Visual capture produced by prism spectacles[1]

John C. Hay, *SMITH COLLEGE* **Herbert L. Pick, Jr.,** *UNIVERSITY OF MINNESOTA*
Karren Ikeda,[2] *SMITH COLLEGE*

Abstract

A study of the immediate effects (rather than the after-effects) of viewing one's hand through a wedge prism. The "feel" of the hand is found to be pulled towards the displaced optical stimulus, and this effect is termed visual capture (after Tastevin). The effect of capture lingers after the eyes are covered, and this residue may be related to the after-effects hitherto studied.

Problem

When one views one's hand through a wedge prism, the optical direction of the hand from the eye is displaced from its objective direction, and the result is a discrepancy between the visual and proprioceptive stimuli from the hand. What are the perceptual results of this stimulus conflict? Several studies have shown that there may be after-effects of the conflict (e. g., Held & Hein, 1958), and these after-effects have recently been attributed to an adaptation in the proprioceptive system (Harris, 1963; Pick et al, 1963). But the immediate effects of the conflict, from which these after effects presumably spring, have not been measured. Does S start by feeling his hand in one location, and seeing it in another? In less subjective terms, do the discrepant visual and proprioceptive stimuli produce conflicting localization responses?

Method

S viewed his stationary right hand through a 14 degree displacement prism, under instructions to make six judgments of where he felt his hand to be located, and six judgments of where it looked to be located. He was told that in the particular viewing situation there might be a difference between the two. The judgments were obtained, in counterbalanced order, when S first looked through the prism. The apparatus consisted of a horizontal shelf extending from a chin rest: S's right index finger was placed at a target point on the visible top-surface of the shelf; he used his unseen left hand to push one of 30 electric buttons on the under-surface of the shelf, directly below the felt or seen location of his right index finger. Control measures were taken as follows: six judgments of where the hand felt with the eyes covered, and six judgments of where the target point looked with the hand removed from it. Eighteen Ss, all undergraduate girls, were tested, half with the prism displacement to their left, half with it to their right.

Results

When S viewed his hand through the prism, its felt and seen locations did not differ significantly (95% confidence limits = $1.7^{\circ} \pm 2.3^{\circ}$, in the expected direction). Most of the Ss commented that they were unaware of any discrepancy, and if anything strange was noted about the hand, it tended to be its shape or distance, rather than its direction. We may infer that a kind of perceptual fusion of the discrepant visual and proprioceptive stimuli occurred.

In this fusion, it was the proprioceptive stimulus that failed to evoke its normal response. Seeing the hand through the prism, as contrasted with not seeing it at all, caused a displacement in felt location of $8.6^{\circ} \pm 2.9^{\circ}$ (99% confidence limits). We label this change in the feel of the hand, imposed by a displaced visual stimulus, visual capture (after Tastevin, 1937; see below). Visual capture occurs despite the fact that the proprioceptive stimulus by itself (with eyes covered) provided accurate localization (99% confidence limits for constant error = $0.3^{\circ} \pm 3.5^{\circ}$).

The visual response, by comparison, showed no detectable change when the proprioceptive stimulus was added. When S judged the target point location without his hand on it, his error was $10.9^{\circ} \pm 3.6^{\circ}$ (99% limits) in the direction of the prism displacement. When he judged the visible location of his hand placed on the target point, the reduction in error was only $0.7^{\circ} \pm 2.3^{\circ}$ (99% limits).

What happens when S shuts his eyes after seeing his stationary hand through the prism? Does the felt location of the hand immediately return to normal? Several tests with the above basic procedure have consistently found a short-term residual effect of capture. In one experiment, S saw his hand for 3 sec. through a 14 degree displacement prism, and then marked the felt location of his hand 3 sec. after his eyes were covered. Sixteen Ss (including 12 undergraduate men) showed a residual effect of $3.6^{\circ} \pm 3.1^{\circ}$ compared to a visual capture effect of $6.4^{\circ} \pm 2.2^{\circ}$ (99% confidence limits). Since the residual effect was significantly smaller than the capture effect ($p < .001$), we may infer that the proprioceptive stimulus had regained some control over the localizing response.

Discussion

These results are consistent with early findings on the stability of vision, and its domination of the other senses (Ryan, 1940). They also agree with the recent findings of Rock & Victor (1964) for a similar conflict, but one which precluded sight of the hand. Our results are most directly akin to the observation of Tastevin (1937, p. 68) who used a kind of mechanical analogue to the prism situation: S saw a plaster replica of one of his fingers protruding from under a cloth, while his real finger was concealed from view several centimeters away. The result was that S identified the plaster finger as his own, and attributed his tactual impressions

to it. Tastevin christened this phenomenon "captage," and we have adopted his term.

What relationship exists between visual capture and the apparently proprioceptive adaptation which makes the hand, after several minutes' prism exposure, err systematically in pointing at targets of any sense modality? (Harris, 1963; Pick et al, 1963) Certain differences between them are clear: First, whereas capture consists of a prepotency of visual over proprioceptive stimuli, when both are present, proprioceptive adaptation is a changed response to proprioceptive stimuli, when they alone are present. Second, whereas visual capture has been demonstrated here for the stationary hand, at least one form of adaptation effect has been found to be dependent on hand movement during the prism exposure (Held & Hein, 1958). Third, whereas the residual effect of capture measured here was for the same hand position as was seen through the prism, the adaptation effects have been demonstrated for hand positions not seen through the prism (Harris, 1963). Fourth, whereas capture takes place in the first seconds of prism exposure, all the adaptation studies cited seem to have required several minutes of exposure. These differences suggest that visual capture is the more elementary phenomenon and that it serves, when suitable auxiliary conditions are met, as the source of proprioceptive adaptation.

References

HARRIS, C. S. Adaptation to displaced vision: visual, motor, or proprioceptive change. Science, 1963, 140, 812-813.

HELD, R., & HEIN, A. V. Adaptation of disarranged hand-eye coordination contingent upon reafferent stimulation. Percept. mot. Skills, 1958, 8, 87-90.

PICK, H. L., JR., HAY, J. C., & PABST, JOAN. Kinesthetic adaptation to visual distortion. Unpublished paper presented at Midwestern Psychological Association Meetings, May 1963.

ROCK, I., & VICTOR, J. Vision and touch: an experimentally created conflict between the two senses. Science, 1964, 143, 594-596.

RYAN, T. A. Interrelations of the sensory systems. Psychol. Bull., 1940, 37, 659-698.

TASTEVIN, J. En partant de l'experience d'Aristote. L'Encephale, 1937, 1, 57-84, 140-158.

Notes

1. This work was supported by Grant MH 07588-02 from the National Institute of Mental Health. The authors wish to acknowledge the generous provision of research space by Cornell University, and the invaluable assistance of Mr. William Frayer.

2. Now at the University of Pennsylvania.