J-STAGE Advanced published date: August 24, 2016, doi: 10.2150/jlve.IEIJ160000575

**Paper**

# Effects of Spectral Component of Light on Appearance of Skin of Woman's Face with Make-up

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Received February 23, 2016, Accepted June 24, 2016

ABSTRACT

This study aims to clarify which spectral component is critical for preferable appearance of the skin of the women's faces in daily lives. We conducted a subjective experiment on the appearance of a woman's face with make-up. We created spectral distributions by adding or cutting a specific wavelength on a flat spectral distribution with a wavelength programmable light source. We set up 53 kinds of lighting conditions with different spectral distributions in total. We measured the skin color of the face of the female model, and transformed measured chromaticity values into RGB values of a calibrated LC-display for generating the digital images of the lower half of the face. Twenty female participants observed the cheek illuminated by one of lights with different spectral distributions and evaluated the "naturalness", "activity", "sophistication", "health", "familiarity" and "preference" of the face. The results show that the lighting including the spectral component of 534 nm makes look the women's skin worst, and the preference of women's face can be explained with three aspects, naturalness, activity and sophistication.

KEYWORDS: appearance of face skin, spectral component of light, preference

## 1. Introduction

The appearance of skin of women's face with make-up is one of the important factors for their own fashion and self-expression in daily lives. The color appearance of the skin depends on the spectral distribution of the luminaires. Recently, LED lamps have been popular as luminaires in our environments. The spectral distributions of LED lamps are generally different from conventional lamps such as incandescent lamps and fluorescent lamps.

The impression of a woman's face under low correlated color temperature was better compared to under high color temperature using some kinds of LED lamps[1]. Also, it was reported that evaluations of human complexions under the illuminations were determined by two main factors, "activity" and "refinement" according to the experimental results using fluorescent lamps differing in correlated color temperature[2)3]. The preferred complexion of Japanese women was shown in chromaticity coordinates under 40 lighting color conditions using fluorescent lamps[4], and a preference index *PS* for Japanese women complexion was proposed[5]. It was confirmed that *PS* for Japanese women complexion was suitable to the evaluation results under various kinds of light sources including fluorescent lamps defined by CIE15.3[6] and LED lamps, white LEDs (blue chips and some phosphors) and RGB LEDs (blue, green and red chips)[7].

Meanwhile, several kinds of research on the estimation of human skin color have been reported in vision science, imaging technology and computer graphics[8)–15]. The data of approximately 800 skins' color of Japanese female in 1991–1992 and in 1999–2002 were published, implying that the facial skin color became lighter[13] with the times. On the other hand, it was reported that the perceived age of the skin is affected by the luminance distribution by analyzing skin images[14]. In addition, the concentration of pigments in the human skin can be estimated by the measured surface spectral reflectance[15]. Thus, imaging technology will be a powerful tool for studying visual appearance depending on lighting.

The present study aims to clarify which spectral component is critical for preferable or unfavorable appearance of the skin of the women's faces in daily lives. We conducted a subjective experiment under some lighting conditions differing the spectral distribution. We used carefully reproduced digital images of the women's face as visual stimuli[16].

## 2. Methods

### 2.1 Setting of lighting conditions

We set up the lighting conditions using a wavelength programmable light source (One Light Spectra, One Light Corporation) that could create arbitrary spectral power distributions. First, a flat spectral distribution ranging from 420 to 640 nm was prepared. Next, a spe-

doi: 10.2150/jlve.IEIJ160000575

cific wavelength's component from 424 to 636 nm was added or cut on the flat spectral power distribution in 8 or 9 nm pitch. We prepared 53 kinds of lighting conditions with different spectral distributions in total. Figure 1 shows 53 kinds of spectral power distributions. Table 1 indicates the details of each lighting condition. The range of the correlated color temperature of these lighting conditions was from 5029–6344 K, and the mean value was 5726 K.

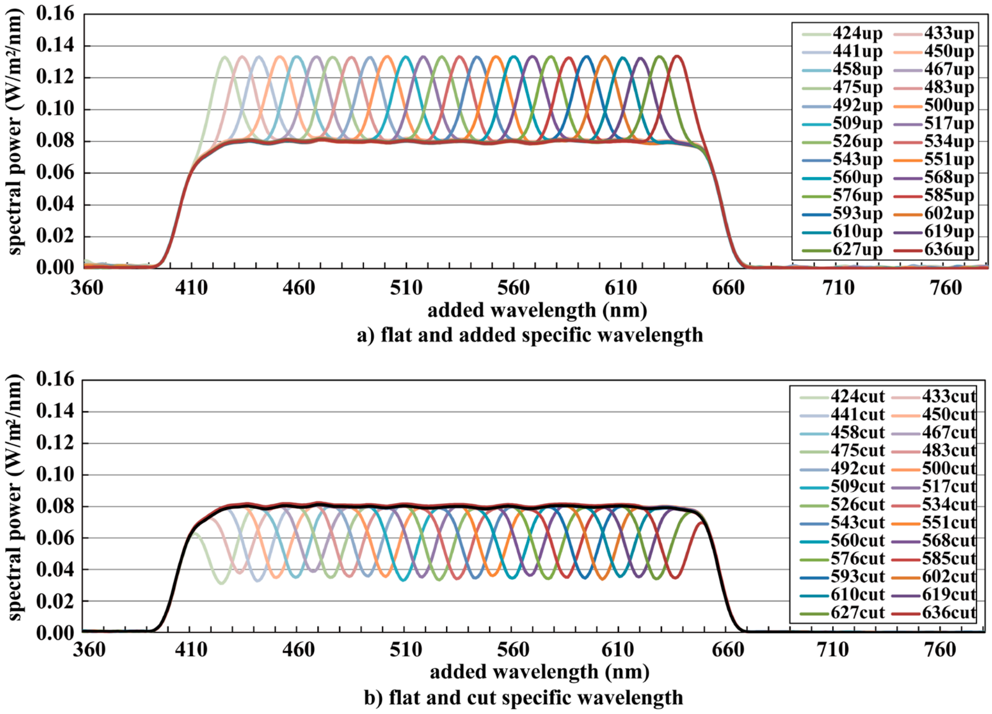


Figure 1 Spectral power distribution of lighting conditions.

Table 1 Properties of all lighting conditions.

| Conditions | *x* | *y* | CCT[K] | *⊿uv* | *Ra* | *R13* | *R15* | Conditions | *x* | *y* | CCT[K] | *⊿uv* | *Ra* | *R13* | *R15* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| flat | 0.328 | 0.336 | 5698 | -0.001 | 97.1 | 98.1 | 95.4 | | | | | | | | |
| +424 | 0.322 | 0.324 | 6025 | -0.004 | 95.9 | 96.7 | 94.9 | -424 | 0.334 | 0.347 | 5453 | +0.003 | 96.2 | 98.2 | 93.6 |
| +433 | 0.320 | 0.319 | 6190 | -0.006 | 95.4 | 96.1 | 94.8 | -433 | 0.336 | 0.351 | 5376 | +0.004 | 95.8 | 97.7 | 92.6 |
| +441 | 0.318 | 0.316 | 6298 | -0.006 | 95.3 | 95.5 | 95.2 | -441 | 0.338 | 0.355 | 5283 | +0.005 | 95.5 | 96.9 | 91.2 |
| +450 | 0.318 | 0.317 | 6310 | -0.006 | 95.9 | 95.5 | 96.4 | -450 | 0.338 | 0.355 | 5271 | +0.004 | 95.9 | 96.4 | 90.6 |
| +458 | 0.317 | 0.317 | 6342 | -0.005 | 96.2 | 95.1 | 96.9 | -458 | 0.338 | 0.353 | 5266 | +0.004 | 95.8 | 95.7 | 90.1 |
| +467 | 0.318 | 0.322 | 6236 | -0.003 | 95.8 | 95.5 | 98.1 | -467 | 0.337 | 0.348 | 5329 | +0.002 | 95.1 | 95.6 | 90.7 |
| +475 | 0.320 | 0.326 | 6150 | -0.002 | 95.0 | 95.9 | 99.0 | -475 | 0.336 | 0.344 | 5362 | +0.000 | 94.2 | 95.3 | 91.2 |
| +483 | 0.321 | 0.332 | 6053 | +0.000 | 94.8 | 96.7 | 99.0 | -483 | 0.334 | 0.340 | 5428 | -0.001 | 94.2 | 95.5 | 92.5 |
| +492 | 0.322 | 0.336 | 5990 | +0.002 | 95.3 | 97.7 | 97.4 | -492 | 0.333 | 0.336 | 5464 | -0.003 | 94.4 | 95.8 | 93.8 |
| +500 | 0.322 | 0.340 | 5978 | +0.004 | 95.9 | 98.9 | 95.5 | -500 | 0.333 | 0.332 | 5466 | -0.005 | 94.8 | 96.2 | 95.2 |
| +509 | 0.322 | 0.344 | 5971 | +0.006 | 96.6 | 99.2 | 93.1 | -509 | 0.334 | 0.328 | 5429 | -0.007 | 95.0 | 96.2 | 96.7 |
| +517 | 0.322 | 0.347 | 5969 | +0.008 | 96.6 | 97.4 | 91.2 | -517 | 0.334 | 0.326 | 5440 | -0.009 | 95.2 | 96.0 | 97.0 |
| +526 | 0.322 | 0.350 | 5943 | +0.009 | 95.2 | 95.4 | 90.0 | -526 | 0.333 | 0.323 | 5443 | -0.010 | 94.3 | 94.9 | 96.3 |
| +534 | 0.323 | 0.351 | 5886 | +0.009 | 93.1 | 93.5 | 89.4 | -534 | 0.332 | 0.322 | 5495 | -0.010 | 92.6 | 93.3 | 95.5 |
| +543 | 0.325 | 0.351 | 5808 | +0.008 | 91.1 | 91.2 | 88.0 | -543 | 0.331 | 0.322 | 5580 | -0.009 | 91.5 | 91.6 | 94.5 |
| +551 | 0.328 | 0.351 | 5710 | +0.007 | 89.4 | 88.2 | 85.5 | -551 | 0.328 | 0.323 | 5695 | -0.008 | 91.2 | 89.3 | 92.9 |
| +560 | 0.330 | 0.350 | 5597 | +0.005 | 88.9 | 86.3 | 83.8 | -560 | 0.326 | 0.323 | 5825 | -0.007 | 90.9 | 86.6 | 90.6 |
| +568 | 0.334 | 0.348 | 5458 | +0.003 | 88.2 | 85.2 | 81.8 | -568 | 0.323 | 0.326 | 5958 | -0.004 | 91.8 | 87.3 | 90.0 |
| +576 | 0.337 | 0.345 | 5326 | +0.000 | 88.9 | 87.6 | 81.3 | -576 | 0.320 | 0.327 | 6126 | -0.001 | 92.4 | 89.5 | 88.6 |
| +585 | 0.340 | 0.342 | 5195 | -0.002 | 90.4 | 91.9 | 82.6 | -585 | 0.317 | 0.330 | 6251 | +0.001 | 94.8 | 95.0 | 91.0 |
| +593 | 0.342 | 0.340 | 5096 | -0.005 | 92.3 | 95.9 | 87.7 | -593 | 0.315 | 0.332 | 6345 | +0.004 | 97.4 | 98.6 | 97.8 |
| +602 | 0.343 | 0.338 | 5029 | -0.006 | 92.9 | 95.0 | 94.4 | -602 | 0.314 | 0.334 | 6397 | +0.005 | 96.0 | 94.0 | 93.3 |
| +610 | 0.343 | 0.336 | 5041 | -0.007 | 93.0 | 92.6 | 94.4 | -610 | 0.314 | 0.336 | 6365 | +0.006 | 93.4 | 91.4 | 86.7 |
| +619 | 0.341 | 0.335 | 5113 | -0.007 | 93.9 | 91.8 | 91.7 | -619 | 0.316 | 0.337 | 6279 | +0.005 | 92.0 | 91.0 | 84.1 |
| +627 | 0.339 | 0.335 | 5188 | -0.006 | 93.6 | 91.9 | 90.8 | -627 | 0.318 | 0.337 | 6188 | +0.005 | 91.6 | 91.6 | 83.9 |
| +636 | 0.337 | 0.335 | 5287 | -0.005 | 94.2 | 93.2 | 92.2 | -636 | 0.320 | 0.337 | 6071 | +0.003 | 92.5 | 93.1 | 86.1 |

doi: 10.2150/jlve.IEIJ160000575

### 2.2 Generating of visual images

First, we prepared a female model for making visual stimuli. She was 22 years old, and usually used a base-cream (ARSOA, Livest's SP Prepare Lotion), a cosmetic powdery foundation (Kanebo, Coffret D'or Silky Fit, beige B) and a face powder (ARSOA, Livest's pressed powder S) in makeup. Table 2 shows the color data of the lower cheek skin of the female model and the Japanese female data of skin color reported in the previous study[13]. Also, Figure 2 shows the spectral reflectance rate of the lower cheek skin, measured by spectrophotometer [CM-700D, KONICA-MINOLTA]. Secondly, we measured the chromaticity values of her face with make-up using a 2D colorimeter (Topcon, UA-1000) under the 53 lighting conditions mentioned in the previous section. Figure 3 shows the measurement space. Thirdly, measured chromaticity values of the face were transformed into their RGB values using the calibration data of a LC-display (EIZO, CG245W) used in this experiment. According to the color management process, the digital images were displayed with the same chromaticity values as the real object very precisely. Table 3 shows the chromaticity values of the model's lower cheek of each digital image.

### 2.3 Experimental procedure

Each generated image of the woman's face was presented on the calibrated LC-display. Figure 4 shows the experimental room. The lower half of the woman's face was displayed to concentrate participant's attention in order to the lower cheek and to avoid recognizing the expression of the woman. Figure 5 shows the displayed visual images under all conditions with added component including the flat spectral distribution.

Five kinds of evaluation aspects, naturalness, activity, sophistication, health and familiarity, were answered as the appearance of the face skin with make-up, considering results of the previous studies[2]. Each visual image for evaluation was presented to a participant for 60 s. Participants observed both of lower cheeks of the woman's face and evaluated the appearance of the face skin in these aspects, and also evaluated preference as the comprehended appearance of the face skin. They rated each evaluation according to a 21 steps numerical scale from −10 (bad) to +10 (good) under the 53 lighting conditions. The blank was presented between the evaluation images for 10 s for cancelling effects of the former condition.

Twenty undergraduate students participated in this experiment. They were all female in their twenties. They passed Ishihara test, thus all participants had normal color vision.

## 3. Results

The evaluation results acquired in this experiment were shown graphically in the median values of the responses and the standard errors. We analyzed the data as the basis on the results of ANOVA and Tukey's HSD.

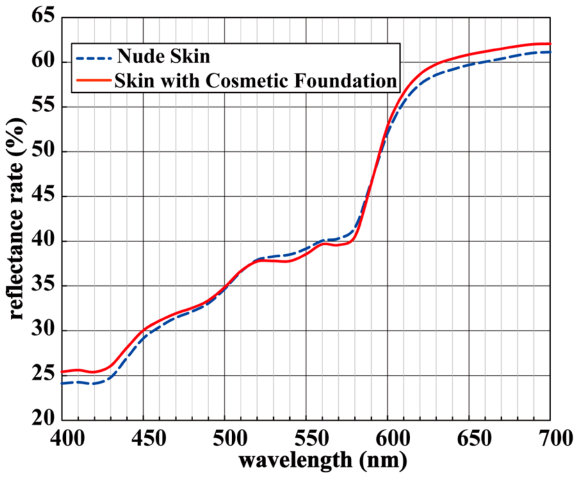


Figure 2 Spectral reflectance of the lower cheek skin of the female model.

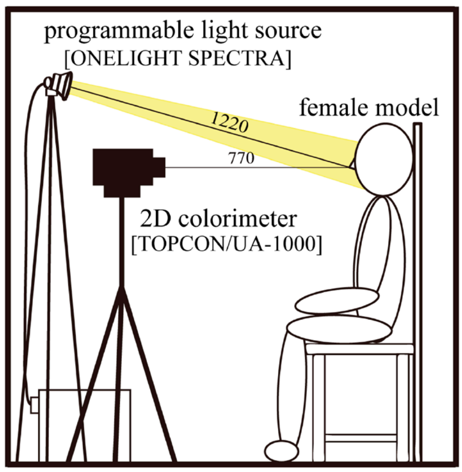


Figure 3 Measurement space.

Table 2 Color data of the lower cheek skin of the female model.

| target color | Hue | Value | Chroma | Melanin Index |
|---|---|---|---|---|
| skin with makeup of this female model | 4.25YR | 6.93 | 3.34 | — |
| naked skin of this female model | 6.00YR | 6.94 | 3.28 | 1.04 |
| average of Japanese female skin in 2001[13] | 5.57YR | 6.91 | 3.54 | 1.14 |

doi: 10.2150/jlve.IEIJ160000575

Table 3 Color data of the lower cheek skin of the female model.

| Conditions | Y | x | y | Conditions | Y | x | y |
|---|---|---|---|---|---|---|---|
| flat | 19.9 | 0.414 | 0.379 | | | | |
| +424 | 19.9 | 0.402 | 0.375 | -424 | 19.0 | 0.414 | 0.388 |
| +433 | 20.3 | 0.408 | 0.367 | -433 | 19.1 | 0.413 | 0.390 |
| +441 | 20.0 | 0.394 | 0.364 | -441 | 18.7 | 0.418 | 0.391 |
| +450 | 20.6 | 0.398 | 0.363 | -450 | 19.0 | 0.417 | 0.396 |
| +458 | 20.4 | 0.396 | 0.363 | -458 | 19.8 | 0.422 | 0.391 |
| +467 | 19.4 | 0.401 | 0.368 | -467 | 19.5 | 0.421 | 0.387 |
| +475 | 19.6 | 0.401 | 0.366 | -475 | 19.8 | 0.420 | 0.386 |
| +483 | 19.9 | 0.406 | 0.374 | -483 | 20.7 | 0.417 | 0.384 |
| +492 | 20.9 | 0.404 | 0.378 | -492 | 18.9 | 0.418 | 0.377 |
| +500 | 20.5 | 0.400 | 0.381 | -500 | 20.3 | 0.415 | 0.378 |
| +509 | 20.1 | 0.407 | 0.385 | -509 | 20.9 | 0.415 | 0.379 |
| +517 | 21.1 | 0.400 | 0.389 | -517 | 19.8 | 0.418 | 0.369 |
| +526 | 19.4 | 0.403 | 0.390 | -526 | 18.8 | 0.418 | 0.367 |
| +534 | 20.1 | 0.395 | 0.396 | -534 | 19.2 | 0.417 | 0.365 |
| +543 | 20.3 | 0.401 | 0.394 | -543 | 20.3 | 0.415 | 0.365 |
| +551 | 20.1 | 0.399 | 0.397 | -551 | 19.3 | 0.418 | 0.364 |
| +560 | 20.1 | 0.406 | 0.391 | -560 | 19.5 | 0.419 | 0.364 |
| +568 | 19.6 | 0.403 | 0.395 | -568 | 19.4 | 0.417 | 0.364 |
| +576 | 20.5 | 0.412 | 0.387 | -576 | 19.5 | 0.411 | 0.373 |
| +585 | 20.0 | 0.419 | 0.383 | -585 | 20.3 | 0.402 | 0.374 |
| +593 | 20.3 | 0.427 | 0.380 | -593 | 18.6 | 0.397 | 0.379 |
| +602 | 20.4 | 0.426 | 0.379 | -602 | 19.1 | 0.390 | 0.383 |
| +610 | 20.4 | 0.432 | 0.375 | -610 | 18.5 | 0.397 | 0.380 |
| +619 | 19.4 | 0.430 | 0.374 | -619 | 18.5 | 0.394 | 0.384 |
| +627 | 20.1 | 0.426 | 0.376 | -627 | 18.7 | 0.395 | 0.386 |
| +636 | 20.0 | 0.426 | 0.372 | -636 | 19.1 | 0.402 | 0.382 |

Illuminance on the face : 300 lx

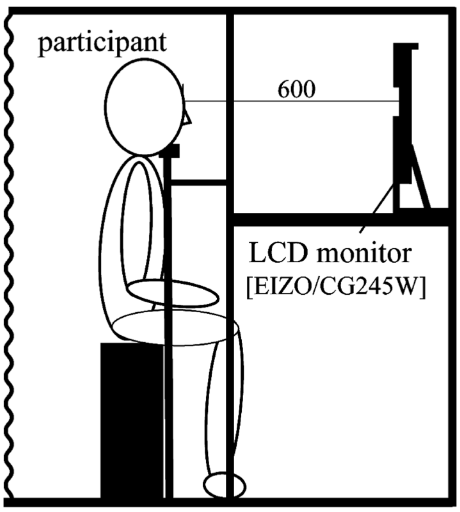


Figure 4 Experimental Space.

### 3.1 Results of "naturalness" of the woman's face

Figure 6 illustrates the results of "naturalness" of the face skin under each lighting condition. The evaluation of naturalness (*En*) was significantly affected by the lighting conditions ($p<.001$). *En* was less than −1 under the lighting added the component of 517–551 nm, and was the lowest (*En*=−3.75) in the case of the lighting added the component of 534 nm. *En* was also low (*En*=−2.30) under the lighting conditions cut the component of 610 nm and 636 nm whereas *En* was more than 3 under the lighting added the components of 467 nm and 593–627 nm, and under the lighting cut the components of 467 nm, 475 nm and 492–509 nm. *En* under the lighting added the component of 593–627 nm was higher than that added 517–560 nm ($p<.05$). Also, *En* under the lighting cut the components of 610 nm and 636 nm was lower than that cut 458–509 nm, 526–560 nm and 576–585 nm ($p<.05$).

### 3.2 Results of "activity" of the woman's face

Figure 7 illustrates the results of "activity" of the face skin under each lighting condition. The evaluation of activity (*Ea*) was significantly affected by the lighting conditions ($p<.001$). *Ea* was less than −2 under the lighting added the components of 517 nm and 534–560 nm, and was the lowest (*Ea*=−3.75) in the case of the lighting added the component of 534 nm. It was also low (*Ea*=−2.70) under the lighting conditions cut the component of 636 nm whereas *Ea* was more than 3 under the lighting added the component of 585–636 nm, and under the lighting cut the components of 475 nm, 492–534 nm and 551–560 nm. *Ea* under the lighting added the component of 585–636 nm was higher than that added 500–576 nm ($p<.05$). Also, *Ea* under the lighting cut the component of 492–560 nm was higher than that

doi: 10.2150/jlve.IEIJ160000575

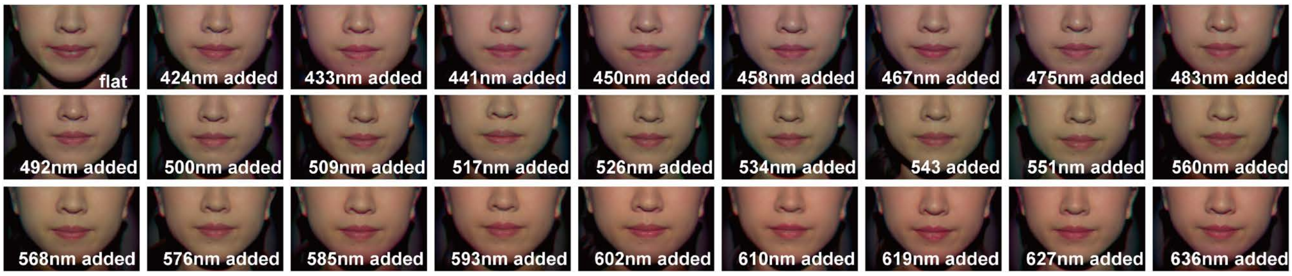


Figure 5 Visual images under the lighting conditions of the flat spectral power distribution and the added a specific wavelength on the flat distribution.

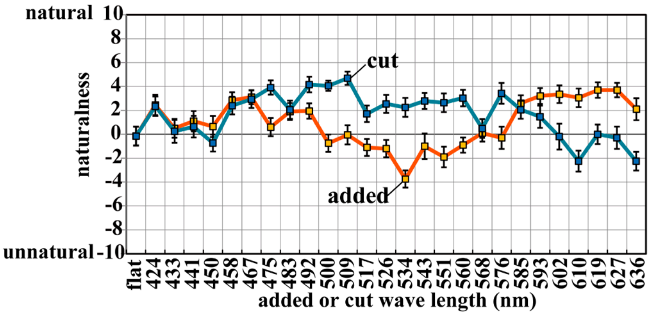


Figure 6 Results of “naturalness”.

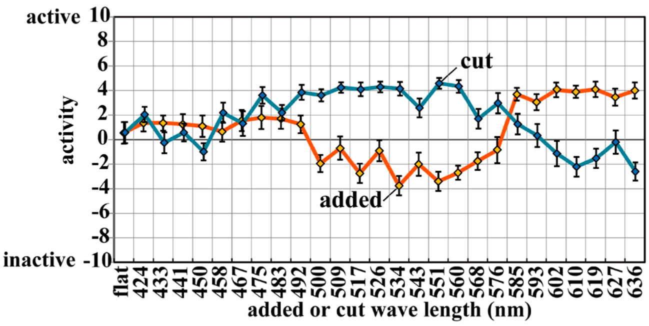


Figure 7 Evaluation of “activity”.

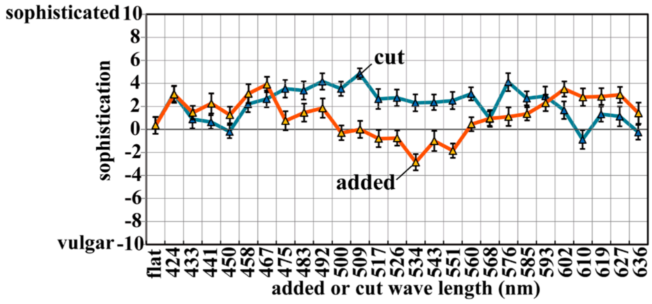


Figure 8 Results of “sophistication”.

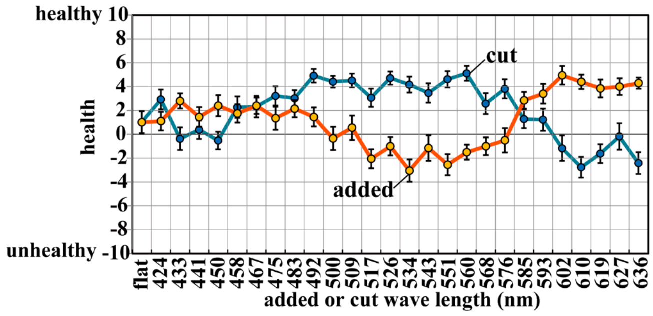


Figure 9 Evaluation of “health”.

cut 602–636 nm and 450 nm ($p$<.05).

### 3.3 Results of “sophistication” of the woman’s face

Figure 8 illustrates the results of “sophistication” of the face skin under each lighting condition. The evaluation of sophistication (*Es*) was significantly affected by the lighting conditions ($p$<.001). *Es* was less than −1 under the lighting added the component of 534–551 nm, and was the lowest (*Es*=−2.85) in the case of the lighting added the component of 534 nm whereas *Es* was more than 3 under the lighting added the components of 458 nm, 467 nm, 602 nm and 627 nm, and under the lighting cut the components of 433 nm, 475–509 nm, 560 nm and 576 nm. *Es* under the lighting added the component of 467 nm was higher than that added 517–551 nm ($p$<.05), and *Es* under the lighting added the component of 534 nm was lower than that added 424–475 nm, 483 nm, 492 nm and 585–636 nm ($p$<.05). Also, *Es* under the lighting cut the component of 509 nm was higher than that cut 433–350 nm, 568 nm, 610 nm and 636 nm ($p$<.05).

### 3.4 Results of “health” of the woman’s face

Figure 9 illustrates the results of “health” of the face skin under each lighting condition. The evaluation of health (*Eh*) was significantly affected by the lighting conditions ($p$<.001). *Eh* was less than −1 under the lighting added the component of 517–568 nm, and was the lowest (*Eh*=−3.05) in the case of the lighting added the component of 534 nm. *Eh* was also low (*Eh*=−2.80) under the lighting conditions cut the component of 610 nm whereas Eh was more than 3 under the lighting added the component of 593–636 nm, and under the lighting cut the components of 475–560 nm and 576 nm, and was the best (*Eh*=5.10) in the case of the lighting cut the component of 560 nm. *Eh* under the lighting added the component of 534 nm was lower than that added 424–492 nm and 585–636 nm ($p$<.05), and Eh under the lighting added the component of 500–576 nm was lower than that added 602–636 nm ($p$<.05). Also, Eh under the

doi: 10.2150/jlve.IEIJ160000575

lighting cut the component of 602–636 nm was higher than that cut 492–560 nm ($p$<.05).

### 3.5 Results of "familiarity" of the woman's face

Figure 10 illustrates the results of "familiarity" of the face skin under each lighting condition. The evaluation of familiarity ($Ef$) was significantly affected by the lighting conditions ($p$<.001). $Eh$ was less than −1 under the lighting added the wavelength of 517–560 nm, and was especially worst ($Ef$=−3.05) in the case of the lighting added the wavelength of 534 nm. $Ef$ was not so good ($Ef$=−1.50) under the lighting conditions cut the wavelength of 610 nm whereas $Ef$ was more than 3 under the lighting added the component of 593–636 nm, and under the lighting cut the components of 433 nm, 475–509 nm and 526–560 nm, and was the best ($Ef$=5.45) in the case of the lighting cut the component of 509 nm. $Ef$ under the lighting added the component of 534 nm was lower than that added 424–492 nm and 585–636 nm ($p$<.05), and $Ef$ under the lighting added the component of 517–560 nm was lower than that added 585–636 nm ($p$<.05). Also, $Ef$ under the lighting cut the component of 610 nm was lower than that cut 424 nm and 458–560 nm ($p$<.05), and $Ef$ under the lighting cut the component of 526–560 nm was higher than that cut 602–619 nm ($p$<.05).

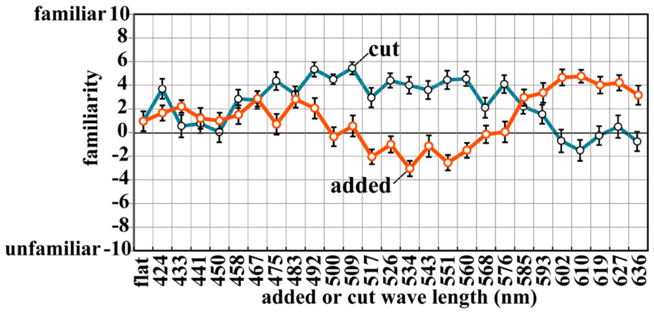

Figure 10 Results of "familiarity".

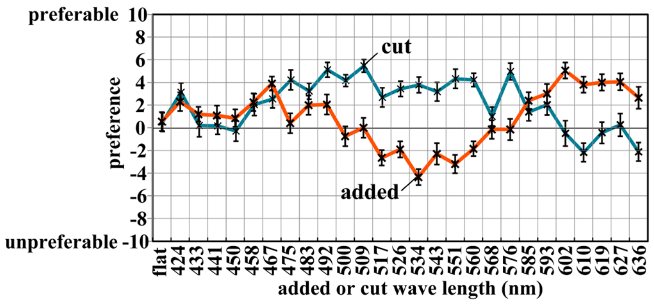

Figure 11 Evaluation of "preference".

### 3.6 Results of "preference" of the woman's face

Figure 11 illustrates the results of "preference" of the face skin under each lighting condition. The evaluation of preference ($Ep$) was affected by the lighting conditions ($p$<.001). $Ep$ was less than −1.50 under the lighting added the component of 517–560 nm, and was the lowest ($Ep$=−4.35) in the case of the lighting added the component of 534 nm. $Ep$ was also less than −2.5 under the lighting conditions cut the components of 610 nm and 636 nm whereas $Ep$ was more than 3 under the lighting added the components of 467 nm and 602–627 nm, and under the lighting cut the components of 475–509 nm, 526–560 nm and 576 nm, and was the best ($Ep$=5.20) in the case of the lighting cut the component of 509 nm. $Ep$ under the lighting added the component of 517–560 nm was lower than that added 585–636 nm ($p$<.05), and $Ep$ under the lighting added the component of 534 nm was lower than that added 424–492 nm ($p$<.05). Also, $Ep$ under the lighting cut the components of 610 nm and 636 nm was lower than that cut 424 nm, 467–560 nm and 576 nm ($p$<.05).

## 4. Discussion

The results showed the face skin with make-up did not look preferable by the lighting including components of medium wavelength, especially 534 nm, indicating that the lighting excluding components of medium wavelength could make the face preferable. Skin color is mainly determined by the color of melanin (dark brown pigment) and hemoglobin (deep red pigment), and the spectral reflectance distribution of hemoglobin recessed in medium wavelength band, especially around 540 nm and 580 nm[17)18)]. This tendency is also shown in Figure 2. This may relate to the reason why the lighting including components of 534 nm, around 540 nm, decreases the preference of the face skin. However, the lighting including components of around 580 nm does not decrease the preference of the skin. Thus, it is necessary to examine the effects of wavelength by using other models who have different skin colors.

The evaluation results of "familiarity" were very similar to those of "preference", and the correlation relationship between these evaluations was very high ($R$=0.92). Thus, we analyzed the evaluation results with a multiple regression, using "preference" as response variable, and "naturalness", "activity", "sophistication" and "health" as explanatory variables with a statistic application (IBM SPSS 20.0). There was a multi-collinearity between "activity" and "health". We reanalyzed these results using

Table 4 Statistic results of multiple regression.

| evaluation factors | standardized partial regression coefficient | *P*-value |
|---|---|---|
| naturalness | 0.323 | 0.000 |
| activity | 0.318 | 0.000 |
| sophistication | 0.389 | 0.000 |

doi: 10.2150/jlve.IEIJ160000575

"naturalness", "activity" and "sophistication" as explanatory valuables. Table 4 shows the statistic results of the multiple regression by standardized partial regression coefficients. It was revealed that the preference of the face could be determined by naturalness, activity and sophistication. This result was coincident with the previous study[3], in which it was reported that the evaluation of human complexion was determined by "activity", "refinement" (close to "sophistication", both words were used as the same Japanese "Hin" or "Hinsei" in each experiment), and "naturalness", as the results of the experiment using 6100 K fluorescent lamps.

## 5. Conclusions

(1) The evaluation of naturalness is better under the lighting including the component of 593–627 nm than that including 517–560 nm.
(2) The evaluation of activity is better under the lighting including the component of 585–636 nm than that including 500–576 nm.
(3) The evaluation of sophistication is better under the lighting including the component of 467 nm than that including 517–551 nm.
(4) The evaluation of health is better under the lighting including 602–636 nm than that of 500–576 nm.
(5) The evaluation of familiarity is better under the lighting including the component 585–636 nm than that of 517–560 nm.
(6) The evaluation of preference is better under the lighting including the component 585–636 nm than that of 517–560 nm.
(7) The lighting including the component of 534 nm makes look the women's skin worst.
(8) Preference of the women's face can be explained with three aspects, naturalness, activity and sophistication.

In the future, the wider range of correlated color temperature should be taken into consideration in setting of the lighting conditions, and the relationship between the evaluation values and some kinds of indexes of the color fidelity or color preference should be examined.

## Acknowledgments

This study was supported by JSPS KAKENHI Grant Number 25282006. We would like to thank Mikako Yamamoto who was an undergraduate student in DWCLA for conducting this experiment. We would like to also thank Mami Masuda who is a graduate student in YNU for generating the visual images.

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Part of this work is reported in the proceedings of IFSCC conference 2015, P-201.