

# Measures and Evaluation of Designs Applied to Barrier-Free Color Vision for Guidance Information

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Our NPO provides barrier-free information for smoother mobility on the website, “ekipedia” and has issues to promote the barrier-free information in expression and content. This research intends improvement in visual regions mainly for route maps and station guidance maps publicized on the website and has obtained a good result to present a unified model after research of design systems and evaluation systems dealing with different types of color vision. We report the results of the research and the evaluation test together.

## Barrier-Free Information, Universal Design, Color Vision Deficiency, Barrier-Free Color Vision, Smoother Mobility, Guidance Systems

### 1. Research Background

While barrier-free access to facilities such as transportation keeps improving, it is required to provide the barrier-free information for use of these facilities when going out.

“Ekopedia” is one example of measures. Since the website was provided, the improvement of barrier-free color vision has been expected. It is said that 5 % of Japanese men, three million in the country have color vision deficiency. Not only for this research, available work is expected in design systems practically applied to barrier-free information on the point of universal view,

### 2. Research Measures

The route map and the station guidance map in three dimensional design for smoother mobility are the subjects to be improved and the left of Figure 1. and 2 show the typical examples.

As application to barrier-free color vision in multicolor design, the guide line recommends to use lines and patterns, not relied on colors only. However there are many cases that an addition of the secondary component turns out to be noise as in this example with many components. It is important to grasp the color region that can be applied at first. Therefore this research verifies the effect only by improvement in color.

The improvement verification and evaluation of color vision deficiency have been conducted under the environment that color vision can be examined in visual testing (on test monitor display) like Picture1, because people with normal color vision cannot imagine the view of color vision deficiency. Figure 3 is a chart made to grasp characteristic view of deuteranopia type 1 and 2 on the test monitor. It is necessary to research whether the use of this color vision testing is available.

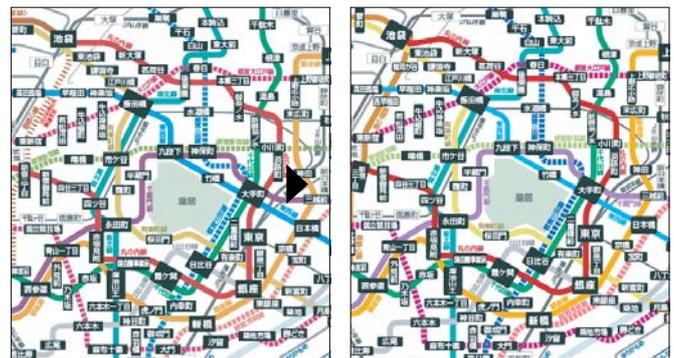


Figure 1: Route Map - Before (left) and After (right) Improvement Introduced

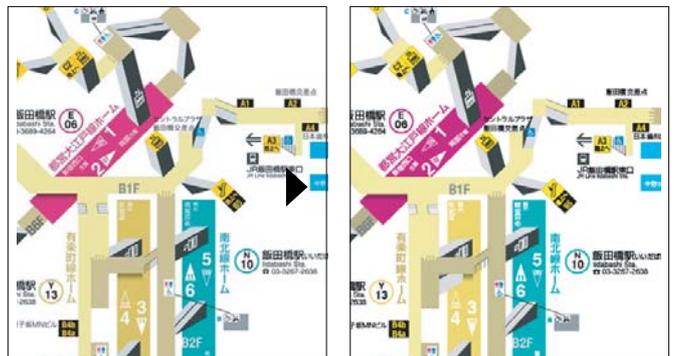
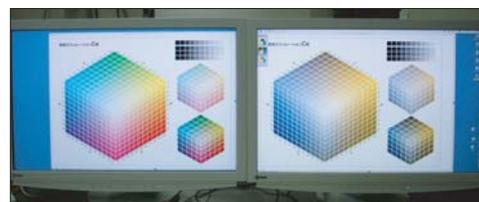


Figure 2: Station Map - Before (left) and After (right) Improvement Introduced



Picture 1: Design and Evaluation Environment (left: original drawing, right: test color vision display)

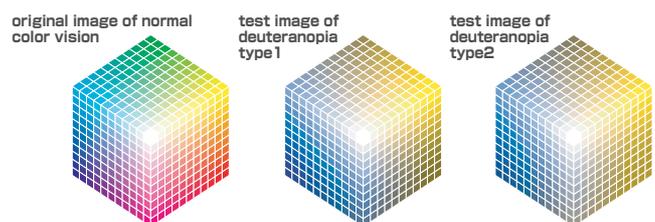


Figure 3: Test Image of Color Vision Deficiency

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### 3. Verification of Evaluation Measures and Current Evaluation

The visual testing and evaluation of color vision deficiency have been conducted to compare and get current situation for improvement. Figure4 is a test image of the route map in Figure1 that is a subject to be improved. The evaluation is based on distinction between colors used as route colors. To distinguish colors easier, we created a color evaluation chart in Figure5. The marks in the figure indicate evaluation of people with color vision deficiency in response about difficult distinction between colors. Figure 6 shows that people with normal color vision evaluate the same color chart in the test image environment.

There was the combination of the colors that cannot be distinguished by color vision deficiency in comparison with the possible color distinction of normal color vision in visual testing on the same monitor. However there are many coincided parts of evaluation and so we consider that the evaluation of color vision test has the definite efficiency. About the improvement verification we have decided to keep promotion under this evaluation, confirming colors in visual testing.

As for the improvement of a station guidance map, we have promoted the verification to make a model figure with the common components to all the figures as in Figure7 because there are many different designs of individual stations. We have created a color chart as well as the route map under the general evaluation on the issue whether the smoother movement route has become easy to understand with the figure and the relations of the colors in use.

### 4. Improvement Verification and Intermediate Evaluation

The left of Figure8 shows the color chart evaluation of the route map design that people with normal color vision drew to pursue evaluation of people with color vision deficiency in the middle of verification process. Compared with the evaluation of Figure5, the difficult color distinction parts of color vision deficiency have been greatly improved. The settled colors are not quite different from the route map coloring in printed matters that people with normal color vision are used to see. It is important for the function criteria to prevent confusion arising from the difference of color vision in the case that the coloring image is familiar like the route map distributed widely as information. The universal design does not premise to provide the same measures for people with different physical attributes. Using media characteristics of website, the verification has been conducted to be applied to color vision deficiency with measures in the different use from normal color vision. However we have decided to promote reconsideration under the unified proposal made from the evaluation result of the intermediate verification.

In verification process, the designer of deuteranopia type 2 made the helpful proposal in the right of Figure8. Some colors out of the familiar coloring are included but the tendency to expand the color range with advanced saturation and brightness has become a help to people with color vision deficiency to understand the concrete color differences.

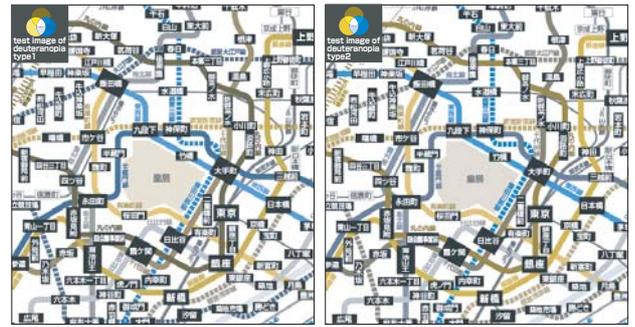


Figure 4: Test Image of Deuteranopia Type 1 and 2 (before improvement)

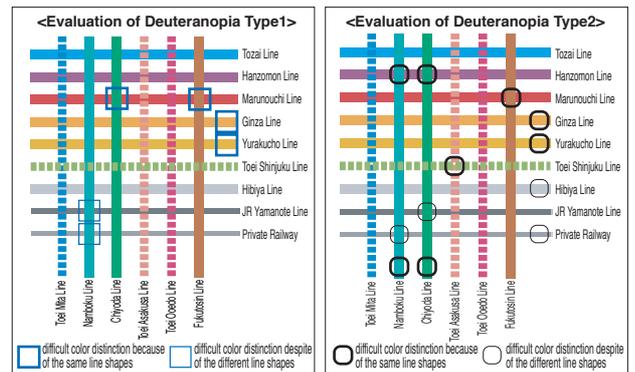


Figure 5: Route Map-Color Chart and Evaluation of Color Vision Deficiency (before improvement)

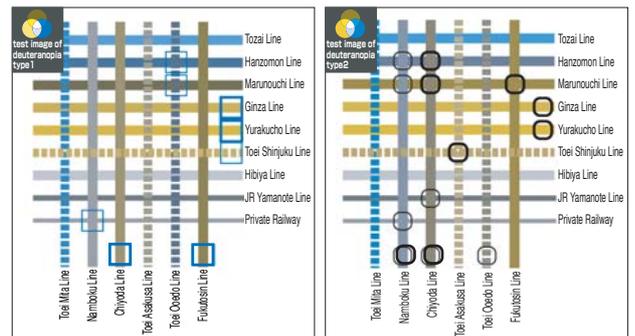


Figure 6: Evaluation of Normal Color Vision in Test Image (before improvement)

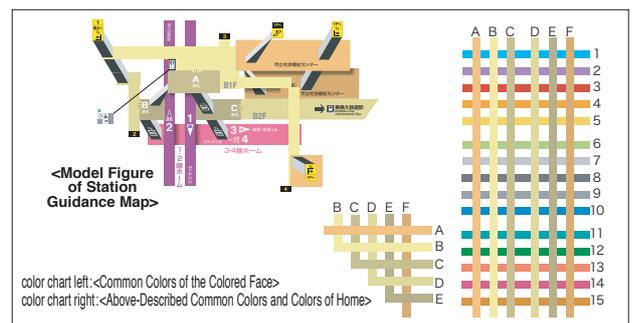


Figure 7: Station Guidance Map- Model for Evaluation and Two Types of Color Charts

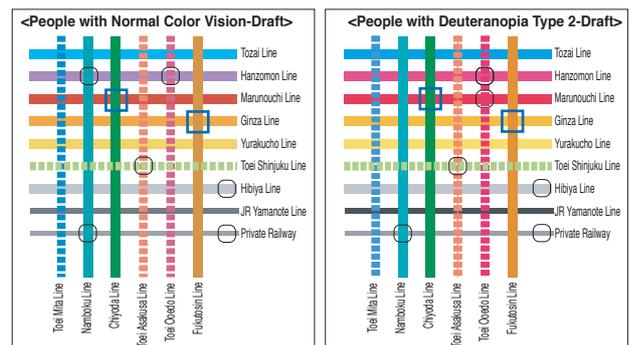


Figure 8: Route Map-the Comparison with Verification Proposal of Used Colors-Evaluation of Color Vision Deficiency

## 5. Verification of Improvement Model

Both of the people with or without color vision deficiency have become to verify the models before and after improvement of the route map under the intermediate evaluation. We have created the question color chart (Figure 10) limited to the used colors with a lot of problems. Figure 11, 12 are reflected with the response about the difficult color distinction of people with different color vision.

Before improvement D (Figure 12) had many parts with high negative values in evaluation (minus evaluation). In comparison with it, after improvement C has decreased the negative parts and values and the evaluation has become higher because of overall improvement. The improvement has been largely conducted about the combination of colors that was evaluated as mostly impossible distinction between a) Fukutosin Line and Marunouchi Line, b) Ginza Line and Yurakucho Line in common by both types of people with color vision deficiency before improvement. However we hope the average value will become below the evaluation point 1: difficult distinction as the aim of the improvement. We decided to readjust the colors in use on introduction operation. For your information, we provide Figure 13 that shows the test image of color vision deficiency of Figure 12.

### <Verification of Barrier Color Vision>

#### 1. Attribute of subject\_color vision :

when samples are provided widely from normal color vision to partial color blindness (tritanopia), it is necessary to understand color visions of the subjects to be united. Therefore we designed Figure 9 and tested it. It is thought as effective measures but a retest will be necessary in consultation with color vision.

#### 2. Attribute of subject\_the way related to colors :

in the case of each deuteranopia type 1 and type 2, "the ways to view" colors are thought to be approximate but not uniform under response to questions about Figure 10 (judgment of concrete color distinction). The way related to colors on the job in daily life is thought to have influence.

#### 3. Environmental difference of subject :

each subject has different environment on website depending on quality of monitor and configuration. The comparison of the environments settled for this verification is not sufficient.

The above mentioned items are necessary to conduct and verify measures in designs against barrier to color vision differences. We expect the research will collect samples widely hereafter and develop in this field.

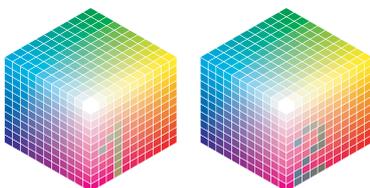


Figure 9: Confirmation Chart of Color Vision Type

Deuteranopia Type1: possible to see the number, 1, but impossible to see 2 in the right.

Deuteranopia Type2: possible to see the number, 2, but impossible to see 1 in the right.

Distinction of Crossing Colors X impossible:3points Δ difficult:1point ○ possible:0point

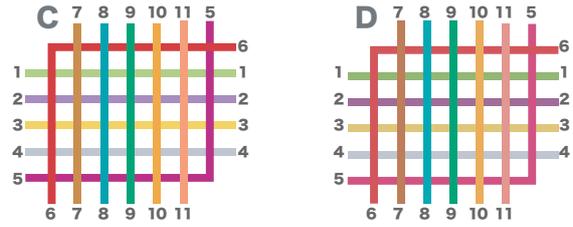


Figure 10: Difficult Color Distinction - Question Color Chart

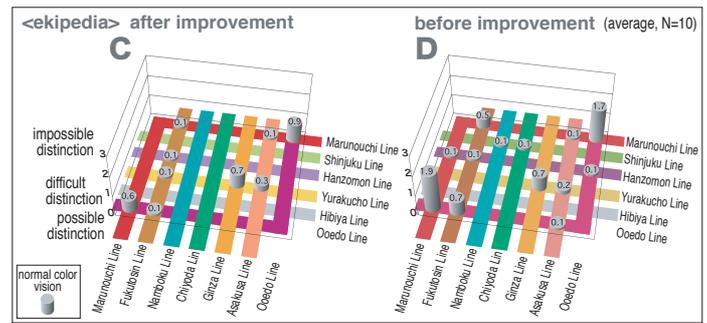


Figure 11: Difficult Color Distinction-Evaluation of Normal Color Vision

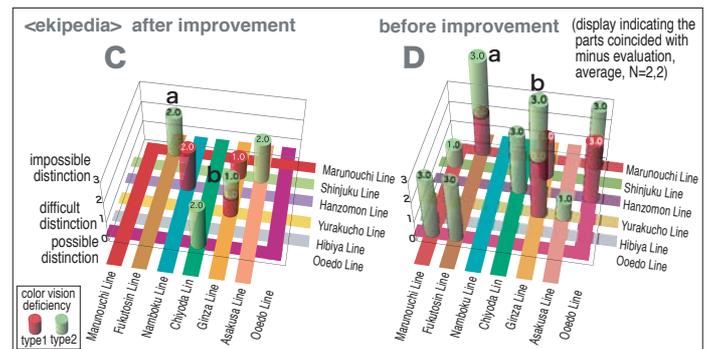


Figure 12: Difficult Color Distinction-Common Evaluation of Color Vision Deficiency

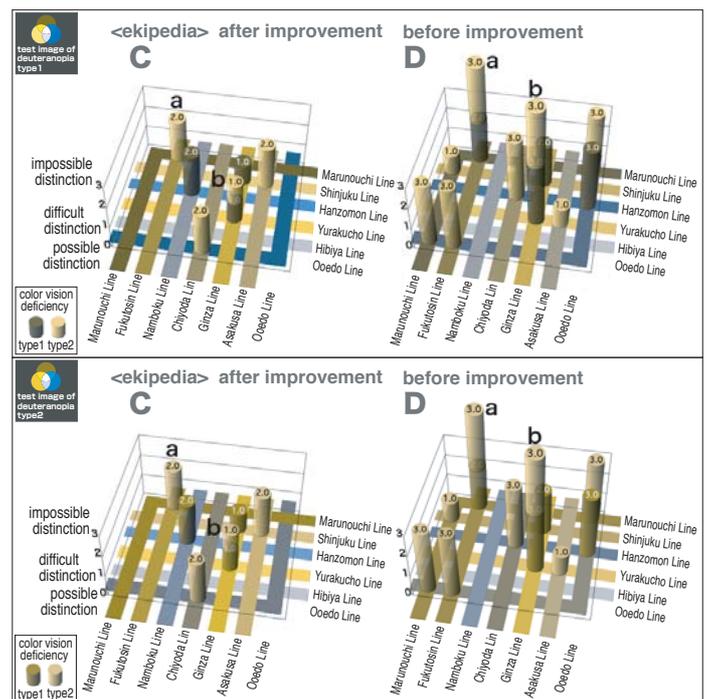


Figure 13: Test Image-Common Evaluation of Color Vision Deficiency

## 6. Conclusion

Figure 14 shows the response to the questions on verification about 6 items related to color vision in daily life. In case of color vision deficiency, type 1 and 2 have different tendency but both have the same difficulty to see the route map and the time table. It indicates the difference clearly from normal color vision about the items relating to the safety and will become an important problem to promote barrier free guide information provided in public transportation systems.

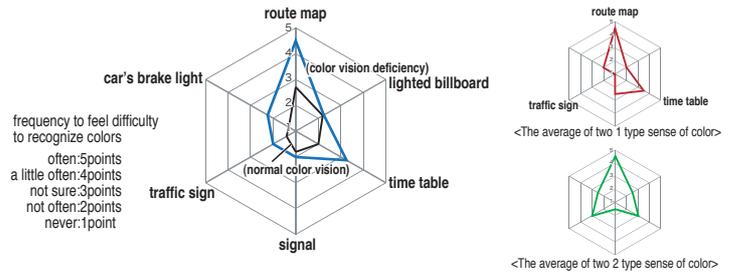


Figure 14: Matters in daily life to feel difficulty to recognize colors

## Improvement in color distinction and recognition of a route map

As the result of verification, Figure 15 shows that the improvement model has received the evaluation of color vision deficiency about the color distinction under the result of Figure 12 such as close evaluation of normal color vision before improvement.

We have not changed the components except line colors of the route map and asked for the response, showing the route maps in the new and the old coloring. The evaluation slightly improved on the impression as overall understandability and the function as introductory remarks. Therefore improvement in color distinction will lead to better function as route map design.

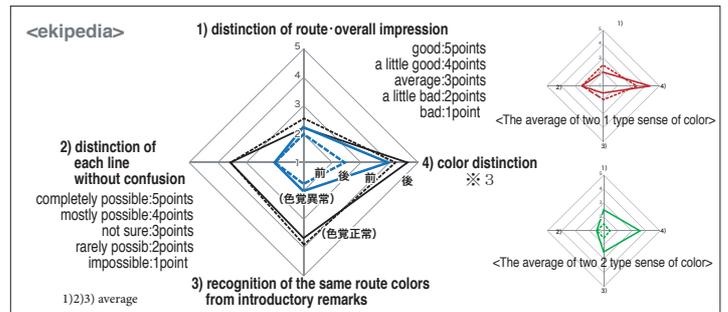


Figure 15: Color Distinction and Route Map <Improvement of Ekikipedia>

## 7. Reference Comparison with Examples of Other Companies

Figure 16,17 show the result of verification in the same way, using the route maps provided on website of Tokyo Metro and Toei Subway. Distinction of line colors largely depends on line shape and thickness, relations with adjacent lines. Though we cannot compare simply with the route maps in the different designs, we can compare Figure 15,16 under the same conditions because the indicator is based on the evaluation of Figure 10.

\_1. About the evaluation of color vision deficiency that both companies received, all of 4 indicators are low and the situation is not convenient for practical use.

\_2. Figure 17 shows the evaluation of difficult color distinction on the route maps of both companies in use. The parts where minus evaluation is remarkable are a), b), a) because of the color combination, deuteranopia type 2 cannot distinguish Fukutosin Line/Marunouchi Line and deuteranopia type 1 cannot distinguish Tokyo Metro. b) both type 1 and type 2 of deuteranopia cannot distinguish Ginza Line /Yurakucho Line.

\_3. Indicator "color distinction" shows the evaluation of Figure 15 is higher than Figure 16 in the improvement case. As in the research the improvement in color distinction makes the route map easier to understand. We expect that the verification of the colors in use will lead to the improvement of guidance information for color vision deficiency.

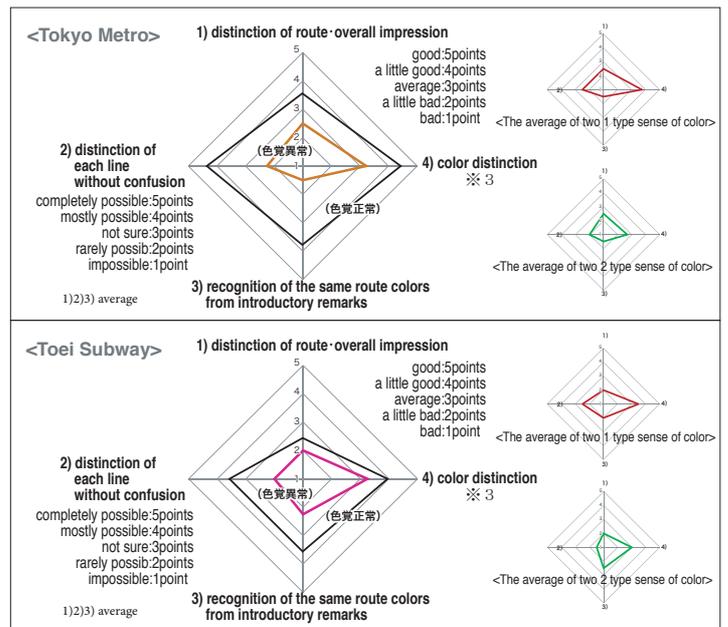


Figure 16: Color Distinction and Route Map <Tokyo Metro> <Toei Subway>

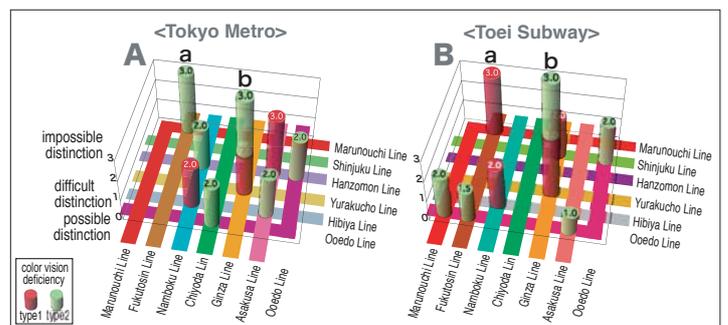


Figure 17: Color Distinction Common Evaluation of Color Vision Deficiency

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