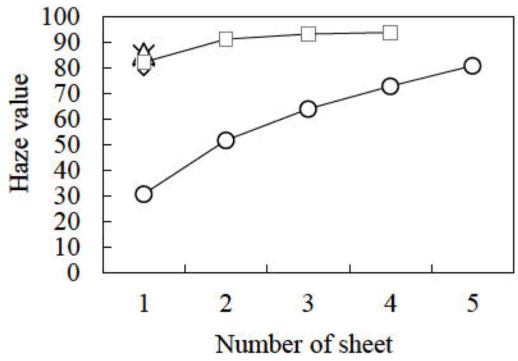



**Figure 1 Haze value of cover sheet for different number of sheets. Symbols indicate materials, ○, silk fabric, □, tissue, ◇, ground glass, Δ, lining fabric, and *, Toray fabric.**

SCC stimuli were made of printed papers of four colors and of the size 23x23 $cm^2$ . At the center a gray patch of Mussel Value of about N5 of the size 3 x 3 $cm^2$ was pasted. The four colors of the surround were red, yellow, green, and blue and their chromaticities are shown by open circles in Fig. 2. A cross indicates the chromaticity of the central gray test patch. Their values are listed on Table 1 including L*, a* and b*. Small filled circles indicate surround colors with one tissue and their colors are very much desaturated coming close to a white. Open squares are chromaticities of four colors when they are presented on a display, which is employed in Experiment 2. Those paper test stimuli were placed on a table in a room lit with ceiling fluorescent lamps of the daylight type. On the table the illuhminance was 1116 lx.

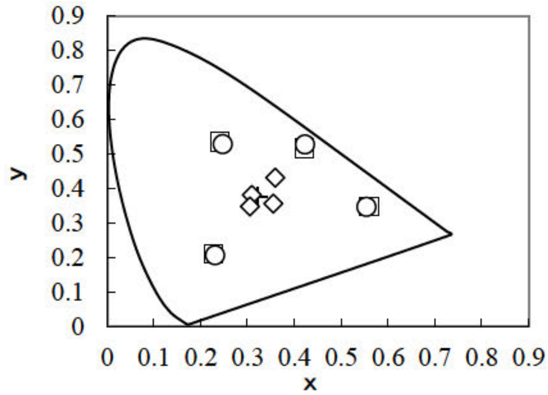



**Figure 2. Chromaticities of four colors of surround in Experiment 1 (○), in Experiment 2 (□), ◇ shows paper stimuli with a tissue and cross shows a white color of tissue.**

**Table 1: Color specifications**

| Color | Y | x | y | L* | a* | b* |
|---|---|---|---|---|---|---|
| R | 63.4 | 0.554 | 0.346 | 41.02 | 62.56 | 45.88 |
| Y | 166 | 0.423 | 0.527 | 86.27 | -14.9 | 90.19 |
| G | 36.7 | 0.247 | 0.528 | 44.61 | -72.22 | 30.07 |
| B | 13.5 | 0.231 | 0.206 | 19.9 | 24.84 | -43.18 |
| Test | 53.4 | 0.315 | 0.364 | 59.31 | -0.09 | 0.62 |

### Experiment 1

In this experiment paper stimuli were investigated. Three subjects participated in the experiment. When a subject entered the experimental booth, he/she was presented a test stimulus with a cover sheet. He / She judged the color of the gray test patch by the elementary color naming method, namely amounts of chromaticness, whiteness, and blackness in percentage. If there was chromaticness he/she judged amounts of unique hues in percentage. After the judgment another cover sheet was given. This process was continued until all the cover sheets, 13 sheets altogether, were investigated. In the case of the frosted glass, only the frosted surface up was investigated.

## RESULTS

### Results of Experiment 1

Results are shown in Fig. 3 for the subject SJ for four surrounding colors. The abscissa gives HV and the ordinate the amount of chromaticness after the elementary color naming. Each point is the average of three repetitions. An open circle at HV=0 was given without a cover sheet, namely a direct observation of the test patch. The amount of chromaticness was 12 %. Filled circles are from silk fabric and open diamonds are from tissue. One tissue had HV of about 80 and the subject observed 23% of chromaticness for red surrounding, 33 % for yellow, 20 % for green, and 20 % for blue. They were all higher value compared to 12% of the direct observation of the test patch. Fig. 4 shows results of another subject SC. In her case the amount of chromaticness was not significantly larger than that of the direct observation for red and green surroundings, but it was larger for yellow and blue surroundings.

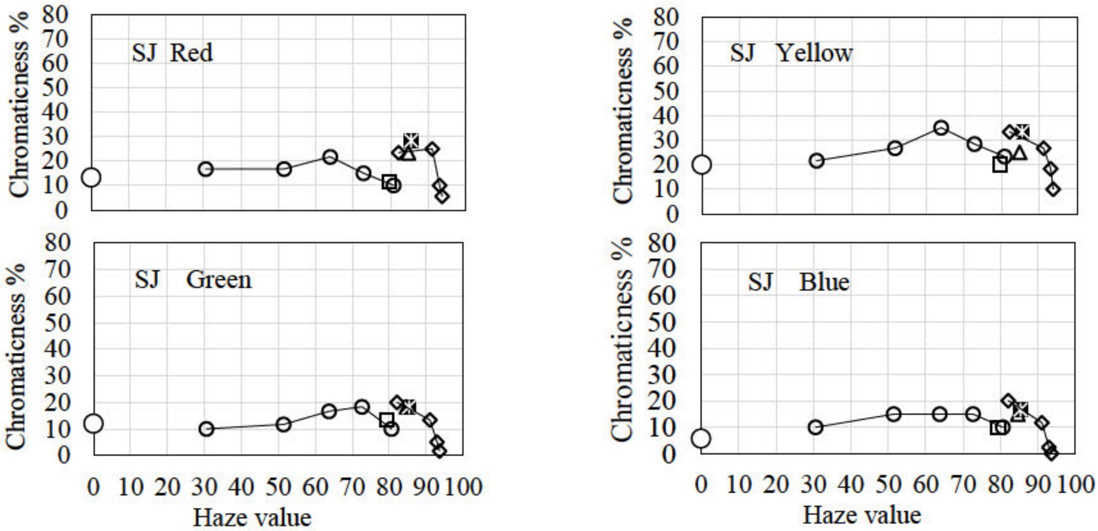
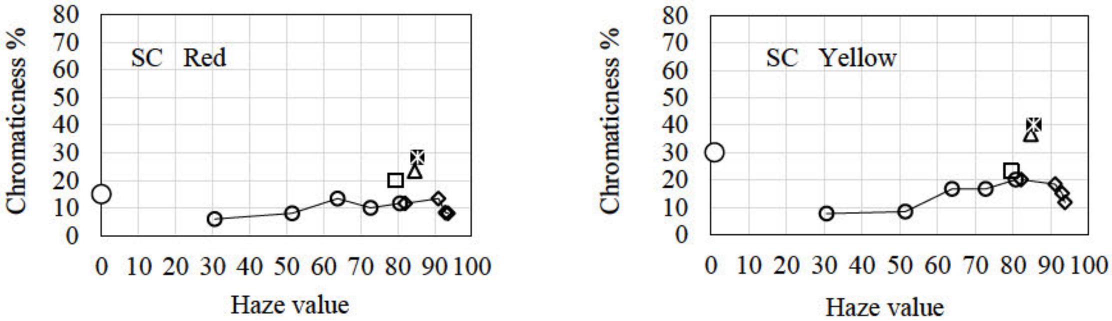



**Figure 3. Amount of chromaticness plotted for HV of different materials judged by the subject SJ.**



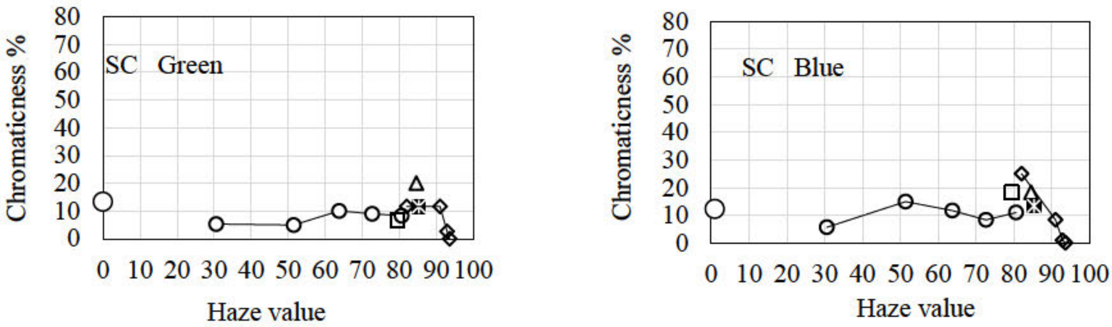



**Figure 4. ibid. but for the subject SC.**

Fig. 5 gives the average of three subjects. Open circles are from silk fabric and open triangles are from tissue. By observing both curves we may say that the increase of HV induced more chromaticness but the results from tissue indicate the amount of chromaticnes begins to reduce at HV of 80.

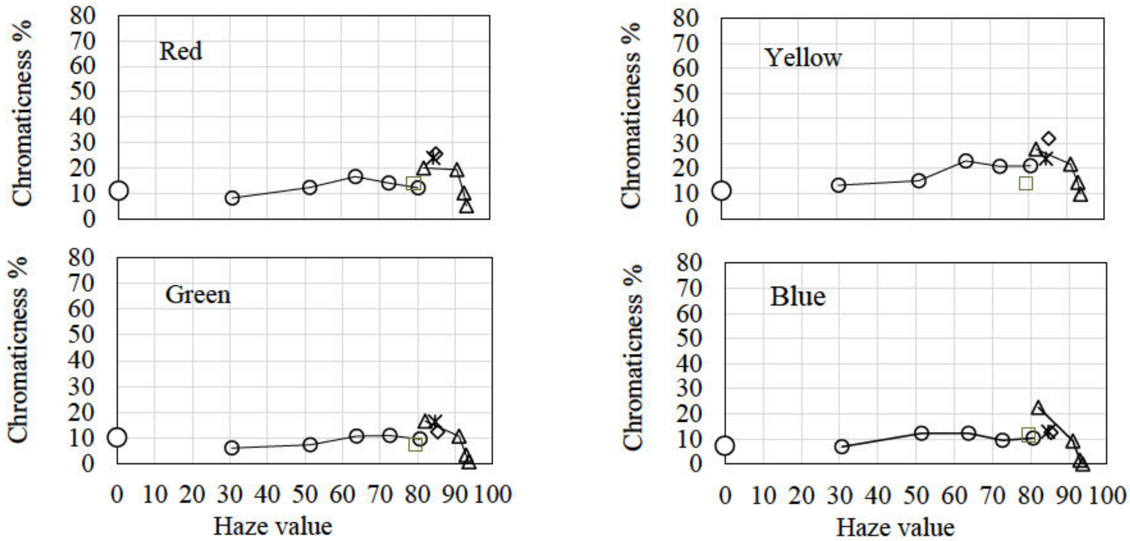
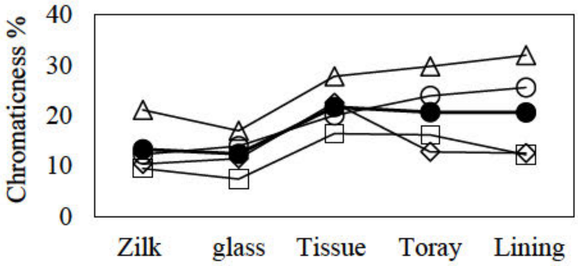



**Figure 5. Averaged amount of chromaticness of three subjects plotted for HV.**

Different material gave different effect on the SCC. The amounts of chromaticnes at around 80 are taken from Fig. 5 and shown in Fig. 6 for different materials. Symbols indicate the color of surrounds, ○, red; △, yellow; □, green; ◇, blue. Solid circles with a thick lines are the verge. Tissue cover seems to give the strongest effect for the SCC phenomenon. The effect is rather small with silk and ground glass.




**Figurer 6. Amount of chromaticness for different materials of HV 80.**

## EXPERIMENT 2

In this experiment a display is used to present the SCC stimulus and the experiment was carried out at Chiba University. Japan and Rajamangala University of Technology Thanyaburi RMUTT as one of the authors SJ of MUTT stayed at Chiba U to do internship.

### Experiment 2

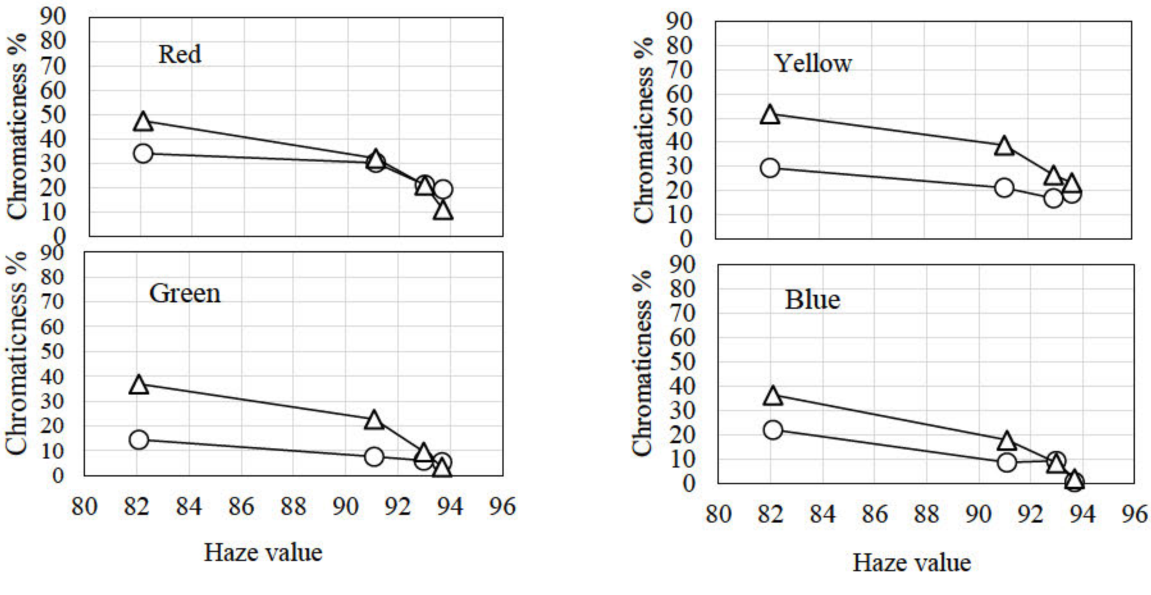
The same colors, red, yellow, green, and blue were employed which were made same as Experiment 1. Their chromaticities were shown by open squares in Fig. 1. The chromaticity points completely overlap with those at RMUTT (○). The display was EIZO.

In Chiba experiment surrounding colors of display were made same as paper stimuli with tissue of different number. To do this the colors of paper stimuli with different number of tissue were measured. At each presentation of SCC stimulus on display subjects adapted for 1 minute before judging color appearance. Five subjects, two Japanese and three Thai participated in the experiment. Each subject repeated for five times of judgment.

In RMUTT experiment colors and shape of paper stimuli were reproduced on a display and the color judgment was made for tissues overlaid on the display. The display was laid down horizontally to make the observing condition exactly same as for the paper experiment. No adaptation time was given. Three Thai students participated in the experiment and the judgment was repeated for three times in both display and in paper experiment.

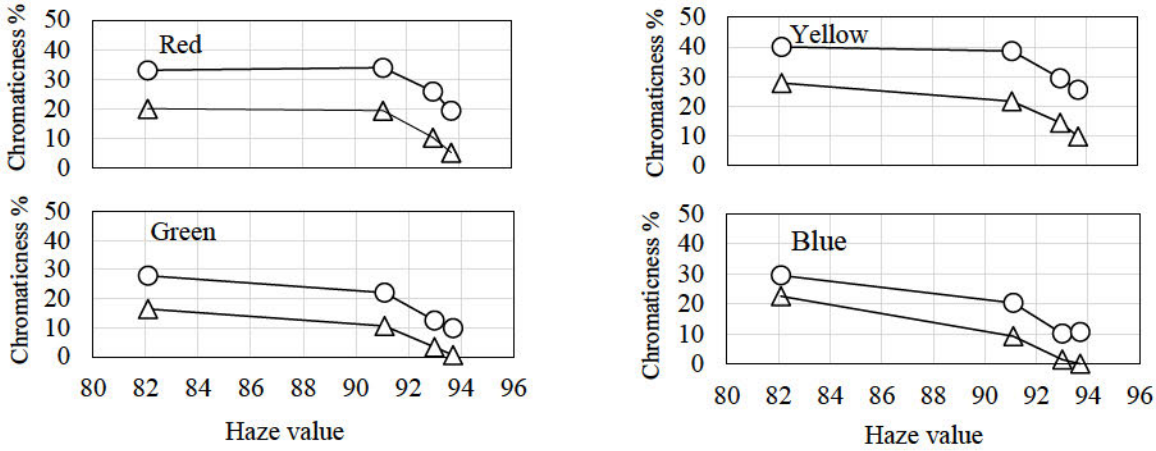
## RESULTS OF EXPERIMENT 2

Results of Chiba U are shown in Fig. 7. Along the abscissa HV is taken and along the ordinate the amount of chromaticness is taken. Results of display are indicated by open circles and those of paper stimulus by open triangles. For all the colors of surround the chromticness was larger with display.




**Figurer 7. Amount of chromaticness for different HV with display stimuli (○) and paper stimuli (△). Data obtained at Chiba U.**

Results of RMUTT are shown in Fig. 8. On the contrary to Chiba results chromaticness was larger with display.




**Figurer 8. Amount of chromaticness for different HV with display stimuli (○) and paper stimuli (△). Data obtained at RMUTT.**

## CONCLUSION AND DISCUSSION

Amount of chromaticness gradually increased with increase of HV of tissue when the color appearance of the central gray patch surrounded by some color was measured by the elementary color naming method. The increase stopped at around HV=80, beyond which the amount rapidly decreased. Different materials were employed as a cover sheet, but no significant difference was found for the SCC phenomenon.

Paper stimuli and display stimuli were compared for the effect of SCC. Results of Chiba University showed larger chromaticness with paper stimuli than the display stimuli. Stimuli on the display were made same with paper stimuli with tissue in color but the appearance of the shape of the test patch was not made same. While it is blurred in the paper stimuli it remained sharp in the display stimuli. Graham and Brown2) pointed out that the fact that a tissue obscures contours as well as to reduce saturation and evidence of texture may increase the vividness of the induced color. This explanation may apply to the difference of the results between two universities. In the case of RMUTT subjects noticed the stimuli appeared brighter with display. This might cause the chromatic adaptation to surrounding color worked stronger than the paper stimuli.

## ACKNOWLEDGEMENT

Suppattra Jinphol thanks RMUTT for giving her the Co-operative Education, Rajamangala University of Technology Thanyaburi scholarship that made her to spend at Chiba University for 3 months to carry out internship. Also thanks students at Prof Mizokami's laboratory at Chiba University who helped her experiment and for serving subjects.

## REFERENCES

1. Parsons, J H (1924). *An introduction to the study of color vision.* 2nd ed. 139. Cambridge Press
2. Graham, C H. and Brown, J L, John Wiley& Sons. (1965). *Vision and visual perception*, Chapter 16 "Color contrast and color appearance: Brightness constancy and color constancy" p.461.

# EFFECT OF VIEWING DISTANCE TO THE SIMULTANEOUS COLOR CONTRAST

Piyamon Nguensawat[1*], Mitsuo Ikeda[1], Chanprapha Phuangsuwan[1], Yoko Mizokami[2]

[1] *Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2]*Graduate School of Engineering, Chiba University, Japan*.

*Corresponding author: Piyamon Nguensawat, 1159108020622@mail.rmutt.ac.th, nammon.png@gmail.com

**Keywords**: Simultaneous color contrast, Visual angle, Recognized visual space of illumination, Chromatic adaptation

## ABSTRACT

When a small gray patch is surrounded by a colored field the patch appears a color roughly complementary to the surrounding color. This is a phenomenon called the simultaneous color contrast SCC. When the stimulus pattern is made of a paper the phenomenon is quite small. In the present research the visual field size for the SCC stimulus was extremely enlarged by making the stimulus horizontally curved and the color appearance of the gray patch was measured by the elementary color naming method for different observing distance. The vividness of the color of the gray patch increased for shorter distance to confirm the prediction based on the concept of recognized visual space of illumination RVSI [1] but partly. Even in the case of the shortest viewing distance the amount of chromaticness did not significantly increase.

## INTRODUCTION

Chromatic adaptation is a popular subject in the study of color vision and the concept of recognized visual space of illumination RVSI proposed by Ikeda asserts that the human visual system adapts to the illumination color of the space where the observer stays and not to the object color that he/she is looking at [1]. Thus, the effect of the simultaneous color contrast SCC is not strong on a printed paper as the observer recognizes an object for the paper and hardly recognizes the illumination on the paper. If, however, the SCC pattern occupies a large area of the retina it becomes hard for the observer to recognize the pattern as an object. Then, the adaptation to illumination that is transferred from the object color should become apparent and the effect of SCC should become large. In the present experiment a paper pattern of SCC is presented as to make an arc with convex toward a subject to delete the recognition for an object and emphasize recognition of illumination. If the viewing distance becomes very short so that the eyes come inside the arc of the stimulus the subject cannot recognize the edges of the stimulus. An object appearance is composed of two, one is its shape or contours and the other is the color or light filling in the contours. If the subject cannot see the edges he/she only recognizes color or light and the color appearance of the central gray patch should become vivid. The color appearance was measured as a function of the viewing distance by the elementary color naming method.

## EXPERIMENT

Four colored papers, red, yellow, green, and blue of which size was 66 cm wide and 52.5 cm high were held at a frame to serve a SCC stimulus as shown by a thick semicircle line in Fig. 1. The radius of the circle was 22 cm. A subject S stood in front of the stimulus at distance d from the gray test patch T. The visual angle of the stimulus for the subject was determined by the opening size of the semicircle indicated by a dotted line (44 cm) and the viewing distance.

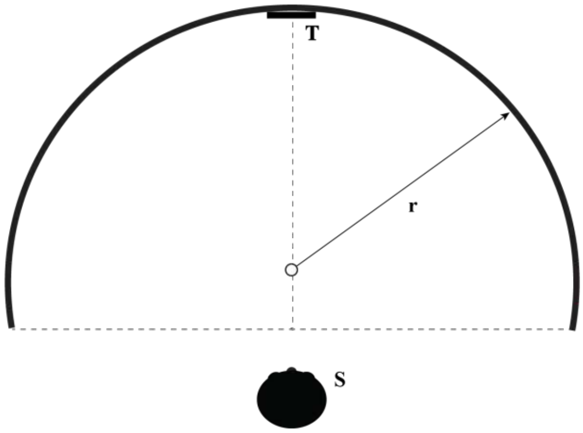



**Figure 1. Experimental arrangement seen from above.**

Relation of the viewing distance to the visual angle is shown in Fig. 2. It becomes more than 180° when the eyes come close to the test patch. At 27 cm both edges of the stimulus disappeared from the subject's visual field.

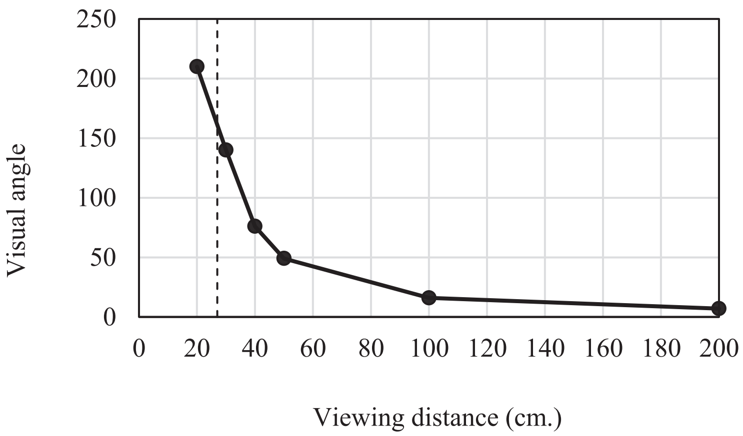



**Figure 2. Visual angle-viewing distance relation.**

The SCC stimulus was illuminated by two fluorescent lamps of the daylight type placed at upper position of the stimulus the ceiling lamps of the same type of fluorescent was lit during the experiment. The vertical plane illuminance at the test patch was 667 lx. Under this illumination the chromaticities of the gray test patch were x=.323 and y=.352, which is indicated by a cross in Fig. 3. Its illuminance was 57 cd/$m^2$. Chromatic points of four surroundings are shown by open circles. Their luminance was 41, 138, 33, and 27 cd/$m^2$, respectively for red, yellow, green and blue.

Three subjects participated in the experiment. The subjects' task was to judge the color of the test patch by the elementary color naming method by using two eyes. The viewing distance was randomly chosen from dashed line indicates the visual and the vertical 20, 30, 40, 50, 100, and 200 cm. When a subject saw the test patch its color appearance sometime changed gradually. In such case the subject was instructed to wait until the appearance became stable. This particularly happened at very short viewing distances such as 2 and 3 cm. In such case the adapting time became one or two minutes.

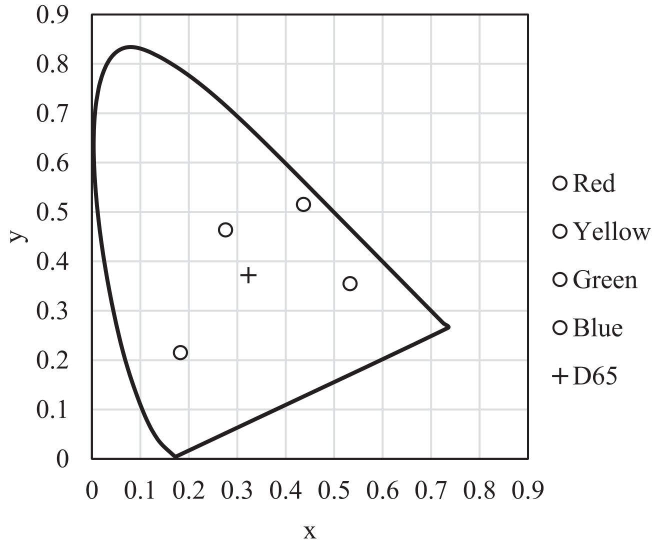



**Figure 3. Chromaticities of red, yellow, green and blue surrounds, shown by open circles, and of gray test patch shown by a cross.**

## RESULTS

Results are shown in Fig. 4 for all three subjects, PN, SJ, and MI. They repeated the judgement for 8, 7, and 6 times. There were 4 months past from the first experiment to the last experiment. The abscissa gives the visual angle in degrees and the ordinate the amount of chromaticness in %. The vertical dashed line indicate the visual angle beyond which subjects could not see edges of the SCC stimulus. Colors of the stimulus were indicated by different symbols, circles for red, triangles for yellow, squares for green, and diamonds for blue. Each subject showed small amount of chromaticness at the viewing distance 200 cm and rapid increase for 100 cm distance. After that a gradual increase was observed. But there are difference observed among individuals. The subjects SJ and MI did not see or only small amount of color on the test patch at 200 cm, implying no simultaneous color contrast for any color of surrounding, while the subject PN could see a large amount of color at the viewing distance, especially for the yellow surrounding. She experienced a strong simultaneous contrast phenomenon for the yellow surrounding for all the viewing distances. In her case the phenomenon was weak for the blue surrounding. MI did not see any color for the blue surrounding and the amount of chromaticness was zero for all the viewing distance.

Fig. 5 gives the average of the three subjects shown in Fig. 4. All the colors showed a similar shape of curve, a rather rapid increase at small visual angle and a gradual increase up to the largest visual angle employed. The SCC phenomenon was strongest for the yellow surrounding and smallest for the blue surrounding. It is seen in Fig. 5 that any sudden change of chromaticness amount was observed at the visual angle shown by a dashed line.

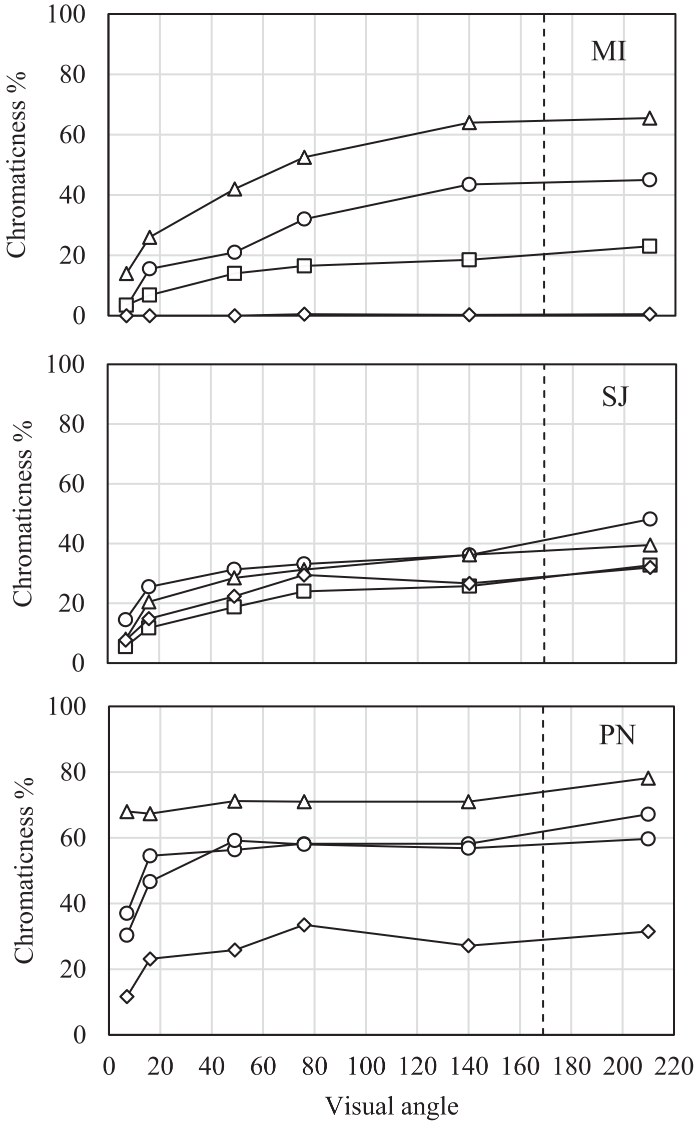



**Figure 4. Amount of chromaticness plotted for viewing visual angle for three subjects○, red surround;△, yellow;□, green;◇, blue.**

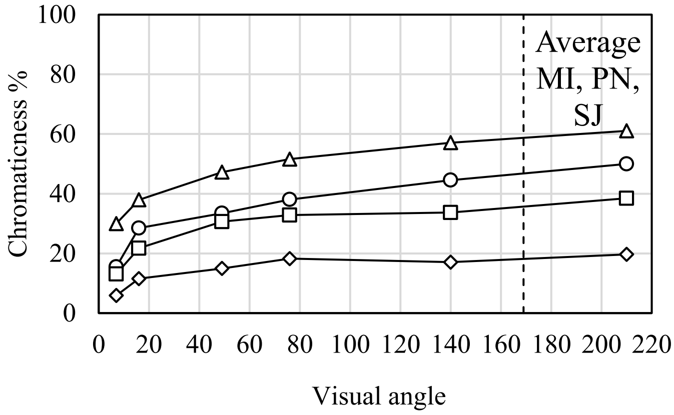



**Figure 5. Average of chromaticness amount plotted for viewing visual angle.**

The apparent hue of the induced test patch color was obtained by the amounts of red, yellow, green, and blue unique colors and it can be shown on a polar diagram used in the opponent colors theory. Fig. 6 shows the average of three subjects of the apparent hue of the surrounding (open symbols) and the apparent hue of the test patch (filled symbols). The angle from the red axis in the anticlockwise direction gives the apparent hue angle and the distance from the origin to a point shows the amount of chromaticness, the circumference showing 100 % of chromaticness. Surrounding colors were almost unique red, yellow, green, and blue as seen by their points almost on the horizontal and vertical axes. The induced color by the red surrounding was greenish blue or cyan, which is not green, the opponent color to the red as already confirmed [2]. This indicates that the SCC does not follow the opponent colors theory. It is true with the green surrounding, which induced blueish red color to the test patch. Yellow and blue surroundings gave the test patch almost opponent colors, blue and yellow, respectively.

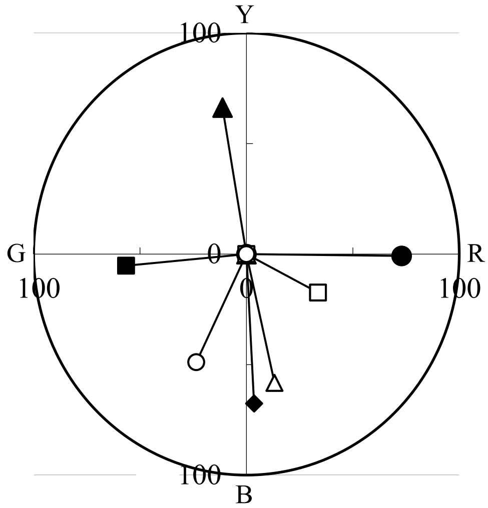



**Figure 6. Apparent hue of surrounds (filled symbols) and the corresponding test patch (open symbols) plotted in a polar diagram.**

## DISCUSSION AND CONCLUSION

The simultaneous color contrast phenomenon became larger for shorter viewing distance, namely for larger visual angle. This is in accordance with the concept of the recognized visual space of illumination RVSI proposed by Ikeda, which insists that the chromatic adaptation takes place to the illumination not to the color of object [1]. In the SCC the illumination comes from the color of the surrounding. The surround is composed of a shape or contours or outlines and color or light. If the former recognition is reduced the remained is the color or light and a subject get larger chromatic adaptation. When the viewing distance was extremely shortened as the visual angle exceeded to extinguish the edges of the stimulus this situation should occur and the SCC phenomenon becomes very strong. Fig. 5, however, did not indicate the expectation as the chromaticness mount did not significantly increase beyond the dashed line.

## ACKNOWLEDGEMENT

Piyamon Nguensawat thanks RMUTT for giving her the scholarships, the student development foundation of RMUTT that made her to spend at Chiba University for 3 months to carry out internship. Also thanks students at Prof Mizokami's laboratory at Chiba University who helped her experiment and for serving subjects.

## REFERENCES

1. Ikeda M. (2004). Color appearance explained, predicted and confirmed by the concept of recognized visual space of illumination. *Opt. Rev*. 11, 217-225.
2. Phuangsuwan C. and Ikeda M. (2017). Chromatic adaptation to illumination investigated with adapting and adapted color. *Color. Col Res Appl*. 42, 571-579. doi.org/10.1002/col.22117

# CHROMATIC ADAPTATION TO ILLUMINATION

**Chanprapha Phuangsuwan***
*Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand*
*Corresponding author: Chanprapha Phuangsuwan, Phuangsuwan@rmutt.ac.th

**Keywords**: Chromatic adaptation, adapt to illumination, RVSI Theory, Devices, 2D picture

## ABSTRACT

Here we like to demonstrate chromatic adaptation to illumination based on the concept of the recognized visual space of illumination RVSI developed by Ikeda. Pungrassamee et al. (2005) also showed that color appearance of achromatic patch depended on which illumination that subject adapted to. Phuangsuwan et al. (2013) showed that to recognize the 3D space on 2D picture so that subject could adapt to the illumination in the 2D picture the color constancy occurred in this circumstance. Recently we demonstrate the chromatic adaptation to illumination under various devices; paper, projector, display and real scene (two-room technique). The result suggests that at projector and display show the strong chromatic adaptation almost same as in the real scene.

## INTRODUCTION

It is a classical topic, "Chromatic adaptation", which was taken up by many researchers proposing great theory in the past up to now. [1] For example, a white and a black paper under the strong sunlight reflecting a lot of light to our visual system, they are perceived white for the white paper as white and the black paper as black. Another example that is a white paper under an incandescent light, but we perceive it a white paper in spite of the yellowish light. Our visual system has ability of discount color from illumination that is called "color constancy". The well-known Von Kries coefficient law describes the relationship between the illuminant and the human visual system sensitivity. [2] Illumination is a big factor which affects our color perception. Ikeda proposed the Recognized Visual Space of Illumination, RVSI theory [1-2] to explain how our color vision works. It emphasizes the adaptation to illumination. The theory says when a person enters to a room (space) he/she recognizes the space and understands the illumination, then adapts to illumination in the space. After that he/she perceives real color of an object. The color constancy takes place. This is an action of the brain. RVSI for the illumination is constructed. Pungrassamee also demonstrated the color appearance of a gray patch depending on which illumination he/she adapted. [3] It is a common understanding that the color constancy does not take place for a 2D photograph. Nevertheless, according to the RVSI concept there is a possibility of the color constancy in a 2D photograph. Namely if we can recognize a 3D space in the photograph, we can understand the illumination and consequently the color constancy holds. This was indeed proved by Phuangsuwan by two approaches, color appearance and chromatic adaptation. [4] Currently, color vision researches normally conduct the psychophysical experiment by using self-luminous display. It is interested to know how our color vision work with the self-luminous circumstance. Phuangsuwan demonstrated chromatic adaptation through simultaneous color contrast phenomenon on various devices such as paper, two-room technique, display and projector and found that the chromatic adaptation was device dependent.

## EXPERIMENT

Chromatic adaptation to illumination will be described by color appearance through two-room technique and D-up viewer, second by simultaneous color contrast on various devices.

Refer to Pungrassamee's work, the color appearance was measured for a gray test patch which was placed in a test room illuminated by daylight lamps and was looked at from a subject room illuminated by one of four colored illuminations, red, yellow, green and blue, through windows of various sizes as shown in Fig. 1.

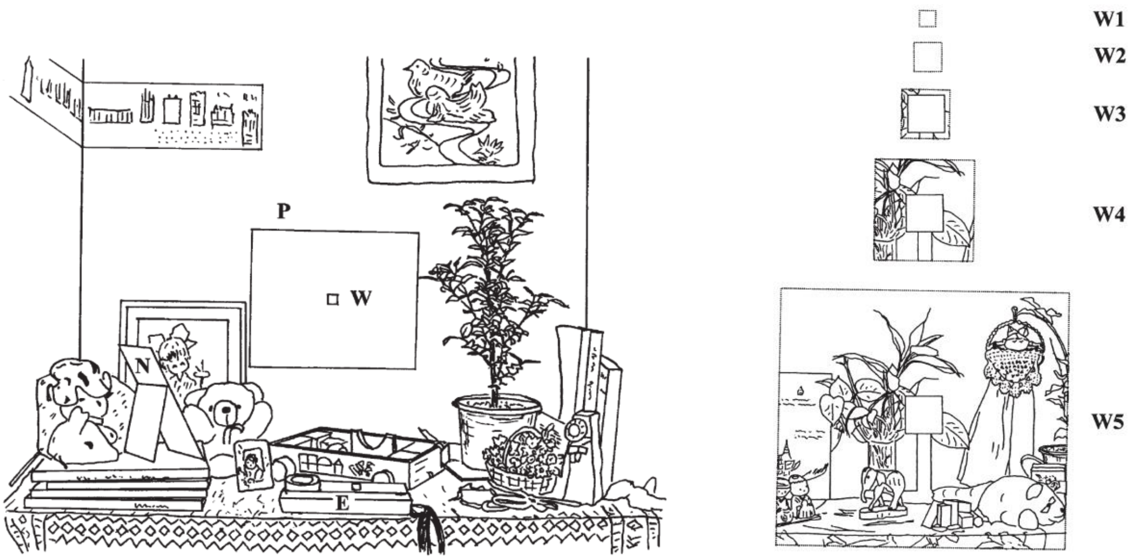



**Figure 1. Front view in the subject room (left) and view of the test room under different size of windows (right) [3].**

Based on the above experiment we simulated the same circumstance but, on photograph, and giving a perceived space to photograph by using D-up viewer and checked the color appearance of the gray test patch at the center of the front wall (see the left figure of Fig. 2). The experimental room was built as we called a two rooms technique or stimulus and environment independent technique. On the separating wall a window was opened to show the test patch from test patch room. The middle figure of Fig. 2 shows a different size of window from W1 to W5 and at W1 and W2 a subject could see only a gray test patch but from W3 to W5 subject gradually sees the objects in the test room. Four colors of light were adopted to illuminate the subject room and it was red, yellow, green and blue. Twenty photographs were prepared (4 color lights x 5 sizes of window). The task of subject was to judge the color of a gray test patch through the window on the front wall in the real room by elementary color naming method which judged the percentage of chromaticness, whiteness and blackness totaling 100%, and then judged the color by unique red, yellow, green and blue in percentage. The subject was asked to move out from the real room and was asked to judge the color of gray test patch in a photograph on a LCD display through a D-up viewer by the color naming method as before. The subject was asked to do the experiment five times. Five subjects who have a normal color vision participated in this experiment.

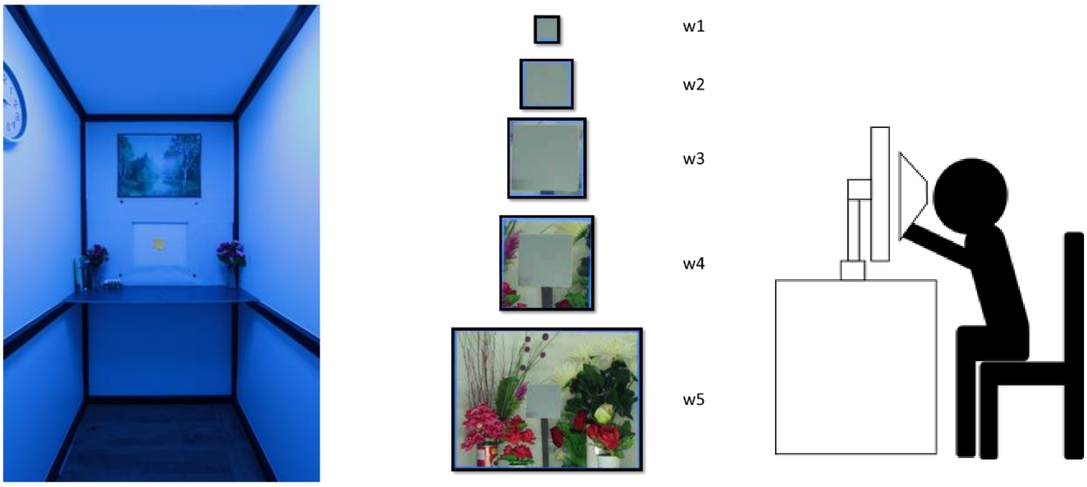



**Figure 2. Front view in the subject room (left), view of the test room through different sizes of window (middle) and photograph on display observing through D-up viewer (right).**

The concept of RVSI theory that says recognition of a space and adaptation to the illumination in the space is very importance for the color perception. Here we demonstrate the chromatic adaptation to illumination by the phenomenon called “simultaneous color contrast” under the various devices. The most common and traditional pattern was presented on a paper as often demonstrated on textbooks, which we call object color mode experiment. The recently many researchers use display unit, with which people can manipulate stimulus pattern easily for various experimental conditions. It is possible that different devices give different data to draw different conclusions about the simultaneous color contrast. In this experiment the central gray patch was an achromatic paper of Munsell Value N6. A similar visual field was prepared with four difference devices; object stimulus made of a paper covered with a tissue (Fig. 3 c) and without the tissue (Fig. 3 d), a display (Fig. 3b), a projected pattern (Fig. 3 d), and two rooms technique (Fig. 3 a). Four colors, red, yellow, green, and blue were employed for the surround and they were of a large size. We reproduced the similar colors for all the five devices. The luminance of the surround was set similar among five. In the object with tissue the color appearance of stimulus was judged with a commercially available tissue paper placed on and over the stimulus. Both object and tissued object were observed under fluorescent lamps of the daylight type as shown in Fig.3c, d. Figure 3a illustrates the two-rooms technique. The illuminance level in the test room was adjusted so that the appearance at W was the object color mode and the horizontal plane illuminance was 30 lx just in front of the gray test patch T. The subject room was illuminated by LED lamps and when it was red, for example, a stimulus pattern of the simultaneous color contrast of red surround was produced on the retina. The color appearance was judged by the elementary color naming method. When a stimulus was presented a subject adapted to the field for about one minute and judged the color appearance of the central patch, and then the surround. Four colors were pseudo-randomly presented. The judgment was done for the central test patch and for the surround. For each stimulus condition the judgement was repeated for five times on different day or time. Five subjects participated in the experiment.

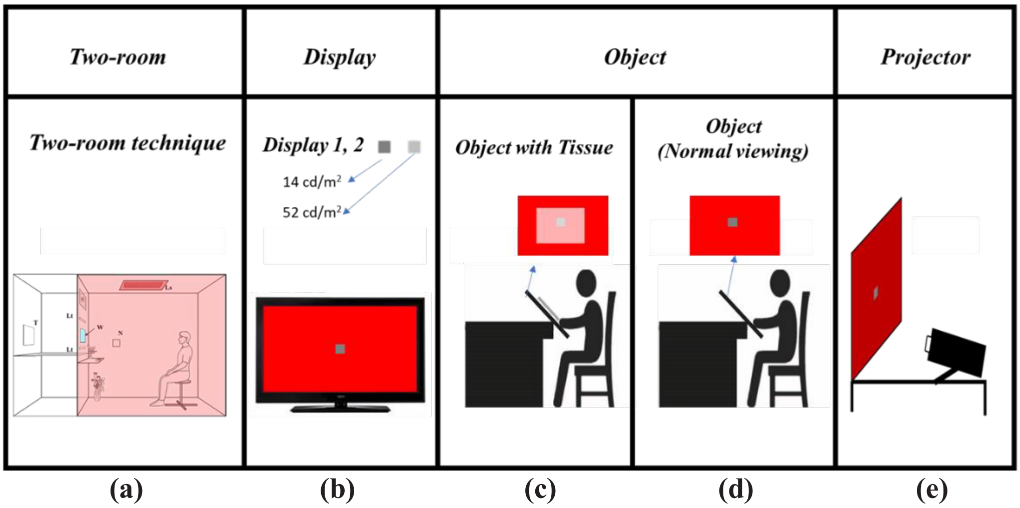



**Figure 3. Different devices. a, two-rooms technique; b, display; c, object with tissue; d, object without tissue; e, projector.**

## RESULTS AND DISCUSSION

Pungrassamee et. al. found the color appearance of test patch was dependent on the color of illumination to which the subject adapted. The results were plotted on a polar diagram used in the opponent color theory as shown in Fig. 4. The results were under the yellow light (■) and the test patch was green color condition. The open small symbols represent the color appearance of green test patch under W1 and W2 and filled small symbols were from W3 to W5. The result showed that the color of green test patch returned to the original green when subjects could recognize the illumination in the test room. In the case of W1 and W2 subjects recognized the yellow illumination in the subject room and chromatic adaptation was working for the yellow light causing to the green test patch appeared blue color because of color constancy worked for the yellow illumination in the subject room.

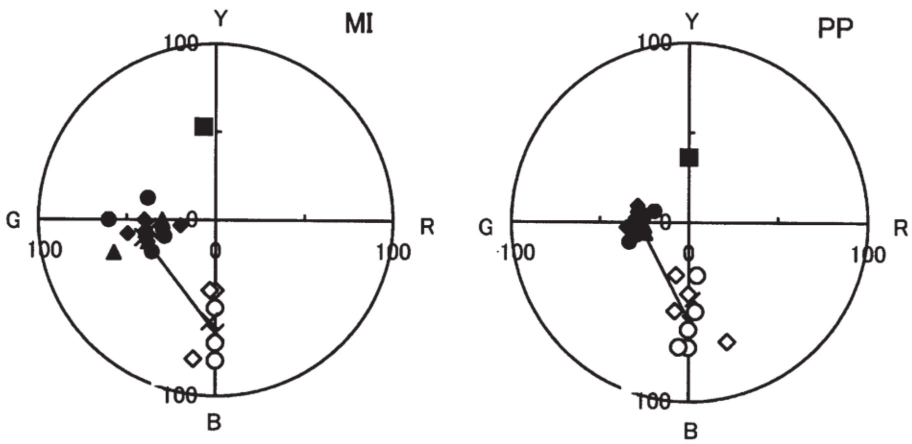



**Figure 4. Example result from 2 subjects under yellow light and green color of test patch.**

Figure 5 was the mean results of the gray test patch under red (■), yellow (◆), green (▲) and blue (●) lights. The polar diagram on the left most shows the results with the two-room condition, the middle shows results of D-up view condition and the right most shows results of normal view (2D) condition. Note that in the D-up view and normal view subjects observed the color of gray test patch in photographs. We found similar result as Pungrassamee in the two-room case where subjects adapted to color lights in the subject room and showed very vivid complementary color for the gray test patch for W1 and W2. The color of gray patch returned to the original at the W3 to W5. It was very interesting to confirm the prediction of RVSI theory with the D-up view experiment that the subjects could perceive a three dimensional (space) in the photographs and perceived the complementary color at gray test patch in W1 and W2 and the color almost disappeared from W3 to W5 respectively. With the normal view (2D) condition the color on the gray patch almost disappeared. The result strongly implied the chromatic adaptation to illumination was important to the color appearance of an object.

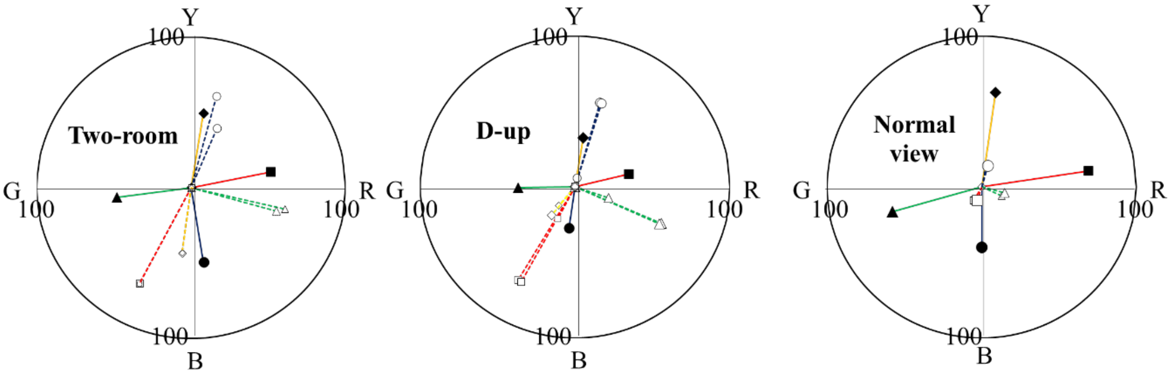



**Figure 5. Mean of color appearance from W1 to W5 under red, yellow, green and blue.**

The average result of chromatic adaptation to illumination through simultaneous pattern under various devices was showed in Fig. 6. Those results were the color appearance of a gray test patch which was surrounded by color red (○), yellow (△), green (□) and blue (◇). The large filled symbols were the color of surrounding. The results showed that the color of a gray test patch was complementary to the color of surrounding and it appeared the most vivid with the two-room, then display, projector, paper with tissue and paper without tissue in that order. The result suggested chromatic adaptation was working very well with devices to give light directly to the eyes like the two-rooms technique, a self-luminous display, and stimulus produced by projecting light on a white screen but not to the light reflected by an object, to which the light color belongs.

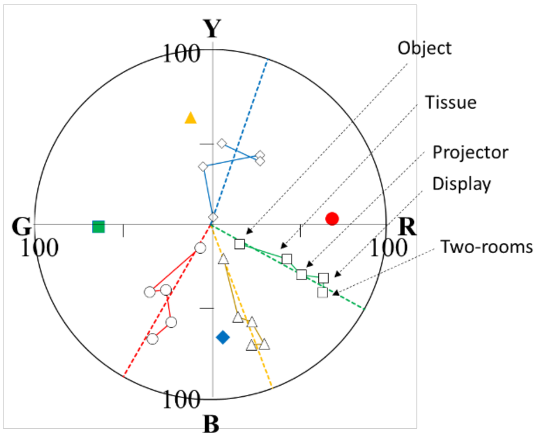



**Figure 6. Averaged results of five subjects of color appearance of the central test patch for four different surrounding colors; ○, red surround; △, yellow surround, □, green surround, ◇, blue surround. Dotted lines show representative hues of respective surrounding color.**

## ACKNOWLEDGEMENT


I would like to thank the ACA2019 organizing committee that gave me an opportunity to give a keynote speech. Also acknowledge Prof. Ikeda for encouraging and helping me in carrying out research at Color Research Center of RMUTT.


## REFERENCES


1. Fairchild, M. D. (2005). *Color Appearance Models*, 2nd Edition. England, John Wiley & Sons Ltd.
2. Foster, D. H. (2011). Color constancy. *Vision research, 51*(7), 674-700.
3. Pungrassamee, P., Ikeda, M., Katemake, P. and Hansuebsai, A. (2005). Color Appearance Determined by Recognition of Space. *Optical Review, 12*(3), 211–218.
4. Phuangsuwan, C. and Ikeda, M. (2018). Chromatic adaptation in a 2D photograph demonstrated by a D-up viewer. *Color Research and Application, 43*(4). 544-550. DOI: 10.1002/col.22214
5. Phuangsuwan, C. and Ikeda, M. (2019). Device dependent simultaneous color contrast. Proceeding of CSAJ2019, 43(3).

# SIZE CONSTANCY DEMONSTRATED ON PHOTOGRAPHS

**Onsucha Upakit[1]**, Chanprapha Phuangsuwan[2] and Mitsuo Ikeda[2]
[1] *Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand*
[2] *Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand*
*Corresponding author: Onsucha Upakit, Onsucha_u@rmutt.ac.th, Onsucha.u@gmail.com

**Keywords**: Size constancy, Mountain, Photographs, D-up viewer

## ABSTRACT

Size constancy is referred to the fact that our perception of the size of objects are relatively constant although the size of the retina image varies greatly with viewing distance. You can experience of the size constancy by putting your hand in front of your eyes and moving back and forth. The retinal image size changes greatly but the perception of the hand size remains almost same. When we travel to the forest, we always perceive a big mountain even though we are far away from the mountain. And we are often disappointed later to see a small mountain on the photograph. In this paper we investigate the perceived size constancy of mountain on photographs that give the same size of the real impression while we are looking at the mountain. The experiment started by taking a photograph of mountain by setting the focal length at 50 mm giving the field of view at 46°. And then the size of a mountain on a photograph was changed by software Adobe Photoshop to several sizes. The subject's task was to ask to remember the size of the mountain in the real scene. Then subject was asked to select the picture of the mountain that appeared the same perceived size of the mountain. They selected photographs of larger mountain image than the original picture so shows no size constancy. As the second step we asked the subjects to observe the photographs in a D-up viewer, which gave a 3D perception of photographs. The original photograph taken by the camera was selected to show the size constancy for a 3D photograph.

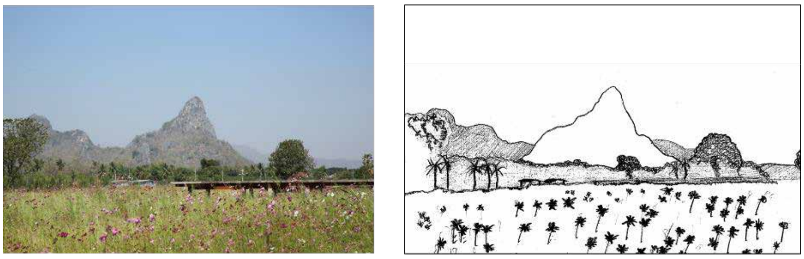
## INTRODUCTION

Size constancy is a perception phenomenon in the cognitive level. [1]. We perceive the real size of object even the viewing distance changes. It is interpreted as result of the brain function called a size correction. [2]. In our retina the image size varies depending on the viewing distance. A building appears very tall and high even we are standing far from the building. This paper aims to demonstrate the size constancy of a mountain on a photograph by using a D-up viewer.

## EXPERIMENT

### Stimuli

We selected a well know mountain in Lopburi province, named "Khao Jeen Lae" for the experiment. The mountain height is 650 meters above the sea level. A photograph was taken by Canon EOS 5D Mark III with the focal length 70 mm, ISO200. Figure 1a shows the photograph and Fig. 1b its sketch. The mountain was kept white in the sketch and other parts were filled gray. In front of the mountain there was a forest to hide the mountain foot. The field from the forest to the subject position was a wide flat field filled with flowers. The distance to the mountain from the subject and camera was 5,600 meters which gives the visual angle of 6.6°. The original photograph was edited by Adobe Photoshop CS6 to manipulate the size of only the mountain to have 10 pictures including the original with different size of the mountain, which was presented on a display one by one. Figure. 2 show the pictures, where the original picture is number 4. The picture number 1 to 3 were smaller than the original (number 4). From picture number 5 to 10 the mountain size is bigger than the original and those of 1 to 3 smaller than the original. Other parts than the mountain remained same in those ten pictures. The size of a picture was 17.5 x 26 cm on the display. Table 1 gives the size of the mountain in each picture in centimeter (on the left two columns) and visual angle (on the right two columns). The thick outline in the table 1 shows the size of original picture.



a b

**Figure 1. a, the original photograph and b, its sketch.**

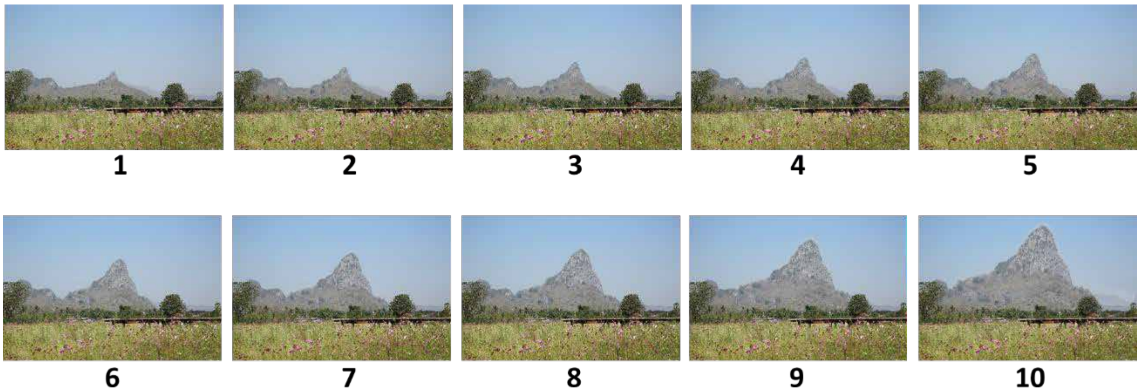



**Figure 2. Pictures stimuli.**

**Table 1: Size of mountain in centimeter and visual angle.**

| Size of Mountains | | | | |
|---|---|---|---|---|
| Pic. No. | Size (cm) | | Visual angle (°) | |
| | height | width | height | width |
| 1 | 2.6 | 4.7 | 4 | 7.3 |
| 2 | 4 | 6.7 | 6.2 | 10.4 |
| 3 | 5.4 | 8.7 | 8.3 | 13.4 |
| 4 | 6.8 | 10.7 | 10.5 | 16.5 |
| 5 | 8.2 | 12.7 | 12.6 | 19.5 |
| 6 | 9.6 | 14.7 | 14.8 | 22.5 |
| 7 | 11 | 16.7 | 16.9 | 25.5 |
| 8 | 12.4 | 18.7 | 19 | 28.4 |
| 9 | 13.8 | 20.7 | 21.1 | 31.3 |
| 10 | 15.2 | 22.7 | 23.2 | 34.1 |

**Apparatus**

The D-up viewer was built to change the mountain scene from 2D picture to 3D perception to the subjects. The principle of the D-up viewer is to eliminate any information beside the picture and help the subject to receive only the information in the picure. A 2D picture is perceived a 3D scene. [3]. A scheme of the D-up viewer is shown in Figure 3. By a hood a subject can see only the picture displayed on a display.

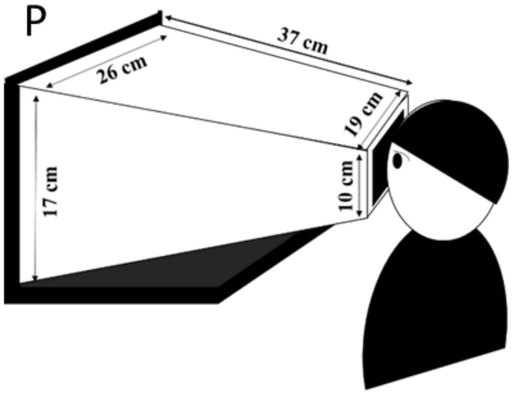



**Figure 3. Observing picture through D-up viewer.**

**Procedure**

Nine people participated in the experiment. A subject was asked to look at the mountain scenery and remember the impression of the size and then to select a picture on the LCD display that he/she felt the same size of the mountain as the impression for the real scene. Binocular view was adopted. Then, the subject did the same as before to observe the real mountain and remember size. After that he/she moved to look at the pictures through D-up viewer on the display monocularly and selected one out of 10 pictures that gave the same impression about the size of mountain as they looked at the real mountain. Notice that subjects took some time to perceive the mountain of picture as a 3D scene. The experimenter recorded the answer from the subjects by number of pictures. The observing was done for 3 times.

## RESULTS AND DISCUSSION

The results are shown in the left of Fig. 4. The abscissa indicates subjects and the ordinate picture number that the subjects chose. The solid triangles with dotted line are the results of the first step of experiment, where the subjects chose a picture without D-up viewer. A red line is drawn at the picture number 4, that is the original picture. Subjects chose pictures of larger number, which means that the subjects needed much larger size (no. 7-9) of the mountain to match with the impression of the real scene. But when they observed pictures with the D-up viewer they had the same impression as the real scene fort a small number of pictures, from 4 to 6.5. Only one subject (WP) chose the original picture. The results are replotted on the right of Fig. 3 with the visual angle for the ordinate. A dotted line indicates the visual angle of actual visual angle for the mountain, 6.6°. Almost all the subjects selected the size of mountain of much larger visual angle without D-up viewer in agreement with our daily experience, for example, subject PS needs the visual angle 31° to be matched with the real scene impression of 6.6° showing the size constancy. In the case of D-up viewer the visual angle showed smaller that the results from normal observation without D-up viewer. The difference of filled circles from filled triangles at each subject indicates that the difference was supplemented by the amount gained by the size constancy function in the pictures by seeing the pictures as 3D scenes.

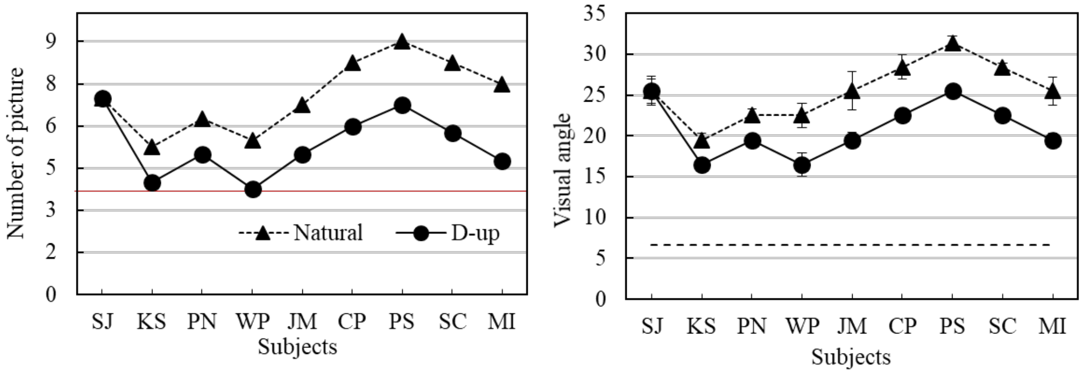



**Figure 4. Observing picture through D-up viewer.**

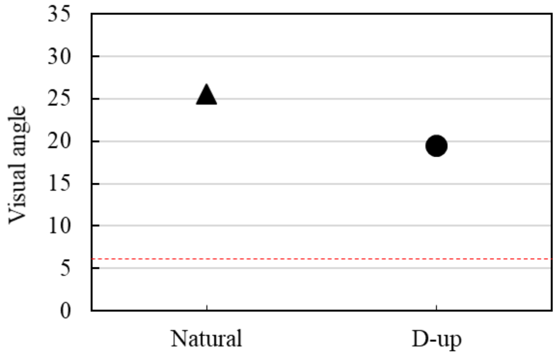



**Figure 5. Averaged results of without (natural) and with D-up viewer.**

The averaged results of all the subjects are shown in the Fig. 5. The ratio of the visual angle for the natural view and for the real view was 3.78 (Visual angle of natural view/Visual angle of actual retina image). For the D-up viewer observation the ratio was 3.03 (Visual angle of D-up view/Visual angle of actual retina image). Based on this experimental result we can conclude that to get the size constancy we need to perceive object as three dimensional.

## ACKNOWLEDGEMENT


We thank Faculty of Mass Communication Technology for giving us the research fund 2019. We also thank students of Ikeda and Chompoo laboratory, who contributed to this research as subjects. We acknowledge Janejira Mepean, a student of the laboratory, as a research assistant.


## REFERENCES


1. Sperandio, I. and Chouinard PA. (2015). The Mechanisms of Size Constancy. *Multisensory Research, 28*(3-4), 253-283.
2. Maturana, H. R., Varela, F.G., Frenk, S.G. (1972). *Size constancy and the problem of perceptual spaces, Cognition, 1*(1), 97-104.
3. Phuangsuwan, C, Ikeda, M, and Katemake, P. (2013). Color constancy demonstrated in a photographic picture by means of a D-up viewer. *Optical review, 20*(1), 74-81.

# REPRESENTATIVE COLORS OF GRAPES

Kanchaporn Jankeaw[1]*, Kitirochna Rattanakasamsuk[1], Ryo Kihara[2] and Mikiko Kawasumi[2]

[1] *Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2] *Faculty of Science and Technology, Meijo University, Japan.*
*Corresponding author: Kanchaporn Jankeaw, 1159108020135@mail.rmutt.ac.th, bbkan.day@gmail.com

**Keywords**: Grape Color, Color Memory, Representative Color

## ABSTRACT

In the market, grapes are categorized into three kinds as red grapes, green grapes, and black grapes. For red grapes, the range of color sometimes can be from red, reddish brown to reddish purple. For green grapes, the range of color can be from greenish yellow, light green to dark green. For black grapes, the range of color includes black, dark blue, dark purple. We can see that the color of each kind of grape is a wide variety. However, the perception of grape color for the customer may not match with the real grape color. In this research, we want to investigate the representative color of each kind of grapes. The subject is 20 females and 20 males aged between 19-23 years old who have normal color vision. The experiment is divided into two parts. In the first part, the representative hue of grapes is identified. The stimulus is a gray background and 40 Munsell color chips. These 40 color chips are varied in hue cover every hue in Munsell color. Each color chip has chroma 8 and value 5. These 40 color chips are attached on the gray background to form the Munsell ring. Size of each color chips is two degrees of visual angle. Subject's task is to indicate the color chip which represented the color of red grape, green grape and black grape in their memory. In each trial, the subject must select at least a color chip. If the subject thinks the range of color of grape is wide, they can select more than a color chip to cover that range. This process repeats until 3 kinds of color of grapes are selected. Each subject must repeat totally 3 judgments (3 colors of grapes x 1 judgments). The result shows that the range of representative hue of red grape covers from 2.5RP, 5RP, 7.5RP, 10 RP, 2.5R, 5R and 7.5R. For green grape, the range of representative hue of green grape covers from 2.5GY, 5GY, and 7.5GY, 10GY. For the black grape, the range of representative hue of black grape covers from 5PB, 7.5PB, 10 PB, 2.5P, and 5P. These selective hues of each grape color will be used in the next part. In the second part, Munsell value and chroma of the representative color of grape will be identified. Munsell color chart of the selective hues from the first part will be presented to the subject. The subject will be asked to select every color chip which represented the color of red grape, green grape, and black grapes. The result will be used as a database for creating a color scheme for grape packaging design.

## INTRODUCTION

Grapes are the 6th most popular fruit in the world [1]. Grapes can be divided into 3 main colors, which are green grapes, red grapes, and black grapes [2] [3]. Although grapes are popularly consumed as fresh fruits but grapes can be processed into other products. Product presentation is important to attract and create memories for consumers, and color is an important element on the product packaging. Previous research revealed that people make a subconscious judgment about a person, environment, or product within 90 seconds of initial viewing and that between 62% and 90% of that assessment is based on color alone [4]. Therefore, the researcher has the idea that studying color to find colors that represent grape will help increase interest in grape products and can increase value to the product. The research was divided into two parts. The first part, each subject identified the representative hue of green grapes, red grapes, and black grapes by selecting hue from Munsell ring. For the second part, each subject identified Munsell value and chroma in the Munsell color chart.

## EXPERIMENT

### PART I: HUE IDENTIFICATION

The first part of experiment is to select hue that represents three types of grape color, green, red, and black grapes. The criterion of the hue identification is that the selected hue must represent the subject's image color of green grapes, red grapes and black grapes. The subject can be select an unlimited number of hue per type of green grapes, red grapes and black grapes.

**Apparatus**

The apparatus was a test room size of 93 cm × 62 cm × 78.5 cm. The test room was made of the whiteboard and top on the room was covered with white wax paper to filter and diffuse light. The illuminance of the subject room was measured by an Illuminance meter (Konica Minolta T - 10) and was kept constant between 1000-1200 lux. The stimulus was 40 Munsell color chips which represent the entire hue in Munsell color (Munsell Book Glossy Collection X-rite). Each color chip has chroma 8 and value 5. These color chips were pasted on a gray background paper (N6) to form the Munsell ring. The Munsell ring was placed on the wall in front of the subject. A chin rest (Takei Scientific Instruments T.K.K 930a) is used to fix the subject head's position. Each color chip contains 2 degrees of the visual angle.

**Subject**

The subjects were 30 undergraduates from the Department of Information Engineering at Meijo University. There were 15 females and 15 males. All of them had normal color vision.

**Experimental Procedure**

Before starting the experiment, the subject sees a set of photographs of 3 grape colors on a laptop. After 2 hours or more, the experiment starts. In each trial, the Munsell ring was randomly rotated. The experimenter selected a type of grapes and told to the subjects. The subject then imagined the color of that type of grape. After that, the subject select the color chips which represented the Hue of the subject's image color. There was no limitation of the number of the selected color chips. The experimenter recorded the selected Hue. These selected hues of each grape color will be used in the next part.

**Result**

The result of experiment 1 was shown in Figure 1. The radius of the radar graph was the frequency of the selected hue. Red line, green line and purple represented the result of the hue identification of red grape, green grape and black grape, respectively. If a Munsell hue was chosen by higher than 20% of the subject, that Munsell hue will be used in the next part of the experiment. This criterion was represented by the dashed circle line.

For the red grape, there most selected hue was 5RP and 7.5R. The other selected hue were 2.5RP, 7.5RP, 10RP, 2.5R, and 5R. For the green grape, 4 Munsell hue; 2.5GY, 5GY, 7.5 GY, and 10GY; were selected. For the black grape, 7.5PB, 10PB, 2.5P, and 5P were selected. These selected Hue were used in the next part of the experiment.

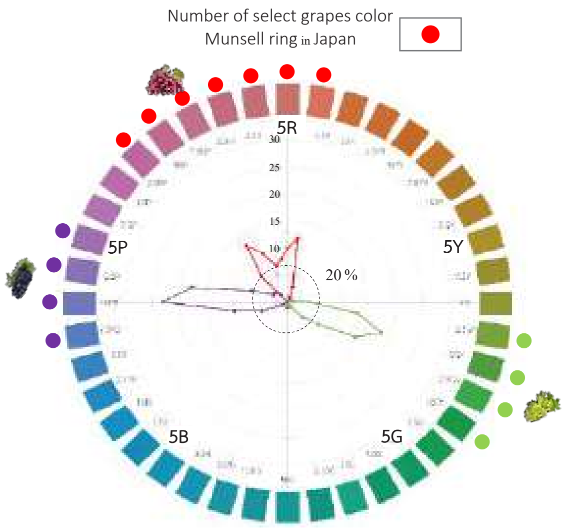



**Figure 1. The selected Hue of red, green and black grapes**

## PART II: MUNSELL VALUE AND CHROMA IDENTIFICATION

The second part of the experiment is to identify Munsell value and chroma that represents three types of grape color, green, red, and black grapes. There are two types of value and chroma Identification. The first type is based on the subject's image color of those three grapes. The second type is based on the color which is suitable for the packaging of grape products. The subject can select unlimited number of color chips for each type of identification.

### Apparatus

The test room was the same room which were used in the first part of the experiment. The illuminance of the test room was measured by an Illuminance meter (KONICA MINOLTA T - 10) and was kept constant between 1000-1200 lux. Table 1 shows the selected hue used in this part of experiment. For each hue, there was a Munsell color chart which contained several color chips. The color chips were varied in value and chroma as shown in Figure 2. A viewing mask was used when the subject selects the color chips. This viewing mask was made from 15 cm × 21 cm gray sheet (N6). There was a 1.5 cm × 2 cm square aperture at the center of the viewing mask. A laptop was used for presenting the grape's photo before the experiment started.

**Table 1: The selected hue of each type of grapes**

| Grapes Color | Selected Hue |
|---|---|
| Green | 2.5GY, 5GY, 7.5GY, 10GY |
| Red | 2.5RP, 5RP, 7.5PR, 10RP, 2.5R, 5R, 7.5R |
| Black | 7.5PB, 10PB, 2.5P, 5P |

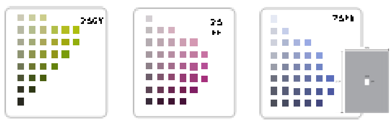


**Figure 2: Figure 2: Munsell color chart and viewing mask**

### Subject

The subjects were 40 undergraduates from the Department of Information Engineering at Meijo University. All of them had a normal color vision they are female 20 people and male 20 people.

**Experimental Procedure**

Before starting the experiment, a set of photographs of red grape, green grape and black grape were presented to the subject. After 2 hours or more, the experiment starts. There are two tasks for each subject. The first task is to identify the image color of grapes. In each trial, the experimenter selected a type of grapes and told to the subjects. The Munsell color charts of the selected hue which corresponded to the type of grape were placed on the table. The subject then imagined the color of that type of grape. After that, the subject using the viewing mask to see the color chip through the hole, one by one color. When the subject selected the desired color, the mask will be placed on that color. The subject can choose an unlimited number of colors for each type of grapes color. This procedure was repeated until all type of grape were selected. For the second task, the procedure was same as the procedure of the first task except from the criterion of selecting color. The criterion of this task is to identify the color which were suitable for the packaging of the grape product. These two tasks were done in the separated session.

**Result**

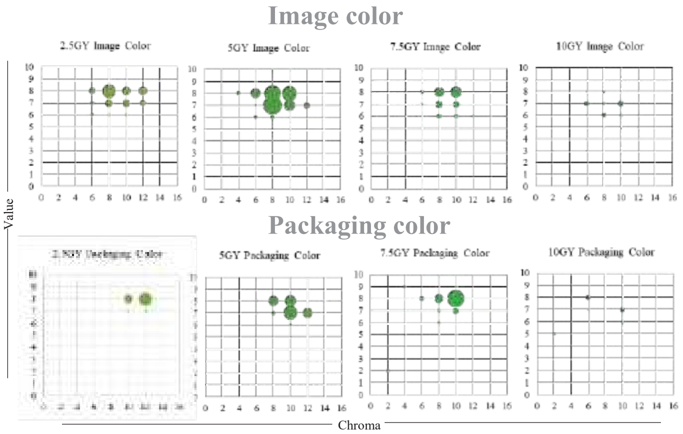



**Figure 3. Comparative result between image color and packaging color of green grapes**

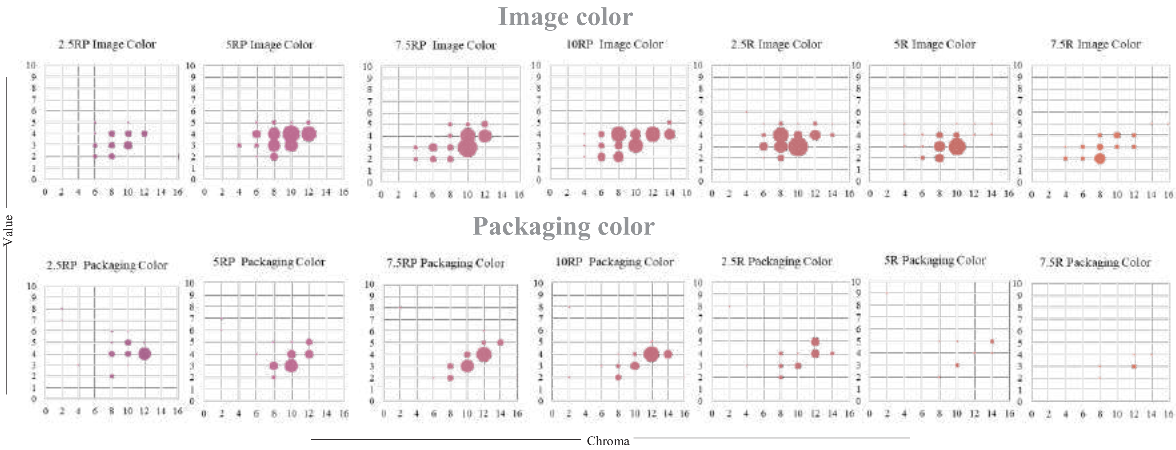



**Figure 4. Comparative result between image color and packaging color of red grapes**

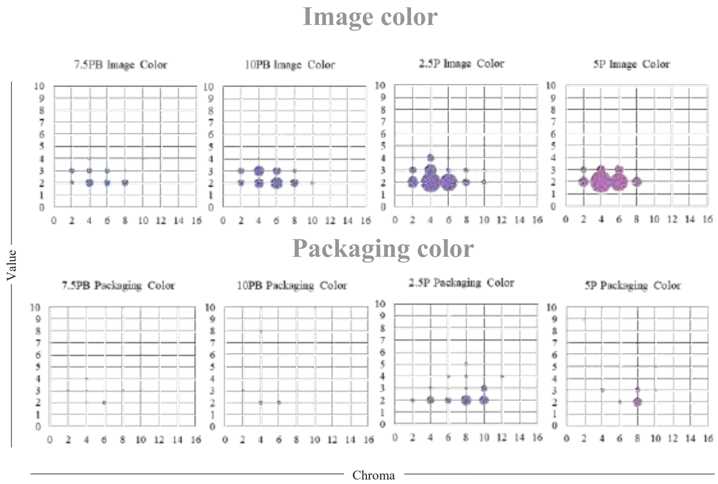



**Figure 5. Comparative result between image color and packaging color of black grapes**

Figure 3 shows the image color and the packaging color of the green grape. The bubble size represented the frequency of the selected color. There was some difference between these two kinds of color. Most of the image color of the green grape was greenish yellow with chroma range of 8-10 and value range of 7-8. For the packaging color, the suitable colors were more vivid and slightly darker than the image color.

Figure 4 shows the image color and the packaging color of the red grape. The image color of red grapes covered wide range of color. The Munsell hue range was from 2.5RP to 7.5R. However, the popular color of red grape was divided in to two groups; reddish purple and slightly purplish red. For the packaging color, the reddish purple was more popular.

Figure 5 shows the image color and the packaging color of the black grape. Even though this kind of grape was called as the black grapes, but the image color was darkish purple with low chroma (range of 2-4) and low value (range of 2-3). The packaging color was considerably different from image color. The subject preferred more vivid purple for the grape product packaging.

Based on our result we created the color palette for the grape packaging design. Table 2 shows Munsell color notation of the colors which were obtained from two methods. The first method was the top five rank of the selected Munsell color chips. The second method was five color calculated from K-mean cluster analysis. For the packaging design, the top 5 rank should be used as the primary color of the packaging. And the color from K-mean cluster analysis should be the secondary color to make the packaging more colorful. For the future work, the quality of these color palette must be examined. It is necessary to use these color palettes for designing the packaging of grape products.

## CONCLUSION

The color palettes obtained from the image color have more variety of colors than those obtained from the packaging color. But color in the color palettes of packaging color will have more vibrant colors. To design grapes packaging, colors in the popular colors' palette can be use as primary colors. If the packaging with a variety of colors is required, color in the palettes from K-Means Cluster Analysis can be used as the secondary color.

**Table 2: The color palettes from top 5 and K-Means Cluster Analysis**

| Grapes Color | Top 5 | | K-Means Cluster Analysis | |
|---|---|---|---|---|
| | Image Color | Packaging Color | Image Color | Packaging Color |
| Green | 5GY 7/8 | 7.5GY 8/10 | 5GY 7/10 | 5GY 8/11 |
| | 5GY 8/8 | 5GY 7/10 | 5GY 8/9 | 7.5GY 6/9 |
| | 5GY 8/10 | 2.5GY 8/12 | 7.5GY 6/9 | 5GY 8/9 |
| | 2.5GY 8/8 | 5GY 8/10 | 7.5GY 7/5 | 7.5GY 8/5 |
| | 5GY 7/10 | 5GY 8/8 | 7.5GY 4/5 | 7.5GY 4/2 |
| | 7.5GY 8/10 | 5GY 7/12 | | |
| Red | 7.5RP 3/10 | 7.5RP 4/12 | 10RP 4/10 | 5RP 4/11 |
| | 5RP 4/10 | 10RP 4/12 | 5R 3/8 | 10RP 3/9 |
| | 5R 3/10 | 2.5RP 4/12 | 5RP 4/8 | 2.5R 5/13 |
| | 5RP 4/12 | 5RP 3/10 | 2.5R 3/5 | 7.5RP 8/2 |
| | 7.5RP 4/10 | 7.5RP 3/10 | 2.5R 5/13 | 7.5RP 3/5 |
| | 10RP 4/8 | | | |
| | 10RP 3/10 | | | |
| | 10RP 4/12 | | | |
| | 2.5R 4/8 | | | |
| Black | 5P 2/4 | 2.5P 2/8 | 2.5P 3/3 | 10PB 3/4 |
| | 2.5P 2/4 | 2.5P 2/10 | 5P 2/5 | 2.5P 2/8 |
| | 2.5P 2/6 | 2.5P 2/4 | 10PB 2/7 | 10PB 4/9 |
| | 5P 2/6 | 2.5P 2/6 | 10PB 4/8 | 10PB 7/3 |
| | 2.5P 3/4 | 2.5P 3/10 | 10PB 3/3 | 2.5P 6/7 |

## ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Scholarships of Co-operative Education from Rajamangala University of Technology Thanyaburi (RMUTT) for supporting my internship at Meijo University. Special thanks to Professor Mikiko Kawasumi who accepted me for internship for 3 months. Thanks to the staffs and students of Meijo University and everyone who participated as subjects in the experiment.

## REFERENCES

1. Misachi, J. (2017). The Most Popular Fruit in the World. Retrieved September 10, 2019, from https://www.worldatlas.com/articles/the-most-popular-fruit-in-the-world.html.
2. Lancaster, J. E., Lister, C. E., Reay, P. F., & Triggs, C. M. (1997). Influence of Pigment Composition on Skin Color in a Wide Range of Fruit and Vegetables. *Journal of the American Society for Horticultural Science*, 122(4), 594–598. doi: 10.21273/jashs.122.4.594
3. Carreño, J., Martinez, A., Almela, L., & Fernández-López, J. A. (1996). Measuring the color of table grapes. *Color Research & Application*, 21(1), 50–54. doi: 10.1002/(sici)1520-6378(199602)21:1<50::aid-col5>3.0.co;2-4
4. Morton, J. (2010). Why Color Matters. Retrieved September 20, 2019, from https://colormatters.com/color-and-design/why-color-matters

# COMPARISON OF COLOR INTERFERENCE IN GENDER IDENTIFICATION BETWEEN THAI AND JAPANESE

Kitirochna Rattanakasamsuk[1]* and Mikiko Kawasumi[2]

[1]Color Research Center, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.
[2]Faculty of Science and Technology, Meijo University, Japan.

*Corresponding author: Kitirochna Rattanakasamsuk, kitirochna@rmutt.ac.th; kitirochna@gmail.com

**Keywords**: Color Code, Color and Gender, Gender Identification

## ABSTRACT

Color was used as a code to identify gender. For example, female baby clothes are generally pink while male baby clothes are generally blue. In some culture, the color code is almost standardized for gender identification. We can see in Japan that most of the female toilet sign is red or pink, whereas the male toilet sign is blue, so it is not necessary to recognize the detail of the sign. You can identify the toilet type by just seeing the toilet sign's color. In this research, we investigated the color code usage for gender identification of Japanese and compare the results with Thai. The experiment was conducted in Thailand and Japan. In each country, the subjects are 25 female 25 male university students. The stimuli were three patterns of female and male toilet sign. Each pattern was applied by five colors included blue, navy blue, red, pink and black. Therefore, the stimuli were composed of a combination of two genders, three patterns, and five colors, totally 30 signs. The stimuli were presented on an LED monitor. The size of stimuli was between 12-15 degree of visual angle. There were two tasks for each subject. For the first task, the subjects assessed the color of the sign whether that color was identified as male or female. For the second task, the subjects assessed the details of the signs whether they were male or female. In each judgment, a sign was presented for two seconds and separated by at least five seconds blank screen. If the subject did not judge within 5 seconds of a blank screen, the blank screen will appear until each judgment was finished. The results suggested that there was a firm linkage between color and gender in Japanese culture. More than 90% of Japanese pointed out that red and pink were identified as the color of female whereas light blue, navy blue and black were identified as the color of the male. This linkage was truly strong enough so that some color could interfere their gender identification by the sign. When the female sign was applied with red or pink and the male sign was applied with blue, navy blue and black, the percentage of correct judgment is higher than 90%. However, when the female sign was applied with navy blue and the male sign was applied with pink, the correct judgment decreased significantly to be about 60%. Unlike the result of Japanese, the linkage between color and gender did not firmly hold in Thai culture. Most of all Thai subject could correctly identify gender regardless of color in sign.

## INTRODUCTION

Previous research has shown that color preference was affected by many factors such as age, culture etc. Gender was one of the important factors to determine color preference [1], [2], [3]. "Men like blue and women like pink" was the belief that intentionally implanted by the marketeer in order to increase the product sale. For example, female baby clothes are generally pink while male baby clothes are generally blue. This belief was somehow transformed to be a color code and was used to identify gender. In some culture, the color code is almost standardized for gender identification. We can see in Japan that most of the female toilet sign is red or pink, whereas the male toilet sign is blue. Therefore, it is not necessary to recognize the detail of the sign. You can identify the toilet type by just seeing the toilet sign's color. We hypothesized that in the culture which color were obviously referred to gender, the color can interfere the interpretation of sign meaning. In this research, we investigated the interference of color on gender identification of Japanese people and compare the results with Thai people.

## METHODOLOGY

*Subject*

The subject were 50 Japanese and 50 Thai students. Each group of subjects were composed of 25 male and 25 female subject aged between 18-24 years old. All subjects had normal color vision.

*Stimuli*

The stimuli were three patterns of female and male toilet sign as shown in Figure 1. Each pattern was applied by five colors included blue, navy blue, red, pink and black. The color values of each color were shown in Table 1. The stimuli were composed of a combination of two genders, three patterns, and five colors, totally 30 signs. Each sign was placed on the white background. The size of the stimuli was between 12-15 degree of visual angle.

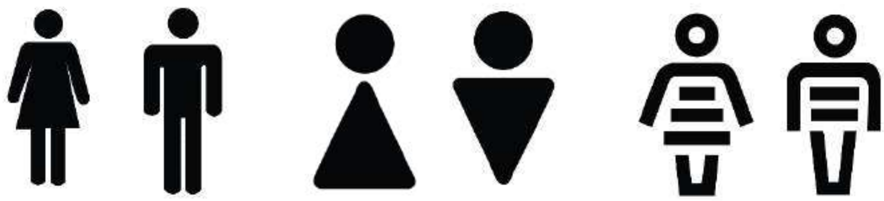


**Figure 1. Three patterns of female and male sign**

**Table 1: Luminance and xy chromaticity of color stimuli**

| Color | Luminance (cd/m$^2$) | x | y |
|---|---|---|---|
| Black | 0.4 | 0.320 | 0.369 |
| Pink | 63.2 | 0.462 | 0.305 |
| Red | 35.6 | 0.588 | 0.341 |
| Blue | 95.5 | 0.218 | 0.298 |
| Navy Blue | 37.6 | 0.201 | 0.233 |
| White Background | 250.0 | 0.310 | 0.330 |

*Experimental Procedure*

The stimuli were presented on an LED monitor which was placed inside a subject room. The background behind the monitor is a white wall. The illuminance measured at the monitor position was 400 lux.

There were two tasks for each subject. For the first task, the subject was asked to judge whether each stimulus was male or female sign. For the second task, the subject was judge whether the color of each stimulus was referred to male or female. These two tasks were done in separated session.

In each session, the subject must sit inside the room for at least two minutes before starting the experimental session. After the two minutes adaptation, the experimental start by pressing the space bar. The blank screen appeared for three seconds. Then a color stimulus was presented for two seconds. After that, the screen turned to be blank screen. The subject gave the judgement by pressing "1" on the keypad for male and "3" on the keypad for female. The blank screen continuously appeared for at least five seconds before the next stimulus was presented. If the subject did not judge within five seconds of a blank screen, the blank screen will appear until each judgment was finished. The order of color stimulus was random. The procedure repeated until all 30 color stimuli were presented.

## EXPERIMENTAL RESULTS

The relation between color and gender of Thai and Japanese was investigated. After presenting the color female or male sign, the subject would indicate whether the presented color was the color of the male or the female. The results were shown in Figure 2.

In case of Japanese subjects, more than 90% of Japanese pointed out that red and pink were identified as the color of the female whereas blue, navy blue and black were identified as the color of the male, regardless of the gender of sign.

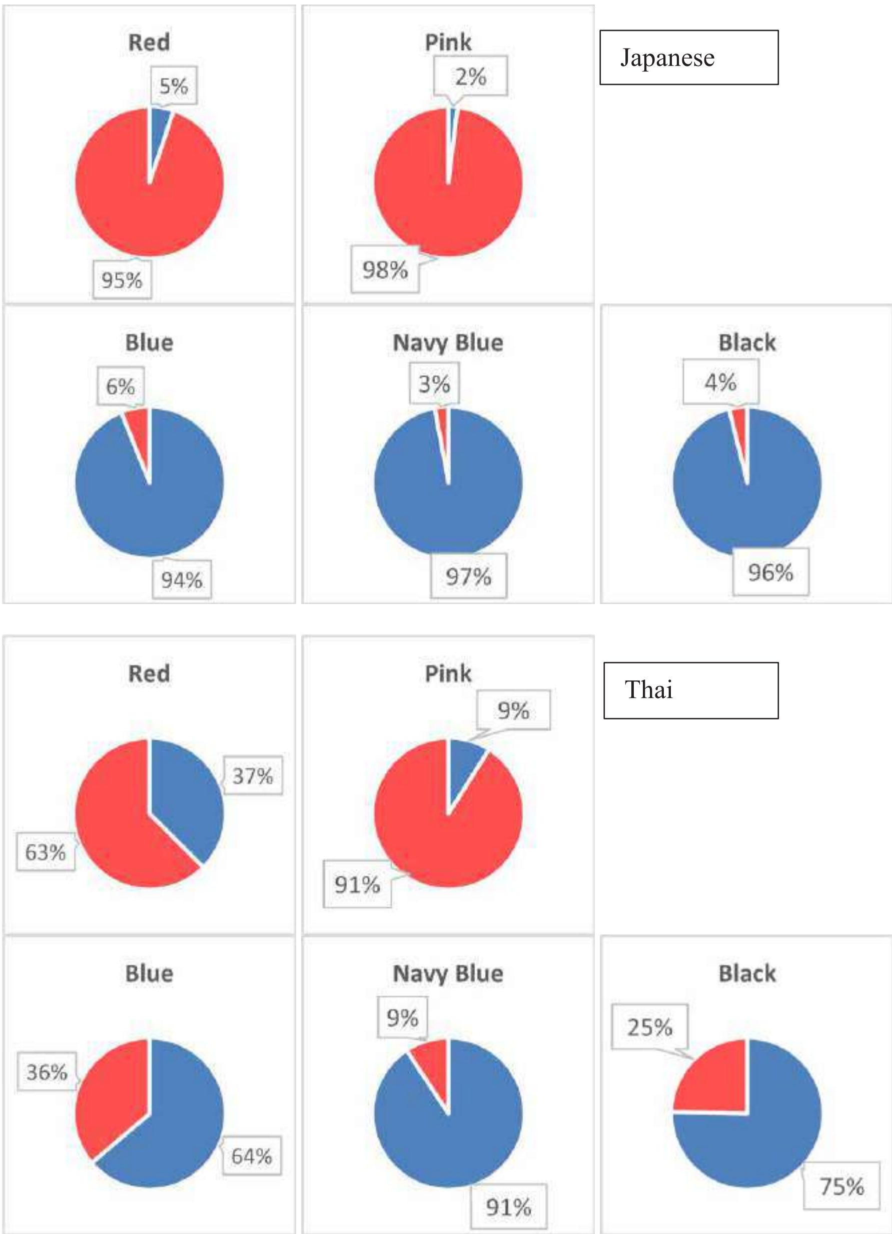



**Figure 2 Color and gender relation by Japanese (above) and Thai (below). Red and blue represent female and male response, respectively.**

In case of Thai subjects, only pink and navy blue were obviously identified as the color of the female and the male respectively. Black was majorly identified as the color of the male but 25% of response also identified it as the color of female. Most of Thai's responses identified that blue was the color of the male and red was the color of the female. However, about 36% of response from Thai also indicated that red was the color of the male and blue was the color of the female. Therefore, red and blue seems to be unobvious to identify their gender for Thai.

The above result showed that there was a firm linkage between these colors (red, pink, blue, navy blue and black) and their gender in Japanese culture. On the other hand, the relation between these colors and their gender were not obvious in Thai culture. The possible reason was that Japanese people familiar with the color code usage for gender identification. Red and pink always used for female objects whereas and blue, navy blue and sometime black were used for male objects. This color code was the de facto standard especially for the color of toilet sign. In contrast to Japanese, the implementation of color code in Thailand was not successful. For example, there is no standard for the color of toilet sign.

Figure 3 shows the result of gender identification of color stimuli judged by Japanese and Thai. The abscissa represents five colors of the sign. The ordinate represents percentage of response which subject identified the sign as female (red bar) and male (blue bar). For the female sign, the correct gender identification should be female which is the red bar graph. But for the male sign, the correct gender identification should be male which is the blue bar graph.

In case of Japanese, when the female sign was red and pink, the correct gender identification was higher than 90%. But when the female sign was black, blue and navy blue, the correct identification considerably decreased. Especially in case of blue and navy blue, the percentage of correct gender identification was only 64% and 50%, respectively. When the male sign was investigated, the correct gender identification of black, blue and navy blue sign was nearly 100%.

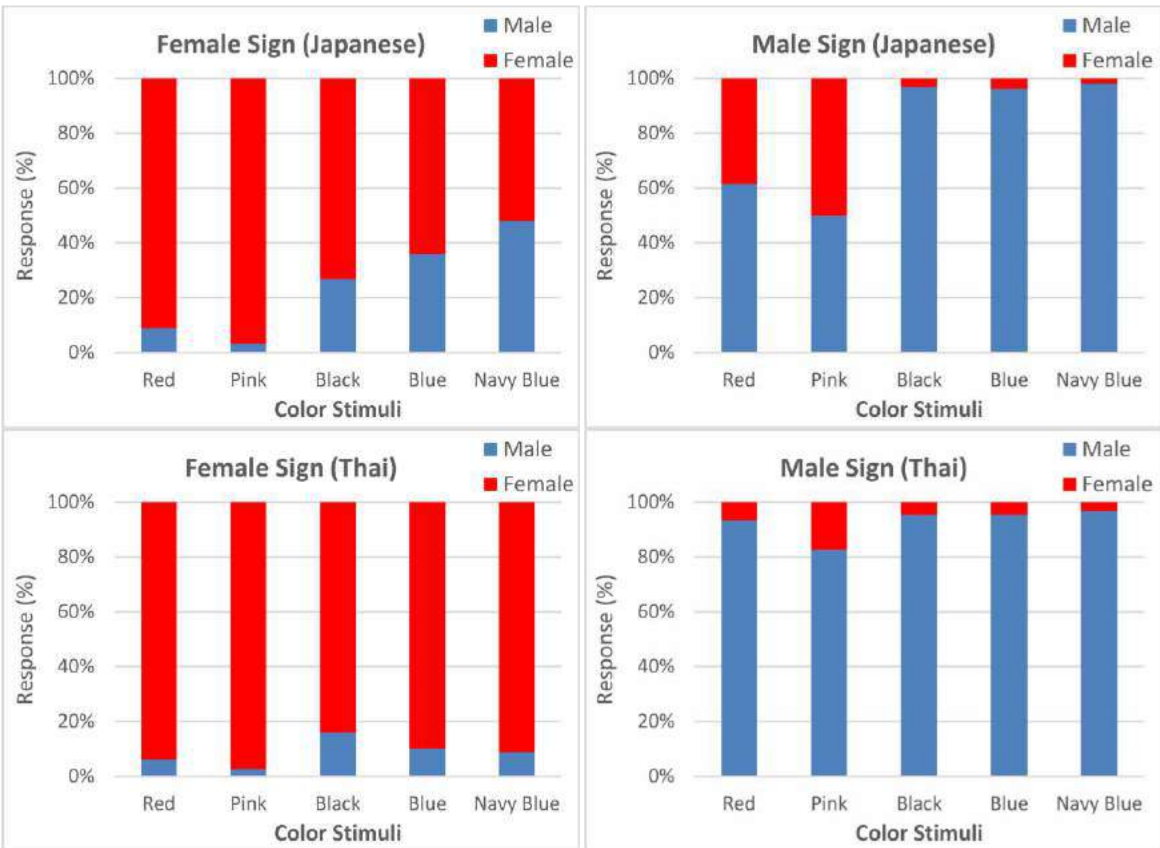



**Figure 3 Gender identification of female and male color sign by Japanese and Thai.**

However, the pink and red male sign made the gender identification significantly incorrect. There were only 62% and 52% correct responses for red and pink male sign.

In contrast to Japanese, color seems to be slightly affected the gender identification of male and female sign. The correct gender identification by Thai subjects was higher than 80% regardless of color. Pink and black possibly interfered the gender identification but the effect of these two colors was not clear. The wrong gender identification was still lower than 20% which considerably differed from Japanese's result.

Based on the above results, there was the evidence that the color could interfere the gender identification. The interference of color on gender identification was possibly due to the linkage between color and gender. For Japanese which the color and gender linkage was firmly hold, the interference of color on gender identification was clearly distinct. But the influence of color on gender identification would be small, if there was no linkage between color and gender in their culture. However, to the further investigation is also required to confirm this hypothesis.

## CONCLUSION

Our result supported the hypothesis that the color could interfere the interpretation of the sign meaning. In the culture which color were obviously linked to gender, color would show strong influence on the gender identification like in Japanese culture.

## ACKNOWLEDGEMENT

This research was partially supported by Research Fellowship Program of Meijo University, Nagoya, Japan. We would like to thank Prof. Mikiko Kawasumi for the collaboration of this research. Thanks also to Mr. Narupon Keawpilab and Ms. Kanchaporn Jankeaw for their contribution to this research.

## REFERENCES

1. Bonnardel, V., Beniwal, S., Dubey, N., Pande, M., & Bimler, D. (2017). Gender difference in color preference across cultures: An archetypal pattern modulated by a female cultural stereotype. *Color Research & Application, 43(2),* 209–223. doi: 10.1002/col.22188
2. Hurlbert, A. C., & Ling, Y. (2007). Biological components of sex differences in color preference. *Current Biology, 17(16),* R623–R625. doi: 10.1016/j.cub.2007.06.022
3. Lobue, V., & Deloache, J. S. (2011). Pretty in pink: The early development of gender-stereotyped colour preferences. *British Journal of Developmental Psychology, 29(3)*, 656–667. doi: 10.1111/j.2044-835x.2011.02027.x

# RELATIONSHIP BETWEEN PROPER CONTRAST AND IMAGE SATISFACTION

Suwat Puenpa[1]* Kitirochna Rattanakasamsuk[2] and Ploy Srisuro[3]

[1] *Photography and Cinematography Technology, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*
[2] *Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand.*
[3] *Advertising and Public Relations Technology, Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.*

*Corresponding author: Suwat Puenpa, suwat_p@rmutt.ac.th

**Keywords**: image contrast, zone system, grayscale image, photographer and image satisfaction

## ABSTRACT

For an image retouching process, image contrast adjusting is a way to obtain the quality of the image. However, we observed that in the case of a grayscale image, most of the non-professional photographers think that good grayscale image must be low contrast image. Unlike most professional photographers, they prefer to retouch the image by keeping original image contrast or slightly increasing the image contrast. Therefore, we investigated whether this observation is true or not. The objective of this research was to investigate the relationship between proper contrast and image satisfaction of these two groups. The subjects were fifteen professional photographers and fifteen non-professional photographers. The stimuli were five landscape images. All image is 8-bit grayscale at zone system 5. Weber Contrast of each image was varied to seven levels which include original contrast level, one increment contrast levels, and one decrement contrast levels. The stimuli were presented on a 24-inches LED monitor situated in the experimental room. The distance between the subject's eye and the monitor was 95 centimeters. The size of the stimuli was 29 X 43 degrees. The task of the assessors was to evaluate the image satisfaction with rating scales from 1-5 which 1 is the highest dissatisfaction and 5 is the highest satisfaction. Each subject must complete 35 evaluations. The expected result was that the non-professional photographers might prefer a lower contrast image than original contrast. On the other hand, professional photographers might prefer a high contrast image.

## INTRODUCTION

Landscape Photography is one of the most popular niches of photography, for both professional and non-professional photographers. It is to capture the beauty of the scenery in the natural park. The atmosphere of the fields in rural areas is extraordinarily beautiful. This invites a photographer or general person to hold the camera up to take this impressive beauty.

The Photography enthusiasts see the beautiful atmosphere through the viewfinder of a digital single lens Reflex camera (DSLR) or smart phones, that are visible and displayed in color images as if they were seen with eyes. The perfect composition, good lighting conditions and the right shooting time are the best moments in photography. On the other hand, the image becomes normal, lack of depth and interest when converted to black and white. Because the colors that appear on those photos will help to distinguish and interest themselves. And colorful photography will create great excitement in the viewing experience as opposed to black and white photos. For adjusting a color image into a black and white photo, various colors may turn out to be the same or have very similar tones or become a low contrast black and white image. Black and white photos with low contrast will cause the image to lack depth or lack of detail and make the image uninteresting.

The best black and white photos usually have some portion of the photo that is near to pure white, and some portion of the photo that is near black. This increased contrast adds interest to the scene. Therefore, a suitable black and white photo should have a different gray tone according to the Zone System. In this regard, it is appropriate to consider the contrast level of the grayscale of black and white photos. Between professional photographers and amateur photographers, which may affect the satisfaction of high and low contrast to different black and white photos.

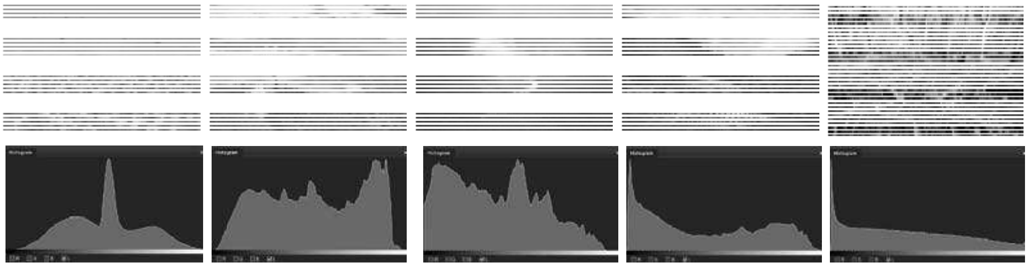
## METHODOLOGY

**Apparatus and Procedure**

The relationship between appropriate contrast and satisfaction with Landscape Photography in a black and white image was studied with the following steps.

Step 1: The Preparation Process

The experimenters began researching the related information from books, articles and expert interviews to adjust the contrast of the middle tone grayscale of landscape photos. Then they set the images with a grayscale chart. The experimenters were adjusting the color image to black and white of the landscape photos with software for image enhancement. Later, 5 landscape photographs were selected by the experimenters. The objective criteria that determine whether an image that has the characteristics of pixel distribution from the darkest black, the middle gray and the whitest as shown in the histogram of Figure 1.

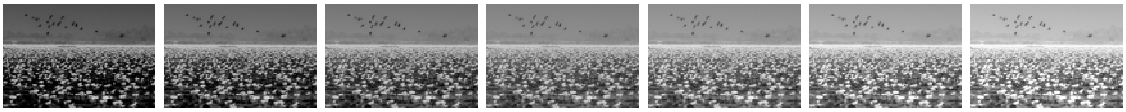


a b c d e

Figure 1. Histogram of Landscape Photographs

Step 2: The Adjustment Contrast Process

The Landscape photographs were adjust the contrast level, referring to the grayscale of the Ansel Adams Zone System, consisting of 7 levels, covering gray levels from deep tonalities, representing the darkest part of the image in which some detail is required (ZoneII) to white with textures and delicate values (ZoneVIII) or -3 -2 -1 0 +1 +2 +3 as an example shown in Figure 2.



a(-3) a(-2) a(-1) a(0) a(+1) a(+2) a(+3)

Figure 2. Seven Gray Levels of Landscape Photographs

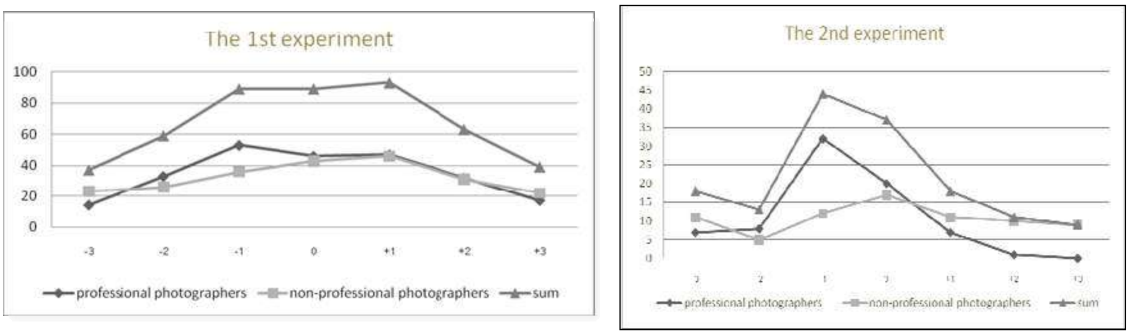
Step 3: The Evaluation Process

The Landscape images were used in all five images experiments in seven sets of contrast levels. Each image was arranged in a different presentation. The experiment was conducted in a dark room. The Landscape Photographs were presented on a 24-inch LED screen in the laboratory. The distance between the eyes of the person and the screen is controlled to be 95 centimeters. The size of the stimuli was 29x43 degrees. The assessors will have to consider a total of 35 images, evaluate 2 experiments. The first experiment, the assessors selected more than 1 image in each set. And the second experiment, the assessors were asked to select only one of the most satisfying images in each set.

## RESULT AND DISCUSSION

The results from the first experiment, the assessors were able to choose the satisfaction of more than 1 photograph from Figure 3. (a). It was found that a group of professional photographers were satisfied with the image contrast between -1 0 +1 but there were trends of satisfaction with black and white photos which has a high contrast or gray tone, zone VI (Dark light). The non-professional photographers were satisfied with the contrast between 1 0 +1 but tend to be satisfied with black and white images with low contrast or gray tone, zone IV (Light dark).

In the second experiment, the assessors consider black and white photos. From figure 3. (b), it was found that a group of professional photographers were satisfied with the contrast of positions at position-1, which had quite high contrast characteristics or gray tones, Zone VI (Dark light). In contrast, the non-professional photographers were satisfied with the contrast between 1 0 +1 and tend to be satisfied with the black-and-white image which has a normal contrast to the low, gray tones, Zone IV (Light dark) or a picture that looks quite bright.




(a) More Than 1 image Satisfaction (b) Highest Image Satisfaction

Figure 3. The Assessment Result

The study found that the grey tone images at different grayscale levels according to the Ansel Adams Zone System affects the satisfaction of the professional photographers and non-professional photographers. A group of professional photographers was satisfied with the high contrast. On the other hand, a group of non-professional photographers was satisfied with low contrast.

Additional findings during the observation of the photograph evaluation, the experimenter found the different methods for determining the photo contrast of these two assessor groups. The professional photographer group took the time to consider the details of each tone of the photos presented on the screen. While the non-professional photographer considered the contrast of the picture together with the elements of the beauty of the image. The second group was elderly and tends to be satisfied with the brighter images than the professional photographer group.

## ACKNOWLEDGEMENTS

This Research was supported the by Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi, Thailand.

## REFERENCES

1. Panyawat Leawpaibool and Suwat Puenpa (2018) Studying Landscape photography by Using the tone tontrol with Zone System.
2. Panyawat Leawpaibool and U-krit Na Songkhla (2018). Studying black and white cityscape photography by Using the tone tontrol with Zone System.
3. Sheppard, R. (2012). Black-and-White images: Examining The Rich Tradition and Today's Potential of Black-and-White Landscapes. *Landscape Photography: From Snapshots to Great Shots*, 159. Berkeley, CA. Peachpit Press.

# DETECTABILITY OF COLOR-CODED TOILET SIGNS

Chanprapha Phuangsuwan — Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand
Mitsuo Ikeda — Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand
Wipada Pumila — Department of Digital Printing and Packaging Tech., RMUTT, Thailand

**Keywords:** Color-code, Toilet sighs, Detectability, Goggles, Distance

## 1. Introduction

In Thailand the color-coded toilet signs are not popular yet and we are developing proper signs. As in the Fig.1 shows the variety of using color for the toilet signs and it is difficult to discriminate by the shape of graphic or by the variety of colors as no systematic of using. Japan is developed country and they proposed the color-code for toilet sign as shown in the Fig. 2. Color is help to improve detectability without clearly shape of male or female graphics. The roles of sign are better concern to patterns, the locations, the legibility distance, and the sign design etc. [1] To put color to a sign is one of important factor for the sign design. In addition, the checking capability of sign after the designing also needed. The reaction time for Identifying to the sign is often used in the engineering or architecture fields. Yi-Lang Chen and Cai-Cin Sie (2016) investigated the reaction time for identifying toilet sign with Taiwanese and found that Chinese text with color gave a short reaction time than the graphic sign with color. [2] However, the result claimed by Lang Chen and Cai-Cin Sie was not confirmed by elderly yet. Our group hypothesized that color may be helpful for toilet sign detecting ability of anybody. In the previous paper we reported colors to represent male (5PB4/12) and female (7.5RP5/14) that were obtained from 100 Thai subjects. [3] We then experimented to see if colored sign is better than achromatic sign to detect from a far distance.

Fig. 1 Toilet signs in Thailand

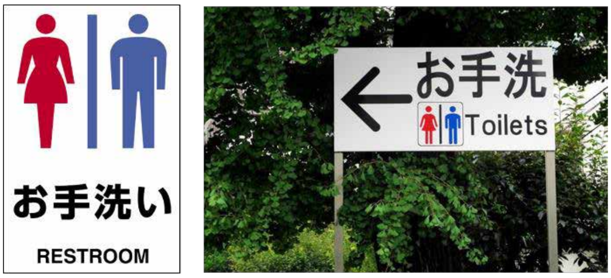



Fig. 2 Toilet signs in Japan

## 2. Experiment

The toilet signs were prepared in achromatic signs (black figure on a white background) for male and female figures, respectively, and the blue male sign and the red female sign as shown in Fig. 3. [3] The size of toilet signs was surveyed in various places and decided toilet sign sized at 7 cm, wide and 15 cm, high. The sign was put at the holder which was 150 cm height from the ground.

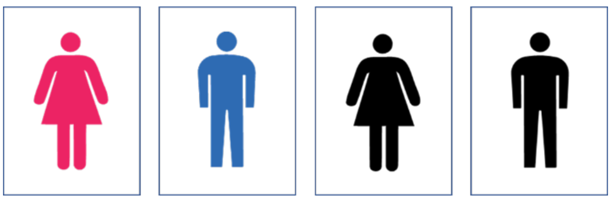


Fig. 3 Toilet signs used in the experiment.

The toilet signs were presented at different 11 viewing distances, from 35, 50, 70, 90. 110, 130, 150, 170, 190, 210, 230, and 250 m and subjects responded which sign they recognized. The experiment was carried out outdoors at daytime. The viewing distances were randomly selected and 10 repetitions at each distance were conducted. From the responses, probability-of-correct seeing curves were obtained for each sign to find the viewing distance threshold for correct detection of the toilet signs. The observation was done with the naked eyes and with the cataract experiencing goggles. The results of 10 subjects were obtained.

Fig. 4 The cataract experiencing goggles to simulate elderly vision. [4]

**3. Results and Discussion**

The result of corrected responses was plotted in the probability of seeing curve. Figure 5 shows the result of two subjects MI and WP which is result of naked eyes showing on the left and goggles on the right columns. The abscissa represents to viewing distance and the ordinate represents to correct responses in percentage. Dotted line shows the 50% of probability of correcting percentage. The black filled symbols are achromatic sign which is triangles for female and squares for male graphic signs. The filled squares with blue connecting line are male graphic sign and filled triangles for female, respectively. The red sign gave the longest viewing distance. The blue sign turned out to be a black sign for far viewing distance and gave a similar result as the achromatic black sign. To see clearly, we took an average of result of achromatic and blue signs (blue line on the graph) with red sign (orange line on the graph) from subject MI and WP as shown in Fig. 6. The result suggested the blue color works same as achromatic for the far distance but red color was very good for detectability even for the goggles view (elderly).

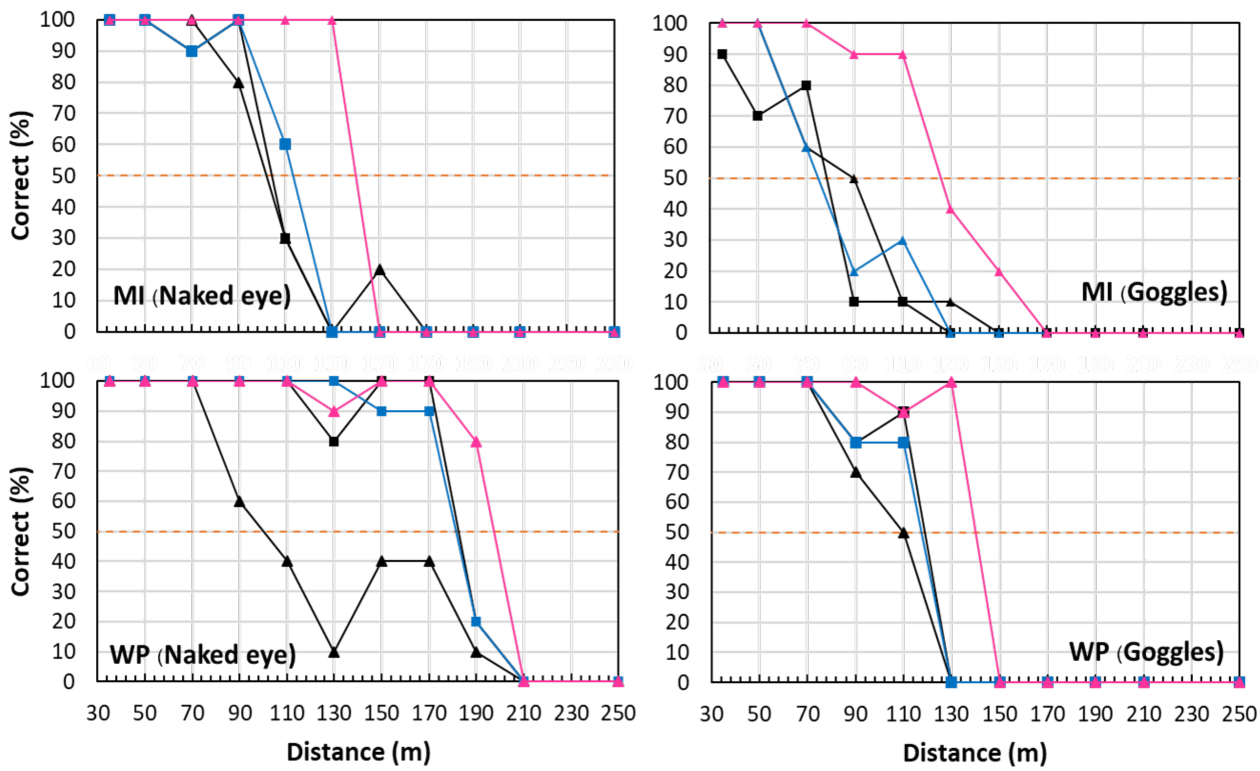



Fig. 5 The individual of correcting responses of probability of seeing curve from subject MI and WP. Naked eyes (left) and with goggles (right).

The threshold distance for detecting sings is summarized in Table 1 based on10 subjects. The two achromatic sings and the blue sign gave the threshold distance of 143.3 m and the red sing gave 167.3 m with the naked eyes. The eyes with the goggles gave 115.9 m and 137.1 m, for the achromatic and red signs, respectively. The difference between achromatic and red signs is 23.9 m with naked eyes and 21.2 m with goggles to show the advantage of the colored signs.

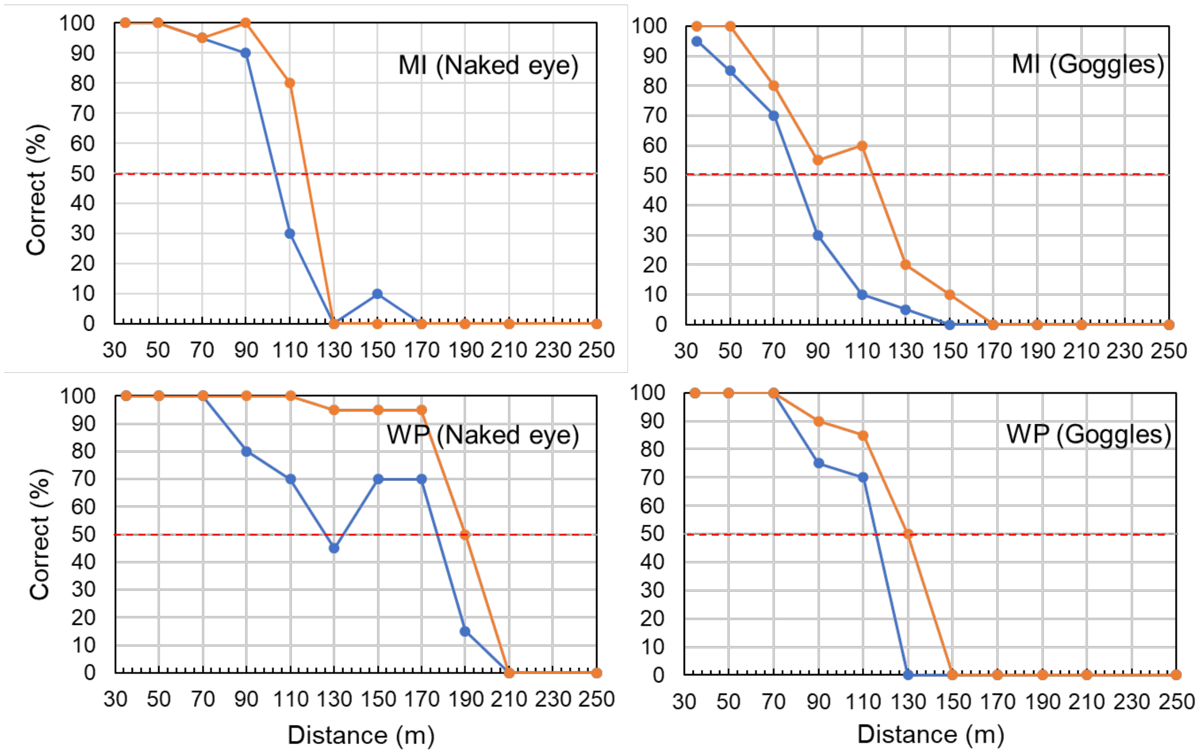



Fig. 6 Comparison the averaged result between achromatic plus blue and red sign from subject MI and WP. Naked eyes (left) and with goggles (right).

Table 1 Averaged result of corrected responses at 50% of probability of seeing curve, naked eyes; top and goggles; bellow.

| Naked eyes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Items | MI | WP | SC | SJ | PN | KS | CP | PT | SK | AP | Mean |
| Achromatic sign | 105 | 126 | 153 | 199 | 118 | 126 | 153 | 112 | 188 | 154 | 143.4 |
| Chromatic sign | 135 | 171 | 190 | 199 | 130 | 193 | 160 | 122 | 195 | 178 | 167.3 |
| Difference | 30 | 45 | 37 | 0 | 12 | 67 | 7 | 10 | 7 | 24 | 23.9 |

| Goggles | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Items | MI | WP | SC | SJ | PN | KS | CP | PT | SK | AP | Mean |
| Achromatic sign | 80 | 115 | 74 | 158 | 91 | 123 | 168 | 112 | 129 | 109 | 115.9 |
| Chromatic sign | 114 | 131 | 101 | 188 | 130 | 150 | 168 | 125 | 139 | 125 | 137.1 |
| Difference | 34 | 16 | 27 | 30 | 39 | 27 | 0 | 13 | 10 | 16 | 21.2 |

## 4. Conclusion

To apply the color in toilet sign is helpful for detectability for young and elderly people. In particular the red color is useful for identification as a female toilet. The blue sign, however, did not show an advantage for the threshold distance as it appeared black when observed at far distances. In practice the detection of either one is enough to know which is which toilet as two signs are observed at a time and If the red sign is clearly detected people can know the other is male toilet and no problem should happen.

## References

1) K. Nassar: Sign Visibility for Pedestrians Assessed with Agent-Based Simulation, Transportation Research Record Journal of the Transportation Research Board. 2264 (2011), pp.18-26

2) Y.L. Chen and C.C. Sie: Design Factors Affecting the Reaction Time for Identifying Toilet Signs: A Preliminary Study, Perceptual and Motor Skills. 122-2 (2016), pp. 636–649

3) W. Pumila, C. Phuangsuwan, Y. Mizokami and M. Ikeda: Colors for female and male image by Thai and Japanese people. Proceeding of ACA2019 Nagoya. 29 Nov.-2 Dec., pp. 204-209

4) T. Obama and M. Ikeda: Desaturation of color by environment light in cataract eyes. Color Research and application. 33-2 (2008), pp. 142-147

# SIMULTANEOUS COLOR CONTRAST WITH A LARGE SURROUNDING FIELD

Mitsuo Ikeda Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand
Chanprapha Phuangsuwan Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand
Piyamon Nguensawat Department of Digital Printing and Packaging Tech., RMUTT, Thailand

**Keywords:** Simultaneous color contrast, elementary color naming, chromatic adaptation

## 1． Introduction

When a gray patch is placed on a colored paper it is perceived slightly colored, which is known as the simultaneous color contrast phenomenon. The recognized visual space of illumination RVSI theory proposed by Ikeda (1993) [1,2], explains the simultaneous color contrast SCC as a result of the brain chromatic adaptation to the light coming from the surround. Any visual stimulus is composed of a shape (contour) and color (light). Namely,

**Visual stimulus = Contour + Light**

If the perception of the shape or the contour becomes weak or none the only color or light remains, which gives the visual system a good chromatic adaptation to the light coming from the surround. The RVSI theory says that the visual system constructs a space over the SCC stimulus of which illumination is the colored light of the surround. The chromatic adaptation becomes strong and the central gray patch appears a vivid color. A SCC stimulus is normally made of a paper and its size is not large. A subject perceives it as a mere plane object. But it is possible to reduce the object perception by blurring the contour of the central gray patch with a help of, for example, a tissue. The SCC effect is enhanced by a tissue.[3] Another way to reduce the object perception would be to make the SCC stimulus extremely large so that the entire visual field is occupied by the surrounding color. It becomes difficult for the subject. The present paper will confirm the prediction. In the experiment 1 large visual field is achieved by making a semi-circular surround and a subject enters inside of the circular surround. In the experiment 2 a flat but large surround is employed to make the subject visual field for the surround very large.

## 2. Experiment

### 2.1 Experiment 1

The SCC stimulus is made of a semi-circular paper background of which radius was 22 cm as shown by a thick solid line in Fig. 1. Four colors, red, yellow, green, and blue, were employed for the background.

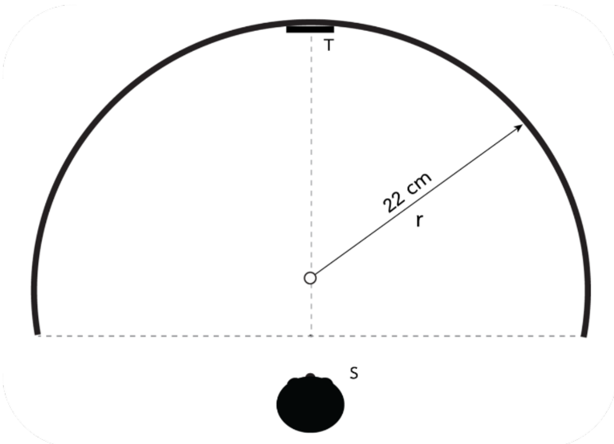



Fig. 1 The SCC stimulus specifications used in experiment 1.

A central gray paper test patch T of the size 3×3 $cm^2$ was pasted at the center of the background. A subject S observed T binocularly at different viewing distances, 20, 30, 40, 50, 100, and 200 cm measured from T. The visual angles of the horizontal direction of the surround at these distances are given in Fig. 2. At 30 cm of the viewing distance the visual angle of the surround was 159° and at 20 cm it became 211°, larger than 180° shown by a dotted horizontal line in Fig. 2. The both edges in the horizontal direction disappeared at between 30 and 20 cm of the viewing distance. The stimulus was illuminated by two fluorescent lamps of the daylight type placed above and below the stimulus to give vertical plane illuminance 1,147 lx on the stimulus.

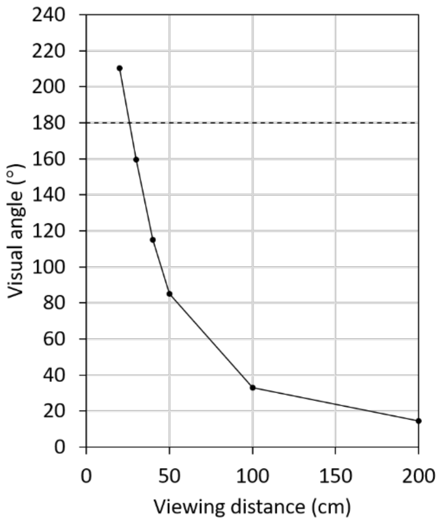



Fig. 2 Visual angle of the surround at viewing distance.

Five subjects participated in the experiment. One was a well experienced subject in this kind of psychophysical experiment and other four were naïve subjects. They judged the color of the central gray test patch by the elementary color naming method and repeated five times in different sessions. Stimuli were pseudo randomly presented and the viewing distance was also pseud-randomly selected.

### 2.2 Experiment 2

A large flat paper surrounds were employed of which size was 227×198 cm$^2$. Red, yellow, green, and blue colors were employed. Each paper was held against a wall of a room and a gray test patch of the size 5×5 cm$^2$ was pasted at the center of the background. The stimulus was illuminated with fluorescent lamps of the daylight type from above and the luminance on the surround near the test patch was 20, 58, 16, and 14 cd/m$^2$ for red, yellow, green, and blue surround, respectively. The viewing distances from the stimulus were 20, 30, 40, 50, 100, 200, and 500 cm, which gave the visual angle of the horizontal direction of the surround as shown in Fig. 3. The maximum visual angle was 160° which was obtained at 20 cm of viewing distance.

Five naïve subjects participated in the experiment, three of them were same as in Experiment 1. Each subject repeated observation for five times. Experimental procedure was same as in Experiment 1 except change of surrounds. With one surround the experiment was continued until all the data were taken.

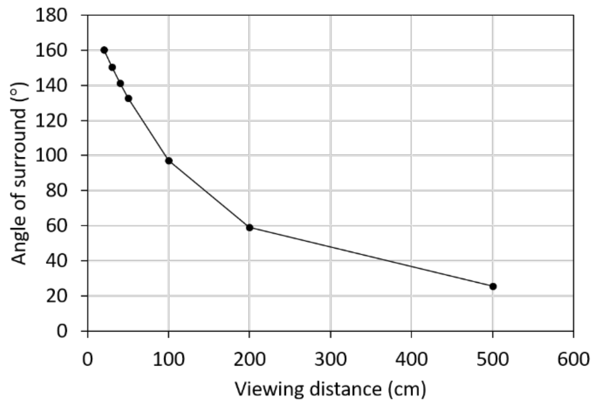



Fig. 3 Surrounding visual angle in Experiment 2.

## 3. Results

### 3.1 Result of experiment 1

The average of five subjects of the amounts of chromaticness for red, yellow, green, and blue surrounds are shown in Fig. 4. The abscissa gives the visual angle of the surround that were given in Fig. 2, and the ordinate the percentage of the chromaticness. A vertical dotted line indicates 170° where the both edges disappeared. Short bars indicate SD of five subjects. The shape of curves is similar among the four surrounding colors.

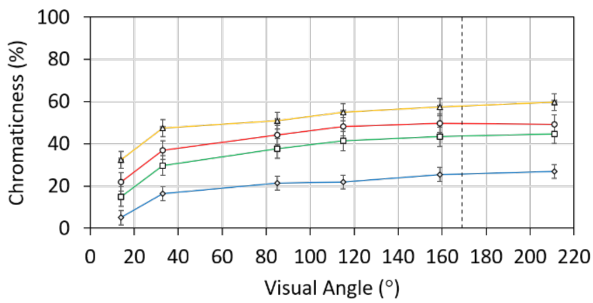



Fig. 4 Amount of chromaticness for visual angle of the surround.

The chromaticness increases suddenly in the beginning and saturates at shorter viewing distances. At the nearest viewing position, the mount went up to 60% with the yellow surround and almost 50% with the red surround, which are very large, which never happens with normal paper stimulus. It was expected, however, that the chromaticness increases suddenly at two furthest distances where the visual field is filled with the surrounding colors, but it did not occur. The result can be expressed in a different way, that is, by a polar diagram as shown in Fig. 5. Unique red and green are taken on the horizontal axis and unique yellow and be on the vertical axis. Apparent hue is taken as the angle from the red axis in the counterclockwise direction. The amount of chromaticness is taken along a radius direction giving zero at the origin and 100% at the circumference. The result shown in Fig. 5 is shown in Fig. 5. Large red circle, yellow triangle, green square, and blue diamond indicate the color appearance of respective surround. They were almost unique hues. Red open circles give the color appearance of the test patch with the red surround. The nearest point to the origin was obtained at the viewing distance 200 cm and the four points were obtained at the viewing distance 100, 50, 40, 30, and 20 cm, respectively, the last two overlapping. It is clearly shown that the apparent hue does not change for different viewing distance and only amount of chromaticness changes. The properties are roughly applied to other surrounding colors. The apparent hues of the test patch for the four surrounding colors are same as reported previously that were obtained by the two rooms technique [4] and by the afterimage experiment. [5]

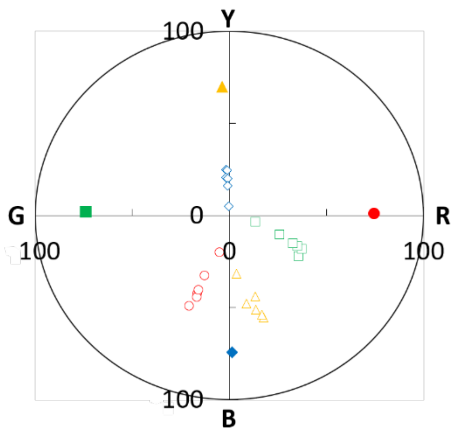



Fig. 5 Color appearance of the test patch plotted on a polar diagram.

**3.2 Result of experiment 2**

Averages of the five subjects are shown in Fig. 7 as Fig. 4 for four surrounding colors. Amounts of chromaticness increased for shorter distance, or for larger visual angle of the surrounds. The color appearance of the test patch is shown in Fig. 7 as Fig. 5. Both figures are similar with each other.

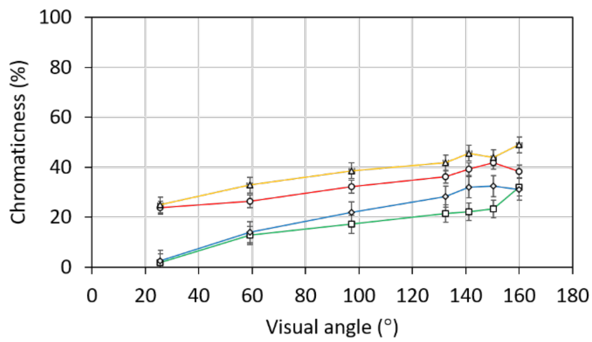



Fig. 6 Chromaticness amount of test patch in Experiment 2.

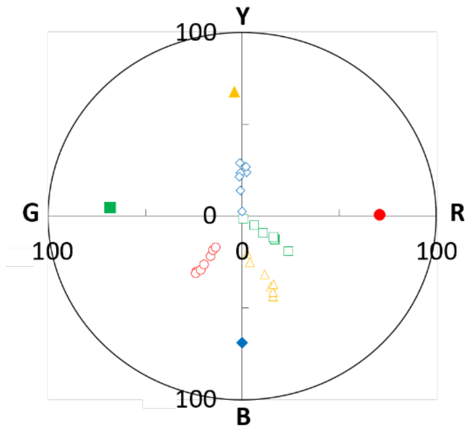



Fig. 7 Color appearance of surrounds and the corresponding test patch.

To compare Experiment 1 and 2 Fig. 8 was prepared, which is a Coalescence of Figs. 3 and 6. One common property is the increase of chromaticness for larger visual angle of the surround.

**4. Discussion**

When we observe a SCC stimulus of a paper of A4 size, we hardly perceive vivid color at the central gray patch. The visual angle of A4 is about 40° assuming the viewing distance 40 cm. With that visual angle we obtained about 40% of chromaticness amount with the curved surround of Experiment 1and 25% with the flat surround of Experiment 2 for red surround, which is quite large. A difference between the A4 case and the present experiments is the viewing distance. The 40 degrees of the surround can be obtained at 87 cm of the viewing distance in Experiment 1 and at 310 cm in

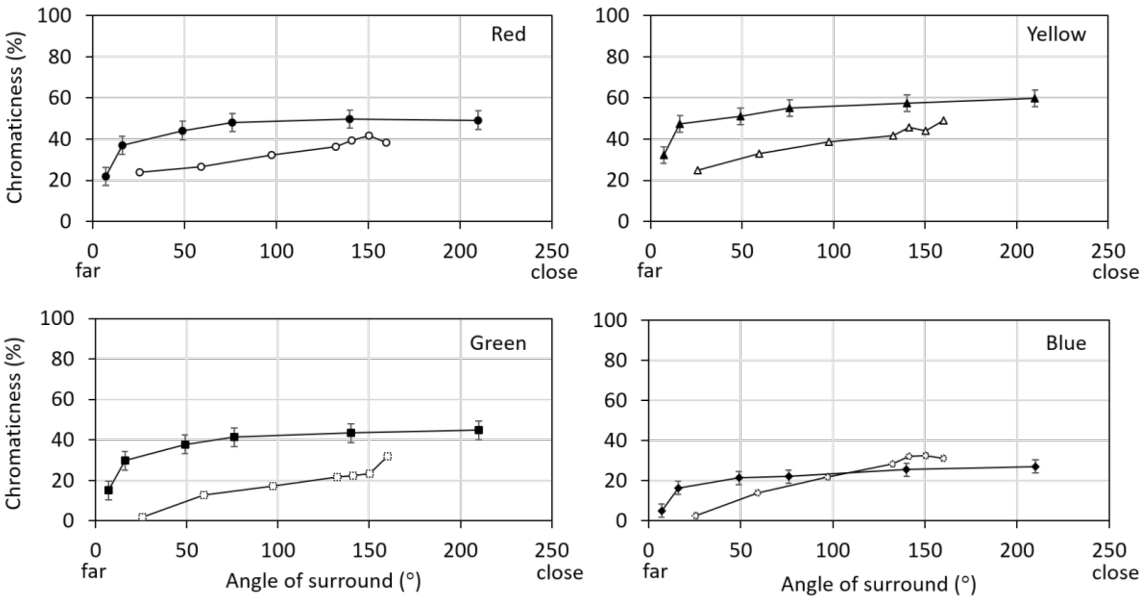



Fig. 8 Chromaticness mounts for surrounding size compared between Experiment 1 (solid circles) and 2 (open circles).

Experiment 2, which are much larger than the case of the A4 stimulus. The difference might have caused the difference in the vividness of the test patch, but this is an opinion to be investigated in the future.

**References**

1) M. Ikeda, K. Motonaga, N. Matsuzawa, T. Ishida, Threshold determination for unnatural color appearance with local illumination. Kogaku (Optics) 22 (1993), pp. 289-298

2) M Ikeda, P. Pungrassmee, P. Katemake, A. Hansuebsai, The Brain Adaptation to the Color of Illumination and not the Retinal Adaptation to the Color of Objects that Determines the Color Appearance of an Object in the Space. Opt. Rev. 13 (2006), pp. 388–395

3) M. Ikeda and C. Phuangsuwan, The effect of tissue paper on the color appearance of colored papers. Jr. Opt. Soc. Am A 37 (2020), pp. 114-121.

4) C. Phuangsuwan and M. Ikeda, Chromatic adaptation to illumination investigated with adapting and adapted color. Col Res and Appl 42 (2017), pp. 571-579

5) M. Ikeda and C. Phuangsuwan, Strong effect of the simultaneous color contrast in an afterimage. Col Res Appl 44 (2018), pp. 50-53

# Does Rainbow Color Truly Represent Alternative Gender?

Kitirochna Rattanakasamsuk　Color Research Center, RMUTT, Thailand
Charunya Nontawongsa　Color Research Center, RMUTT, Thailand
Ploy Srisuro　Color Research Center, RMUTT, Thailand
Chanprapha Phuangsuwan　Color Research Center, RMUTT, Thailand

**Keywords:** Alternative Gender, LGBTQ+, Memory Color, Representative Color.

## 1. Introduction

In the gender binary system, the gender identity of people was generally classified into two genders, i.e., "Male" and "Female". This system was widely used in many societies for a long time. However, some people believe that their gender identity was not limited to only "Male" and "Female". Nowadays, there is a group of people who identified themselves as "LGBTQ+". This "LGBTQ+" came from the word "Lesbian (L)", "Gay (G)", "Bisexual (B)", "Transgender (T)", "Queer (Q)" and "Other (+)". In Thailand, the "LGBTQ+" is normally called "Alternative Gender".

There were several cases that color was used to represent this gender variance. During the Nazi regime in 1933-1945, the pink triangle was used as a badge to indicate the gay prisoner in a concentration camp. But later the pink triangle became the symbol of the LGBT's right movement (Waxman, 2018). In 1978, a rainbow color flag was firstly used by a gay activist, Gilbert Baker, to represent the alternative gender (Swanson, 2015). Later, the rainbow color was perceived as the representative color of the alternative gender. It is still questionable whether the rainbow color truly represents the alternative gender since the rainbow color was originally used in a political movement. It may not be suitable to use in some designs which required a minimal number of colors. Therefore, the objective of this research is to investigate the representative color of the alternative gender.

## 2. Methodology

*Stimulus*

The stimulus composed of 44 color chips pasted on a gray background as shown in Figure 1.

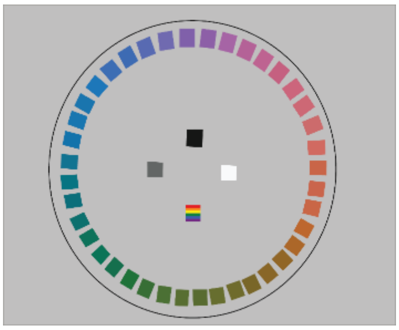


**Figure 1.** Stimulus configuration

Forty Munsell color chips with value 5 and chroma 8 of all Munsell hue were arranged to form a Munsell ring. Inside this Munsell ring, N1, N5, N9, and a rainbow color chips were placed. The size of each color chip is two degrees of visual angle.

*Subject*

The subjects were 120 university students who volunteered to participate in this experiment. They were classified into two groups based on their gender identity. The first group, "Non-alternative Gender", was 30 male and 30 female subjects. The second group was 60 subjects who did not identify themselves as "Male" or "Female". They identified themselves as, "Alternative Gender". In case of the alternative gender subjects, if they agreed, we collected their gender identities in detail. They could freely specify their gender identity such as "Gay", "Lesbian", "Transgender", "Tomboy" or "Katoey (Thai word means a man who wants to be a woman)". All subjects had a normal color vision.

*Experimental Procedure*

The experimental room's wall was covered by a white wallpaper. The room illuminance measured at the subject position was 1200 lux. The stimulus was placed on the front wall. Before starting each selection, the experimenter randomly rotated the Munsell ring. The subject's task was to select the

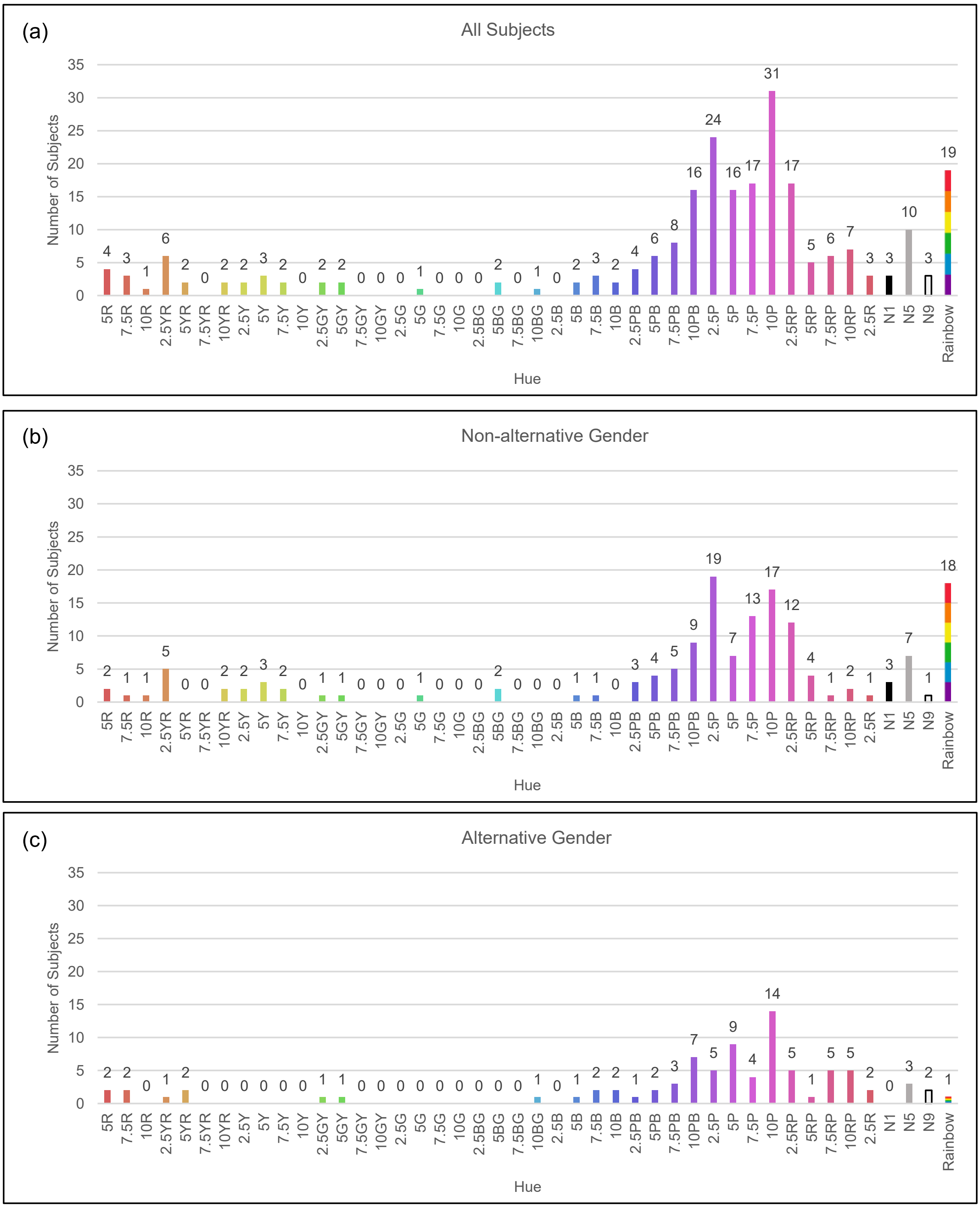



**Figure 2.** Representative color selected by (a) all subject, (b) Non-alternative Gender and (c) Alternative Gender

color chips which represent the alternative gender. The subject could select the color chip as many as they want.

### 3. Result

Figure 2(a) shows the representative color selected by all subject. The ordinate represented the frequency of selection. The range of high selected color was 10PB 5/8, 2.5P 5/8, 5P5/8, 7.5P 5/8, 10P 5/8, and 2.5RP 5/8. This range covered color in the range of bluish purple, purple and reddish purple. The top selected color chip was 10P 5/8 and 2.5 P5/8. When we focus on these two colors, there might be some tendency in a color selection based on gender.

Most male subjects selected 2.5P 5/8 while most female subjects chose 10P 5/8. Even though both colors were purple, the female subject might prefer pinkish purple, but male subject possibly preferred bluish purple. This tendency quite agrees well with previous research studied on the relation between color preference and gender (Ellis & Ficek, 2001; Hurlbert & Ling, 2007).

Apart from these colors, the third rank of representative color was the rainbow color which was selected by only 19 subjects. This number was not as high as our expectations. Although the rainbow color flag has been popularly used as the symbol of the alternative gender movement, it is still questionable that the rainbow color is accepted to be the representative color of the alternative gender. This question was realized when the result was analyzed based on gender identity. Figure 2(b) and 2(c) showed the representative color selected by the non-alternative gender subjects and the alternative gender subject, respectively. Both groups agree that the purple color was the representative color as the alternative gender. However, it was surprisingly found that only one of 60 alternative gender subjects selected the rainbow color. Almost the rainbow color selection was made by non-alternative gender subjects. This result indicated the disagreement between the non-alternative gender and the alternative gender over the rainbow color. Most of the alternative gender did not agree that the rainbow color was their representative color.

## 4. Conclusions

Our result suggested that that the rainbow color was not the most appropriate color to represent the alternative gender. Even though the rainbow color was perceived as one of the representative colors of the alternative gender, but the alternative gender themselves did not agree with that perception. The possible candidate which both groups agree to be the representative color was purple.

## References


- Ellis, L., & Ficek, C. (2001). Color preferences according to gender and sexual orientation. Personality and Individual Differences, 31(8), 1375–1379. doi: 10.1016/s0191-8869(00)00231-2
- Hurlbert, A. C., & Ling, Y. (2007). Biological components of sex differences in color preference. Current Biology, 17(16). doi: 10.1016/j.cub.2007.06.022
- Swanson, A. (2015, June 29). How the rainbow became the symbol of gay pride. Retrieved September 26, 2019, from https://www.washingtonpost.com/blogs/wonkblog/wp/2015/06/29/how-the-rainbow-became-the-symbol-of-gay-pride/
- Waxman, O. B. (2018, May 31). How Nazi Pink Triangles Symbol Was Reclaimed for LGBT Pride. Retrieved from https://time.com/5295476/gay-pride-pink-triangle-history/

# COLOR OF THAI ICED TEA

Chanida Saksirikosol Color Research Center, RMUTT, Thailand
Kitirochna Rattanakasamsuk Color Research Center, RMUTT, Thailand
Chanprapha Phuangsuwan Color Research Center, RMUTT, Thailand
Jarunee Jarernros Color Research Center, RMUTT, Thailand

**Keywords:** Thai iced tea, Boundary of Thai tea Color, milk tea, Boundary color

## 1. Introduction

Thai iced tea is a famous drink among Thai and foreigners because it is nice-smelling, tasty.

The color of Thai iced tea is quite unique which is slightly orange tone. The orange color of Thai tea is brewed from the mixture of black tea, condensed milk, and sugar.

However, the color of Thai tea has variety depends on the method of brewing, proportion and amount of Thai tea mixed with condensed milk. This proportion is able to affect the final color of Thai tea. Thus, the color of Thai tea is memorized in a different way individually. The perception of Thai tea color is various due to personal experience as shown in figure 1.

Besides, the unique color of Thai tea has widely known and be named as one shade of color term in Thailand. Therefore, the aim of this study is to investigate the boundary of Thai tea color.

Fig. 1 Thai Iced Tea

## 2. Experiment

The experimental room was divided into 2 rooms. In the first room is namely test room. A monitor (EIZO Color Edge) 27 inches was placed in the test room. The color stimulus will be presented on a monitor. Between test room and subject room there is a separating wall which has a small window size 5x5 $cm^2$. Another room is called subject room which was mounted with white wall paper. The illuminance of the subject room was kept constant at 300 lux. A small window at the front wall of subject room was surrounded by gray paper 25.5 x 25.5 cm. Figure 2 shows the drawing of experimental room.

The participants were able to see the result color through this aperture. The distance between subject and the wall was set at 60 cm that is giving the visual angle of the color stimulus at 2°.

100 participants with normal color vision were participated in this experiment. Mostly, participants are female with average age of 18 to 25 years old.

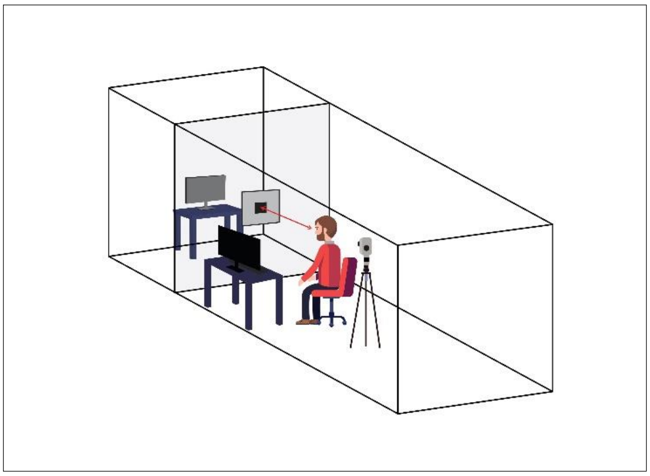


Fig. 2 Experimental Room

Task for subject: subjects were asked to identify Thai tea color by using mouse to select the color from color mixing bar on the left-hand side monitor. Each subject was asked to repeat the task for 3 times. Then, the resulted-color was measured by using Konica Minolta CS-100A. The color of Thai iced tea result is converted to CIEL*a*b.

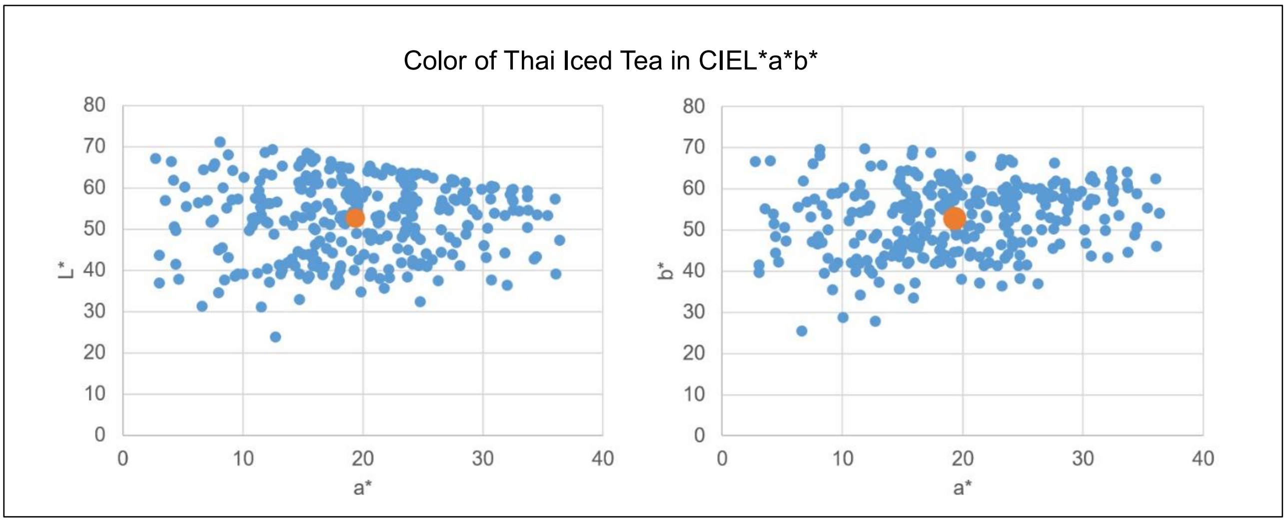



Fig. 3 Color of Thai Iced Tea in CIEL*a*b*

### 3. Results and Discussion

The result of mixing color for Thai Tea was showed in CIEL*a*b* color space. Figure 3 left is the color values that plotted in a* and L*, on the right is plotted in a* and b*. The result showed the boundary of Thai iced tea color was identified in the yellowish orange region. The range of L* value started from 23.78 to 71.10, range of a *value started from 2.76 to 36.41 and range of b *value started from 25.41 to 69.69.

The averaged of Thai tea color was L* = 52.61, a* = 19.36, b* = 52.81. The sample of averaged color is shown in Fig. 9 (right).

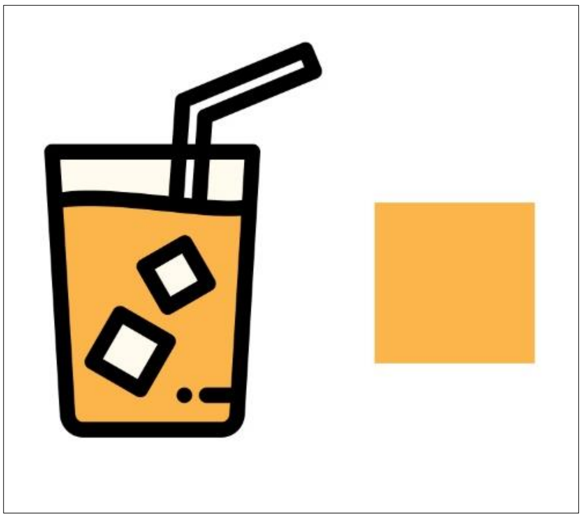


Fig. 4 Averaged Color of Thai Iced Tea

### 4. Conclusion

According to the inclusive result of this study revealed that the boundary of Thai iced tea color was identified widely in the orange region.

Therefore, the boundary of Thai tea color could be applied from L* = 23.78 to 71.10, a* = 2.76 to 36.41 and b* = 25.41 to 69.69. Moreover, those range of Thai tea colors can be grouping by further experiment. At least the average color that we found in CIEL*a*b* value of Thai tea color can be applied to the product design, graphic design, advertising design etc.

Further, the result of this study will be adjusted for Thai tea product design. Then, the color will be tested in order to evaluate the suitability when the color is painted on actual product in the future.

### References

1) Tim Cheung. (2018). World's 50 Most Delicious Drinks. https://edition.cnn.com/travel/article/most-delicious-drinks-world

2) W. Jullaya and R. Wongpaisarnrit: 105 Recipe of Coffee and Tea, (2015), pp.57

3) P. Katemake and M. Ikeda: Visual Psychophysics Basic and Applied, (2012)

4) S. Panya: Colors for Plain Cigarette Packaging Design, (2018)