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Individual differences in feelings about red

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Abstract

Red does not stand out brightly to dichromatic individuals with a different sense of color from the majority. However, they know that the color of passion is red.

In this paper, we investigate the red appearance and color sensitivity of people with different types of color blindness: "Protan and Deutan."

Background

Many people who take the Ishihara color vision test recognize red as an outstandingly bright color. Therefore, a brighter shade of gray is often chosen when participants are asked to pick a gray that is at the same level as red. However, humans vary in their sense of color. Individuals who have Protan and Deutan color deficiencies do not see red as a dazzling or a remarkably bright hue. This study analyzes how people with Protan and Deutan deficiencies perceive the bright and vivid shades of red as dark hues.

Confusion between red and green is said to be prevalent in approximately 0.6% of Japanese women and about 4.5% of Japanese men. Individuals with these deficiencies find it difficult to distinguish between red and green. For such people, the distinctions between blue and red, and blue and green are clear.

With regard to color deficiency, one of the two colors (red or green) is classified as a model sense of color, and when there are two senses of color, the condition is known as trichromacy. The type with two colors has three models and is referred to as Protan, which represents a defect in the M cone. The type that has a defect in L, M, and 3 cones of S is called Deutan.

For example, individuals who have Protan experience red as gloomy. Therefore, they see black as dark red. If green is part of the warm color system (blue is not included), it is viewed as brown, and Deutan cannot be detected.

Purpose

In P-type color vision (Protanopia, Protanomaly), red is reported to appear dark, but it is not clear which shade of red looks dark and how much red cannot be determined by the color of the object.

Meanwhile, in D-type color vision (Deuteranopia, Deuteranomaly), although red does not look dark, which we do not know for a fact.

Moreover, is one's sense of dark and bright linked to a sense of cold and hot, sharp and blunt, and so on? Our purpose is to clarify these points.

Experimental Method A

We used 18 colors, including red (basic color) and 18 achromatic colors (JIS standard color glossy plate). Participants chose an achromatic color that appeared as bright as the color shown. The lightness of the achromatic color was the actual brightness that was experienced. To avoid area effects, participants used a 2 × 3 cm hollow mask. The experiment was performed in a dark room with a D65 light source. There were 5 Protanopia, 1 Protanomaly, 7 Deutanopia, 4 Deutanomaly, and 18 C-type Ishihara plate passes.

The 18 actual red colors are shown in Figures 1 and 3, and Table 2, and 18 achromatic colors are shown in Figure 2, and Table 1. The numbers are the values of the Lab as measured by the spectral colorimeter.

We conducted the selection on the basis of red brightness, saturation, and devised each red to be evenly spaced.

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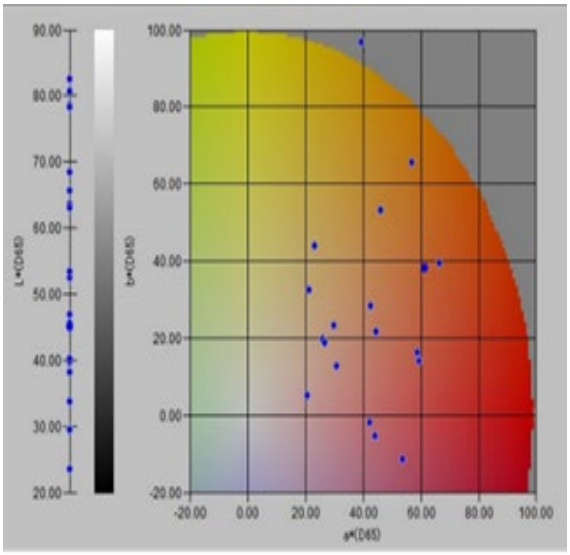

Figure 1. The coordinates of the selected red color

These are the 18 actual red colors and 18 achromatic colors. The numbers are the values of the lab as measured by the spectral colorimeter.

We conducted the selection of red brightness, saturation, and arranged each red at equal distances so that they were not too close to each other.

Result A

Figures 4 and 5 show the experiment results. The Figure 4 graph shows Protanopia, and the Figure 5 graph demonstrates Deuteranopia. The broken line is the L value actually measured with a spectrometer. The selected achromatic color values are represented by dots.

We found that Protanopia felt darker than the actual value generally. All the respondents stated that the 1st, 4th, 5th, 7th, 11th, 12th, and 18th color charts looked darker than they actually were.

These 18 colors contained a lot of red, so P-type color vision indicates that red appears dark. There is no more than one Protanomaly, but no respondents said that they felt it was particularly dark.

The polygonal line shows the luminance, and the point indicates perceived brightness. In both cases, red was not found to be dark but, rather, bright. However, it was confirmed that some of the people who were Protonomalous saw that the color was dark overall and others were bright overall.

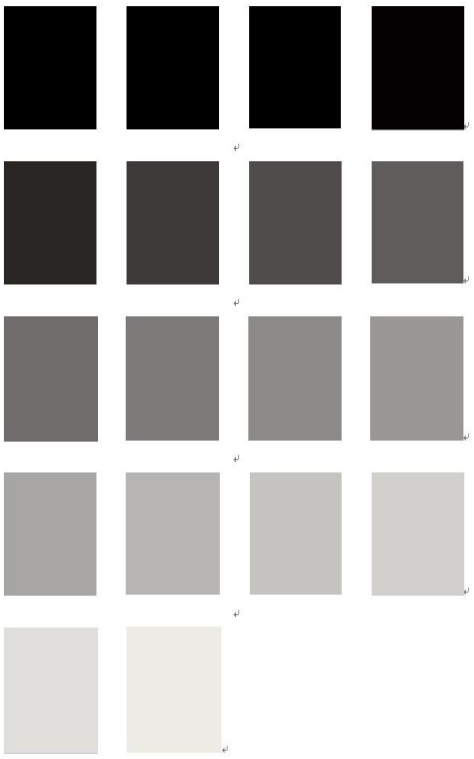

Figure 2. Gray of 18 degrees.

番号	L*(D65)	a*(D65)	b*(D65)
1	39.6	58.81	16.08
2	78.23	23.02	43.82
3	23.58	30.81	12.81
4	52.5	56.68	65.38
5	38.17	46.17	53.15
6	82.5	20.74	4.93
7	40.27	29.98	23.17
8	46.77	53.8	-11.56
9	65.6	44.42	21.43
10	80.64	21.34	32.48
11	33.72	42.45	28.29
12	45	61.27	38.2
13	78.43	26.16	19.66
14	68.25	39.38	96.58
15	29.37	42.16	-2.06
16	63.02	26.71	18.88
17	63.48	44.01	-5.5
18	53.24	66.43	39.36

Table 2. The coordinates and luminance of the selected red color.

無彩色	L*(D65)
9.5	93.38
9.0	88.93
8.5	83.84
8.0	79.30
7.5	73.82
7.0	68.30
6.5	63.14
6.0	58.06
5.5	52.09
5.0	46.51
4.5	39.67
4.0	32.78
3.5	25.02
3.0	15.77
2.5	0.64
2.0	0.00
1.5	0.00
1.0	0.00

Table 1. The Luminance of the Gray of 18 degrees.

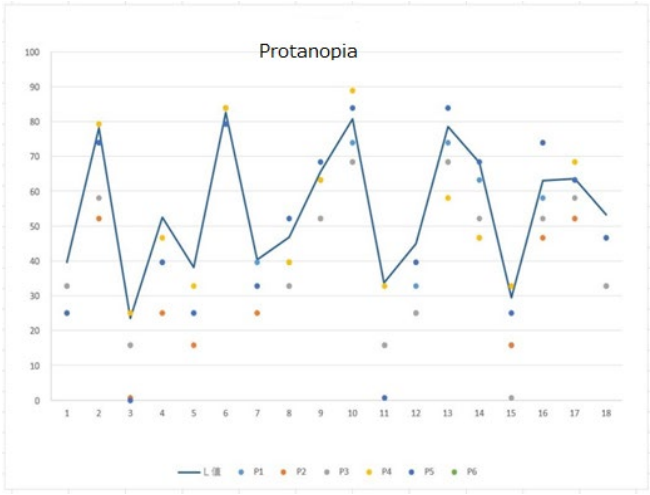

Figure 4. Protanopia.

Figure 3 The coordinates of the selected red color.

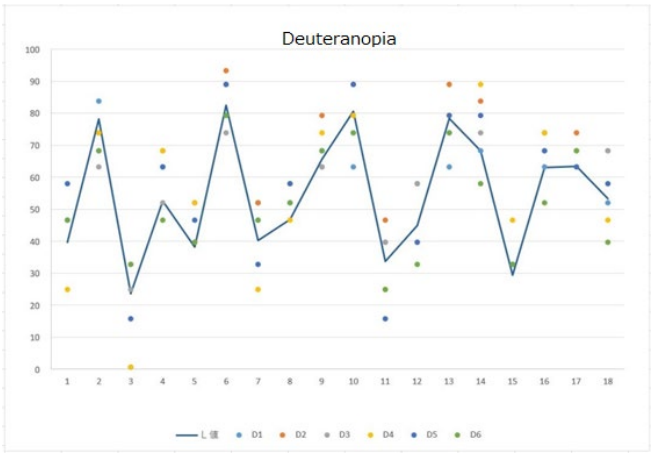

Figure 5. Deuteranopia

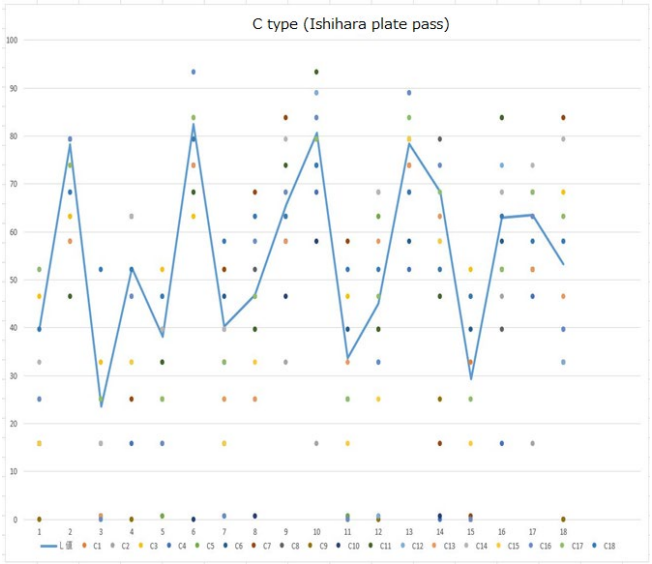

Figure 6. C-type (Ishihara plate pass)

Figure 6 is a graph of C-type color vision. The results here were more variable compared to the P-type and D-type results. The variation is less yellow or bluish color compared to other colors found in the twelfth and eighteenth color patches near pure red.

Experimental method B
Figure 3 is 18 red color chips used in the experiment.

Figure 7. Paired adjectives.

We conducted an impression evaluation for each of the 18 red colors. The experiment was performed under a D65 light source in a dark room, and to avoid area effects, a 2 × 3 cm mask was used. The test was performed by 7 Protanopia, 3 Protanomaly, 6 Deutanopia, 5 Deutanomaly, and 6 C-type (Ishihara plate pass) subjects.

Result B

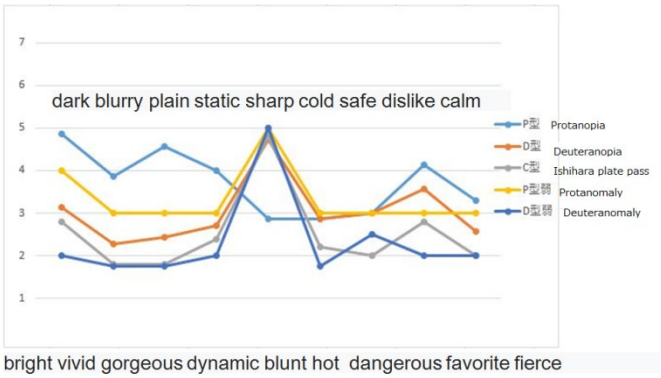

Figure 8. In Protanopia, a tendency different from the other sense of color type is found.

While other color vision types showed the same trend, Protanopia showed a different trend. (Figure 8). Protanopia was found to have the opposite feeling on the gorgeous-plain scale and the blunt-sharp scale.

Conclusion

The object color (red) appeared dark to one with Protanopia color vision, while those with Deuteranopia and Deuteranomaly color vision felt the same as actual lightness.

C-type color vision varies greatly between individuals. We found significant individual differences in both P- and D-types. D-type and C-type individuals belong to the same group in terms of how they feel about red.

In contrast, Protanopia strength tends to be the opposite. Red No. 12 is blunt in Protanopia color vision and sharp in C- and D-types.

Future Tasks

We hope to investigate how differences in color vision affect how colors are perceived. We found a variation in how the color was perceived by C-type individuals, so we want to organize this statistically. There seems to be a turning point in which red feels like protanomaly.

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Author Biography

Yasuyo G. Ichihara received her BS in Arts from Joshibi University of Art and Design (1986) and her PhD in Artistic Anatomy from Tokyo National University of Art and Music (1991). Since 1995 she has worked in the Hosen Junior University and since 2007 as an associate professor, Kogakuin University.

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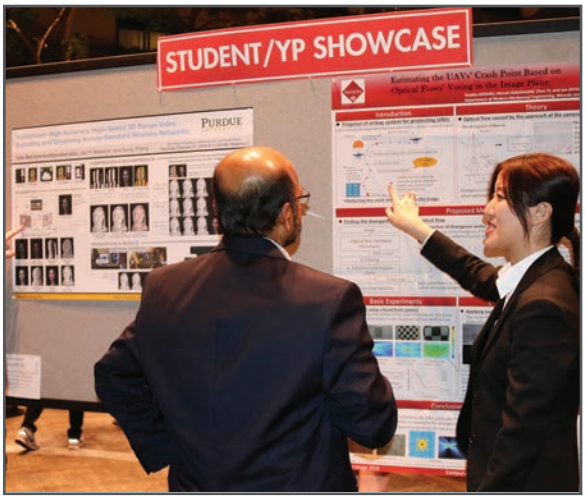

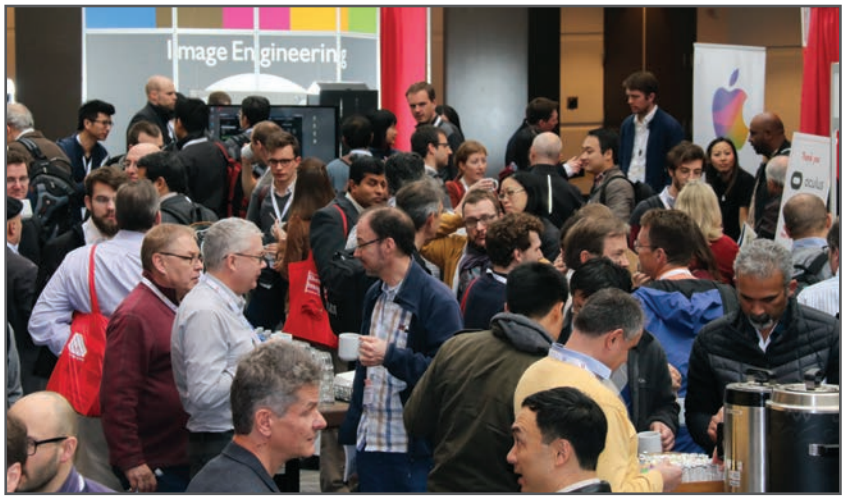

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