# THE IMPRESSION OF HUE IN PRACTICAL COLOR CO-ORDINATE SYSTEM(PCCS)

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## ABSTRACT

The Practical Color Coordinate System (PCCS) was developed by the Japan Color Research Institute in 1964. The main feature of PCCS is its 'Hue–Tone system'. In PCCS, a color is represented by two attributes: hue and tone. As Wakata and Saito has reported in 2012 on PCCS tones, this study focuses of hues. Stimuli were 12 hues in PCCS. Each hue consisted of 11 tones. For each hue, the tones were pasted in a row on a neutral grey mount. A total of 129 subjects were asked to respond to the images of the stimuli. We used a 7-point semantic differential method (20 words) to record their responses. We have obtained four factors be the factor analysis. These results showed that the factor structure of hue was different from that of tone.

## INTRODUCTION

Many colors exist in our life. When treat the color, we use any color system. Many color order systems were developed such as Munsell system, Ostwald system, and NSC. This study focuses on perceptions of hue in the Practical Color Coordinate System (PCCS).

PCCS was developed by the Japan Color Research Institute in 1964, based on psychological elements. The psychological intervals of individual attributions (hue, lightness, and saturation) are constant. The feature of the PCCS is "Hue–Tone system." Tone consists of lightness (value) and saturation (chroma). Color is usually represented by three attributes—hue, value, and chroma—but the PCCS can represent a color by two attributes, hue and tone, hence the name "hue–tone system." Each tone has an individual image, that is, "dark" tone colors (low lightness and middle saturation) have a heavy and dim image; "vivid" tone colors (middle lightness and high saturation) have a bright and clear image. These images are common even with different hues. Thus, the PCCS offers the advantage of treating the color as an image by using tone. We reported about tone in *conference of the color science association of Japan 2012* and *AIC 2012*. The PCCS has a hue-tone system. Tone refers to intensity of colors such as "pale red," "deep blue," or "soft purple." Hue refers to color quality, for example, the terms "reddish" and "bluish" refer to hues.

This study investigates the influence of color, parti cularly hues, in the PCCS gradation scheme.

## METHOD

**Stimuli**

Hue circle of tones; eleven tones (vivid, bright, deep, light, soft, dull, dark, pale, light grayish, grayish, dark grayish) were used for tone stimuli. Tone stimuli (twelve hues; 1.5 cm × 1.5 cm) were pasted in a circle on a neutral gray mount (10 cm × 10.5 cm) (Figure1).

Gray scale; chromatic color stimuli (nine color chips; 1.5 cm × 0.7 cm) were pasted in a row on a neutral gray mount (10 cm × 10.5 cm) (Figure2).

Hue belt; typical twelve colors (2:R, 4:rO, 6:yO, 8:Y, 10:YG, 12:G, 14:BG, 16gB, 18B, 20:V, 22:P, 24:RP) were used as hue stimuli, and each stimul us (eleven tone color chips, 3 cm × 1.5 cm) was pasted in a row by gradation (order in which value and chroma change) on a neutral gray mount (5 cm × 21 cm) (Figure3).

*Figure 1. Sample of hue circle of tones*

*Figure 2. Sample of Gray scale*

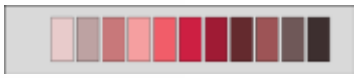

*Figure 3. Sample of Hue belt*

**Procedure**

In this experiment, the number of participants was 129(70 male and 59 female, average age 20.7 ± 1.4 years). The seven-point scale semantic differential method (SD method) was used with a questionnaire consisting of twenty pair words (warm–cool, sweet–not sweet, soft–hard, feminine–masculine, loosen–strained, cheerful–gloomy, bright–dark, dynamic–static, light–heavy, distinctly–blurred, dull–sharp, clear–muddy, gaudy–subdued, composured–fidgety, preferable–hateful, stable–unstable, beautiful–ugly, plain–rich, modern–classic, and loud–quiet).

Subjects were divided in five groups. Each group was presented with a different order of colors and a different order of the twenty pair words. The subjects looked at each color and answered the questionnaire.

## RESULT and DISCUSSION

Note: This paper reports only data on hues. The related data on tones are reported in *conference of the color science association of Japan 2012* and *AIC 2012*.

**Factor Analysis**

The SD results were evaluated by factor analysis. The result of the factor analysis (maximum likelihood method, promax rotation) revealed four significant factors (Table1). The first factor seemed to combine Osgood's notions of a ctivity and potency. The second factor consisted of concepts "loose–strained," "distinct–blurred," "dull–sharp," "clear–m uddy," and "gaudy–sub dued." It seemed to be Osgood's potency, but the words that constituted the potency were divided

into first factor, "bright-dark" etc. Oyama (2001) proposed that Osgood's potency was split into sharpness and lightness. The second factor was trig gered by perceptions of sharpness and lightness, which served as stimuli for judging color gradations. The term "distinct–blurred," for instance, was related to color shade specifically. The third factor w as similar to Osgood's notion of evaluation. The fourth factor consisted of the concepts "light–heavy" and "plain–rich." This factor reflected the "mood" or "atmosphere" of colors. It is thought that this factor had the same triggers as the second factor.

*Table 1. Pattern matrix(Factor analysis)*

| | | | FACTOR | | | |
|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 |
| warm | − | cool | .810 | −.345 | −.023 | −.036 |
| sweet | − | not sweet | .721 | −.124 | .186 | −.164 |
| feminine | − | masculine | −.675 | .086 | −.115 | .210 |
| dynamic | − | static | .604 | .183 | −.255 | −.131 |
| cheerful | − | gloomy | .594 | .234 | .024 | .137 |
| bright | − | dark | .575 | .196 | −.002 | .243 |
| soft | − | hard | .567 | −.370 | .100 | .148 |
| loud | − | quiet | .499 | .214 | −.399 | −.129 |
| sharp | − | dull | −.150 | .667 | −.013 | .062 |
| distinctly | − | blurred | −.121 | .664 | .083 | .002 |
| clear | − | muddy | −.070 | .530 | .296 | .272 |
| gaudy | − | subdued | .399 | .517 | −.016 | −.012 |
| loosen | − | strained | .478 | −.513 | .145 | .157 |
| preferable | − | hateful | .181 | .169 | .748 | −.131 |
| beautiful | − | ugly | .172 | .368 | .745 | −.137 |
| composured | − | fidgety | −.144 | −.192 | .572 | .067 |
| stable | − | unstable | .045 | −.063 | .467 | −.079 |
| light | − | heavy | .261 | .125 | −.147 | .580 |
| plain | − | ric | −.236 | .031 | −.120 | .552 |

The fourth factor was not relevant for the unicolored experiment because "mood" or "atmosphere" is caused by interaction with color factors. For example, in an everyday scene, impressions of fashion were based on colors of jackets, shirts and pants, or skirts; impressions of interiors were based on cushions, sofa s, and carpets. These interacted with each other to form the overall impression of the scene. (Of course, shape and materials of these items is important, but we referred to only color in this study.) Items of fashion and interior can unify and combine hue as well as the tone, for example, "reddish colors" or "bluish colors." Thus, the cause by which the fourth factor was observed is based on such a color scheme. This was also applied to the second factor.

**Factor Score**

The average value of the factor score for each stimulus was calculated and plotted on the scatter plots (Figure4, 5). First factor: This factor expressed "activity" and "potency." Red (2:R) and red–purple (24:RP) showed high values, and green (12:G) and purple (22:P) showed values near 0.0, and blue (18:B) and violet (20:V) showed low values. A previous study showed that red scores high and blue scores low for "activity" (Osgood et al.; 1957). Second factor: This factor expressed "intensity" or "clarity." Variations in scores were narrow. The highest value was 0.414 in 2:R, and lowest value was −0.407 in 10:YG. Hue did not play a role in this factor. Third factor: This factor expressed "evaluation." The variations in scores were narrow here as well. However, the feature of hue affects values: Cool colors showed high values, while warm colors showed low ones. The highest value was 18:B, and the lowest value was 8:Y. PCCS employs the psychological four primary colors consisting of red (2:R), yellow (8:Y), green (12:G), and blue (18:B). In addition, yellow and blue are paired in Herring's Opponent process. Thus, it is possible that combinations that are potentially paired are relevant. From another viewpoint, previous studies showed that blue tends to be favored. These results are also applicable to this study.Fourth factor: This factor expressed "mood" or "atmosphere." The tendency through which the value of each color circulates

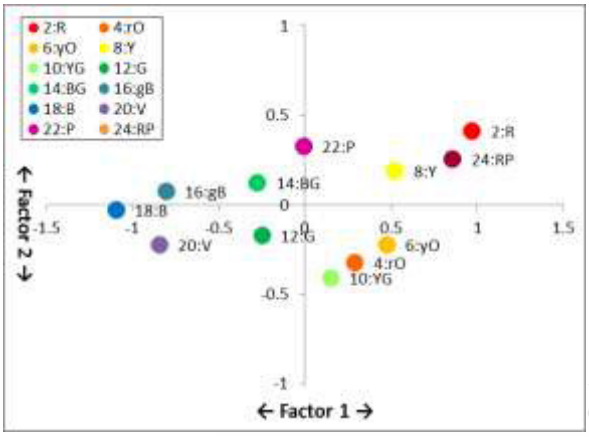


*Figure 4.Image map of factor score(Factor1×Factor2)*

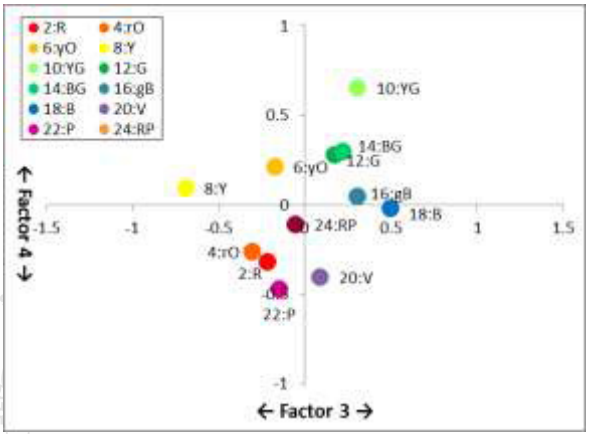


*Figure 5.Image map of factor score(Factor3×Factor4)*


*Figure 6. Image profile of factor score: Factor4*

was observed by making 10:YG into the peak; 22:P showed the lowest value. 10:YG and 22:P represent a complementary color relationship in PCCS hue circle(Figure6).

## CONCLUSION

The result of factor analysis suggested that the impression of hue was based on four factors. The influence of hue's gradation scheme was observed in the second and fourth factors. The influence of a color was not observed in the scores of the second factor because of individual differences in capturing stimuli. In the fourth factor, it was characteristic that change of the impression that met the hue circle by making 10:YG into the peak was observed.

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