COLOR
RESEARCH
CENTER

2022
ANNUAL REPORT

PREPARED BY

Pappim Chuenjai

Preface

2022 is comparable to a year of new beginning. After the covid situation was better, we tried our best to continue many activities.

This annual report 2022 of Color Research Center aimed to present the academic activities and other activities which were happened in 2021 (Year budget from October 1st, 2021 – September 31st, 2022). There are many contents presented in this report such as CRC information, activities, cooperation, and research. These will be presented the achievement of Color Research Center all the year.

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

Director of Color Research Center

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Message from CRC's Director

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

In 2022, the COVID-19 situation seems better. So, we could continue doing onsite activities such as join research and conferences. Therefore, this annual report will present the achievements and activities that were happened in the budget year 2022.

Chanprapha Phuangsuwan

Director of Color Research Center

General Information

A Briefly History

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

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

CRC Logo

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

General Information

Location

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

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

Contact information

Tel: +66 2 5494538

Email: crc@rmutt.ac.th

Website: www.crc.rmutt.ac.th

CRC Members

Dr. Chanprapha Phuangsuwan, Director of CRC

Associate Professor

Field to cover: Color vision and color appearance

Dr. Mitsuo Ikeda

Professor

Field to cover: Color vision,
Visual information processing

Dr. Uravis Tangkijviwat

Assistant Professor

Field to cover: Color preference
and color psychology

Dr. Kitirochna Rattanakasamsuk

Assistant Professor

Field to cover: Elderly vision and
universal color design

Dr. Waiyawut Wuthiastasarn

Assistant Professor

Field to cover: Media Accessibility

Chanida Saksirikosol

Lecturer

Field to cover: Color Applications

Pappim Chuenjai

Technical Assistant

International Advisors

Dr. Hirohisa Yaguchi

Emeritus Professor, *Chiba University, Japan*

Dr. Hiroyuki Shinoda

Professor, Department of Information and Computer Intelligence

College of Information Science and Engineering,

Ristumeikan University, Japan

Dr. Yasuki Yamauchi

Professor, Faculty of Engineering

Yamagata University, Japan

Dr. Mikiko Kawasumi

Associate Professor, Department of Information Engineering,

Faculty of Science and Technology

Meiji University, Japan

Visiting researcher, Rajamangala University of Technology Thanyaburi

International Advisors

Dr. Yoko Mizokami

Professor, Department of Imaging Sciences,
Graduate School of Engineering

Chiba University, Japan

Dr. Miyoshi Ayama

A former Dean of the Graduate School of Engineering and School ofEngineering and a Professor Emerita of *Utsunomiya University*.

Dr. Miho Saito

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

Instruments

No.	Instruments	Amount
1	Spectroradiometer: Konica Minolta CS2000	1
2	Spectrophotometer (360-740 nm.): CM-3700d	1
3	Spectrophotometer: Konica Minolta CM-512m3A	1
4	Spectrophotometer: Konica Minolta FD-7	1
5	Illuminance Meter: Konica Minolta CL-200A	3
6	Illuminance Meter: Konica Minolta T-10A	1
7	Illuminance Meter: Konica Minolta T-10MA	1
8	Illuminance Spectrophotometer: Konica Minolta CL-500 A	1
9	Luminance Meter: Konica Minolta CS100A	2
10	Chroma Meter: Konica Minolta CS-160 **(New instrument)**	1
11	Haze Meter: HM-150	1
12	Farnsworth-Munsell: 100 Hue Test	1
13	The Munsell Book of Color Glossy Collection	1
14	Eyes Tracking: ASL The EYES-TRACKING*7	1
15	Program ASL Result Plus	1
16	Laptop HP	1
17	Laptop DELL	1
18	White Calibration Plate (Square)	1
19	White Calibration Plate (Circle)	1
20	Haze Standard Plate for HM-150	4

Instruments

Spectroradiometer:

Konica Minolta CS2000

Spectrophotometer (360-740 nm.):

CM-3700d

Spectrophotometer:

Konica Minolta CM-512m3A

Spectrophotometer:

Konica Minolta FD-7

Illuminance Meter:

Konica Minolta CL-200A

Illuminance Meter:

Konica Minolta T-10A

Instruments

Illuminance Meter:

Konica Minolta T-10MA

Illuminance Spectrophotometer:

Konica Minolta CL-500 A

Haze Meter: HM-150

Luminance Meter:

Konica Minolta CS100A

Chroma Meter: Konica Minolta CS-160

Farnsworth-Munsell: 100 Hue Test

Instruments

The Munsell Book of Color
Glossy Collection

Laptop HP

Laptop DELL

White Calibration Plate

Haze Standard Plate for HM-150

Instruments

SCAN HERE!

BORROWING RETURNING

Online Borrowing and return system

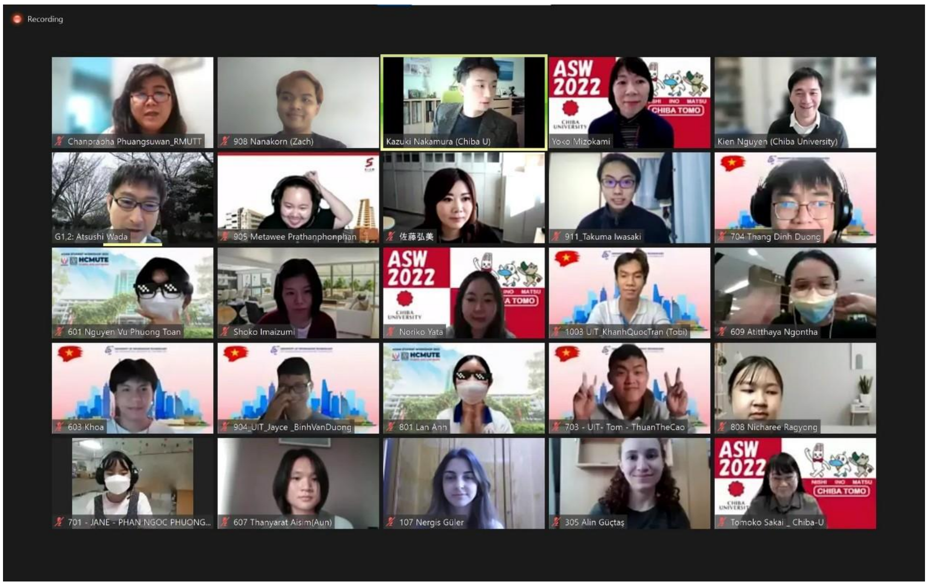
There is the online system for borrowing and returning the instrument of Color Research Center. People who would like to borrow and return instrument can scan QR code and submit the google form. QR code can be found in CRC website - http://www.crc.rmutt.ac.th/ or CRC office.

Report the instrument used

No.	Instruments	Frequency
1.	Luminance Meter: Konica Minolta CS100A (A)	11
2.	Luminance Meter: Konica Minolta CS100A (B)	10
3.	Illuminance Meter: Konica Minolta CL-200A	10
4	Spectrophotometer: Konica Minolta FD-7	5
5.	Spectroradiometer: Konica Minolta CS2000	5
6.	Illuminance Spectrophotometer: Konica Minolta CL-500 A	5
7.	White standards	5
8.	Illuminance Meter: Konica Minolta T-10A	5
9.	The Munsell Book of Color Glossy Collection	3
10.	Spyder calibration monitor	2
11.	Dell laptop	1

Activities

1. Asia Student Workshop 2022 (Online)



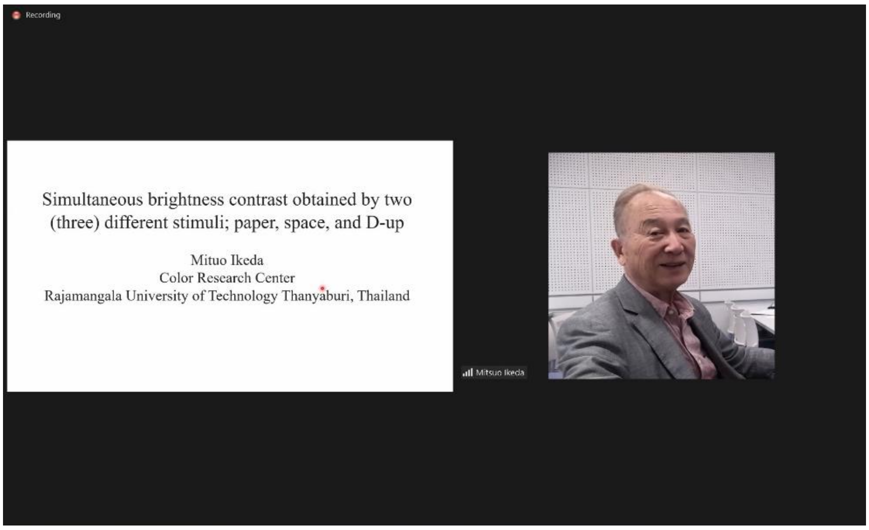
On 7th – 11th March 2022, Asia Student Workshop on Image Science 2022 or ASW 2022 was organized as an online activity. There were 120 students in 6 countries included Japan, Thailand, Vietnam, Loas, Malaysia. Turkey participated in this online exchange program.

There were 4 students of Color Research Center, RMUTT participated in this program as follows.

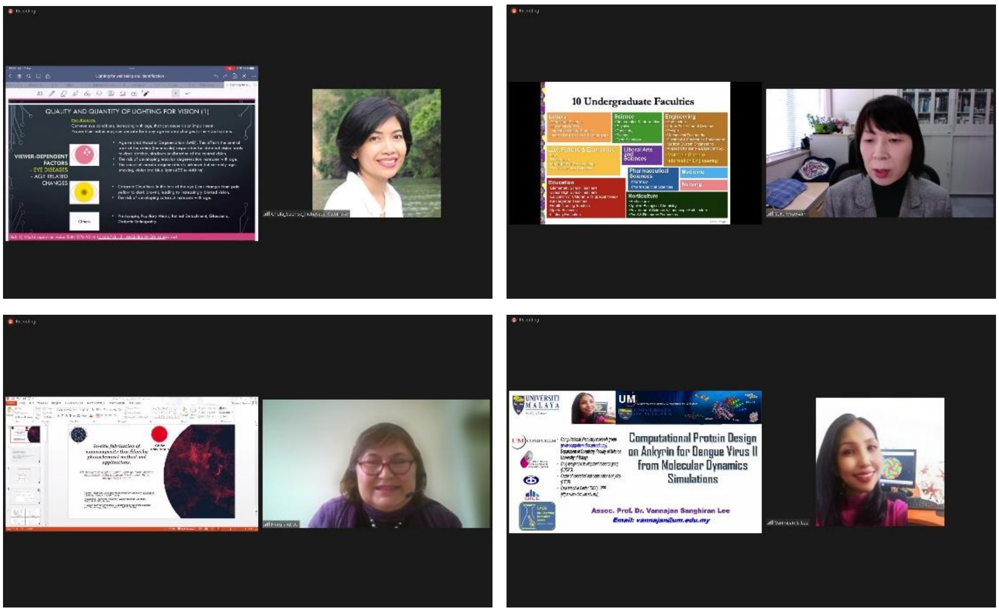
1.	Miss Janejira Mepean	Ph.D
2.	Mr. Phubet Chitapanya	Ph.D
3.	Mr. Nanakorn Taengpian	Undergraduate students
4.	Miss Nicharee Ragyong	Undergraduate students

The Program started by Symposium on 7th March 2022 at 12:00 a.m. (Thailand time). Then on 8th – 10th March, there was a workshop program. The symposium of students, also, was on 8th March 2022. The last day, 11th March 2022 was a presentation day.

Activities



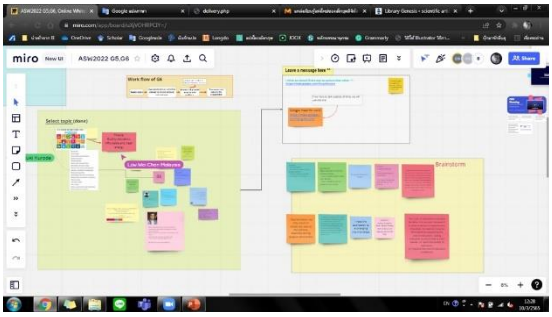
Prof. Mitsuo Ikeda's talk



Other invited speakers

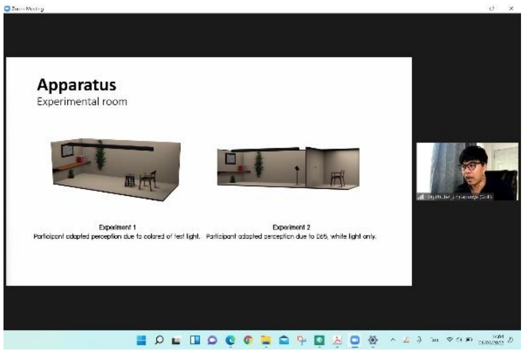
On 7th March 2022, Prof. Mitsuo Ikeda of Color Research Center talked about "Simultaneous Brightness Contrast Obtained by Two (Three) Different Stimuli: Paper, Space, and D-up" in the symposium. Also, there were many professors in many countries who presented their research at this event.

Activities

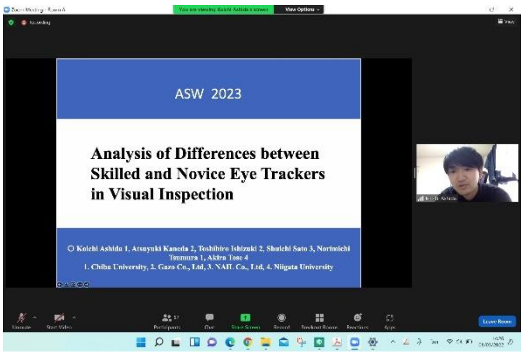


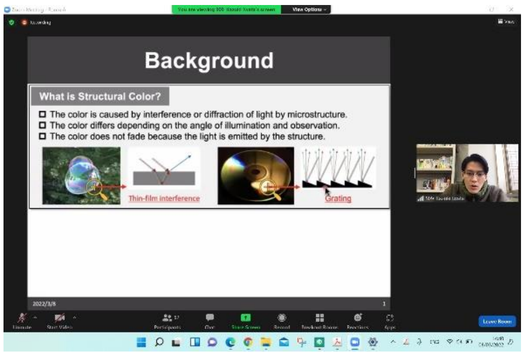
Students' workshop

For the workshop on 8th – 10th March 2022, all students will be divided into 10 groups. They worked together on the main topic "Sustainable Development Goals: SDGs". The application used for the workshop and discussion was the Miro website and Zoom application. CRC students exchanged knowledge and idea with other students from other countries.



Janejira and Phubet talked in the student symposium

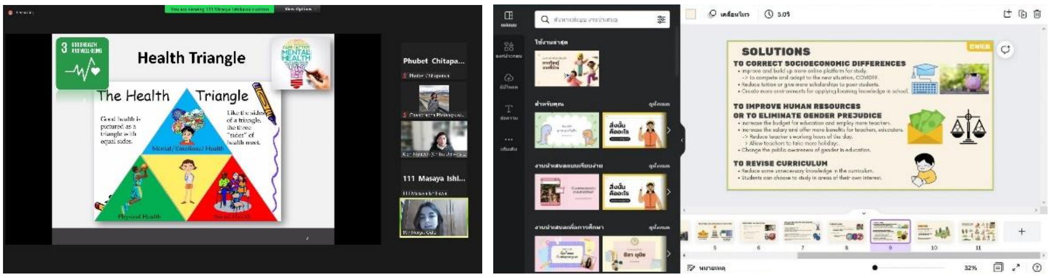




Chiba students talked in the symposium

Activities

Moreover, on 8th March 2022, there was a symposium of students. 2 graduated students from Color Research Center presented their research. There also were 2 graduated students from Chiba University who talked about their project.



Students' final presentations

On 11th March 2022, each group presented their project that worked for 3 days through the Zoom application.

Activities

2. Joint Research

6 students and 1 staff from Chiba University, Japan joined the exchange program at Color Research Center, RMUTT. They were supported by Formation of a Strategic Base in Asia Creating and Developing of Global Minded Imaging Science, BAGIS to do the joint research at CRC from 8^{th} – 28^{th} September 2022.

1.	Ryo Michishita	1^{st} year Master student
2.	Haruya Shiba	2^{nd} year Master student
3.	Yuka Onozaki	2^{nd} year Master student
4.	Akane Takahashi	2^{nd} year Master student
5.	Yuanyuan He	3^{rd} year Ph.D. student
6.	Asst. Prof. Hiromi Sato	Staff

In this exchange program, they did not only research and experiment but also learned the Thai culture such as Thai language, how to make Thai tea and study the history at the Ayutthaya National Park, the ancient and historical place of Thailand.

Thai language class and historical study

Conferences

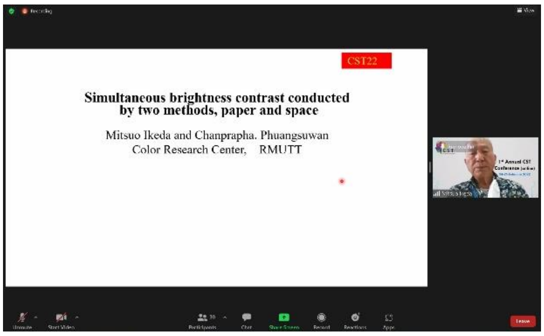
1. The 1st Annual Conference of CST

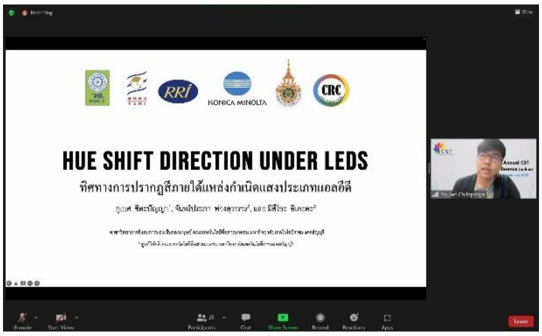
Call for paper poster

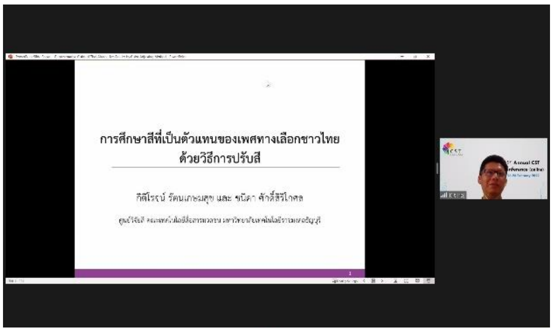
Color Research Center was a co-host to organize the 1st Annual Conference of CST on 24th – 25th February 2022 as an online conference with Chulalongkorn University.

In the event, there were many CRC members and CRC students presented the papers.

Conferences







CRC members and students did the oral presentation.

Conferences

2. The 11th Rajamangala University of Technology International Conference or RMUTCON 2022

Call for paper poster

Rajamangala University of Technology Thanyaburi was the host of The 12th Rajamangala University of Technology National Conference and The 11th Rajamangala University of Technology International Conference or RMUTCON 2022. This event was held from 18th – 20th May 2022 at Royal Cliff Grand Hotel Pattaya, Thailand.

CRC team

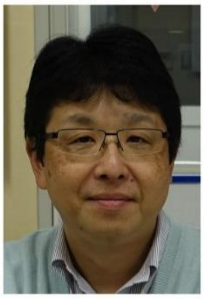
Conferences

Color Research Center organized the international session, Visual Information Processing and Color Vision, on 19th May 2022 from 9.00 am – 5.00 pm. The session was held as a hybrid, online and onsite. Prof. Mitsuo Ikeda was a chair session and the CRC team played important role in the event.

Invited Speakers

CRC invited 3 professors from Japan to be invited speakers in the session.

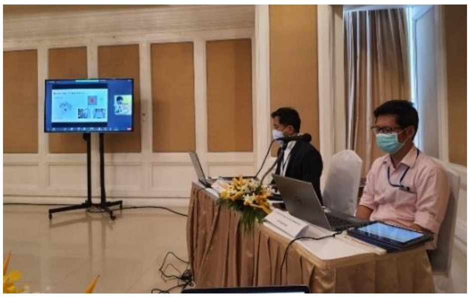




Prof. Hirohiko KANEK, Prof. Yoko Mizokami, Prof. Katsunori Okajima

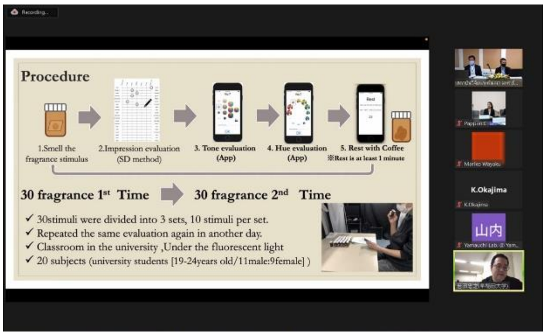
- Prof. Hirohiko KANEKO from Tokyo Institute of Technology. He talked about "Information input interface based on pupillary response
- Prof. Yoko Mizokami from Chiba University. She spoke about "Color and material appearance influenced by lighting conditions"
- Prof. Katsunori Okajima from Yokohama National University. He presented about "Object appearance beyond color perception"

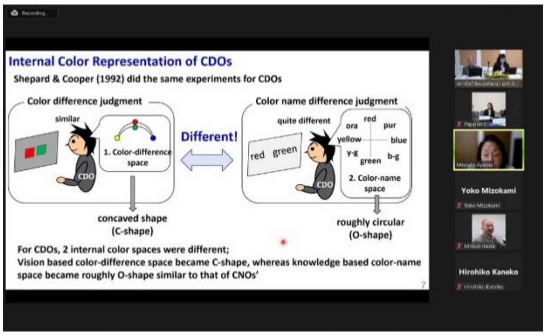
Oral presentations

The chair sessions

Conferences

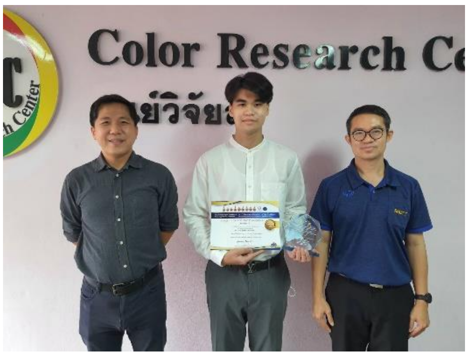


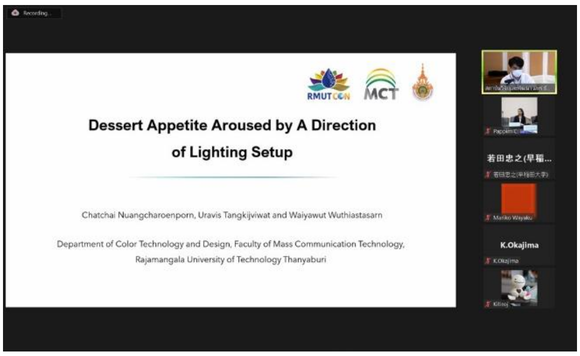


Online and onsite presentation

There were 18 papers submitted to the session and there were 17 papers presented on 19th May 2022 at Sapphair A Meeting room. All presenters had 15 minutes presentation and 5 minutes for discussion in their topic.

<u>The best presentation</u>





Chatchai and his advisors, Asst. Prof. Dr. Uravis and Asst. Prof. Dr. Waiyawut, and his presentation.

Mr. Chatchai Nuangcharoenporn, a Master's degree student of CRC won the best presentation in Visual Information Processing and Color Vision session. He presented "Dessert Appetite Aroused by A Direction of Lighting Setup".

Cooperation

1. Local Cooperation

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

2. International Cooperation

Color Research Center (CRC) cooperates with Color Society of Thailand (CST) to organize AIC2023 15th of the International Colour Association or AIC2023. It will be held on 28th November – 2nd December 2023 in Chiang Rai, Thailand. All CRC members are the main committees of the conference.

Research

There is total 24 research produced and co-produced by CRC members published in the journal and proceedings as following details.

1. Two (2) research published in the journal of Color Research and Application.
2. Nine (9) research published in Proceedings of 6th Asia Color Association Conference.
3. Six (6) research published in E-proceedings of The 11th Rajamangala University of Technology International Conference
4. Seven (7) research published in Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan

No.	Research name	Publish	Year
1.	Panitanang, N., Phuangsuwan, C. and Ikeda, M. (2022). Basic color terms in Thai. Color Research and Application. 1-24. https://doi.org/10.1002/col.22800	Color Research and Application	2022
2.	Chitapanya, P., Phuangsuwan, C. and Ikeda, M. (2022). Color appearance of color chips under light-emitting diodes lamps part II: Hue shift direction. Color Research and Application. 1-13.. DOI: 10.1002/col.22825	Color Research and Application	2022
3.	Chitapanya, N., Phuangsuwan, C., and Ikeda, M. (2021). Basic Color Name in Thai: Investigation of Regions and Gender. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 13-18.	Proceedings of 6th Asia Color Association Conference 2021	2021
4.	Nuangcharoenporn, C., Wuthiastasarn, W., and Tangkijviwat, U. (2021). The Influence of Lighting Direction for Food Photography on Attractiveness. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 26-31.	Proceedings of 6th Asia Color Association Conference 2021	2021
5.	Saksirikosol, C., Jarernros, J., and Rattanakasamsuk, K. (2021). The Investigate Color of Thai Iced Tea for Advertising. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 76-80.	Proceedings of 6th Asia Color Association Conference 2021	2021
6.	Chitapanya, P., Phuangsuwan, C., and Ikeda, M. (2021). Color Appearance of Color Chips under Vivid Colored Leds. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 96-101.	Proceedings of 6th Asia Color Association Conference 2021	2021

No.	Research name	Publish	Year
7.	Mepean, J., Ikeda, M., and Phuangsuwan, C. (2021). Effect of Room Illuminance on Simultaneous Color Contrast Displayed on an Electric Display with or Without a Paper Tissue. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 102-107.	Proceedings of 6th Asia Color Association Conference 2021	2021
8.	Phuangsuwan, C., Ikeda, M., Mepean, J., and Tongsawang, A. (2021). Device Dependent Simultaneous Color Contrast. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 114-120.	Proceedings of 6th Asia Color Association Conference 2021	2021
9.	Pattarasoponkun N., Chanprapha Phuangsuwan, C., and Ikeda, M. (2021). Analysis of Thai Skin Color on Ciel*C*H*. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 144-149.	Proceedings of 6th Asia Color Association Conference 2021	2021
10.	Jarernros, J, Saksirikosol, C., and Srisuro, P. (2021). Effect of Lighting on Lipstick Texture for Advertising Photography. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 150-156.	Proceedings of 6th Asia Color Association Conference 2021	2021
11.	Jarernros, J, Saksirikosol, C., and Srisuro, P., and Rattanakasamsuk, K. (2021). Colors to Represent Thai Alternative Genders. Proceedings of 6th Asia Color Association Conference 2021, Yogyakarta, Indonesia, pp. 171-176.	Proceedings of 6th Asia Color Association Conference 2021	2021
12.	Chitapanya, P., Phuangsuwan, C., and Ikeda, M. (2022). Color Constancy Assessed by the Elementary Color Naming under RGB-LEDs. E-proceedings of The 11th Rajamangala University of Technology International Conference, Pattaya, Thailand, pp. 297-301.	E-proceedings of The 11th Rajamangala University of Technology International Conference	2022
13.	Mepean, J., Ikeda, M., and Phuangsuwan, C. (2022). Simultaneous Color Contrast on an Electronic Display with or without a Tissue Paper under Various Room Illuminances. E-proceedings of The 11th Rajamangala University of Technology International Conference, Pattaya, Thailand, pp. 302-306.	E-proceedings of The 11th Rajamangala University of Technology International Conference	2022

No.	Research name	Publish	Year
14.	Nuangcharoenporn, C., Wuthiastasarn, W., and Tangkijviwat, U. (2022). Dessert Appetite Aroused by A Direction of Lighting Setup. E-proceedings of The 11th Rajamangala University of Technology International Conference, Pattaya, Thailand, pp. 343-348.	E-proceedings of The 11th Rajamangala University of Technology International Conference	2022
15.	Saksirikosol, C., Tongsawang, A., Phuangsuwan, P., and Rattanakasamsuk, K. (2022). Color Name and Aroma of Thai Flowers. E-proceedings of The 11th Rajamangala University of Technology International Conference, Pattaya, Thailand, pp. 349-353	E-proceedings of The 11th Rajamangala University of Technology International Conference	2022
16.	Chinda, K., Saksirikosol, C., and Srisuro, P. (2022). The Effectiveness of Augmented Reality Data Access through a Smartphone. E-proceedings of The 11th Rajamangala University of Technology International Conference, Pattaya, Thailand, pp. 354-357.	E-proceedings of The 11th Rajamangala University of Technology International Conference	2022
17.	Wuthiastasarn, W. (2022). The Comparison of the Weather Forecast Program with Thai Sign Language and Captioning between Hearing Impaired, Deaf and Hearing. E-proceedings of The 11th Rajamangala University of Technology International Conference, Pattaya, Thailand, pp. 358-362.	E-proceedings of The 11th Rajamangala University of Technology International Conference	2022
18.	Nuangcharoenporn, C., Wuthiastasarn, W., and Tangkijviwat, U. (2022). Customer's Feelings on Food Photographs affected by Lighting Direction. Proceedings of the 53rd Annual Meeting, Tokyo, Japan, pp. 82-85	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022
19.	Saksirikosol, C., Chuenjai, P., Phuangsuwan, P., and Rattanakasamsuk, K. (2022). Comparison of Thai Tea Color between from Memory and Real Products. Proceedings of the 53rd Annual Meeting, Tokyo, Japan, pp. 86-88.	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022
20.	Rattanakasamsuk, K., Saksirikosol, C., and Phuangsuwan, P. (2022). K-mean Cluster Analysis of Representative Color of Thai Alternative Gender. Proceedings of the 53rd Annual Meeting, Tokyo, Japan, pp. 89-91.	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022
21.	Chitapanya, P., Phuangsuwan, C., and Ikeda, M. (2022). Hue shift direction under vivid color LED. Proceedings of the 53rd Annual Meeting, Tokyo, Japan, pp. 92-94.	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022

No.	Research name	Publish	Year
22.	Mepean, J., Ikeda, M., and Phuangsuwan, C. (2022). Device Dependency Investigated by Simultaneous Color Contrast. Proceedings of the 53rd Annual Meeting, Tokyo, Japan, pp. 95-98.	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022
23.	Ikeda, M., and Phuangsuwan, C. (2022). Simultaneous Brightness Contrast Measured by Two Techniques: Paper Stimuli and Space. Proceedings of the 53rd Annual Meeting, Tokyo, Japan, pp. 99-102.	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022
24.	Phuangsuwan, C., Ikeda, and Pumila, W. (2022). Use of Representative Gender Color for Toilet Signs. Proceedings of the 53rd Annual Meeting, Tokyo Japan, pp. 103-109.	Proceedings of the 53rd Annual Meeting of The Color Science Association of Japan	2022

Appendix

BASIC COLOR NAME IN THAI: INVESTIGATION OF REGIONS AND GENDER

Nischanade Chitapanya[1]* Chanprapha Phuangsuwan[2], 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*.

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

Keywords: Thai color names, Color categories, World color survey, Munsell color samples.

ABSTRACT

The varieties of color name can be influenced by cognitive process and linguistic-specific. Due to the diversity of Thai cultures, dialects, and environments that varied according to the regions, causing questions about the basic color name in Thai. Here we investigated the use of color name from 161 Thai-native speakers (89 females and 72 males) who live in 4 regions of Thailand; North, Northeast, central, and South. We employed 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 of 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. The subjects were asked to name the color chips using monolexemic color term. Although there are diversity of cultures and dialects among 4 regions, we found pattern of color names used are similar in all regions, also number of color names are not significantly different ($F=0.246$, $p=0.864$): mean number of color name in all regions are about 19. We also noticed that in all regions the subjects used the least number of color names of 12. However, the t-test revealed gender difference that reflected the significant difference in color naming. Females use non-basic color term (non-BCTs) more significantly than males ($t=2.65$, $p=0.004$), mean number of non-BCTs in females is 20 and 17 in males. We also found that females use more non-BCTs to identify warm colors than males.

INTRODUCTION

Humans can perceive a wide range of colors, and to communicate about the colors people have invented various of color names. The names of colors can be influenced by cognitive processes as well as language and gender differences [1], [2], [3]. There is a variety of accents and dialects spoken in different regions of Thailand. Beside the interlingua/common Thai language which is mainly used in Central region of Thailand and used as the official Thai language, other regions also have their dialects: Northern dialect, Southern dialect, Isan dialect (Northeastern dialect), etc. According to the different dialect spoken in each region, we questioned whether it would affect the use of color names in different regions or not. In addition, we also examined the differences in the use of color names among different genders.

METHODOLOGY

Subjects

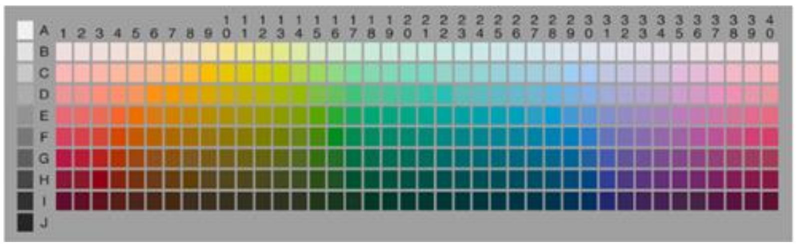
There were 161 Thai native speakers participated in this study, 89 females and 72 males, age ranges from 18 to 60 years-old, the average age was 21.95 ± 5.93. The subjects have domiciled in different provinces of Thailand, which in this study we divided the provinces into four regions: North (42 subjects), Northeast (38 subjects), central (50 subjects), and South (31 subjects) according to cultural characteristics. All subjects were tested for their normal color vision by using the Farnsworth Munsell D-

15 Color Vision Test before starting experiment, only the subject who pass the test could participate the experiment.

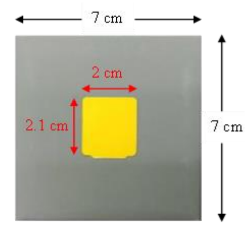
Color stimuli

We employed 330 color chips taken from the Munsell Book of Color Glossy Edition which were almost the same as was used in the World Color Survey [4]. The color chips composed of 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 (see Fig. 1). The color chips have the size of 2 x 2.1 cm, each chip was mounted on a square cardboard of the size 7 x 7 cm covered by gray matte paper of approximately N5.

(a)



(c)



(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 to 10RP. The left most vertical column shows Munsell values from 1.5 to 9.5. Number inside the graph shows Munsell chroma of each chip. (c) Example of color chips.

Experimental booth

This study was conducted under control experiment using experimental booth. The booth has the size of 150 cm (L) x 180 cm (H) x 60 cm (W) illuminated by 6 fluorescent lamps provided illuminance at 2,509 lx, correlated color temperature 5,859 Kelvin, color rendering index (RI) was 97. The color samples were presented on a gray background surrounded by white walls of the booth.

Procedure

Before starting experiment, a subject was asked to fill a questionnaire to give his/her information about region, and dialect. After that, each of color chips was presented to a subject one by one with a fixed pseudorandom order. The subject was asked to give a color name by using a monolexemic color term; the color name without mixed colors (no combination of two or more colors, such as yellow-green) or modified colors (no word that specifies the darkness or brightness, such as dark green). However, the subject was allowed to use object names if they felt that those are commonly used in their daily life, such as coffee or banana, etc.

RESULTS

There was no statistically significant difference for the number of color names used per subject among four regions (F = 0.246, p = 0.864). The mean number of color names used per subject in North is 19.19, Northeast 18.58, Central is 19.50, and South is 19.03. The total number of color names obtained from all subjects in North was 72, Northeast was 56, Central was 74, and South was 67 color names. Figure 2 shows the color categories pattern used by the subjects in each region. We can see the color categories patterns in the four regions are very similar. Although there is difference in the shape of the categories, the number of color categories and location of those categories are the same.

Twenty highly frequent color names used by subjects in each region are shown in Figure 3. The subjects used similar color names in all four regions, *bai-tong* 'banana leaves' and *kram* 'indigo' found in the highly frequent list of color names in North. While *seat* 'orange trumpet' was found in the highly frequent list of color names in Northeast, and *mint* was found in the highly frequent list of color names in South. But none in the highly frequent list of other regions. This finding suggested that the subjects in the four regions have shared the same color names despite the dialects, cultural, and natural environment among the four regions are different.

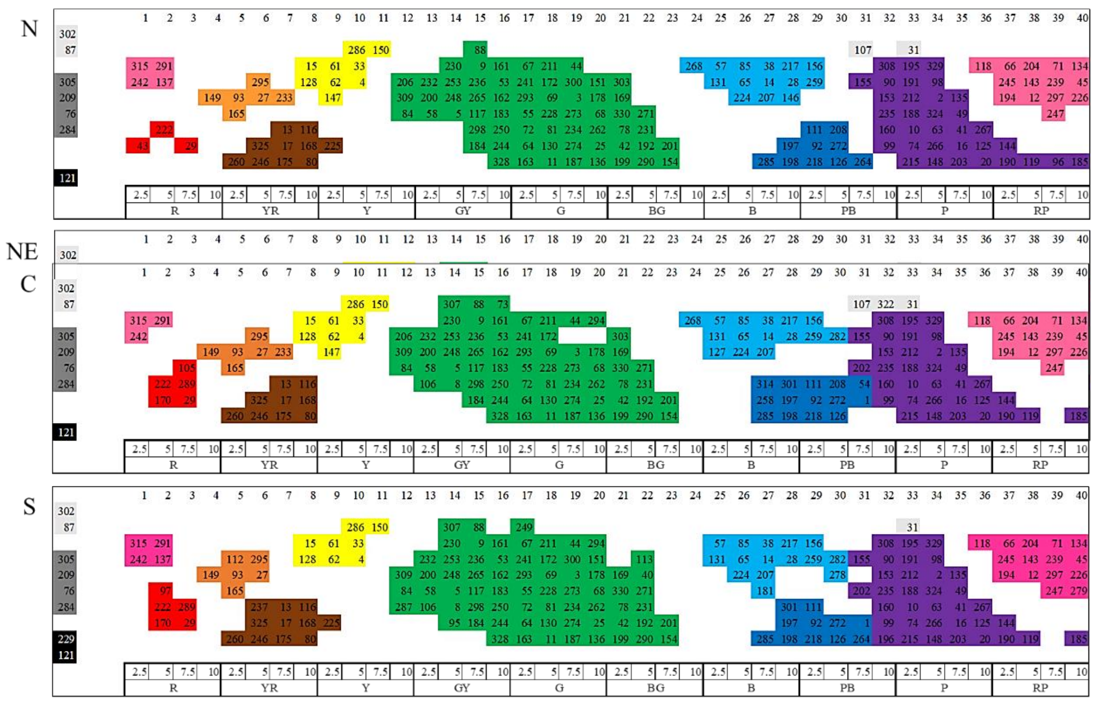


Figure 2. Color categories pattern for each region plotted on WCS color chart with the consistency of response ≥80% in each color chip, obtained from free-naming.

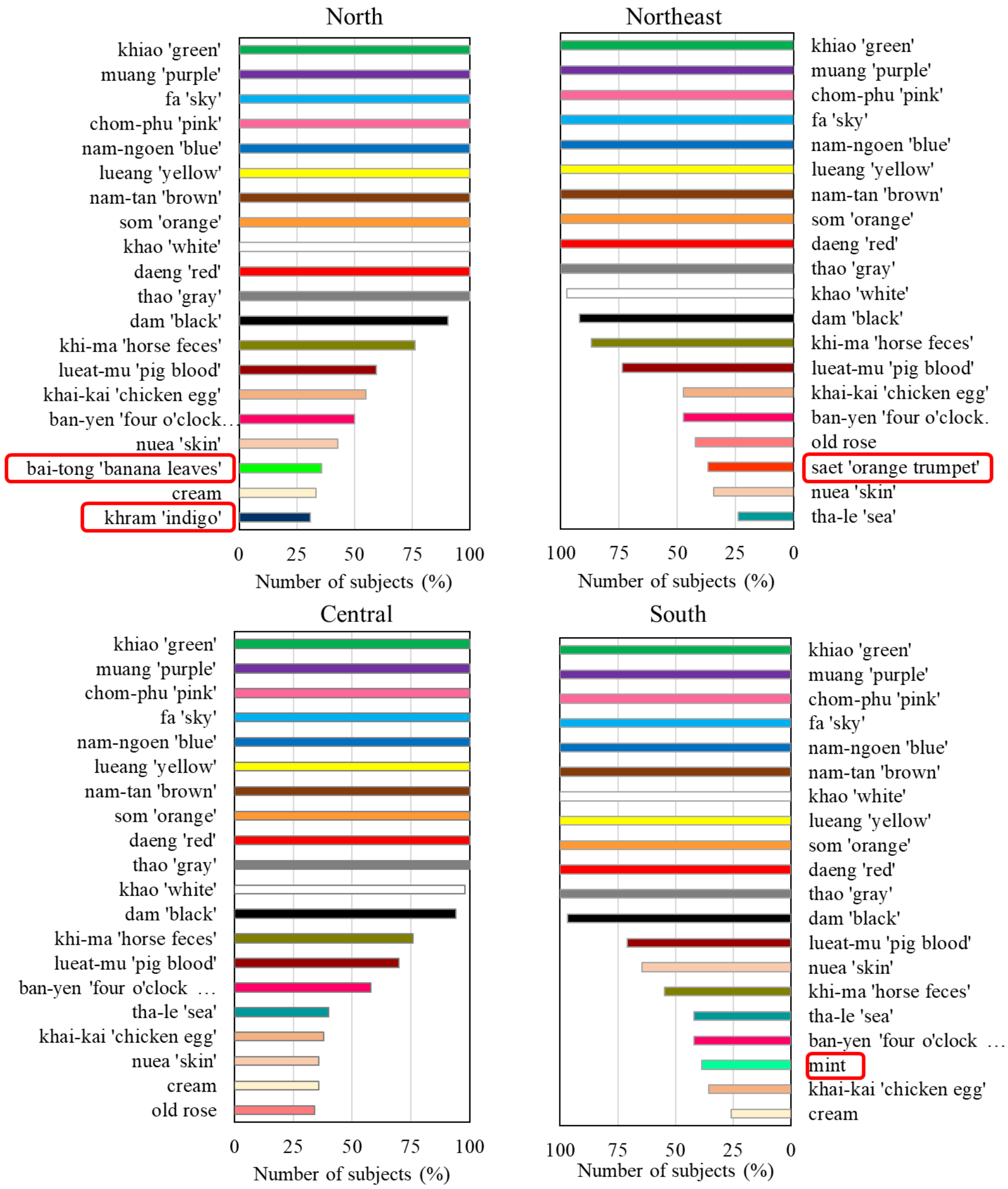


Figure 3. Twenty highly frequent color names used by subjects in each of four regions. The red rectangles indicated color names which highly frequent use in only that region, but not in other regions.

We also examined differences in the use of color names between females and males. There was a statistically significant difference in the number of color names used per subject among the two genders, which females used slightly more non-BCTs than males (t=2.65, p=0.004), see Figure 4. Total number of color names used by female was 89 and used by male was 80. The mean number of color names used per female subjects is 20.11 ± 5.45 and 17.88 ± 4.58 for male subjects. Figure 5 illustrated the color categories patterns used by females and males with ≥80% consensus of responses, the patterns appear quite same for both genders, especially the shape of *lueang* 'yellow' category, and all categories were in the same location.

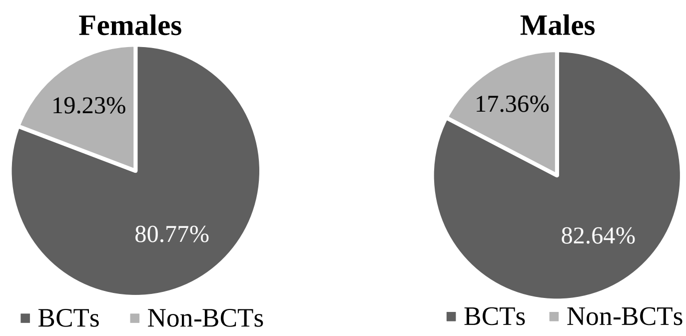


Figure 4. The proportion of use BCTs and non-BCTs in females and males.

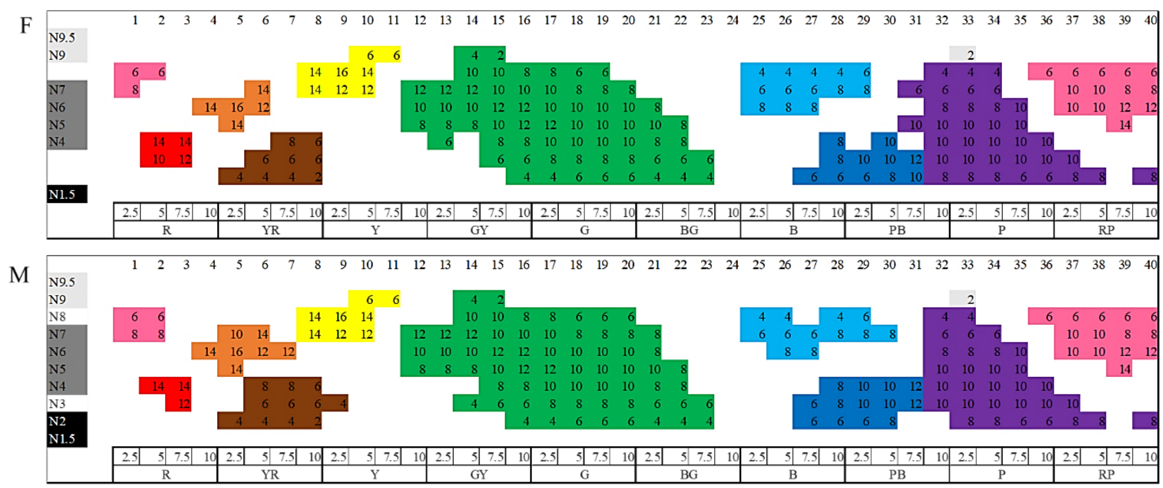


Figure 5. Color categories pattern for difference gender plotted on WCS color chart with the consistency of response ≥80% in each color chip, obtained from free-naming.

Figure 6 shows twenty color names that are frequently used for males and females, and there were similar trends in both genders. Both females and males used quite the same color names, but different in order and percent of use. It also reveals gender differences that some color names; *old rose* and *bai-tong* 'banana leaves' were frequently used for females but not in the males' frequent color names. Conversely, *cream*, and *saet* 'orange trumpet' were frequently used for males, but not among the females' frequent color names. In addition, we also found that females use more non-BCTs to identify warm colors than males, whereas males more refine in the use of more non-BCTs in cool colors, this is consistent with the finding of Mylonas et al. [1]. The color names in warm colors that were given by females but not by males are *chi-won* 'yellow robe of Buddhist monk', *klip-bua* 'petal of the lotus blossom', *kha-min* 'turmeric', *phlai* 'zingiber cassumunar', *ma-miao* 'pomerac', *pun-haeng* 'dry mortar', *cha-nom* 'milk tea', *khlon* 'mud', *sa-nim* 'rust', *thian* 'candle', *khrang* 'shellac', *thap-thim* 'ruby', *caramel*, *chat* 'crimson', *dok-khun* 'golden shower', *dao-rueang* 'marigold', and *fak-thong* 'pumpkin'. The color names in cool colors that were given by males but not by females are *tha-han* 'military color', *sa-rai* 'seaweed', *turquoise*, *cantaloupe*, *khi-pet* 'duck feces', *ton-kluai* 'banana tree', *ton-mai* 'tree', *phrik-yuak* 'bell pepper', *taeng-kwa* 'cucumber', *khi-nok* 'bird feces', and *fak* 'winter melon'.

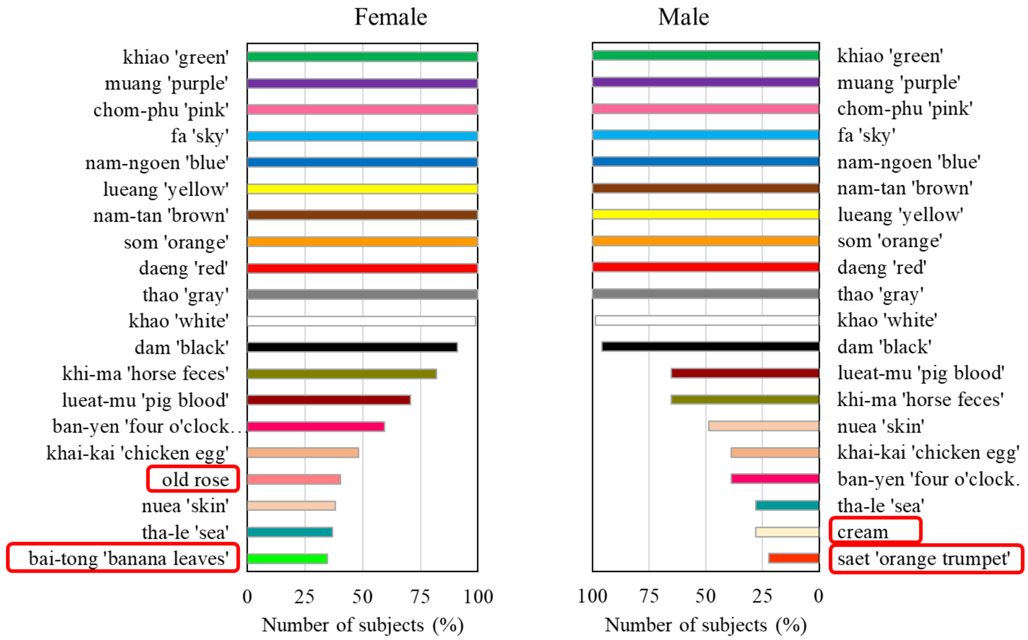


Figure 6. Proportion of use BCTs and non-BCTs in females and males. The red rectangles indicated color names which highly frequent use in only that gender, but not in another.

ACKNOWLEDGEMENT

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REFERENCES

1. Mylonas, D. Paramei, G.V. MacDonald, L. (2014). Gender Differences in Colour Naming. In: Anderson W, Biggam CP, Hough CA, Kay CJ, editors. *Colour Studies: A Broad Spectrum*. Amsterdam/Philadelphia: John Benjamins, 225–239.
2. Lindsey, D. T., Brown, A. M. (2014). The color lexicon of American English. *Journal of Vision*, 14(2), 1-25.
3. Paramei GV, Griber YA, Mylonas D. (2017). An online color naming experiment in Russian using Munsell color samples. *Color Research & Application*. 43(3), 358– 374.
4. Cook RS, Kay P, Regier T. (2005). The World Color Survey Database. *Handbook of Categorization in Cognitive Science*. 223–241.

THE INFLUENCE OF LIGHTING DIRECTION FOR FOOD PHOTOGRAPHY ON ATTRACTIVENESS

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Keywords: attractiveness, food photography

ABSTRACT

Nowadays online food delivery is very popular. One of the factors that help consumers make decisions to buy food is pictures. Food photography is important to catch customers' attention that they desire to order more because it looks appetizing. Food photographs also could increase sales volume. However, the photographs could be affected by various factors for instance photography equipment, the color of lighting, art composition, and so on. These factors were found to influence attractiveness in food photography. A direction of light is one of the photography procedures lighting setups. It would be interesting to investigate how the direction of light affects consumers' attractiveness. This study, hence, aimed to investigate a relationship between the direction of light setting and the attractiveness of food photography. Thai dessert was selected for taking a photograph with different directions of lighting, consisting of a combination of four vertical elevation angles (0°, 30°, 60°, and 90°) and twelve horizontal side angles of dessert dish from 0 to 330 degrees. Fifty-two participants were asked to judge their feelings on thirty-seven pictures by using an attractiveness scale. Results showed the higher a vertical elevation angle, the higher an attractiveness score with a significant difference at 0.001, whereas it was not found in a horizontal side angle. This experimental result will be used as a practical tool for the lighting setup, especially for dessert photography.

INTRODUCTION

Nowadays, a sharing of photography through social media, websites, and blogs becomes very popular, in particularly a food photograph [1,2]. A variety of food photographs published on cooking or restaurant website aims at to catch a customer's attention and to be appetite [3]. Many factors have an influence over customer's attention for instance an expensive ingredient, food decoration, and food composition [4]. In addition, photography techniques such as lighting setup, special effect, and camera angle are also arouse our taste sensation [5]. Food photographs, hence, are published on social media, websites, and other media for increasing a sale volume [6].

In a previous study, Kazuma et. al. [3] proposed an attractiveness prediction model for food photographs by using a machine learning system. A camera angle, an appearance of the entire food, and the appearance of the main ingredients are variables in the model. Furthermore, they also found that food photo attractiveness on customers could be affected by a lighting technique. A lighting setup not only is concerned with color temperature, but also lighting direction. Illuminants for lighting setup consist of a main light and a fill light. The main light is a primary illuminant that uses for exposing light to objects. It's located at an angle of 45° to the object. The fill light located at the opposite angle to the main light. To reduce shadows that are created from the main light and the fill light illuminance is always weaker than the key light [7]. Moreover, the direction of main light affects to direction and intensity of object's shadow. When the main light changes direction and intensity, a shadow of object could be changed. This change might affect customer's attention. This study, therefore, aimed to investigate a relationship between a lighting direction and an attractiveness of food photography.

METHODOLOGY

Participants

Fifty-two subjects with age ranging from 21 to 31 years (23 men and 29 women) participated in this experiment. All subjects were a normal or corrected to normal vision and passed a Ishihara's color blindness test vision.

Stimuli

Photographs of Thai dessert fruit-shaped mung bean, namely Luk Chup, were taken as a stimulus (figure 1). The intensity of illuminants was fixed at 11000 lux for main light and 5500 lux for fill light. Figure 2 (a) and (b) showed the position of a main light with moving a vertical elevation angle from 0 (●), 30° (■), 60° (◆) to 90° (◯) and a horizontal side angle of the dish from 0°, 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300° to 330°. The fill light and camera were fixed at 45° of a vertical elevation angle (▲) and 0° of a horizontal side angle. Thirty-seven photographs were obtained from a combination of a vertical elevation angle and a horizontal side angle.

Figure 1. Thai dessert fruit-shaped mung bean "Luk Chup"

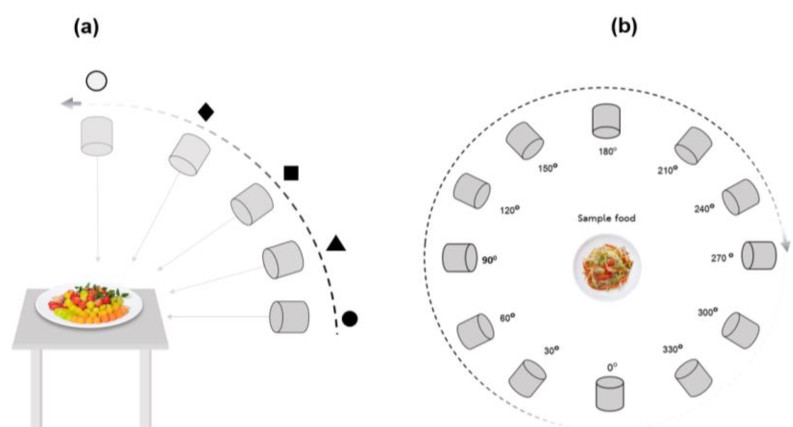

Figure 2. (a) A position of a vertical elevation angle from 0° (●), 30° (■), 60° (◆) to 90° (◯) and (b) a position of a horizontal side angle from 0°, 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300° to 330°.

Procedure

This study was conducted on an online questionnaire. The first part of the questionnaire was general information and opinions in deciding to order food. All participants were asked to rate their current hunger/fullness status on five point of Likert scales (1 = extremely hunger to 5 = extremely full) and they were asked to rate liking of Thai fruit-shaped mung dessert on two Likert scales which are like and dislike. We asked them about "Do you think food photos are important in deciding to order food?" on five-point of Likert scales (1 = strongly agree to 5 = strongly disagree) and we also asked subjects which factor they consider first when deciding to order online food delivery by using choice that we prepare choice to them (i.e. price, food photo, promotion, review and brands).

In experiment, 37 photographs were randomly presented. Each participant was asked to rate their feeling in an attractiveness scale for given photography. The attractiveness scale was ranged from 1(extremely unattractiveness) to 6(extremely).

RESULT

All participants had reported common information on hunger/fullness that they were not hungry (mean = 2.67, SD.=1.043) and most of the participants liked Thai fruit-shaped mung desserts, Participants were strongly agreed with the question of would you think a photograph is important in deciding to order food (mean =4.40, SD.= 0.634). In a question of the factor that their considered to order food, the first-three factors were a photograph, prices, and promotion in respectively.

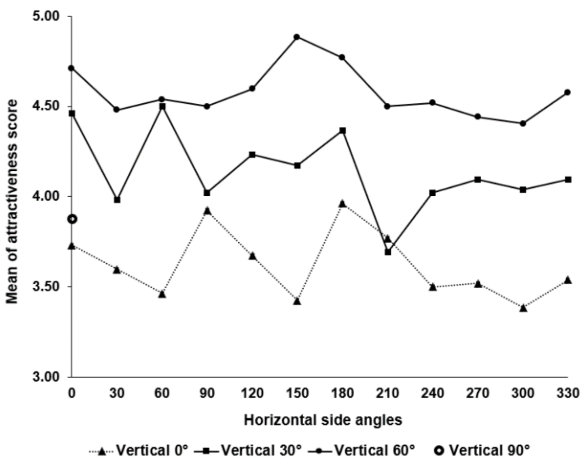

Figure 3. The difference of attractiveness score in each vertical elevation angles of 0°-90° classified by horizontal side angles of 0° - 330° of food photography.

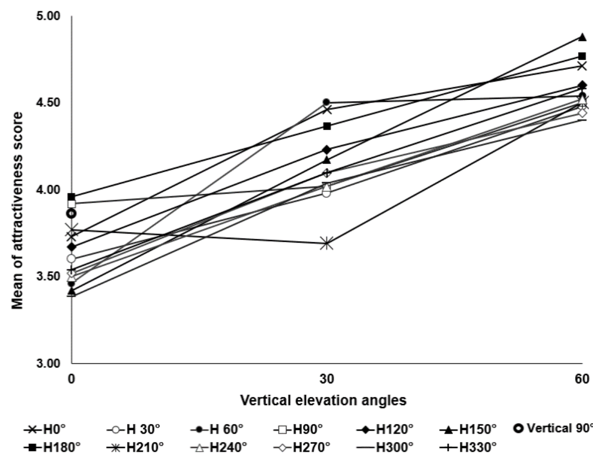

Figure 4. Comparison of mean attractiveness scores of food photos on vertical elevation angles.

Influences of lighting direction on horizontal side angles

Data of attractiveness score obtained from all participants were performed by means of SPSS 25.0 for Window. Figure 3 demonstrated a mean of attractiveness scores for dessert photography in a difference of horizontal side angles. An abscissa axis represented a horizontal side angle from 0° to 330°, whereas a vertical axis represented the mean of attractiveness score. In addition, vertical elevation angle 0° (▲), 30° (▪) and 60°(•) displayed a set of mean of attractiveness scores on different horizontal side angles, respectively. Moreover, the mean score of the photograph was taken on vertical 90° displayed by opened circle (**o**).

Results showed that dessert photography with vertical elevation angle 0° (▲) had the highest mean attractiveness score at horizontal side angles 180° (Mean =3.96, SD.= 1.441), and photograph with the lowest mean attractiveness was horizontal side angles of 300° (Mean = 3.38, SD.= 1.457). For vertical elevation angles of 30° (▪), the dessert photograph with the highest mean attractiveness score was horizontal side angles 60° (Mean = 4.50, SD.=1.163), and the lowest mean attractiveness was found in a horizontal side angle of 300° (Mean = 3.69, SD.= 1.528). In a 60° degree (●) vertical elevation angle, the dessert photograph with the highest mean attractiveness score was horizontal side angle 150° with the mean 4.88 (SD.= 1.114). A dessert photograph with the lowest attractiveness averages was horizontal side angle of 300°, with mean 4.40 (SD.= 1.225).

In addition, the participants assessed their attractiveness to dessert photographs taken on the vertical angle of 90° (○) with mean = 3.87 (SD.=1.519). However, when compared the results of horizontal side angles to a difference of vertical elevation angles, the result was not clear. In addition, a significant difference was tested with One-Way ANOVA. Table 1 showed the mean attractiveness of dessert photograph in horizontal side angles was not statistically significant difference at p - value 0.05.

Table 1. One-way ANOVA analysis on mean attractiveness in each a vertical elevation angle and a horizontal side angle.

	Sum of squares		df	F	Sig.
Vertical 0, Horizontal 0 -330	Between Group	20.63	11	0.825	0.615
	Within Group	1391.86	612		
Vertical 30, Horizontal 0 -330	Between Group	29.23	11	1.482	0.134
	Within Group	1097.63	612		
Vertical 60, Horizontal 0 -330	Between Group	11.65	11	0.812	0.628
	Within Group	798.65	612		

Influences of lighting direction on vertical elevation angles

Figure 4 showed the mean attractiveness score of dessert photograph in each horizontal side angle from 0° to 330° classified by a vertical elevation angle 0°, 30° and 60°, where vertical axis represented the mean of attractiveness score and an abscissa axis represented the vertical elevation angle from 0°, 30° to 60°. For mean value of photograph with vertical elevation angles 90° was shown by a opened circle (○).

Results showed when the vertical elevation angles increase, the mean attractiveness of food photographs increased. For example, dessert taken under lighting at horizontal side angle 150° with vertical elevation angles 0°, 30° and 60° had mean attractiveness score 3.42 (SD.=1.649), 4.17 (SD.=1.324) and 4.88 (SD.=1.114), respectively. This result occurred in all horizontal side angle except 210° (∗), the mean attractiveness decreased when the vertical elevation angle increased.

Furthermore, dessert photographs at horizontal side angle 60° (●) in vertical of 0°, 30° and 60° had mean attractiveness 3.46 (SD.=1.488), 4.50 (SD.=1.163), and 4.54 (SD.=1.111), respectively. It was found that when vertical elevation increased from 30° to 60°, the mean score was stable and then a bit increased. With the mean attractiveness increasing trend, vertical affects the attractiveness of dessert photography. Therefore, we tested with one-way ANOVA to find significance.

Table 2. One-way ANOVA of mean attractiveness score of dessert photograph in each horizontal side angles on vertical elevation angle of 0°, 30°, 60° and 90°

Food photo on horizontal angles of dish and vertical angles													
		H0	H30	H60	H90	H120	H150	H180	H210	H240	H270	H300	H330
df	BG:	3	3	3	3	3	3	3	3	3	3	3	3
	WG:	204	204	204	204	204	204	204	204	204	204	204	204
SS	BG:	34.42	21.38	42.36	13.03	26.01	58.94	26.72	21.24	27.86	23.53	27.96	29.73
	WG:	353.88	388.53	364.90	401.73	387.25	411.50	365.26	415.36	443.01	426.38	380.80	390.19
F		6.61	3.74	7.89	2.20	4.56	9.74	4.973	3.47	4.27	3.75	4.99	5.18
P		.000**	.012*	.000**	0.88	.004*	.000**	.002*	.017*	.006*	.012*	.002*	.002*

*Notes: * p<0.05, **p<0.001, H: Horizontal side angle, BG: Between Group - WG: Within Group*

As shown in Table 2, the results of One-Way ANOVA of mean attractiveness in dessert photograph in each horizontal side angle on a vertical elevation angle of 0°, 30°, 60° and 90°. There was a statistically significant difference between vertical elevation angle and horizontal side angle with mean attractiveness score at $p<0.001$ ($F = 52.73$, $p = .000$).

It was found that the dessert photograph taken under vertical 60° of lighting could have the greatest impact on the attractiveness of dessert photography. The result indicated that increasing the height of vertical elevation angles of lighting tends to increase the attractiveness. This tendency was occurred in all condition. However, the mean of attractiveness was not significantly different at horizontal angles of 90° (□) and all vertical angles ($F = 2.21$, $p = 0.88$).

DISCUSSION

Influences of lighting direction on vertical elevation angles of food dish on attractiveness

Our finding showed that increased vertical elevation angles from 0° to 60°. This leaded to an increased sense of attractiveness on dessert photography as well. The dessert photographs (b) Vertical 0°-Horizontal 0°, (c) Vertical 30°- Horizontal 0° compared with the (d) Vertical 60° - Horizontal 0° degrees. We found that the intensity of shadows in the dessert on the dish can be clearly reduced. The higher of a vertical elevation angle may provide a high illuminance level to convey a bright photograph. This result implied that the level of shadow intensity could reduce the feeling of attractiveness on customers.

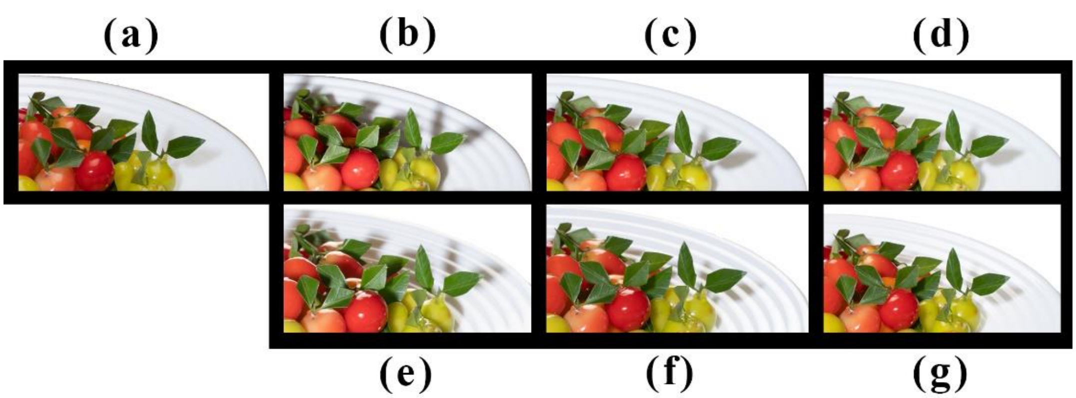

Figure 5. An example of a comparison of vertical angle food photos in shadow areas (a) V90°, (b) V0°-H0°, (c) V30°-H0°, (d) V60°-H0°, (e) V0-H180°, (f) V30°- H180° and (g) V60°-H180°

Lighting horizontal side of dish not affected on attractiveness of food

Lighting direction of horizontal side angles does not affect to the attractiveness of dessert photography. Kazuma et al. studied of estimation of the attractiveness of food photography based on image features [3]. They suggested that a camera angle was an important factor in enhancing attractiveness. In addition, their research also was found that the type of the food including the shape and position of the appearance of main ingredient in that dish could increase the level of attractiveness. In this study, the dessert was used as the stimulus. It does not contain the main ingredient and no exact direction. Therefore, the changes in the type of dessert or food stimuli to other categories of foods, the horizontal side of angles might be affecting to attractiveness on consumers. It implies that a changing type of foods would be required to understand the direction of lighting on horizontal angle change attractiveness in future experiments.

We concluded that the direction of lighting on vertical elevation angles can modulate the attractiveness of dessert photography. whereas horizontal angle did not statistically significant difference in attractiveness.

REFERENCES

1. Cai, W., Richter, S. and McKenna, B. (2019), "Progress on technology use in tourism", Journal of Hospitality and Tourism Technology, Vol. 10 No. 4, pp. 651-672.
2. Oliveira, B. and Casais, B. (2019), "The importance of user-generated photos in restaurant selection", Journal of Hospitality and Tourism Technology, Vol. 10 No. 1, pp. 2-14, available at: https://doi.org/10.1108/JHTT-11-2017-0130
3. Kazuma T, Tatsumi H, Keisuke D, Yasutomo K, Takatsugu H., Ichiro I, Daisuke D, & Hiroshi, M. (2019) Estimation of the attractiveness of food photography based on image features. IEICE TRANS. INF. & SYST., VOL.E102–D, NO.8 AUGUST 2019
4. Chen, X., Ren, H., Liu, Y., Okumus, B. and Bilgihan, A. (2020), "Attention to Chinese menus with metaphorical or metonymic names: an eye movement lab experiment", International Journal of Hospitality Management, Vol. 84, p. 102305
5. Martin, C.K., Nicklas, T., Gunturk, B., Correa, J.B., Allen, H.R. and Champagne, C. (2014), "Measuring food intake with digital photography", Journal of Human Nutrition and Dietetics, Vol. 27, pp. 72-81.
6. Liu, I., Norman, W.C. and Pennington-Gray, L. (2013), "A flash of culinary tourism: understanding the influences of online food photography on people's travel planning process on Flickr", Tourism Culture and Communication, Vol. 13 No. 1, pp. 5-18.
7. Rea MS (2000). The IESNA lighting handbook, 9th edn. New York: Illuminating Engineering Society of North America.
8. Hasenbeck, A., Cho, S., Meullenet, J. F., Tokar, T., Yang, F., Huddleston, E. A., et al. (2014). Color and illuminance level of lighting can modulate willingness to eat bell peppers. Journal of the Science of Food and Agriculture, 94, 2049–2056.

THE INVESTIGATE COLOR OF THAI ICED TEA FOR ADVERTISING

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Keywords: Color of Thai iced tea, Boundary of Thai tea color, Milk tea, Boundary color

ABSTRACT

Individuals' interpretation of Thai tea color might vary based on their experiences because each area's color range of Thai tea has a different color shade. The Thai tea color is distinctive, which may provide communication issues if employed in the design or creation of advertisements. Therefore, this research aims to investigate the color of Thai tea color for advertising. The subjects were students and staff of the Faculty of Mass Communication Technology. They were all tested for color vision deficiency using the Ishihara Tests. The experiment was divided into two parts. The first part was to identify the hue of Thai tea color by selecting the color chips from Munsell hue ring. The second part was to select the color chips from the Munsell color chart of the hue obtained from experimental part I. According to the results of experiment part I, six Munsell hues were selected by at least one subject (i.e., 5YR, 2.5YR, 7.5YR, 10R, 10YR and 2.5Y). In the second experimental part, the subjects selected the colors from 241 color chips that had the hue from the first experimental part. Eight Munsell colors that were consistently selected by at least 20 percent of the subjects were 3.75YR 6/12, 3.75YR 5/12, 5YR 5/12, 1.25YR 5/12, 2.5YR 5/12, 5YR 6/10, 2.5YR 6/12 and 2.5YR 5/14. All colors appeared orange.

INTRODUCTION

Color is an important part that is used in various fields and for the benefits of communication in human daily life, such as to classify the clarity, to convey the meaning, to be used as a symbol [1]. In the advertising field, color has a significant impact on creative works because the colors chosen to be used in the work arise from human's learning to interpret what they perceive naturally. These processes occur automatically in all humans [2]. Nowadays, the names of natural objects or objects of a particular color are often used as references to name colors in order to reduce communication errors and to enable those who are communicating to imagine and visualize the object.

Nowadays, tea beverages are becoming popular among Thai people [3]. For Thailand, there is a famous and unique tea drink both Thais and foreigners known as "Thai Iced tea", which is used as a name instead of the color name. Due to the unique color characteristics of tea leaves, when brewing through hot water, the tea turns orange-red. The flavoring process is with various ingredients such as sugar, sweetened condensed milk, regular condensed milk and fresh milk resulting in the color of Thai tea that is in orange tone. The ingredients in tea brewing in each region are different. As a result, the color of Thai iced tea is various [4].

There was very little research that tried to investigate the representative color of Thai iced tea based on our survey. Saksirikosol et al. (2020) conducted an experiment to establish the representative hue of Thai iced tea [5] and discovered that perception of Thai iced tea color varies depending on an individual's field of experience. By mixing colors through a computer screen, the color choosing process was from the memory of the subject. The result of mixing color for Thai Tea was showed in CIEL*a*b* color space. The boundary of Thai iced tea color was identified widely in the orange region. The averaged of Thai iced tea color was L* = 52.61, a* = 19.36, b* = 52.81. However, there is a limit of color gamut shown by the computer screen, so it may not be able to display the colors that the subject wants.

In this study, the researchers used the Munsell color system in an experiment to allow the subjects to select a color from the color chip they saw. This covered the colors that our eyes see more than the colors on the monitor. The objective is to investigate the color of Thai iced tea for advertising.

METHODOLOGY

This experiment was divided into two parts. The samples were students and staff of the Faculty of Mass Communication Technology, Rajamangala University of Technology Thanyaburi who have normal vision and pass the Ishiharas Tests plates. There were 400 subjects in experimental part 1 and 144 subjects in experimental part 2.

Experimental part I

The researchers created the Hue Ring using 40 Munsell color chips covering all hue colors in the Munsell Book (Munsell Book Glossy Collection X-rite). Each color chip had chroma 8 and value 5. These colors are arranged in circles on a gray background, as shown in figure 1. Then the Munsell hue ring was installed in a laboratory. The subjects were asked to choose a color that represents the color of Thai iced tea from Munsell hue ring with no limit on the number of choices.

Figure 1. Munsell hue ring used in this experiment

Experimental part II

The other color chips that are in the same color chart as the hue from Experiment part 1 were randomly arranged on a gray board. Then the subjects chose a color chip that represents the color of Thai iced tea based on their field of experience with no limitation on the number of choices in a laboratory. The illuminance in the experimental room was set between 1000-1200 lux. Figure 2 show the schematic diagram of the set up in the experimental room.

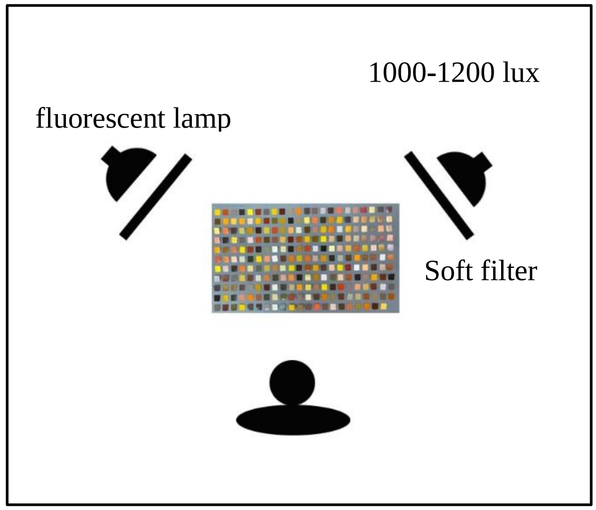

Figure 2. Schematic diagram of the experimental room (Top view)

RESULT AND DISCUSSIONS

Experimental result part I

Result of the selected hue representing the Thai iced tea color was shown in Figure 3. The abscissa represented Munsell hue. The ordinate represented the number of selections. The result showed that there were 6 selected hues. The most selected hue is 5YR which was selected 336 times, followed by 2.5YR, 229 times; 7.5YR, 182 times; 10R, 33 times; 10YR, 26 times, and 2.5Y, 14 times respectively. All selected hue was in an orange shade which relating to an identity color of Thai iced tea.

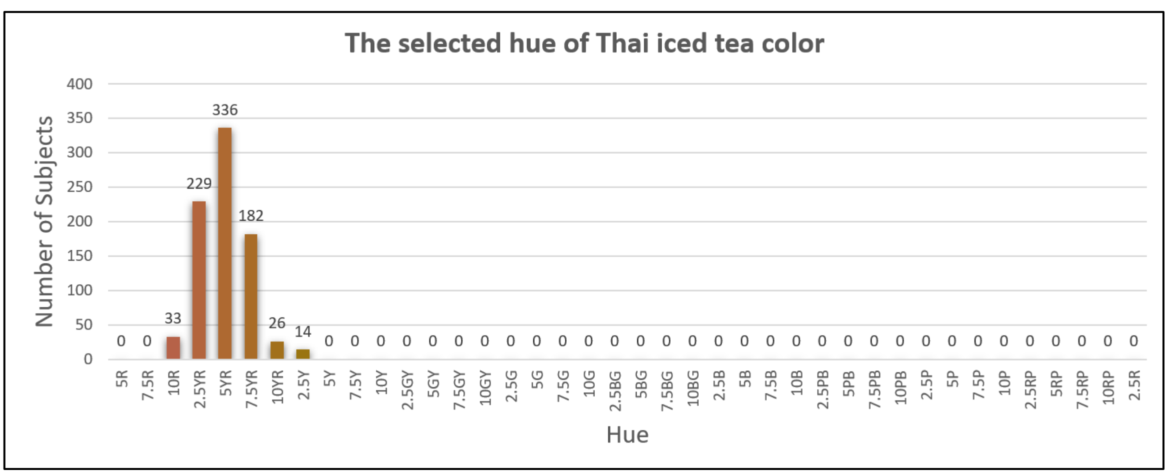

Figure 3. Representative hue selected by all subjects

Experimental result part II

The total of 241 color chips randomly arranged on gray paper was in Munsell 6 hue, 217 color chips, and 24 additional supplementary colors in the same color hue. From the experiment, it was found that the colors that were selected more than 20% from 144 subjects consisted of 8 colors, as shown in Figure 4. The area of the color represents the frequency of the selection. The 8 colors representing Thai iced tea colors are 3.75YR 6/12 (43.75%), 3.75YR 5/12 (57.00%), 5YR 5/12 (36.81%), 1.25YR 5/12 (30.56%), 2.5YR 5/12 (26.39%), 5YR 6/10 (22.92%), 2.5YR 6/12 (21.53%), and 2.5YR 5/14 (20.83%). Table 1 shows the color values in the CIEL*a*b color space to be used in the printing industry.

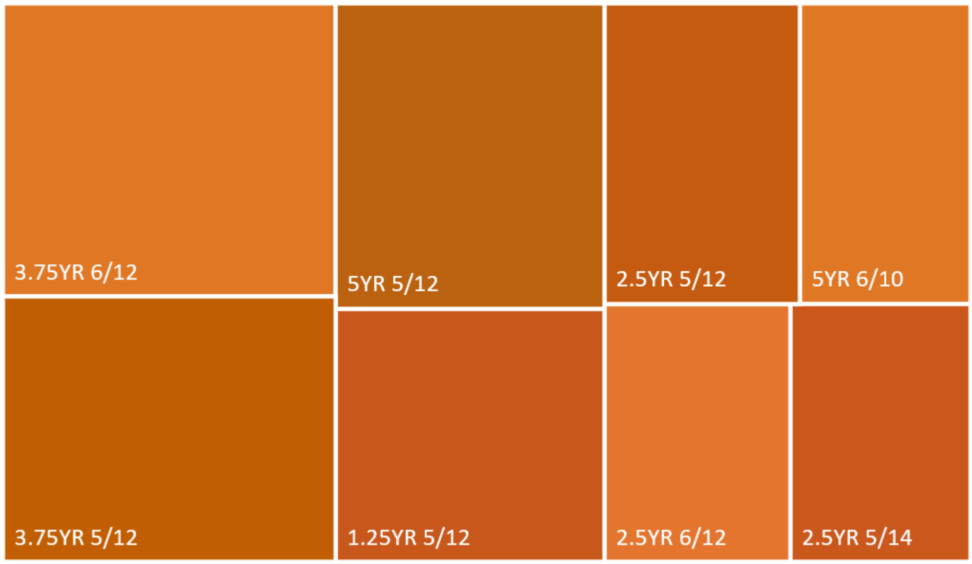

Figure 4. Top selected Munsell color for Thai iced tea color
(Note: color might not present the exact color appearance to subjects)

Table 1. CIEL*a*b* of Thai tea color

Munsell	L*	a*	b*
1.25YR 5/12	51.45	43.70	54.37
2.5YR 5/12	51.70	40.95	63.21
2.5YR 5/14	54.16	44.79	72.04
2.5YR 6/12	61.20	41.98	63.76
3.75YR 5/12	50.52	36.70	64.33
3.75YR 6/12	61.32	37.40	63.97
5YR 5/12	52.84	32.94	64.50
1.25YR 6//10	62.32	29.00	55.70

According to Saksirikosol et al. (2020), the average CIE L*a*b* color value of the Thai iced tea color is (52.61, 19.36, 52.81) [5]. In this experiment, the average of 8 CIE L*a*b* colors is (55.69, 38.43, 62.74). When compared, it was found that the CIE L*a*b* color value had a color difference (ΔEab) of 21.72. Color differences occur as a result of differences in a* and b* values. The large color differences may be caused by the limitation of the monitor' color gamut. As a result, it was unable to display the colors that the subjects want.

CONCLUSION

This research suggested a color that can be used to define or represent the color of Thai iced tea to be used as a guideline for designing advertisements. According to the Munsell color system, the colors that represent the color of Thai iced tea are 8 colors, which are 3.75YR 6/12, 3.75YR 5/12, 5YR5/12, 1.25YR5/12, 2.5YR5/12, 5YR6/10, 2.5YR6/12, and 2.5YR5/14. All color was high chroma orange.

ACKNOWLEDGEMENT

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REFERENCES

1. Srithong N. (2019, August 2). Thaitone – See Thaitone “Attaluk hang tone Thai Roo wai mai tok trend”. [Thaitone - Thaitone color “Identity of Thaitone know that not out of trend”] Retrieved from https://www.baanlaesuan.com/58106/design/lifestyle/thaitone-2.
2. Supaporn N. (2013). Perception of People on Well-being in Bang Pai Community. Nontaburi: Rajapruk University.
3. Ongjarit C. (2011). Evaluating Colour Images of Espresso. The 1st National and International Graduate Study Conference 2011. Bangkok.
4. Tim Cheung. (2018). World’s 50 Most Delicious Drinks. Retrieved from https://edition.cnn.com/travel/article/most-delicious-drinks-world.
5. Saksirikosol, C., Rattanakasamsuk, K., Jarernros, J. and Phuangsuwan, C. (2020). Color of Thai Iced Tea. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement. Kyoto, Japan, pp.180-181.
6. Jankeaw, K., Rattanakasamsuk, K., Kihara, R. and Kawazumi, M. (2019). Representative Color of Grape. The 5th Asia Color Association Conference: Color Communication. Nagoya, Japan, pp.283-287.

COLOR APPEARANCE OF COLOR CHIPS UNDER VIVID COLORED LEDS

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Keywords: Color appearance, color constancy, vivid illumination, elementary color naming, RVSI

ABSTRACT

The ability to stably perceive the color appearance of objects under various colored lights is called color constancy. Color Constancy Index (CCI) is a measure to quantify the efficacy of the phenomena. This index was commonly calculated based on a color space that used a physical color object as a reference. It varies from 0 to 1 to show poor color constancy to perfect color constancy. Whereas the index is usually based on a magnitude of distance shift between observation's judgment and ideal value, in this study, the color appearance of color chips was investigated by using perception color space. In the first experiment, there were 100 persons participated. An observer sat in the experimental booth and judged color appearance by the elementary color-naming method for each of 26 color chips under 13 RGB-LED illuminations of six hues: red, yellow, green, cyan, blue, and magenta, plus a white light, D65. The light of each hue had two saturations, dull and vivid. In the second experiment, the booth was extended into test rooms and subject rooms. There was a small hole in a wall between those rooms. A participant sat in the subject room illuminated by White LEDs to see a color chip placed on a stand holder in the test room. Using this two-room technique, participants reported that they could perceive a color chip placed on a wall in the subject room, even originality it placed under the test room. As a result, color constancy was poor under yellow, cyan, and green light more than the others. Moreover, color constancy was usually low when the color chip was complementary to the colored light.

INTRODUCTION

Inside our brain, there is a mechanism whose ability is to control our perception. Color constancy is a phenomenon that makes a human stably perceive the same color under various colored illuminations. This statement is applicable only when illumination is located near the white illumination or not vivid colored illumination. To see the same color, researchers predicted that the mechanism should understand or know the color of illumination [19] in the first place. Therefore, lack of clue of illuminations or initial visual information (IVI) [20-21] under vivid colored illumination can be expected to be a poor color constancy or be difficult for the mechanism to understand the original surface color.

There were many ways to measure color constancy. The most famous method was color matching [22] which the participant has to match the test color to appear to be the same as the reference color, and in an achromatic setting [23] which the participant must adjust the test under a circumstance to appear to be neutral or gray. These methods were claimed to be valuable and accurate. Still, they required lots of time to match, and sometimes participants hardly obtained a satisfactory setting since there was a range in adjusting a step depending on the experimental design. Another method was categorical color naming. By naming color, which a participant judged what color he or she was seeing allowed the researcher to expand various test color stimuli with the advantages of a fast tasking and familiar to human behavior. Even there was a good point. This method limited participant's answers by only a certain number, for example, eleven colors as the basic color naming [24].

In the present experiment, we used elementary color naming, which is quantitative judgment and allowed us to study a variety of color chips under vivid color illuminations. We proposed a modified color constancy index which ranged from 0 to 1 as poor color constancy to perfect color constancy, respectively, to be appreciated to the polar diagram, which is a perceptual color space.

METHODOLOGY

The first experiment done inside a room-size was 172×82×132 cm, as shown in Figure 1. The room was decorated with a flower vase, a picture on the wall, and a collection of books to stimulate a participant's daily life situation. The room was illuminated by only RGB-LED light, a Phillips product as Kinetics color cover MX power core model. The light was put on the left ceiling of the room and covered by translucent white paper to obtain a uniform illumination. In front of a subject's chair, there was a small table which a rectangular paper (Munsell N6) of 33×33 cm. dimensions giving 22.5° arc of visual angle with a viewing distance of a subject position. A test patch which size was 6×6 cm. giving 5.7 °, was placed on the paper.

Figure 1. Apparatus of experiment 1

In the second experiment, the room was extended to be a test room on the left side in Figure 2, and the right room is called a subject room. The test room was illuminated by the same RGB-LED light, which can be changed colored light depending on illumination conditions. On the other hand, the subject room was illuminated by only D65 LED light. Between the test and subject room, there was a small square hole on the wall in which the subject sits in the subject room could see a color chip placed on the holding stand in the test room. This procedure is called the two-room technique, in which the subject adapts to only the white light, while the color appearance of color chips is not affected by the color light of the illumination conditions.

There were thirteen illuminations, including white as D65, in this experiment. The illuminations are composed of 6 colors: red, yellow, green, cyan, blue, and magenta. There were two saturation steps: a dull or less vivid color light group and a high saturation color light group, as shown in Figure 3 as connected by the dashed line and solid line, respectively. In our experiment, the illuminant was controlled in all lighting as 100 ± 5 lx except the B2 condition, which is limited to blue diode capacity in our experiment, for the B2 condition was 80 ± 5 lx. The coordinate of each light in Figure 3 was plotted on u'v' graph, which is almost a uniform color space.

Figure 2. Apparatus of experiment 2

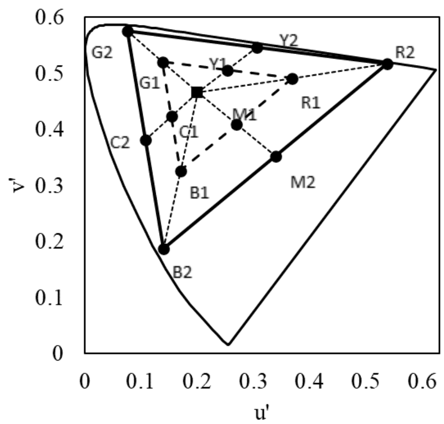

Figure 3. Illumination conditions

In Figure 4, 26 color chips were produced by Konica Minolta printer C83HC. The chips can be divided into three groups as 15 chips based on the Test color sample [25], which used to measure color constancy index as shown in a solid circle symbol, 8 chips which represented as the color gamut of the printer shown as an open circle symbol, and 3 chips as achromatic chips which is a square symbol in the figure.

There were 100 subjects who participated in experiment 1, and 30 subjects participated in experiment 2. They were students from Rajamangala University of Technology Thanyaburi and had a normal color vision tested by Ishihara test and got a score credit in return. Before participating, they had taken a color vision class and were trained to judge color appearance by the elementary color-naming method.

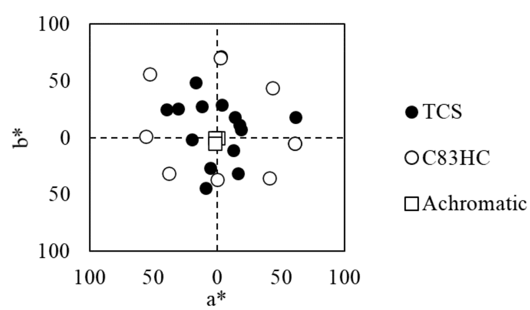

Figure 4. 26 Color chips printed by Konica Minolta C83HC

Every changing illumination, a subject had to adapt the light for 3 minutes. During the time, he or she has to look around the room without seeing the RGB-LED instrument. Each color chip would be placed in front of the subject's chair on the grey paper as a background. The subject had to judge color appearance of color chips by assessed how much percentage of chromaticness, whiteness, and blackness. Then, the percentage of red, yellow, green, and blue. The second judgment was based on the opponent color theory. A subject could not judge red and green together, and vice versa. Totally, one subject had to be named 26 color chips × 13 illuminations for one repetition. A subject could participate in only 3-4 illuminations to prevent exhaust, not exceeding 4 hours per day, including relaxing time.

RESULT

The average result of elementary color naming can be transformed and plotted on the polar diagram as shown in Figure 5 and Figure 6. The color area in each figure represents color perception under each test illumination, while the behind area as dash area is the color perception under D65 illumination. This figure shows that color perception under less vivid color light was not much different from the reference light compared to the vivid light condition. The color perception under the vivid case was narrow and even reversed shape in some conditions, such as Y2.

Color constancy index was calculated based on Eq. (1-3). Ordinary color constancy index (OCCI) is an index measurement based on the different magnitude between a distance of color appearance under D65 to the appearance under the test illumination, as shown in Figure 7. While the hue color constancy (HCI) can be calculated as a hue angle as blur arc line compared to the red arc line in the same manner as OCCI. Finally, the modified color constancy index (MCCI) was calculated based on the multiplication of those previous indexes to show the color constancy index performance under test illumination.

$$OCCI = 1 - \frac{a}{b} \tag{1}$$

$$HCI = 1 - \frac{\theta a}{\theta b} \tag{2}$$

$$MCCI = OCCI \times HCI \tag{3}$$

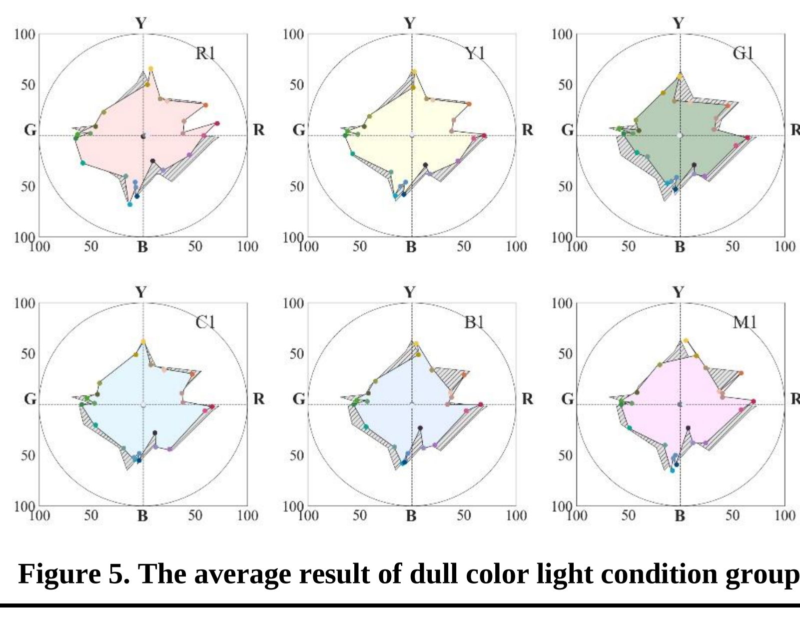

Figure 5. The average result of dull color light condition group

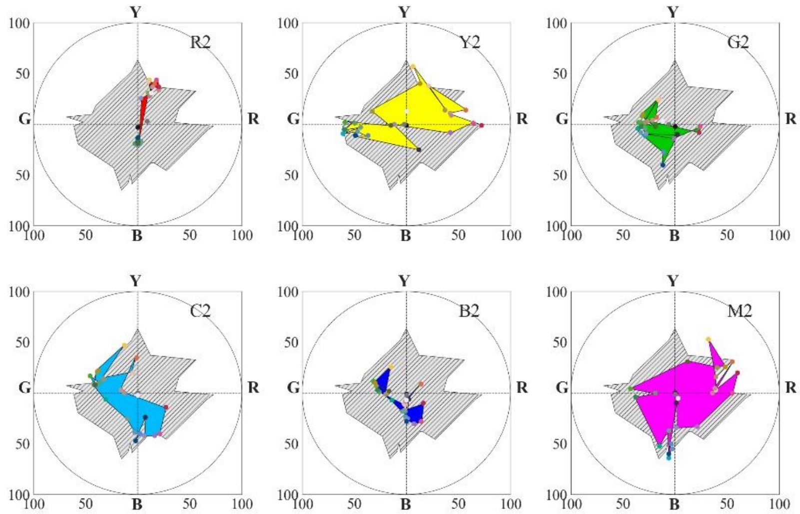

Figure 6. The average result of vivid color light condition group

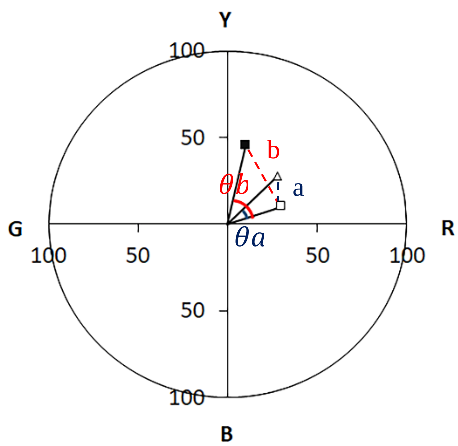

Figure 7. The color constancy index in the polar diagram.

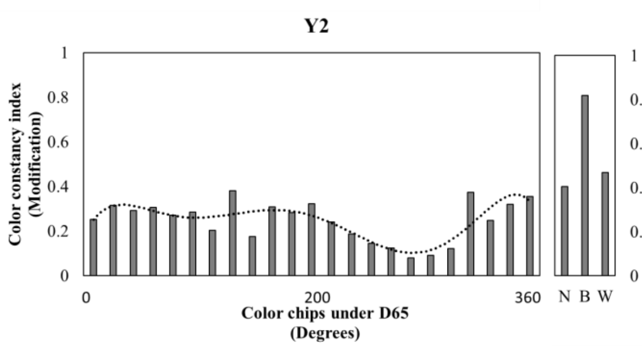

Figure 8. The result of color constancy index under Y2

The example of the color constancy index result under the Y2 condition is shown in Figure 8. The result showed that the lowest color constancy index was around the color chip, which appeared to be blue. Similar results also occurred in another colored illumination. Figure 9 shows the color constancy index on the ordinate and light condition distance from D65 on the abscissa. The result showed color constancy was poor as early dropped under cyan, yellow, and green illumination more than the others.

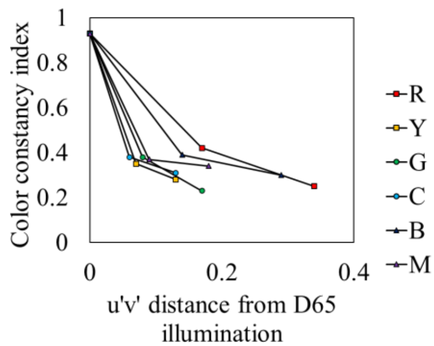

Figure 9. The average result of vivid color light condition group

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REFERENCES

19. Morimoto, T., Kusuyama, T., Fukuda, K., & Uchikawa, K. (2021). Human color constancy based on the geometry of color distributions. *Journal of Vision*, *21*(3), 7. https://doi.org/10.1167/jov.21.3.7
20. Ikeda, M. (2004). Color Appearance Explained, Predicted and Confirmed by the Concept of Recognized Visual Space of Illumination. *Optical Review*, *11*(4), 217–225. https://doi.org/10.1007/s10043-004-0217-x
21. Yamauchi, R., Ikeda, M., & Shinoda, H. (2003). Walls Surrounding a Space Work More Efficiently Construct a Recognized Visual Space of Illumination than Do Scattered Objects. *Optical Review*, *10*(3), 166–173. https://doi.org/10.1007/s10043-003-0166-9
22. Arend, L. E., Reeves, A., Schirillo, J., & Goldstein, R. (1991). Simultaneous color constancy: papers with diverse Munsell values. *Journal of the Optical Society of America A*, *8*(4), 661. https://doi.org/10.1364/josaa.8.000661
23. Rajendran, S. S., & Webster, M. A. (2020). Color variance and achromatic settings. *Journal of the Optical Society of America A*, *37*(4). https://doi.org/10.1364/josaa.382316
24. Berlin, B., & Kay, P. (2000). *Basic color terms: Their universality and evolution*. California, USA: CLSI Publ.
25. Hunt, R. W. G., & Pointer, M. R. (2011). *Measuring colour*. West Sussex, UK:John Wiley & Sons.

EFFECT OF ROOM ILLUMINANCE ON SIMULTANEOUS COLOR CONTRAST DISPLAYED ON AN ELECTRIC DISPLAY WITH OR WITHOUT A PAPER TISSUE

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Keywords: Electric display, Elementary color naming, Simultaneous color contrast, Room illuminance, Tissue paper.

ABSTRACT

It is known that the simultaneous color contrast SCC is a phenomenon to show the chromatic adaptation. Stimulus pattern of SCC is a colored field with an achromatic patch at the center. It was pointed out that the colored surrounding field works as an adapting color and the color appearance of the central gray test patch is a result of the chromatic adaptation to the surrounding color. In the case of paper stimulus, the test patch does not appear vivid color but if it is observed through a tissue paper the SCC effect is much enhanced and the central gray test patch appears vivid in color. The phenomenon is explained that the tissue blurs the gray test patch contours reducing the object recognition of the stimulus and only the colors remain to give a stronger chromatic adaptation. We investigate if the tissue also works for an electric display, a self-luminous display, in case of simultaneous color contrast. Luminance of four surrounding colors, red, yellow, green, and blue, was kept constant at 46, 128, 88, and 15 cd/m^2, respectively, and the room illuminance was adjusted to 10 levels ranging from 3 to 1600 lx. Subjects judged color appearance of the test and the surround by the elementary color naming with or without a white tissue paper. A ratio of chromaticness of test patch to the chromaticness of surround suddenly increased from the room illuminance 200 lx despite of decrease of the surrounding chromaticness.

INTRODUCTION

One of the phenomenon of color appearance is the simultaneous color contrast or SCC to show mechanism of the chromatic adaptation to the surrounding color, a gray test patch at the center appeared cyan if surrounded by red, for example. In the case of paper stimulus, the phenomenon is not strong and the cyan color is not vivid, but if the SCC stimulus is covered by a white tissue the SCC effect is much enhanced and the central gray test patch appears more vivid in color [1, 2] we can explain by the recognized visual space of illumination RVSI theory [3]. A subject adapts to the color of illumination of a space constructed over the surrounding surface [4, 5]. In the case of the paper stimulus, one of the major effects is the level of ambient lighting in viewing condition. But nowadays many researchers present stimulus by using an electronic display that is self-luminous which gives a stronger adaptation than object stimulus and the experiments are mostly performed in a dimly illuminnated room to avoid the effect of reflections of the room illumination on the surface of display. We are interested if the tissue still works in the SCC effect for an electric display with existence of room illuminance.

EXPERIMENT

To obtain effect of room illumination, the illuminance was changed at ten levels, 3, 6, 13, 25, 50, 100, 200, 400, 800, and 1600 lx on the display by using six ceiling fluorescent lamps. The surrounding luminance was kept constant for all four colors of surrounds, red, yellow, green, and blue at 41.3, 124, 83.5, and 9.5 cd/m^2, respectively, the central gray patch at 41 cd/m^2. Their xy chromaticities are shown in Figure 1 for without-tissue (a) and for with-tissue (b).

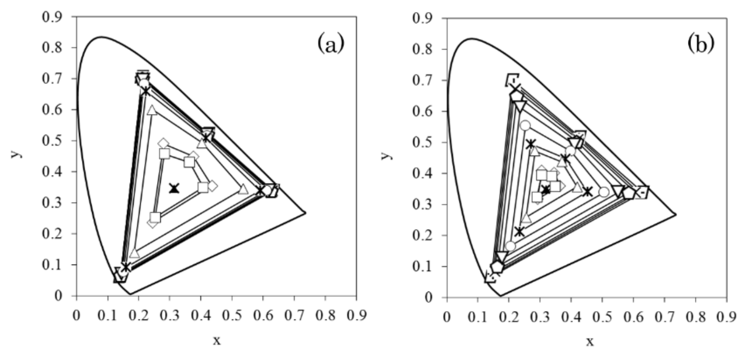

Figure 1. The surrounding colors under ten levels of illuminance without-tissue (a), with-tissue (b) (▱, 3 lx; □, 6 lx;□, 13 lx; ⬠, 25 lx;▽, 50; ◯, 100; □, 200 lx; △, 400 lx; ◇, 800 lx; □, 1600 lx;, ▲, white, and r, gray

A 24.1″ EIZO LCD display was used to present the SCC stimulus. The display was placed horizontally on a table and was masked with black paper. The size of the surround was 23x23 cm^2 (25.9° of visual angle) and the gray patch was 3x3 cm^2 (3.4° of visual angle). We use the one sheet of commercially available white tissue stretched flat on the frame to cover the stimulus in with-tissue condition, the size of the tissue within the frame was 13x14 cm^2. The transmittance was constant at 56 % for visible wavelength and the haze value was 80 %. The physical effect of a tissue is to blur the image and to reflect the white ceiling light toward a subject reducing the contrast of the image and desaturating color of the image on the display.

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

RESULTS

Figures 2 and 3 show examples of results of red surround for subject JM and PC, respectively. The amounts of chromaticness at ten levels of room illuminance are shown for the surround in (a) and for the gray test patch in (b), open circles for the with-tissue and filled circles for the without-tissue. The abscissa shows the room illuminance and the ordinate the amount of chromaticness. The subject JM perceived quite constant chromaticness for surrounding without tissue (2a), but the chromaticness clearly reduced for higher illuminance with tissue. The chromaticness of test patches stayed constant at all of illumination both with and without-tissue (2b). As we are interested in the power of surround to induce color at the test patch, we took ratio of chromaticness of test patch to the chromaticness of surround, and the results are shown in (2c) of Figures. 2 and 3, the ordinate giving the chromaticness ratio. The effect of tissue is quite apparent at the higher room illuminances of 200 lx in both subjects.

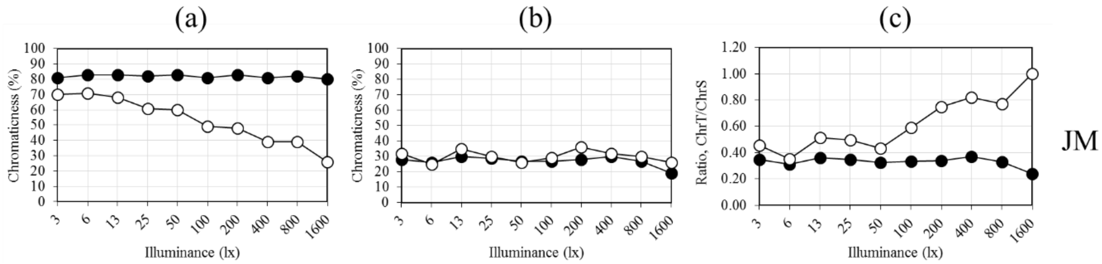

Figure 2. a, Amount of chromaticness of red surrounding with ten levels of illuminance surrounding, (b) test patch. The chromaticness ratio red stimulus (c), compared between without tissue (=) and with tissue (◯). Subject, JM

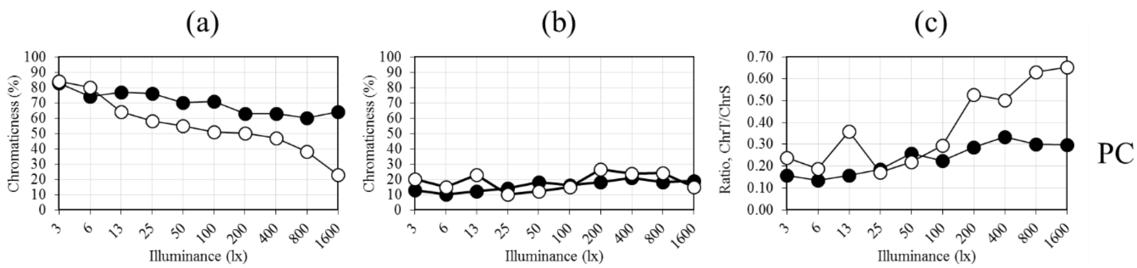

Figure 3. Amount of chromaticness of red surrounding with ten levels of illuminance (a) surrounding, (b) test patch. The chromaticness ratio red stimulus (c), compared between without tissue (=) and with tissue (◯). Subject, PC

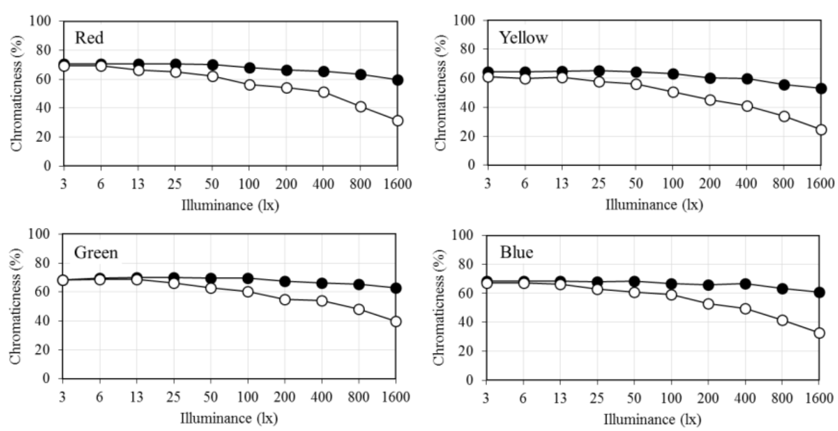

Figure 4. Amount of chromaticness of four surrounding colors with ten levels of illuminance compared between without-tissue (●) and with-tissue (✦)

We averaged the results of color perception of four surrounds for ten subjects and showed the result in Figure 4, the chromaticness of four surrounds is quite constant without tissue, but it clearly decreased with tissue as the illuminance increased. Figure 5 shows the chromaticness of the test patches without-tissue (●) and with-tissue (○). It shows a relatively similar and relatively constant value of chromaticness at all the illuminance levels, except green surround, where the chromaticness reduces slightly higher illuminance.

Figure 6 shows the chromaticness ratios that were obtained from Figures 4 and 5. It seems to be constant under room illumination level from 3-100 lx, but at the illuminances over 200 lx it increased, except with the green surround. Finally, their averages of all four surrounding colors are shown in Figure 7.

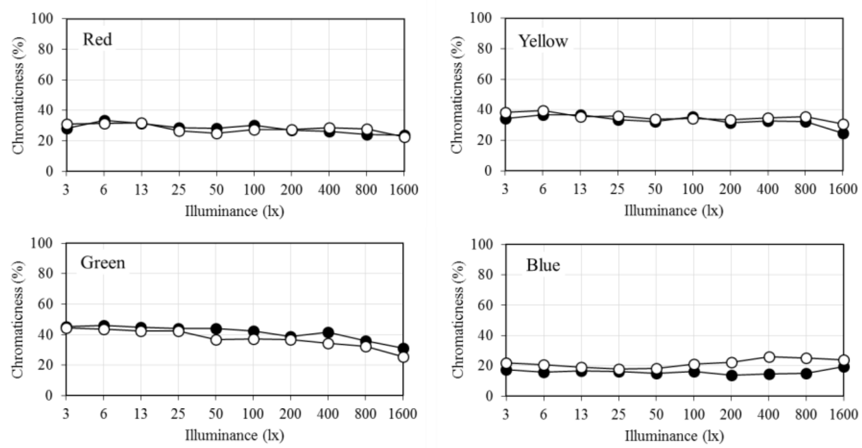

Figure 5. Amount of chromaticness of test patch in each surrounding color with ten levels of illuminance compared between without-tissue (●) and with-tissue (✦)

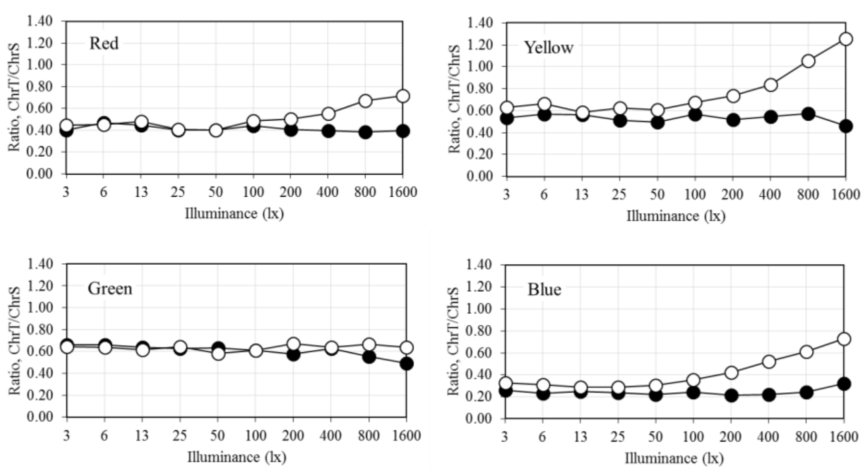

Figure 6. Chromaticness ratio of four surrounding colors with ten levels of illuminance compared between without-tissue (●) and with-tissue (✦)

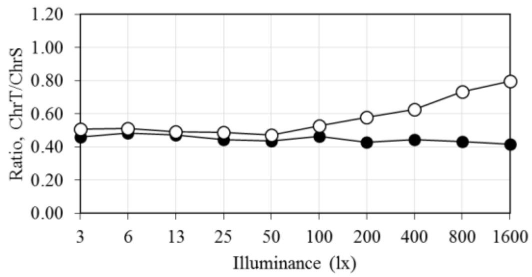

Figure 7. Averaged results from four surrounding colors compared between without-tissue (●) and with-tissue (✦).

Finally, the apparent hue of test patch of four surrounding colors in all levels of illuminance is shown in Figure 8 by hue angle of test patch for the without-tissue by solid lines and for the with-tissue by dashed lines. It is shown that the hue angle does not change for all levels of illuminance. And overlaps for both without and with-tissue, except the test patches of red appearance with-tissue.

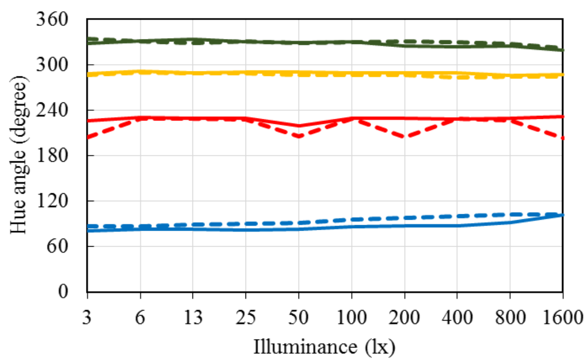

Figure 8. Apparent hue changes for test patch in each surrounding color with ten levels of illuminance compared between without-tissue (——) and with-tissue (- - -).

CONCLUSION AND DISCUSSION

Room illuminance did not affect the amounts of chromaticness of the simultaneous color contrast viewed through tissue paper. But when expressing them in the ratio of test patch chromaticness to surrounding chromaticness, the effect showed stronger at illuminance over 200 lx. We found that the ratio continued to increase from the illuminance 200 lx and beyond. Higher room illuminance increases the reflection of white light from the tissue surface and the subjects see~~n~~ a reduced surrounding color through the tissue paper but still perceived the occurrence of simultaneous color contrast as same as without-tissue. A more reflection of the ceiling light at the stimulus reduced the image contrast and reduced the sharpness perception of the edges of the test patch and increased the color induction by the same token as the image blurring effect.

We can understand these results by taking account of the tissue effect of the image blurring and the reflection of white light. The image blurring effect reduced an object recognition of the test patch leaving only color or light which caused higher illuminance perception of vertical space (or vertical RVSI) constructed over the surface of the stimulus causing the test patch color to appear more vivid. [4]

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REFERENCES

1. Graham, H. C. & Brown, L. J. (1965). *Vision and visual perception:* Color contrast and color appearance: Brightness constancy and color constancy. USA: John Wiley & Sons.
2. Ikeda, M. & Phuangsuwan, C. (2020). The effect of tissue paper on the color appearance of colored papers. *Journal of the Optical Society of America A*, *37*(4), A114-A121.
3. Ikeda, M. (2004). Color Appearance Explained, Predicted and Confirmed by the Concept of Recognized Visual Space of Illumination. *Optical Review*, 11(4), 217–225.
4. Phuangsuwan, C. & Ikeda, M. (2017). Chromatic adaptation to illumination investigated with adapting and adapted color. *Color Research and application*, 42, 571–579.
5. Phuangsuwan, C. & Ikeda, M. & Mepean, J. (2018). Color appearance of afterimages compared to the chromatic adaptation to illumination. *Color Research and Application*, 43(3), 349–357.

DEVICE DEPENDENT SIMULTANEOUS COLOR CONTRAST

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Keywords: Simultaneous color contrast, Device dependence, Illumination, Printed paper, Elementary color naming

ABSTRACT

The simultaneous color contrast was investigated with two different devices, a printed paper, an electronic display. In all two devices a stimulus was made of a small gray patch surrounded by a color. The color appearance of the gray patch was measured by the elementary color naming method, namely amounts of chromaticness, whiteness, and blackness in percentage, and amounts of four unique hues, red, yellow, green, and blue, in percentage. Stimulus conditions such as chromaticities, luminance and sizes are made similar between the two devices. Results showed that the color appearance of the gray patch was most vivid with the electric display and the paper which gave the least amount of chromaticness. The results indicate that the simultaneous color contrast phenomenon is device dependent.

INTRODUCTION

Simultaneous color contrast is a phenomenon that occurs when one color is influenced by a surrounding color. The color changes both in hues and brightness. In the case of brightness change it is called simultaneous brightness contrast. Many researchers used the simultaneous color contrast to investigate how our visual mechanism works. [1-4] A concept of recognized visual space of illumination RVSI proposed by Ikeda [5] asserts that the chromatic adaptation takes place to the illumination of the space where the simultaneous color contrast experiment is done. The most common and traditional pattern is a paper stimulus as demonstrated on textbooks [6, 7], which we call object color mode experiment. Currently, many researchers employed electric display, with which they can manipulate stimulus easily and present complicated patterns to meet various experimental conditions [1, 2, 8]. The previous studies on the topic suggested that the simultaneous color contrast is device dependent. [9,10] However, in this experiment, the size and luminance of the stimuli were not precisely controlled. And we noticed that the environment light was not same. In the electronic display subjects judged the simultaneous color in a dark room while in the printed paper they did in the bright room. In the present study we aim to demonstrate whether the color appearance of the simultaneous color contrast is device dependent under precise control of chromaticities, luminance and size of stimuli and of the room illuminance. Two devices are investigated printed papers and an electronic display. This study is important because as in the printing industry or graphic design, proof of the color is normally done on a monitor instead of paper. However, the final reproduction will be on the paper or other materials which found that they were often disappointed by the colors that are produced.

EXPERIMENT

Table 1. Chromaticities and luminance

Surround Colors/test patch	Paper			Display		
	Y	u′	v′	Y	u′	v′
Gray	83	0.193	0.492	84	0.193	0.489
Red	47	0.357	0.519	48	0.359	0.518
Orange	86	0.277	0.538	86	0.276	0.540
Yellow	197	0.203	0.557	198	0.203	0.551
Greenish yellow	110	0.173	0.549	111	0.174	0.548
Green	52	0.141	0.535	52	0.141	0.534
Cyan	70	0.142	0.416	70	0.146	0.416
Blue	23	0.160	0.385	21	0.162	0.380
Purple	28	0.251	0.419	27	0.251	0.415
Gray patch	99	0.192	0.419	99	0.194	0.491

A common stimulus for the simultaneous color contrast experiment was prepared. There is a large colored field with a small gray patch at the center as shown on the left of Figure 1. Surrounds were made of nine colors and one color for the gray patch. The chromaticites u′v′ and luminance Y were controlled almost the same between devises as shown in the table 1.

The surrounding colors were printed on the matt paper 230 g/m^2 by digital printing. The gray patch was printed by the same printer but on a matt paper 210 g/m^2 to avoid the shadow while putting it on the surrounds. The size was 31×44.5 cm (34.5° ×48°) and gray patch was 4×4 cm (4.6° ×4.6°), when viewed at the distance 50 cm.

The EIZO LCD display 27inches, model: ColorEdge CX271, Color mode sRGB, CCT 5500K was employed in the experiment.

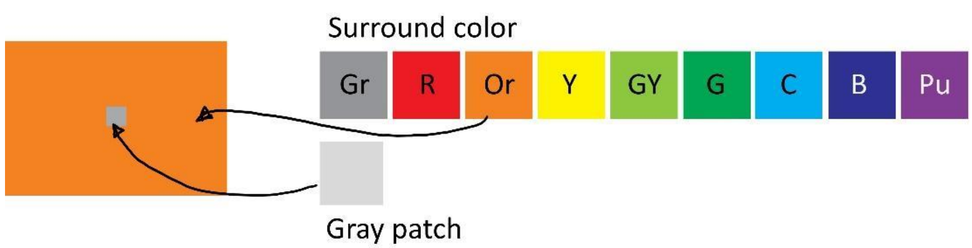

Figure 1. Simultaneous color stimulus, surrounding colors and a gray test patch

Procedure

The color appearance was judged by the elementary color naming method. That is to estimate the amounts of chromaticness, whiteness, and blackness in percentage, and the apparent hue by the amounts of two or one unique hues also in percentage, where that red and green and yellow and blue cannot be answered at the same time. The stimulus was presented in the experimental room (110×215×200 cm), where the illuminance was kept constant at 900 lx, chromaticities at x = 0.339, y = 0.377, and CCT at 5500K both in the paper and display conditions. The viewing distance was 50 cm. When a stimulus was presented, a subject adapted to the surrounding field for about one minute and judged the color appearance of the surround, and then the central patch. Nine surrounding colors were pseudo-randomly presented. The judgement was repeated for 3 times on different day or time. Figure 2 shows the atmosphere of the experiment.

Participants

Three subjects, CP, MI and JM participated in the experiment. The age range is from 25 to 88 years old. CP and JM were Thai females and MI was a Japanese male. They were experienced subject and have a normal color vision checked by 100 hues test and Ishihara test.

Figure 2. Simultaneous color pattern, surrounding colors and gray patch

RESULT AND DISCUSSION

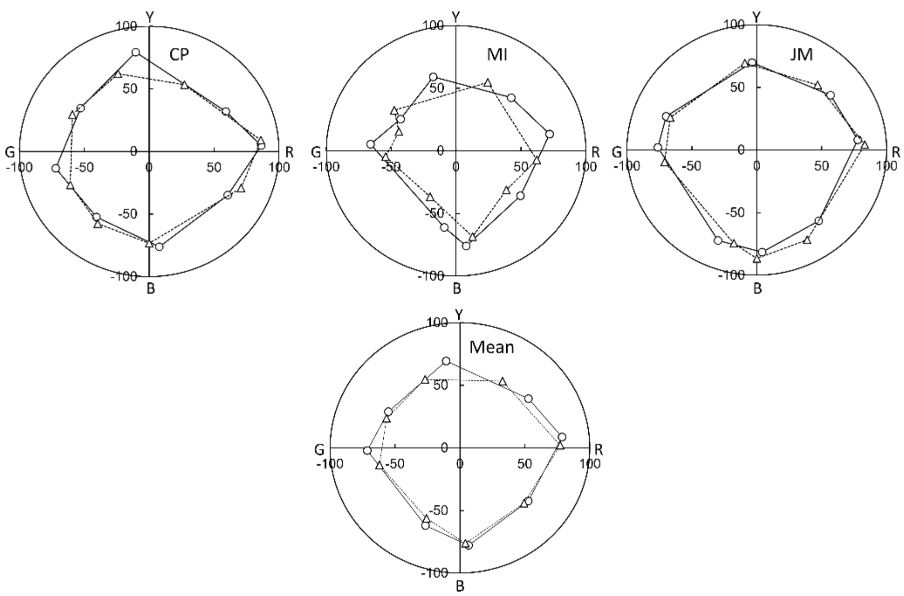

Figure 3. The results of the surrounding colors compared between printed paper and electronic display. □; printed paper, △; electronic display

The color appearance of surrounding colors is plotted on a polar diagram used in the opponent colors theory. The unique red and green appearance are taken along the horizontal direction, red being positive and green negative and unique yellow and blue along the vertical direction, the former being positive and the latter being negative. The distance from the origin along the radial direction gives the amount of chromaticness, the circumference giving 100% of the chromaticness. Apparent hue is expressed by the angle from R-axis in the counterclockwise direction and it is determined by the ratio of amounts of unique hues. Upper three graphs in Figure 3 show the mean results within individual subject, CP, MI and JM and the bottom diagram is there. Open circles show the results of printed paper condition and open triangles show for electronic display condition. The amount of chromaticness of the surround is almost same in all surrounding colors, but the apparent hue showed difference. There is no difference in red, greenish yellow, cyan, blue, and purple, but in orange, yellow and green there is found difference. Before seeing the difference, the apparent hue angle was defined as the angle of a line connecting the origin of the graph to the concerned point measured from R axis. Then $\triangle\theta$ was obtained by (θdisplay - θpaper) and the results are shown at the last column of the table attached in Fig. 4. Orange, yellow, green gave large values of $\triangle\theta$.

Sur	θ display	θ paper	dis-pa Δθ
Gr	162	162	0
R	5	6.5	-1.5
Or	59	38	21
Y	118	99	19
GY	157.5	151.5	6
G	192.5	182	10.5
C	244	247	-3
B	273.5	275	-1.5
P	319	322	-3

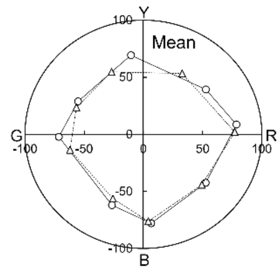

Figure 4. Hue difference $\triangle\theta$ (θdisplay−θpaper).

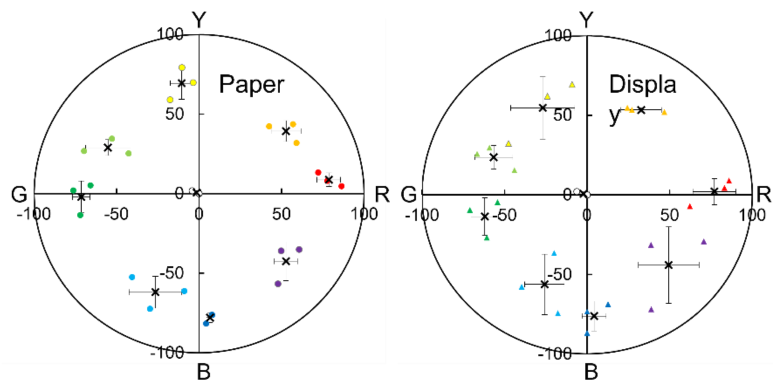

Figure 5. The standard deviation among 3 subjects for apparent color surrounding

Figure 5 shows the standard deviation among subjects for color appearance of surrounds. SD in the case of paper is smaller than that in the case of display to imply more difficult to judge the color on display. In other words, the color appearance on papers is more stable than on display, a self-luminous surface.

The upper figure of Figure 6 shows by dotted contours the mean result of simultaneous color contrast of gray test patch under 8 surrounding colors in the case of paper in each subject (the gray surround is not shown). The solid contours show the color appearance of test patch in the case of display. The illustration shows much difference in the amount of chromaticness between the electronic display and the paper stimuli. The amount is much larger in the display, implying device dependency. There is also seen difference among individuals. Particularly the contours of the subject MI, who is the oldest, are very small compared with other subjects, particularly with the subject JM who is the youngest among three subjects. When MI and JM started to look at the display at the same instance the subject JM immediately perceived a vivid color at the gray test patch, but MI did not perceive color at all or had to wait for a while until to perceive slight color. The effect of the age on the simultaneous color contrast effect should be investigated more in the future. The bottom figure of Fig. 6 gives the mean result of the three subjects. The colored lines connect points of same color pairs. For example, the red colored line connecting the solid contour to the dotted contour indicates the color appearance of simultaneous color contrast of gray test patch when it is surrounded by red color and the line locates in the cyan area(area between unique green and blue).The fact that these lines do not necessarily converge to the origin in the graph indicates that the apparent hues of the test patch are not necessarily same in the paper stimuli and the display stimuli, again implying the device dependency. Disagreement of apparent hues between the display and the paper is also shown by variance in △θ defined as (θdisplay−θpaper), which is shown in Table 2.

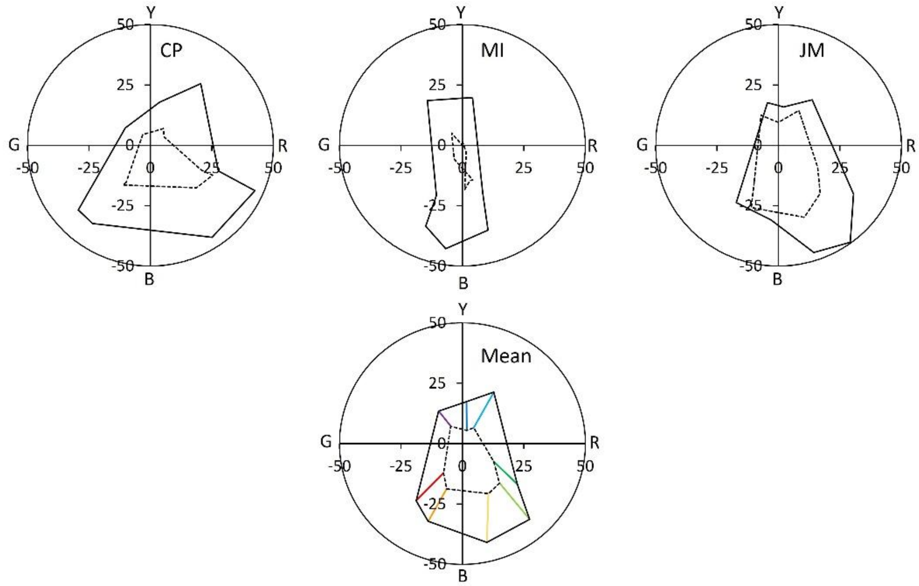

Figure 6. The results of the simultaneous colors contrast compared between printed paper; dotted line and electronic display; solid line

Table 2. Hue difference △θ (θdisplay−θpaper) of gray test patch inducted

	θ Display	θ Paper	Δθ dis-pa
Gr	0	0	0
R	233.5	238	-4.5
Or	248	256	-8
Y	284	296.5	-12.5
GY	309.5	305.5	4
G	319.5	320.5	-1
C	61	78	-17
B	81	44	37
P	124	121	3

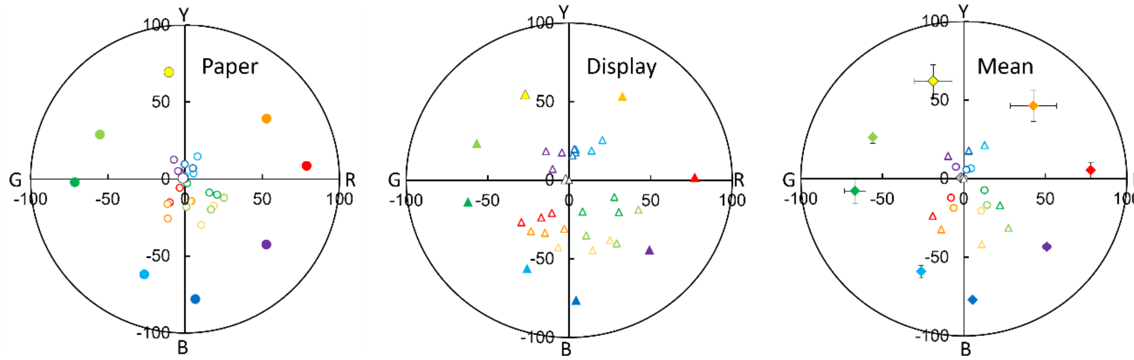

Figure 7. Color appearance variances among 3 subjects of gray test patch inducted

The results of this experiment agree well with the phenomenon adapting and adapted color, which was explained by RVSI theory. It said that the simultaneous color contrast is a mechanism of chromatic adaptation to illumination of a space.[11] Figure 7 shows the color appearance variances among subject for simultaneous color contrast at gray test patch. There are three points with same symbols that correspond to the three subjects. Colors of the symbols indicate the surrounding colors and large filled circles with colors indicate the color appearance of the surrounds. It is seen that the variance among subjects is larger in display.

CONCLUSION

We conclude that the simultaneous color contrast demonstrated under printed paper and electronic display were device dependent. The chromatic adaptation works strongly with the electronic display. To the electronic display subjects recognized the color of light stronger than to the paper even though the physical colors were kept same in both devices. On the other hand, the subjects recognized the paper stimuli as objects, not light and the chromatic adaptation did not work strongly.

In the printing industry they do proofing the printed color mostly through the display (soft proof). The most important process to set the color proofing is called Color Management System [12] which assumes the device independence. Our results confirmed that our color appearance is device dependent but cannot draw the systematic conclusion at the moment we need to do further experiment by investigating more factors such as the proper luminance of color which give the lowest device dependent.

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REFERENCES

1. Ekroll, V. and Faul, F. (2013). Transparency perception: the key to understanding simultaneous color contrast. *J. Opt. Soc. Am. A 30*(3), 342-352.
2. Wu, R.C. and Wardman, R. H. (2007). Lightness and Hue Contrast Effects in Surface (Fabric) Colours. *Col. Res. Appl. 32*(1), 55-64.
3. Takahashi, S. and Ejima, Y. (1982). The Study on Simultaneous Color Contrast Effect by the Opponent Color Responses. *Kogaku (Optics).11*, 478-484. [in Japanese]

4. Brown, R.O. and MacLeod, D. I.A. (1997). Color appearance depends on the variance of surround colors. *Current Biol. 7*(11), 844-849.
5. Ikeda, M. (2004). Color appearance explained, predicted, and confirmed by the concept of recognized visual space of illumination. *Opt. Rev. 11*, 217-225.
6. Hurvich, L.M. (1981). *Color Vision*. Plate 2-2 and 13-1, Sinauer Assoc. Inc.
7. Boynton, R.M. (1979). *Human Color Vision*. Fig. 2.4 P37, Holt, Rinehart, and Winston.
8. Ekroll, V., Faul, F. and Niederée, R. (2004). The peculiar nature of simultaneous colour contrast in uniform surrounds. *Vision Research, 44*(15), 1765-1786.
9. Phuangsuwan, C. and Ikeda, M. (2018). Simultaneous Color Contrast Demonstrated on Different Devices. *Proceeding of CSAJ, Osaka, Japan, Supplement in Journal of the Color Science Association of Japan*. *42*(3), 2-3 June 2018, 54-56.
10. Phuangsuwan, C., and Ikeda, M. (2019). Device dependent simultaneous color contrast. *Proceeding of CSAJ, Osaka, Japan, Supplement in Journal of the Color Science Association of Japan. 43*(3), 121-124.
11. Phuangsuwan, C. and Ikeda, M. (2017). Chromatic adaptation to illumination investigated with adapting and adapted color. *Color Research and Application, 42*, 571-579.
12. Kipphan, P.K. (2001). Handbook of print media. Verlag Berlin Heidelberg, Springer.

ANALYSIS OF THAI SKIN COLOR ON CIEL*C*H*

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

ABSTRACT

The CIEL*c*h* color system is helpful to describe lightness (L*), chroma (c*), and angle of color or hue angle (h*). In this study, we wanted to analyze the results of the skin color of Thai people in the CIEL*c*h* color space system, using 171 Thai people aged 24-70 years old to measure all 5 points of the body, namely the left cheek and the right cheek, forehead, chin and inner arm by using the Konica Minolta CS-100A as a tool to measure the skin color of Thai people. The participants must not use any skincare or cosmetics before skin measuring. A white reference plate was measured in the same positions of a part that measured the real skin, and after that, the real skin was measured. The results showed that the inner arm area had the highest mean lightness, followed by the forehead, cheeks, and chin, which were 61.35, 57.92, 57.77, and 55.12, respectively. The distribution of chroma in the cheek tends to decrease as the skin lightness increases on the forehead and inner arms, although there is a slight tendency. For the average value of chroma, the cheek was the highest of chroma, followed by chin, forehead, and inner arm (23.87, 23.31, 22.93, and 22.03, respectively). However, when comparing the lightness with the Hue angle, there was no relationship in the cheek, forehead, chin, and inner arm. The inner arm was the highest for the average hue angle value, followed by forehead, cheek, and chin (57.88, 52.42, 52.16, and 51.32, respectively).

INTRODUCTION

Hemoglobin and melanin are substances in the body that are the constituents in the appearance of human skin color [1]. The amount of both substances varies for each individual. Including daily exposure to sunlight can also affect the amount of Hemoglobin and Melanin in different people, even if they are of the same ethnicity. Moreover, some studies have found that the redness of the skin on the face is greater than that of the trunk because there is better blood flow in the skin than the body [2]. It was found that the redness of the skin strongly depends on the location on the body [3]. Therefore, the location on the body might be a factor that can cause different skin tones.

CIEL*c*h* is a color system in the polar coordinate color space. Developed from the CIEL*a*b* color system, the lightness or L* is the same scale as CIELAB, ranging from 0-100, with 0 being black and 100 being white. The chroma or c* indicates the quality of a color's purity, intensity, or saturation. If the chroma value is low, the color will be dull. But if the higher the chroma value, the vividness of color. The hue angle or h*, 0 to 360 degrees, indicates red by 0 and 360 degrees, yellow by 90 degrees, green by 180 degrees, and blue by 270 degrees as indicated in Fig.1 [2]. The values L*, c*, and h* can be calculated from the equation 1, 2, and 3, respectively.

Normally, the skin color analysis is most often analyzed in the CIELAB color system because it can quantify the pigmentation of the skin, such as the redness or yellowness of the skin. But the analysis using the CIEL*c*h* is not common in research in Thailand. Therefore, we wanted to analyze the results of the skin color of Thai people based on the CIEL*c*h* color system. In addition, also we investigated the different positions of the body that can affect the difference in lightness, chroma, and hue angle of the Thai skin.

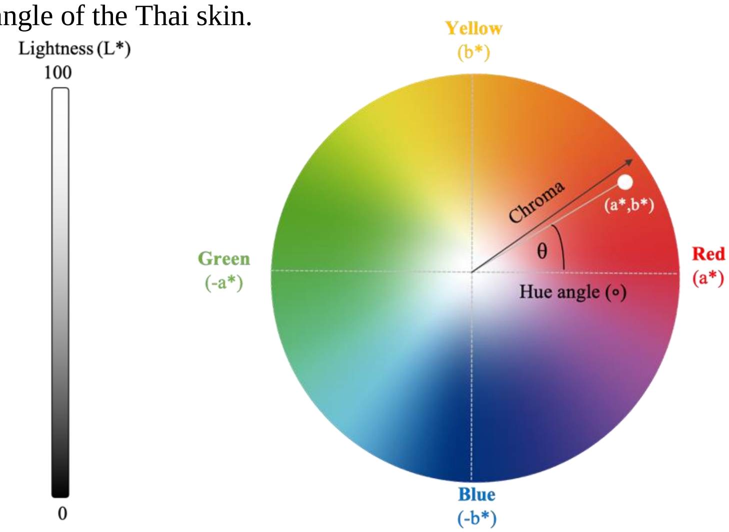

Figure 2. The CIEL*c*h* color system.

$$\text{Lightness, L*} = 116\left(\frac{Y}{Y_0}\right)^{1/3} - 16 \tag{1}$$

$$\text{Chroma, c*} = \sqrt{(a*)^2 + (b*)^2} \tag{2}$$

$$\text{Hue angle (°), h*} = \operatorname{atan}\left[\frac{b*}{a*}\right] \tag{3}$$

METHODOLOGY

171 Thai people had participated in this study including 81 males and 90 females. The age ranged 24 to 72 years old. Most of the participants were working outdoors and indoors. The four positions of the face were measured, left and right cheek, forehead, and chin which represent parts most exposed to the sunlight, and inner arm which represents part least exposed to the sunlight.

Konica Minolta CS-100A chromameter was used to measure the skin color of Thai people. This instrument was portable, lightweight, and gave the value close to the spectroradiometer CS-2000 that has been tested in a preliminary experiment for instrument testing. Moreover, the chromameter eliminated the problem of the pressure factor which affects skin color change. A disadvantage of this type of instrument was to require external light to measure the color. Therefore, it was necessary to measure the white reference plate as a reference.

(A) **(B)**

Figure 2. (A) White reference plate measurement. (B) Real skin measurement.

Prior to the participants must not use any skincare or cosmetics or had to wash their face. Then, the personal informations were recorded such as age, gender, occupation, workplace characteristic, hometown province, and skincare and cosmetic use. The white reference plate was measured at the same position as the real skin. Five real skin positions were measured immediately after the white reference measurement as indicated in Fig. 2. One-way ANOVA was used with a significance level of 0.05 to check difference between two data.

RESULT AND DISCUSSION

The two sides of the cheek were averaged in one value to represent the cheek in each participant. The cheek and forehead were in the same range in lightness values of about 40 – 75 and had the average L* were 57.77(±7.99) and 57.92(±7.42), respectively. The inner arm had a wider distribution of L* than other three positions with a range of about 31-84 and the highest L* of average value at 61.35 (±8.34). But the chin had the lowest in L* with a range of about 38-70 with the average value of 55.12 (±6.95). Moreover, the distribution of chroma values of all positions was the same range about 15-33 as indicated in Fig.2. The average of chroma of cheek, forehead, chin, and inner arm was 23.87 (±2.66), 22.93 (±2.93), 23.31 (±2.94), and 22.03 (±2.93), respectively. The chin was a significantly different in L* in cheek and forehead (P=0.008 and P=0.004, respectively). The L* of the inner arm was significantly different from three parts of the face (P=0.000) as indicated in Fig.4. The inner arm also was significantly different from the position of face in saturation of skin or chroma as indicated in Fig.5 (inner arm vs. cheek; P=0.000, forehead; P=0.021 and chin; P=0.000, respectively). The cheek was significantly different from forehead when compared with other part of the face (P=0.013).

Figure 6. indicates hue angle, the inner arm showed the widest distribution in a range about 30° - 85°, while the parts of the face (cheek, forehead, and chin) were the same range about 30° - 65°. As a result of h* of the inner arm, the highest in average was 57.88 (±5.01) and more towards yellow than the facial. The average h* of cheek, forehead, and chin was 52.16 (±5.15), 52.42 (±5.16), and 51.32 (±6.94), respectively. The h* of the inner arm was significantly different from cheek, forehead, and chin (P=0.000) as indicated in Fig.7.

The face is an area with more blood flow than the inner arm. As a result, the face has larger redness of the skin than the inner arms as well as the faces area being frequently exposed to sunlight which affects the production of Melanin [3, 4, and 5]. Therefore, the skin color of the face was darker, higher in chroma, and a shade of red than the inner arm.

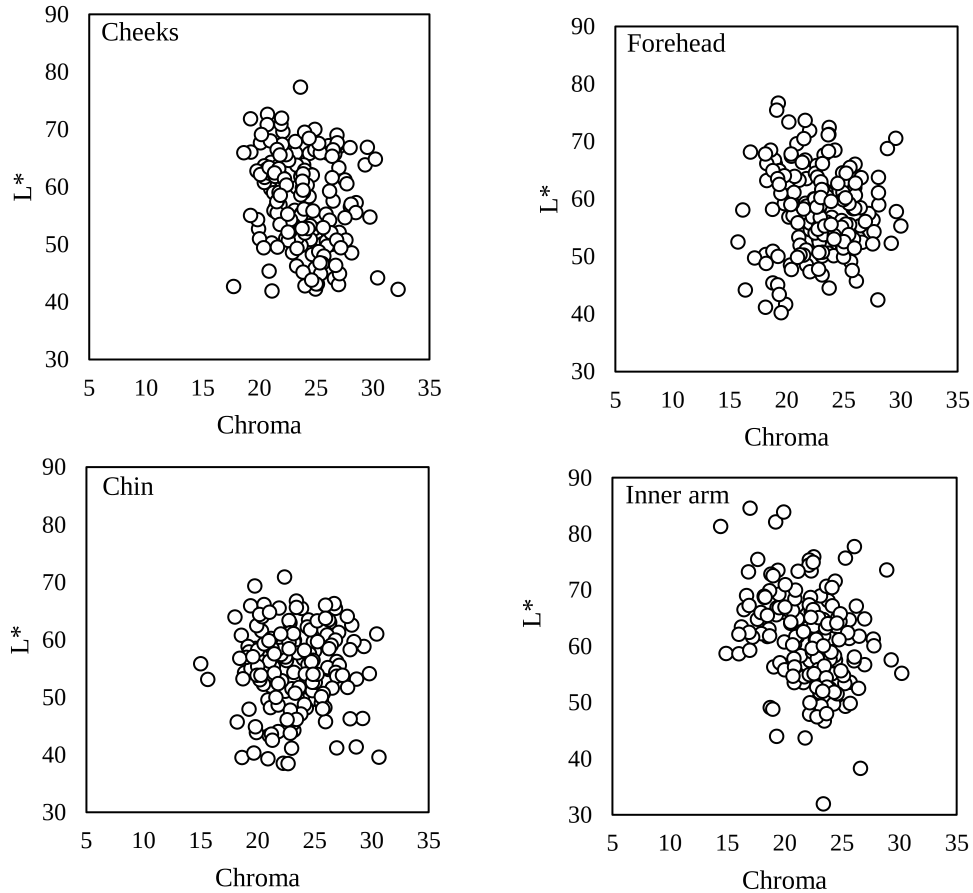

Figure 3. The distribution of Thai skin tone in each position of measurement between chroma and lightness

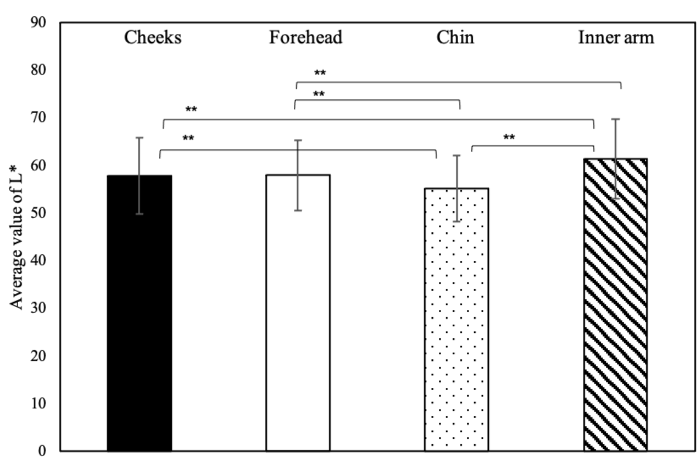

Figure 4. The average lightness of Thai skin tone in each position of body (* ; P<0.05 and **; P<0.00)

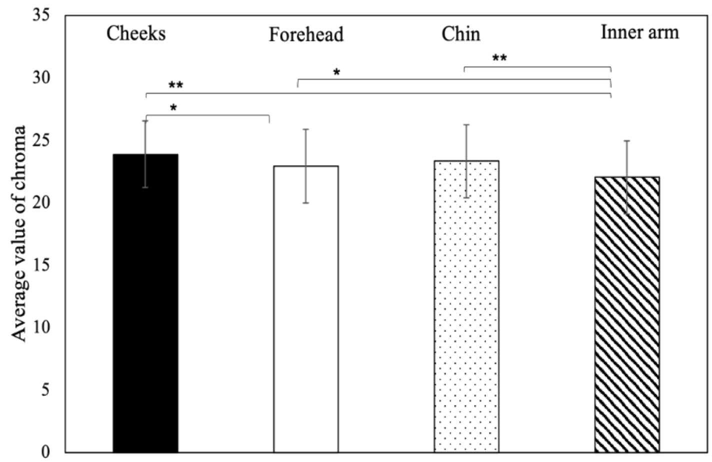

Figure 5. The average chroma of Thai skin tone in each position of body (* ; P<0.05 and **; P<0.00).

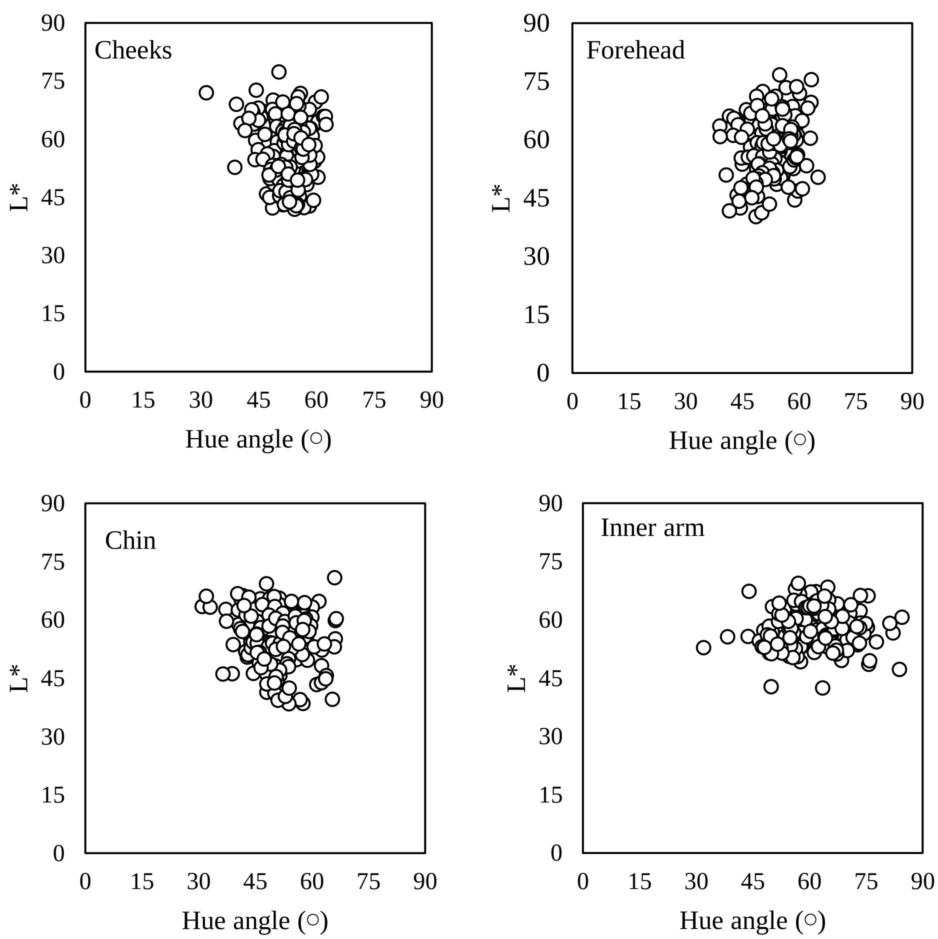

Figure 6. The distribution of Thai skin tone in each position of measurement between chroma and lightness

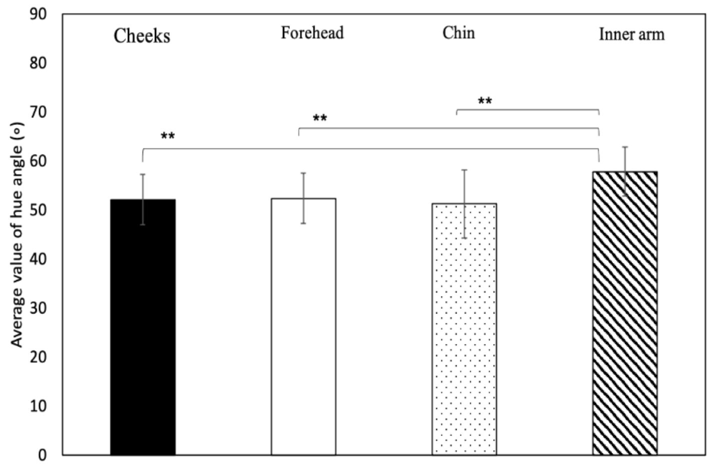

Figure 7. The average hue angle of Thai skin tone in each position of body (* ; P<0.05 and **; P<0.00).

CONCLUSION

The results suggested that the facial area which most exposed to the sunlight is affected to skin to become darker, more saturate and to tend to red color than the inner arm. The difference between body positions affected the lightness, chroma, and hue angle of Thai skin color.

REFERENCES

1. Takanori Igarashi, Ko Nishino and Shree K. Nayar. (2007). The Appearance of Human Skin: A Survey. Foundation and Trend in Computer Graphic and vision, 3(1), 1-95.
2. Weatherall IL and Coombs BD. (1992). Skin color measurements in terms of CIELAB color space values. J Invest Dermatol, 99, 468–473.
3. In Sik Yun, Won Jai Lee, Dong Kyun Rah, Yong Oock Kim and Be-young Yun Park. (2010). Skin color analysis using a spectrophotometer in Asians. *Skin Research and Technology*, 16, 311-315.
4. F. J. Ruiz, Nuria Agell, Cecilio Angulo and Monica Sanchez. (2012). A qualitative learning system for human sensory abilities in adjustment tasks. Conference: 26th International workshop on qualitative reasoning, California, United States of America.
5. Stucker M, Steinberg J, Memmel U et al. (2001). Differences in the two-dimensionally measured laser Doppler flow at different skin localisations. Skin Pharmacology and Applied Skin Physiology, 14, 44-51.

EFFECT OF LIGHTING ON LIPSTICK TEXTURE FOR ADVERTISING PHOTOGRAPHY

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Keywords: Lipstick, Texture of lipstick, Lighting, Hard light, Soft light

ABSTRACT

The purpose of this study was to investigate the effect of lighting on lipstick texture in advertising photographs. The approach involves photographing four varieties of lipstick using soft and hard light: Lip Gloss, Tinted Balm, Matte Powder, and Liquid Lipstick. The researcher set the lipstick color to orange and red and set the picture size to close up (CU) and extreme close up (ECU). The photographs were given to thirty subjects, who were then asked to classify lipstick using a questionnaire. The finding showed that the influence of light has a little effect on different lipstick textures. The texture of lipstick may be seen more clearly in hard light than in soft light. The distinction between soft and hard light has no effect on lipstick classification. The accurate lipstick classification is influenced more by soft light than by hard light.

INTRODUCTION

Lipstick is a well-known and extensively used product. Customers may be perplexed when they view the image of the lipstick advertising since the lipstick has a range of textures and personalities. Because advertising pictures are crucial in influencing consumers' purchase decisions, photographers must consider the authenticity of the lipstick's texture when photographing the advertising.

When photography advertisements, lighting is important in order to correctly depict the texture of the lipstick. Photographers must use lighting that complements the textures. Depending on the light quality, the image will be influenced differently. Soft light, for example, will provide the sense of soft light with low contrast between dark and light, whereas hard light will give the impression of harsh light with strong contrast between dark and light. Soft and hard light, as well as differences in light and shadow, have an effect on the reflection of various object surfaces. Soft light has a less influence on object reflection than hard light. For example, if we want to photograph a luster item, we will see more reflections and less shine if we use soft light rather than hard light.

METHOD

The researchers used soft and hard light to photograph four different types of lipsticks in this study: Lip Gloss, Tinted Balm, Matte Powder, and Liquid. The researchers then used a questionnaire to analyze the photos in order to determine if the subjects could classify the lipstick. The following approaches were utilized by the researchers:

1. Set two types of light: Hard light with mono flash and standard reflector, soft light with mono flash, standard reflector and diffuser.

Figure 1. Example of the lighting for photography

2. Set four types of lipsticks: Matte Powder, Liquid Lipstick, Lip Gloss and Tinted Balm.

3. Set the color of lipstick from two popular colors which were red and orange.

4. Close-up (CU) and extreme close up (ECU) picture sizes were chosen from a survey of popular image sizes used in lipstick advertising.

5. The photos were presented to thirty subjects who are familiar with the sort of lipstick and have purchased it online. The subjects saw the pictures on a 10.9-inch Apple iPad Air screen in white light before answering the questionnaire using the methods below.

5.1 Place two example photos of the same lipstick type, color, and size, one shot with soft light and the other with hard light, side by side. The subjects selected the photograph that showed the texture of lipstick more clearly.

5.2 Bring the sample photos to the subjects and have them look at them one by one. The subjects were then asked to select a lipstick from four options: Matte Powder, Liquid Lipstick, Lip Gloss and Tinted Balm.

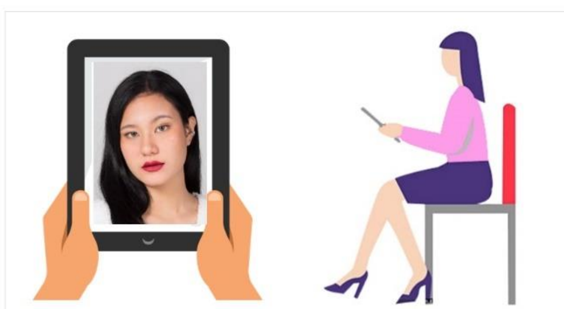

Figure 2. Scenario of the data collection method

Examples of photographs for lipstick advertising used in the study

Figure 3. Example of the orange lipstick photo, Close Up (CU)

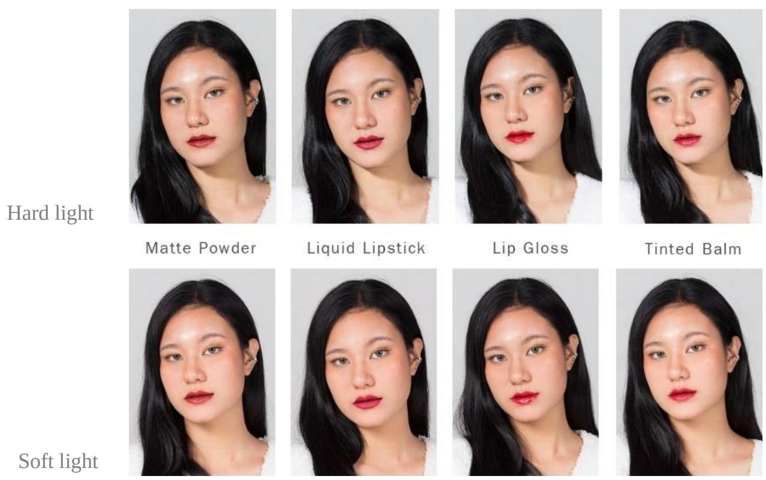

Figure 4. Example of the red lipstick photo, Close Up (CU)

Figure 5. Example of the orange lipstick photo, Extreme Close Up (ECU)

Figure 6. Example of the red lipstick photo, Extreme Close Up (ECU)

RESULT

The result of the study of effect of lighting on lipstick texture for advertising photography was as the following.

1. Result of the study of clarity of showing the texture of lipstick was shown as Figure 7.

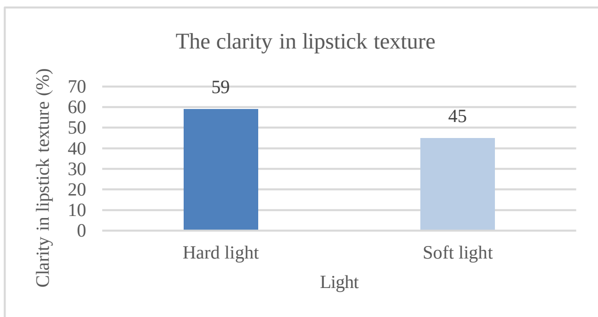

Figure 7. Shows results of clarity in lipstick texture

Hard light, according to the chart, may reveal 59 percent of the texture of the lipstick. Soft lighting may reveal 45 percent of the texture of a lipstick. As a result, hard light might reveal more lipstick texture than soft light. This might be because hard light accentuates the contrast between light and shadow, and the reflections of the subject texture are more prominent than soft light. It clarifies the texture of lipstick better than soft light.

2. Result of the study on the accuracy of lipstick classification

2.1 The accuracy of the lipstick classification by the difference of lighting was shown as Figure 8.

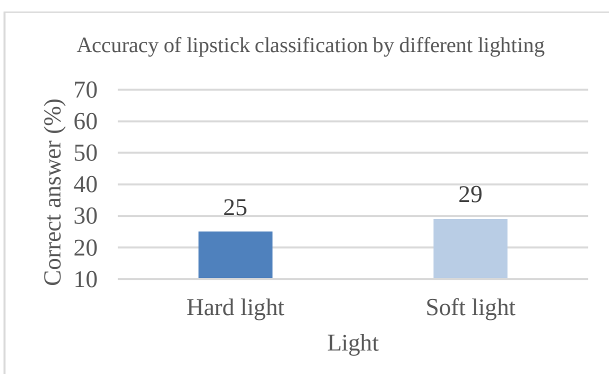

Figure 8. Shows results of accuracy of lipstick classification by different lighting

According to the chart, soft light had a 29 percent effect on lipstick classification accuracy while hard light had a 25 percent effect. The difference between soft and hard light has no influence on lipstick classification accuracy. Soft light has a bigger effect on lipstick classification accuracy than hard light.

2.2 The accuracy of the lipstick classification by the color difference was shown as Figure 9.

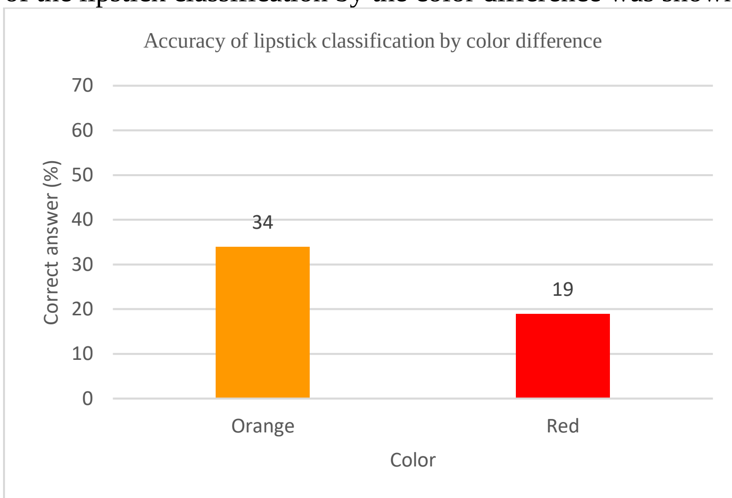

Figure 9. Shows results accuracy of lipstick classification by color difference

According to the chart, orange represented lipstick type accuracy of 34 percent, while red represented lipstick type accuracy of 19 percent. It is possible to conclude that orange indicates lipstick type accuracy more than red. This might be because red has a higher color intensity than orange, resulting in distinct reflections and a different perception of the lipstick texture.

2.3 The accuracy of the lipstick classification by the image size was shown as Figure 10.

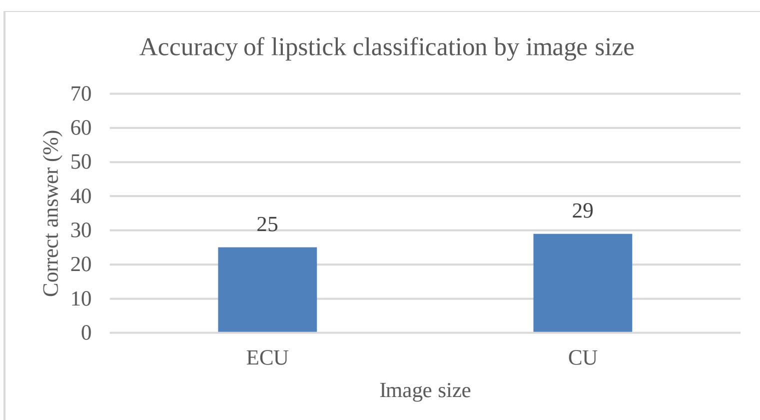

Figure 10. Shows results of accuracy of lipstick classification by image size

According to the chart, a close-up (CU) image had a 29 percent accuracy in lipstick classification, while an Extreme Close Up (ECU) image had a 25 percent. Differences in picture size can have a little impact on the accuracy of lipstick classification. The close-up can reveal considerably more about the accuracy of lipstick classification than the extreme close-up.

2.4 The accuracy of the lipstick classification by the texture of lipstick was shown as Figure 11.

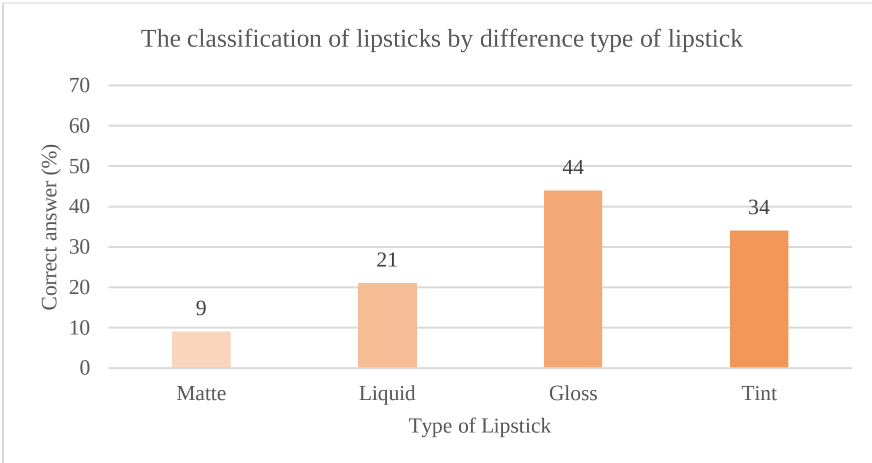

Figure 11. Shows results accuracy of lipstick by texture of lipstick

According to the chart, lip gloss was the most preferred lipstick texture, accounting for 44 percent, followed by tinted balm 34 percent, liquid lipstick 21 percent, and matted powder 9 percent. This might be due to the fact that lip gloss has a distinct glossy texture that distinguishes it from other types of lipsticks. This allows subjects to quickly classify the types of lipsticks. Matte powder lipsticks have the least texture, likely because they have a texture similar to liquid lipsticks, making it difficult for subjects to classify lipsticks

CONCLUSION

The findings of this study were separated into two categories: the clear texture of lipsticks and the accuracy of lipstick type. The research reveals that the lighting used in lipstick advertisement photography has minimal effect on the texture of lipstick when photos of the same size, color, and kind of lipstick are taken. However, with the varied lighting circumstances, soft light and hard light, there was a little difference between the two to highlight the clearer texture of the lipsticks. When the subjects saw the photos one by one and chose the type of lipsticks, they did it more properly with the soft light. There was, however, a minor variation between these two lightings. The explanation for the minor difference might be that the lips are generally matte. When a thin coating of lipstick is applied to the lips, the texture of the lipstick is not apparent. As a result, while photographing lipstick advertising, the difference in lighting should not be considered alone. However, additional factors must be considered, such as the direction of the light, the camera angle, or the consumer lipstick purchasing experience, among others.

ACKNOWLEDGEMENTS

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REFERENCES

1. Earnest, A. (2019). The New Lighting for Product Photography: The Digital Photographer's Step-bye-Step Guide to Sculpting with Light. New York, NY: Amherst Media.
2. Freeman, M. (2006). The Complete Guide to Light & Lighting in Digital Photography. Utah, UT: Lark Book.
3. Jarearnros, J., Srisuro, P., Phuangsuwan, C. (2019). The Influence of Background Color of Silver Jewelry Advertising on Purchasing Decision. Proceeding of the 50th Annual Meeting of the Color Science Association of Japan Conference, pp.211-213.

COLORS TO REPRESENT THAI ALTERNATIVE GENDERS

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Keywords: Alternative Gender, LGBTQ+, Representative Color

ABSTRACT

The rainbow color was commonly used to signify alternative genders, particularly in political or social movements. However, it is still debatable if the rainbow color actually represented the alternative genders. Previous research has shown that purple was more acceptable than the rainbow to be the representative color of the alternative gender. However, the previous result only identified Munsell hue of the representative color. Therefore, the objective of this study is to identify Munsell color which represents the color of the alternative genders. There were 62 alternative gender subjects and 60 non-alternative gender subjects. 198 Munsell color chips in the range of Munsell hue 10PB, 2.5P, 5P, 7.5P, 10P, 2.5RP were presented to the subjects. The subjects were asked to select the color chips which were the representative color of the alternative gender. The number of selections was no limit. The results showed that the most selected Value/Chroma was 4/12. The most selected color for the representative color was 7.5P 4/12 and 2.5P 4/12 respectively.

INTRODUCTION

Nowadays, the classification of gender identity is not limited to only “Male” and “Female”. There is a group of people who identified themselves as “Lesbian (L)”, “Gay (G)”, “Bisexual (B)”, “Transgender (T)”, “Queer (Q)” and “Other (+)”. The term “LGBTQ+” is generally used to represent these people. However, the term “LGBTQ+” is not popularly used in Thailand. People who have a variance of gender identity and variance of sexual orientation are normally called “Alternative Gender”.

The color was used to represent this gender variance in many cases. In 1933-1945, the pink triangle was used as a badge to indicate the gay prisoner in a concentration camp during the Nazi regime [1]. In 1978, a gay activist, Gilbert Baker designed a rainbow color flag as a symbol of the LGBT rights movement. [2]. Until now, the rainbow color was perceived as the representative color of the alternative gender. However, this rainbow color was originally used in social and political movements. It is still questionable whether the rainbow color is suitable to represent the alternative gender in other circumstances. In the concept of minimalist design [3], fewer color is preferable. Therefore, a solid color that can refer to the alternative gender is more useful for a designer. For example, blue or black were used for male toilet sign and pink or red were used for female toilet sign. This standard color code has been already implemented in Japan and will be implemented in other countries. However, the rainbow color for alternative gender’s toilet sign is still debatable because it is not harmonious to color design.

There was very little research that tried to investigate the representative color of the alternative gender based on our survey. Rattanakasamsuk et al. (2020) have conducted an experiment to identify the representative color of the alternative genders [4]. A rainbow color, N1, N5, N9, and 40 Munsell color chips covered all Munsell Hue were presented to 120 Thai subjects. They were asked to select color chips that referred to the alternative gender. The result showed the rainbow color was a candidate for the representative color of alternative gender as expected. However, only one of 60 alternative gender subjects selected the rainbow color as the representative color of the alternative gender. Although the rainbow color flag has been used as the symbol of the alternative gender movement, Thai alternative gender subjects did not agree to use it as their representative color. Apart from the rainbow color, more than 50% of selected color chips were in the purple region. It is indicated that purple was more acceptable as the representative hue of the alternative gender by both alternative and non-alternative gender subjects. There were six Munsell hues (i.e., 10PB, 2.5P, 5P, 7.5P, 10P, 2.5RP) that were selected by more than 10% of the subjects.

In this research, we conducted an experiment to identified Munsell color of the representative color of the alternative gender. The stimuli were Munsell color chips in the region of purple covered from 10PB to 2.5RP. Sixty-two alternative gender subjects and sixty non-alternative gender subjects were asked to specify color chips which are represented the alternative gender.

METHODOLOGY

Stimuli

The stimuli were Munsell color chart of 10PB, 2.5P, 5P, 7.5P, 10P, 2.5RP as shown in Figure 1. The total number of the color chip was 198 color chips. Each color chip subtended two degrees of visual angle.

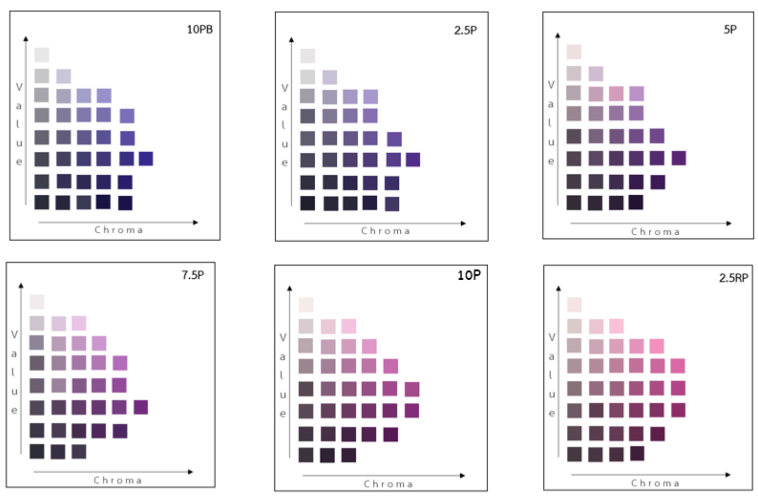

Figure 1. Schematic diagram of the stimuli.

(Note: color might not present the exact color appearance to subjects)

Subject

The subjects were 120 university students who volunteered to participate in this experiment. All subjects had a normal color vision. 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 62 subjects who did not identify themselves as "Male" or "Female". They identified themselves as, "Alternative Gender". In the 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 "Kratoey (Thai word means a man who wants to be a woman)". The subject's gender identity was shown in Table 1.

Table 1. Gender identity of the subjects

Gender Identity	Number
Non Alternative Gender	60
Male	30
Female	30
Alternative Gender	62
Lesbian	13
Gay	14
Bisexual	12
Transgender	8
Tomboy	11
Kratoey	4
Total	122

Experimental Procedure

The wall of the experimental room was covered by white wallpaper. There was a table covered with gray paper inside the experimental room. The room illuminance measured at the table was 1200 lux. The stimuli were presented by placing the Munsell color charts on the table. The Munsell chart was arranged to be 2 rows and 3 columns as shown in Figure 1. The position of each chart was random for each subject. Before starting the experiment, the subjects had to sit inside the experimental room for at least two minutes. After two minutes of adaptation, the stimuli were presented to the subjects. The subjects were asked to select the color chips which referred to the alternative gender. The subjects could select the color chips as many as they wanted.

RESULTS AND DISCUSSIONS

Figure 2 showed the results of the representative color of the alternative gender. Each panel represented the result of each hue. The abscissa represented the Munsell chroma and the ordinate represented the Munsell Value. Each circle represented the selected Munsell color of the representative color of the alternative gender. The size of the circle represented the number of the selected color. As described in the introduction part, purple was accepted as the representative hue of the alternative gender. In this result, most of the selected Munsell colors representative of the alternative gender were the high chroma color. Figure 3 showed the top five selected Munsell colors which were 7.5P4/12 followed by 2.5P 4/12, 7.5P 5/10, 7.5P 3/10, 5P 7/8 respectively. Note that the appearance of the Munsell colors in Figure 3 were simulated based on the Munsell Renotation Data [5,6]. Their color appearance might not be the exact color appearance of these Munsell colors chips. These five Munsell colors would be named "Purple" or "Violet" or "Lavender" in English. But in the Thai language, these five Munsell color chips would be named "Muang" which covered the appearance of "Purple", "Violet" and "Lavender". [7,8]

Figure 4 showed the selected Munsell color categorized by Value/Chroma. The size of the circle represented the number of the selected Munsell color. Regardless of Munsell hue, the highest selection Munsell Value/Chroma was 4/12 followed by 5/10, 3/10 and 4/10 respectively. These Munsell value/chroma covered more than 75% of the color which were selected to be the representative color of the alternative gender. We also asked the subjects for the reason for their selection. Most of them answered that they had experienced the linkage between purple or violet or lavender and the alternative gender. In Thailand, before the word "LGBTQ+" was used, "Chao-See-Muang" which means "purple people" was popularly used to call the alternative gender. Therefore, the color chips in the range of high chroma (10-12) which clearly appeared "Muang" would be selected to be the representative color of the alternative gender.

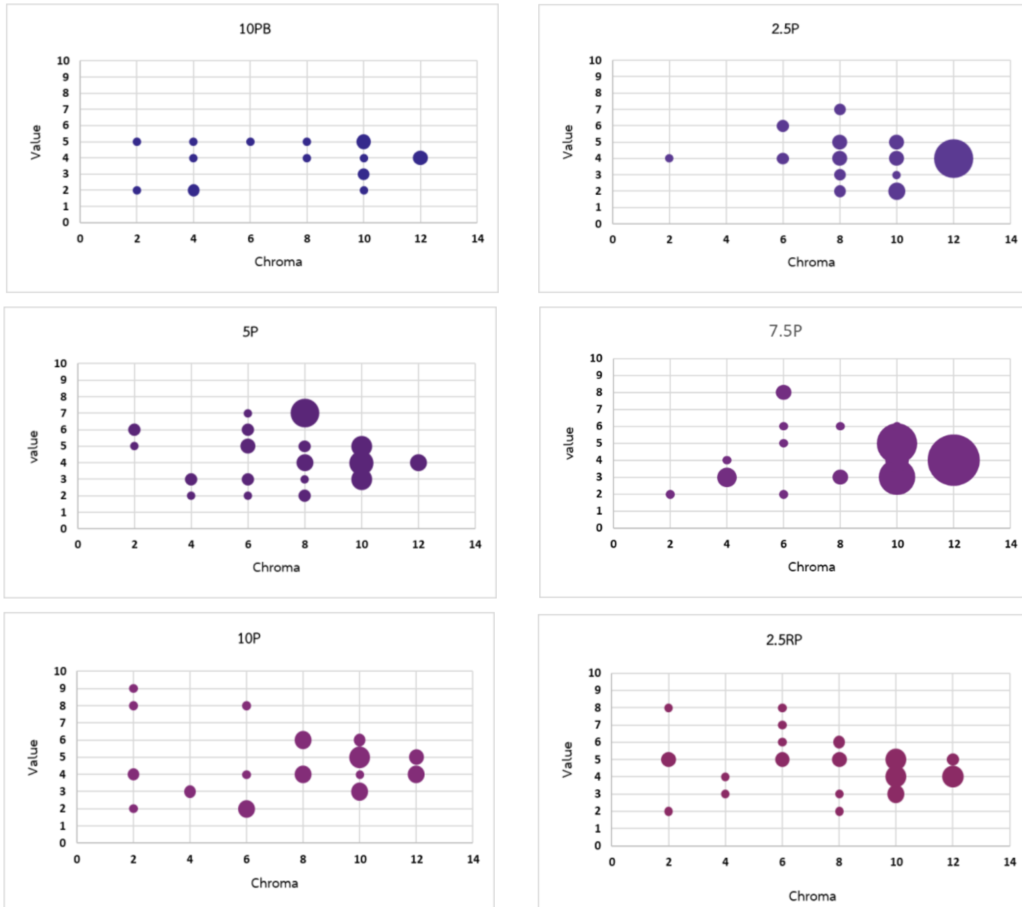

Figure 2. Selected Munsell color of the alternative gender. Size of circle represents number of selections.

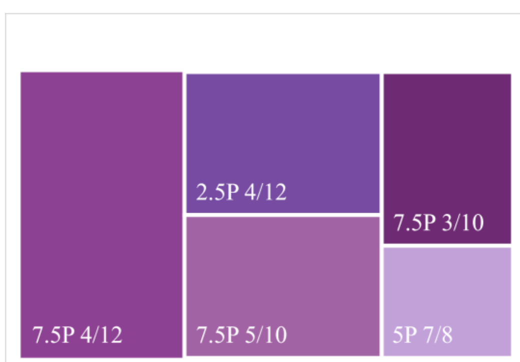

Figure 3. Top five representative color of the alternative gender by all subjects.
(Note: color might not present the exact color appearance to subjects)

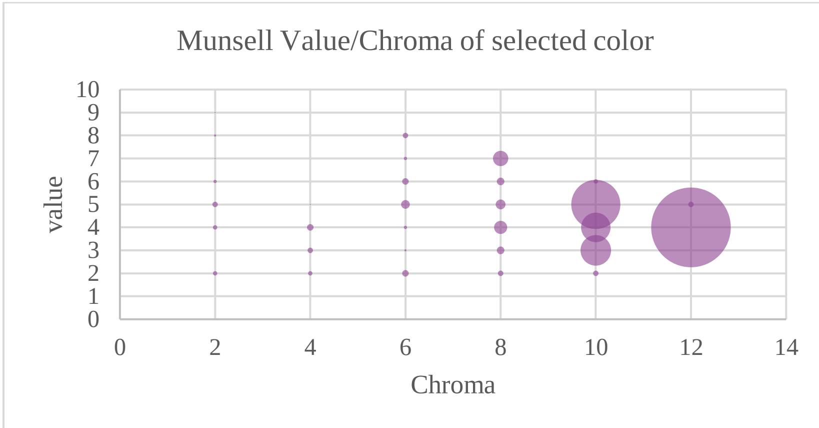

Figure 4. The selected color of the alternative gender categorized by chroma/value.

Comparison of the top five selected Munsell colors of the representative color of the alternative gender between the alternative gender subjects and the non-alternative gender subjects were shown in Figure 5. The area of each color represented the number of selections. 7.5P 4/12 was the largest number of the selected color by the alternative gender subjects followed by 7.5P 510, 7.5P3/10, 5P 7/8 and 7.5P 4/10, respectively. For the non-alternative gender subjects, 2.5P 4/12 was the largest number of the selected color followed by 7.5P 4/12, 7.5P 3/10, 7.5P 5/10 and 7.5P 4/10. Even though the number of 2.5P4/12 selection was largest for the non-alternative gender subject, the alternative gender subjects tended to be not interested in 2.5P 4/12. Its number of selections was very low.

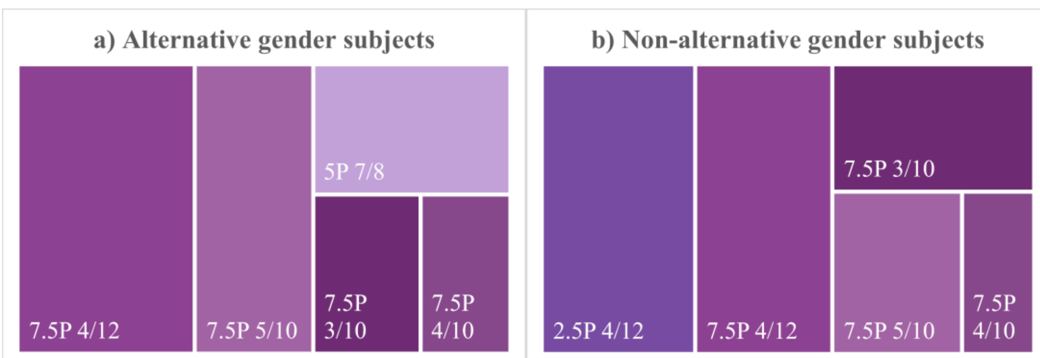

Figure 5. Top five representative color of the alternative gender by a) alternative gender subjects and b) non-alternative gender subjects.

(Note: color might not present the exact color appearance to subjects)

From the subject's interview, several alternative gender subjects reported that 2.5P 4/12 were too bluish. When we asked some alternative gender subjects to do categorical color naming for 2.5P 4/12, some of them did not categorize 2.5P4/12 into "Purple" but categorized it into "Blue". An interesting result was also found for the alternative gender subjects. Regardless of their sex (physical characteristics at birth), 2.5P 4/12 was not selected by any of the alternative gender subjects who distinctly expressed the feminine characteristics (Transgender, Kratoey). We still questioned that these two aspects would associate with the discard of 2.5P 4/12 by the alternative gender subjects or not. Previous research has shown that there was the existence of sex differences in color preference. [9, 10] Female preferred reddish or pinkish color to bluish color. In this research, the feminine characteristic alternative gender subjects might prefer reddish purple to bluish purple. However, there was a lack of evidence to support this assumption because the tendency to discard 2.5P 4/12 did not clearly exist in the case of female subjects.

CONCLUSION

In this research, Munsell color of the representative color of the alternative gender was identified. The results showed that the most selected Value/Chroma was 4/12. The most selected Munsell color was 7.5P 4/12 followed by 2.5P 4/12, 7.5P 5/10, 7.5P 3/10 respectively. There was a slight difference in the results obtained by the alternative and non-alternative gender subjects. 2.5P 4/12 was mostly selected by the non-alternative gender subjects but the alternative gender subjects rarely selected this color. Therefore, this research indicated that the representative color of the alternative gender was 7.5 P4/12. Other candidates for the representative color of the alternative gender (i.e., 7.5P 5/10 and 7.5P 3/10) also can be used to create a color palette for product design for the alternative gender.

ACKNOWLEDGEMENT

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REFERENCES

1. Waxman, O. B. (2018). How Nazi Pink Triangles Symbol Was Reclaimed for LGBT Pride. Retrieved from https://time.com/5295476/gay-pride-pink-triangle-history/
2. 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/
3. Obendorf, H. (2009). Minimalism, Simplicity and Rule of Design. In Minimalism: Designing simplicity., Springer.
4. Rattanakasamsuk, K., Nontawongsa, C., Srisuro, P. and Phuangsuwan, C. (2020) Does Rainbow Color Truly Represent Alternative Gender? Journal of the Color Science Association of Japan, 44 (3+), 27-28.
5. Newhall, S.M., Nickerson, D., & Judd, D.B. (1943). Final Report of the O.S.A. Subcommittee on the Spacing of the Munsell Colors. Journal of the Optical Society of America, 33, 385-418.
6. Munsell Color Science Lab. (n.d.). Munsell Renotation Data. Retrieved October 12, 2019, from https://www.rit.edu/cos/colorscience/rc_munsell_renotation.php.
7. 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, 29 November - 2 December 2019, Nagoya, Japan, 164-169.
8. Panitanang, N., Phuangsuwan, C., and Ikeda, M. (2019). Thai Color Names in Different Regions of Thailand. Journal of the Color Science Association of Japan, 43(3+), 86-89.
9. 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
10. 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

Color Constancy Assessed by the Elementary Color Naming under RGB-LEDs

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Abstract

Nowadays, Light-emitting diodes (LED) have become wide using lighting instead of a fluorescent lamp which has various benefits such as multi-color generation. In this experiment, 23 chromatic color chips and three achromatic chips were assessed by 100 participants inside a booth decorated like an actual living situation. The booth was lit by only RGB-LED light, which thirteen illumination conditions, including white light as D65. The other colors were red, yellow, green, cyan, blue, and magenta. Each subject judged each color chip by the elementary color-naming method, which required a percentage of chromaticness, whiteness, and blackness. Then, the observer had to assess a portion of color depending on the opponent's color theory as red, yellow, green, and blue, in which red and green cannot be observed and judged together and vice versa. Our result showed area ratio, which is color area perception under test light condition compared to area perception under D65, and color constancy had a similar agreement that cyan, yellow, and green illumination was not recommended to use in the case of poor color constancy when increasing a saturation light.

Keywords: color constancy, LED, elementary color naming

Introduction

There are three factors in human vision, the spectral power distribution of the light source, the spectral reflectance of an object, and the spectral sensitivity of human perception. Human has the ability to stably perceive the same object regardless of colored illuminations. This phenomenon is called color constancy. For example, a white object seen under white light would be perceived as white under another light.

Color constancy index or CCI was a measurement to study the performance of chromatic adaptation under a test illumination. It was ranged from 0 to 1 as poor color constancy to perfect color constancy. Typically, CCI was studied by matching and achromatic setting methodology. The tasks were based on physical color space, such as a chromaticity diagram. Also, the adjustment setting was not a natural task as we do in daily life. Another method was color naming which is a familiar step as we usually call the object's color name. Categorical color naming (Ma, R., Liao, N., Yan, P., & Shinomori, K. 2018, Troost, J. M., & De Weert, C. M. 1991) is the method that requires a participant to call the color generally based on eleven basic color naming. The color constancy could be obtained by averaged and calculated based on the centroid of the color category within the same color name. The problem was a limitation of this method. The color naming mandatory forces a participant to name a stimulus with hesitation.

Nowadays, Light-emitting diodes or LEDs is dominated the fluorescent lamp with various benefits such as less energy consumption and generating numerous color light. In the case of changing illuminant spectral power distribution, the color perception is also affected. However, there was little research about color appearance under LEDs light.

In this study, twenty-six color chips were perceived and judged by 100 participants under thirteen illumination conditions with an elementary color-naming method (Ikeda, M. 2004, Phuangsuwan, C., Ikeda, M., & Mepean, J. 2018, Pungrassamee, P., Ikeda, M., Katemake, P., & Hansuebsai, A. 2005). This naming method was absolute judgment and allowed researchers to figure out the color appearance of objects based on the perception of color space as a quantitative measurement.

Experiment

Two experiments were designed to obtain both color appearance of the color chip with and without adapted to color light. Figure 1 shows the apparatus for experment1. The booth was designed and decorated like an actual living condition. A grey rectangular on the table acted as a background with a color chip (6 cm square) will be placed on it. The boom was illuminated by LEDs hanging on the left ceiling of this room. The light could only be controlled by the computer connected through cable wire outside the room. Figure 2 shows the experimental booth used to obtain the stimuli's color appearance without adapting to the test light condition. The booth was extended and divided into the test room and the subject room. The test room was the same as experiment 1, except the color chip will be placed on the standing pole instead of the table. On the other hand, the subject had to move to the subject room, which was illuminated by only white reference light, D65. The participant could see the stimulus through a small hole between these rooms.

Figure 1 Apparatus for experiment 1

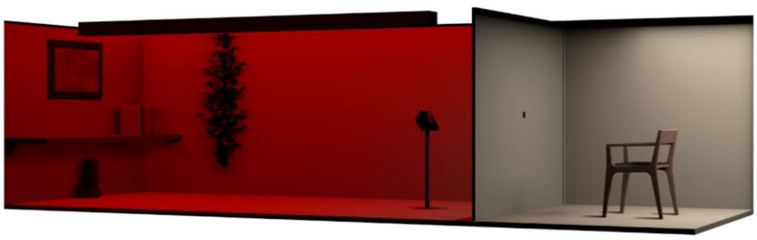

Figure 2 Apparatus for experiment 2

There were twenty-six color chips used in this experiment, as shown in Table 1. The color chips were designed based on three groups. The first was the 15 test color sample used to study and calculate the color rendering index. The second was a gamut of the printer, Konica Minolta C83HC, which we used to reproduce these stimuli. There were eight-color chips in the second group. There were three color chips: neutral, white, and black, classified as an achromatic group for the last one.

Table 1 Color chips

Chip No.	Hue (°)	Luminance (cd/m^2)	a*	b*	Type
01	16	5.39	61.49	17.93	TCS
02	21	9.08	18.84	7.22	TCS
03	33	10.25	17.6	11.39	TCS
04	45	9.18	43.02	43.74	Gamut
05	53	15.99	13.83	18.17	TCS
06	83	8.21	3.35	28.88	TCS
07	88	16.83	3.03	71.75	TCS
08	88	9.06	2.57	70.28	Gamut
09	109	9.83	-16.74	48.3	TCS
10	113	4.18	-11.86	27.61	TCS
11	133	9.61	-52.95	56.13	Gamut
12	140	8.55	-30.8	25.56	TCS
13	148	5.38	-39.93	24.79	TCS
14	179	9.33	-56.05	1.28	Gamut
15	185	8.72	-19.63	-1.8	TCS
16	220	9.9	-37.67	-31.69	Gamut
17	258	4.02	-9.09	-44.09	TCS
18	259	8.67	-5.45	-27.05	TCS
19	270	7.87	-0.12	-36.67	Gamut
20	298	8.81	16.44	-31.35	TCS
21	319	7.45	40.9	-35.81	Gamut
22	319	1.46	12.62	-10.96	TCS
23	356	8.25	60.61	-4.75	Gamut
B	337	0.75	0.59	-0.25	Achromatic
N	237	5.59	-16.2	-2.55	Achromatic
W	247	23.02	-2.11	-5.16	Achromatic

There were 13 illuminations shown in Table 2, including the white light as D65. There were six hues, red, yellow, green, cyan, blue, and magenta. The light conditions could be divided into less vivid light and vivid light. The illumination of each situation generally varied between 95 – 101 lx except B2 as a limited of LEDs (Phillips: Kinetics color cover MX power core) used in this experiment. For B2, the illumination was 80 lx.

Table 2 Illumination Conditions

Illuminations	u'	v'	Illuminant (lx)
D65	0.200	0.466	100.9
R1	0.369	0.492	97.9
R2	0.538	0.518	99.1
Y1	0.253	0.506	98.6
Y2	0.307	0.546	97.1
G1	0.138	0.520	99.4
G2	0.075	0.575	98.5
C1	0.154	0.423	100.6
C2	0.108	0.381	101.0
B1	0.170	0.326	95.2
B2	0.140	0.187	80.6
M1	0.270	0.409	98.6
M2	0.339	0.352	97.2

One hundred participants, who were students from the Rajamangala University of Technology Thanyaburi, assessed these color chips by using the elementary color-naming method. Each participant gave an amount percentage of chromaticness, whiteness, and blackness for each set. Then, another amount of the opponent's color theory was judged as red, yellow, green, and blue.

Result

The result obtained by the naming method could be transferred and plotted on a graph called a polar diagram. The result showed that the color perception area of the less vivid light group was less than the saturated group. The color constancy index could be calculated based on the distance between perception and physical shifts, as shown in Equation 1. In the equation, the 'a' symbol was a perception based on the distance between color naming results under D65 to test illumination. The 'b' symbol was a physical shift judged by experiment 2 under test illumination away from D65.

$$CCI = 1 - \frac{a}{b} \tag{1}$$

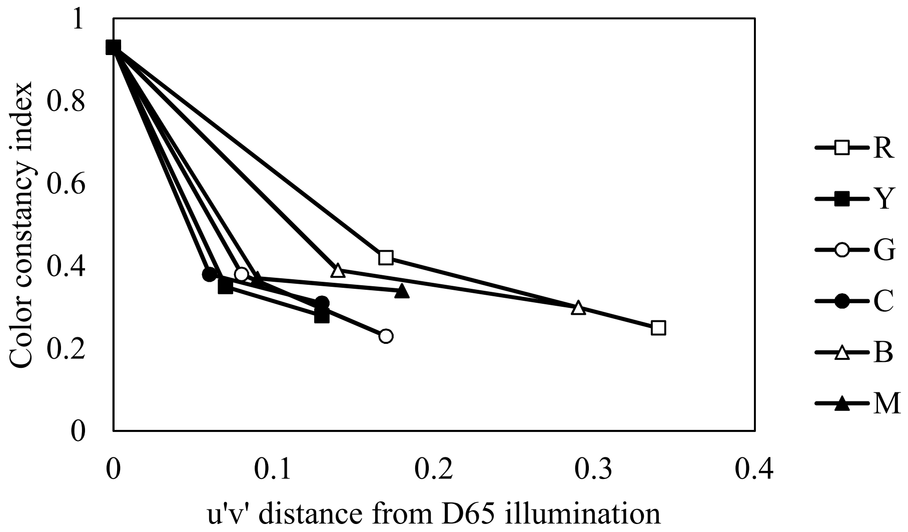

Figure 3 Color constancy index result

The result of calculating color constancy is shown in Figure 3. The graph clearly shows that the color constancy index was poor when increasing light saturation as u'v' distance away from D65 on the abscissa. Especially, the color constancy index was dropped early under cyan, green, and yellow illumination. Our results suggested avoiding these lights in the case of vivid illumination requirements.

References

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

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

Phuangsuwan, C., Ikeda, M., & Mepean, J. (2018). Color appearance of afterimages compared to the chromatic adaptation to illumination. *Color Research & Application. 43*(3), 349-357. doi:10.1002/col.22207

Pungrassamee, P., Ikeda, M., Katemake, P., & Hansuebsai, A. (2005). Color appearance determined by recognition of Space. *Optical Review. 12*(3), 211-218. doi:10.1007/s10043-005-0211-y

Troost, J. M., & De Weert, C. M. (1991). Naming versus matching in color constancy. *Perception & Psychophysics. 50*(6), 591-602. doi:10.3758/bf03207545

Simultaneous Color Contrast on an Electronic Display with or without a Tissue Paper under Various Room Illuminances

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Abstract

A well-known phenomenon to show the chromatic adaptation is the simultaneous color contrast or SCC. The subject perceives an opponent or complementary color of surrounding on the achromatic test patch placed at the center. In case of an object stimulus such as a printed paper, the color of the test patch does not appear vivid, but it appears more vivid if the stimulus is covered entirely by a tissue paper. The phenomenon is explained in a way that the tissue blurs the contour of the test patch to reduce the object recognition of the stimulus and only the color remains in the surround to give a stronger chromatic adaptation. In this paper, we investigate if the tissue paper still works for an electronic display which is a self-luminous display. Ten levels of room illumination from 3 to 1600 lx were employed. Four colors, red, yellow, green, and blue were used for surround, and one gray for central test patch. The luminance was kept constant at 46, 128, 88, 15 cd/m2 for the surround and 41 cd/m2 for the test patch. Subjects judged color appearance of the test patch by the elementary color naming method with and without a tissue paper. The results showed that the ratio of chromaticness of test patch to the chromaticness of surround stayed constant for all the illuminance levels without-tissue but it increased at 200 lx and beyond.

Keywords: Simultaneous color contrast, Electronic display, Room illuminance, Tissue paper

Introduction

The simultaneous color contrast or SCC is the phenomenon to show mechanism of the chromatic adaptation to the surrounding color, a gray test patch at the center under red surrounding was appeared cyan, for example. In the case of paper stimulus, the phenomenon is not strong and the central gray test patch is not vivid, but if the SCC stimulus is covered by a white tissue the SCC effect is much enhanced and the central gray test patch appears more vivid in color because the physical effect of a tissue is to blur the image and to reflect the white ceiling light toward a subject reducing the contrast of the image and desaturating color of the image on the surface of stimulus (Graham, H. C., & Brown, L. J. 1965) we can explain by the recognized visual space of illumination RVSI theory (Ikeda, M. 2004) that a subject adapts to the color of illumination of a space constructed over the surrounding surface. (Phuangsuwan, C., & Ikeda, M. 2017, Phuangsuwan, C., Ikeda, M., & Mepean, J. 2018) So far, many studies use an electronic display for presenting stimulus because an electronic display is self-luminous which gives a stronger adaptation. However, the experiments are mostly performed in a dimly illuminated room to avoid the effect of reflections of the room illumination on the surface of display. In this paper we are interested to investigate if this tissue effect occurs in an electric display, by changing display luminance and room illuminance.

Experiment

Four surrounding colors; red, yellow, green, and blue were employed including the central gray patch. To obtain effect of room illumination, the illuminance in the room was changed at ten levels, 3, 6, 13, 25, 50, 100, 200, 400, 800, and 1600 lx on the display by using ceiling fluorescent lamp. Their xy chromaticities of stimuli under levels of illumination are shown in Figure 1 for without-tissue (a) and for with-tissue (b).

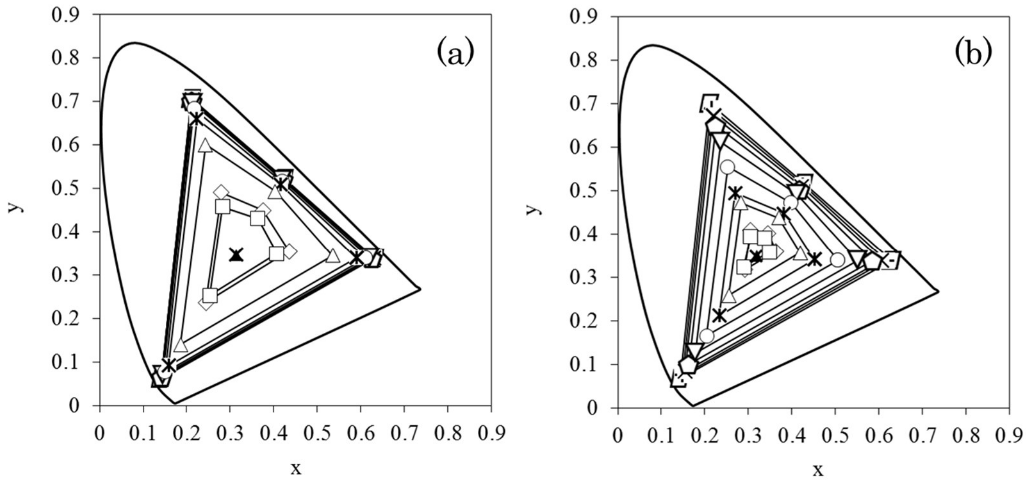

Figure 1 The surrounding colors under ten levels of illuminance without-tissue (a), with-tissue (b) (☐ 3 lx, + 6 lx, ✕13 lx, ⬠ 25 lx,▽ 50, ○ 100 lx, ✱ 200 lx, △ 400 lx, ◇ 800 lx, ☐ 1600 lx, ▲ white point, and ✕ central gray patch.

A 24.1″ LCD display (EIZO monitor) was used to present the SCC stimulus. The display was placed horizontally on a table and was masked with black paper which a rectangular hole in the middle. The size of the surround was 23x23 cm^2 and the gray patch was 3x3 cm^2, from the distance 50 centimeter of observation was gives 25.9° and 3.4° of visual angle, respectively. In with-tissue condition we use the one sheet of white tissue stretched flat on the frame to cover the stimulus, the size of the tissue within the frame was 13x14 cm^2. The haze value was 80 % and the transmittance was constant at 56 % for visible wavelength.

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

Results and Discussion

We averaged the results of color perception of four surrounds for ten subjects and showed the result in Figure 2 and 3 open circles for the with-tissue and filled circles for the without-tissue. The abscissa shows the room illuminance and the ordinate the amount of chromaticness. Figure 2, the chromaticness of four surrounds it clearly decreased with tissue as the illuminance increased, but is quite constant for without tissue. Figure 3 shows the chromaticness of the test patches without-tissue and with-tissue. It shows a relatively constant and relatively similar value of chromaticness at all the illuminance levels, except the case of green surround, that the chromaticness slightly reduces as higher illuminance.

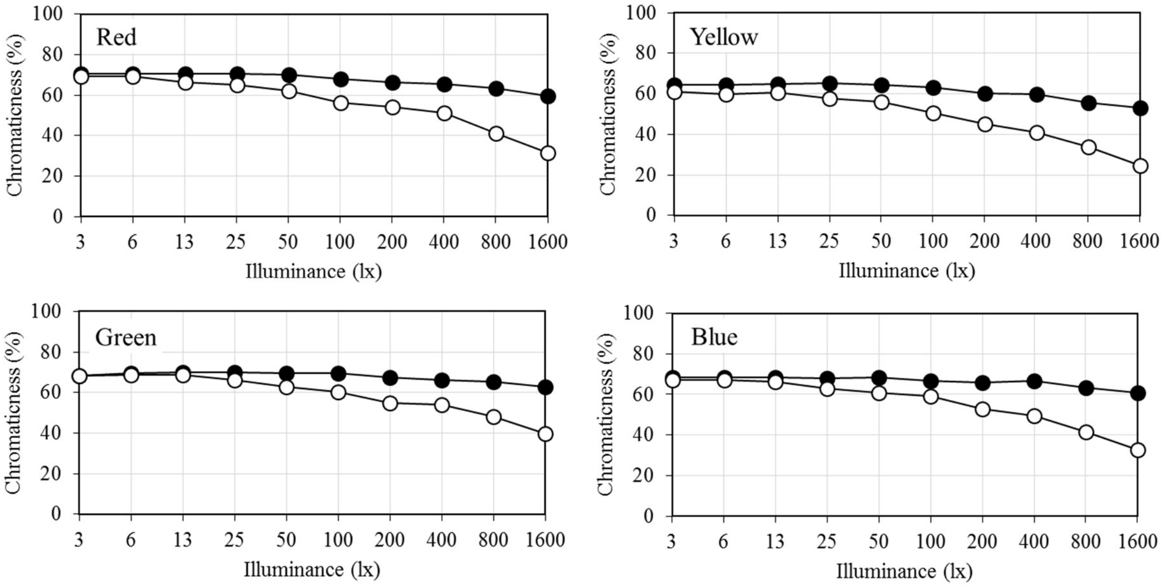

Figure 2 Amount of chromaticness of four surrounding colors with ten levels of illuminance compared between without-tissue (●) and with-tissue (○).

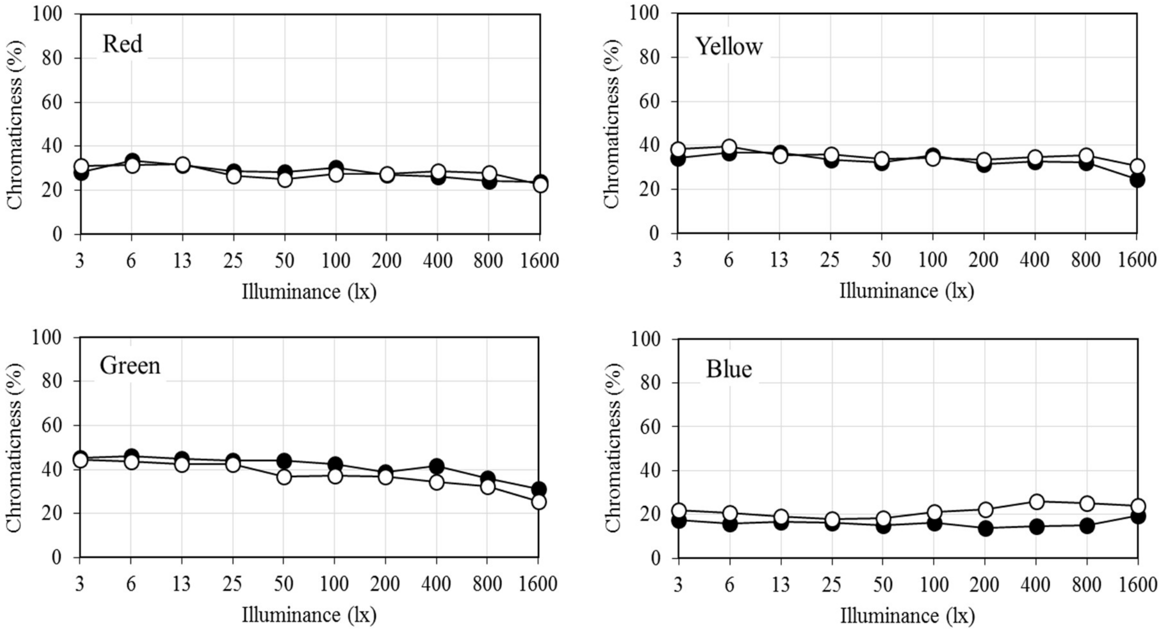

Figure 3 Amount of chromaticness of test patch in each surrounding color with ten levels of illuminance compared between without-tissue (●) and with-tissue (○).

As we are interested in the power of surround to induce color at the test patch, we took ratio of chromaticness of test patch to the chromaticness of surround as shown in Equation 1, and the results are shown in Figures 4 and 5. The abscissa shows the room illuminance and the ordinate giving the chromaticness ratio.

$$Chromaticness\ ratio = \frac{chromaticness\ of\ test\ patch}{chromaticness\ of\ surround} \qquad (1)$$

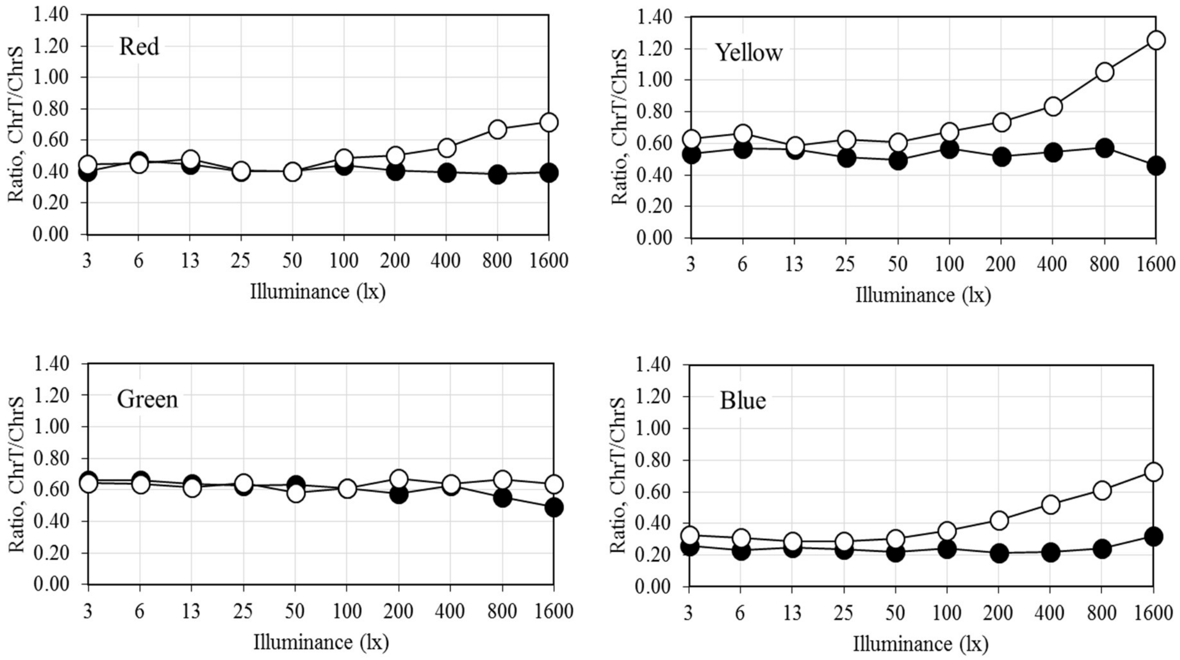

Figure 4 Chromaticness ratio of four surrounding colors with ten levels of illuminance compared between without-tissue (●) and with-tissue (○).

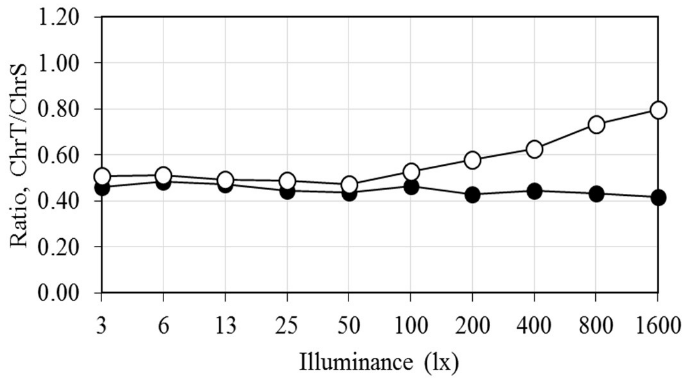

Figure 5 Averaged results from four surrounding colors compared between without-tissue (●) and with-tissue (○).

Figure 4 shows the chromaticness ratios that were obtained from Figures 2 and 3. It seems like constant under room illumination level from 3-100 lx, but increased when over 200 lx, except under green surround. Finally, their averages of all four surrounding colors are shown in Figure 5.

These results indicated that the ratio continued to increase from the illuminance 200 lx and beyond. Higher room illuminance increases the reflection of the white light from the tissue surface and the subjects seen a decreased surrounding color through the tissue paper but still perceived the appearance of simultaneous color contrast as same as without-tissue.

Acknowledgement

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References

Graham, H. C. & Brown, L. J. (1965). *Vision and visual perception: Color contrast and color appearance: Brightness constancy and color constancy*. USA: John Wiley & Sons.

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

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

Phuangsuwan, C. & Ikeda, M. & Mepean, J. (2018). Color appearance of afterimages compared to the chromatic adaptation to illumination. *Color Research and Application. 43*(3), 349–357.

Dessert Appetite Aroused by A Direction of Lighting Setup

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Abstract

Thai desserts are popular desserts in Thailand. The nature of Thai desserts shows precise and refined. Thai desserts are outstanding in taste, color, beautiful appearance and look appetite. Nowadays, the growth of business including bringing Thai desserts to sell abroad and the government sector that also encourages the consumption of more Thai desserts. Therefore, the presentation of Thai dessert media is more important. Normally, there were various factor to make photographs look interesting. In previous studies, we found that the lighting in photography is the main factor affecting the attractiveness. It's would be interesting for study using the lighting direction in dessert photography influence appetite on consumer. This study aimed to investigate a relationship between the direction of lighting and the appetite of dessert photography. In this study, Thai mung bean desserts were used as stimuli for taking a photo with different directions of lighting, consisting of a combination of four vertical elevation angles (0°, 30°, 60°, 90 degrees) and twelve horizontal side angles of food dish from 0° to 330 deg. Fifty-two participants were asked to judge their feelings on thirty-seven photographs of dessert by using an appetite scale from 1 (not looked appetizing) to 6 (looked appetizing). Expected result finding that the direction of lighting and greatly influence participants' appetizing. The results of this research can be used as a guide for the lighting set up of Thai dessert photography.

Keywords: Dessert Photography, Dessert Appetite, Lighting Setup

Introduction

Nowadays, a sharing of photography through social media, websites, and blogs becomes very popular, in particularly a food photograph [1,2]. A variety of food photographs published on cooking or restaurant website purpose to catch a customer's attention and to be appetite [3]. Many factors have an influence over customer's attention for instance an expensive ingredient, food decoration, and food composition [4]. In addition, photography techniques such as lighting setup, special effect, and camera angle are also arouse our taste sensation [5,6].

In a previous study, Kazuma et. al. [3] proposed an attractiveness prediction model for food photographs by using a machine learning system. A camera angle, an appearance of the entire food, and the appearance of the main ingredients are variables in the model. Furthermore, they also found that food photo attractiveness on customers could be affected by a lighting technique. A lighting setup not only is concerned with color temperature, but also lighting direction. Illuminants for lighting setup consist of a main light and a fill light. The main light is a primary illuminant that uses for exposing light to objects. It's located at an angle of 45° to the object. The fill light located at the opposite angle to the main light. To reduce shadows that are created from the main light and the fill light illuminance is always weaker than the key light [7]. Moreover, the direction of main light affects to direction and intensity of object's shadow. When the main light changes direction and intensity, a shadow of object could be changed. This change might affect customer's attention. This study, therefore, aimed to investigate a relationship between a lighting direction and an appetite of dessert photographs.

Methodology

Participants

Fifty-two volunteers consisted of 23 men and 29 women. Participants were age ranging from 21 to 31 years. Prior to the experiment participants were screened for color blindness using the Ishihara color test. All the participants were normal or collected to be normal eyes vision.

Stimuli

The Thai dessert fruit-shaped mung beans, Luk-Chup were taken as a stimulus (figure 1). Intensity of illuminance levels of two lighting for the main-light and fill-light were controlled, ranging 11,000 and 5,500 lux. respectively. We controlled the position of main-light move along the side of the dish and keeping a fixed position of the camera and fill-light at 0° on horizontal side angles. Luk-Chup were served on a white dish for taking a photo with different directions of lighting, consisting of a combination of four vertical elevation angles (0°, 30°, 60° and 90° deg.) and correspond to take on twelve of horizontal angles of food dish side from 0 to 330 deg. With the step of 30 deg. (0°, 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300° and 330°), respectively. With photography method, we obtained 37 dessert picture stimuli from a combination of a vertical elevation angle and a horizontal side angle.

Figure 1 Thai dessert fruit-shaped mung beans, Luk-Chup

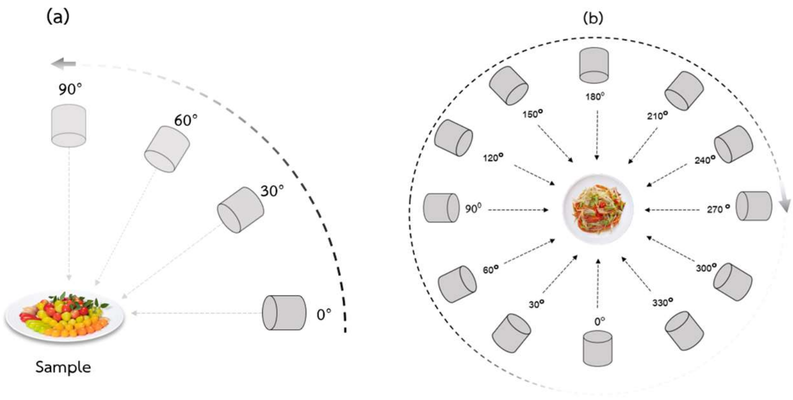

Figure 2 (a) Lighting on vertical elevation angle from 0° to 90° and (b) all position of lighting on horizontal side angles of dish from 0°, 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300° and 330°

Procedure

This study was conducted on an online questionnaire. In experiment, 37 dessert photographs were order randomly presented. Each participant was asked to rate their feeling in an appetite scale for given photography. The appetite scale was ranged from 1(extremely unappetizing) to 6 (extremely appetizing).

Result

Influences of lighting direction on horizontal side angles

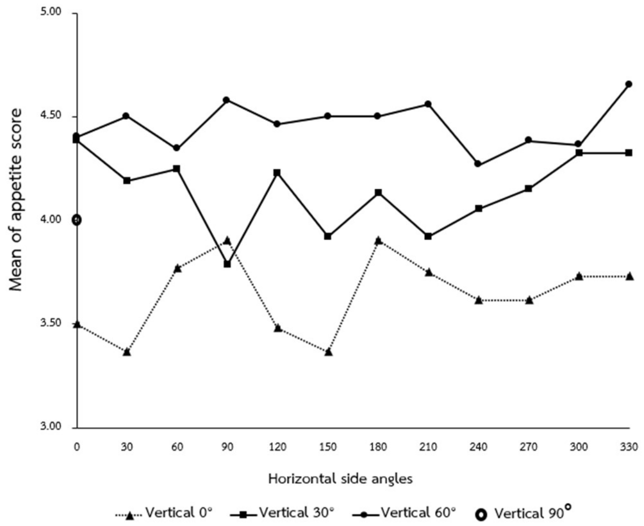

Figure 3 The difference of appetite score in each vertical elevation angles of 0°-90° classified by horizontal side angles of 0° to 330° of dessert photographs

As shown in figure 3 Data of appetite score obtained from participants were performed by means of SPSS for Window. A mean of appetite scores for dessert photography in a difference of horizontal side angles. An abscissa axis represented a horizontal side angle from 0°to 330 and vertical axis represented the mean of appetite score. In addition, vertical elevation angle 0°- 60°displayed a set of mean of appetite scores on different horizontal side angles, respectively.

Results showed that dessert photograph with vertical elevation angle 0° (▲) had the highest mean appetite score at horizontal side angles 90° ($\bar{x}$ = 3.90, SD.= 1.50) and 180° ($\bar{x}$ =3.90, SD.= 1.29) whereas photograph with the lowest mean appetite was horizontal side angles of ($\bar{x}$ =3.37, SD.=1.428) and 150° ($\bar{x}$ =3.37, SD.=1.618). For vertical elevation angles of 30° (■), the dessert photograph with the highest mean appetite score was horizontal side angle 0° ($\bar{x}$ =4.38, SD.=1.163), and the lowest mean appetite on horizontal side angle of 90° ($\bar{x}$ =3.79, SD.=1.446) vertical elevation angle (●) 60°, the dessert photograph with the highest mean appetite score was horizontal side angle 330° ($\bar{x}$ =4.65, SD.=1.090). A dessert photograph with the lowest appetite score was horizontal side angle of 240° ($\bar{x}$ =4.27, SD.=1.346). For dessert photographs taken on the vertical angle of 90° (○) with mean ($\bar{x}$ =4.0, SD.=1.557). We used One-Way ANOVA analyzed to find significant the result showed that the mean appetite of dessert photographs in horizontal side angles was not a statistically significant difference at p-value 0.05.

Influences of lighting direction on vertical elevation angles

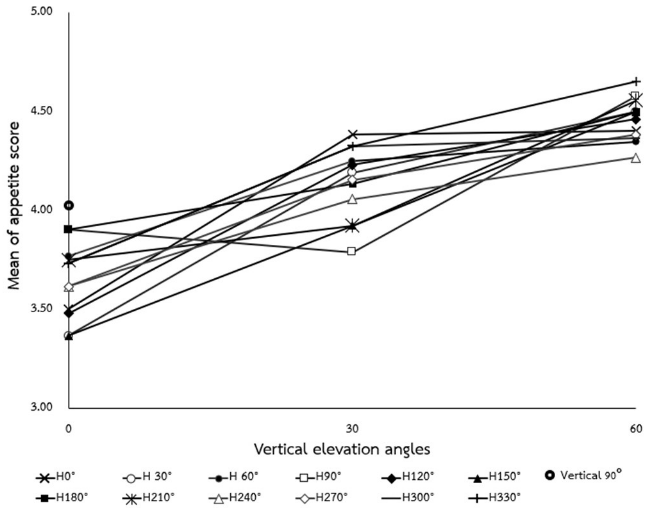

Figure 4 Comparison of mean appetite scores of food photos on vertical elevation angles

Figure 4 showed the mean appetite score of dessert photograph in each horizontal side angle from 0° to 330° classified by a vertical elevation angle 0°, 30° and 60°, where vertical axis represented the mean of appetite score and an abscissa axis represented the vertical elevation angle from 0°, 30° to 60°. For mean value of photograph with vertical elevation angles 90° was shown by an opened circle (○).

Results showed when the vertical elevation angles increase lead to the mean attractiveness of food photographs increased. For example, dessert taken under lighting at horizontal side angle 150° with vertical elevation angles 0°, 30° and 60° had mean appetite score ($\bar{x}$ = 3.37, SD.=1.633), ($\bar{x}$ = 3.92, SD.=1.426) and ($\bar{x}$ = 4.50, SD.=1.276), respectively. This result occurred in all horizontal side angle except 90°, the mean appetite decreased when the vertical elevation angle increased ($\bar{x}$ = 3.90, SD.=1.512), ($\bar{x}$ = 3.79, SD.=1.460) and ($\bar{x}$ = 4.58, SD.=1.194), With the mean increasing trend, vertical affects the appetite of dessert photography. Therefore, we tested with one-way ANOVA to find significance.

Table 1 One-way ANOVA of mean appetite score of dessert photograph in each horizontal side angles on vertical elevation angle of 0°, 30° and 60°

		H0	H30	H60	H90	H120	H150	H180	H210	H240	H270	H300	H330
df	**BG:**	3	3	3	3	3	3	3	3	3	3	3	3
	WG:	204	204	204	204	204	204	204	204	204	204	204	204
ss	**BG:**	28.091	35.82	10.51	19.17	27.47	33.66	10.65	19.03	11.59	16.30	13.94	24.97
	WG:	385.82	381.13	398.75	423.88	429.13	448.75	381.57	388.26	445.36	395.38	373.73	391.44
F		4.95	6.39	1.79	3.07	4.35	5.10	1.89	3.33	1.770	2.80	2.53	4.33
Sig.		.002*	.000**	.150	.029*	.005*	.002*	.131	.020*	.154	.041*	.058	.005*

Notes: *p<0.05, **p<0.001, H: Horizontal side angle, BG: Between Group – WG: Within Group

As shown in Table 1, the results of One-Way ANOVA of mean appetite in dessert photograph in each horizontal side angle on a vertical elevation angle of 0°, 30° and 60°. There was a statistically significant difference between vertical elevation angle and horizontal side angle with mean attractiveness score at $p<0.001$ ($F = 38.58$, $p = 0.000$).

It was found that the dessert photograph taken under vertical 60° of lighting could have the greatest impact on the appetite of dessert photography. The result indicated that increasing the height of vertical elevation angles of lighting tends to increase the attractiveness. This tendency was occurred in all condition. However, the mean of appetite was not significantly different at horizontal angles of 60°, 180°, 240° and 300° with p-value ($F = 1.79$, $p = 0.150$), ($F = 1.89$, $p =.131$), ($F =1.770$, $p =.154$) and ($F =2.53$, $p = .058$)

Discussion

Influences of lighting direction on vertical elevation angles of food dish on appetite

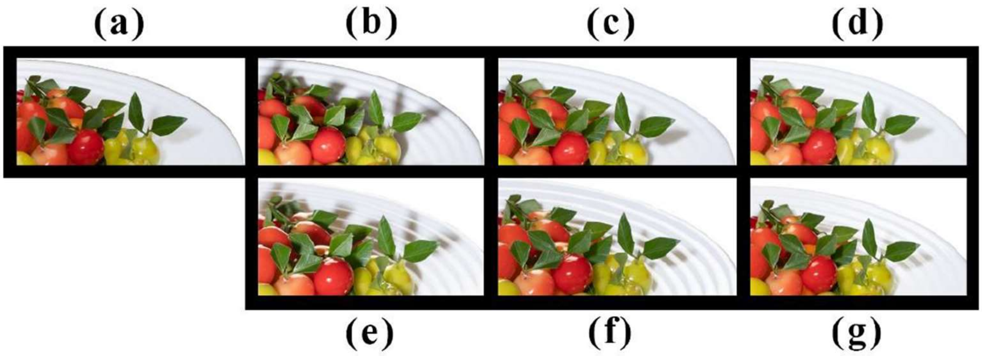

Figure 5 An example of a comparison of vertical angle food photos in shadow areas
(a) V90°, (b) V0°-H0°, (c) V30°-H0°, (d) V60°-H0°, (e) V0-H180°, (f) V30°- H180° and (g) V60°-H180°

Our finding showed that increased vertical elevation angles from 0° to 60°. This leaded to an increased feeling of appetite on dessert photography as well. The dessert photographs (b) Vertical 0°- Horizontal 0°, (c) Vertical 30°- Horizontal 0° compared with the (d) Vertical 60° - Horizontal 0° degrees. We found that the intensity of shadows in the dessert on the dish can be clearly reduced. The higher of a vertical elevation angle may provide a high illuminance level to convey a bright photograph. This result implied that the level of shadow intensity could reduce the feeling of appetite on customers.

Lighting horizontal side of dish not affected on attractiveness of food

Lighting direction of horizontal side angles does not affect to the appetite of dessert photography. Kazuma et al. studied of estimation of the attractiveness of food photography based on image features [3]. They suggested that a camera angle was an important factor in enhancing attractiveness. In addition, their research also was found that the type of the food including the shape and position of the appearance of main ingredient in that dish could increase the level of appetite. In this study, the dessert was used as the stimulus. It does not contain the main ingredient and no exact direction. Therefore, the changes in the type of dessert or food stimuli to other categories of foods, the horizontal side of angles might be affecting to attractiveness and appetizing on consumers. It implies that a changing type of foods would be required to understand the direction of lighting on horizontal angle change attractiveness in future experiments.

We concluded that the direction of lighting on vertical elevation angles can modulate the appetite of dessert photography. whereas horizontal angle did not statistically significant difference in appetite.

References

Cai, W., Richter, S. and McKenna, B. (2019). "Progress on technology use in tourism". *Journal of Hospitality and Tourism Technology*, *10*(4), 651-672.

Chen, X., Ren, H., Liu, Y., Okumus, B. and Bilgihan, A. (2020). "Attention to Chinese menus with metaphorical or metonymic names: an eye movement lab experiment". *International Journal of Hospitality Management*. *84*, 102305.

Kazuma T, Tatsumi H, Keisuke D, Yasutomo K, Takatsugu H., Ichiro I, Daisuke D, & Hiroshi, M. (2019). Estimation of the attractiveness of food photography based on image features. *IEICE TRANS. INF. & SYST., VOL. E102–D*, NO.8 AUGUST 2019.

Liu, I., Norman, W.C. and Pennington-Gray, L. (2013). "A flash of culinary tourism: understanding the influences of online food photography on people's travel planning process on Flickr". *Tourism Culture and Communication. 13*(1), 5-18.

Martin, C.K., Nicklas, T., Gunturk, B., Correa, J.B., Allen, H.R. and Champagne, C. (2014). "Measuring food intake with digital photography". *Journal of Human Nutrition and Dietetics*, *27*, 72-81.

Oliveira, B. and Casais, B. (2019). "The importance of user-generated photos in restaurant selection". *Journal of Hospitality and Tourism Technology*. *10*(1), 2-14, available at: https://doi.org/10.1108/JHTT-11-2017-0130.

Rea MS (2000). *The IESNA lighting handbook*. 9th edn. New York: Illuminating Engineering Society of North America.

Color Name and Aroma of Thai Flowers

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Abstract

In Thailand, the essential oil is commonly used and there is a wide variety of unique aromas which obtained from the essential oil extracted from Thai flower such as Rose, Jasmine, Indian Cork, Plumeria etc. In the design of Thai aroma products, it is important to emphasize the uniqueness of the flower aroma. Color is an element that can enhance the recognition of those aroma. Therefore, this research aims to study the relationship between the color name and aroma from eight Thai flower: Rose, Jasmine, Plumeria, Cananga, Sweet Osmanthus, White Champaka, Indian Cork, and Moke. 109 subjects aged between 15-60 years old who has normal color vision are asked to smell the aroma dropped into a piece of cotton. After smelling, they must identify the color name which related to that aroma. Three color names must be selected from a set of 12 Thai basic colors which consist of red, orange, yellow, green, purple, pink, brown, blue, sky blue (*Fah*), gray, black, and white. Before each smelling, the subject's nose will be neutralized by smelling coffee beans for 5 seconds and rest for at least 5 seconds. The results show that there is a high correspondence between Thai flower aroma and yellow.

Keywords: Thai basic color, Thai flower, Aroma

Introduction

The essential oil is a natural product which can be extracted from many parts of plants such as flowers, petals, stems, seeds, etc. In Thailand, the essential oil extracted from flower such as Rose, Jasmine, Indian Cork, Plumeria, etc. is commonly used to produce Thai aroma. They are popularly used in Thai massage, traditional ceremonies to create the relaxing atmosphere. In aromatherapy, they are also used to reduce the pain and to heal the injury. Comparing between human's basic five senses: touch, sight, hearing, smell and taste, smell is not the highest sensitive sense. However, humans can discriminate between 10,000 different odors [1]. Therefore, we can perceive and discriminate each Thai flower aroma which has their own unique smell and characteristic.

For Thai aroma product design, it is important to emphasize the uniqueness of each Thai flower aroma. It is obvious that color is an element which impact customer purchasing decision [2]. Previous research has reported that there is an association between color and odor [3]. For example, there is a correspondence between the cinnamon and red color, or between the caramel and brown color. In case of Thai flower aroma, the uniqueness of smell is quite strong so that people can easily recognized their smell. There might be the correspondence between flower smell and some color such as the flower's color. For example, when people smell the Jasmine, they will refer to white which is Jasmine color. On the other hands, people will refer to red if they smell Rose. Therefore, this research aims to study the correspondence between the color name and Thai flower aroma. In this experiment, aroma of Rose, Jasmine, Plumeria, Cananga, Sweet Osmanthus, White Champaka, Indian Cork, and Moke are selected because of their distinct smell popularity.

Methodology

The subjects were 109 voluntary people which consists of 58 female, 44 male and 7 LGBT aged between 18-60 years old. All subjects had pass Ishihara test for checking their normal color vision. The stimuli were aroma of eight Thai flowers: Rose, Jasmine, Plumeria, Cananga, Sweet Osmanthus, White Champaka, Indian Cork, and Moke. Each aroma was prepared by dropping 2 drops of the aroma on a 0.5x5.0 cm perfume test paper.

The experiment started by smelling the coffee beans for 5 seconds and rest for at least 5 seconds for neutralizing subjects' nose. Then the subjects were asked to smell the aroma on the perfume test paper. After smelling, they were asked to identify the color name which related to that aroma. Three color names must be selected from a set of twelve Thai basic colors which consists of red, orange, yellow, green, purple, pink, brown, blue, sky blue (*Fah*), gray, black, and white. This procedure was repeated until each subject have smell all aroma. The order of aroma smelling was random for each subject.

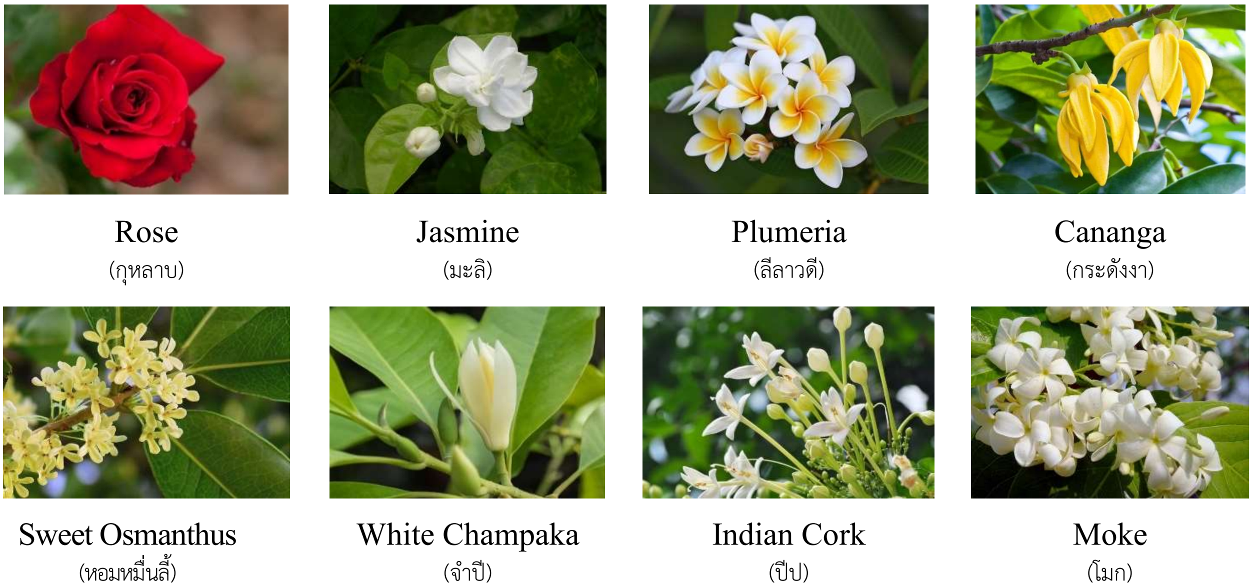

Figure 1 Thai flowers used for aroma in this experiment

Results and Discussion

Figure 2 showed the results of selected color names from 109 subjects. The abscissa was 12 Thai basic color names [4] and the ordinate was the frequency of selected color names in three time (one color name could be selected only one time for 1 subject). The total response was 327 (109×3). First, we found that all of 12 basic color names were selected for each essential oil from Thai flowers. Second, we found that yellow color name showed highest frequency selected at 66 for White Champaka, 53 for Rose, 51 for Indian Cork, 50 for Sweet Osmanthus and 49 for Cananga, respectively. Additionally, green color name showed highest frequency selected at 64 for Moke, 57 for Plumeria and 49 for Cananga (noted; there was the same frequency selected with the yellow color name for Cananga also). White color name showed highest frequency selected at 59 for Jasmine.

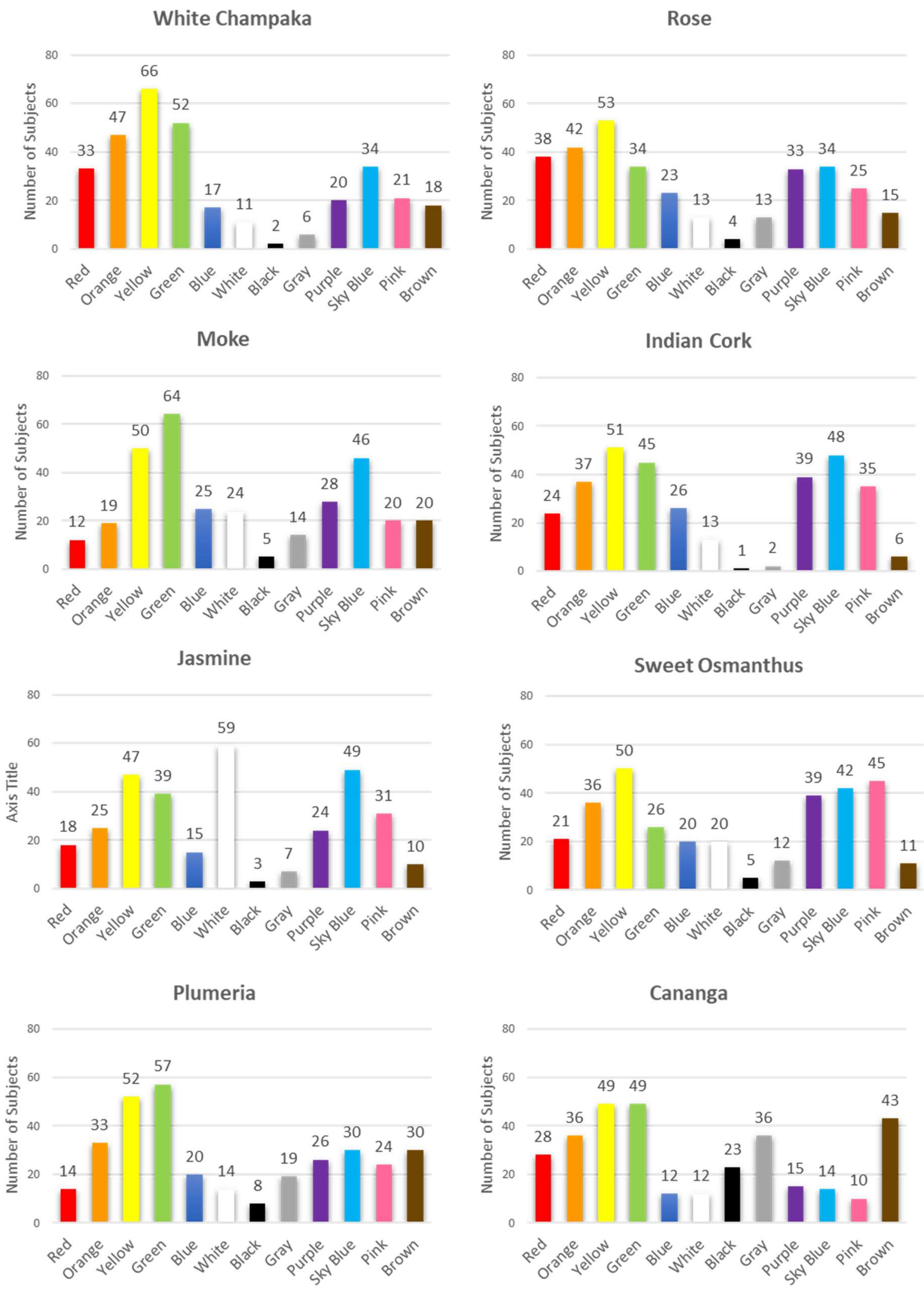

Figure 2 The selected color names of Thai flower by 109 subjects

In addition to the highest frequency, we also found that two other high-frequency colors were associated with essential oils, see in Table 1. White Champaka was yellow, green and orange, respectively. Moke was green, yellow and sky blue (Fah). Jasmine was white, sky blue (Fah) and yellow. Plumeria was green, yellow and orange. Rose was yellow, orange and red. Indian Cork was yellow, sky blue (Fah) and green. Sweet Osmanthus was yellow, pink and sky blue (Fah). Cananga was distributed in color name such as yellow, green was the same highest frequency, secondary high frequency was brown and third secondary frequency was orange and gray, respectively. The result implied that color and smell of essential oil from Thai flowers has some relationship in yellow and green.

Chanisthar et al. (2019) showed the relationship between color and smell of Thai flower aroma by asking the observers smelled aroma and selected the color that represented to that smell from the Munsell color book [5]. This method was different from the present paper at the observers smelled and thought about the color name which did not give any information about color to the subject. We supposed this present method may show the real color that represented to that smell.

Table 1 Top three rank of selected color name

Essential oil from Thai flowers	Color name		
	First rank	**Second rank**	**Third rank**
Whit Champaka	Yellow	Green	Orange
Moke	Green	Yellow	Sky blue (Fah)
Jasmine	White	Sky blue (Fah)	Yellow
Plumeria	Green	Yellow	Orange
Rose	Yellow	Orange	Red
Indian Cork	Yellow	Sky blue (Fah)	Green
Sweet Osmanthus	Yellow	Pink	Sky blue (Fah)
Cananga	Yellow, Green	Brown	Orange, Gray

Conclusions

Through this experiment we can say color and aroma from Thai flower had some relationship. Particularly, yellow color was somehow showed strong relationship with the smell of Thai flowers. However, the different method might give the difference of the color that related to the smell of Thai flower. The further experiment will be investigated more details about color such as hue, lightness and saturation, etc.

Acknowledgement

We would like to thank Miss Yanika Jaitieng for collecting the data in this research.

References

Kavinna, K. (2021). *Properties of essential oil*. Retrieved from website : https://oem.thaimedicos.com/2021/12/02/benefits-of-essential-oils/.

Levitan, C. A., Ren, J., Woods, A. T., Boesveldt, S., Chan, J. S., McKenzie, K. J., Dodson, M., Levin, J. A., Leong, C. X. R., & van den Bosch, J. J. F. (2014). Cross-Cultural Color-Odor Associations. *PLoS ONE*, *9*(7), e101651. https://doi.org/10.1371/journal.pone.0101651.

Patitanang, N., Phuangsuwan, C., Kuriki, I., Tokunaga, R. and Ikeda, M. (2019). Thai basic color terms and new candidate nomination. *Proceeding of ACA2019 Nagoya*, 164-169.

Seher, T., Arshad, M., Ellahi, S., & Shahid, M. (2012). Impact of colors on advertisement and packaging on buying behavior. *Management Science Letters*, *2*(6), 2085–2096. https://doi.org/10.5267/j.msl.2012.06.011.

Trainaja, C., Phuangsuwan, C. and Ikeda, M. (2019). Colors to represent fragrance, *Journal of the Color Science Association of Japan*, *43*(3), Supplement, 233-236.

The Effectiveness of Augmented Reality Data Access through a Smartphone

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Abstract

Augmented Reality (AR) is a technology that combines the real world with virtual reality using software and connecting devices such as a camera from a smartphone or tablet. The virtual picture will emerge on the screen of the mobile phone or display device and will immediately interact with the user. Augmented Reality technology has gained popularity and is being utilized in a wide range of applications. AR technology has been utilized in advertising to gain customer attention, especially in a period where everyone is dealing with the COVID-19 pandemic, where AR technology helps develop new experiences for consumers. Due to the high cost of AR production, the advertiser should avoid the issue of information access. As a result, the purpose of this study is to investigate the image recognition factors that influence access to AR via a smartphone by analyzing geometric shapes such as squares, triangles, circles, and Oval. The number of shapes is increased and sorted at random. The effectiveness of AR data access through a smartphone is then evaluated using 30 subjects.

The results revealed that the format of the photos used to construct the AR Marker influences the display's accuracy and sensitivity. It features an oval outside border and a design. There are also Abstract details inside. It was rated as the most accurate, with a score of 92.2 percent.

Keywords: Augmented Reality, Image Analysis, Advertising, Image Recognition, Smart Device

Introduction

Manufacturing and communication technologies are changing at a rapid pace. As a result, many businesses are progressively replacing conventional labor with computer equipment, robots, or electronic gadgets. In today's economy, more informed and competent workers are needed in manufacturing, creative labor, planning, design, and the usage of more modern or complex technologies. Augmented Reality (AR) is another technology that has been used in communication and as a tool for advertising. AR is a technology that mixes the real world with virtual reality using software and linked devices such as a mobile phone's camera and a tablet. The virtual picture will appear on the computer screen, mobile phone screen, or display device. The virtual visuals that arise will immediately interact with the user in either a 3D static image or motion.

Many stores have been impacted and forced to close their doors as a result of the COVID-19 outbreak. It also makes it hard for customers to buy or try on things on their own. The inability to test a product before purchasing it is a big issue for customers, prompting entrepreneurs to alter their trade practices. Many organizations are interested in using AR technology to mimic virtual reality items for customers to test out things, and it is frequently utilized to create a distinctive and memorable picture of products and services.

Using this technology to enhance sales and marketing is another way to increase consumer recognition and credibility in the scenario when cellphones are the 5th factor, but producing AR is rather costly. If there is an issue with obtaining diverse information via AR, the product owner may miss out on the opportunity to market their items. The goal of this research was to investigate the parameters influencing AR accessibility via smartphone-like mobile devices by developing AR Markers in square, circle, oval, and triangle shapes.

Methodology

Squares, circles, ovals, and triangles were used in the AR Marker development process to produce a face-like pattern on both the outer contour and the inner detail of the Marker. It is separated into two types: regular patterns with distinct outlines of the inner and outer frames, and abstract inner and outer frames, with a total of 16 pictures, as shown in Figure 1.

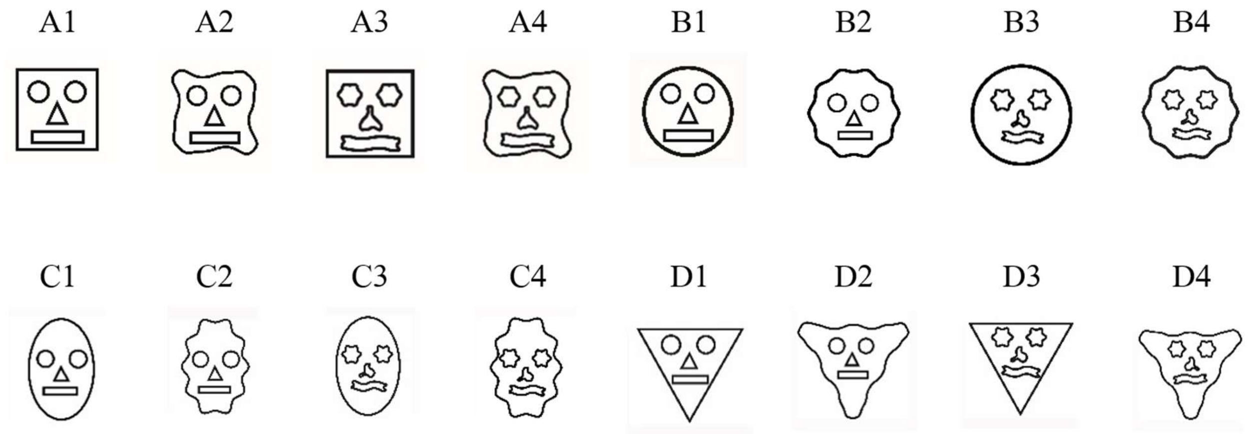

Figure 1 The 16 AR Markers

To construct a Marker Database, all 16 AR Marker images were submitted to the VIDINOTI website, which is a website used to create AR as illustrated in Figure 2. To test the functioning with a Smartphone, the V-Player application was installed.

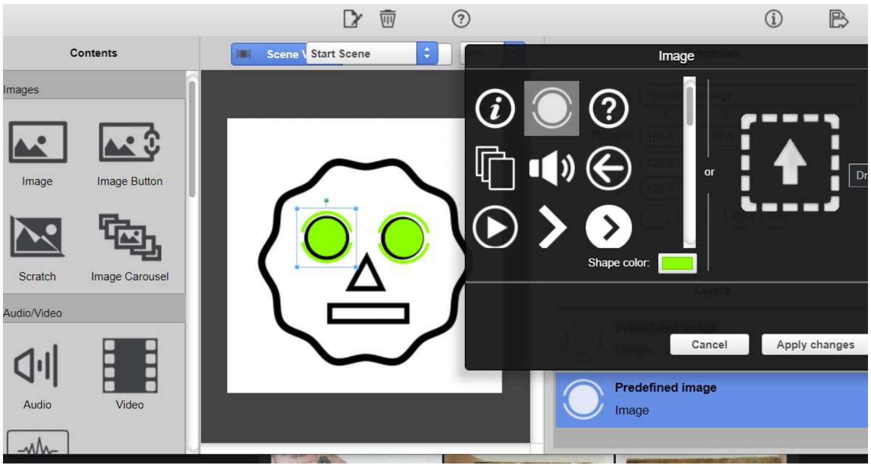

Figure 2 Creating AR Marker through VIDINOTI website

A group of 30 people were shown the AR Marker. The sample scanned the image at random, one image at a time. The light was regulated inside a room such that shadows did not obscure the Marker. The sample must be retested three times via an app on a smartphone or tablet. The sample assessed the display's accuracy. The data's presentation was timed to determine how soon the AR Marker shows.

Result

A study of the factors affecting AR accessibility through a smartphone from 16 AR Marker images discovered that the top three AR Marker patterns were able to display correctly, as shown in

Figure 3. These were image C3 (image with an oval outer border), image D2 (image with abstract triangular outer border, with arithmetic internal details) with a display accuracy of 91.1 percent, and images C1, C4 and D1 with the same evaluation score of 85.6 percent.

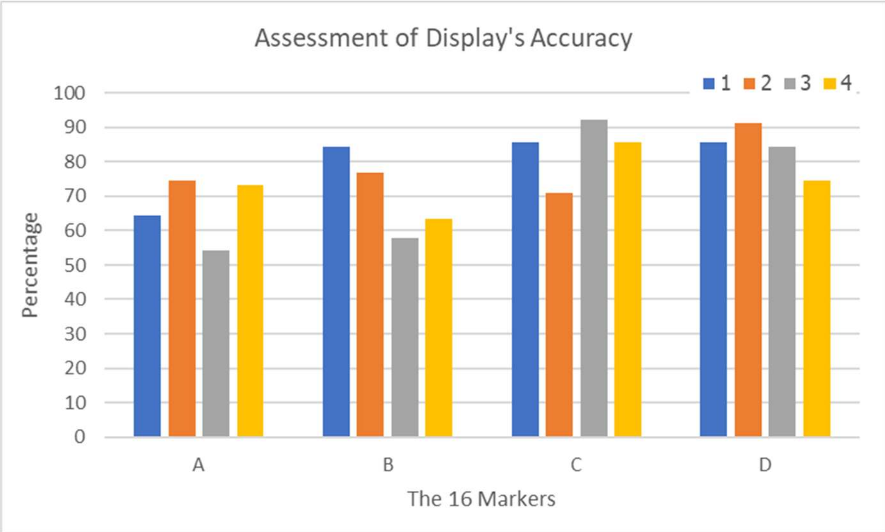

Figure 3 Assessment of Display's Accuracy

The top three AR Marker patterns examined for the fastest rendering were image B3 with an average speed of 1.77 second, image A4 with an average display speed of 1.79 second, and image D3 with an average display speed of 1.82 second in the examination of AR Marker rendering speed. Image B2, which took the longest to produce, had an average display speed of 1.82 second equivalent to 2.35 second, as shown in **Figure 4.**

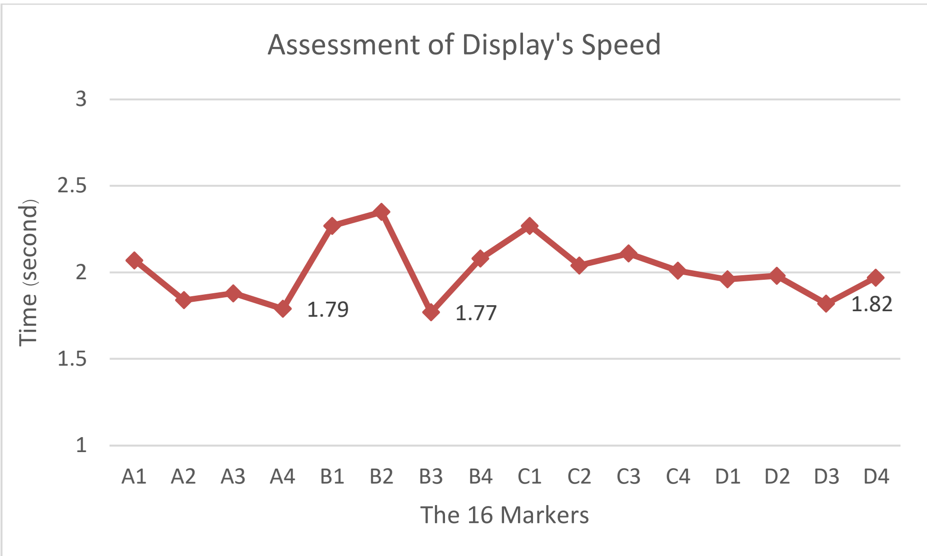

Figure 4 Assessment of Display's Speed

Conclusion

The image that accurately displays the information and takes the least time is image D3 with the rendering speed of 1.82 seconds and the score for the accuracy of impressions was 84.4 percent, according to a study of factors affecting the access to AR through a smartphone from 16 images of AR Marker. This study proposed an image format for creating an AR Marker that may be utilized as a reference for advertising design. The image with the outline of the outside border differs from the image with the outline of the interior detail. However, due to the tiny number of samples, it cannot be characterized as a Systematic Rule. As a result, more samples and picture formats should be investigated in the future.

References

AR Technology with Customer's Experience for Business Efficacy after Covid-19 (2021). Retrieved from website: https://workpointtoday.com/augmented-reality-digital-disruption-01/.

Cirulisa A, Brigmanis KB (2013). 3D outdoor augmented reality for architecture and urban planning. *Procedia Computer Science*, *25*, 71-79.

Foresight Factory report (2021). retrieved from website: https://forbusiness.snapchat.com/blog/what-consumers-want-as-they-return-to-stores-us.

How difference between AR and VR for Advertising (2020). Retrieved from website: https://www.teedd360.com/how-different-ar-vr/.

Khaoluang, D. and Anukulwetch, A. (2018). *The Development of Virtual Reality Interactive 3D Learning Materials by Using Augmented Reality (AR) Technology for Enhance Thinking Skill's Vocational Education Students with Different Critical Thinking levels*. Burapha University.

The Comparison of the Weather Forecast Program with Thai Sign Language and Captioning between Hearing Impaired, Deaf and Hearing

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Abstract

The research examines how Thai sign language and captioning help the hearing impaired and the deaf understand the weather forecast program on television. This research objective was investigated the satisfaction of the contents from the weather forecast program when the hearing impaired and the deaf perceived the weather forecast program on television compared to the hearing. A Quasi-Experimental was designed for this research and selected data by Google Online. The hypothesis tested was used by One Way ANOVA. The finding showed that captioning was preferred by the hearing, the deaf but the hearing impaired unsatisfied. The hearing, the hearing impaired and the deaf were satisfied on Thai sign language and results found that the score of understanding was not different significantly between the hearing and the hearing impaired or the deaf.

Keywords: Thai sign language, captioning, hearing impaired, deaf, hearing

Introduction

Announcement of the National Broadcasting and Telecommunications Commission on Promoting the protection of the right of people with disabilities to access or recognize and take advantage of television programs B.E. 2556 (2016) establishing laws on television access for disabled and disadvantaged people. The National Broadcasting and Telecommunications Commission (NBTC) has provided TV stations with facilities by promoting the protection of disability rights to access or recognize and take advantage of television programs classified by disability as follows: Types of deaf and hearing impaired people to have facilities include: Sign Language Interpreter Service Captioning service Blind or low vision types include facilities including Audio Description. The law has been in effect since 2016, which means that if this law was applied seriously, the law was enforced. These three services must be performed in television business in proportion to the legal limits from 2016 to 2020.

Despite the announcement of the National Broadcasting and Telecommunications Commission on Promoting the protection of disability rights to access or recognize and utilize the 2016 television program , it has also been found that produced TV shows often separate facilities, causing disabled people and people with disabilities did not benefit from the assessing in television business, so this study was interested in studying the satisfaction of television programs that provide Thai sign language interpreters and captioning by conducting a study comparing the hearing impaired and the deaf to normal people. In this study, it was made to study only sign language interpreter services and captioning, which provide facilities for access television media instead of audio services. This was because the number of beneficiaries of captioning services was the largest in the number of service recipients available from people with hearing impairments. People who were deaf or deaf who can read Thai sign in addition to people with hearing impairments who benefit from captioning, they're not. It also includes old people whose hearing deteriorates, cannot hear the same sound, can use captioning reading instead of audio to gain access to TV program, and also foreigners who want to learn Thai language can take advantage of captioning to practice Thai grammar. Sign language interpreter services have a smaller number of users because sign language was a language that communicates only to the deaf community, thus making it legal to define the proportion of services given to a smaller volume than subtitles instead of audio.

In addition, as a result of the new outbreak, Coronavirus 2019 or COVID-19 causes TV broadcasters to wear face masks in order of the center for the administration of the situation due to the outbreak of the communicable disease coronavirus 2019 (COVID-19). Defined, the phenomenon hindered the hampering of hearing impaired or the deaf viewers who often use the broadcaster's lip reading, thus making it impossible to read lips from broadcasters. The assumption of how to make providing captioning and sign language interpreters services to help hearing impaired and deaf people access the contents of the TV program. By providing captioning and sign language interpreters along with presentations on the program. This may be a way to allow deaf and the hearing impairment to access content from television media in the state of TV broadcasting under the COVID-19 pandemic.

Objective

1. To compare satisfaction with the programs that provide captioning service for hearing impaired and the deaf.
2. To compare satisfaction with the programs that provide sign language interpreters for hearing impaired and the deaf.

Methodology

The study titled " The comparison of the weather forecast program with Thai sign language and captioning between hearing impaired, deaf and hearing" surveyed satisfaction from watching TV program produced as weather forecast programs 5.30 minutes long, then let the viewer who were 97 deaf, 38 hearing impaired and 67 normal people do a satisfaction assessment of the captioning consist of the letter, font size, font color, the number of letters and the length of appearance of the letters was provided by the viewers and to perform a satisfaction assessment of sign language interpreter services, including: size of sign language interpreter frame, the position of the sign language interpreter frame, the background color of the sign language interpreter, sign language gestures, and the dress code of the sign language interpreter, assessed through a Google Form questionnaire. After that, the data was analyzed statistically by testing variance between groups with statistics. One Way ANOVA and Independent Sample T –Test was significant level at 0.05

Results

The study of comparing the quality of weather programs with Thai sign language interpreters and subtitles instead of voices between the deaf. The survey showed that there were 83 male and 119 female informants, including 202, according to Table 1.

Table 1 Gender Information

Gender	Number (persons)
male	83
female	119
Total	202

The informants in this survey have hearing levels divided into three groups, as shown in Table 2.

Table 2 Hearing Level Information

Hearing level	Number (persons)
deaf.	97
hearing impaired	38
normal people.	67
Total	202

Survey of informant groups by age level It was found that there were informants with age levels as shown in Table 3.

Table 3 Age Level Information

Age level	Number (persons)
Under 25 years old	110
25 years – 35 years	38
36 years – 45 years	30
46 years – 50 years	12
More than 50 years old	12
Total	**202**

A comparison of the quality of the weather list with captioning between the deaf, hearing impaired with normal people, as shown in Table 4.

Table 4 Difference Test Results, Satisfaction in Captioning Classified by Hearing Level

Hearing level	amount	average	standard deviation	F Value	df	p.
normal people.	67	3.6866	0.95233	3.183	201	0.044*
hearing Impaired	38	3.2263	0.86639			
deaf	97	3.6392	0.99651			
Total	202	3.5772	0.96922			

From Table 4 explains that people with hearing impaired were less satisfied with providing captioning than the deaf and normal. Considering the details of providing captioning for testing to know the hearing level group, there was a satisfaction in providing subtitles instead of audio. Using the Least Significant Difference (LSD) method for multiple comparisons, which resulted in the test results as shown in Table 5.

Table 5 Multiple Comparisons to Test Differences in Narration Instead of Audio Satisfaction Classified by Hearing Level group

Hearing Level		normal people	hearing impaired	deaf
		3.6866	**3.2263**	**3.6392**
normal people	3.6866	-	0.46025* (0.019)	0.04739 (0.756)
hearing impaired	3.2263	-0.46025* (0.019)	-	-0.41286* (0.026)
deaf	3.6392	-0.04739 (0.756)	0.41286* (0.026)	-

From Table 5 explains that hearing impaired people were less satisfied with providing captioning than normal people. There was less satisfied with providing captioning than deaf people. There was different from the sign language interpreter service satisfaction survey. It was statistically not statistically significantly different from the sign language interpreter service. As shown in Table 6.

Table 6 Results of Sign Language Interpreter Satisfaction Difference Test Results Classified by hearing level

Hearing level	amount	average	standard deviation	F Value	df	p.
normal people	67	3.9701	0.90403	2.486	201	0.086
hearing impaired	38	3.5421	1.18359			
deaf	97	3.9134	0.97635			
Total	202	3.8624	1.00302			

Discussion

According to this study, sign language interpretation and captioning services can satisfy the normal people, the hearing impaired and the deaf. Instead, they found that hearing impaired people were less satisfied with captioning on average than the samples who were normal and the deaf. However, this study found that people with hearing impairments were worthy of satisfaction in providing subtitles instead of voices (3.2263) while normal were satisfied with captioning (3.6866) and the deaf were worth the satisfaction of providing captioning (3.6392). When comparing multiples to test the differences in satisfaction in providing captioning. Classified by hearing level group, hearing impaired people were less satisfied with providing captioning than normal and were less satisfied with providing captioning than deaf people at a significant level of 0.05.

It was reality because the manufacturer has not yet fully complies with the law. Because of the overlap of definitions in the law, such as news programs or material types, captioning broadcast times cannot be calculated instead of audio. Sign language interpreter and audio description too. (Sirimit

Praphanturakit, 2019, pp. 172 -173), while Waiyawut Wuthiastasarn surveyed the need for closed captioning of viewers in Bangkok. It was found that closed captioning or captions were less satisfying in deaf than normal people (Waiyawut Wuthiastasarn, 2019, p. 207). Research by Li, Gong and Kawabata, Yasuhiro, (2021) found that using graphics and character in TV news programs may increase the emphasis on news content. When the experiment was conducted, it was found that the color and concentration of graphics and letters were found. It can stimulate the audience's perception of the TV news. In this study, graphics and apostles were used in weather programs, which was highly likely that graphics and apostles generate interest that interfere with character in the captioning of the hearing impaired. As a result, the results of the satisfaction survey had lower scores than normal and deaf people.

References

Gong, L. and Yasuhiro, K. (2021). *"Effects of OCT color on value perception in the news context"*. Retrieved from https://www.researchgate.net/publication/354760963_Effects_of_open_caption_telop_color_on_value_perception_in_the_news_context_From_the_tone_perspective.

Praphanturakit, S. (2019). "Rethinking Genre and Proportions of Services for Sign Language, Closed Captions and Audio Description in Thai Television Enterprises". *Journal of Journalism*, *12* (1), 124-190.

Wuthiastasarn, W. (2019). "A Survey of Closed Captions Viewing in Bangkok". *Journal of Journalism*, *12*(1), 191-214.

Customer's Feelings on Food Photographs affected by Lighting Direction

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Keywords: attractiveness, food photography

1. Introduction

Nowadays, food photographs on social media and websites become very popular [1]. One of the factors that helps consumers' decisions to buy food is a photograph. It arouses customers' attention and increases sales [2]. Many factors have an influence customer's attention for instance an expensive ingredient, food decoration, and food composition [3]. In addition, photography techniques such as lighting setup and camera angle are also attention attractiveness in customer [4].

In a previous study, Kazuma et. al. [2] proposed an attractiveness prediction model for Japanese food photographs by using a machine learning system with data set of camera angle and an appearance of the entire food and the food of the main ingredients. Moreover, they also found that food photograph attractiveness on customers could be affected by a lighting technique. A lighting setup is concerned with lighting direction. Illuminants for lighting setup consist of a main light and a fill light. The main light is a primary illuminant that uses for exposing light to objects. It is located at an angle of 45° to the object. The fill light is located at the 315° to the object. The fill light reduces shadows from the main light and the fill light illuminance is always weaker than the key light [6]. In addition, the direction of main light affects to direction and intensity of object's shadow. When the main light changes direction and intensity, a shadow of object could be changed. This study, hence, aimed to investigate a relationship between the direction of light and an attractiveness of a food photography.

2. Methodology

Participants

A total of 51 subjects (25 male and 26 female) with age ranging from 18 to 48 years (mean = 21.92) participated in this study. All participants were screened color blindness using the Ishihara color test.

Stimuli

Three types of Thai food, consisting of Pad Thai (Stir-fried rice noodle), Tom Yum Goong Soup, and Papaya Salad, were taken a photograph under a variety of a light direction. The intensity of illuminants was fixed at 11000 lux for main light and 5500 lux for fill light. Figure 2 (a) and (b) showed the position of a main light with moving a vertical elevation angle from 0° 30° 60° to 90° and a horizontal side angle of the dish from 45°, 105°, 135°, 165°, 225°, 285°, 315° to 345°. The camera was fixed at 45° of a vertical elevation angle. In each food, twenty-five photographs were obtained from a combination of a vertical elevation angle and a horizontal side angle in each food category.

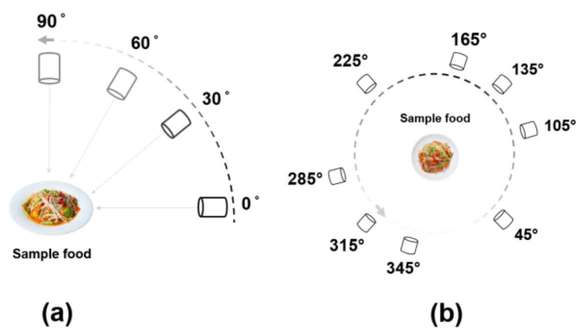

Figure 1. A position of lighting on (a) vertical elevation angle from 0° 30° 60° to 90° and (b) horizontal side angle from 45°, 105°, 135°, 165°, 225°, 285° 315°, 315° to 345°.

3. Procedure

This study was conducted in experiment room. The room size was 3 m. in length x 2 m. in width x 2.5 m. in height, and there was no window to avoid illuminance interference. Participants sit in experiment room that simulate as living room with 6500 K fluorescent lamp. Illuminance levels was set at 300 Lux. In the experiment, a set of twenty-five photographs in each food were randomly presented on LED monitor with a screen mode of 1920×1080 pixels. Monitor were set correlated color temperature at 5500 K and color mode sRGB. Size of stimuli were 16.10° cm x 10° or 16.10°cm x 13.7° depending on plate or blow size. Each participant was asked for rate their feeling on a given food photograph. Feeling scales consist of attractiveness, like, dynamic, appetite, fresh, and intense flavor with a 5-point Likert scale ranging from 1 (not at all) to 6 (very). No time limit for judgment in each photograph. After judgment, gray screen appears in 5 second before appearing a next stimuli photograph.

4. Result

Influences of lighting direction on horizontal side angles

Data of feeling evaluation scores obtained from all participants were performed by means. As shown in Figure 2, a set of mean attractiveness, like, appetite, dynamic, fresh, tasty, and intense flavor scores for three Thai food photographs was plotted in different horizontal side angles. Fig2. an abscissa axis represented a horizontal side angle from 45°to 345°, whereas a vertical axis represented the mean of the score.

Fig 2a. showed the feeling of mean score of Pad Thai that taken with the direction lighting of vertical angle of 0° in vertical axis and classified by horizontal side angles of 40° to 345° in abscissa axis. The result demonstrates that Pad Thai shot with direction of lighting vertical angle 0° and horizontal side angle 45° show mean score from participant on (a) attractiveness ($\bar{x}$ =3.71, S.D.=0.879), (b) like ($\bar{x}$=3.67, S.D.=0.931), (c) appetite ($\bar{x}$ =3.71, S.D.=0.923), (d) dynamic ($\bar{x}$ =3.69, S.D.=1.029), (e) fresh ($\bar{x}$ =3.75, S.D.=1.163), (f) tasty ($\bar{x}$ =3.63, S.D.=1.058) and (g) intense flavor ($\bar{x}$ =3.45, S.D.=1.189).

For figure2b. showed the feeling of mean score of Pad Thai with lighting direction of vertical angle at 30°. In this case, the combination of lighting vertical angle 0° and horizontal side angle 45° show mean score from participant on (a) attractiveness ($\bar{x}$=4.31, S.D.=0.812), (b) like ($\bar{x}$ =4.30, S.D.=0.787), (c) appetite ($\bar{x}$=4.14, S.D.=0.895), (d) dynamic ($\bar{x}$ =3.80, S.D.=1.096), (e) fresh ($\bar{x}$ =4.24, S.D.=0.885), (f) tasty ($\bar{x}$=4.20, S.D.=0.980) and (g) intense flavor ($\bar{x}$=4.24, S.D.=0.929).

From the figure 2a to 2c, we found the feeling of sense attractiveness, like, appetite, dynamic, fresh, tasty, and intense flavor can increase with higher of vertical angle of lighting. The result showed this trend in Fig3 when the lighting is increased from 0 to 60 Participants can feel highest sense of feeling in Pad Thai photographs.

In addition, a significant difference was tested with One-Way ANOVA. The result showed the mean feeling of Pad Thai photographs in lighting of horizontal side angles was difference at $p < 0.05$. We also tested One-Way ANOVA on lighting vertical elevation angle and feeling score. The results of One-way ANOVA revealed that a change of vertical angle lighting can affect participant's feeling significantly different ($p<0.005$) Furthermore, this tendency was occurred in Papaya salad and Tom Yum Kung Soup photographs.

Influences of lighting direction on vertical elevation angles

In Figure 3, showed evaluation mean score from Pad Thai (●), Papaya salad (▲) and Tom Yum Goong Soup (■). The Figure3a. show the mean score Papaya salad photographs taken on the vertical angle of 0° had the highest mean score in all of feeling as attractiveness ($\bar{x}$ =3.00, S.D.=1.139), (b) like ($\bar{x}$=2.97, S.D.=1.151), (c) appetite ($\bar{x}$=2.92, S.D.=1.175), (d) dynamic ($\bar{x}$ =3.11, S.D.=1.124), (e) fresh ($\bar{x}$ =2.88, S.D.=1.205), (f) tasty ($\bar{x}$ =2.90, S.D.=1.184) and (g) intense flavor ($\bar{x}$=2.84, S.D.=1.227).

Whereas, for Tom Yum Goong Soup had lowest mean scores in all feelings among three-foods as attractiveness ($\bar{x}$=1.76, S.D.=0.902), (b) like ($\bar{x}$=1.67, S.D.=0.895), (c) appetite ($\bar{x}$=1.98, S.D.=0.997), (d) dynamic ($\bar{x}$ =1.98, S.D.=0.997), (e) fresh ($\bar{x}$ =1.68,

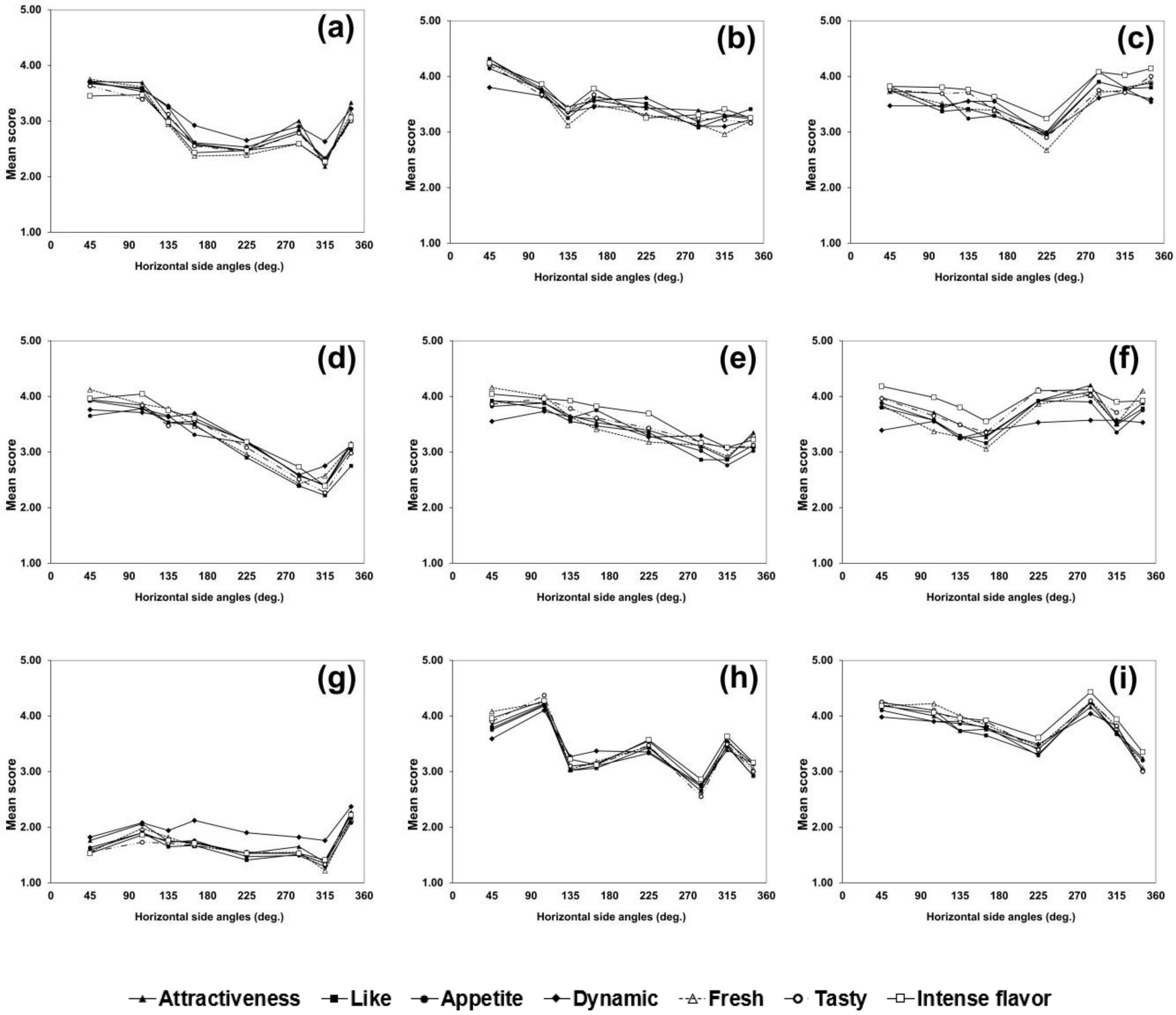

Figure 2. The difference of feeling mean score in each lighting vertical elevation angles of 0° (first column), 30° (second column), 60° (third column) classified by horizontal side angles of 40° - 345° of picture of Pad Thai (a to c), Papaya salad (d to f) and Tom Yum Goong (g to i) photographs

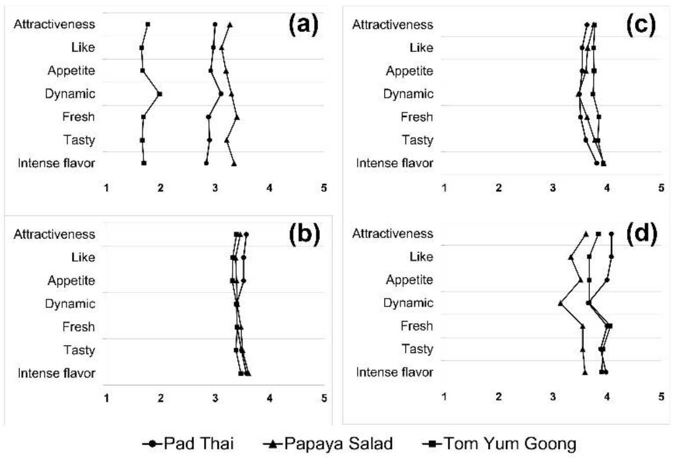

Figure 3. Comparison of a mean feeling score of lighting of (a) vertical angle of 0°, (b) vertical angle of 30°, (c) vertical angle of 60° and (d) vertical angle of 90° among three of Thai foods photograph

S.D.=0.907), (f) tasty (x̄ =1.66, S.D.=0.908) and (g) intense flavor (x̄=1.69, S.D.=0.944). The results imply that when the vertical angle of lighting increased lead to increase of feeling on consumer.

The reason why menu of Tom Yum Goong Soup had the lowest mean feeling score at vertical 0°. It can be explained that the Tom Yum Goong container obscures the direction of the light, Vertical elevation angle of 0° and when the lights were moved higher, the mean feeling score was increased close to other food. While both of Papaya salad and Pad Thai were served on a plate. Therefore, there was no part that blocks the direction of the lighting in vertical angle 0 degrees.

5. Discussion

(a) (b) (c) (d)

Figure 4. An example of a comparison of vertical elangle of Tom Yum Goong photos in shadow areas; (a) Vertical angle of 0°- Horizontal side angle of 285°, (b) Vertical angle of 30°- Horizontal side angle of 285° (c) Vertical angle of 60° - Horizontal side angle of 285° and (d) Vertical angle of 90°

The present study found that when the lighting of vertical angles increased from 0° to 90°, it led to an increase in the sense of feeling in food photographs. Fig 4 (a) shown that Tom Yum Goong were taken with the lighting of the vertical angle of 0° and compared to Fig 4 (d). that taken with the lighting of a vertical angle of 90° the result proved that less of the intensity of shadows, higher level of lighting on vertical elevation angles may provide a high illuminance to reduced shadow. The results of this experiment can be explained as the intensity of shadows can influence negative feelings and reduce the sense of attractiveness, like, appetite, dynamic, freshness, and intense flavor in consumers.

Our finding was consistency with Aimee Hasenbeck, et al. [5] studied on Color and illuminance level of lighting can modulate willingness to eat bell peppers that participants illuminance level of lighting can affect consumers' liking and acceptance of appearance in bell peppers. Their result showed bright lighting conditions make the surface colors of bell peppers more clear. In contrast, dark lighting conditions distort the colors of them, which may decrease liking of appearance.

It seems that higher lighting of vertical elevation angle conveys brightness to food looked more attractive, appetite, and fresh. whereas the lighting at the vertical angle of 0° makes shadow distort freshness, appetite, and attractiveness in Thai foods. It implies that a shadow area of foods would be required to understand the direction of lighting in future experiments.

6. Conclusion

In the present study, we proposed a method for lighting setup. The lighting on vertical elevation angle and horizontal side angle of dish can modulate the feeling of Thai food photo. The result could be used for increasing the attractiveness like appetite fresh tasty and intense flavor in Thai food photography. This experimental result could be used as a guideline for the lighting setup, especially for Thai photography.

References

1. Cai, W., Richter, S. and McKenna, B. (2019), "Progress on technology use in tourism", Journal of Hospitality and Tourism Technology, Vol. 10 No. 4, pp. 651-672.

2. Kazuma T, Tatsumi H, Keisuke D, Yasutomo K, Takatsugu H., Ichiro I, Daisuke D, & Hiroshi, M. (2019) Estimation of the attractiveness of food photography based on image features. IEICE TRANS. INF. & SYST., VOL.E102–D, NO.8 AUGUST 2019

3. Chen, X., Ren, H., Liu, Y., Okumus, B. and Bilgihan, A. (2020), "Attention to Chinese menus with metaphorical or metonymic names: an eye movement lab experiment", International Journal of Hospitality Management, Vol. 84, p. 102305

4. Martin, C.K., Nicklas, T., Gunturk, B., Correa, J.B., Allen, H.R. and Champagne, C. (2014), "Measuring food intake with digital photography", Journal of Human Nutrition and Dietetics, Vol. 27, pp. 72-81.

5. Hasenbeck, A., Cho, S., Meullenet, J. F., Tokar, T., Yang, F., Huddleston, E. A., et al. (2014). Color and illuminance level of lighting can modulate willingness to eat bell peppers. Journal of the Science of Food and Agriculture, 94, 2049–2056.

Comparison of Thai Tea Color between from Memory and Real Products

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Keywords: Color of Thai Tea, Boundary Color of Thai Tea, Memory color, Munsell

1. Introduction

Thai iced tea, Thai milk tea, or Thai tea is a popular beverage in Thailand. The smell and taste of Thai tea made it be a favorite drink widely for not only Thais but also foreigners.[1] Thai tea is one of Thailand's signatures. Its color is quite unique. Compared to iced tea in other countries, Thai tea is an orange tone. Although the color of Thai tea which is seen with bare eyes is orange, there are various colors depending on the mixing of the ingredient such as black tea, condensed milk, fresh milk, and sugar. [2] Importantly, condensed milk is an ingredient that makes Thai tea has various shade of orange. Also, the perception of Thai tea color is various due to personal experience.

There are previous studies related to Thai iced tea on memory. Saksirikosal et al. (2019) investigated the boundary of Thai iced tea by color adjusting method on a display.[3] Those result has shown that the boundary of Thai tea color was identified as the yellowish-orange region. The average color was L* = 52.61, a* = 19.36, b* = 52.81. Saksirikosal et al. (2021) also continually studied the color of Thai iced tea for advertising by using the Munsell Color System.[4] The color chips were selected as a representative color of Thai tea based on their field experience. The result showed that there were 8 colors representing Thai iced tea: 3.75YR 6/12, 3.75YR 5/12, 5YR 5/12, 1.25YR 5/12, 5YR 6/10, 2.5YR 6/12, and 2.5YR 5/14.

In this research, we investigated the different colors between Thai tea in memory[3, 4)] and real products. The sample was placed inside the illuminance-controlled cabinet and was measured by using a CS-100A. The CIEYxy value was transformed to CIE L*a*b* color space.

The result of this study will be advantageous for the maker to improve their Thai tea's color.

2. Methodology

Thai tea samples were randomly bought from 33 shops located in Bangkok metropolitan. All samples were ordered without any specific request such as low sweetness, or extra condensed milk to get Thai tea which was generally sold. Each sample was prepared by pouring 100 ml of Thai tea into a white paper cup as shown in Figure 1. Each sample was placed inside the experimental cabinet for color measurement.

Figure 1. Thai Tea Color.

Figure 2. Experimental Booth.

The inside wall of the experimental cabinet was covered by the gray paper as shown in Figure 2. The illuminance at the cup position was 2500 lux and the correlated color temperature of illumination was 5000 K.

A Chroma Meter Konica Minolta CS-100a was used for color measurement. The direction of measurement was 45 degrees to the surface of Thai tea to avoid the specular reflections. Color value of each Thai tea sample was reported by the average of three measurements. CIE Yxy of the white reference measured at the cup position was [712 cd/m^2, 0.321, 0.371].

To compare the results with previous research by Saksirikosol et al. (2019) and Saksirikosol et al. (2021), All color values were transformed to CIE L*a*b* color space by the following equations:

$$L^* = 116\left(\frac{Y}{Y_n}\right)^{1/3} - 16 \quad (1)$$

$$a^* = 500\left\{\left(\frac{X}{X_n}\right)^{1/3} - \left(\frac{Y}{Y_n}\right)^{1/3}\right\} \quad (2)$$

$$b^* = 200\left\{\left(\frac{Y}{Y_n}\right)^{1/3} - \left(\frac{Z}{Z_n}\right)^{1/3}\right\} \quad (3)$$

where X_n, Y_n, Z_n is CIE XYZ of the white reference.

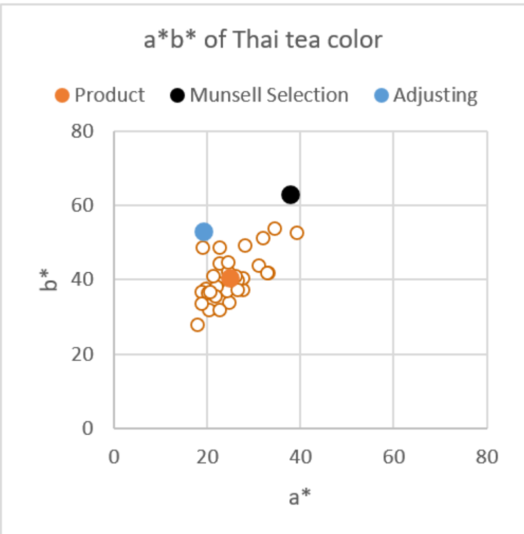
3. Result and Discussion

The measurement result of Thai tea samples from 33 shops located in Bangkok metropolitan showed with opened circles with an orange color border in Figure 3.

The color was plotted on a* b* plane in the picture from the left side, and on a* L* plane in the right side. Those result indicated the Thai tea color samples were in the range of L* between 50-70, a* between 18-39, and b* between 27-54. The filled orange circle showed the average of CIEL*a*b* of 33 samples which equal with L*= 61.12, a*= 24.93, b*= 40.32. It is seen that the color of Thai tea from real products was yellowish orange. Moreover, there was moderate relative lightness.

The black circle was the average Thai tea color in memory from Munsell color selection, the value was L*= 55.12, a*= 37.95, b*= 62.82. The blue circle was the average Thai tea color in memory from the color adjustment, the value was L*= 52.61, a*= 19.36, b*= 52.81. Table 1 shows the comparison of those average Thai tea colors. It was found that the real color of Thai tea had more L* value than Thai tea color in memory. That means the color in the memory was darker than the real one. The value of b* was lower than color in memory from both the Munsell color selection and the color adjustment. The value of a* of the real products has larger than the monitor adjustment but smaller than the selection from Munsell Book.

If the color difference was considered (ΔE*ab), it is found that the color of Thai tea in memory was rather different from the real one. The difference was ΔE*ab = 26.72 for the selection from Munsell Book and 16.11 from the monitor adjustment.



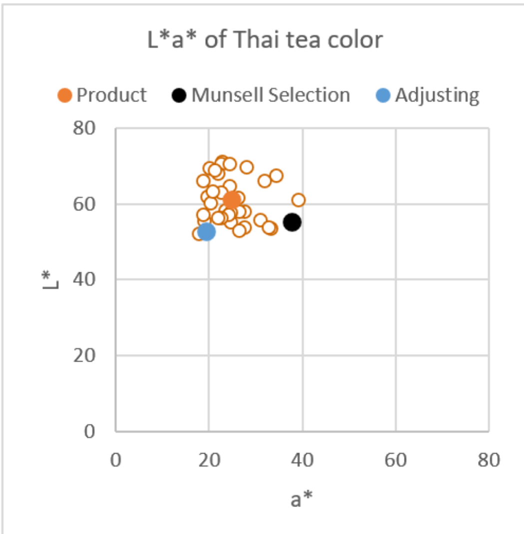


Figure 3. CIE L* a* b* of Thai tea color measured from products (blanked orange circle) and their average (orange circle). Black and blue circle represent the result from Munsell selection and color adjusting method

Table 1. Average CIEL*a*b*, chroma, and hue angle of Thai tea from the real product, Munsell selection, and adjusting.

Thai tea color	L*	a*	b*	C*	h°	ΔE^*_{ab}
Product	61.12	24.93	40.32	47.41	58.3	-
Munsell selection	55.12	37.95	62.82	73.39	58.9	26.72
Adjusting	52.61	19.36	52.81	56.25	69.9	16.11

The chroma (C*) and hue angle (h°) from the average CIEL*a*b* of the real product, Munsell selection, and adjusting methods were calculated. The C* of the real product was 47.41, 56.25 for adjusting, and 73.39 for Munsell selection. Both adjusting and Munsell selection showed higher C* than the real product.

In the case of the h°, it showed a similar hue angle between the real product (h=58.3) and Munsell selection (h=58.9), but the hue angle of adjusting (h=69.9) showed different from the others.

4. Conclusion

The real color of Thai tea showed quite different from consumers' memory. The real one was lighter and had lower saturation. Therefore, for advertising design of the color of Thai tea, it is better to adjust the color of Thai tea to an orange color that is high saturation (C*~65) and low lightness (L*~54) than the color of real Thai tea to suit the Thai tea color memory.

References

1) Tim Cheung. (2018). World's 50 Most Delicious Drinks. Retrieved from 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) Saksirikosol, C., Jarernros, J. and Rattanakasamsuk, K. (2021). The Investigate Color of Thai Iced Tea for Advertising. The 6th Asia Color Association Conference 2021: Color and Culture. Yogyakarta, Indonesia, pp.78-80.

4) Saksirikosol, C., Rattanakasamsuk, K., Jarernros, J. and Phuangsuwan, C. (2019). Color of Thai Iced Tea. Journal of the Color Science Association of Japan, Vol.44, No.3 Supplement, Kyoto, June 27-28, pp.180-181.

5) Phuangsuwan, C. and Ikeda, M. (2020), Vision and Color. Pathum Thani: Innovation Design Center and Media Convergence.

K-mean Cluster Analysis of Representative Color of Thai Alternative Gender

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Keywords: Representative color, alternative genders, LGBTQ+, memory color

1. Introduction

People who do not define their gender identities as "Male" and "Female" are generally called "LGBTQ+". In Thailand, however, the term "LGBTQ+" is not commonly used. People who have a variance in gender identity and sexual orientation are normally called "Alternative Gender".

Much research has been studied on the relationship between color and gender. Ellis and Ficek (2003) have revealed that male prefers blue while female prefers green. They also reported that there was no significant effect of gender and sexual orientation on color preference. While blue is a universally preferred color, Hurbert and Ling (2006) showed that there is a gender difference in blue preference. Female tends to prefer reddish blue, while male prefers greenish blue. Gender association of pink with the girl and blue with the boy is longer established especially in children's cloth and toys. For the LGBTQ+ or alternative gender, the rainbow color is associated with them based on the use of a rainbow color flag in the social and political movement. However, it is questionable whether the rainbow color should be the representative color of the alternative gender. Rattanakasamsuk et al. (2020) have conducted an experiment to identify the representative color of the alternative genders. The result showed that the alternative gender subjects did not select the rainbow color as their representative color. On the other hand, the most selected color was in the range of purple hue. Jarernros et al. (2021) have conducted an experiment to specify the representative color of the alternative gender by color selecting method. The subjects were asked to select the Munsell color chips whose hue was 10PB, 2.5P, 5P, 7.5P, and 10P. Their result showed that the most selected color was 7.5P 4/12. However, there was an arguable point that the subject was limited to selecting only the purple color. They could not select other colors, even though they might think that the representative color of the alternative gender was not purple.

In this research, we conducted an experiment to identify the representative color of the alternative gender by asking the subjects to adjust the color on a monitor to match their memory color. By this method, the subjects could select any color without the limitation of the presented hue.

2. Methodology

Subject

106 university students aged between 18 and 25 years old voluntarily participated in this research. All of them had passed the Ishihara test to confirm normal color vision.

Apparatus

The experimental room was divided into two parts separated by a wall. The first part was a test room. A monitor (EIZO ColorEdge CG277) connected to a computer was placed inside this room. The white point of the monitor was set to match D65 with maximum luminance at 300 cd/m^2. The color presented on this monitor could be adjusted by pressing a keyboard or moving a mouse. The second part was a subject room which was illuminated by a set of ceiling lamps. The room's illuminance was 1200 lux measured at the subject's seat position. The wall in the subject room was pasted with white wallpaper. On the front wall which connected to the test room, a 25 × 25 cm^2 gray paper was pasted. At the center of this gray paper, a 5 × 5 cm^2 aperture was made so that the subjects could see the color presented on the monitor inside the test room. From the subject's viewpoint, the stimulus configuration was 2° × 2° and color patch surrounded by a 10° × 10° gray background.

Experimental Procedure

Before starting the experiment, the subjects sat inside the experimental room for at least two minutes. The experimenter explained how to use the mouse and the keyboard to adjust the color patch. The subjects' task was to specify the representative color of the alternative gender by adjusting the color patch. There was no time limit for the color adjusting. After each color adjusting, CIE Yxy of the color patch was measured by using a Konica Minolta CS-100a. Each subject had to finish three repetitions.

3. Result and discussion

The experimental result showed that most of the specified colors were in a range of luminance between 10 and 75 cd/m^2. Their chromaticities were in a range of x values between 0.1 and 0.4 and in a range of y values between 0.1 and 0.3. These colors were in magenta, violet or purple region which were named as "Muang" in Thai language. There were also some specified colors which located in other region such as yellow or red. Hence, it is not suitable to use average of all data to be the representative color of the alternative gender. Data clustering was necessary to reduce the error from the uneven data dispersion. Since we did not do categorical color naming of each specified color, we cannot cluster the colors based on their color name. Therefore,

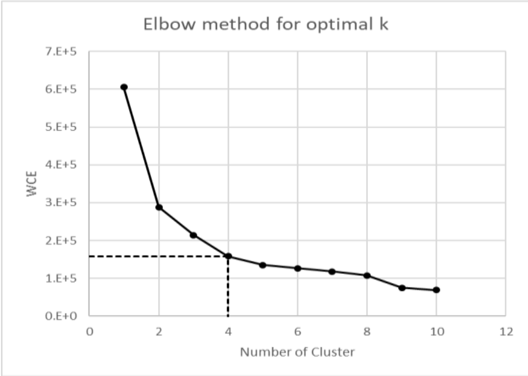

Figure 1. Elbow method for optimal k

statistical data clustering was necessary. In this research, k-mean cluster analysis was implemented to cluster the data.

K-mean cluster analysis is a method to partition data into k clusters. Two important points are needed to concern. The first one is the Euclidian distance between data. In our research, the color coordinate in CIE Yxy is not a uniform 3D color space. Therefore, CIE Yxy of the specified colors was transformed to CIE1976 L*a*b* color space which is a more uniform 3D color space. The second one is the number of clusters or k value. We used the Elbow method to find the optimal k by coding a program with Python (Van Rossum and Drake, 2009) and Pyclustering library (Novikov, 2019).

Figure 1 showed the relationship between the number of clusters and WCE (within cluster error). It clearly showed the elbow form, so the optimal number of clusters or k value was four clusters.

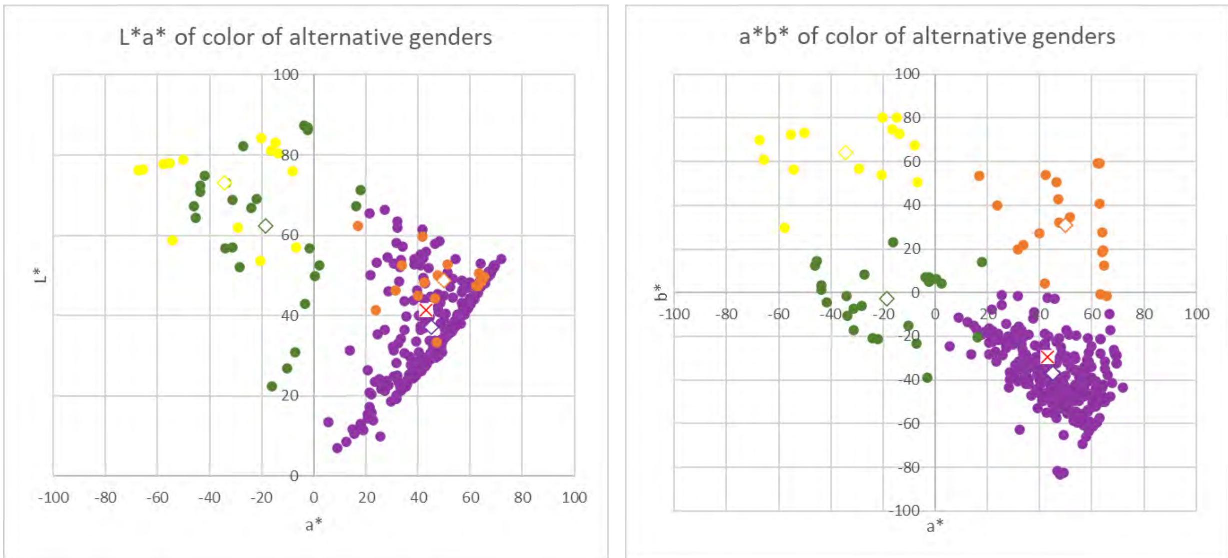

Figure 2. k-mean cluster analysis of the representative color of the alternative gender. Diamond symbols represent the centroid. Cross symbols represent 7.5P 4/12.

Figure 2 showed the result of k-mean cluster analysis for the representative color of the alternative gender in CIE L*a*b* color space. The Left and right panels showed the result plotted in L*a* plane and a*b* plane, respectively. Each circle represented the specified color of the alternative gender. Members of each cluster were differentiated by the different color circles. The centroid of each cluster was represented by the diamond symbol.

From the result, the largest cluster was the purple cluster which contained 81.4% of total data while the green, orange, and yellow clusters contained only 7.9%, 6.3% and 4.4% of total data respectively. This result can be implied that purple was commonly accepted to be the representative color of the alternative gender in Thailand. The CIEL*a*b* of the centroid of the purple cluster was [37.03, 45.18, -37.08].

From previous work, Jarernros et al. (2021) have proposed that the representative color of the alternative gender was the Munsell color 7.5P 4/12. CIEL*a*b* of this color was measured and compared with our result as shown by the cross symbol plotted in Figure 2. We can see that our result agrees quite well with the previous work. Color difference (ΔE^*_{ab}) between 7.5P 4/12 and the centroid of the purple cluster was 8.8. Compared to 7.5P4/12, our result was slightly darker (ΔL^* = -4.3), more vivid (ΔC^* = 6.3) and less reddish ($\Delta h°$ = -5°).

4. Conclusion

Our results confirmed that the representative color of the alternative gender in Thailand should be purple. By color adjusting method and k-mean cluster analysis, CIEL*a*b* of the representative color of the alternative gender obtained from the centroid of the purple cluster is [37.03, 45.18, -37.08].

References

1) 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
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
3) Rattanakasamsuk, K., Nontawongsa, C., Srisuro, P. and Phuangsuwan, C. (2020) Does Rainbow Color Truly Represent Alternative Gender? Journal of the Color Science Association of Japan, 44 (3+), 27-28.
4) Jarernros, J., Saksirikosol, C. Srisuro, P. and Rattnakasamsuk, K. (2021). Colors to Represent Thai Alternative Gender. Proceedings of the 6th Asia Color Association Conference, 2-3 November 2019, Yogyakarta, Indonesia, 171-176.
5) Van Rossum, G., & Drake, F. L. (2009). Python 3 Reference Manual. Scotts Valley, CA: CreateSpace.
6) Novikov, A., (2019). PyClustering: Data Mining Library. Journal of Open Source Software, 4(36), p.1230. Available at: http://dx.doi.org/10.21105/joss.01230.

Hue shift direction under vivid color LED

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Keywords: Hue shift, LEDs, RVSI, Complementary color, Elementary color naming

1. Introduction

Light Emitting Diode or LEDs became the dominant light system in both household and commercial companies with several benefits such as less energy consumption, lifespan, ETC. The apparent advantage is the ability to beam various colored lights with a combination of three diodes, red, green, and blue.

Chromatic adaptation is one of the human functions to perceive an object under various light situations. An object appears identical to the same object under the normal condition as white light though this ability is never perfect. The recognized visual space of illumination or RVSI [1] is a concept to describe the footprint of this function. This assumption was proved by the two-room technique [2] to see the effect of chromatic adaptation and the RVSI concept.

In the previous research [3], we studied the color appearance of the color chip under RGB-LEDs based on color constancy analysis. We found that color constancy was poor under yellow, green, and cyan illuminations. In this article, we continued to analyze the same experiment in terms of hue shift to understand the characteristic of chromatic adaptation under vivid illumination.

2. Apparatus

Figure 1 shows the experimental booths for this experiment. The left booth was designed to obtain the color appearance of the object, with participants adapting to the colored light. The booth was decorated with many kinds of stuff to simulate a real-life situation for a participant. The booth was illuminated by only RGB-LEDs of Phillips product model Kinetics color cover MX power core attached on the ceiling. The colored light is changeable and controllable by a computer on the outside of the booth. The right booth in Figure 1 shows the extended room of the left booth and is divided as a two-room technique. Each color chip would be placed under the RGB-LEDs called the test room, while a participant had to move to the introduced room called the subject room, illuminated by only standard white illumination as D65.

3. Stimulus and illumination

The stimulus was printed by Konica Minolta C83HC. There were twenty-four color chips used as stimulus in this experiment composed of three groups. The first group was based on 15 test color samples used in studying the color rendering index. The second was eight-color chips derived from the

a. b.

Figure 1 The experimental booths

printer's color gamut, and the last group was achromatic chips, as shown in Figure 2.

The illumination condition is shown in Figure 3 on the u'v' color diagram. There were six vivid colored lights, red, yellow, green, cyan, blue, and magenta. D65 was used as standard illumination in this experiment. The illuminance of all the lights was approximately 100 lx except for the blue condition, which was about 80 lx. In this experiment, the color code was R2, Y2, G2, C2, B2, and M2, respectively.

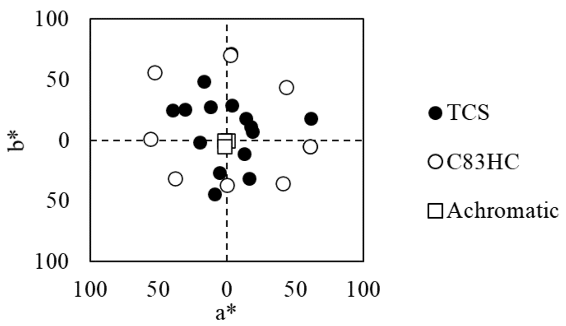

Figure 2 Color chips on a*b* color space

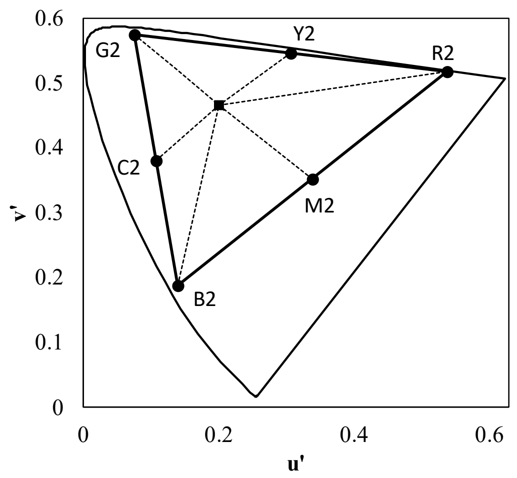

Figure 3 Illumination conditions

4. Procedure and participation

Each subject had to name each color chip using the elementary color naming. The subject had to judge how much percentage of chromaticness, whiteness, and blackness. Then, the participant had to judge the percentage of red, yellow, green, and blue colors.

There were 100 subjects participating in this experiment. Most of them were students who took a color vision class and had a chance to learn about the naming method. They had normal color vision tested by the Ishihara test.

The subject had to judge twenty-three color chips under the RGB-LED one by one, as shown in Figure 1(a), in order to obtain the color appearance of the object, which the subject had to adapt to the colored light. Then, the achromatic test patch as the grey chip will be placed in the test room in Figure 1(b) to obtain the color appearance of the color illuminations, while the subject adapts to only the white light. By using the two-room technique, each colored room illumination could be observed.

5. Result and discussion

The result of naming can be plotted on a graph called the polar diagram, as shown in Figure 4. The maximum of each axis of the diagram is 100 and is the most saturation of color chip along the axis as green and red on the horizontal axis and yellow and blue on the vertical axis. In the figure, it is an example of an average naming result under the R2 condition. The open squares indicated the average result of each color chip under the standard illumination, D65. The solid triangles were the result under test illumination as R2.

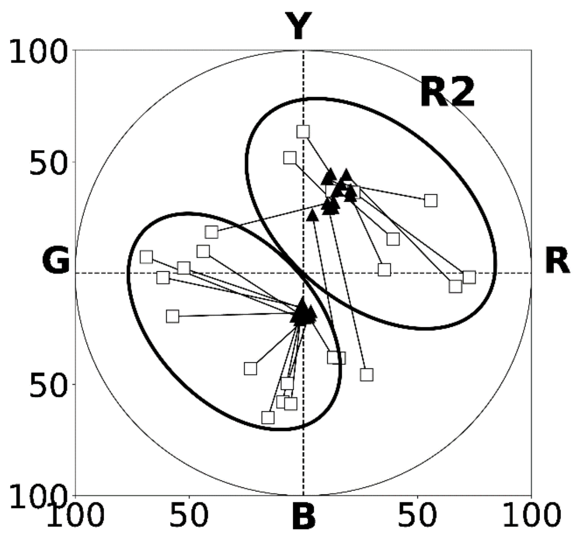

Figure 4 The naming result under the R2 condition

We found at least two converging points in each illumination condition as two eclipses shown in Figure 4. Then, we averaged the triangle symbol positions in each ring. The average position was called centroid for each group. The result of the average centroid is shown in Figure 5. On the abscissa was the color chip arranged by the hue of the color chip under white light. On the ordinate was illumination condition ranged from the hue of illumination. The numbers in the squared scheme were the average hue of each centroid.

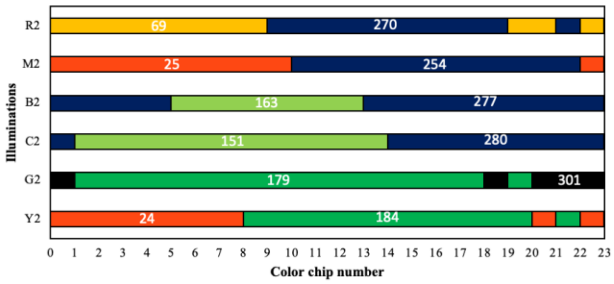

Figure 5 The centroid color scheme of each illumination condition

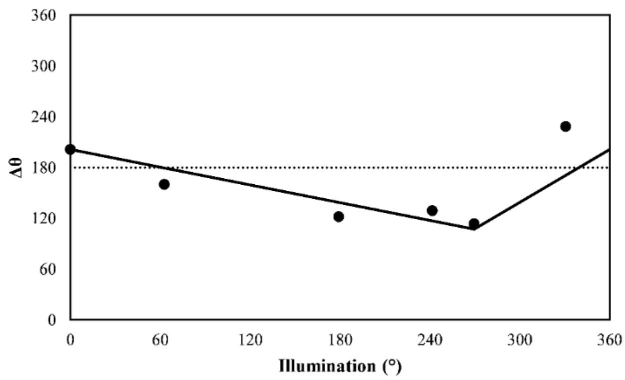

Figure 6 The difference between each centroid of each group

We calculated the difference between each centroid of each colored illumination and plotted the result, as shown in Figure 6. In the graph, abscissa was colored illumination in terms of hue angle. The ordinate was the difference between the two centroids. The line indicates that the pattern of the difference does not follow the opponent color theory as the solid lines do not follow the dotted line. The black line had a similar pattern to previous studies [4-5].

We believe that the present and previous analysis result was related to the illumination adaptation at the brain level, not the retina. A human adapted to the illumination and constructed information called RVSI inside our brain. Any object in the illumination space would be adapted relating to the size and color of the lighting. The black line in Figure 6 was not based on the opponent color theory but trended to be the complementary color that typically existed at our brain level [6].

References

1) Ikeda, Mitsuo. “Color Appearance Explained, Predicted and Confirmed by the Concept of Recognized Visual Space of Illumination.” Optical Review, vol. 11, no. 4, 2004, pp. 217–225.

2) Pungrassamee, Pontawee, et al. “Color Appearance Determined by Recognition of Space.” Optical Review, vol. 12, no. 3, 2005, pp. 211–218.

3) Chitapanya, Phubet, et al. “Color Appearance of Color Chips under Light - Emitting Diodes Lamps.” Color Research & Application, 2021.

4) Phuangsuwan, Chanprapha, et al. “Color Appearance of Afterimages Compared to the Chromatic Adaptation to Illumination.” Color Research & Application, vol. 43, no. 3, 2018, pp. 349–357.

5) Ikeda, Mitsuo, and Chanprapha Phuangsuwan. “Strong Effect of the Simultaneous Color Contrast in an Afterimage.” Color Research & Application, vol. 44, no. 1, 2018, pp. 50–53.

6) Pridmore, Ralph W. “Complementary Colors Theory of Color Vision: Physiology, Color Mixture, Color Constancy and Color Perception.” Color Research & Application, vol. 36, no. 6, 2011, pp. 394–412.

DEVICE DEPENDENCY INVESTIGATED BY SIMULTANEOUS COLOR CONTRAST

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Keywords: Color appearance, Devices, Elementary color naming, Perceive color, Simultaneous color contrast.

1. Introduction

The simultaneous color contrast is a well-known phenomenon; a gray test patch surrounded by a color appears complementary color. This is considered as the result of the chromatic adaptation to surrounding color[1]. It has been studied for a long time with various experimental methods such as colored paper, electronic display, two-rooms technique, and projector. These different evices showed the different results. Previous studies compared the color appearance of simultaneous color contrast on different devices and indicated that the simultaneous color contrast is device dependent [2, 3]. However, it was noted that some experimental conditions were not strictly controlled, such as chromaticities, luminance values. the visual size of the stimulus This could be one of the factors that affect the results shown.

Therefore, the present study investigates the simultaneous color contrast by controlling the conditions of the stimuli with four different devices.

2. Experiment

2.1 Devices

Fig. 1 illustrates four devices used in the present investigation; colored paper, electronic display, projector, and two-rooms technique. The former three devices were used in a same room with illuminance at 200 lx. The colored paper was printed on matt coated paper for surround and test patch by a digital printer. The electronic display was 24.1 inches EIZO LCD Display with sRGB mode, and the projector was Viewsonic model PA503S the projector, two types of screens were used, a white paper screen (Projector W) and a black paper screen (Projector B). They were to control color and luminance to become close to those of other devices.

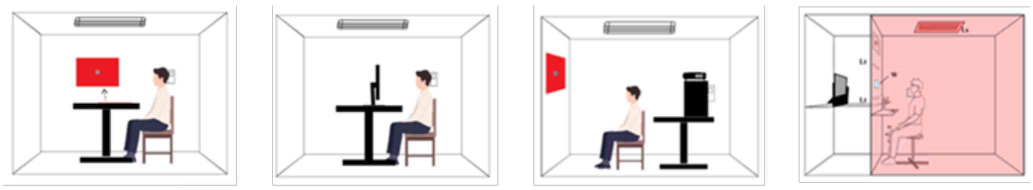

Figure 1. Four devices of observation

Table 1 The visual angle of the stimulus

Devices	Size (cm)		Viewing distance (cm)	Size (°)	
	Surround	Test patch		Surround	Test patch
Paper	31.5*45.5	4*4	50	35*49	4.6*4.6
Display	31.5*45.5	4*4	50	35*49	
Projector	45*65	5.6*5.6	70	35*49	
Two-rooms	110 (wall width)	4*4 (window)	50	95.5	

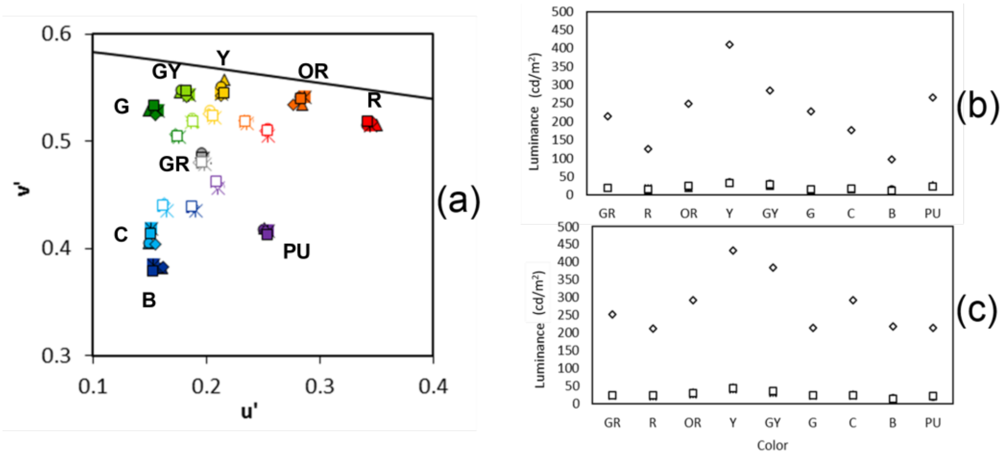

Figure 2. The u'v' chromaticity coordinate (a) filled symbols for surround and open symbols for test patch and the luminance values of the surround (b) and test patch (c). △ paper, ○ display, ◇ projector W, □ Projector B, and ∗ two-rooms

The two-rooms technique was composed of a subject room and a test room which a small window on the separating wall between the two rooms. A subject looked at a test patch paper placed in the test room through the window. The color of the subject room was controlled by LED ceiling lamps. The test room was illuminated by two florescent lamps of the daylight type.

The visual angle of stimuli was controlled to keep them almost same size for all devices as shown in Table 1.

2.2 Stimuli

We employed nine colors for both test patch and surround; red, orange, yellow, greenish yellow, green, cyan, blue, purple, and gray. They were printed on papers by controlling CMYK. Saturated colors for surrounds and their desaturated colors for test patches. The colors were measured with color luminometer as standards for other services. Colors of other devices were made almost same as the standard on u'v' chromaticity coordinates. The results are plotted on the u'v' diagram as illustrated in Fig. 2a. All the five points of devices overlapped on

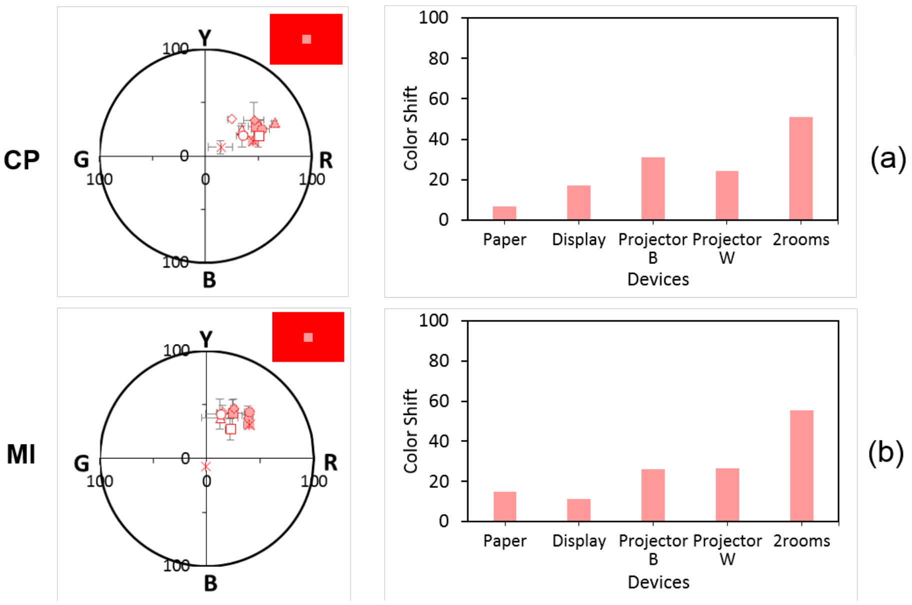

Figure 3. Left, color appearance of red test patch with red surround and with a gray surround from the subject CP and MI. Filled symbols for test patch under red surround and open symbols for test patch under gray surround. Right, size of the color shift with devices. a for CP and b for MI

the graph. Points of test patches came between the surround colors (filled symbols) and a white point to show desaturation. About the luminance, it was made equal in Most devices except projector W and they are shown by respective symbols in Fig. 2 b,c but they overlapped with open squares of Projector B. The luminance of Projector W gave very high luminance as shown by open diamonds in the figure. The luminance was reduced by projecting stimuli on a black paper and the luminance became same as other devices as shown by open squares in Fig. 2b,c.

Ten observers with normal color vision participated in the experiment, they were asked to judge the color appearance of the surround and test patch by the elementary color naming method, which was to estimate the amounts of chromaticness, whiteness, and blackness in percentage including the apparent hue by the unique hues (red, yellow, green, and blue). The repetition of each device was 3 times on different days.

3. Results

Examples of results are shown on the left of Fig. 3 taken from the subject CP (a) and MI (b) for red test patch with red surround by filled symbols. They are plotted on a polar diagram normally used in the opponent-colors theory. The red test patches under gray surround are also plotted by open symbols. Different symbols correspond to devices as in Fig. 2. We can see that the color appearance of red test patch changed by changing the surrounding color from gray to red.

We calculated the change by the equation

$$\text{color shift} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

by calculating the color difference between the test patch under a gray surround (x_1, y_1) compared to those under a red surround (x_2, y_2) and show in the right graph to compare the size of color shift for all devices. The size of the color shift shows different in each devices the smallest at paper and the largest

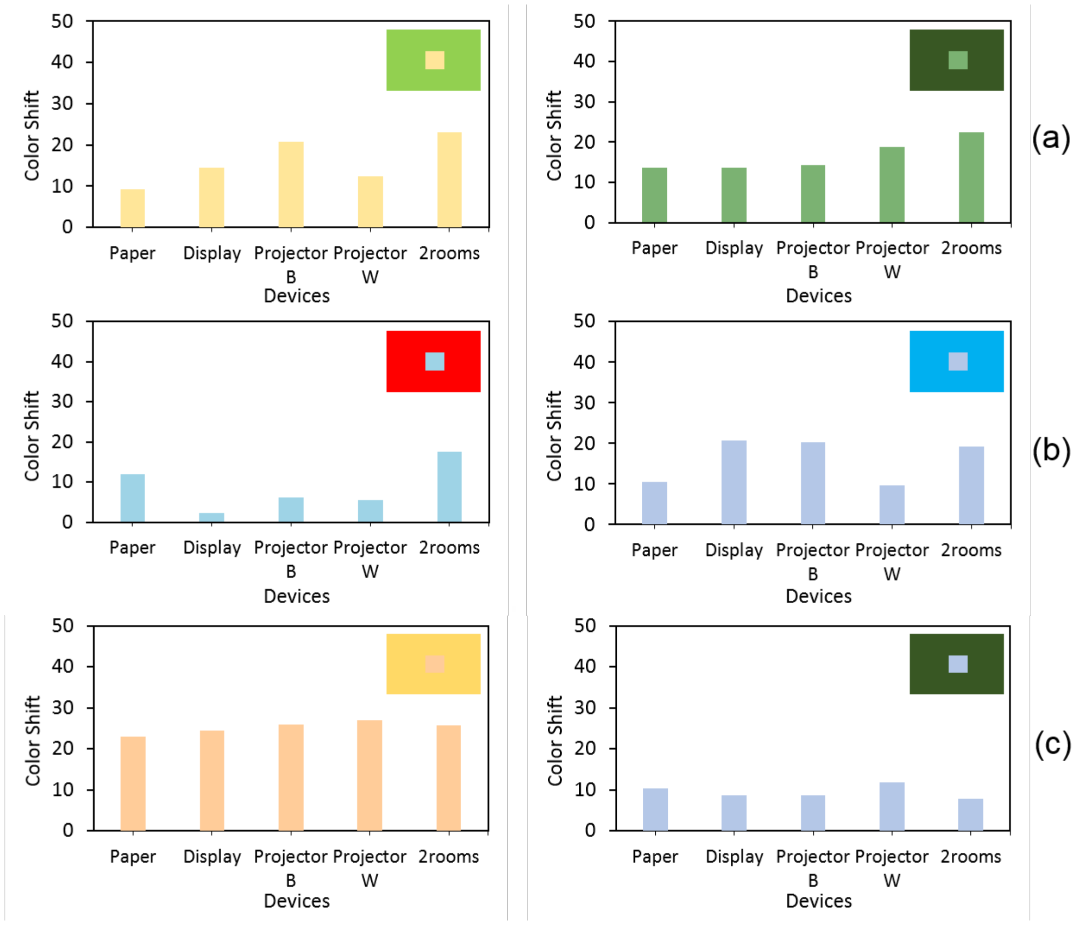

Figure 4. The size of the color shift of test patches with surrounding for different devices. a, yellow-greenish yellow and green-green, b, cyan-red and blue-cyan, c, orange-yellow and cyan-green.

is Two-room.

Fig. 3b shows similar results from another subject MI the results show the same tendency as subject CP.

Finally, we took the average of the color shift of all color pairs from ten subjects and the results are shown in Fig. 4 in samples of color pairs to represent the tendency of the results.

4. Discussion and Conclusion

Fig. 4a, the result of yellow test patch under greenish yellow surround and green test patch under green surround show the similar tendency as the result of Phuangsuwan and Ikeda[2,3] that smallest on object (colored paper) and being larger on display, projector, and two-rooms, respectively. Which can be explained by RVSI theory[1], the chromatic adaptation takes place to the color of light that illuminates the space as in the two rooms technique, a space is illuminated by colored light and the visual system adapts to the color and an electronic display which is self-luminous, the subjects can recognize the color as the illumination. So, the effect should be very small in the colored paper which is object mode.

Fig. 4b, some color pairs were shown dependent on the device also, but no tendency as in Fig. 4a such as cyan test patch under red surround and blue test patch under cyan surround. On the other hand, some color pairs show independent for all device as in Fig. 4c.

Here, the different results were shown under controlled conditions, it would be interesting to investigate this further to explain for these findings. However, the results suggested that the simultaneous color contrast was dependent on the device under controlled conditions as in previous studies, except in some color pairs.

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References

1) V. Ekroll and F. Faul: Transparency perception: the key to understanding simultaneous color contrast. J. Opt. Soc. Am. A. 30-3 (2013). pp.342-352

2) C. Phuangsuwan and M. Ikeda: Simultaneous Color Contrast Demonstrated on Different Devices, Supplement in Journal of the Color Science Association of Japan (CSAJ). 42-3 (2018). pp. 54-56.

3) C. Phuangsuwan and M. Ikeda: Device dependent simultaneous color contrast, Supplement in Journal of the Color Science Association of Japan (CSAJ). 43-3 (2019). pp. 121-124

SIMULTANEOUS BRIGHTNESS CONTRAST MEASURED BY TWO TECHNIQUES: PAPER STIMULI AND SPACE

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Keywords: Simultaneous brightness contrast, Paper stimuli, Space stimuli, Whiteness, Elementary color naming.

1. Introduction

When an experiment of the simultaneous color contrast SCC was carried out by using a two-rooms technique, where the stimuli were produced on the front wall of the subject room by colored illumination, the phenomenon is much more enhanced compared to stimuli that were produced by printed papers.[1)]

In this paper, the same two-rooms technique is applied to the simultaneous brightness contrast SBC and results of printed paper and space stimuli were compared.

2. Paper experiment

2.1 Paper stimuli

Coated papers of A4 size were printed to nine different lightness to be used as surrounds as shown in the first column of Table 1 as L_s^*. Five other papers were printed as shown in the second column of Table 1 as L_t^*. They were cut to pieces of 2×2 cm^2 size to serve test stimuli of the size 2.3° with a view distance 50 cm. Forty-five different stimuli were prepared altogether. Increment or decrement of the test patch is defined as $\Delta L^* = (L_t^* - L_s^*)$ and they are plotted in Fig. 1 for L_s^*. The abscissa gives L_s^* and the ordinate ΔL^*. Each curve corresponds to different L_t^*. A horizontal dotted line is at $\Delta L^* = 0$, or zero contrast, when no test patch is seen.

Table 1 Lightness of surrounds and tests.

L_s^*	L_t^*
11	31
18	37
30	46
39	60
46	69
61	
68	
78	
86	

2.2 Procedure

The experiment was carried out on a table in a normal room with ceiling lamps of the daylight type. The illuminance on the table was 370 lx. Stimuli were presented one by one in a pseudorandom order and subjects assessed the brightness of surround and test patch by the elementary color naming method. When all the forty-five stimuli were observed, one session was over. Six subjects participated in the experiment, four of them did at Mizokami laboratory of Chiba university, Japan and two did at Color Research Center, Rajamangala University of Technology Thanyaburi, Thailand.

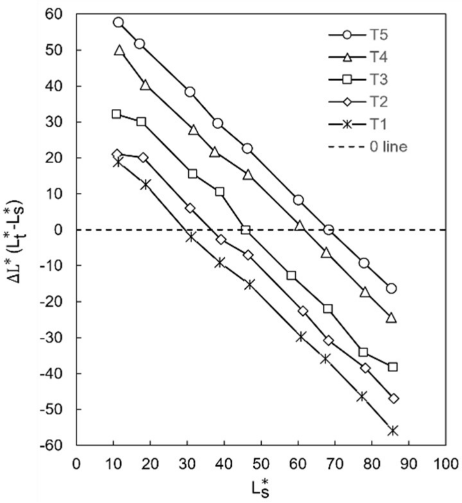


Fig.1 Lightness increment of paper stimuli plotted for the lightness of surround.

2.3 Results of the paper experiment

Whiteness of surrounds are shown in Fig. 2, where the abscissa gives the lightness of surround L_s^* and the ordinate the whiteness of surroundW_s. Each point is the average of six observers. Points can be approximated by a liner equation,

$$W_s = 1.13L_s^* - 6.60, \qquad [1]$$

which is in accordance with a previous finding by Phuangsuwan et al.[2)], where patches of the size 3×3 cm^2 were employed. We can conclude that the amount of whiteness is linearly related to the lightness of papers.

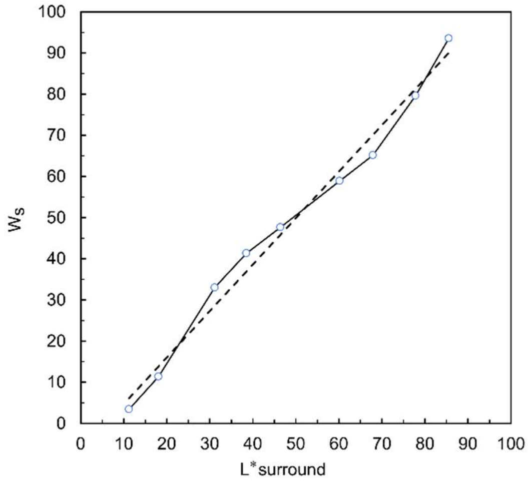


Fig. 2 Whiteness amount of surround W_s plotted for the surround lightness with a regression line.

The amounts of whiteness of test patch W_t are shown in Fig. 3, each curve corresponding to a test patch lightness L_t^*. The short bars attached to curves of T5 and T1 show SD of six subjects. They are not small but the shape of all the curves shows a gradual decrease for larger L_s^*.

Wallach emphasized contrast of the test patch to the surround in determining the brightness of test patch[3)].

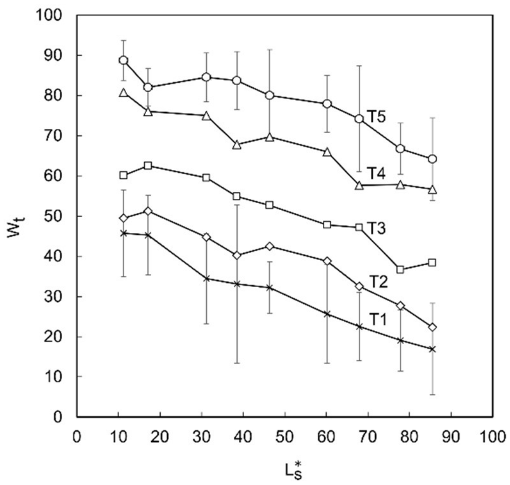


Fig. 3 Amount of whiteness of test patch W_t for five test patches, T1 (bottom) through T5 (top) for surrounding lightness L_s^*. Short vertical bars indicate SD of 6 subjects.

So, we replotted data of Fig. 3 for the luminance contrast C, $\Delta L/L_s$, where $\Delta L=L_t-L_s$. This luminance was measured with Konica Minolta CS150 under the observing situation in the experiment. The results are shown in Fig. 4. Five curves correspond different test patch.

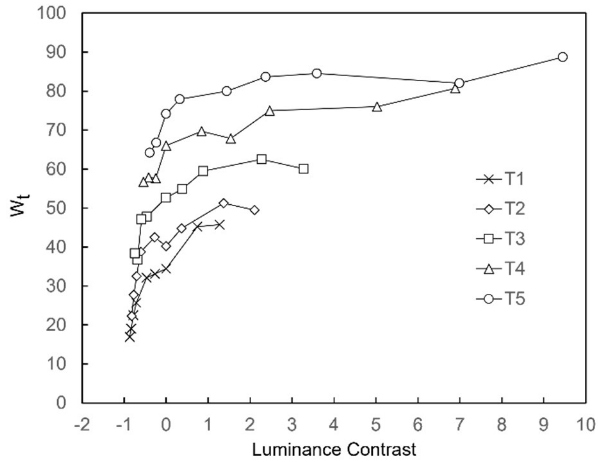


Fig. 4 The amount of whiteness of test patch W_t plotted for the luminance contrast.

It is clear that a same contrast does not necessarily give a same W_t, not in agreement with Wallach's assertion. But we notice that all the curves have a similar shape feature, a rapid rise, a gradual rise, and a saturation.

3. Space experiment

3.1 Space stimuli

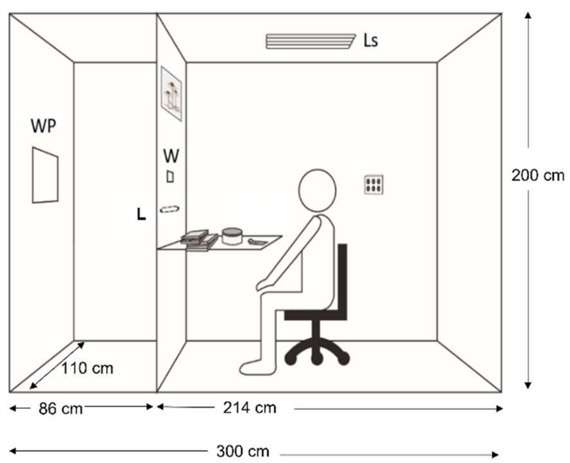


Fig. 5 A scheme of the two-rooms apparatus.

To present space stimuli, a two-rooms technique was used as shown in Fig. 5. The room was composed of a subject room and a test room. On the separating wall a small window W of the size 5×5 cm^2 was opened through which a subject saw a white plate WP. W served a test patch, having the visual angle 2.6° at viewing distance 108 cm. Illuminance of the subject room and that of the test room were controlled by fluorescent lamps of the daylight type, L_s and L, respectively. By controlling them the luminance of the front wall and of WP were made equal to the luminance of the surrounds and the test patch of the paper stimuli, thus giving the same quantal distribution on the retina of the subject as the paper stimuli.

Two subjects, CP and MI participated in the experiment, the authors of the present paper. The experiment was done similarly as in the paper experiment in the way presenting stimuli and responding stimuli by the elementary color naming method. The subjects repeated five times of measurement.

3.2 Results of the space experiment

Results are shown by solid symbols and solid lines in Fig. 6, where the abscissa gives the luminance of the surround Ls and the ordinate the amount of whiteness W_t. Each curve corresponds to a test patch, the curve of T1 locating at the bottom. Dotted lines indicate points of zero contrast. All the curves seem to converge a point of W_t = 100 and from there they gradually drop down separately.

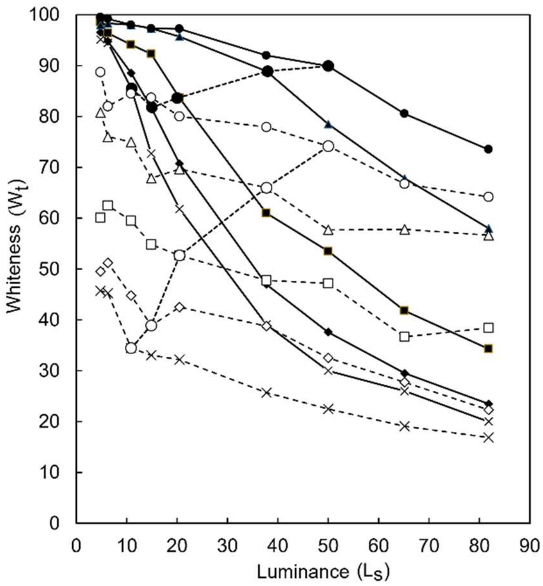


Fig. 6 Averaged amount of whiteness of test stimulus plotted for the surrounding luminance. Filled symbols are from the pace experiment and open symbols are from paper experiment. Points connected by dotted lines indicate zero contrast between the test stimulus and the surround. Dashed curves are for the results of paper experiment.

Open symbols connected by dashed lines are from Fig. 3 of the paper experiment. All the curves are smooth in their shape and do not show any peculiarity at the zero contrast points as reported by Heinemann[4]. Results of both stimuli, space and paper are quite different in spite of the same quantal distribution on the retina for stimuli.

Let show the results of space experiment for the contrast following Wallach's idea. The results are shown on the left in Fig. 7 by filled symbols for the subject MI and open symbols for CP. Data of both subjects came close and the averages were taken for W_t as the figure on the right. Different symbols indicate different test patch. All the data points construct one curve of a nonlinear power equation[5],

$$Y = a10^{-bx}. \quad [2]$$

In the present case, Y corresponds to Wt and x to the L contrast C. a and b are some constants.

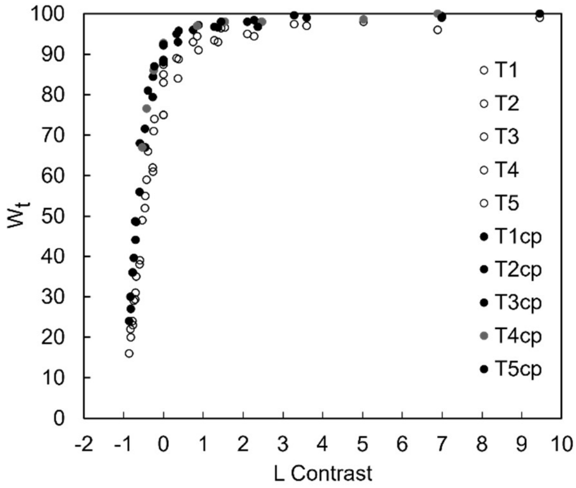
After applying a nonlinear regression, we got

$$Wt = 98 - 13\times10^{-0.9\times C}, \quad [3]$$

which is shown by a solid curve in Fig. 7 right.

4. Discussion and Conclusion

Heinemann reported[4] that at the point of zero contrast of stimulus some peculiarity occurred, but in the present case no such phenomenon occurred as shown in Fig. 7. Heinemann used the matching method to assess the brightness of the test patch. The reference stimulus was composed of only a patch, while the test stimulus was composed of a test patch with surround. When the luminance of the surround becomes higher than the test patch, the patch begins to appear black, which cannot be reproduced by the reference stimulus, thus causing the mercuriality. The present method of the elementary color naming has no such problem and did not show the peculiarity. On the other hand, the elementary color naming method judges the whiteness in percentage with 100 % as the maximum. When the luminance of the surround became low the test patch appeared luminous, but the answer was still 100 or near to it, thus showing at the lowest Ls as seen in the space stimuli in Fig. 7. This is one of the drawbacks of the elementary color naming method.



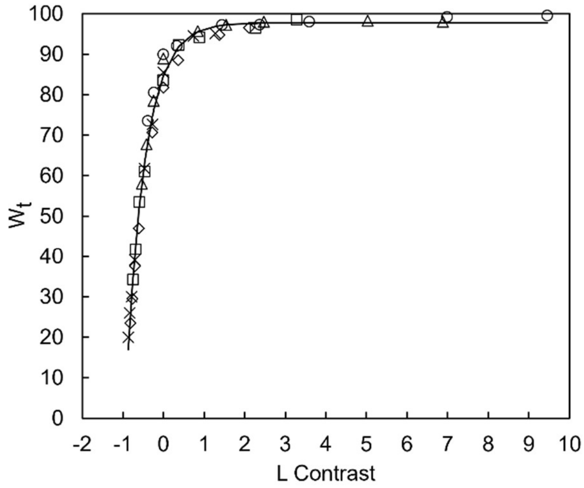


Fig. 7 Left, results of the space experiment from the subject CP (open symbols) and MI (filled symbols). Right, The averaged results of two subjects and a nonlinear regression curve

Both data of paper and space can be expressed by W_t-C curves. So, the Wallach's notion of emphasizing the contrast is appropriate. But it is so for the space experiment but for the paper experiment some other factor should be considered.

Acknowledgement

Four of our students could do part of the paper experiment at Prof. Y Mizokami's lab. of Chiba University, Japan. We thank her for offering them the Asia Student Workshop scholarship. We thank Prof. M Ayama of Utsunokiya University, Japan to suggest us the nonlinear equation for the results of the space experiment.

References

1) C. Phuangsuwan and M. Ikeda: Chromatic adaptation to illumination investigated with adapting and adapted color, Col. Res. Appl. 43 (2017), pp. 571–579.
2) C. Phuangsuwan, S. Saingsamphun, and M. Ikeda: Whiteness (W) and lightness (L*) relationship, J. Col. Sci. Assoc. Jpn. 40 (2016), pp. 157-159.
3) H. Wallach: Brightness constancy and the nature of achromatic colors. Jr Experimental Psychol, 38 (1948), pp. 310-324.
4) E. G. Heinemann: Simultaneous brightness induction as a function of inducing- and test-field luminances, Jr. Exp. Psychol. 50 (1955), pp. 89-96.
5) The nonlinear equation was suggested by M. Ayama who referred to a paper by Shinoda et al.[6]

USE OF REPRESENTATIVE GENDER COLOR FOR TOILET SIGNS

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Keywords: Representative gender color, Toilet sign, Distance, Cataract experiencing goggles.

1. Introduction

This research aimed to investigate the advantage of using representative gender color to the toilet signs by measuring detection distance. The use of color for toilet identification has not been practiced in Thailand as shown in Fig.1 as an example. Pumila et al. (2019) investigated the color to represent gender and showed 5PB4/12 (blue) and 7.5RP5/14 (pink) for male and female, respectively.[1] We further investigated by printing those colors in the rectangular to avoid the recognition by shape. The achromatic stimuli having male and female shape were included to check the influence of chromatic and figures of toilet signs. There were two viewing conditions to observe the toilet signs: with naked eyes and with cataract experiencing goggles. The experiment was caried out outdoor. We expect that the advance of use representative gender color to toilet sign will be clearly shown.

Fig. 1 Example of toilet signs in Thailand.

2. Experiment

Stimuli

Two pairs of stimuli were prepared, one for figures and the other for colors by printing them on papers as shown in Fig. 2. The figures were printed black, and their height was 15 cm. The distance between hands were 6 cm in the male figure and 8.5 cm in the female figure. As for the color stimulus two colored rectangles were prepared. The size was 15 x 7 cm for both male and female, and the color was followed Pumila et al.[1] 5PB4/12 ($L^* = 54.36$, $a^* = -6.44$, $b^* = -37.42$) for male and 7.5RP5/14 ($L^* = 52.16$, $a^* = 33.2$, $b^* = 2.54$) for female. We determined the size of stimuli by surveying the toilet signs around the university campus including a supermarket nearby.

Procedure

The experiment was carried on a straight road in front of the faculty of Mass Communication Technology, MCT under clear sky, where illuminance was around 50,000 lx. The stimulus was presented one by one (one figure or one color) at a time on the standing of which height was 135 cm from the ground as shown in Fig.3. An observer drove a motor bicycle to move away from stimulus to about 300 meters or until she/she could not detect toilet sign at all. Then the observer approached the stimulus by driving a motor bicycle very slowly at about 10 km/hr. The observer stopped from time to time confirming whether he/she could detect the gender. If not, he/she again approached the stimulus and finally found a point where the stimulus was just detectable and measured the distance from the stimulus which was marked on the road and reported it to an experimenter together with the gender of toilet sign that observer had seen by a mobile. This method of obtaining the detectable distance is the method of limits, but only approaching close to stimulus direction. After an experimenter recorded the answer and then changed the stimulus to a male or female figure or one of the representative gender colors. For the color stimulus the observer reported the distance and color only that he/she detected. The experiment was carried out both by naked eyes and by eyes with cataract experiencing goggles. The cataract experiencing goggles was invented by Obama et al. of Panasonic co.[2)] The goggles transmittance was 54% and haze value was 16%.

Six subjects with normal color vision and good visual acuity participated in the experiment. The daily glasses were allowed to use while observer carrying the experiment. They were students and staff of RMUTT. There were 4 females and 2 males with ages range from 20-44 years old. The repetition was 5 times.

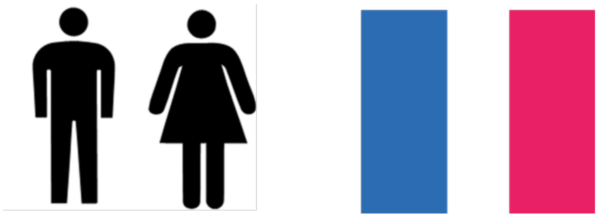

Fig. 2 Stimuli used in the experiment: figures and colors.

Fig. 3 Stimuli used in the experiment: a figure.

3. Results and Discussion

The detection distance of six observers for figure and colors were presented in Fig. 4. Upper figure of Figure 4 shows the detection distance with naked eyes and below with goggles for figure (open bars), for blue (filled bars), and for pink color (shadowed bars). The detection distance of male and female figures was almost same, here we took the average. The ordinate indicates the detection distance in meters and the abscissa indicates observers by their initials. The observers are arranged in the order of the detectable distance for pink with naked.

The result showed clearly that the figures needed the closest distance for detecting the toilet sign. The blue color showed slightly longer distance than the figure sign. The pink color gave longest distance to detect than any other stimuli. The same tendency result occurred in the goggles condition. Moreover, it is clear that detectability decreased with goggles. To see the advantage of colors to figures, the distance ratios (colors/figures) were calculated, and the result is shown in Fig. 5.

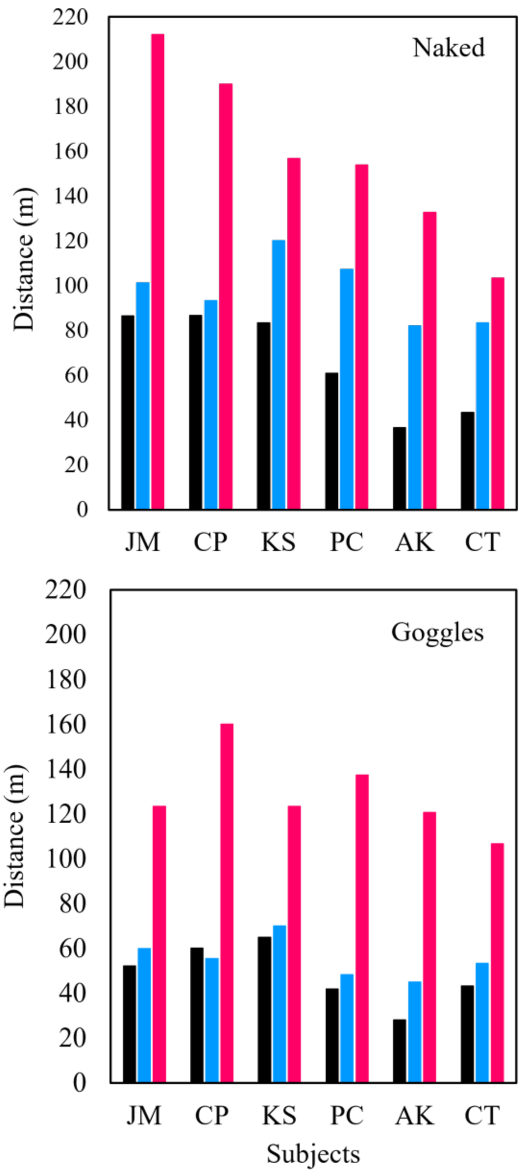

Fig. 4 Detecting distances shown by bar graph. Upper, with naked eyes; lower, with goggles.

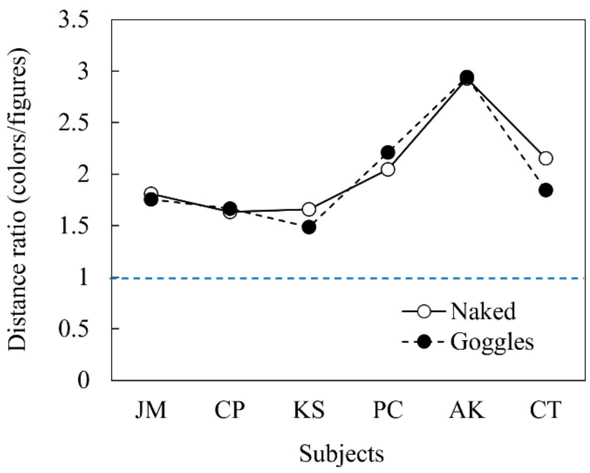

Fig. 5 Distance ratio between figures and colors.

The abscissa indicates observer's initial, and the ordinate indicates distance ratio. Opened symbols were the ratios of naked eyes and filled symbols of goggles. The ratios were obtained from color divide by figures (for the colors, an average distance of pink and blue; for the figures, an average distance of male and female figures). All the ratios are over unity to imply that observers could detect ~~to~~ colors stimuli better than figures stimuli with both normal and cataract eyes.

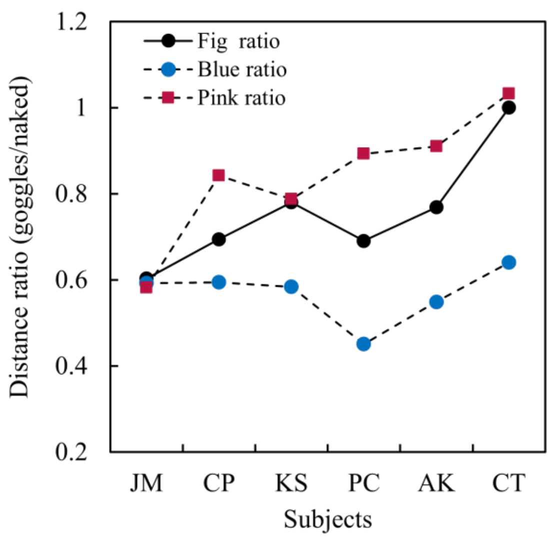

Fig. 6 The distance ratio between goggles and naked eyes.

To see the detectability of each stimulus: pink, blue and figures, the distance ratio calculated by distance of goggles divided by distance of naked eyes were obtained and shown in Fig. 6. The abscissa indicates the observer's initial, and the ordinate indicates the distance ratio. The ratio results showe~~d~~ variance among observers excepting blue. The highest ratio occurred at the pink color except for the observer JM. The result implies that elderly people (normally with cataract) can see pink color well even it locates at far distance. The ratio of blue color showed lowest compared to others. But if we use the pink together with blue for the toilet signs, people can detect the pink color easily to judge it a female toilet and they will automatically guess another nearby sign to be male.

5. Conclusion

It was shown that to adopt representative gender color for toilet is useful for detecting toilet signs for normal and elderly people. We recommend the Thailand government to consider improving the toilet sign by using the color codes as examples shown in Fig. 7.

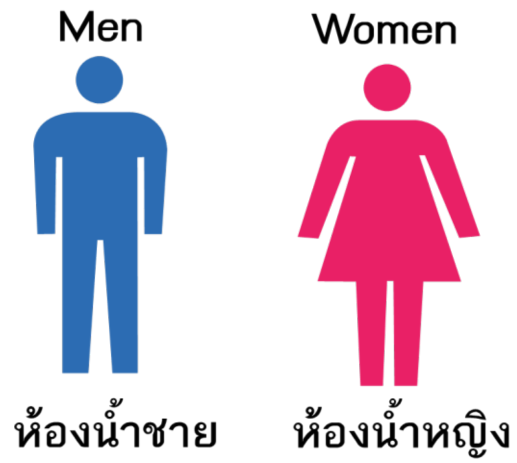

Fig. 7 Toilet signs with representative gender colors.

Acknowledgement

We acknowledge all the students who belong to Ikeda and Chompoo laboratory, who participated in this experiment.

References

1) W. Pumila, C. Phuangsuwan, Y. Mizokami and M. Ikeda: Colors for female and male image by Thai and Japanese people, Proceedings of ACA2019Nagoya conference. (2019), pp. 204–209.

2) T. Obama, H. Uozato, H. Teramachi and M. Matsuoka: A qualitative determination of senile cataract experience filters, J. Col. Sci. Assoc. Jpn. 28 (2004), pp. 245-252. [in Japanese]

Colors, Color Preferences, and Everyday Objects

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Keywords: Color preference, bedroom, clothes, kitchen appliances, color pencils

1. Introduction

Numerous studies[1,2] have examined human preferences for simple patches of color but is not yet clear how these abstract color preferences generalize to different object contexts.

The purpose of this study is to investigate and identify the association between color preferences and everyday objects. The aim is to identify whether personal color preferences extend to everyday products when there are numerous color choices, or to what degree might an individual want personal color preference to feature in their everyday objects.

2. Methodology

2-1. Participants

122 Japanese university students (67 female and 55 male) between the ages of 19 to 24 (M=20.7) participated in this study.

2-2. Procedure

Before the experiment, each participant was provided with a set of 48 color pencils. The name of the color pencils was written on them, and participants were to use those names. The experiment consisted of the following steps which was done randomly among the participants:

- Respondents were asked to choose most/least favorite, happiest/saddest, most beautiful/ugliest, masculine/feminine, warmest/coolest, brightest/darkest, most powerful/weakest, most peaceful/chaotic, most modern/old-fashioned, most formal/casual, most unique/ordinary, softest/hardest, most refreshing/boring, most elegant/unsophisticated color among the color pencils. They were advised to write the name of the color pencil as well as use the chosen color pencil to write the answer.
- Participants were given detailed realistic drawings of bedroom, car (sports car and SUV), clothes (women's night gown, men's suit, polo shirt), and kitchen tools (pots, utensils, dinnerware) and were asked to consider these items as their own and color them accordingly. (*Due to copyright issues, the figures cannot be shared in this research paper.*)

3. Results

3-1. Color Preferences and characteristics

This section focuses on the step where participants had to choose a color for a specific character and adjective. Due to space, only some of these are discussed within this research paper. In addition, please note that only colors selected are shown in the figures.

As it can be observed from Figure 1, blue and red hues are among most favorite colors of the participants. White, light yellow, and yellow are considered bright.

Moreover, blue hues are considered masculine, while light carmine and pink are considered feminine. Lavender and turquoise are considered the most beautiful colors by the respondents. Lavender is considered elegant as well. Peach and lime green are considered as peaceful colors.

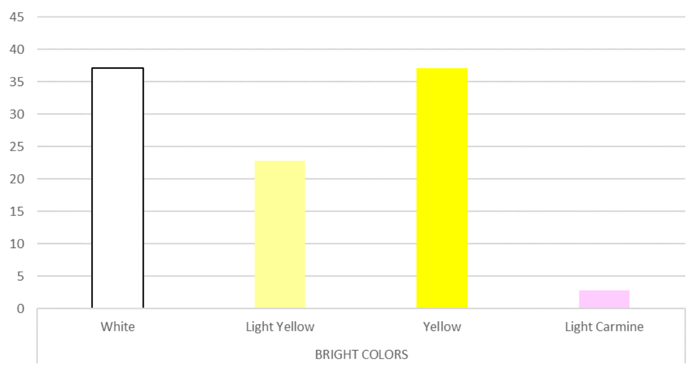


Figure 1A. Bright colors

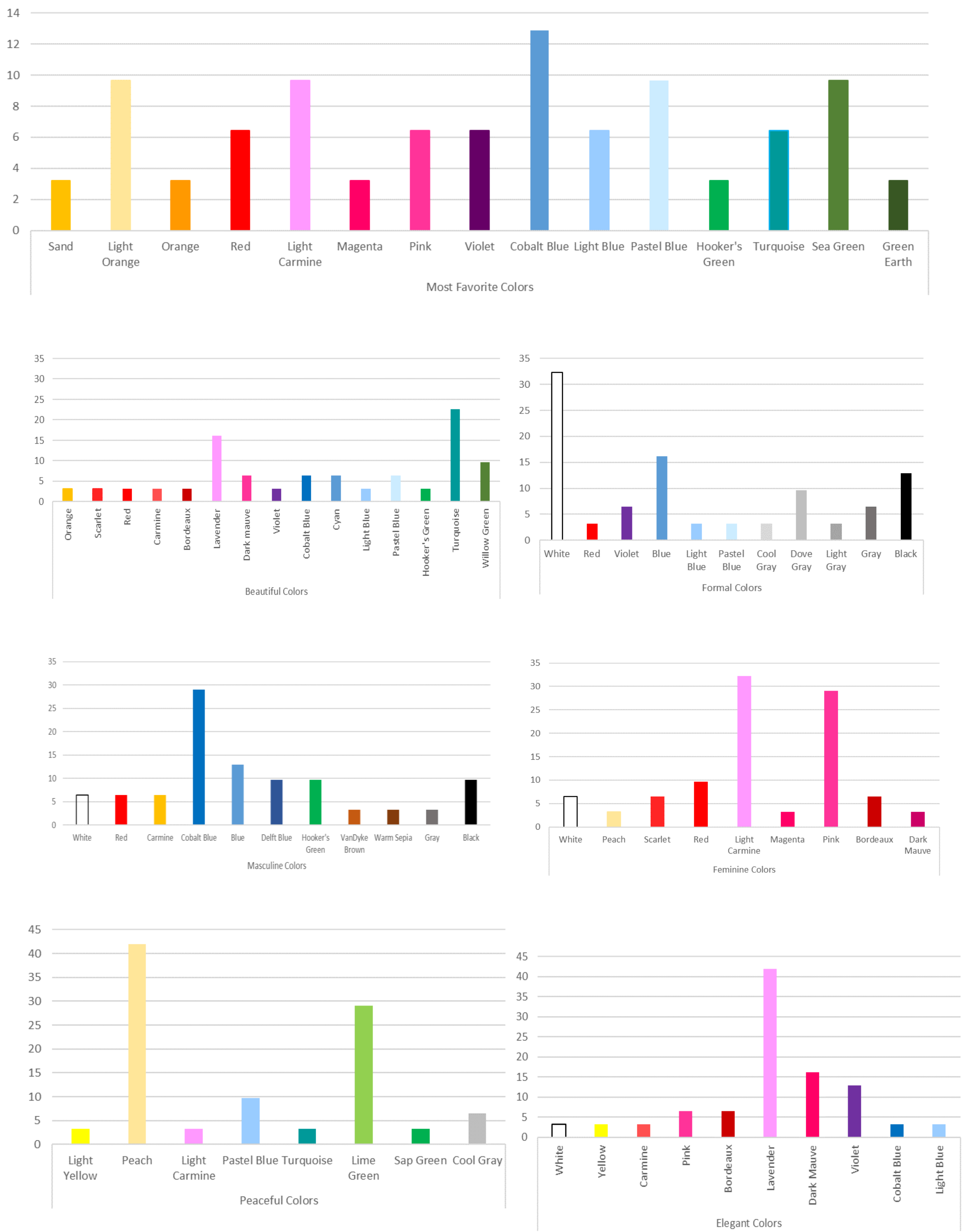
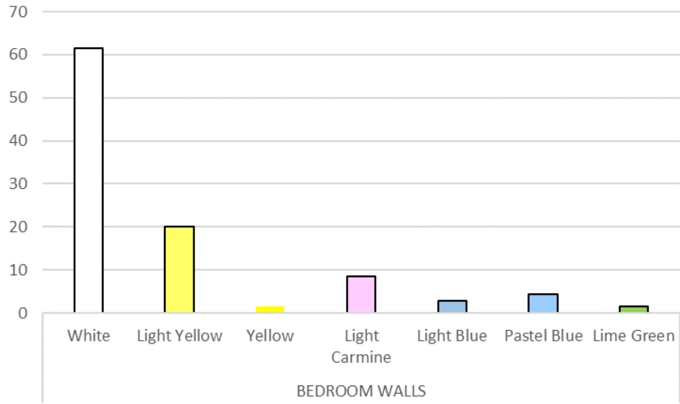
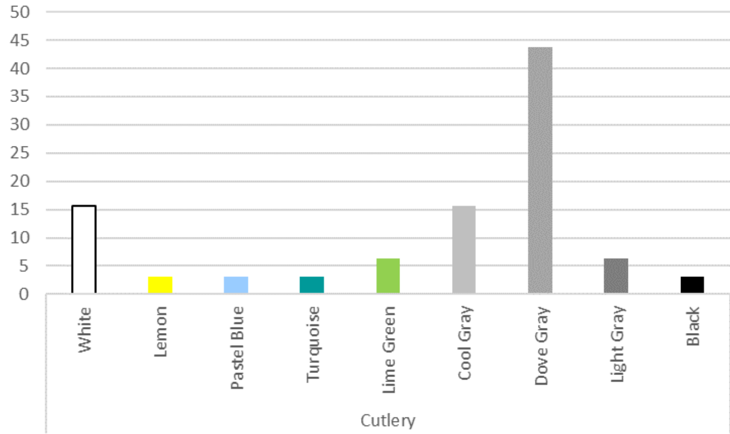
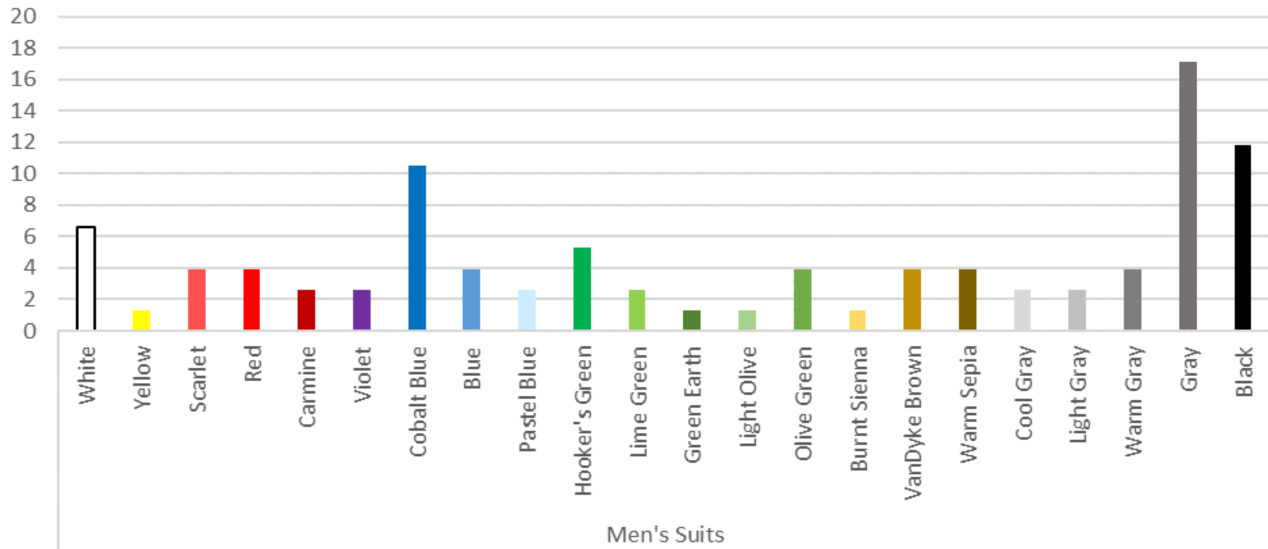


Figure 1B. Favorite, beautiful, formal, masculine, feminine, peaceful, and elegant colors







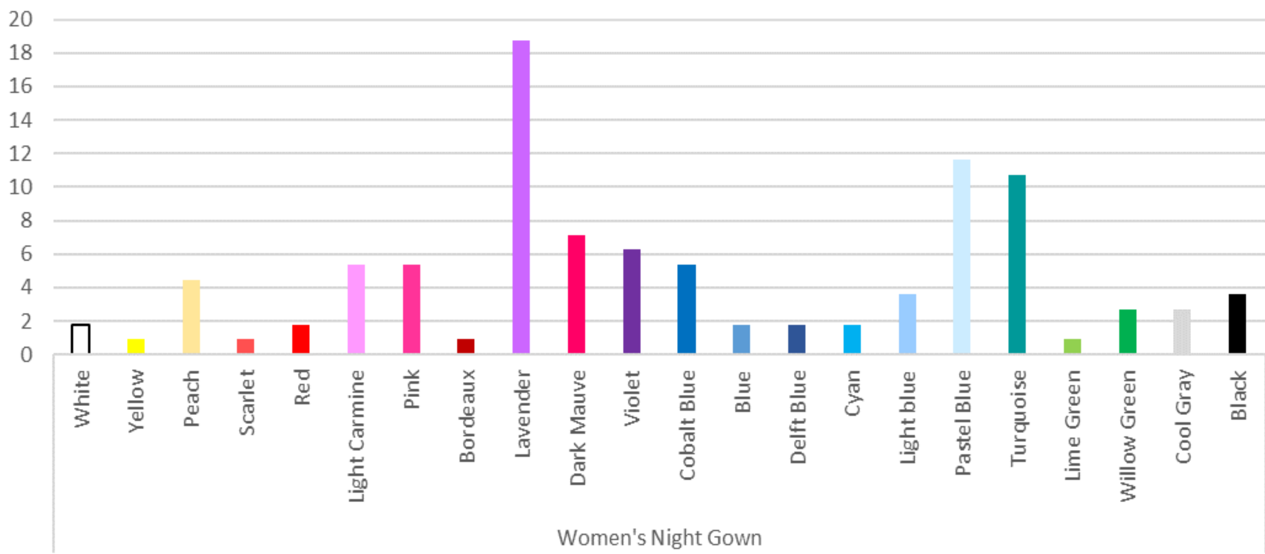


Figure 2. Color preferences for bedroom walls, cutlery, men's suits, and women's night gown

3-2. Preferences for objects

Participants were given realistic drawings of different items and were asked to consider these items as their own and color them accordingly. The results can be seen in Figure 2. As can be observed, white is the color used the most in the bedroom walls ($P<0.01$).

Gray hues, blue hues, and black are colors used in the men's suits. These are colors that are considered masculine and formal. Lavender, turquoise, and pastel blue are colors selected the most for the night gown. These are colors that are considered elegant and beautiful. Moreover, gray hues were used for cutlery. Participants stated that they like silverware and that's why they chose these colors.

4. Discussion

The purpose of this study was to identify whether personal color preferences extend to objects when there are numerous color choices. It was observed that participants used colors considered bright in their bedroom walls. Moreover, more than 60% used white. Similar result was observed in another study[3] as well. The participants of this study were Japanese and since Japanese houses are small, this could be the reason for using bright colors. The night gown was mainly in colors they consider beautiful and elegant, and the suit was in colors they consider masculine and formal. Moreover, although some participants did choose their favorite color for the cutlery, but they mainly selected gray hues as they stated that they like silverware.

Although not featured in this research paper, but other kitchen tools were in colors they consider normal for these items. For example, black was selected the most for frying pan. They stated that this is the best color for heat. White was mainly selected for plate because they said that white makes food look delicious. Warm sepia was selected the most for chopsticks as it resembles the color of wood. Red was most selected for the sports car. SUV was in colors they thought is suitable for outdoor activities.

In sum, it was observed that rather than using their preferred color for every item, the participants used colors which they thought were most suitable for the product.

References

1) K.B Schloss, E.D. Strauss, and S.E. Palmer: Object Color Preferences, Color Research and Application. 38-6 (2013), pp. 393-411

2) S.E. palmer and K.B. Schloss: An ecological valence theory of human color preference, Proceedings of the National Academy of Sciences of the United States of America. 107-19 (2010), pp. 8877-8882

3) M. Baniani and S. Yamamoto: A comparative study on correlation between personal background and interior color preference, Color Research and Application. 40-4 (2015), pp. 416-424