Color Emotions from Two-Color Combinations with Various Area Ratios

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Abstract

The color emotion evoked from the two color combination is investigated by varying the area ratio between those two colors. Four color pairs (Dull Blue(R90B 3050)–Pale Yellow(Y1030), Pale Yellow(Y1030) – Vivid Red(R1080), Dark Grey(N7000) – Dull Blue(R90B 3050), Vivid Red(R1080) – Light Green(G2060)) are chosen for the experiment and displayed on the LCD monitor with 9 different area ratio including single colors. For each color combination patch, eight bipolar color emotion pairs are scaled by 10 observers. The three color-emotion factors: color activity, color weight, and color heat are identified by the factor analysis, showing consistent results with previous researches. Color Activity is consisted of clean-dirty, active-passive, and fresh-stale. Color Weight is consisted of heavy-light, hard-soft and tense-relaxed. Color Heat is consisted of warm-cool and masculine-feminine. The responded emotions are compared between two-color combination patches with different area ratio. The observers show diverse emotions for the two color combinations compared to single color emotions. Also it is found that using two colors together having the same feelings do not necessarily enhance the original feelings. In some cases, color emotion of one color strongly affects the perceived emotions for two-color combination.

1. Introduction

Color evokes many feelings. When people see 'red' color, people may feel warm, feminine, dangerous or angry. Most studies on color emotions are concerned with developing color emotion space by establishing emotion space and mapping the colors on it. For example, Kobayashi[1] suggested that color have warm-cool, soft-hard and clear grayish color emotion space.

Note that object colors are rarely shown as isolated colors. In most cases, color has surrounding colors. Even single color object has shadow and highlight. Therefore, researches on the emotions of color combinations have more practical application. However, there can be countless color combinations and surveying the evoked emotions from all the possible color combinations is nearly impossible. Therefore the main research issue will be developing a model to predict the emotion of color combination from those of single colors. Representatively, Ou et al. [2] demonstrated that the color emotion evoked by color combination follow arithmetic average of each single color emotions.

Most of studies on color combination are based on the assumption that all the colors in the combination have the same area although, in practical situation, it is more likely to have different area between colors. Therefore, the present study is aimed to figure out effect of area ratio between two-colors on color emotion.

In this study, four color pairs are chosen and the test color patterns are designed on the LCD monitor such that the area ratios between two colors are varied gradually. Then the emotions evoked by each color combination with different area ratio are surveyed using category judgment. Finally color emotion changes by area ratio changes are analyzed.

2. Experiments

2.1 Color Characteristics of LCD monitor

The 24-inch EIZO LCD monitor (ColorEdge CG242W) is used in this study to present the color patterns. The EIZO LCD monitor is calibrated to have Adobe RGB using the hardware calibration function. Table 1 and Figure 1 show the measured primary colors using the spectroradiometer Minolta CS-2000.

	x	y	Y(cd/m²)
Red	0.6589	0.3259	75.36
Green	0.2064	0.6852	147.49
Blue	0.1514	0.0672	18.96
White	0.3262	0.3305	242.99

Table 1. *Color Characteristics of EIZO monitor*

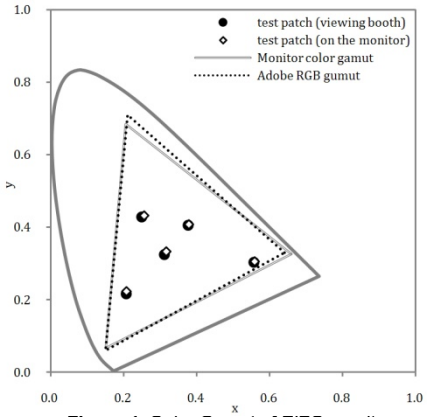


Figure 1. *Color Gamut of EIZO monitor*

2.2 Test Color Pairs

Four color pairs are chosen for this study as shown in Table 2 based on the authors' previous study [3] on color emotion. Each single color is from NCS color chart. In Table 2, rough description of each color patch is given as well to help the visualization of

each color patch. For example, R90B 3050 can be categorized as dull blue.

	Left Color	Right Color
Pair 1	R90B 3050 (Dull Blue)	Y1030 (Pale Yellow)
Pair 2	Y1030 (Pale Yellow)	R1080 (Vivid Red)
Pair 3	N7000 (Dark Grey)	R90B 3050 (Dull Blue)
Pair 4	R1080 (Vivid Red)	G2060 (Light Green)

Table 2. *Test Color Pairs*

Each color patch is measured using spectroradiometer Minolta CS-2000 in the viewing booth illuminated with D65. Then the measured XYZ values are reproduced on LCD monitor using the PLCC model [4]. Average CIELAB color difference is 1.98 ΔE^*_{ab}. The measured XYZ values and CIELAB values of the patches are plotted in Figure 1 and Figure 2 respectively.

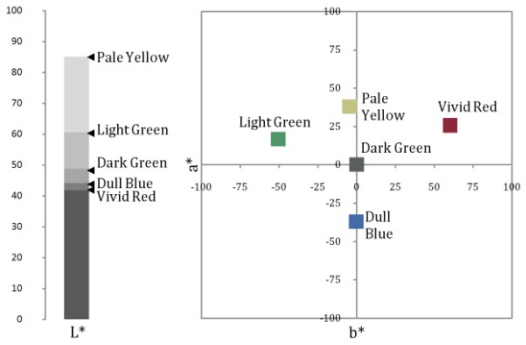


Figure 2*. Test Color patches in CIELAB color space*

2.3 Test Color Patterns

Figure3 illustrate the test color pattern shown on the monitor. There is a square color-combination patch in the center with mid-gray background. The screen size is 520mm x 325 mm and the color patch has 480 x 480 pixels (h/2.5). At the bottom of the screen, emotion scales are written with reference white color (D65) for the adaptation.

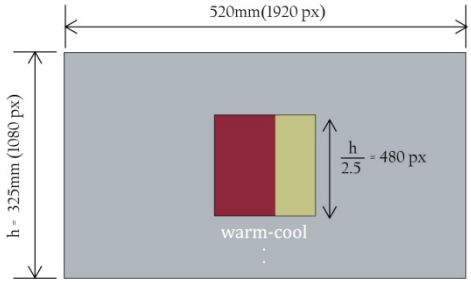


Figure 3*. Test color pattern displayed on the monitor*

The color combination patch is designed such that, for each color pair (Color A - Color B), the total area is fixed (480 x 480 pixels) while the area ratio between Color A and Color B within the fixed area are changed from 0% (Color A 100%, Color B 0%) until 100% with 8 equally distributed steps i.e. (0%, 8.3%, 25.0%, 33.3%, 50%, 67%, 75%, 92% 100%) as illustrated in the Figure 4.

Figure4. *Test color patterns with various area ratios*

The position of colors in a test pattern is not changed meaning that, for Color A – Color B combination, Color A is shown on the left side all the time and Color B is on the left.

2.4 Psychophysical Experiment

Eight bipolar color emotion scales are judged in the experiment: warm-cool, heavy-light, clean-dirty, active-passive, hard-soft, tense-relaxed, fresh-stale, masculine-feminine. These were most frequently us1ed scales in early studies [2]. Each test color patterns are shown randomly.

According to author's previous study [3], there are no differences between English and Korean language. Thus English words are selected. During the experiment, a bipolar emotion pair (e.g. warm-cool) is given and each observer is asked to pick one emotion in the pair related to the color-combination pattern shown on the monitor. Then, according to the emotional strength or intensity, observer responds from 1 to 5.

Ten observers, including 4 male and 6 female, took part in the experiment. They are mid-twenties and are familiar with English. They all passed color vision test and Munsell Hue test. They had experience judging author's previous color emotion experiments [3]. Each observer made 288 judgments (4pairs x 9steps x 8emotion scales). The experiment was conducted in a dark room.

3. Results

Psychophysical experimental data is converted to -5 to 5 scale - first emotion scale is positive, second scale is negative - and then averaged.

3.1 Color Emotion Space

The averaged data is used for the factor analysis using JMP 8.0. Using factor analysis technique, eight color emotion scales are categorized into three groups as shown in Table 3. The color emotion pairs in the same group (or factor) can be interpreted as having the same characteristics and each factor corresponds to the axis of color emotion space.

It is notable that the color emotion pairs grouped as the same factor are nearly the same with those from Ou et al.'s study[2,5] and the authors' previous experiments [3]. This experimental result implies that the color emotion factors in Table 3 are fairly consistent. Therefore the names of the factors are decided to follow those from Ou et al.'s study i.e. Color Heat, Color Activity and Color Weight.

Factor 1	Factor 2	Factor 3
warm-cool feminine-masculine	clean-dirty active-passive fresh-stale	heavy-light hard-soft tense-relaxed
Color Heat	Color Activity	Color Weight

Table3. *Result of factor analysis.*

The color emotion of each color-combination pattern is represented on the color emotion space by averaging the responses

in the same Factor. Figure 5 represents the color emotion changes of 0%, 50% and 100% cases for each color pairs in the color emotion space.

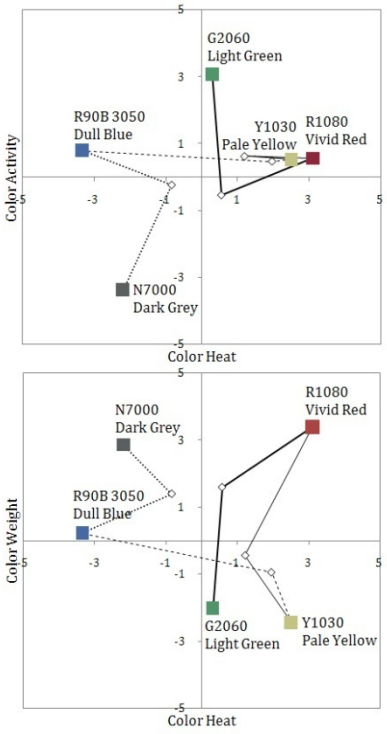


Figure 5. *Color emotion space*

3.2 Color Emotion vs. Area ratio between Two Colors

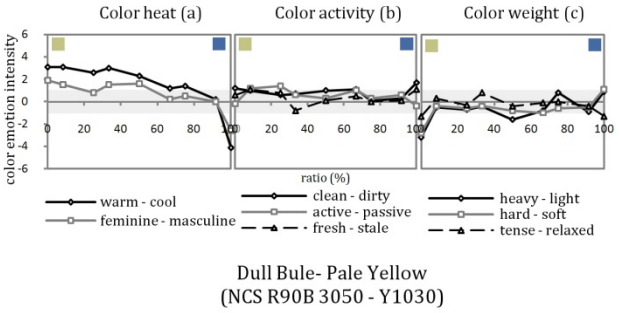
The effect of area ratio change between two single colors on the color emotion is analyzed in detail for each color pair.

Dull Blue (R90B 3050) – Pale Yellow (Y1030)

Figure 6 summarizes the color emotion changes by the area ratio between Dull Blue (R90B 3050) and Pale Yellow (Y1030) colors.

First of all, as can be seen in Figure 6(a), it is notable that Pale Yellow (Y1030) and Dull Blue (R90B 3050) colors evoke strong emotions for the emotion pairs belong to 'Color Heat' group. Yellow is perceived as warm and feminine colors while Blue represents cool and masculine feelings. As a part of the Yellow color is replaced with Blue, perceived warmness or feminine-ness starts to decrease. Interesting phenomena is observed for 8% Yellow - 92% Blue patch. Even though most of the colored area is filled with Blue, this patch does not evoke cool feeling any more. This result indicates that in the case of Yellow (Y1030) - Blue (R90B 3050) combination, the evoked emotions are more strongly affected by those from Yellow.

For other emotion scales such as active-passive and heavy-light, the average responses are close to zero meaning no strongly evoked emotions by those colors.



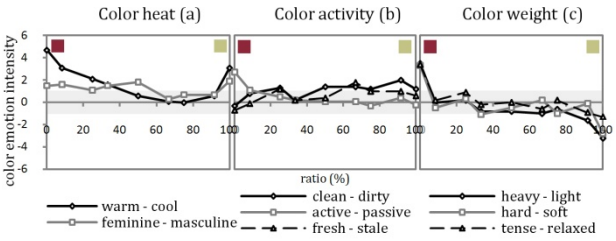
Dull Bule- Pale Yellow
(NCS R90B 3050 - Y1030)

Figure6. *Color emotions of Dull Blue- Pale Yellow*

Pale Yellow (Y1030) – Vivid Red (R1080)

Pale Yellow (Y1030) – Vivid Red (R1080) pair shows very interesting color emotion changes by area ratio changes as shown in Figure 7. Both Yellow and Red have high heat i.e. warm and feminine as shown in Figure 7(a). However putting those two warm and feminine colors together decreases the perceived warmness. Figure 8 represents the frequency graph of the observers' warm-cool scale responses for 66.6% Yellow – 33.3% Red patch. Note that half of the observers felt coolness while the other half felt warmness from that color combination.

In the case of Color Weight group, Red evokes heavy, hard, and tense emotions while Yellow reminds light, soft and relaxed feeling. For Red-Yellow combination, all the emotions belong to 'Color Weight' group disappear.



Pale Yellow-Vivid Red
(NCS Y1030-R1080)

Figure 7. Color combination of Pale Yellow and Vivid Red

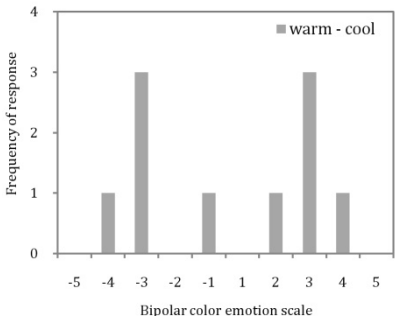
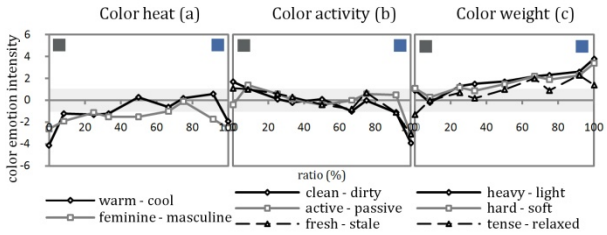


Figure8. Observer Frequency when Pale Yellow 66.6%, Vivid Red 33.3%

Dark Grey (N7000) – Dull Blue (R90B 3050)



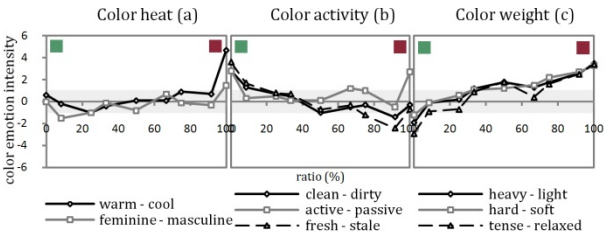
Dull Bule- Dark Grey
(NCS N7000-R90B3050)

Figure 9. *Color combination of Dull Blue and Dark Grey*

The Dark Grey (N7000) and Dull Blue (R90B 3050) combinations do not evoke any strong emotion though each single color presents unique emotions for 'Color Heat' and 'Color Activity'. The Color Weight feelings are mostly determined by that of Blue color than Gray.

Vivid Red (R1080) – Light Green (G2060)

The Vivid Red (R1080) and Light Green (G2060) combinations lose warm and feminine feelings of Red and High Activity emotions of Green. The emotion of Color Weight is mostly determined by Red.



Vivid Red-Light Green
(NCS R1080-G2060)

Figure10. Color combination of Vivid Red and Light Green

4. Conclusion

The color emotion evoked from the two color combination is investigated by varying the area ratio between those two colors.

Four color pairs (Dull Blue(R90B 3050)–Pale Yellow (Y1030), Pale Yellow(Y1030) – Vivid Red (R1080), Dark Grey (N7000) – Dull Blue(R90B 3050), Vivid Red(R1080) – Light Green(G2060)) are chosen for the experiment and displayed on the LCD monitor with 9 different area ratio including single colors.

For each color combination patch, eight bipolar color emotion pairs are scaled by 10 observers. The three color-emotion factors: color activity, color weight, and color heat are identified by the factor analysis, showing consistent results with previous researches. Color Activity is consisted of clean-dirty, active-passive, and fresh-stale. Color Weight is consisted of heavy-light, hard-soft and tense-relaxed. Color Heat is consisted of warm-cool and masculine feminine.

The responded emotions are compared between two-color combination patches with different area ratio. In many cases, observers are confused or show diverse emotions for the two color combinations resulting in small emotional intensity compared to single color emotions. For example, Red is felt heavy and warm while Yellow gives light and warm feelings, but on the average, Red-Yellow combinations do not give any heavy or light emotions and even have low warm feeling. It means that using two colors together having the same feelings does not necessarily enhance the original feelings.

In some cases, color emotion of one color strongly affects the perceived emotions for two-color combination. For example, Color Hear feeling of Blue and Yellow combination is from that of Yellow color. Similarly, emotions from Blue affect the overall Color Weight feelings for Gray-Blue combination.

In summary, based on this small scale experiment with 4 color pairs, any simple and systematic color emotion changes by the change of area ratio could not be found. It indicates that emotions by color combinations cannot be predicted from those by single colors in a simple way. More systematic and thorough researches are required to understand the color emotions from single colors and color combinations.

References

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Author Biography

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