A study on the angle visual illusion in the road image

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Abstract

In this study, we found a visual illusion; the angle of corner at the vanishing point drawn by parallel white lines in road images is observed smaller than the correct one. We investigated relationship between pictorial cues for depth perception in images and this visual illusion. Our results showed the evidence of this visual illusion, and the kind of pictorial cue was an important factor to control the visual illusion. In addition, we were interesting in directions of presented images, which also could control the visual illusion. We expected that this illusion has a relationship with Ponzo illusion. The effects of the pictorial depth cues and the direction of images were similar to the results of previous reports on the Ponzo illusion. However, in the images observed the new illusion, Ponzo illusion was not clear, and vice versa. It is possible that this new angle illusion and Ponzo illusion aren't completely the same mechanism in our vision system.

Key words *Perspective, Vanishing point, Depth cue, Ponzo illusion*

1. Introduction

As for the visual illusion related to the sense of perspective, Ponzo visual illusion is famous[1][2]. This visual illusion was devised an Italian psychologist Ponzo in 1928. When two horizontal parallel lines with the same length put between crossing lines like a turned "V" shape, the upper line of parallel lines is perceived longer length than the lower line. Not only simple crossing lines, but we can observe this illusion in cave images, road images, and rail road images also. To observe this illusion, it is important that a pair of spread lines is drawn in the image like a vanishing point and parallel lines in perspective images. There are many studies about this visual illusion, they have paid attention to changing of object's size located between the crossing lines[3].

In this study, we investigated whether the angle of corner at a vanishing point drawn by parallel lines in perspective images was perceived correctly, and the factors to observe this error of angle estimation. Then, we discussed a relationship between Ponzo illusion and this error of angle estimation.

2. Experiment 1

We experimented on the perceived angle of corner at a vanishing point in road images. We controlled pictorial depth cues in the images, and direction of the images for presentation to observers.

2.1 Method

(Participants)

The observers were 10 university students, 7 males and 3 females, aged 21-28 years. They have normal sense of color, and normal eyesight (including the correction).

(Stimuli and apparatus)

We prepared 32 standard stimuli. At first, we set 4 levels for controlling pictorial depth cues in each image. Figure 1 shows 4 example images, a road image, a paved road image, a road & cones image, and a no background image. Second, we set 4 variations of road width, 2,750mm, 3,000mm, 3,250mm, and 3,500mm. Third, when the stimuli were presented on a LCD display SONY, PCVD-17SM2/K), we selected the direction of

presentation, the normal direction like Fig.1 and the upside-down direction. As a result, the stimuli were 4 times 4 times 2 variations (the pictorial cue, the road width, and the display direction). The images were generated by 3-dimensional computer graphics. The position of camera was the center of the road and 1 m height. The focus distance of camera was 50 mm. The size of displayed image was 25.9 by 34.5 cm.

On the other hand, the comparison stimuli were a black isosceles triangle drawn on a white paper. The base line of the triangle was located at lower position, but this line was not drawn. That is, the comparison stimuli seem like a turned "V" shape. 19 sheets between from 30 degrees to 120 degrees by 5 degrees were prepared. Figure 2 shows the experiment environment to display these stimuli.

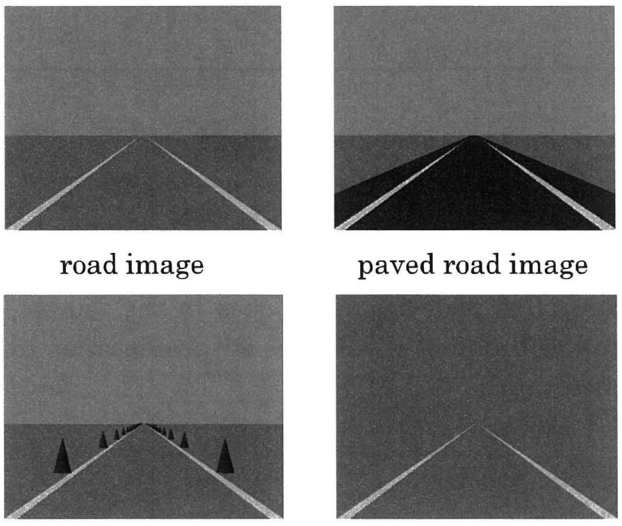

Figure1. Normal stimulation

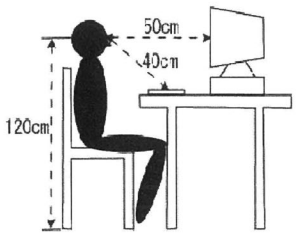

Figure2. Experimental environment

(Procedure)

The standard stimulus was presented on the LCD display by random order. The observers were directed to gaze at the vanishing point in the standard stimulus, and compare the standard stimulus and the comparison stimulus without watching two stimuli at the same time. The comparison stimulus was presented on a table from the smallest angle to the bigger angle or from the biggest angle to the smaller angle in turn. The observer selected the comparison stimulus when they thought that the comparison stimulus was the same angle as the standard stimulus. An observer's perceived angle of each standard stimulus was calculated by the average of 2 selected angles.

2.2 results and discussion

Figures 3 and 4 show the results of stimuli displayed with the normal direction and the upside-down direction respectively. An analysis by using the 95% confidence limits revealed that there were significant differences from the correct angle in all stimuli.

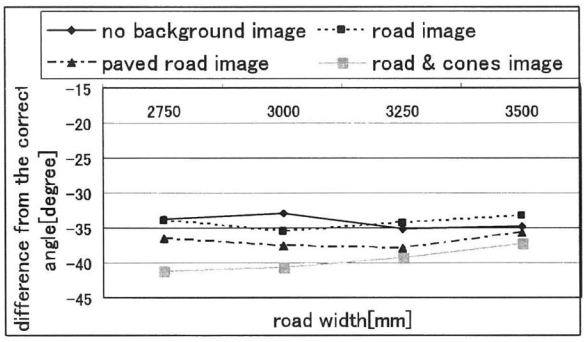

Figure3. Normal direction

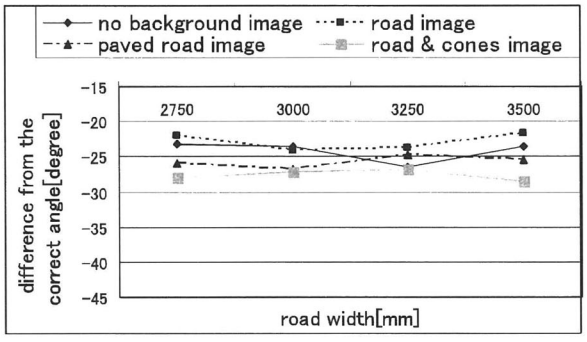

Figure4. Inversion

3-way analysis of variance, pictorial cues for the depth perception (depth cues), road width, and display direction, revealed the main effect of the depth cues [F(3)=8.708, p=0.0003]. The results were subjected to multiple post hoc comparisons by Ryan's method. There is a

significant difference at the pair of the road image and the road & corns image, the pair of a no background image and a road & cones image (0.05 significant level). This results show that in the images with rich depth cues the difference from the correct angle was bigger than that in the images with poor depth cues. It seems that this regularized difference is a kind of visual illusion. We call it as the angle illusion of road images. We think that this visual illusion relates to the sense of perspective like Ponzo illusion.

3-way analysis of variance also revealed the main effect of the display direction [F(1)=9.701, p=0.0124]. The visual illusion of the upside-down direction images was smaller than that of the normal direction.

3. Experiment 2

We experimented on relationship the angle illusion found by the experiment 1 and Ponzo illusion. We controlled the angles of turned "V" shape and "V" shape, investigated the both illusions.

3.1 Method

(Participants)

The observers were 7 university students, 4 males and 3 females, aged 21-28 years. They have normal sense of color, and normal eyesight (including the correction).

(Stimuli and apparatus)

We prepared 30 standard stimuli (Fig.5). First, we set 5 variations of the angle Θ (30, 60, 60, 90, 120, 150 deg.). Second, we set 3 variations of the distance X, 5.6cm(line A), 9.2cm(line B), 13.1cm(line C). Third, when the stimuli were standed on a desk, we selected the direction of presentation, the normal direction like Fig.5 or the upside-down direction. As a result, the stimuli were 5 times 3 times 2 variations (the angle, the line position, and the display direction). The size of a standard stimulus was 22 by 30 cm.

On the other hand, the comparison stimulus were presented on a LCD display (SONY,PCVD-17SM2/K). The comparison stimulus was a turned "V" shape, and the size was the same as the standard stimuli. Figure 6 shows the experiment environment to display these stimuli.

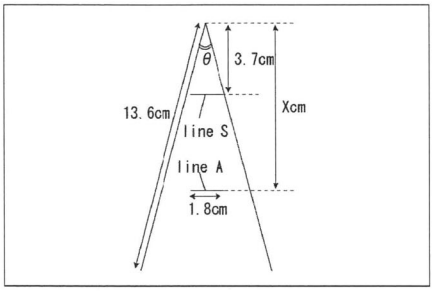

Figure 5Standard stimulus

(Procedure)

The standard stimulus was presented by random order. The observers were directed to adjust the angle of the comparison stimulus to that of the standard stimulus by manipulating of a mouse device without watching two stimuli at the same time. Then the observers were asked about the length of the line S (see Fig.5). They answered the length as the multiple number of the line R.

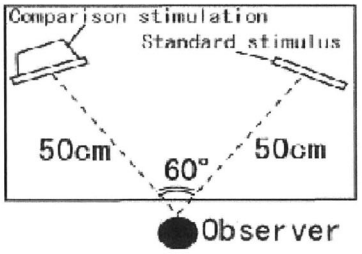

Figure6. Experimental environment

3.2 results and discussion

Figures 7 and 8 show the results of stimuli displayed with the normal direction and the upside-down direction respectively. An analysis by using the 90% confidence limits revealed that there were significant differences from the correct angle in table 1.

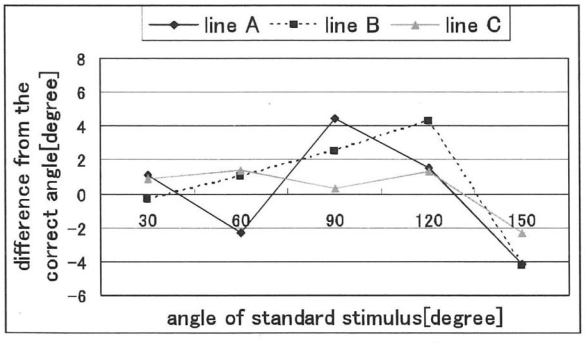

Figure7. Normal direction

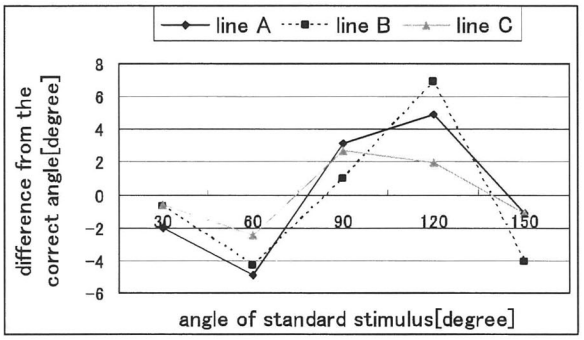

Figure8. Upside-down direction

display direction	angre	line R
Normal	90	A
Normal	150	B
Upside-down	60	B
Upside-down	120	A
Upside-down	120	B
Upside-down	150	B

Table1

In the Ponzo image, it is known that visual quantity of optical illusion tends to decrease with increase of the angle, which made by two lines contacted at a point. In our experiment, however, such the tendency was not confirmed. This discrepancy can be explained as follows. The angle illusion seems to be induced by our perception characteristics. We tend to pay our attention to the triangle formed by reversely V-shaped lines and line S in the Pnzo image. Consequently, we can not perceive a perspective feeling in the image. Thus, we can conclude that origins of Ponzo visual illusion and that of the proposed angle illusion in the road image are different. We have to clarify the difference in the future experiment.

4. Summary

In this study, the followings became clear.

1. The angle of corner at the vanishing point drawn by parallel white lines of road images is observed smaller than the correct one (visual illusion of angle in a road image).
2. The quantity of visual illusion depends on the depth clues.
3. Quantity of visual illusion decreases rapidly by the top and bottom inversion of the projection image. This fact suggests that quantity of the angle illusion is influenced by the depth clues perceived from the given image.
4. Origins of Ponzo visual illusion and that of the proposed angle illusion in the road image seem to be different.

References

[1]Ponzo,M(1912)Rapports entre quelques illusion visuelles de contrite angulaire et l'appreciation de grandeur des asters a l'horizon , Arshives Itakiennes de Biologie

[2]Coren, S. & Girgus, J. S. (1978) Seeing is deceiving : The psychology of visual illusion. Hillsdate : Lawrence Erlbaum Associate, Inc.

[3]Fisher, G. H. (1973) Toward a new explanation for the geometrical illusions, II. Apparent depth or contour proximity? British Journal of Psychology

[4] Pressey, A. W., Burchard, N & Scrivner, L. (1971) Assimilation theory and the Ponzo illusion : Quantitative prediction. Canadian Journal of Psychology