The effect of haptic information on vision
—Using geometrical patterns with and without visual illusion—

Keiko OMORI*,**, Yuji WADA***, Yukio ITSUKUSHIMA*, and Kaoru NOGUCHI*

Nihon University*, Japan Society for the Promotion of Science**, and National Food Research Institute***

We investigated the effect of haptic information on visual illusions and the appearance of simple geometrical patterns without figural components which induce visual illusions. Experiment I was designed to examine the effect of haptic information on the visual illusions of the Hering and Wundt figures. The haptic stimuli with three different curvatures were made of wooden board. The participants were asked to judge the apparent curvature of each test figure, with or without the haptic stimuli. In Experiment II, the participants judged the apparent curvature of each test figure but components inducing visual illusions, with or without the haptic stimuli. It was found that the visual illusions were biased towards the direction of the information given by actively touching the haptic stimuli and that, the visual perception of simple patterns without any inducing components was not affected by actively touching.

Key words: multisensory perception, haptic information, visual illusion

Vision provides perceptual properties such as shape, size, and texture when we recognize an object. Simultaneously, we are able to know the properties of an object by touch. A question to be answered is how we organize information from the different sensory modalities, vision and touch, when we perceive an object. It has been demonstrated that vision is generally dominant over the other modalities in integration of multisensory information (Rock & Harris, 1967), while a few case of haptic capture was reported (Ernst & Banks, 2002; Gallace & Spence, 2005). However, there exists strong evidence that haptic information plays an important role in the people with restored sight (Torii & Mochizuki, 1992). In the present study, we investigated the effect of haptic information on visual illusions, and simple geometrical patterns without figural components inducing visual illusions.

Experiment I

Method

Participants Seven students who had normal touch and vision participated in the experiment.

Apparatus and Materials The visual standard stimuli were visual illusions, the Hering and Wundt figures. In Figure 1A, each of the two vertical lines in these visual standard stimuli was physically convex, parallel, and concave lines. The visual comparison stimuli consisted of nine pairs of vertical lines which changed in curvature from convex to concave lines (Figure 1A). Haptic stimuli were three different shapes (convex, parallel, and concave) made of wooden board (Figure 1B).

Procedure The participants selected one of the visual comparison stimuli which seemed to match the vertical lines in the visual standard stimulus. The standard stimulus was presented on the display in a random order with or without haptic stimulus (Figure 1).

Results and Discussion

The participants' judgments of the degrees of apparent curvature were expressed in terms of PSEs. When an apparent curvature was judged as being parallel (the comparison stimulus ⑤) the PSE was designated as zero. The PSEs were positive values
from 4 to 1 when the judgment was ranging from the comparison stimuli ① to ④ respectively; and the PSEs were negative values from −1 to −4 when the judgment was ranging from the comparison stimuli ⑥ to ⑨ respectively. To test the effect of the haptic information on the visual illusion, the PSEs for each apparent curvature in the visual illusion were analyzed using a two-way ANOVA with visual illusions and haptic information (convex, parallel, concave, and nonhaptic information) as main factors. The analysis of the Hering figure data showed a significant main effect of haptic information $[F(3, 18)=34.43, p<.001]$. The analysis of the Wundt figure data also showed a significant main effect of haptic information $[F(3, 18)=74.03, p<.001]$. A significant main effect of haptic information implied that the haptic information had influences on the appearance of the visual illusion.

**Procedure** The same as in Experiment I.

**Results and Discussion**

The judgments of apparent curvature were expressed in the same manner as in Experiment I. To test the effect of the haptic information on the geometrical patterns, PSEs for each apparent curvature in the geometrical patterns were analyzed using a two-way ANOVA with the geometrical pattern (convex, parallel, and concave) and haptic information (convex, parallel, concave, and nonhaptic information) as the main factors. The analysis showed that the main effect of haptic information was not significant. The result suggests that haptic information did not alter the appearance of the simple geometrical patterns.

**General Discussion**

In Experiment I, visual illusions were biased toward the direction of the information given by touch. In Experiment II, however, the visual perception of simple patterns which did not have any inducing components was not affected by the information given by touch. These results might be explained by the 'optimal integration hypothesis': the interaction between visual and haptic information may function as a maximum-likelihood estimation integrator that minimizes variance in the final estimate (Ernst & Banks, 2002). If this is the case, the appearance of the visual illusions was more ambiguous than that of the simple patterns. To perceive a stable world, our visual system should be organized multisensory information complementarily.

**References**


