

# Comparison of Glare Sensation between the upper visual field and the lower

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**ABSTRACT:** The glare sensation is measured in entire visual field and compared between in lower visual field and in upper visual field. The Glare Tester created for this measurement was used which has two sources: the standard source and the test source. The standard source was set at the BCD luminance (luminance at the Borderline between Comfort and Discomfort) of each observer and the luminance of the test source was increased. The observers were asked to stop when the test source arrived at the same sensation as the standard source. The result of the investigation shows that the glare sensation is more sensitive in the lower field of view than in upper field at symmetrical positions with respect to the horizontal line.

**Keywords:** Discomfort glare; Glare sensation; Luminance; Visual field

## 1. INTRODUCTION

The Unified Glare Rating (UGR) [1], [2] has been recommended internationally by the International Commission on Illumination (CIE) to assess discomfort glare in interior lighting. But, the UGR has a limitation with respect to the position of a glare source. The UGR cannot be used to evaluate discomfort glare from sources located at the lower visual field because the UGR includes the Guth Position Index [3] as a main factor specifying only at the upper visual field.

Considering of the present lighting environment, lights are located not only in the upper visual field but also in the lower visual field. For example, up light is often placed in the lower visual field. Furthermore, the windows occupy partially the lower visual field.

Iwata and Tokura investigated the difference of glare sensation between the upper visual field and the lower visual field [4]. The sensitivity to the glare caused by a source located below line of sight was found to be greater than the sensitivity to the glare caused by a source above line of sight. The

investigation was carried out in the limited visual field within 30 degrees from the line of sight. Now, it is necessary to examine the glare sensation in whole visual field.

In this study, the glare sensation is measured in entire visual field and compared between in lower visual field and in upper visual field.

## 2. METHODS

### 2.1 Glare Tester

Glare Tester was created so that the glare sources can be located at various positions in the whole visual field. Fig.1 shows the Glare tester. It consists of a semi-spherical screen and two halogen lamps mounted on a round boom. The screen has 1 m radius, and its inside surface is painted white to produce diffuse light.

The sources are exposed for one second periods with one second intervals between exposures. The sources can be moved along the round boom automatically in a range of 0-110 degrees from the center of the screen. The boom can circle round so that it has a distinct function placing the glare sources anywhere in visual field.



**Figure 1:** Glare Tester

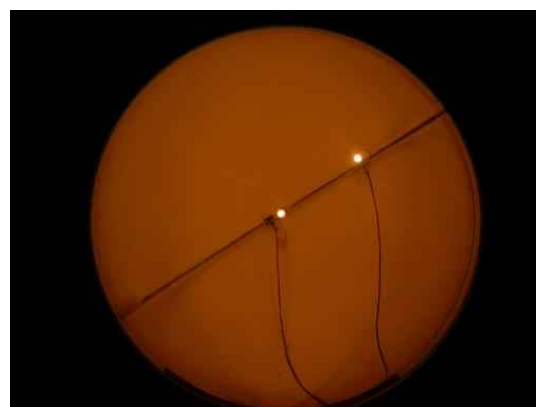


**Figure 2:** Experimental set up

## 2.2 Criterion and subjects

The visual comfort criteria should be used with care since the diversity of individual preferences is large [5]. Any particular sensation would be a matter of considerable debated among a large group of individuals [6]. The BCD (Borderline between Comfort and Discomfort) sensation was adopted as the criterion for this experiment.

Twenty-seven observers participated in the experiment. The observers' age ranged from 21 to 28; the average was 24.5. Five observers wore contact lenses during the experiment. Observers with glasses were not used. Since no significant difference was found between observers with and without contact lenses, the data were analyzed without discrimination [7] [8] [9].

## 2.3 Experimental conditions and procedure

The Glare Tester was located in a chamber without windows. The average illuminance of the chamber was maintained at 30 lx during the experiment. The background luminance was set at  $34.3 \text{ cd/m}^2$  in the inner surface of Glare Tester.

The standard source was put on the center of screen, and the other lamp called the test source was moved to the various positions in the screen (Fig. 2). Fig. 3 represents the source positions where the sensation of brightness was tested.

The observers were asked to put their heads on the headrest and to look at the standard source at the center of the screen.

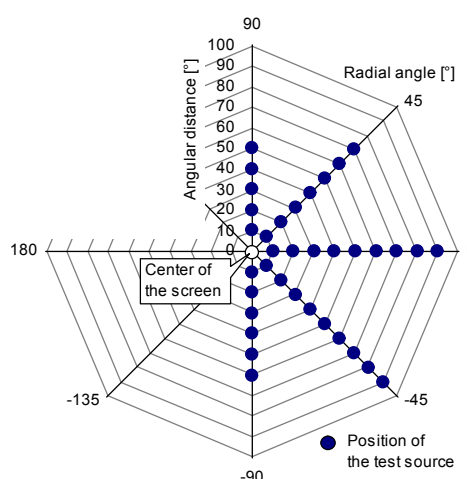


**Figure 3:** Positions where the sensation of brightness was tested

The BCD luminance of the test source was measured at various positions at ten degree intervals from the line of sight.

In the measurement of BCD luminance, the standard source was set at the BCD luminance of each observer.

The test source was located at the designate positions (see Fig. 3) randomly and the luminance of the source was increased. The standard source and the test source were exposed alternately for 1-second intervals. While the luminance of the test source was increasing, the observers were asked to stop when the test source arrived at the same sensation as the standard source. During the measurement, the position of the test source was provided randomly to control for the effect of presentation.

### 3. RESULTS AND DISSCUSION

The BCD luminances of the test source are represented in Table 1. The BCD luminances were obtained at the positions within the boundary of individual visual field. The BCD luminances range from 1614  $\text{cd/m}^2$  to 16037  $\text{cd/m}^2$ . The BCD luminances at the angular distance 10 degrees are lower than the BCD luminance on the line of sight (2590  $\text{cd/m}^2$ ).

The results of this measurement show that the sensation of brightness at the positions deviated 10 degrees from the line of sight is more sensitive than at the other positions.

The BCD luminances at various positions in the visual field are illustrated in the Fig. 4 and Fig. 5. The regression lines in the figures show that the variation of the BCD luminance according to the angular distance. In the Fig. 4, the BCD luminance increases more rapidly on the line of radial angle 90 degrees and 45 degrees than on the line of radial angle 0 degree as the angular distance increases. But, the BCD luminance increases slowly in the Fig. 5. It implies that the BCD luminance has lower value in the lower visual field at symmetrical positions with respect to the horizontal line.

Fig. 6 presents a graphical illustration of the BCD luminance changed according to the positions in the field of view. The heavy solid lines represent the positions having equal BCD luminance. The lines are spread more wildly in the upper field of view than in the lower field.

**Table I:** BCD luminances of the test source

| Angular distance from line of sight [degree] | BCD luminance [ $\text{cd/m}^2$ ]               |      |      |      |     |
|----------------------------------------------|-------------------------------------------------|------|------|------|-----|
|                                              | Radial angles from the horizontal line [degree] |      |      |      |     |
|                                              | 90                                              | 45   | 0    | -45  | -90 |
| 10                                           | 2121                                            | 1799 | 1630 | 2260 | 161 |
| 20                                           | 3406                                            | 3055 | 2270 | 2361 | 267 |
| 30                                           | 5290                                            | 4134 | 2989 | 3354 | 391 |
| 40                                           | 9654                                            | 5505 | 4746 | 4006 | 552 |
| 50                                           | 1429                                            | 8283 | 4844 | 4718 | 643 |
| 60                                           |                                                 | 1244 | 5564 | 5826 | 724 |
| 70                                           |                                                 | 1603 | 6707 | 6495 |     |
| 80                                           |                                                 |      | 7340 | 7301 |     |
| 90                                           |                                                 |      | 9235 | 8108 |     |

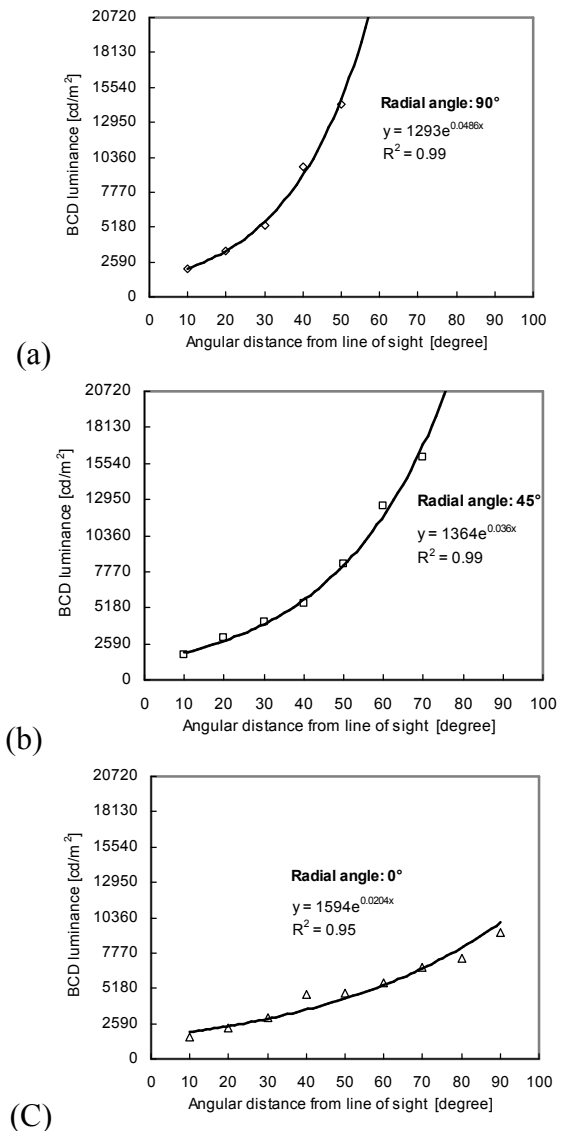
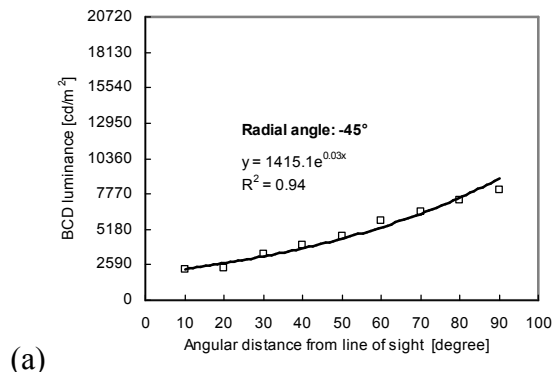
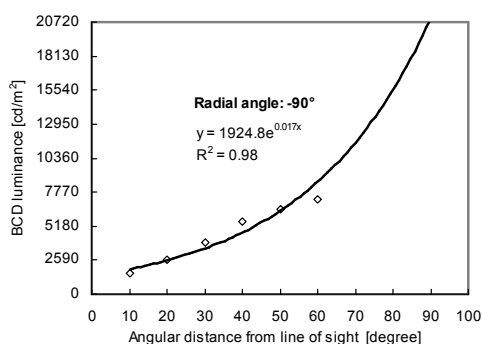


**Figure 4:** The relationship of BCD luminances to the angular distance from line of sight in the upper visual field

It means that the glare sensation is different between the upper visual field and the lower.





(b)

**Figure 5:** The relationship of BCD luminances to the angular distance from line of sight in the lower visual field

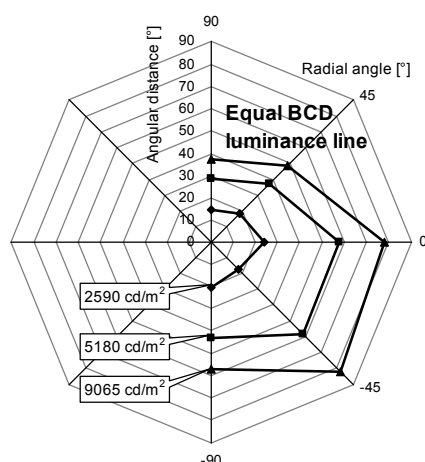


**Figure 6:** A graphical illustration of the BCD luminance

Consequently, the glare sensation is more sensitive in the lower visual field than in upper visual field at symmetrical positions with respect to the horizontal line

#### 4. CONCLUSION

This study was carried out to compare the glare sensation between in lower visual field and in upper visual field. The BCD luminance was measured at various positions in the entire visual field. During the experiment, the Glare tester was used. In the experiment, the standard source was set at the BCD luminance of each observer and the luminance of the test source was increased. The observers were asked to stop when the test source arrived at the same sensation as the standard source. From the results of this measurement, it is known that

the glare sensation is more sensitive in the lower visual field than in upper visual field at symmetrical positions with respect to the horizontal line

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