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Measurement of the Kanizsa Illusion Using Stereopsis

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I. Introduction[1]

Seeing Kanizsa illusion figures like Figure 1, observers report 3 Kanizsa illusions (e.g., Purghe & Coren, 1992).

(1) Inner region looks brighter than outer regions (brightness).
(2) Inner region looks nearer than outer regions in depth, a little (depth).
(3) There are contours between inner region and outer regions (contour).

In typical reports, in this figure, a brighter white triangle covers 3 black circles and an unfilled triangle. And the white triangle has definite contours between other regions.

When we see various Kanizsa-like figures, in many cases these 3 aspects of Kanizsa illusions appear. And magnitudes of these 3 illusions correlate with each other monotonically. So we think these aspects have deep connections with mechanisms of this illusion. In order to learn these mechanisms, we continue to search some stimulus factor affecting these aspects differently (e.g., Ohya et als, 2008). If we find such factors, they may show us the direction for further researches.

In this paper, we investigate the second aspect (depth). In psychology, students of depth perception utilized the stereoscope. When we see objects in different distances from us, images

Figure 1. The typical Kanizsa illusion figure.

on both eyes make disparities of relative positions on the retina (Figure 2). The number indicate the object and its image on the retina. This "binocular disparity" is known to effect the depth perception. In the stereoscope we see objects of the same distance from us (Figure 3). But there relative positions make images like Figure 2. So in this case we see objects of different distances from us.

Researchers utilized stereoscopic stimuli in Kanizsa illusion studies (e.g., Gregory &

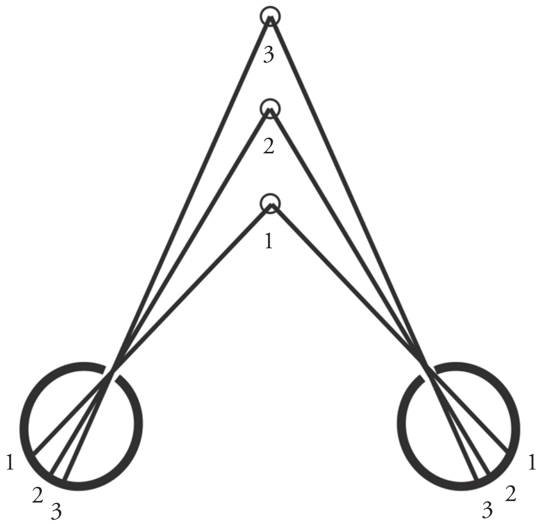

Figure 2. When we see objects of outer world in various distance, disparity of images on both eyes' retina correlate with distance.

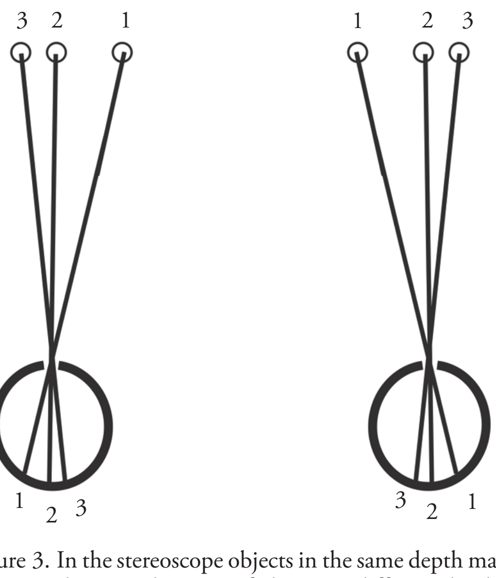

Figure 3. In the stereoscope objects in the same depth make the same disparity of objects in different depths.

Harris, 1974; Simmonds, 1974). They made disparity of stimulus components of Kanizsa illusion. From the binocular disparity of Kanizsa contours, anomalous figure is located in depth.

From our observations of Kanizsa illusion figures, we notice that the magnitude of illusion does not remain constant over the anomalously perceived surface. The brightness of inner region varies at the center and corner. The anomalous contour becomes feeble at the middle part. The surface of Kanizsa illusion figure does not form a plane of constant distance from us. The relation of observed position with inducing figures is considered to be important. For the progress of research, we must measure the distribution of Kanizsa illusion magnitude. In this study, we consider the depth aspect of Kanizsa illusion. We expose Kanizsa illusion figures with no binocular disparity. And another figure having binocular disparity (comparison figure, CF) is exposed. Observers adjust the size of binocular disparity and match the depth perception of Kanizsa illusion figure and CF. If the adjustment is made reliably, we can get the measure of Kanizsa illusion in various positions of stimulus figures. We can use these measures for further researches in the mechanisms of Kanizsa illusion. In this paper we report first trials for this purpose.

II. Method

Observers watch stimuli using the stereoscope (Figure 4) in a dark room. We expose stimuli on 2 displays controlled with computers. Images on each display are reflected 3 times with mirrors and projected into each eye only. The stereoscope is covered with black curtains.

In experiments reported in this paper, rectangular Kanizsa illusion figures are used (Figure

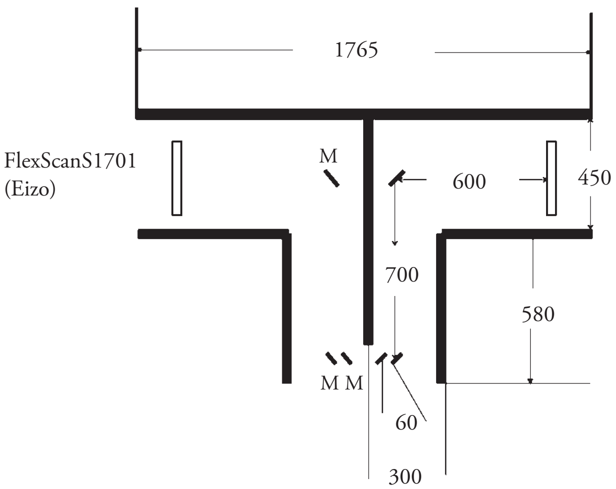

Figure 4. The miniature of the stereoscope apparatus. M represents a mirror. Size unit is mm. Stimulus on display are reflected 3 times with mirrors. Each display image is exposed in each eye only. The apparatus is covered with black curtains.

Figure 5. The miniature of the example of stimulus exposed to left eye. In this experiment CF (black bar) of left eye is not movd. Horizontal position of CF in right eye is adjusted to change the size of binocular disparity.

5). In the typical illusion perception, “a brighter rectangle covers 4 black ellipses”. At the center of display, a fixation point (FP) is exposed. Observers are asked to direct attention to FP in the experiment. 4 ellipses’ size are 35mm×28mm. Horizontal distance of ellipses is 30mm, vertical distance of ellipses is 25mm. Distance between FP and the side of Kanizsa figure is 20mm. In the other side of FP, CF is exposed. The size of CF is 3mm×20mm. The distance between FP and CF is 32mm. The luminance of “black” figure is 2.42cd/m^2, “white” background luminance is 201cd/m^2. In right display the relative horizontal position of CF can be different from the left display. And a black bar is exposed at the lower middle in the left display. In the right display the same bar exposed at the upper middle.

At first observers adjust their looking direction and fixation distance, and make image of right display enter into right eye only and left display image into left eye only. Then observers try to perceive 1 fused image from right and left CP images, and 2 middle bars at the same time. If binocular images are different, 2 images may compete. And if 1 image repress another image, observers perceive only 1 image. But this is not binocular fusion. So in the process of information integration from each eye, for confirming that information from each eye is utilized, 2 middle bars are exposed. When binocular fusion occurs, CF seems to be at various distance from observers. Observers adjust the horizontal position of CF in right display, and match the distance of CF and some instructed position of Kanizsa rectangle as near as possible. The selected binocular disparity is registered.

In Experiment 1, 3 positions are measured (Figure 6). They are the center of the rectangle (Ce), the near upper corner of the rectangle (Co), the middle of side of the rectangle (M). At 1 position, CF is exposed at the left or right of FP. The starting position of CF is perceived “distant” in 2 trials and “near” compared with Kanizsa figure in 2 trials. 1 session consists of 3 (measure position)×2 (CP position)×4 (starting position)=24 trials. Measured position and

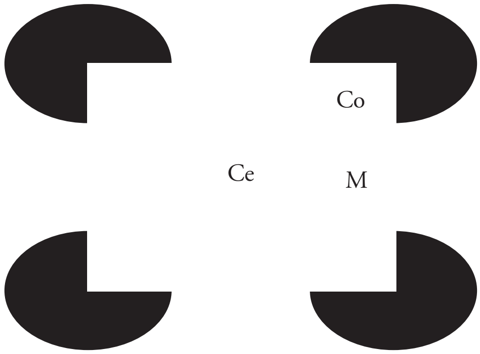

Figure 6. The measured position in Experiment 1. Ce: center of Kanizsa rectangle, M: middle of near side, Co: upper corner of near side.

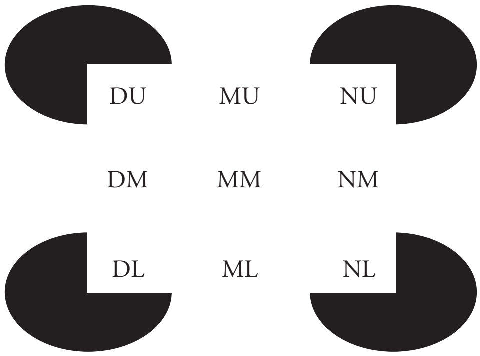

Figure 7. The measured position in Experiment 2. 3 vertical positions and 3 horizontal positions are measured.

CP position conditions are ordered randomly. 2 observers took part of 6 sessions.

In Experiment 2, 9 position are measured (Figure 7). There are 9 conditions, that is, the near side (N) and the center (M) and the distant side (D) of the rectangle (3)×the upper part (U) and the middle part (M) and the lower part (L) of the rectangle (3). 1 observer took part of 6 sessions.

III. Results and discussion

Figure 8 shows the results of Experiment 1. Average values of selected binocular disparity are computed.

M's results indicate Co>Ce>M. In the case of O, results indicate M>Ce>Co. And at each position O>M.

At Ce, every pacman figure lies in the same not so long distance. At Co, one pacman lies

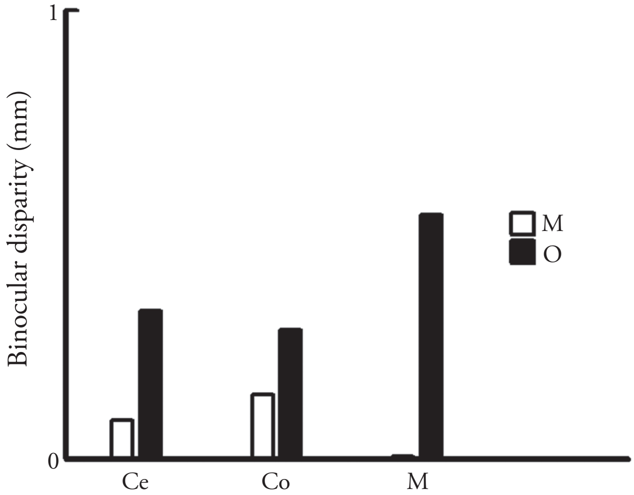

Figure 8. The results of experiment 1. 2 observers' results are shown.

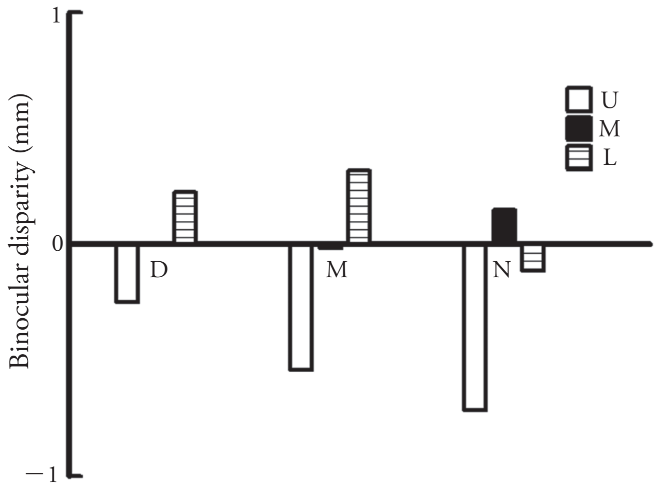

Figure 9. The results of experiment 2. 1 observer compared distances of 9 positions with CF distance perception.

very near, but other 3 pacmans are rather distant. At M, 2 pacmans lie raher distant and other 2 pacmans rather near. These differences in distance distribution may have some influences on Kanizsa illusion.

In Experiment 2, lower part results show greater minus values. And at row position D and M, column position M shows little binocular disparities and L shows plus disparities. These results may suggest the relations between column positions and depth perception.

These results indicate

(1) The magnitude of Kanizsa depth illusion varies at the different position of inner region.There is individual differences in this change.
(2) We can measure these changes of Kanizsa depth illusion using our stereoscopic apparatus.

We are designing further experiments of Kanizsa illusion using our stereoscopic apparatus.

IV. Summary

We constructed a stereoscopic apparatus. Using this apparatus, we measured Kanizsa depth illusion at various positions of the figure.

Magnitude of Kanizsa depth illusion does not remain constant. And some individual differences are found.

This approach proved fruitful for further researches.

Notes

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