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Simple Figures and Perceptions in Depth (2): Stereo Capture

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Following previous paper the purpose of this paper is to collect and publish some useful simple stimuli for observations to facilitate general understanding of scientific psychology. This paper contains elementary simple figures in that collection.

As the target problem, we selected stereo capture. There is a wealth of anatomical and psychological evidence which suggests that when you look at an object in the visual field, its various attributes such as color, motion, depth, and "form" are extracted by separate channels in the visual system. If so, how are these different attributes put back together again to create a unified picture of the object? The visual system seems to extract certain conspicuous image features, and the signal derived from these is then blindly attributed to features throughout the surface of the object. This implies that visual perception is highly sketchy and impressionistic and that much of the richness and clarity that we experience is really an illusion. This mechanism is called "capture".

To understand stereo capture, we explained about the wallpaper effect and Kanizsa illusion. We presented stimuli illustrating these phenomena.

And we presented some stereo capture stereograms. We considered some meanings of these stereogram for capture generating mechanism.

I. Purpose of this paper[1]

As described before (Ohya, 2005), in experimental psychology, observations are the important base of sound investigations. For observations, adequate stimuli are necessary. But even simplest stimuli need some troublesome works for their making. So sometimes basic observations are neglected. This tendency is undesirable for researches. And these observations facilitate general understanding of scientific psychology. Following previous paper, we continue to collect and publish some useful simple stimuli for observations.[2]

II. Types of contours

Ramachandran (1987) argued as follows. There is a wealth of anatomical and psychological evidence which suggests that when you look at an object in the visual field, its various attributes such as color, motion, depth, and "form" are extracted by separate channels in the visual system. If so, how are these different attributes put back together again to create a unified picture of the object? The visual system seems to extract certain conspicuous image features, and the signal derived from these is then blindly attributed to features throughout the surface of the object. This implies that visual perception is highly sketchy and impressionistic

and that much of the richness and clarity that we experience is really an illusion. He called this mechanism "capture".

And he discussed that there are at least four basic types of contours in the visual image:

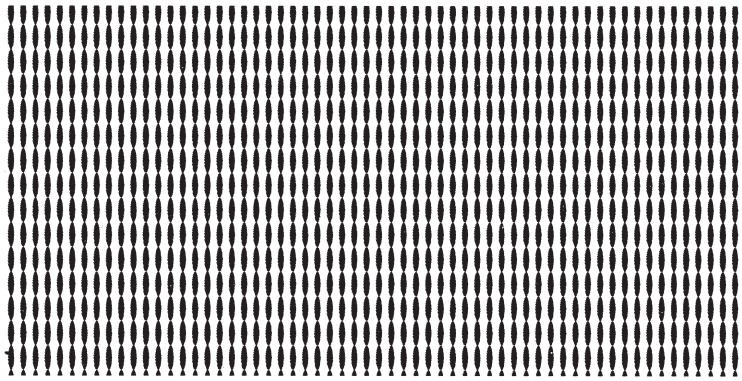
Type 1 contours are continuous contours that form the boundaries of an object occluding its background. Such contours coincide with abrupt depth discontinuities and are always associated with depth cues such as stereopsis and motion parallax.

Type 2 contours or discontinuous contours define texture elements. Such contours are not associated with steep change in depth.

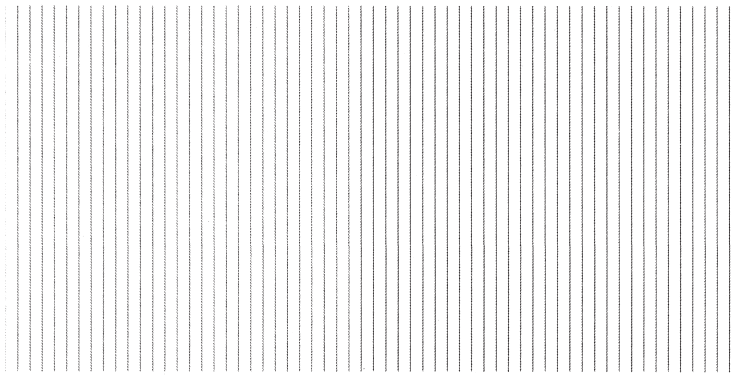
Type 3 contours result from differential illumination of surfaces that meet at a corner. Unlike Type 1 contours there is no steep change in depth coinciding with the contours.

Type 4 contours form the borders of cast (or detached) shadows. Unlike Type 1 and Type 3 contours, there is no associated change of surface depth.

In our environment, there are infinite contours. And depth perception combines with contour perception. In these perception capture mechanism seems to play an important part.



(a)



(b)

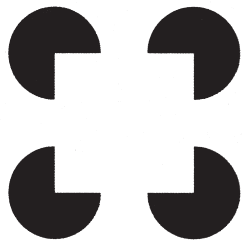
Figure 1. When we see horizontal repetitions of patterns, our depth perception is instable.
(a) lines of ellipses and (b) simple lines show this "wallpaper effect".

In this paper we will present some stimuli related with capture. At first we will explain some phenomena.

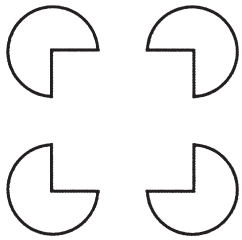
III. Wallpaper effect

Repetitions produce some interesting effects upon human perceptual systems. When viewed binocularly it can convey any one of a number of different depth planes. At any given instant, the entire pattern is seen to occupy only one single plane.The exact plane seen seems to depend mainly on the angle of convergence. In Figure 1 we presented repeating vertical objects. If the reader brings the pattern very close to his nose and changes his angle of vergence while viewing the display, he will perceive corresponding changes in the plane of perceived stereoscopic depth.

In human depth perception, the important cue of distance of an object from the perceiver is the disparity of relative position on each retina of the object's image. In these displays, one image on one retina matches multiple images on the other retina. In result, fluctuations appear in depth perception.



(a)



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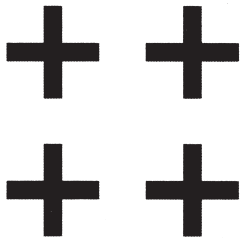


(c)

Figure 2. (a) 4 PACMAN figures produce Kanizsa illusion. (b) contour or (c) component figure's completeness reduce the magnitude of illusion.

IV. Kanizsa illusion and depth capture

In Figure 2 (a), we experience Kanizsa illusion. The region surrounded by 4 component stimuli (PACMAN) and the outer region are same physically. But the inner region and the outer region appear to form different planes. And the inner region is perceived to be lighter than the outer region. In addition, the inner region is perceived to lie over the other objects. Many observer notice the white square over 4 black disks. Although stimulus configurations are similar, in (b) and (c) Kanizsa illusion disrupts. If "subjective square" exists over 4 black disks, disks must have some attributes of incompleteness. But in (b) and (c), component stimuli may be described to be complete in some senses. This may be a factor.

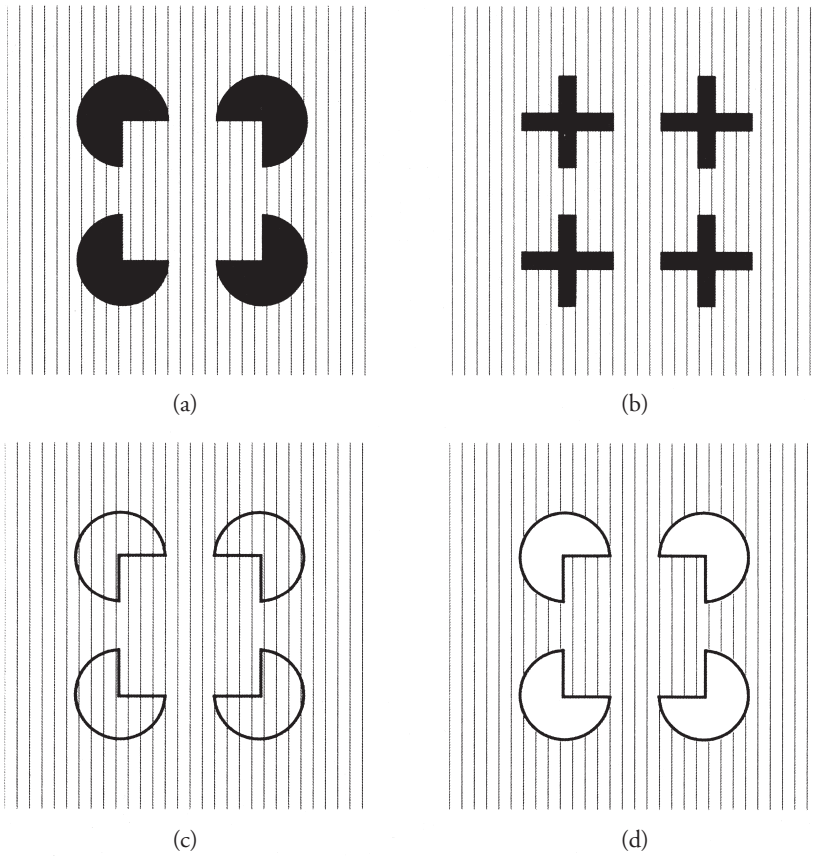


Figure 3. (a) when Kanizsa illusion appears, lines inside of 4 PACMANs are captured in depth. In other figures depth capture does not occur.

When wallpaper pattern and Kanizsa stimului are presented together, what do we perceive?

In Figure 3 (a) and Figure 4 (a), squares are perceived to lie over 4 black disks. On the

surface of square lines lie. And lines on the inner square are perceived to belong to the different plane from the outer lines. There are "jumps" between them. We can say that depth perception of lines are captured by the depth perception of the background.

In other non-Kanizsa displays, there are no depth capture.

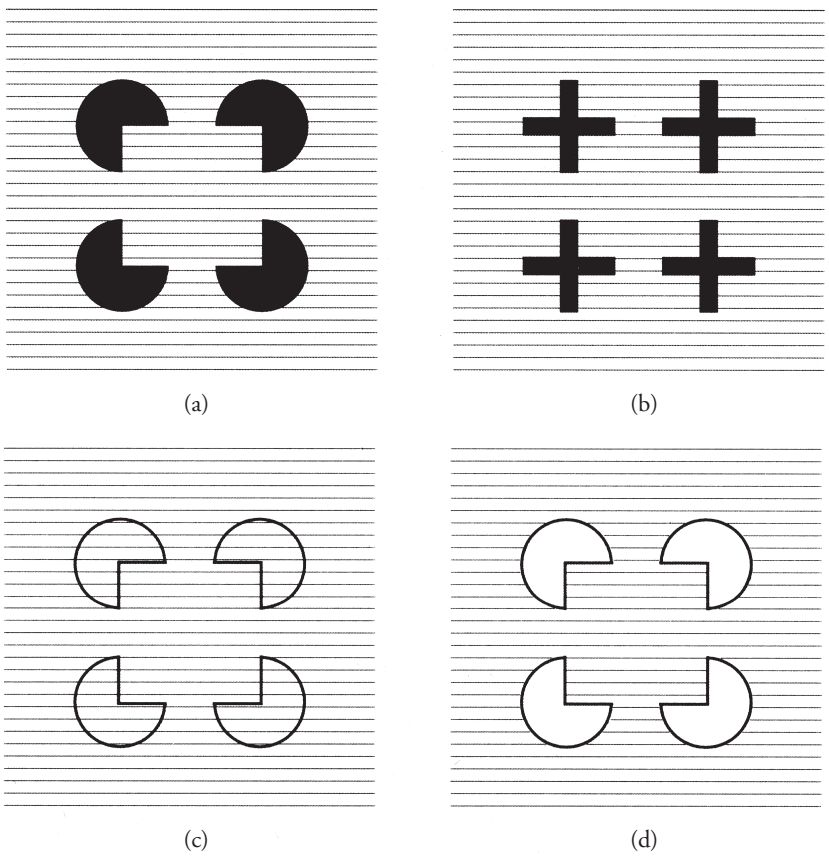


Figure 4. (a) When Kanizsa illusion appears, lines inside of 4 PACMANs are captured in depth. In other figures depth capture does not occur.

V. Kanizsa illusion stereogram and stereo capture

In figure 5, we presented Kanizsa illusion stereograms. PACMAN's mouths have binocular disparities. With parallel viewing method, the disparity in (a) becomes the cue indicating location in front of the fixation point. On the contrary, in Figure (b), the binocular disparity has the information of location in back of the fixation point.

In Figure (a), Kanizsa illusion appears clearer. The white square is perceived in the plane in front of the plane of 4 black disks. Two planes are perceived to be different clearly.

In Figure (b) too, Kanizsa illusion appears, but with difficulty. Sometimes the square

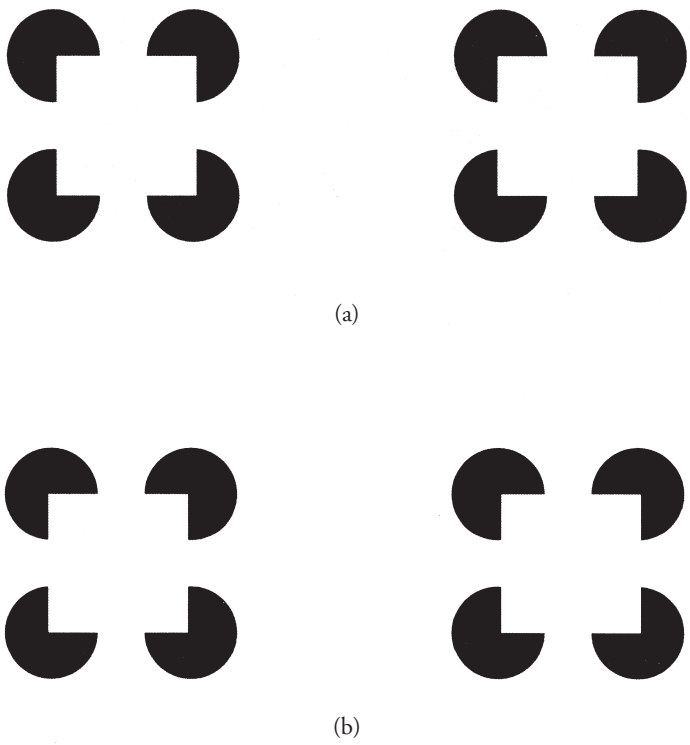


Figure 5. In stereogram (a), you may see a white square in front other objects, more easily.

comes to have some transparency.

Ramachandran & Cavanagh (1985) used Kanizsa illusion stereogram and wallpaper effect patterns together. They argued that stereoscopic depth perception is based on measuring differences between the two eyes's images which arise as a result of binocular parallax. The stereograms illustrate that monocular subjective stimulus can influence the matching of elements in a stereogram even though the elements themselves convey no disparity information. The depth seen from such contours is automatically attributed to texture elements and lines that are enclosed by these contours. They called this finding as stereoscopic capture. We call this illusion "stereo capture". As the disparity of Figure 2 (a) facilitates Kanizsa illusion, we used this disparity. As wallpaper patterns, we used simple lines for simplicity.

In Figure 6, we see 3 planes clearly. The white square with lines lies in the nearest plane. In the next plane 4 black disks lie. In the deepest plane lie the lined background. Lines on the white square appear different from oher parts of lines. The depth perception of inner lines are captured by stereopsis.

Ramachandran et als. considered that for stereo capture, in the each display of the

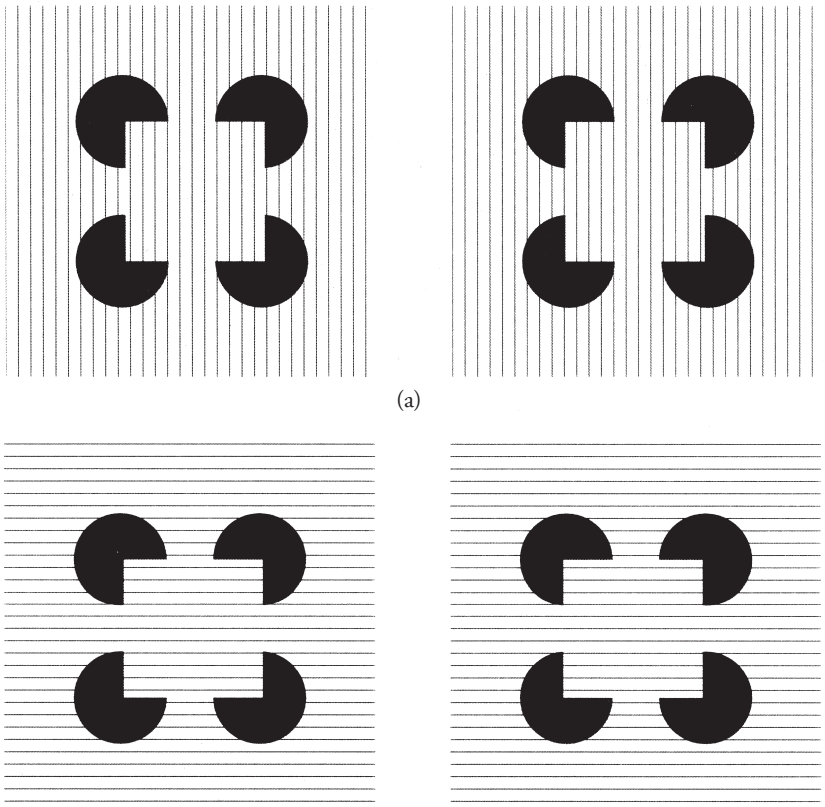


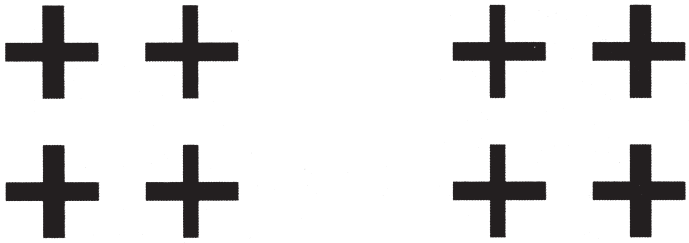
Figure 6. Examples of stereo capture figures.

stereogram Kanizsa illusion must be perceived. Monocular Kanizsa squares work together to make the square in depth, and the depth perception captures the depth perception of near lines. But other researchers have other considerations (e.g., Mather, 1989; Vallortigara & Bressan, 1994). Next stimuli are related with those considerations.

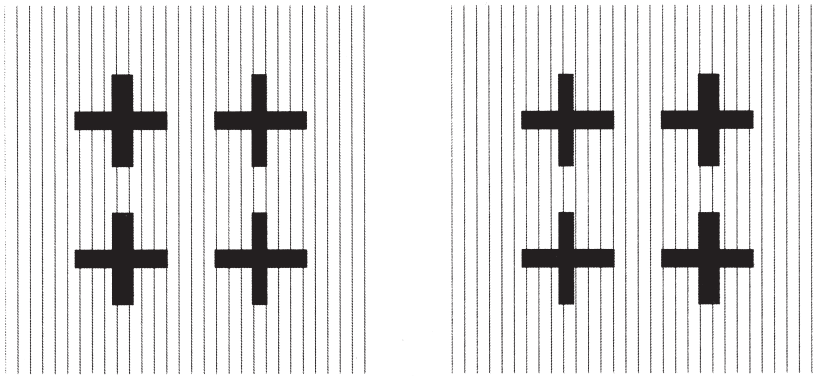
In Figure 7, 4 crosses form Kanizsa-like configurations. In monocular vision, the square is not perceived. But in stereopsis, we perceive the central square in front of other objects, though the square does not appear so solid as in Figure 6.

Especially in Figure 7 (b) and 7 (c), the square is difficult to be perceived. For long time we cannot perceive it. When we perceive it, the square appears instable. It has some transparency. But inner parts of lines appear in the same depth of square. The other parts of lines lie in background. There are separations between them.

In Figure 8 (a), we can perceive the square in front of other objects. The square appear instable a little. Contoured PACMAN appears sometimes a part of occluded disk, but sometimes stays as PACMAN. Probably it depends on whether L-shaped contours are perceived to belong to PACMAN or the square.



(a)



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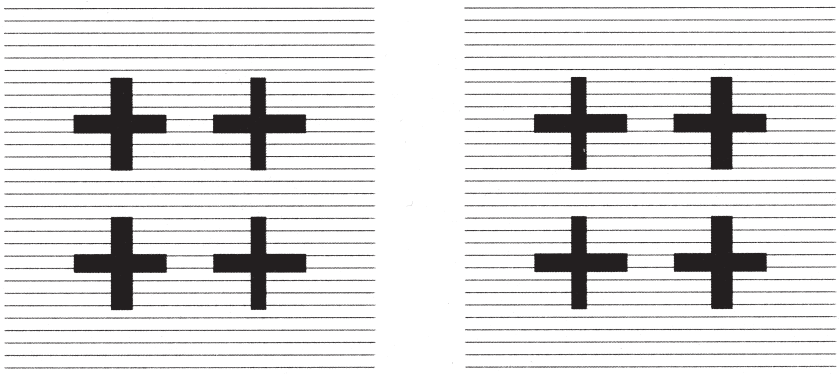


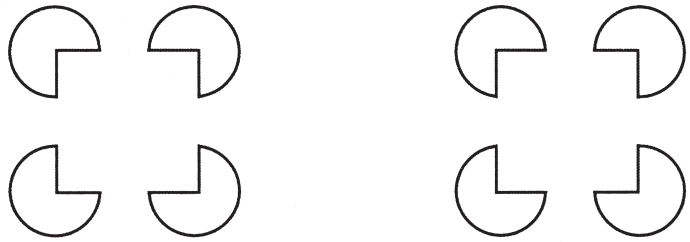
(c)

Figure 7. In each figure Kanizsa illusion does not occur.

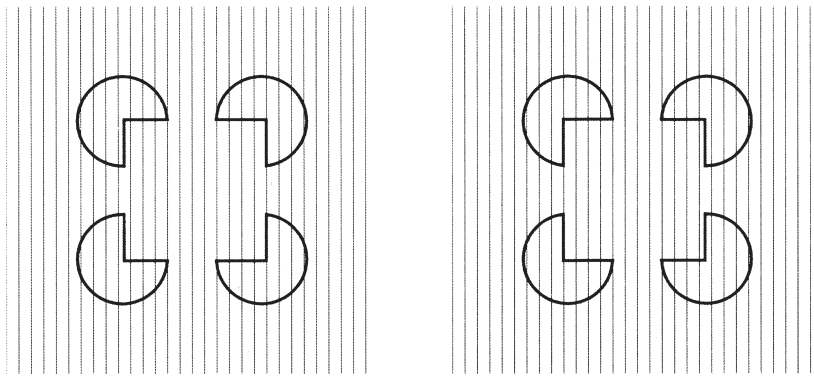
In Figure 8 (b) and 8 (c), we can perceive stereo capture. PACMAN and outer lines lie in background plane.

In Figure 9 (b) and 9 (c), we can perceive stereo capture. 4 white disks lie over lined background.

Whether lines continue over PACMAN makes this differences.



(a)



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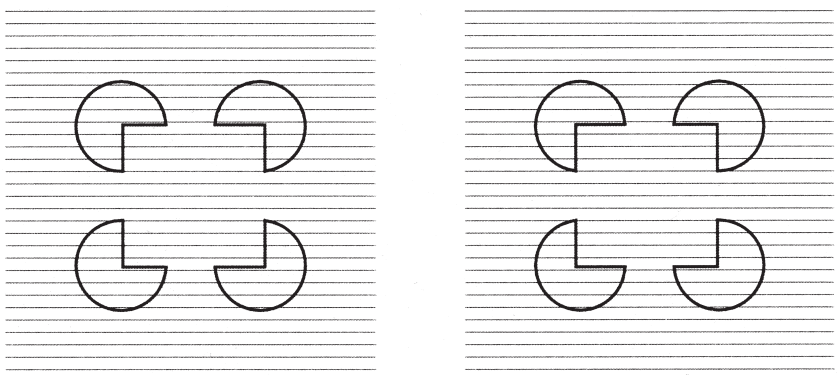

(c)

Figure 8. In each figure Kanizsa illusion does not occur.

From these observations, it follows that the monocular Kanizsa illusion is not the necessary condition of stereo disparity. Local disparity somehow triggers stereo capture. Mather argued that stereo capture may arise from spreading disparity signals. Stereoscopic subjective figures may play a role in this spreading effect, or alternatively may themselves be a result of the effect. Vallortigara et al. proposed that stereo capture arises as the solution to a

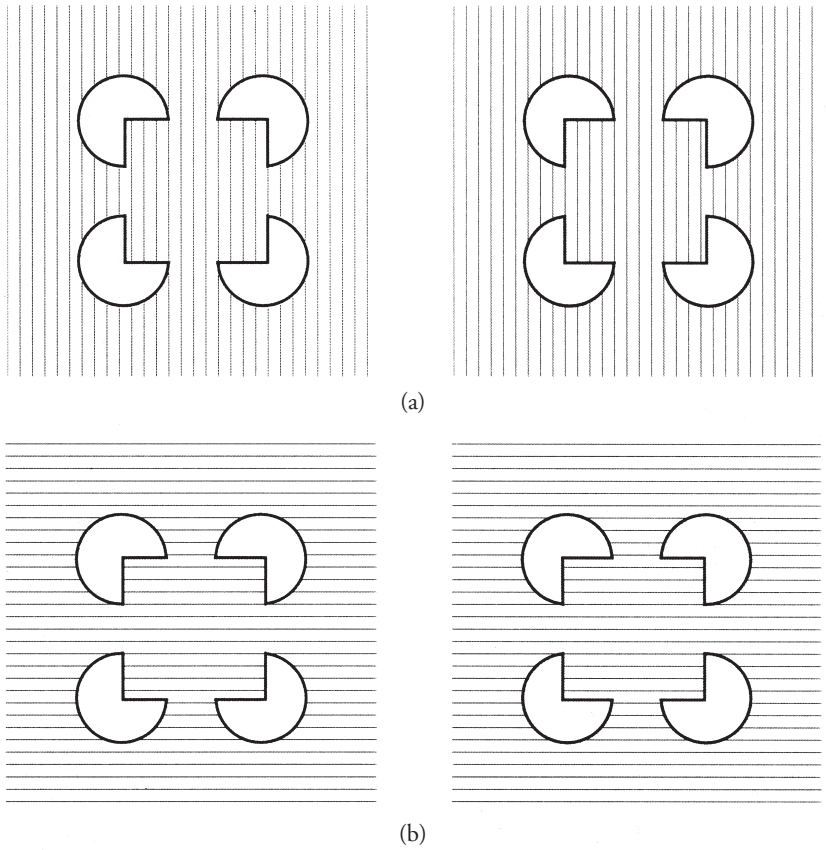

Figure 9. In each figure Kanizsa illusion does not occur.

conflict between information provided by retinal disparity and occlusion.

From these observations it follows that capture mechanism exists. But its functions depend on so many factors. More observations in more complex conditions are necessary.

VI. Summary

Following previous paper the purpose of this paper is to collect and publish some useful simple stimuli for observations to facilitate general understanding of scientific psychology. This paper contains elementary simple figures in that collection.

As the target problem, I selected stereo capture. Capture mechanism is considered as an important factor in visual system.

To understand stereo capture, we explained about the wallpaper effect and Kanizsa illusion. We presented stimuli illustrating these phenomena.

And we presented some stereo capture stereograms. We considered some meanings of these stereogram for capture generating mechanism.

Notes

1 I thank members of Kanizsa illusion research group of Nagoya University, Shinya Takahashi, Keiko Arakawa, Yuko Ishisaka, and Hiroshi Sugiura for their fruitful suggestions.

2 I utilized computer programs, Corel Draw Graphics Suite 12 and PaintShop Professional X (© Corel Corporation).

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