■講演要旨（VISION Vol. 19, No. 3, 151–154, 2007）

Aesthetic and Perceptual Effects of Disparity Size in Stereogram Observation

Daisuke TOYA* and Makoto ICHIKAWA**

* Graduate School of Science and Engineering, Yamaguchi University, Yamaguchi, Japan
** Dept. of Perceptual Sciences & Design Engineering, Yamaguchi University, Yamaguchi, Japan

1. Introduction

The aesthetic effects of disparity size of the stereogram has been rarely examined although there have been a lot of studies on the perceptual effects of the disparity size in stereogram observation. In this study, we focused on the aesthetic effects of the disparity size in stereogram observation. In particular, we examined the relationships among the disparity size, apparent depth magnitude, and impressions in various dimensions, including the dimensions that are related to observer's aesthetic judgment.

2. The aim of this study

Previous study (Noguchi, 2003[1)]) reported that both the extent of illusion and aesthetic preference had peak at the middle range of the stimulus variable. Based on this result, this study proposed that the condition which generates the largest illusion would correspond to the most beautiful condition.

In stereogram observation, the condition that generates the largest illusion would be apart from the middle range of the stimulus variable. In this case, how the extent of the illusion would be related to the aesthetic impression?

We had three aims in this study. First, we investigated how the apparent depth (illusory effects) and rating of the impression in different dimensions (including aesthetic effects) depends on the disparity size (stimulus variable) of stereogram. Second, we examined which dimensions in the impression formation the apparent depth magnitudes would correlate with. Third, we tried to understand how the perceptual and aesthetic effects depend on the type of stereogram.

3. Methods

We used seven types of stereogram (**Fig. 1**). In the first four types, there was binocular disparity between a square frame (5.8×5.8 arc deg) and a vertical line (2.3 arc deg) (Fig. 1a–i), horizontal line (2.3 arc deg) (Fig. 1a–ii), white square (2.3×2.3 arc deg) (Fig. 1a–iii), or black square (2.3×2.3 arc deg) (Fig. 1a–iv) on the white background (**Fig. 2a**). In the other three types, there was disparity, which specify a

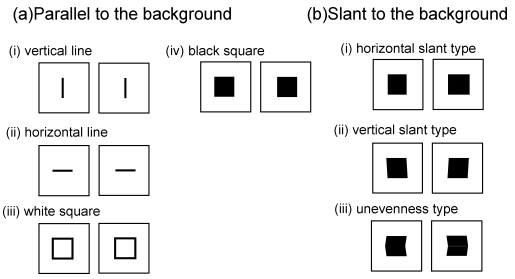

Fig. 1. Types of stereogram. There were four parallel types (a), and three slant types (g).

Presented at ACV 2006

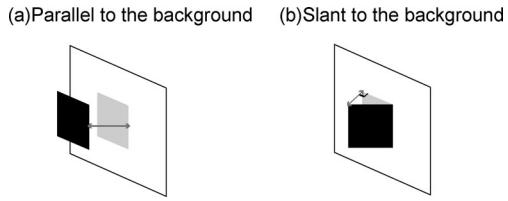

Fig. 2. Diagram of the appearance of the stereograms. Parallel type (a), and slant type (b) with the crossed disparity.

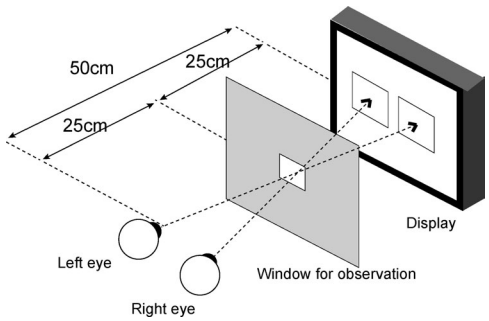

Fig. 3. Equipment.

slant in depth dimension (**Fig. 2b**). That is, the compression disparity (Gillam et al., 1988[2]) defined the slant around a vertical axis (Fig. 1b–i), and the shear disparity defined the slant around a horizontal axis (Fig. 1b–ii, iii) for a black square (2.3×2.3 arc deg). For each of these stereogram types, we prepared five disparity size conditions, ranging from 4.8 to 77.0 arc min for both crossed and uncrossed disparity, as well as 0 disparity condition. Each stereogram was presented once for an observer. Observers (20 university students) viewed the stereogram that was presented on a front parallel display (14 inch) of the laptop computer (TOSHIBA DynaBook SS M4/260CCH) through a window for observation (**Fig. 3**). Then, they reported the apparent depth magnitude in each trial by pulling a tape measure out of its case, and rated their impressions by the use of 11 scales (**Table 1**) which were selected from the scales typically related to the three basic factors of impression; "evaluation", "activity" and "potential" (Osgood et al., 1957[3]).

4. Results and discussion

Apparent depth magnitude tended to increase with the increment of the disparity size for both the parallel and slant types of stereogram. In order to understand the effect of disparity size on the impressions in different dimensions, we conducted factor analyses (Principal factor solution, Varimax method) for the rated scores in 11 scales, and extracted three factors; the evaluation, activity, and weight whose eigen values were larger than 1.0 for both the parallel (Table 1a) and slant types (Table 1b) of stereogram.

The factor score in the evaluation were the highest around the middle range of the disparity size, and they were the lowest for the largest disparity size regardless of the stereogram types (**Fig. 4**). This result does not support Noguchi's proposal that the condition which generates the largest illusion would correspond to the most beautiful condition. Rather, our results suggested that the most beautiful condition would correspond to the middle range of the stimulus variable (Berlyne, 1960[4]), and that the relationship between the extent of illusion (apparent depth magnitude, in this case) and the aesthetic effect depends on the type of illusion.

The factor scores of the activity were the lowest for the zero disparity condition, while the highest in the largest disparity size (**Fig. 5**). Both of the apparent depth and the factor score of the activity had significant correlation with the disparity size while there was no significant correlation between the disparity size and the factor scores in the other two dimensions. These results indicate that both the perceived depth and active impression would be the consequences of a common processing.

Table 1. Factor loading and communality of each scale. Bold and italic numbers show the factor loadings whose absolute values were more than 0.6 and 0.4, respectvery. Each factor's numerial represents the contribution rate.

Factor type	Adjective pairs	(a) Parallel to the background				(b) Slant to the background			
		Communality	Factor I	Factor II	Factor III	Communality	Factor I	Factor II	Factor III
I	Good–Bad	0.715	**0.836**	0.094	−0.091	0.692	**0.817**	0.090	−0.127
	Comfortable–Uncomfortable	0.677	**0.813**	0.100	−0.080	0.656	**0.804**	−0.062	−0.081
	Natural–Unnatural	0.624	**0.780**	−0.079	0.099	0.683	**0.822**	−0.072	−0.033
	Ugly–Beautiful	0.585	**−0.739**	−0.014	0.196	0.554	**−0.735**	−0.061	0.100
	Relax–Nervous	0.382	*0.573*	−0.230	−0.037	0.540	*0.586*	−0.342	−0.282
	Realistic–Fantastic	0.380	*0.489*	0.015	0.374	0.397	**0.625**	−0.076	0.010
II	Activity–Static	0.716	−0.163	**0.830**	−0.012	0.778	−0.229	**0.844**	−0.113
	Excited–Calm	0.703	−0.234	**0.803**	0.068	0.813	−0.272	**0.855**	−0.092
	Live–Unlive	0.562	0.308	**0.681**	0.058	0.644	0.306	**0.741**	−0.035
III	Weight–Light	0.323	−0.0408	0.087	0.560	0.294	−0.072	−0.054	*0.535*
II III	Closed–Open	*0.450*	−0.226	*−0.441*	*0.452*	0.479	−0.127	*−0.471*	*0.490*

The factor scores of the weight were positive only for the crossed disparity in the parallel types of stereogram while they were positive for the large crossed and uncrossed disparities for the the slant types of stereogram (**Fig. 6**). These results suggest that the light impression depends on the floating appearance of the object or the steep slant.

For the parallel types of the stereogram that defined a parallel bar or square to the square frame (Fig. 1a–i, ii), we found no consistent difference among the four stereogram types in perceptual and impressions. However, for the slant types of the stereogram that presented a slant surface (Fig. 1b–i-iii), we found a significant difference in the dimension of activity among the three types of stereogram. That is, the slant around a horizontal axis (Fig. 1b–i) gave less active impression compared to the other two types of the stereogram did with the large disparity size (Fig. 6). Vertical slant (Fig. 1b–ii, iii), which is against the axis of the gravity, would give the observer the unstable impression, and therefore gave more active impression.

5. General discussions

We found that the conditions that generate the largest illusion may be apart from the conditions that exaggerate the aesthetic preference; in stereogram observation, while the illusory effect increased with the increment of the disparity size, the aesthetic preference was exaggerated for the middle range of the disparity size. The relationship between the perceptual effect and aesthetic effect would depend on the type of illusion.

In stereogram observation, the apparent depth magnitude correlated to the active impression. Because, the previous study (Noguchi, 2003[1)]) did not examined the relationship between the extent of illusion and

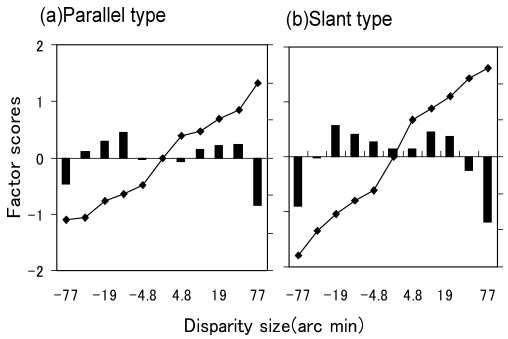

Fig. 4. Averages of the factor scores of evaluation and apparent depth magnitudes.

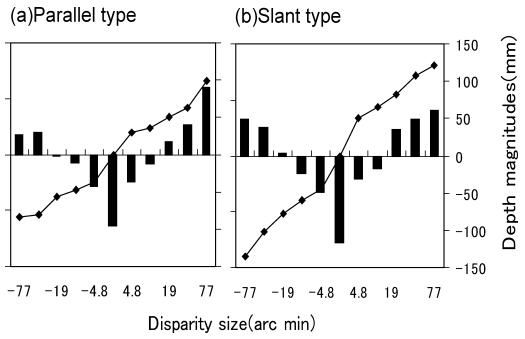

Fig. 5. Averages of the factor scores of activity and apparent depth magnitudes.

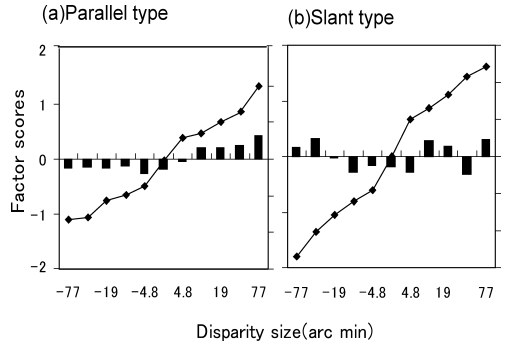

Fig. 6. Averages of the factor scores of weight and apparent depth magnitudes.

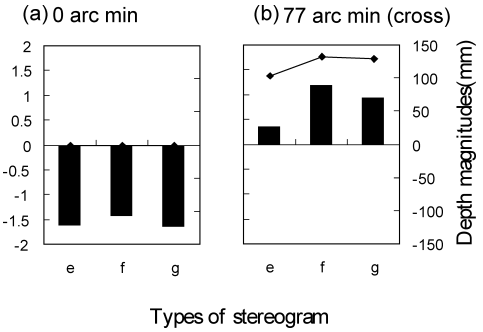

Fig. 7. Averages of the factor scores of activity and apparent depth magnitudes for the condition of 0 arc min (a) and 77.0 arc min of crossed disparity (b).

active impression, future study should examine whether the relationship between the illusory effect and active impression could be generalized for the geometric illusions.

The impressions in the activity depended on the types of stereogram. Future study should examine the proposed hypothesis that the effect depends on the appearance of the object.

References

1) K. Noguchi: The relationship between visual illusion and aesthetic preference-an attempt to unity experimental phenomenology and empirical aesthetics. *Axiomathes* **13**, 261–281, 2003.

2) B. Gillam, D. Chambers and T. Russo: Post fusional latency in sterescopic slant perception and the primitives of stereopsis. *Journal of Experimental Psychology: Human Perception and Performance*. **14**, 163–175, 1988.

3) C. E. Osgood, G. J. Suci and P. H. Tannenbaum: *The measurement of meaning*. University of Illinois Press, 1957.

4) D. E. Berlyne: *Conflict, arousal and curiosity*. McGrow-Hill, 1960.