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The aftereffects of prolonged perception of shape

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The purpose of this study was to investigate the relationship between temporally separated sets of geometric figures and various interstimulus intervals (ISIs). Circles and triangles were inspected at two stimulus durations: 500 msec and 8 sec. There were four ISIs: 0, 250, 500, and 750 msec. It was hypothesized that the stimulus trace of the triangles would persist over longer ISIs than would that of the circles. The results indicated that females perceived both figures as larger than did the males. Larger fixation effects were obtained at a shorter stimulus inspection duration. For triangles, there was perceived expansion at both inspection durations. In most cases, the fixation effect of circle shrinkage was apparent. Generally, triangles were perceived as larger than circles, especially at the longest ISI ($p < .05$). The data reaffirm the idea that whether or not a figure has parallel or intersecting contours determines the direction of the fixation effect.

This study is based on the phenomenon of the figural aftereffect (FAE) of size (Köhler & Wallach, 1944). The conventional effect is a perceived change in the size of a test figure (TF) that is presented after the prolonged viewing of an inspection figure (IF). The direction of the change has been attributed to the relative positions of the TF and IF. There are three possible outcomes of an FAE paradigm (Cowart, Atkeson, & Pollack, 1979): (1) When the TF surrounds the IF, there is a perceived enlargement of the TF due to size contrast between it and the IF. (2) If the retinal trace of the IF bridges the interstimulus interval (ISI) due to stimulus persistence (Axelrod, Thompson, & Cohen, Note 1), the trace of the IF is superimposed on the TF. Thus, FAE magnitude may decrease because of the attraction between the IF and TF. (3) Stimulus persistence may have no effect. Thus, there would be no increase or decrease in FAE magnitude.

The results of a previous study (Cowart et al., 1979) indicated a slight increase in FAE magnitude with age. There are two possible explanations for this finding. Perhaps the FAE was operating as a simple contrast phenomenon, thus eliminating the effects of stimulus persistence. Or, stimulus persistence could be operating to a limited extent. The stimulus trace of the IF could be persisting though only part of the ISI, thus enhancing the contrast effect. Another study involving magnitude differences in the successive Mueller-Lyer illusion as a result of stimulus persistence found an actual reversal of this illusion (Atkeson, 1978). This finding suggests that figures with angles may persist longer than circles.

The present study attempted to alleviate the problem of contrast effects and to determine if angles do persist longer than circles. Fixation effects were employed to study these specific events.

Fixation effects are perceived changes in a stimulus figure that occur during and after prolonged inspection of that figure (Köhler & Wallach, 1944). These effects were investigated by Pollack (1964) in a series of experiments. One experiment investigated the influence of contour orientation on perceived size changes. Pollack's stimuli were circles and triangles for which the IF was its own TF. He predicted that circles would shrink with fixation, whereas triangles would not shrink and might expand. These predictions were confirmed. Pollack concluded that the orientation of the contours of the IF and TF plays a vital role in determining both the direction and magnitude of displacement.

Eliminating contrast effects by using the IF as its own TF produces a more direct test of stimulus persistence. Stimulus persistence can be used also to test the hypothesis that angles persist longer than circles. If this is the case, varying the ISI should make this difference apparent. Both the magnitude of the fixation effect and the length of the ISI over which the stimulus trace persists should be greater for triangles than for circles. If stimulus persistence fails to bridge the gap of the ISI, the fixation effects for triangles and circles would appear similar.

METHOD

Subjects

Twelve males and 12 females served as subjects. The subjects were volunteers or were obtained through the university's research participant pool in partial fulfillment of class requirements. They ranged from 18 to 29 years of age.

All subjects had at least 20/30 corrected or uncorrected vision as determined by the Master Orthorator. Because of the spectral composition of the light in the tachistoscope that peaks at 440 nm (three-channel Scientific Prototype Model GB), subjects who wore tinted contacts were not included.

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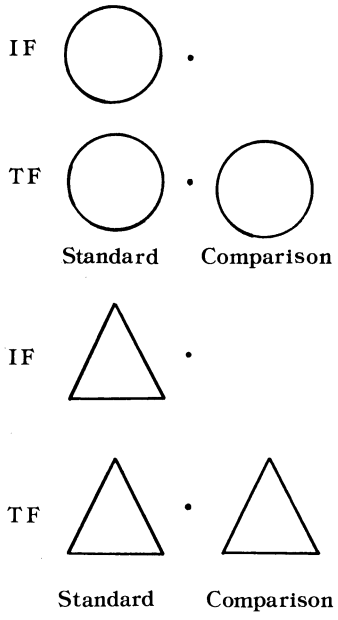

Figure 1. The stimuli: The inspection figures and test figures for circles and triangles.

Stimuli

The present study investigated fixation effects. For this reason, the IF was used as its own TF. Only the comparison figures were of varying sizes.

There were two sets of stimuli (see Figure 1). Both sets were outline figures drawn on white index cards in black India ink. The outlines were .5 mm thick. One set consisted of an IF and TFs in the form of circles. The IF was a circle 9.5 mm in diameter. The TF was composed of a standard circle and several comparison circles. The standard was 9.5 mm in diameter and coincided with the circle of the IF. The 14 comparison circles ranged in diameter from 6.0 mm to 12.5 mm, increasing in increments of .5 mm. Only one comparison circle was paired with the standard at a time.

The second set of stimuli consisted of isosceles triangles that were comparable in dimension to the circles. The height of the IF and TF triangles was identical to the diameter of each circle. The base of each traingle corresponded with the diameter of each matching circle. Thus, there was a triangle IF whose base and altitude corresponded to the diameter of the circle IF, a standard triangle whose base and altitude matched the diameter of the standard circle, and 14 comparison triangles that were equivalent in dimension to each of the 14 comparison circles. The centers of the circle and triangle IFs and TFs were 1.25 cm from the fixation point.

The maximum horizontal visual angle subtended 2 deg. The maximum vertical visual angle was 0 deg 44 min. Reflected illumination of the white background was 6.5 apparent footcandles, as measured by the Macbeth illuminometer.

Procedure

Before and after the experimental conditions, each subject viewed two trials of the standard paired with each comparison stimulus to obtain baseline control data. In the control condition the TF was presented for 500 msec. Circles were presented before the experimental condition with circles, and triangles were presented before the experimental condition with triangles. The stimuli were presented in this and the experimental condition according to Piaget's (1961/1969) converging method of limits.

The experimental condition consisted of two trials of the IF followed by the TF at each ISI. The IF was presented in Channel 1 of the tachistoscope for 8 sec. When the IF terminated, the fixation point appeared during the ISI. There were four ISIs: 0, 250, 500, and 750 msec. After the ISI the TF appeared for 500 msec. Each subject experienced all four ISIs and both sets of stimuli. The subject's task was to state which figure in the TF appeared larger: the standard or the comparison.

There was a 15-sec rest interval between each exposure of IF followed by TF. The rest interval was designed to bring the subject back to baseline so subsequent size judgments would not be influenced by previous exposures (Hammer, 1949).

Each subject participated in two sessions on two separate occasions. In one session, the IF and standard appeared on the left; in the other, they appeared on the right. In addition, initial presentation of the circles and triangles was counterbalanced. The subjects were tested at approximately the same time of day for the two sessions.

RESULTS

After the data were collected, the point of subjective equality (PSE) was assessed for each series of trials (Atkeson, 1978) at each ISI for each figure in both the experimental and control conditions. A five-way ANOVA (ISI by figure by left-right by sex by duration) was performed using these PSEs (Keppel, 1973). This ANOVA revealed a significant four-way interaction

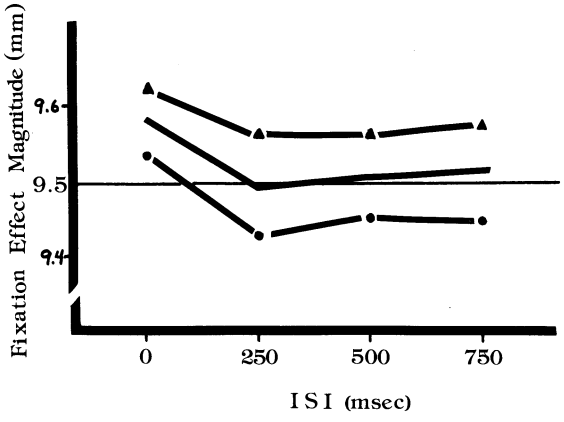

Figure 2. Fixation effect magnitudes for circles, triangles, and both figures at each ISI.

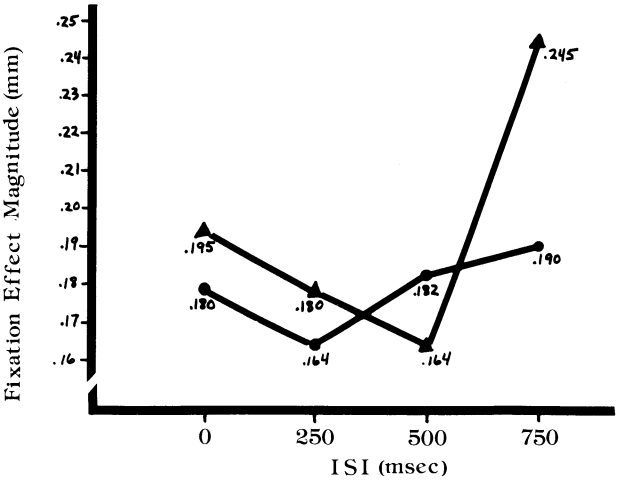

Figure 3. Fixation effect magnitudes using the absolute values of the differences from 9.5 for circles and triangles at each ISI.

Table 1
Summary of Mean Fixation Effects (in Millimeters) for Figures, Sexes, and Durations

Figure		Sex		Duration	
Circle	Triangle	Males	Females	.5 sec	8 sec
9.468	9.583	9.498	9.553	9.554	9.497

between figure, left-right, sex, and duration ($p < .05$); two significant two-way interactions between left-right and duration ($p < .05$) and between figure and left-right ($p < .05$); and several significant main effects [ISI ($p < .05$), figure ($p < .001$), sex ($p < .05$), and duration ($p < .05$)].

The fixation effect magnitude for circles and triangles was plotted for each ISI using PSEs (Figure 2) and absolute values of the magnitude differences from 9.5 (Figure 3). Based on the results of Figure 3, a two-way ANOVA (figure by ISI) was performed using absolute values of the magnitude differences from 9.5, but it was not significant. However, differentiation between the effects of triangle expansion and circle shrinkage was greatest at an ISI of 750 msec ($p < .05$).

Generally, triangles were perceived as larger than circles, females perceived both figures as larger, and both figures were perceived as larger at a shorter inspection duration (see Table 1).

DISCUSSION

It was expected that there would be a gradual decrease in the magnitude of the fixation effect for triangles with increasing ISI. Accompanying this expected decrease, it was hypothesized that there would be a larger decrease in the magnitude of fixation effect for circles, perhaps reaching an asymptote at an ISI of 250 or 500 msec. Figure 3 revealed that at ISIs of 0, 250, and 500 msec, the fixation effect magnitudes for both figures are similar. They only significant difference between fixation effects for circles and triangles was obtained at an ISI of 750 msec.

Figure 2 illustrates similar functions for triangles and circles. Both figures show equal but opposite effects. Triangles at every ISI are perceived as larger than 9.5 mm. Circles are perceived as smaller than 9.5 mm, except at the the 0-msec ISI.

Perhaps the range of ISIs should be extended. With shorter ISIs, the appearance of the TF may inhibit or lessen any influence that stimulus persistence may have. Or stimulus persistence may be operating to the extent that, although the stimulus trace of the IF is present, it fails to bridge the entire ISI. The brief appearance of the IF may serve only to enhance the magnitude of the effect, thus resulting in similar fixation effects for both figures.

According to several researchers (Axelrod et al., 1968), older adults are more susceptible to the effects of stimulus persistence. A broader age range of subjects may help to differentiate whether stimulus persistence is facilitating the appearance of the IF throughout the entire ISI or only part of it.

In most cases females perceived both figures as larger than did the males. This result was surprising but not without precedent. Other researchers (Kline & Nestor, 1977; Kline & Orme-Rogers, 1978) have found comparable results. They noted that changes in visual thresholds have been related to cyclical hormonal changes in females. However, female hormonal variations were not controlled in these or the present study. Perhaps future research can explain the relationship between hormonal variations and fixation effect or aftereffect magnitudes.

Generally, both figures were perceived as larger at a shorter stimulus inspection duration. Perceived circle size was smaller at an 8-sec inspection. Figures with intersecting contours were perceived as larger. The appropriate fixation effects of circle shrinkage and triangle expansion seemed to have been operating. The data reaffirm the idea that whether or not a figure has parallel or intersecting contours determines the direction of the fixation effect. This finding was consistent with the predictions for this study.

REFERENCES

Atkeson, B. M. Differences in the magnitude of the simultaneous and successive Mueller-Lyer illusions from age twenty to seventy-nine years. *Experimental Aging Research,* 1978, **4,** 55-66.

Axelrod, S., Thompson, L. W., & Cohen, L. D. Effects of senescence on the temporal resolution of semesthetic stimulus presentation to one hand or both. *Journal of Gerontology,* 1968, **23,** 191-195.

Cowart, D. A., Atkeson, B., & Pollack, R. H. Figural aftereffects in adulthood. *Bulletin of the Psychonomic Society,* 1979, **14,** 326-328.

Hammer, E. R. Temporal factors in figural aftereffects. *American Journal of Psychology,* 1949, **62,** 337-354.

Keppel, G. *Design and analysis: A researcher's handbook.* Englwood Cliffs, N.J: Prentice-Hall, 1973.

Kline, D. W., & Nestor, S. Persistence of complementary afterimages as a function of adult age and exposure duration. *Experimental Aging Research,* 1977, **3,** 191-201.

Kline, D. W., & Orme-Rogers, C. Examination of stimulus persistence as the basis for superior visual identification performance among older adults. *Journal of Gerontology,* 1978, **33,** 76-81.

Köhler, W., & Wallach, H. Figural aftereffects: An investigation of visual processes. *Proceedings of the American Philosophical Society,* 1944, **88,** 269-357.

Piaget, J. [*Mechanisms of perception*] (G. N. Seagrim, trans.). New York: Basic Books, 1969. (Originally published, 1961.)

Pollack, R. H. The effects of fixation upon the apparent magnitude of bounded horizontal extent. *American Journal of Psychology,* 1964, **77,** 177-192.

NOTE

1. "In the senescent nervous system, there may be increased persistence of the activity evoked by a stimulus, i.e., . . . the rate of recovery from short-term effects of stimulation may be slowed. On the assumption that the perception of the second stimulus as a discrete event depends on the degree to which the neural effects of the first have subsided, the poorer temporal resolution in senescence would then follow" (Axelrod, Thompson, & Cohen, 1968, p. 193).

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