Figural aftereffects as optical illusions? Failure to replicate two results

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Stadler (1972) has reported two experiments which suggest that (a) the figural aftereffect bound to the retinal image of an inspection circle is weaker than the figural aftereffect bound to the spatial frame of reference, and (b) imagining an inspection circle can produce a figural aftereffect. The results of the seven experiments reported here indicate that these results are not replicable when using objective methods.

Stadler (1972) has suggested that the concentric circles configuration shown in temporal sequence in Fig. 1 produces two figural aftereffects (FAEs). A test (T) circle will appear smaller if it is presented within the retinal image of the inspection (I) circle. This retinally bound FAE (FAE_r) is explained by most neurophysiological models, which assume that the neural medium in which FAEs occur is isomorphic with the retina. Stadler also suggests that a T circle will appear smaller if it is presented within the location of the I figure in the spatial frame of reference. He implies that this spatially bound FAE (FAE_s) cannot be explained by neurophysiological models because it is not dependent on the retinal image.

EXPERIMENTS I AND II

Stadler reported an experiment which was designed to measure the relative strengths of FAE_r and FAE_s (FAE_{r-s}) and their combined strength (FAE_{r+s}). The S fixated to the right of an I circle, as shown in Fig. 1. The I circle was removed, and the S shifted his gaze to a point at the center of the visual field, thus splitting the retinal image from the spatial location of the I circle. When the two T circles appeared, T_1 was surrounded by the retinal image and T_2 by the spatial location of the I figure. The T circles were then replaced by a point at the same location as the original point. This was followed by two T circles (not shown), shifted so that the left one fell within the spatial and retinal images of the I figure (now combined) and the right one appeared to the right of the fixation point. The apparent sizes of the first two T circles showed that FAE_s was stronger than FAE_r (FAE_{r-s} was negative). The apparent sizes of the last two T circles showed a weak but positive FAE_{r+s}. The following experiments represent an attempt to replicate Stadler's results with more objective procedures.

Method

The Ss for Experiment I were six males and five females from introductory courses in psychology. They received course credit for their participation. The Ss for Experiment II were an additional six males and five females from the same population.

The stimuli were drawn in black ink on white cards and were presented in a four-field Iconix tachistoscope. The dimensions of the figures are shown in Fig. 1.

The design and procedure were similar to those reported by Stadler, with three major exceptions. First, FAE_{r-s} and FAE_{r+s} were measured in separate experiments. Although Stadler's procedure is efficient, the FAE_{r+s} measurements have little quantitative meaning. The T figures for the FAE_{r+s} measurements always came after the ones for the FAE_{r-s} measurements. Thus, the interstimulus interval was always longer and the strength of the FAE was probably less because of it. The Ss in Experiment I judged the relative sizes of the T circles using Stadler's FAE_{r-s} procedure. The Ss in Experiment II judged the same T circles but fixated throughout at the center of the visual field, thus providing a more valid measure of FAE_{r+s}.

Second, the experiments were run using a double-blind procedure. There is good evidence that the E's attitude may bias the S's responses (cf. Rosenthal, 1966). To avoid this problem, the Es were one male and two female research assistants who had no knowledge of Stadler's results. They and the Ss were told that the experiment was designed to measure the effects of eye movements on the apparent sizes of circles. When questioned after the data had been collected, none knew the purpose of the experiments or that T_1 would have been expected to appear smaller by traditional theories of FAEs.

Third, each S had fewer trials. The FAE was measured by the method of constant stimulus differences. As in Stadler's procedure, T_1 was varied in each sequenced trial from 23.0 to

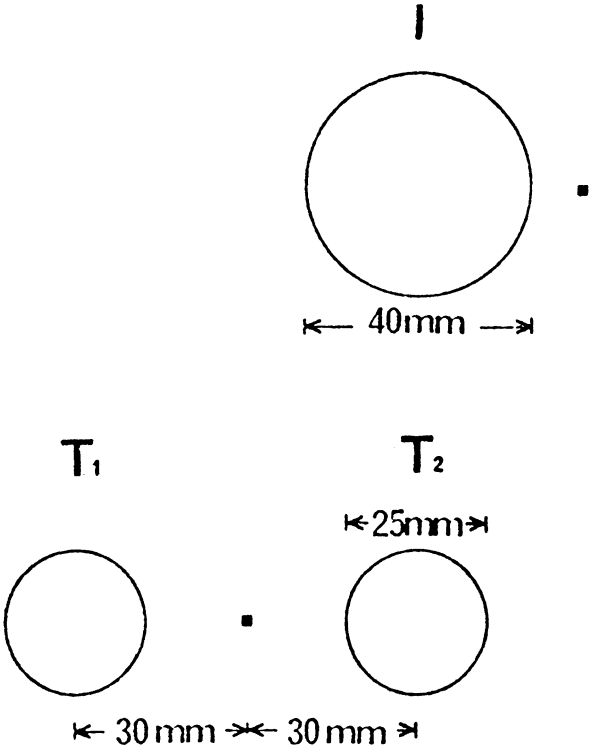

Fig. 1. The stimulus configuration used in Experiments I-IV and its dimensions, shown in temporal sequence.

*Preparation of this paper was supported in part by grants to the author from the Sloan Foundation and the Colgate Research Council.

Table 1
Summary of the Results from Experiments 1-7

Experiment	Mean FAE (mm)	SD	N	t
1	1.03	0.61	11	5.34**
2	0.41	0.40	11	3.24**
3	0.32	0.49	13	2.26*
4	0.45	0.70	16	2.49*
5	−0.01	0.60	15	0.06
6	0.10	0.44	23	1.07
7	−0.07	0.59	25	0.58

**$p < .01$ *$p < .05$

28.0 mm in 1-mm steps. However, each S first saw two random control sequences of the seven T_1 circles paired with the T_2 circle but preceded by a blank card and fixation point instead of the I circle. He then saw four random experimental sequences with the I circle present. This was followed by a third random control sequence. Stadler used six experimental and six control sequences.

The durations of the I circle (or control card), the interfigural field, and the T fields were 5,000, 500, and 500 msec, respectively. All viewing was monocular with the S's right eye. The reflected illuminance was 25.0 fc, monitored 10.0 cm from the surface of the card.

Results

Table 1 shows the mean FAEs computed by subtracting the average point of subjective equality for the second and third control sequences from the average point of subjective equality for the four experimental sequences. The positive values indicate that T_1 appeared smaller than T_2. Since the data suggest that $FAE_{r-s} > FAE_{r+s}$ ($t = 2.38$, $df = 20$, $p < .05$), there is little reason to assume that FAE_s exists.

EXPERIMENTS III AND IV

Experiment III was a replication of Experiment I with two male and two female Es who knew the purpose of the experiment. The Ss were 7 males and 6 females from the same population described above. The same four Es collected the data for Experiment IV, but the I duration was reduced to 1,000 msec. The Ss were 10 males and 6 females from the same population.

Table 1 shows that the results were somewhat weaker than those of Experiment I, but significant and in the same direction. Thus, it seems likely that these results are not due to Type I errors and that Stadler's results are not replicable under the conditions described above.

EXPERIMENT V

If an FAE can be produced by imaging an I figure, then clearly the FAE cannot be explained entirely by models that suppose the FAE to be dependent on the retinal image. Stadler asked his Ss to imagine a 5-mark piece and found that this indeed produced an FAE. In the following experiment, we attempt to replicate his results.

The Ss were eight males and seven females from the same population described above. The design was identical to the one used in Experiment II, except that (1) in the experimental sequences, the S was asked to imagine a circle the size of a half dollar surrounding a dot to the left of the fixation point, and (2) T_2 was varied randomly in each sequence from 12.0 to 18.0 mm in 1-mm steps while T_1 was held constant at 15.0 mm.

The naive Es from Experiment I were also used in this experiment. Although they guessed that the imagined circle should have some effect on T_1, they had no clear idea that T_1 should appear smaller by Stadler's reasoning.

Table 1 shows that there was a very small FAE in the direction predicted by Stadler, which did not approach significance. With power set at 0.80, alpha = 0.05 (two-tailed) and the mean of the sample taken as the unbiased estimate of the population mean, power analysis (Cohen, 1969) suggests that it would require 28,224 Ss to achieve significance. It seems unlikely that the imaginary I figure affected the apparent sizes of the T circles.

EXPERIMENTS VI AND VII

Experiment VI was a replication of Experiment V, using the sophisticated Es from Experiments II and III. The Ss were 11 males and 12 females from the same population described above. In Experiment VII, the E showed the S a circle the size of a half dollar (29.0 mm) between the control and experimental sequences, thus increasing the probability that the S was imaging a circle of the correct size. The Ss were 18 males and 7 females from the same population described above.

The results are roughly the same as Experiment V. Experiment VI shows a small FAE opposite to that predicted by Stadler. Power analysis using the same parameters as before suggests that it would require 152 Ss to achieve significance if the mean of the sample is the true population mean. Experiment VII produced a small FAE in the direction hypothesized by Stadler. Power analysis suggests it would require 557 Ss to reach significance. Thus, it seems unlikely that imagining an I circle affects the apparent sizes of the T circles under these experimental conditions.

DISCUSSION

Although Stadler's intention was to refute Ganz's (1966) model of FAEs, several of his arguments may be generalized to other neurophysiological models. By far the most compelling arguments are those based on the experiments described above, which attempt to show an FAE that is not bound to the retinal image. Our failure to obtain the same results using similar procedures must be considered damaging to Stadler's arguments.

There are several possible explanations for the discrepancies between the data reported by Stadler and those presented above, all of them related to differences in the methods. However, since the design and procedures used in Experiments I, II, and V are objective and hence not open to E and S biases, it would seem appropriate to conclude that Stadler's results are artifacts of his particular method.

Nevertheless, these data do not show that FAEs are exclusively bound to the retinal image. FAEs are complicated phenomena composed of many elements (cf. Howard, 1971;

Howard, Evans, & McDonald, 1973). It would be surprising if none of these elements was influenced by the S's imagination. Thus, it is important to note that the results of Experiments I-IV only show that if FAE_s exists, then it is not as strong as FAE_r and does not add linearly to it. We are currently attempting to replicate Crebus & Stadler's (1971) procedures which are designed to isolate FAE_r and FAE_s rather than measure the difference between them.

It is also possible that an FAE can be produced by imagining the I circle if the Ss have very good imagery. It would be interesting to replicate the entire set of experiments reported above using idetikers.

REFERENCES

Cohen, J. *Statistical power for the behavioral sciences.* New York: Academic Press, 1969.

Crebus, H., & Stadler, M. Über Wahrnehmungsprozesse in den Coordinaten der Netzhaut und des anschaulichen Raumes. Psychologische Forschung, 1971, 34, 325-342.

Ganz, L. Mechanism of the figural aftereffect. Psychological Review, 1966, 73, 128-150.

Howard, R. B. Neurophysiological models of figural aftereffects and visual illusions. Psychonomic Monographs, 1971, 4, 57-72.

Howard, R. B., Evans, G., & McDonald, J. Induction-, test-, and comparison figure interactions in figural aftereffects and illusions. Perception & Psychonomics, 1973, in press.

Rosenthal, R. *Experimenter effects in behavioral research.* New York: Appleton-Century-Crofts, 1966.

Stadler, M. Figural aftereffects as optical illusions? American Journal of Psychology, 1972, 85, 351-375.

(Received for publication August 3, 1973.)

Maintenance and autoshaping of keypecking in undeprived pigeons*

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Experienced undeprived pigeons pecked for food presentations on a VI 3-min schedule. When the schedule was changed to VI 30-sec, response rates increased and behavioral contrast was observed. To investigate the role of experience with reinforced responding, another three undeprived naive birds were autoshaped to keypeck and showed comparable rates of responding on a VI 30-sec schedule.

Neuringer (1969, 1970) reported that food-deprived pigeons responded on a VI 1-min schedule but not on a FR 10 schedule of reinforcement for food, even when food was freely available. Similarly, Carder & Berkowitz (1970) found that hungry rats would barpress for food when 2, but not 10, responses were required. Singh (1970), however, found that rats preferred earned to free food, even when the food was earned on a FR 11 schedule. Experiment I, below, attempted to replicate

*This research was supported by T.C.U. Research Foundation Research Grant PS 6977 to S. Winokur.

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