EFFECT OF COLOR ON THE SPACE BRIGHTNESS USING BORDER LUMINANCE OF COLOR APPEARANCE MODE

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Keywords: space brightness, color appearance mode, border luminance

ABSTRACT

Recently, many researchers have proposed space brightness indices that are well matched to human perception. However, those indices do not accurately reflect space brightness in some cases. Particularly, several studies found that observers reported enhancement of space brightness when there were colored objects (e.g., colored furniture), but the color effects are not taken into account in those indices. In the present study, to examine quantitatively the influence of color on the space brightness, we measured border luminance of color appearance mode for spaces with chromatic or achromatic furniture. Participants observed a test stimulus located in a scale model simulating a room and adjusted its luminance to determine the transition point from object color mode to light source color mode. The results showed higher border luminance in the chromatic furniture condition than in the achromatic furniture condition. This suggests that subject's space brightness was enhanced by chromatic furniture.

INTRODUCTION

To design a lighting environment, horizontal illuminance is generally used as a brightness index of room. However, it is frequently reported that, even when horizontal illuminance is high, a room does not appear bright. To solve this discrepancy between the horizontal illumianance and observer's brightness, many researchers have proposed space brightness indices that are well matched to human perception. In those indicates, however, color effects are not taken into account. There is increasing evidence that, when there are colored objects such as colored furniture in a space, the brightness is enhanced, as compared with that for a space with only non-colored objects.
The purpose of this study was to examine quantitatively the influence of color on the space brightness. For this purpose, we measured a border luminance of color appearance mode, i.e., the transition point from object color mode to light source color mode, to a scale model simulating a room. The number of furniture and horizontal illuminance in the room were manipulated. We compared the border luminance between rooms with chromatic and achromatic furniture.

EXPERIMENTAL METHOD

In the present study, a 1/8 scale models simulating a living-room(width; 450 mm, length; 580 mm, height; 300 mm) was used. Figures 1 and 2 show schematic illustrations of the model and the device to measure the border luminance of color appearance. The room was uniformly illuminated by luminous ceiling with three different levels: 100, 300, and 1000lx (measured at the center of the room). The number of furniture was manipulated: 2, 4, and 8 piece of furniture. Table 1 shows Munsell value of interior surface. A gray test patch (N5, 12 × 15 mm) was placed in the center of

the room. The test patch was illuminated by LED lamps from the bottom and its luminance was able to change independent of the room light.
The participant's task was to adjust the luminance of the test patch and to determine the border of the appearance mode, i.e., transition point from the complete surface-color mode. There were 20 blocks of 18 trials. The order of conditions was randomized across participants. Before an experimental session, participants practiced the task for several times until they familiarized with the task. Participants were 5 people in 20's.

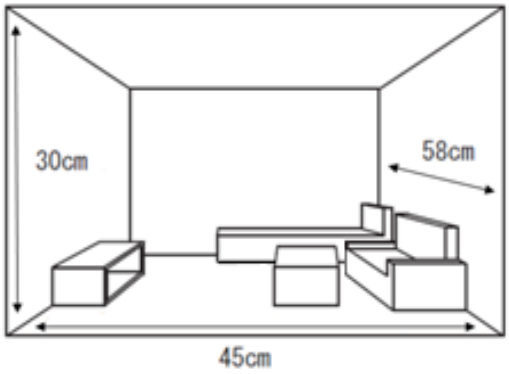

Figure1:Scale model

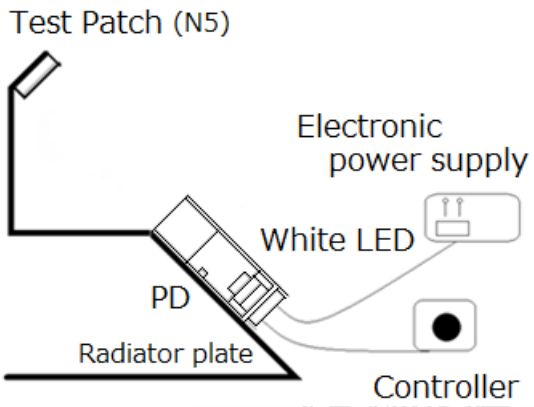

Figure2:Experiment device

Table 1 Munsell value of eight kinds

Item	Chromatic furniture	Achromatic furniture
Wall	N7.7	N7.7
Floor	N3.7	N3.7
Bed1	5B5/9	N5.0
	5PB3/2	N3.0
Bed2	5Y8/14	N8.0
	5YR6/13	N6.0
Sofa1	5GY7/12	N7.0
	5G4/10	N4.0
Sofa2	5PR5/14	N5.0
	5R4/14	N4.0
Table1	5Y8/14	N8.0
	5YR6/13	N6.0
Table2	5P5/9	N5.0
	5PB3/12	N3.0
TV stand1	5PR5/14	N5.0
	5R4/14	N4.0
TV stand2	5GY7/12	N7.0
	5G4/10	N4.0

RESULTS

Fig. 3 shows the results of two subjects (MN1 and YO). The abscissa represents the number of furniture in the room, and the ordinate represents the border luminance on chromatic color furniture condition set by participants. Square, triangle, and circle symbols show the border luminance at the room illuminance of 100, 300, and 1000 lx, respectively. Black and white symbols indicate achromatic and chromatic furniture conditions, respectively. A close inspection of the results from MN1 revealed that the border luminance increased as the room illuminance increased. Furthermore, the border luminance in the chromatic furniture condition was higher than that in the achromatic furniture condition. It was increased as the number of furniture increased.
Unlike the results from MN1, the results of subject YO showed a tendency that the border was almost identical in both the chromatic and achromatic furniture conditions, although it was increased as the room illuminance increased. The number of furniture did not affect the border lumiancne of the participant.

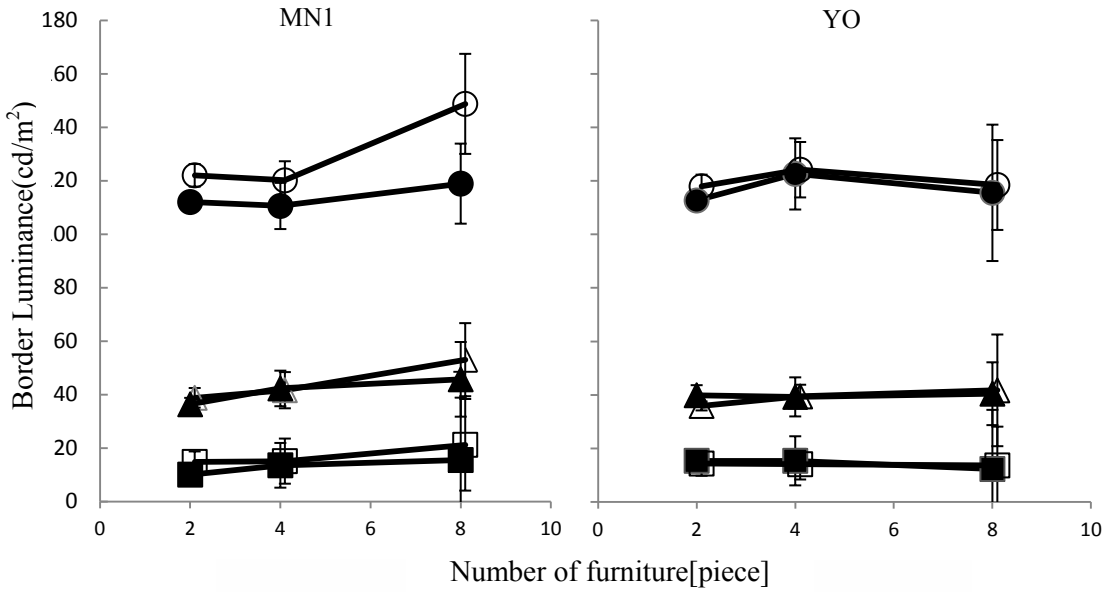

Fig.3. Border luminance as a function of room illuminance

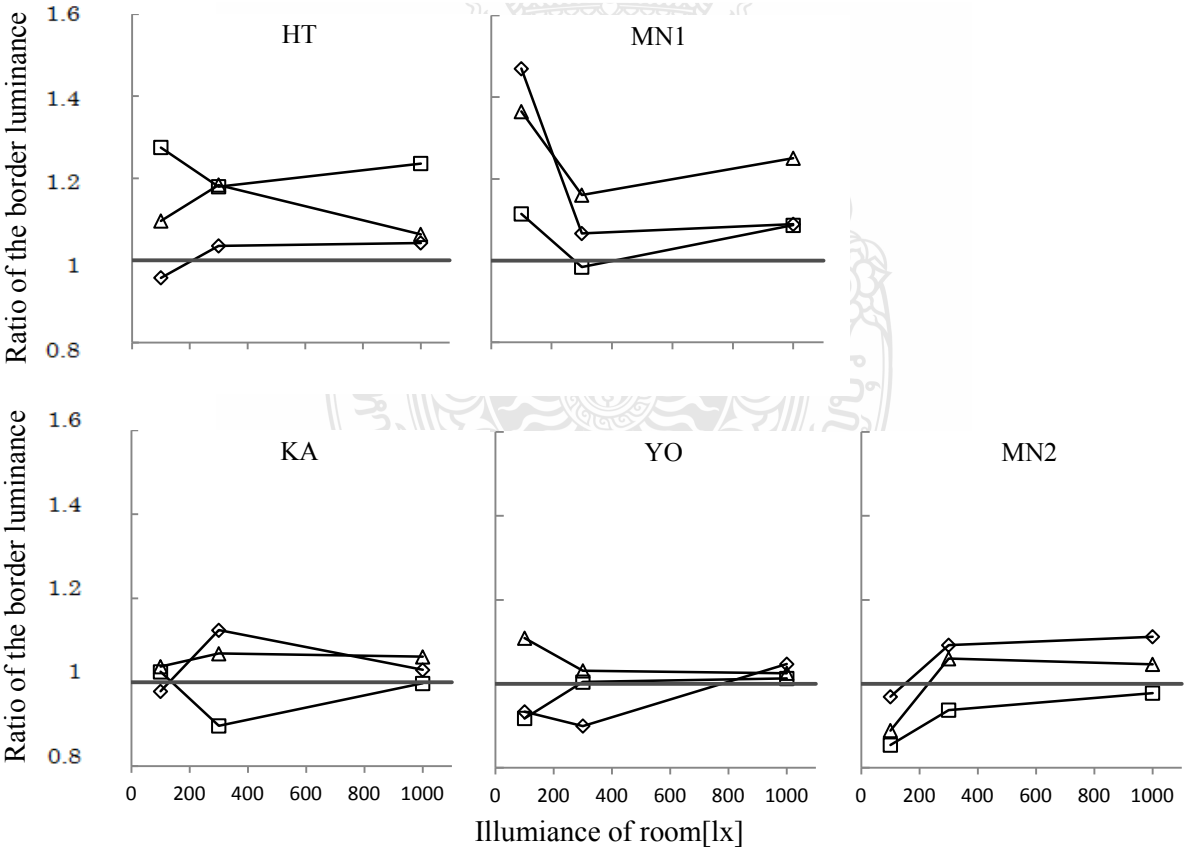

Fig.4. Border luminance as a function of the number of furniture

Fig.4 shows the ratios of the border luminance between the chromatic and achromatic conditions. If these values are more than 1, subject's space brightness was enhanced by chromatic furniture. The abscissa represents the horizontal illuminance measured from the center of the room. Triangle, square, and diamond symbols show the ratios in the furniture conditions of 2, 4 and 8 pieces, respectively. Upper panels show the results of subjects who showed higher border luminance in the chromatic furniture condition than the achromatic furniture condition. The ratio in the border luminance between the two color conditions were more than 1 under the most conditions, specifically in a range of 0.96-1.46. That is, subject's space brightness was enhanced by chromatic furniture. Lower panels in Fig. 4 show the graph of three subjects. As shown in the figure, the border luminance had little influenced by the chromatic furniture. The ratios of the border luminance was almost 1 or less, suggesting that subjects' space brightness had little influenced by chromatic furniture.

DISCUSSION

In this study, to examine quantitatively the influence of color on the space brightness. Particularly, we looked at the number of furniture in the room. We measured border luminance with chromatic or achromatic furniture. All subjects adjusted border luminance highly as the horizontal illuminance was increased. That is, subject's space brightness was enhanced as the horizontal illuminance was increased. Some subjects adjusted border luminance highly as the number of chromatic furniture increased. That is, subject's space brightness was enhanced by chromatic furniture. While other subjects did not change. That is, there was individual difference that enhancing effect of subject's space brightness by chromatic furniture: Takada et al [1] . have shown that subjects was called "color type" who adjusted the border luminance of the chromatic furniture condition was higher than an achromatic condition. Furthermore subjects adjusted border luminance highly as saturation of chromatic furniture increased. While subjects was called "luminance type" who adjusted the border luminance of the chromatic furniture condition was same as an achromatic condition.

The result of this study shows that there was individual difference that enhancing effect of subject's space brightness by chromatic furniture, but it is not clear from the result of this study why it happens. We could research this individual difference by checking whether subjects judge space brightness while watching which position of the space when subjects adjusted border brightness. For example, I measure the movement of eyes directly. Or we could research it that subjects received same amount the influence of the color even if the subjects were watching which position of the space when subjects adjusted border luminance by pasting the color chart on the walls in model.

CONCLUSION

Our results showed that subject's space brightness was enhanced as the room illuminance increased. Some subject's space brightness were enhanced by chromatic furniture. Therefore, the color affects of the space brightness.

REFERENCES

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