EFFECTS OF CERTAIN TARGET AND OBSERVER VARIABLES UPON THE PHENOMENAL DISTANCE OF LEFT SIDE AND RIGHT SIDE FOREGROUND ITEMS

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ABSTRACT

EFFECTS OF CERTAIN TARGET AND OBSERVER VARIABLES UPON THE PHENOMENAL DISTANCE OF LEFT SIDE AND RIGHT SIDE FOREGROUND ITEMS

By

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Previous work by Bartley and others has shown that the perceived nearness of items in the fore and mid grounds of pictures is related to their lateral position and that of other items in the background. The psychophysical method used was a distance matching one in which the comparison targets contained the critical items in different lateral positions, while the standard targets were pictures of essentially the same scenes but reduced in size. The task was to equate the critical items in the standard and comparison prints for distance.

The present study used the same method and attempted to identify other target and organismic variables which influence this phenomenon. In addition to handedness, characteristic direction of eye movement, and sighting dominance, three other variables were studied: (1) the location of the subject's imaginary standpoint along

the horizontal dimension as he views a picture, (2) the presence or absence of a highway in the median plane, and (3) the presence or absence of cropping along the sides of the foreground.

The hypotheses tested were: (I) There is a correlation between the location of one's imaginary standpoint along the foreground and the magnitude of one's sideward effects; (II) Cropping the picture in such a manner as to bring the foreground to a point in the center or adding an object such as a highway with its perspective lines to the median plane of the picture produces two results: (a) one tends to locate his imagined standpoint nearer to the center of the horizontal dimension, and (b) the magnitude of the sideward effects is lessened; (III) (a) Under conditions of Set I, in which the large background items are located on the right, right-handers show a greater tendency than left-handers to perceive an object in the left foreground as closer than one in the right foreground; (III) (b) Under conditions of Set II, in which the large background items are located on the left, left-handers show a greater tenedncy than right-handers to perceive an object in the right foreground as closer than one in the left foreground; (IV) There is a relationship between magnitude of sideward effects and (a) sighting dominance and (b) direction of eye movements.

Hypothesis III (b) was supported by the results, Hypothesis II (a) received partial support, and Hypotheses I, II (b), III (a), and IV were not supported. These results were discussed in terms of other work in this area.

Approved _____

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By

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INTRODUCTION

The perceptual changes resulting from the mirror image reversal of a picture have been discussed by Gaffron (1950, 1962) in a series of articles. While maintaining that these changes will eventually be amenable to classification in terms of basic effects or principles, her efforts have been largely confined to extensive listings of the changes occurring in certain specific pictures.

One effect which she has pointed out again and again in different pictures is the greater salience or apparent nearness of objects in the left foreground over those in the right foreground. To explain this and the other effects occurring upon reversal she postulates a glance curve beginning in the near left corner of the three-dimensional picture-space and ending in the far right corner. The fact that observers tend to locate their standpoint near the beginning of the glance curve explains the greater nearness of the left-hand objects. This does not refer to any physical displacement of the observer vis-à-vis the target but rather the imagined standpoint of the observer in the imaginary three-dimensional picture-space suggested by the target.

Nor is the glance curve to be thought of in its most literal sense:

> It must be emphasized that we are not dealing with voluntary or involuntary eye movements that could be observed by the usual experimental methods. We are dealing with a phenomenon based upon the central processes of visual perception. All objects within the range of this path are recognized spontaneously, while we must look separately for those located outside, i.e. in the right foreground or upper left background. The relationship of the glance curve to physical eye movements has still to be determined [Gaffron, 1950].

A study by Adair and Bartley (1958) represented the first attempt to apply psychophysics to this problem of sideward differences in pictures (sideward is used as the perceptual correlate of the physical term lateral). They used five scenes with varying degrees of sideward asymmetry as determined by five judges. Apprently the main criterion of asymmetry was the sideward distance from the center of the scene at which the prominent objects were located. Corresponding to each of the five scenes was a mirror image reversal with the asymmetry in the opposite direction.

There were two sizes of prints, 4 × 4 inches and 8 × 8 inches. Thus there were four prints of each scene, one with normal and one with reversed orientation in each of the two sizes. During each trial there was one small and one large print visible to the observer. The small prints were placed at a fixed distance just to the right of a track and the large prints were placed on a carriage on the track.

The two large versions of each scene appeared in combination with each of the two small versions of each scene. The Os were instructed to adjust the metric distance of the large print so that the scene in it appeared to be at the same distance as the corresponding scene in the small print.

It was found that the pictures which had the prominent items on the left were placed at a greater distance than were those which had these items on the right. In addition, the distance setting of the prints was influenced by the asymmetry factor in the manner expected; the greater the asymmetry in a scene, the more accentuated were the left-right differences.

In a later study, Bartley and Thompson (1959) used prints whose asymmetry was established on a more objective basis. All scenes consisted of a human figure standing on the center stripe of a roadway extending from the foreground to the horizon. There were also some trees and a few other items in the scenes. The human figure was placed in five different lateral positions, two placements on the left, two on the right and one in the center. In agreement with the previous study it was found that the human figure when on the extreme left appeared closer than when on the extreme right. The same difference was found between the less extreme positions but to a lesser extent.

Further studies by Bartley and DeHardt (1960) and Ranney and Bartley (1963) showed that the statement that objects on the left appear closer than objects on the right is too general; the location of large background objects also affects the perceived nearness of critical objects in the foreground. Specifically, the perception of the left foreground object as being closer than the same object in the right foreground is maximized when a large item is positioned in the right background. In fact, one study (Ranney and Bartley) obtained a reversal of the perceived distance of the right and left critical objects when a large background item was on the left. This study also found that the position of the large background item has a greater effect on small critical objects in the foreground than on large ones.

Recently another factor, lateral eye movements, has been added to handedness as a sort of window upon some of the functional asymmetries of the brain. Handedness is often used as an indication of where certain functional centers lie. The eye movement studies of Bakan (1969) and Bakan and Shotland (1969), on the other hand, have dealt with functions, aptitudes, emotions, etc., whose loci of control are in one hemisphere or the other and whose position (right or left hemisphere) can be considered stable across subjects. Since a characteristic movement in one direction or the other is believed

to result from an easier triggering of the contralateral hemisphere, correlations are sought between the direction of eye movement and the functions controlled by that hemisphere.

This eye movement phenomenon occurs at the beginning of a period of reflection upon a question or problem and was first brought to attention by Day (1964). Of special interest is his statement that "in general the right mover shows an externalized actively responsive distribution of attention emphasizing the visual-haptic modes," whereas "the left-mover shows an internalized, subjective . . . distribution of attention in which he is more reactive to auditory and subjective visual experience [Day, 1967]."

Bakan and Shotland found that right-movers were able to read a list of color names faster than left-movers. They then used this to account for another finding, i.e. that right-movers were able to go through the Stroop color word test faster than left-movers. In this test, the names of different colors are printed in various colors which do not correspond to those indicated by the words.

An obvious question to ask is whether there is any relationship between the sorts of left-right differences discussed by Gaffron, Bartley and others on the one hand and handedness, eye dominance, and direction of eye movements on the other. Gaffron suggests that the left hemisphere is visually dominant for right-handers.

> This means that there exists a difference in our awareness of visual data in favor of those which are perceived within the right visual field. The asymmetric glance curve . . . compensates for this asymmetry in our perceptual field and permits the most complete, unfalsified impression of three-dimensional space by visual space perception [Gaffron, 1950].

A left-handed person, according to this, should have a reversed glance curve; and as evidence she offers the case of Leonardo Da Vinci whose notebook pages and pictures "have to be reversed in order to show the composition which best fits the subject matter from the point of view of the right handed spectator [Gaffron, 1950]." She also says that a glance curve is not found in young children, which, if true, would agree with present beliefs that brain dominance is not present early in life.

In looking for a correlation with handedness or direction of eye movements we are asking two questions: (1) Is this phenomenon the result of a functional imbalance between the two halves of the brain and, if so, (2) does its strength and direction covary with handedness according to the classical formula or is it related to the direction of eye movements or to neither of these factors?

The second major aspect of this study concerns Gaffron's statement that the reason for the greater salience of left-hand objects is that observers tend to locate their imagined standpoint at the beginning of the glance curve.

> . . . we have the feeling that the left side is "our side." . . . A person standing in the left foreground with his back turned toward us arouses a decided feeling of identification with ourselves because his position comes nearest to the one we assume as a spectator. For the same reason, we feel that a person looking out of the picture from the left foreground is directly opposed to us [Gaffron, 1950].

Thompson and Bartley (1959) looked for an effect of this sort in two pictures which contained a human figure standing in the center. The only difference between the two pictures was that in one the subject was facing the camera and in the other he had his back turned to it. They found that the man with his back to the camera seemed nearer.

Whether or not one wishes to accept the idea of a glance curve, it seems logical to postulate that the greater nearness of objects in the left foreground is the result of a general tendency for the majority of subjects (right-handers) to select an imaginery standpoint which is displaced left of center. Even casual observation would suggest that an observer, in locating his imaginary standpoint, would have greater difficulty with the horizontal dimension than with the vertical. It would be quite unusual for an observer to imagine himself as viewing a scene from the midground or background rather than the foreground. However, in fixing his position along the horizontal dimension of this foreground, an observer is faced with the fact that the foreground as represented in a rectangular picture is a poor facsimile of the foreground in a real-life scene.

In this study, there will be four sets of pictures, two of which will be designed to fix the standpoint in the center of the foreground. Subjects will be asked to indicate their standpoint along this foreground and will also be given the usual task of positioning these pictures on a track in such a manner that the critical object appears to be at the same distance as a critical object in a small, fixed version of the picture. It is hypothesized that:

I. There is a correlation between the location of one's imaginary standpoint along the foreground and the magnitude of one's sideward effects.

II. Cropping the picture in such a manner as to bring the foreground to a point in the center or adding an object such as a highway with its perspective lines to the median plane of the picture will produce two results: (a) one will tend to locate his imagined standpoint nearer to the center of the horizontal dimension and (b) the magnitude of the sideward effects will be lessened

III. (a) Under conditions of Set I, right-handers show a greater tendency than left-handers to perceive an object in the left foreground as closer than one in the right foreground. (b) Under conditions of Set II, left-handers show a greater tendency than

right-handers to perceive an object in the right foreground as closer than one in the left foreground.

IV. There is a relationship between magnitude of sideward effects and (a) sighting dominance and (b) direction of eye movements.

METHOD

Subjects

Subjects were fifty-five (twenty-seven male and twenty-eight female) students at Michigan State University who volunteered from undergraduate psychology courses. All had corrected or uncorrected visual acuity of 20/30 or better.

Apparatus

The main piece of apparatus consisted of a 275-inch calibrated track (Figure 1). Mounted on the track was a movable target holder for the large prints. A headrest and screen were located at one end and a hole in the screen allowed monocular viewing of the targets. The headrest could be moved laterally so as to allow viewing with either the left or right eye. The stationary target holder (for the small prints) was positioned 27 inches in front of the screen and 9 inches off to the right of the track. Control knobs on the sides operated the movable target holder.

There was diffuse overhead lighting and a black screen near the other end of the track provided a flat background.

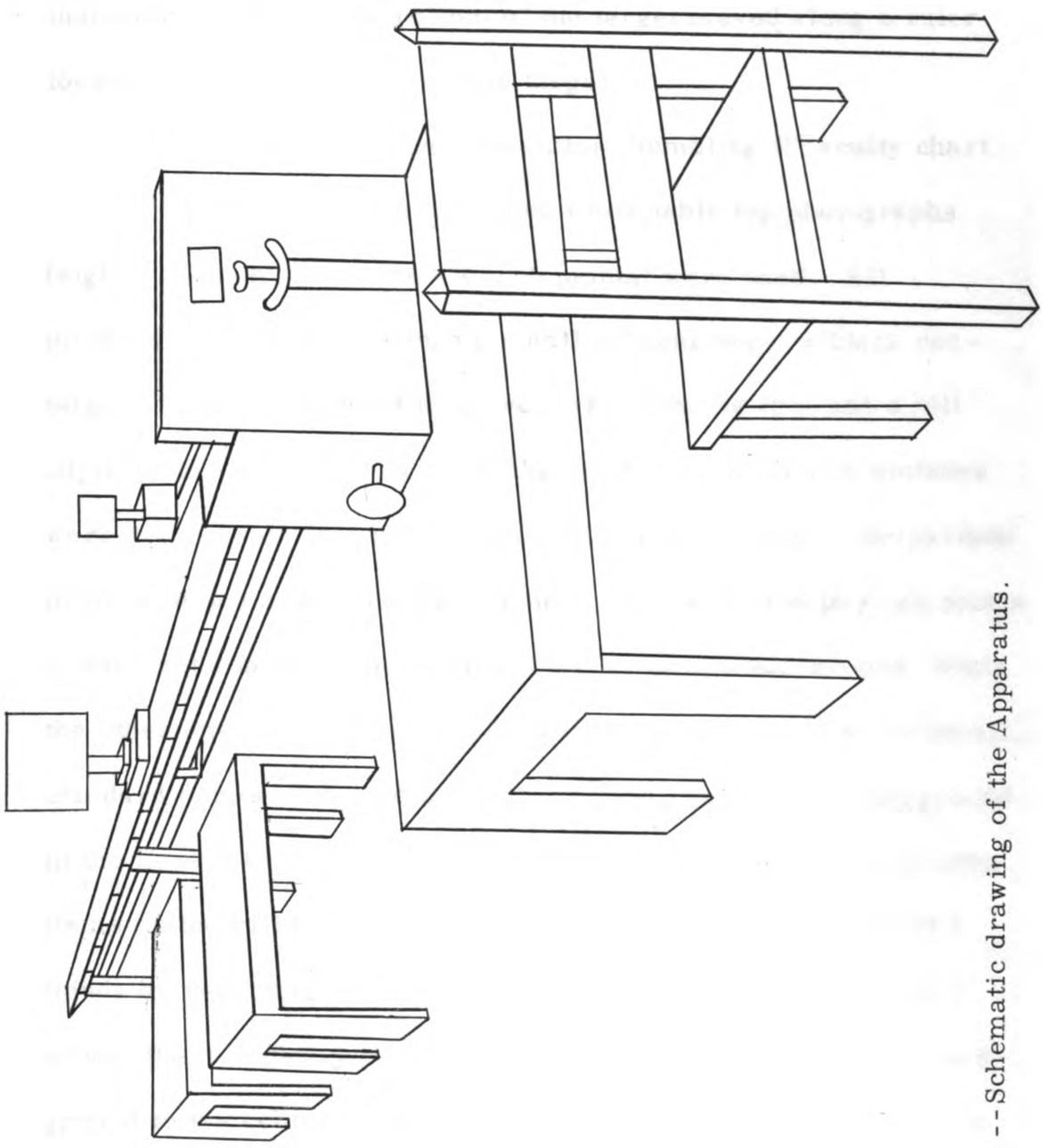

Figure 1. --Schematic drawing of the Apparatus.

An additional piece of apparatus (Figure 2) was a frame in which an 8 ×10 inch target could be placed. The tip of a movable indicator just below the bottom of the target moved along a ruler located behind the bottom of this target.

Acuity testing was done with a "tumbling E" acuity chart.

A total of twelve black and white table top photographs (eight 8 ×8 inch and four 4 × 4 inch prints) were used. All pictures (Figure 3) contained a small critical item, a black rectangle, in the foreground with two large items (a tree and a hill adjacent to each other) in the background. These twelve pictures were divided into four sets, each containing two large, comparison prints and one small, standard print. One of the comparison prints of each set contained the critical item in the left foreground, while the other one contained it in the right foreground. All of the small, standard prints contained the critical item in the center foreground. In the first set (Set I), all pictures contained the large background items on the right. Set II was a mirror-image reversal of Set I (made by reversing the negative). Set III was the same as Set I except that a highway running symmetrically from the center foreground to the center background had been added. Set IV also was the same as Set I except that the pictures had been cropped along the foreground in such a manner as to bring the foreground to a

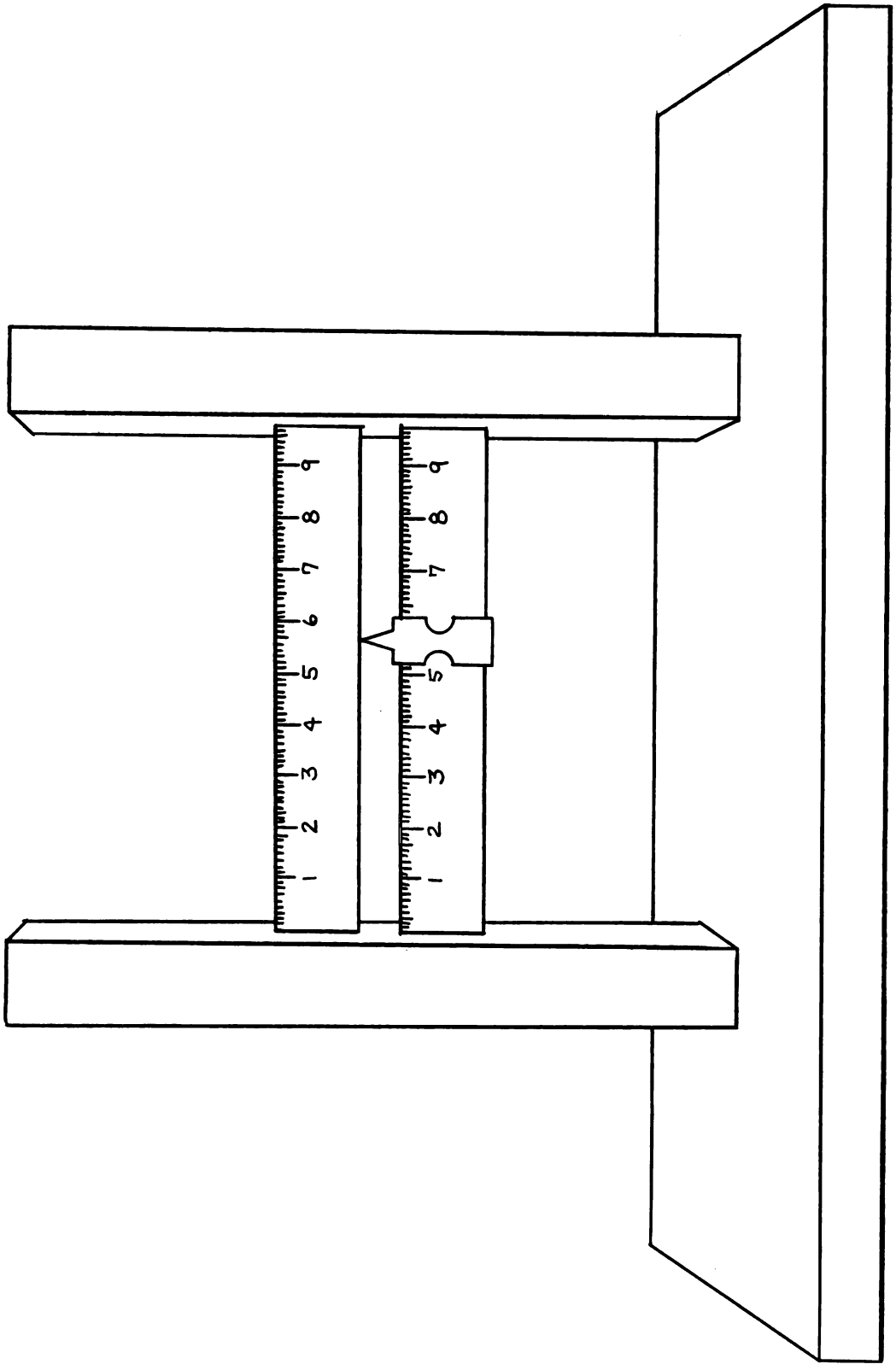

Figure 2. --Picture holder with horizontal indicator.

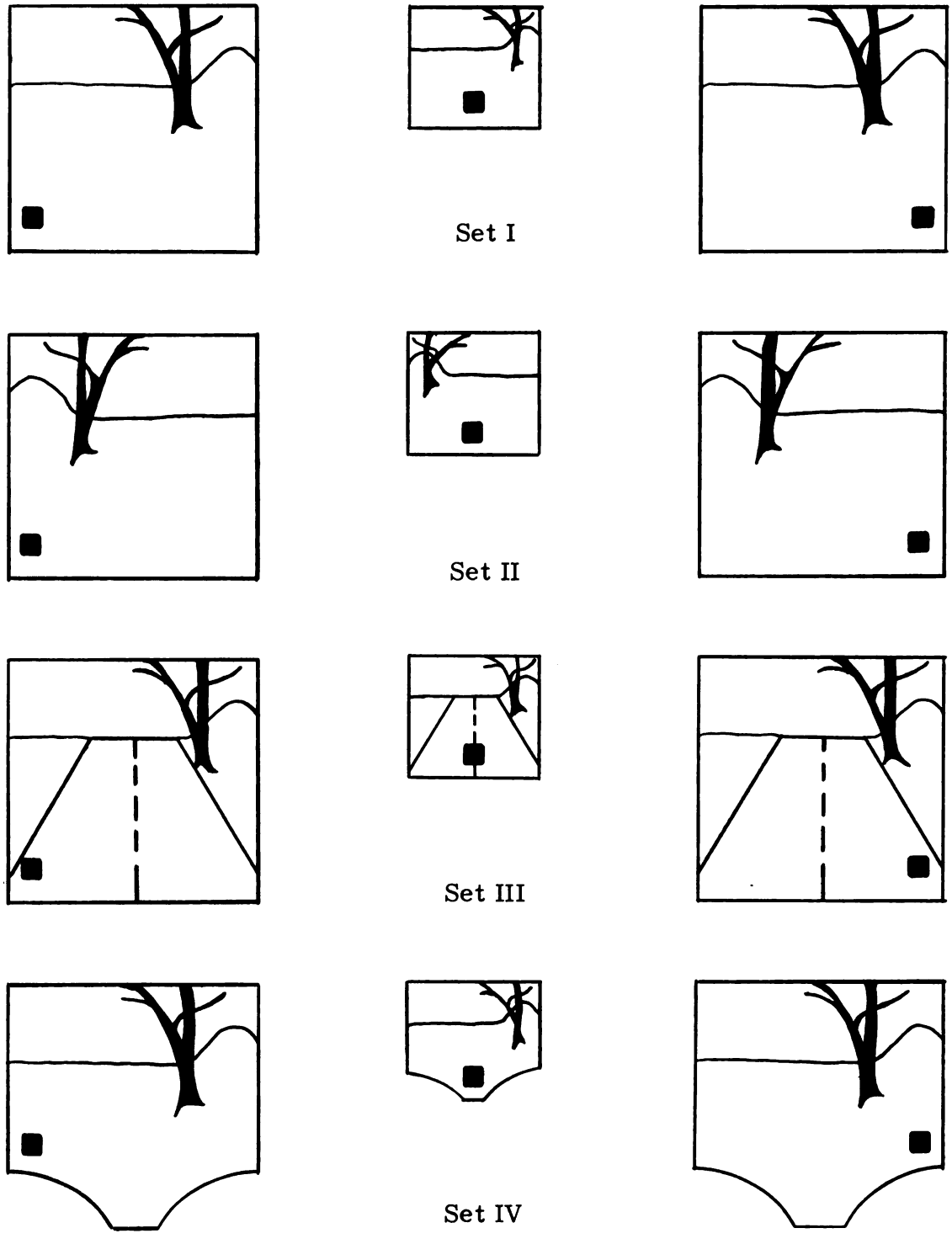

Figure 3. --Targets used in study (schematic).

point in the center. For convenience, the large, comparison print in each set which contains the critical item on the left side will be designated LS and the one which contains it on the right will be designated RS.

Procedure

S came in and was seated in a cubicle in one end of the room. There he was given three sighting tasks: looking through a plastic tube, lining up a pencil with another pencil held by E, and sighting his nose in a 1-inch circle drawn on a mirror. E noted which eye was used for each of the tasks.

E then took S out of the room via the door through which he had entered and told him to go around to the other end of the room. E met S at the door at the other end and gave him the acuity test (no subjects were eliminated by the test, but two were sent home to get their glasses).

Next, S put an eye patch over his nondominant eye while E adjusted the headrest to align the dominant eye with the hole in the screen. E asked the subject if he could see both targets and gave him the following instructions:

> Your job in this experiment is to move the large picture by means of these two control knobs until the black rectangular object in the large picture appears to be the same distance away as the same black object in the small picture. Remember,

> your task is simply to make the two black objects appear to be the same distance away--not necessarily the same size.

If the subject asked a question such as, "Equally far away from what?" he was told the following:

> Well, pretend that this is a real-life scene and you are standing somewhere along the foreground looking at it. In this case, how far away would the objects be?

E then gave the subjects four practice trials on each of two practice sets. These practice prints were pictures of houses (different in each set) in a suburban setting, and each had a black critical item in the foreground.

After the last practice trial, E began the test trials. Four trials were given on each of the eight comparison pictures for a total of thirty-two trials. The method used was, of course, the method of adjustment with different ascending and descending starting points each time. The order of presentation was random, with the restriction that all eight of the comparison prints had to appear once before any could appear for the second time. The same was true of the succeeding rounds of presentation. Ascending and descending trials were counterbalanced by having ascending trials on the first round, descending on the second, descending on the third, and ascending trials on the last round. E recorded, to the nearest inch, the distance setting on each trial.

Upon completion of the distance settings, E again seated S in the cubicle at the other end of the room. E sat in the other chair and faced S at a distance of about 3 feet. The walls of the cubicle were painted black and the two chairs were the only objects inside it.

E then told S that he would read ten proverbs to him and that his task was simply to tell, in his own words, what each meant. These proverbs were:

1. Two wrongs don't make a right.
2. As ye sow, so shall ye reap.
3. Still waters run deep.
4. The early bird gets the worm.
5. Rome wasn't built in a day.
6. A watched pot never boils.
7. Too many cooks spoil the broth.
8. A stitch in time saves nine.
9. Every cloud has a silver lining.
10. The grass is always greener on the other side of the fence.

Before reading each proverb, the experimenter established eye contact with the subject and then, when S broke contact to reflect upon the problem, noted the direction of the very first movement.

Next, handedness was determined by a questionnaire. Use of the same hand in seven of the following ten tasks constituted handedness: combing hair, brushing teeth, writing, hammering a nail, cutting with a knife, drinking, erasing blackboard, opening door, throwing ball, and cutting with a scissors.

For the last task, the picture holder was brought in and the eight large prints were placed in it, one at a time. The subjects were instructed:

> Imagine that this is a real scene which you are viewing from somewhere along the foreground and move the indicator to show where it would seem most natural for you to be standing.

E recorded the setting for each picture.

RESULTS

Before testing the hypotheses, two dependent measures t tests were performed between the LS and RS versions of Set I and between the LS and RS versions of Set II. This was done to determine the magnitude and direction of the left-right differences which had been achieved across all subjects. In Set I, there was a non-significant tendency ($t = 1.22$, $df = 54$) for the critical object to appear closer when on the left side than when on the right side. In Set II, there was a tendency in the opposite direction, i.e., for the critical objects to appear closer when on the right than when on the left, but this just missed significance ($t = 1.98$, $df = 54$).

To test Hypothesis I, two Pearson product-moment correlations were computed between the Ss performance on the track and their indicator settings. First, the subjects' RS settings on Set I were subtracted from their LS settings on that set. A correlation was computed between this score and the scores for Set I on the indicator placement (the sum of the LS and RS versions). The same was done with Set II. Neither correlation proved to be significant.

An Analysis of Variance (Table 1) using the data from the indicator settings was performed to test Hypothesis II (a). The relevant factor here is sets, and this proved to be significant ($F = 5.51$, $p < .01$). A Newman-Keuls test showed a significant difference between all pairs of sets with Set IV producing the greatest leftward bias, Set I producing a slight leftward bias, Set III having a slight rightward bias, and Set II having the greatest rightward bias. The means of the four sets were 8.82, 9.72, 9.94, and 10.35 respectively, with 9.88 being the expected mean under conditions of no directional bias. Thus the leftward bias of Set I, the rightward bias of Set II, and the fact that Set III has the smallest directional bias agree with Hypothesis II (a). However, Set IV, which was expected to have an effect similar to Set III, instead showed the greatest directional bias of all.

Table 1. --Analysis of Variance (Indicator Settings)

Source of Variance	SS	df	MS	F
Sets	34.5	3	11.51	5.51
Laterality	2.3	1	2.32	.38
Subjects	105.5	54	1.95	.77
Sets × Lat	9.3	3	3.08	1.22
Sets × Sub	338.1	162	2.09	
Lat × Sub	332.2	54	6.15	
Sets × Lat × Sub	408.1	162	2.52	

Hypothesis II (b) was tested by means of a t test comparing the mean left-right difference in Set I plus that of Set II with the same combined mean differences of Sets III and IV. This test revealed a nonsignificant tendency ($t = 1.00$, $df = 54$) for the left-right differences in Sets III and IV to be smaller than those of Sets I and II.

Hypothesis III concerned handedness and III (a) was tested by dividing the subjects into right and left-handers by the criterion described earlier. The n of the left-handed group was 8 and that of the right-handed group was 44, with a remainder of 3 subjects who did not fit into either group. Scores were assigned to the subjects by subtracting each subject' s RS score from his LS score for Set I. A t test yielded a nonsignificant difference between the two groups ($t = 1.30$, $df = 50$). III (b) was tested by doing the same with the pictures of Set II, and there a significant relationship ($t = 1.71$, $df = 50$, $p < .05$) was found.

The effects of sighting dominance (Hypothesis IV (a)) were analyzed in a similar manner, with the RS scores from Sets I and II being subtracted from the LS scores. Subjects were divided into left and right sighters according to the eye used on a majority of the sighting tasks. No significant difference was found in either case;

the t for Set I was -1.41 with 53 df, and the t for Set II was 1.21 with 53 df.

As a further test of IV (b), the subjects were divided into males, females, right handers, left handers, right handed males and right handed females and the right and left movers within these sub-groups were compared in the same manner as before. For Set I, within the subgroup Females the left movers had a greater tendency than the right movers to perceive the critical object as closer when in the left foreground than when in the right foreground ($t = 1.92$, $df = 28$, $p < .10$). The same was true within the subgroups Right Handers ($t = 1.98$, $df = 40$, $p < .10$) and Right Handed Females ($t = 2.02$, $df = 21$, $p < .10$).

Thus, Hypothesis III (b) was supported, Hypotheses II (a) and IV (b) received partial support, and Hypotheses I, II (b), III (a), and IV (a) were not supported.

DISCUSSION

Many previous studies of lateral asymmetry in pictures have varied the size and depth of the critical object as well as the position of the background objects. The present study, for the most part, used the same configuration of fore- and background items throughout the various sets while making a somewhat different sort of manipulation.

The present study was designed to take a closer look at the concept of phenomenal nearness by asking whether some of the same logical extensions of metric nearness could be applied to phenomenal nearness. Specifically, it was thought that if the left foreground of a picture appears closer than the right foreground, then logically an observer should perceive his imaginary standpoint in the picture space as closer to the left than to the right side. If this is true, then any manipulation which reduces the leftward displacement of this standpoint should also reduce the sideward effects in the picture.

Although the results gave some support to the idea that observers displace their imaginary standpoints to the right or left depending upon the composition of the picture, the failure of these

displacements to correlate with the size of the sideward effects casts doubt upon the rest of the argument.

It seems probable that handedness and position of background items both produce similar results. For example, in the case of right-handers viewing Set I (background object on the right) or left-handers viewing Set II (background object on left), the two factors tend to summate and strengthen the sideward effect while the other two combinations tend to cancel each other out.

Also, the fact that handedness was significantly related to the one picture but not to the other is reminiscent of a finding by Swartz and Hewitt (1970). In their study, subjects were shown 20 pairs (original and mirror-image reversal) of pictures and were asked to indicate their preference in each pair. While handedness showed no overall relationship to original vs. reversed preferences, there was a relationship of this sort with certain pictures.

Although the correlations between direction of eye movements and sideward effects were suggestive, a serious consideration of these relations would have to await replication. The technique used in analyzing this part of the data was essentially exploratory; it was necessary to perform numerous t tests on basically the same set of data because of our ignorance of just where the relationships should lie. However, this greatly increased the likelihood of a Type I error.

The overall difference between the LS and RS versions of Set I (background item on the left), while not significant, was at least in the same direction as that of previous work in this area. Further, the reversal of direction occurring with Set II (background item on the right) is similar to the findings of the two other studies in which some of the pictures contained the large background items on the left. The studies of Bartley and De Hardt and Ranney and Bartley both achieved this reversal, and in one case (Ranney and Bartley) it was strong enough to be statistically significant.

As mentioned earlier, Gaffron contends that for centuries artists have placed in the left foreground those items upon which they want primary attention focused. The studies of Bartley and De Hardt and Ranney and Bartley as well as the present study indicate another correspondence between traditional practice and sideward effects: those relationships between critical and background items which produce the maximum perceptual nearness of the critical item are the same as those which would be dictated by traditional rules of good "balance" or "composition." When a small foreground item and a large background item are to be essentially the only two items in the picture, it would be rare for an artist to put them both on the same side of the picture. Likewise, the maximum perceptual nearness of the critical object is not achieved when they are on the same side.

The fact that Set II did not appear nearer than all the other sets presents a contrast to the results of a study by Bartley (1959). He found that cropping away part of the surround from the critical item while holding overall print size constant did cause the print to appear nearer. This difference is to be expected, since the cropping in the present study was less uniform and extensive in nature and, more importantly, did not hold overall print size constant. In light of some of the comments from the subjects, these differences seem to have been crucial. Many reported that Set IV seemed to represent an attempt to trick them and that they subjectively added back onto the picture that part which had been cropped.

The fact that a larger difference was not achieved in the original phenomenon (LS-RS differences in Sets I and II) is more difficult to explain. One possible reason is that the ground rose somewhat more rapidly in going from foreground to horizon than in the pictures used in previous research of this type. Thus one inadvertent finding of this study may be that this factor tends to reduce the sideward effects.

As yet, little is known about how this phenomenon of sideward differences relates to other perceptual laws and phenomena. In looking for an overall schema into which this phenomenon might fit, one is tempted to consider work such as that of Luneberg (1950)

and Blank (1958), which has shown something about the distortions inherent in visual space. Their work has attempted to find the functions relating metric space to visual space. While they have shown visual space to deviate considerably from metric space, it is pictured as bilaterally symmetrical. However, their experimentation used simple light points in a dark, impoverished background, and this may have been responsible for their finding symmetry in visual space.

An important caution, though, in attempting to relate these two lines of investigation to each other is the fact that we do not yet know whether these sideward differences occur when an actual three-dimensional scene is viewed or whether these differences occur only as the result of the reduction of a three-dimensional scene to a two-dimensional representation. Investigation of this question is an important area for future research.

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