



145
644
THS

A FURTHER STUDY OF DETERMINANTS OF
PHENOMENAL DISTANCE IN PLANE TARGETS
PERCEIVED AS THREE DIMENSIONAL SCENES

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY

Jane Ellen Ranney

1962

ABSTRACT

A FURTHER STUDY OF DETERMINANTS OF PHENOMENAL DISTANCE IN PLANE TARGETS PERCEIVED AS THREE DIMENSIONAL SCENES

by Jane Ellen Ranney

Two items located at the same position in a scene do not always appear to be the same distance from an observer. Previous studies have delineated the effects of viewing distance, print size, and asymmetry of scenes on apparent distance. However, the effects of item position, crucial item size, and location of a background item have not been clearly determined. The effect of these factors on phenomenal distance of items in photographed scenes were investigated in this experiment.

Twelve observers with visual acuity of 20/20 met a criterion of variability in a practice series. They then compared eight large variable targets to two smaller, fixed targets, matching them so that the crucial items in the photographs appeared to be the same distance from them. The variable targets were photographs of an asymmetrical artificial scene containing either a small or large crucial item to the left or right of center, and mirror images of these prints. In the standard targets the small item was in the center of the scene.

Jane Ellen Ranney

The results led to the following conclusions:

(1) Large items appear nearer than small items located at the same position in the photographs.

(2) The position of a large background item is important in determining the phenomenal distance of the crucial item. It is more important where the crucial item is small, less important when it is large.

(3) The item on the left appears nearer than one on the right when the large background item is on the right.

Several suggestions were made for further research.

Approved by: S. H. B. Smith
Date: October 11, 1962

A FURTHER STUDY OF DETERMINANTS OF
PHENOMENAL DISTANCE IN PLANE TARGETS
PERCEIVED AS THREE DIMENSIONAL SCENES

By

Jane Ellen Ranney

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

Department of Psychology

1962

9 12257
11/2/62

ACKNOWLEDGMENT

Dr. S. Howard Bartley's support and assistance in this endeavor have been invaluable. Also, I wish to thank Dr. Charles Hanley and Dr. Donald M. Johnson for reading and criticizing the manuscript.

J.E.R.

TABLE OF CONTENTS

LIST OF TABLES.....	iv
LIST OF FIGURES.....	v
LIST OF APPENDICES.....	vi
I INTRODUCTION.....	1
II METHOD.....	8
Observers.....	8
Apparatus.....	8
Procedure.....	10
III RESULTS AND DISCUSSION.....	14
IV SUMMARY.....	22
BIBLIOGRAPHY.....	23
APPENDIX.....	25

LIST OF TABLES

Table I. Summary of analysis of variance based on scores for each <u>Q</u> under each condition.....	15
--	----

LIST OF FIGURES

Figure 1.	Sample targets. Large targets and their mirror images were compared to the smaller targets.....	9
Figure 2.	Picture of the apparatus.....	10
Figure 3.	Graph showing the relationship between block size and mean distance of the variable target. This distance is related to phenomenal distance in such a way that the target is placed near <u>0</u> when the block looks far away.....	17
Figure 4.	Graph of distance as a function of lateral position of the small block in the variable target.....	18
Figure 5.	Graph of distance as a function of lateral position of the large block in the variable target.....	18
Figure 6.	Graph of distance as a function of lateral position of trees in the variable targets with the small block.....	18
Figure 7.	Graph of distance as a function of lateral position of trees in the variable targets with the large block.....	18

LIST OF APPENDICES

Appendix I.	Scores for each observer on each condition, and mean scores for each condition.....	25
-------------	---	----

INTRODUCTION

Phenomenal distance is the apparent nearness of an object. Some objects, though located at the same metric distance, are seen as nearer or farther than others. What are the conditions or variables which determine whether an object is seen as near or far?

Many studies of phenomenal distance have used photographic prints in investigating such variables as print size, viewing distance (i.e., the distance from the observer to the target), lateral position of items in the photographs, and certain effects of background on phenomenal distance. These variables have been investigated in various ways. Some investigations have used distance estimation and ratio judgments, but most have used a psychophysical technique where observers match a moveable target to the apparent distance of a standard target. The latter technique is used in the present study.

From several studies (3,7,10,12,13,14,15) it was concluded that viewing distance (the metric distance from 0 to the target) of a standard target is related to phenomenal distance. This principle applies equally to photographs and to three-dimensional objects. Print size has been shown to determine phenomenal distance (2,3,16). Phenomenal distance also reflects the degree of asymmetry, this variable having been investigated primarily in relation to relative nearness of right and

left halves of the field (1,4,6). Studies by Bartley and Adair (3), Bartley and Thompson (6), and Bartley (2), have demonstrated that the phenomenal distance of an item is not determined simply by the visual angle subtended by that item.

The effects of several other factors have not been so satisfactorily nor conclusively determined. The effect of size of the crucial item on phenomenal distance has not been settled, nor has the effect of background items. While several studies have investigated the effect of lateral position of an item, results have indicated that other factors may modify the difference in the phenomenal distance of this item. The effects of these three variables and their interrelations should be specified.

First, we might expect that large items seen at a given distance will seem nearer than small items located at the same position in the scene.

Bartley (2) varied the size of the item by enlarging and cropping prints, so that background items increased proportionally, but the effect of an increase in size relative to the background was not investigated. Bartley concluded that it is not simply the visual angle subtended which determines the phenomenal distance of that item, although the visual angle is positively related in some way to phenomenal distance.

Bartley and DeHardt (5) asked Os to match prints containing a small item with prints containing an item of the same height, but five times wider. They found that the large items appeared significantly nearer than the small items.

Artists intuitively have used differences in the effect of items in the right and left of pictures to create different effects in their compositions. Gaffron (8) compared pictures with their mirror images and suggested that these "laws of composition" might be based on differences in our perception of right and left portions of pictures. From introspective study of the changes in the impression reversal produces, she reported certain differences in emotional effects, and that the items when on the left appeared nearer than when on the right.

Differences in apparent nearness of right and left items have been investigated by Adair and Bartley (1), Bartley and Thompson (6), and in two papers by Bartley and DeHardt (4,5). However, results of the latter two papers have qualified the earlier results.

Adair and Bartley (1) used five scenes, varying in degree of asymmetry, and asked Os to place the larger prints where the scene appeared to be the same distance as a smaller print of the scene which was at a fixed position. Their results showed that the left of a scene

appears nearer than the right. The greatest effect occurred with the most asymmetrical scenes.

Bartley and Thompson (6) varied the degree of asymmetry by cropping a photograph in such a way that the horizontal position of the critical item varied from left to right. Their results corroborated those of Adair and Bartley.

Recent research, however, has indicated that a simple statement that items on the left appear nearer than those on the right is neither adequate, nor accurate. Other factors such as presence of background items and size of crucial item modify the relationship.

Conflicting results have been found concerning the effect of the background on phenomenal distance. Smith (11) magnified reproductions of Gibson's stake photographs so that the space portrayed was equal to 75% and 250% of the original scene depth. One photograph showed the complete field, one was impoverished so only a standard stake and variable stakes remained, and in a third, the stakes with their shadows remained. Os estimated in yards the distances of the far and near stakes as well as their size. Judgments of distance varied as a function of degree of magnification. Size matches did not vary with judged distance. While Smith varied the background, since he used different portrayed distances, the distance judgments cannot be compared.

Smith, Smith and Hubbard's (13) Os compared a photograph of a corridor with five drawings varying in amount of detail at five viewing distances. If O perceived them to differ, he made a ratio-judgment of their depth. Results showed that differences in ratio-judgments were a function of changes in viewed perspective, but were not correlated with differences in shading or degree of detail in the pictures.

Teichner, Kobrick and Dusek (14) used a matching technique in a three-dimensional field where a variable target was moved until O signalled that it appeared to be at the same distance as a standard target. Four standard viewing distances and four terrains were compared. They concluded that qualities of the terrain have little or no effect.

To investigate further the effects of terrain and observation distance on relative depth discrimination, Teichner, Kobrick and Wehrkamp (15) employed three target distances and five terrains. The linear threshold of equality increased with viewing distance, and varied slightly with the terrain. Although the differences between terrains were significant, they were small and not consistent. In these studies, however, differences in terrain were primarily textural differences. That is, perception was tested over silt, macadam road, etc.

Bartley and DeHardt (4), using two scenes with different degrees of asymmetry, asked Os to match items in

the foreground or background. They found that items on the left did not appear nearer than those on the right when the crucial items were in the background. Therefore items in the foreground and background function differently. However, part of the difference may be attributed to the fact that Bartley and DeHardt did not control for the relative amount of the total scene area occupied by foreground and background items.

In another study, Bartley and DeHardt (5) used an asymmetrical scene where background trees on the right or left side provided a major component and a smaller item (a block) could be placed right, center, or left. They found that with the trees on the right the smaller block appeared nearer on the left than on the right, but with the trees on the left, the relationship was somewhat modified. In fact, comparing trees on the right in the standard to trees on the left in the variable, the block appeared nearer on the right. Items in the background affect the phenomenal distance of foreground items.

Therefore, since we are using a similar situation, we would predict that the left-right imbalance is dependent upon the background item appearing on the right, or at least the maximum effect will occur only when the background item is on the right.

Gogel (9) has suggested that the effect of the background on errors in distance perception depends on the relative proximity of the irrelevant item, and on

its size relative to the size of the crucial item. The same might be expected of phenomenal distance. That is, we expect the relative position of the large background items to have a greater effect on the phenomenal distance of small items than of large items. And, we would also predict that the difference between the phenomenal distance of items on the right and left would be greater for large items than for small items.

To summarize, the following hypotheses are to be tested by this experiment:

I. Large items seen at given distances will seem nearer than small items located at the same position in the scene.

II. The left-right imbalance (left items seeming nearer than the same items on the right) depends upon the background item appearing on the right, rather than on the left, or at least the maximum effect will occur only when the background item is on the right.

III. The position of a large background item will have a greater influence on the phenomenal distance of a small item than on a large item.

IV. Left-right differences in phenomenal distance will be greater for large items than for small.

METHOD

OBSERVERS: Twelve male students in an introductory experimental psychology course at Michigan State University served as observers. They all met a visual acuity criterion of 20/20 or better in the right eye.

APPARATUS: Five photographs of an artificial scene were printed in black and white on glossy paper, and the negatives simply inverted to produce mirror images. These provided all possible combinations of two item sizes, right and left position, and two conditions of background complexity.

Trees, a hill and road provided a complex background on the right of the scene, and the left or simple portion of the background was relatively flat with a lake on the horizon. The crucial item, either a small square black block or one of the same width but five times taller, was to the left or right of center in the midground for the variable targets. The small block was in the center for the standard targets. Shadows in the photographs were minimized by taking the photographs in diffuse overhead lighting. Sample photographs are shown in Fig. 1.

The scene was so realistic that Os did not recognize that it was artificial, and asked where the photographs were taken. One even asked what kind of trees were in the background.

In describing the targets, R and L refer to the position of the trees in the background. The tall block

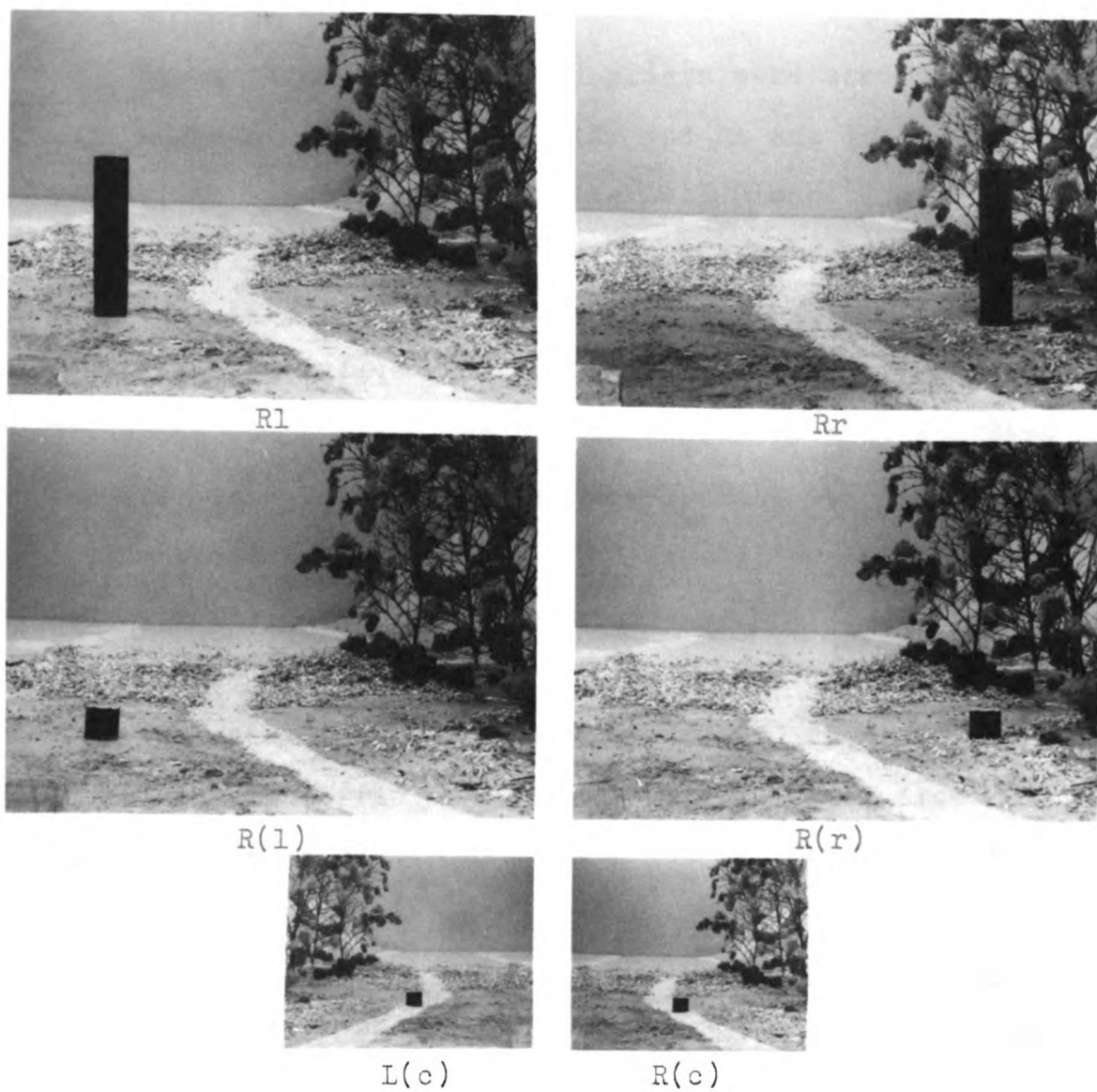


Fig. 1. Sample targets. Large targets and their mirror images were compared to the smaller targets.

is coded as r and l, and the small block as (r), (c), and (l). Thus in Rl the trees are on the right, the tall block on the left.

Eight large (8 x 10-inch) prints were used as variable targets. Four of these (Rr and Rl and their mirror images, Ll and Lr) contained the tall block, and four, R(r), R(l), L(l) and L(r), the small block. These variable targets were compared with the two smaller (4 x 5-inch) targets, R(c) and L(c), held at a fixed distance. Since the small block was in the center in both standard targets, in describing these targets only the position of the trees in the standard target will be stated, followed by the comparison target; thus, LR(l). There were 16 possible combinations of standard and variable targets.

The apparatus for presenting targets consisted of an adjustable carriage mounted on a calibrated track 275 inches long; a stationary target holder to the right of this, and a chin rest and blind to block vision in the left eye. The apparatus is shown in Fig. 2. By turning a crank on the left of the apparatus, O moved the large print along the track. The track was illuminated by diffuse overhead lighting. Targets were seen against a flat black background.

PROCEDURE: Cs were first tested for visual acuity using a "tumbling E" acuity chart. Only individuals with 20/20 acuity or better in the right eye served as Cs.

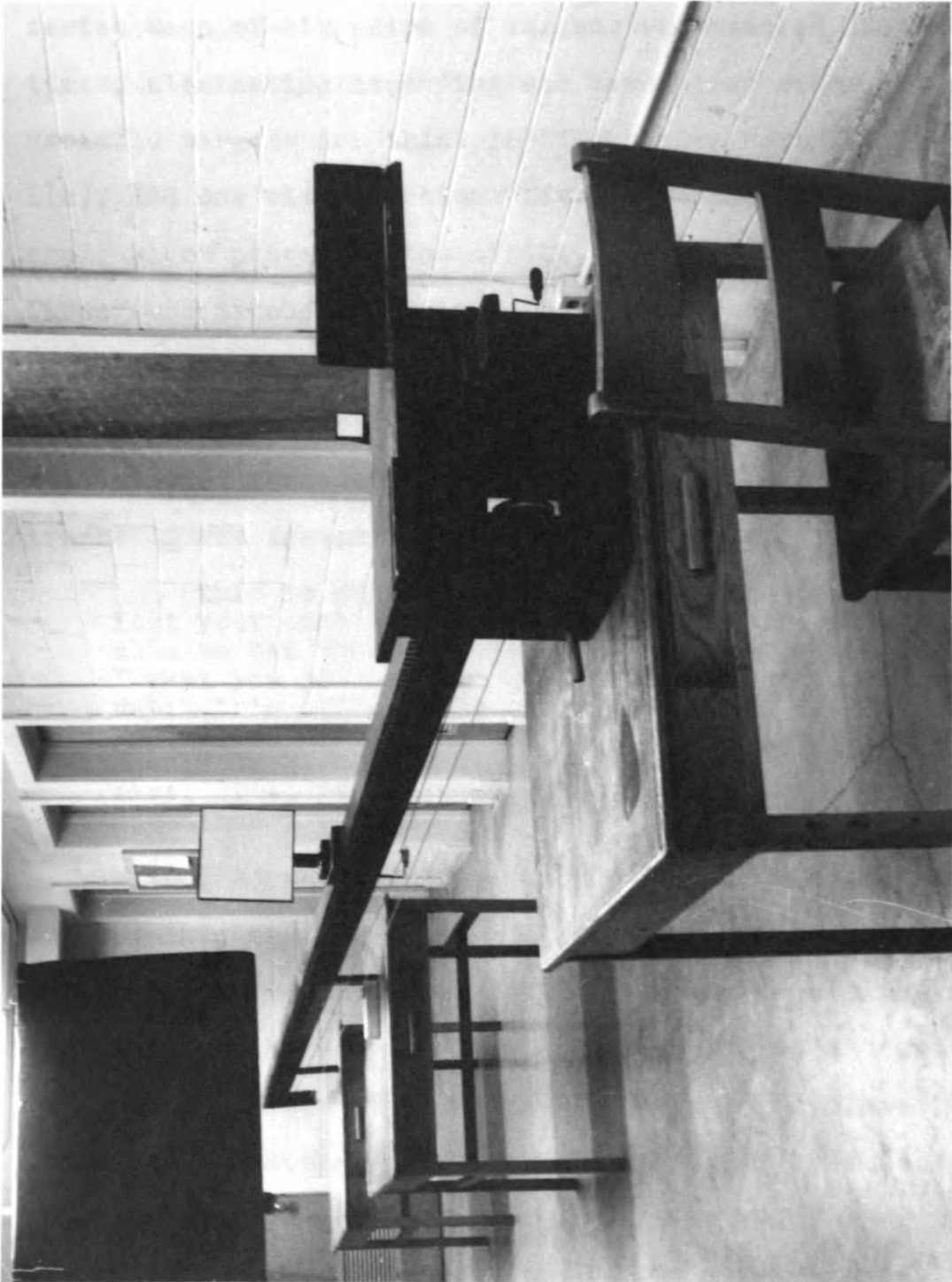


Fig. 2. Picture of apparatus.

To eliminate Os who did not necessarily perform the task, a further criterion was established. In a practice series each of six pairs of targets was matched four times, alternating ascending and descending order. The variable targets for this practice series were R(c), L(c), and one with the block five times the width of the small block placed in the middle, and its mirror image. These were matched to Rr and Ll.

One of the small practice targets was placed on the right, 29 inches from O's right eye, and a large (variable) target randomly positioned along the calibrated track. O was seated before the apparatus and instructed:

This is an experiment in distance judgment. Rest your chin on the chin rest. Now you should be able to see the pictures only with your right eye. I want you to move the large picture with this crank until this object (the block) looks as far away from you as the one in the small picture. The objects should look the same distance from you, not the same size. I'll give you several practice trials, so go ahead and try it.

When O appeared unsure of his task he was told "One subject imagined he was in the scene, and put the large photograph where he thought he would have to walk the same distance to get to the objects in the two pictures."

Os were also told that if they were quite dissatisfied with a response they could repeat the trial. They were free to take a break to stretch whenever they wished, and a break was suggested at the end of the practice trials and after eight conditions had been completed.

The variable target was placed at some random point along the track and O moved the target toward or away from himself until the block appeared to be at the same distance as a similar block in the standard target. The measure then taken was the distance in inches from O to the variable target. If an item in a target appears relatively near, the target is placed farther from O than if a target contains an item which appears farther away.

Unless O's range on three of these six practice conditions was 10 inches or less, he did not complete the experiment. This criterion eliminated two Os who were not necessarily performing the task given them, and whose data would have been meaningless because of the wide range. From this practice O developed a more stable criterion of equality of distance, and therefore a more stable range for the experimental series.

In the main experiment, the same instructions and procedure were used as in the practice series. The sixteen pairs of targets were presented in a random order to each of twelve Os. Since Os made two ascending and two descending matchings for each pair, they made a total of 64 comparisons in addition to the 24 practice trials.

RESULTS AND DISCUSSION

The four readings taken under each condition were averaged to provide scores for the observers. These scores, along with mean scores for each condition, are tabled in Appendix I.

Results of an analysis of variance are presented in Table I. Results of a Bartlett's test for homogeneity of variance of the triple interactions involving observers, and of the four- and five-way interactions involving observers did not permit rejection of the hypothesis of homogeneity of variance. For the triple interactions χ^2 was 4.2906, which, with five degrees of freedom, $p > .75$. For the four- and five-way interactions, $\chi^2 = 4.3894$, $df = 4$, $p > .75$. Therefore, pooled variances were computed to be used as error terms for main effects and double interactions involving observers (pooled three-way interaction variance), and triple interactions involving observers (pooled four- and five-way interaction variance). In all other cases the error term was the interaction of the source of variance being tested with observers. For example, the error term for Block Size was the Block Size by Observers interaction mean square.

The results tend to confirm three of the four hypotheses proposed.

Hypothesis I. It was expected that large items at a given distance would seem nearer, and therefore these prints would be placed farther along the track than

Table I. Summary of analysis of variance based on scores for each Q under each condition.

Source	df	MS	F
A Tree Position (Standard)	1	35.6644	3.1443
B Tree Position (Variable)	1	17.9769	1.9374
C Block Position	1	23.2060	1.5741
D Block Size	1	210.9456	9.2491*
E Observers	11	803.0905	85.1859**
A x B	1	1.2113	.1572
A x C	1	39.6488	5.6939*
A x D	1	15.6124	1.9805
B x C	1	217.2816	12.1568**
B x D	1	52.3441	5.4725*
C x D	1	2.6958	.4100
A x E	11	11.3426	1.2031
B x E	11	9.2787	.9842
C x E	11	14.7423	1.5637
D x E	11	22.8071	2.4192*
A x B x C	1	2.8154	.2659
A x B x D	1	.9143	.0926
A x C x D	1	.0731	.0092
B x C x D	1	38.7450	5.5985*
A x B x E	11	7.7063	1.0017
A x C x E	11	6.9634	.9051
A x D x E	11	7.8829	1.0246
B x C x E	11	17.8732	2.3231*
B x D x E	11	9.5649	1.2432
C x D x E	11	6.5742	.8545
A x B x C x D	1	4.6098	1.4614
A x B x C x E	11	10.5889	
A x B x D x E	11	9.8739	
A x C x D x E	11	7.9291	
B x C x D x E	11	6.9206	
A x B x C x D x E	11	3.1544	
Total	191		
Pooled variance, triple interaction involving E	66	9.4275	
Pooled variance, four- and five-way interactions involving E	55	7.6934	

* $P < .05$

** $P < .01$

prints depicting small items located at the same position in the scene. This is true for seven of the eight comparisons, as is apparent from Fig. 3. The mean distance for prints containing large blocks was 64.73, for small, 62.63. The analysis of variance showed the effect of block size to be significant at nearly the .01 level of significance.

Bartley's (2) research showed that the absolute size of an item determines the phenomenal distance. The present research shows that an item which is large relative to the background is also seen as nearer. This confirms Bartley and DeHardt's (5) results. In future research, these two methods of varying object size should be compared directly, however.

Hypothesis II. We predicted that the left-right imbalance is dependent on the background item appearing on the right. That this is true for the small block is apparent from Fig. 4. However, with the large block this does not appear to be the case. (See Fig. 5.) The item on the left appears nearer than that on the right only in comparing LRL and LRR. This difference in the effect of the position of the background item on the phenomenal distance of the different sized objects is substantiated by the significant Tree Position (Variable) by Block Position by Block Size interaction ($p < .05$), and by the significant Tree Position (Variable)

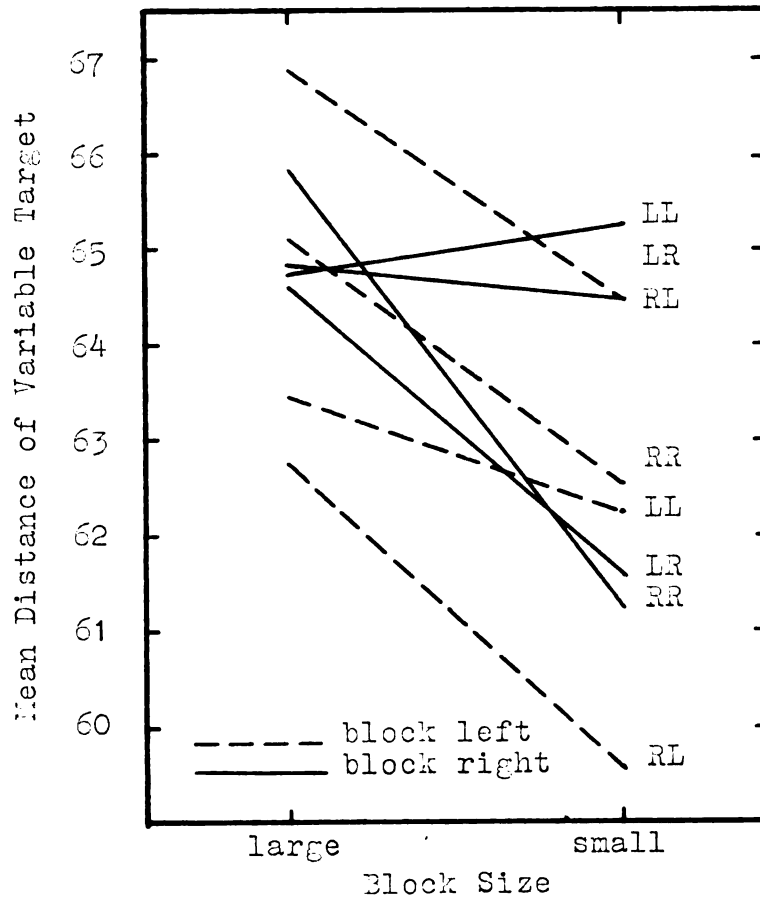


Fig. 3. Graph showing the relationship between block size and mean distance of the variable target. This distance is related to phenomenal distance in such a way that the target is placed near 0 when the block looks far away.

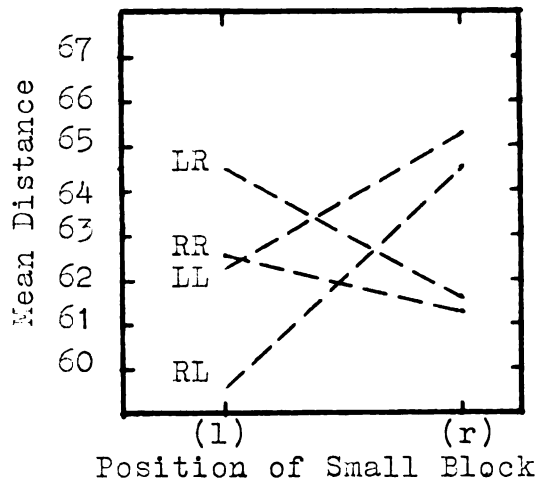


Fig. 4. Graph of distance as a function of lateral position of the small block in the variable target.

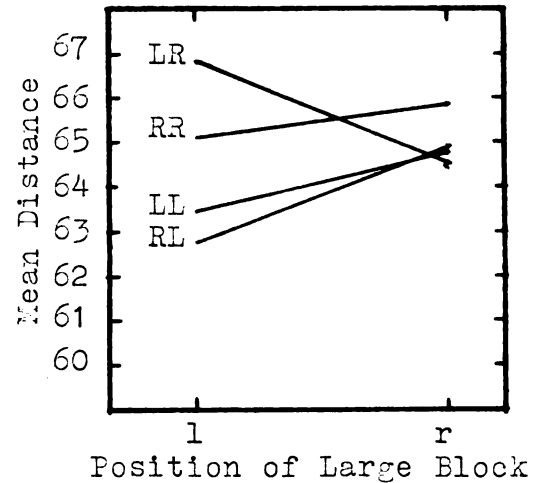


Fig. 5. Graph of distance as a function of lateral position of the large block in the variable target.

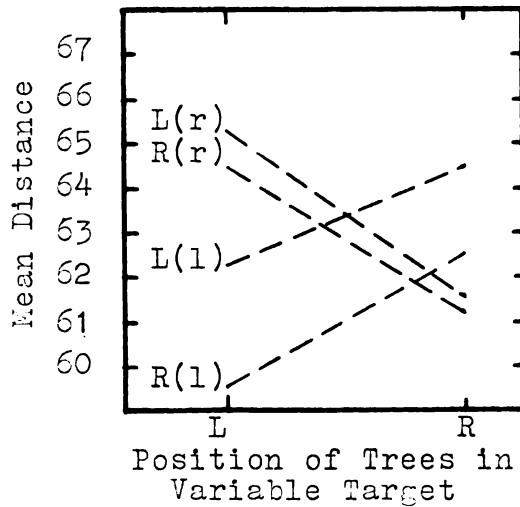


Fig. 6. Graph of distance as a function of lateral position of trees in the variable targets with the small block.

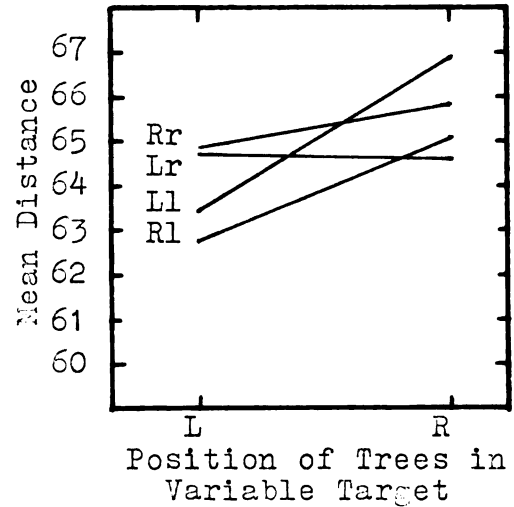


Fig. 7. Graph of distance as a function of lateral position of trees in the variable targets with the large block.

by Block Size ($p < .05$), and Tree Position (Variable) by Block Position ($p < .01$) interactions.

Since Bartley and DeHardt (5) used the same prints with the small block, the results of the two studies should be similar. In both sets of data, with the trees on the right in the variable target, the item on the left appeared nearer. With the trees on the left, this study found that the item on the right looked nearer, where Bartley and DeHardt found it looked farther, although their differences were not statistically significant.

Hypothesis III. We predicted that the position of the large background item (trees) would have a greater influence on the phenomenal distance of the small block than on the large block. That is, we predicted that the difference between the phenomenal distance of the small block on the left and right depends on the position of the background item rather than of the small crucial item. Evidence for this hypothesis is provided by a comparison of Figs. 4 and 6. In Fig. 4 the distance is plotted as a function of the right or left position of the small block in the variable target. In Fig. 6, distance is plotted as a function of the position of the trees in the variable target. From the similarities of these two graphs it is apparent that the phenomenal distance of the small item is largely determined by the position of the large background item.

One would expect, on the other hand, that the phenomenal distance of the larger blocks would not be as greatly determined by the large background items. This is apparent from the differences between Figs. 5 and 7, which are comparable to 4 and 6, but for the large blocks. Here again, the significant Tree Position (Variable) by Block Size, and Tree Position (Variable) by Block Position by Block Size interactions substantiate the graphical data.

Hypothesis IV. We predicted that left-right differences in phenomenal distance would be greater for large items than for small. There is no direct evidence for this hypothesis since we found that the position of the background item largely determines the phenomenal distance of the small item. Therefore the large and small crucial items cannot be directly compared. The Block Position by Block Size interaction predicted by the hypothesis was not significant. This hypothesis should be investigated in an experiment where the problem is not complicated by the presence of a large background item.

The results of this investigation, in conjunction with those of Bartley and DeHardt (5), have demonstrated the importance of background items in determining phenomenal distance. Teichner, Kobrick and Dusek (14), and Teichner, Kobrick and Wehrkamp (15) found little or no difference in the equality point of two objects in a

field situation with different backgrounds. But their background differences were rather minor, simply the differences in texture of the ground, as silt, sand, or macadam road. So perhaps, as may be inferred from Gogel's (9) work with illusions, phenomenal distance depends on the size of the irrelevant item relative to the size of the crucial item. This question should be investigated directly by varying the size of the irrelevant item.

Not only does the presence of a large background item affect the phenomenal distance of a crucial item, but the distance is also dependent on the position of the background item as well as its position relative to the size and position of the crucial item.

In conclusion, the results of this experiment show that phenomenal distance of an item in a scene is affected by (a) the size of the item, (b) the lateral position of the item, (c) the lateral position of a relatively large item in the background; and (d) that these factors interact to determine phenomenal distance.

SUMMARY

This study investigated the effects of item position, item size, and location of a large background item, on the phenomenal distance of an item in a photographed scene.

Twelve observers compared eight large variable targets to two smaller, fixed targets, matching them so that the crucial items in the photographs appeared to be the same distance from the observer. The variable targets were photographs of an asymmetrical artificial scene containing either a small or large item to the left or right of center, and mirror images of these prints. In the standard targets the small item was in the center of the scene.

The results led to the following conclusions:

- (1) Large items appear nearer than small items located at the same position in the photographs.
- (2) The position of a large background item is important in determining the phenomenal distance of the crucial item. It is more important where the crucial item is small, less important when it is large.
- (3) The item on the left appears nearer than one on the right when the large background item is on the right.

Several suggestions were made for further research.

BIBLIOGRAPHY

1. Adair, H., and Bartley, S. H. Nearness as a function of lateral orientation in pictures. Percept. & Mot. Skills, 1958, 8, 135-141.
2. Bartley, S. H. Some comparisons between print size, object position and object size in producing phenomenal distance. J. Psychol., 1959, 48, 347-351.
3. Bartley, S. H., and Adair, H. J. Comparisons of phenomenal distance in photographs of various sizes. J. Psychol., 1959, 47, 289-295.
4. Bartley, S. H., and DeHardt, D. C. A further factor in determining nearness as a function of lateral orientation in pictures. J. Psychol., 1960, 50, 53-57.
5. Bartley, S. H., and DeHardt, D. C. Phenomenal distance in scenes with independent manipulation of major and minor items. J. Psychol., 1960, 50, 315-322.
6. Bartley, S. H., and Thompson, R. A further study of horizontal asymmetry in the perception of pictures. Percept. & Mot. Skills, 1959, 9, 135-138.
7. Dusek, E. R., Teichner, W. H., and Kobrick, J. L. The effects of the angular relationships between the observer and the base-surround on relative depth-discrimination. Amer. J. Psychol., 1955, 68, 433-443.
8. Gaffron, M. Right and left in pictures. Art Quart., 1950, 13, 312-331.

9. Gogel, W. C. Perception of the relative distance position of objects as a function of other objects in the field of view. J. exp. Psychol., 1954, 47, 335-342.
10. Smith, O. W. Comparison of apparent depth in a photograph viewed from two distances. Percept. & Mot. Skills, 1958, 8, 79-81.
11. Smith, O. W. Judgments of size and distance in photographs. Amer. J. Psychol., 1958, 71, 529-538.
12. Smith, O. W., and Gruber, H. Perception of depth in photographs. Percept. & Mot. Skills, 1958, 8, 307-313.
13. Smith, O. W., Smith, P. C., and Hubbard, D. Perceived distance as a function of the method of representing perspective. Amer. J. Psychol., 1958, 71, 662-674.
14. Teichner, W. H., Kobrick, J. L., and Dusek, E. R. Commonplace viewing and depth discrimination. J. Opt. Soc. Amer., 1955, 45, 913-920.
15. Teichner, W. H., Kobrick, J. L., and Wehrkamp, R. F. The effects of terrain and observation distance on relative depth discrimination. Amer. J. Psychol., 1955, 68, 193-208.
16. Thompson, R. W., and Bartley, S. H. Apparent distance of material in pictures associated with higher order meanings. J. Psychol., 1959, 43, 353-358.

APPENDIX I

Scores for each observer on each condition, and mean scores for each condition.

<u>O</u>	RRl	RRr	RR(r)	RR(1)	RLl	RLr	RL(r)	RL(1)
Ha	60.25	58.75	56.50	59.50	54.75	62.00	61.50	53.75
Le	60.50	60.25	55.50	56.50	59.75	61.00	56.00	55.50
Al	69.50	72.00	61.75	60.25	65.50	66.75	64.25	60.50
Ne	64.50	62.75	56.50	59.75	56.00	63.75	59.25	53.25
Lu	55.25	60.25	55.00	53.25	52.25	50.25	59.75	50.50
Po	66.00	64.25	62.00	64.00	66.50	68.00	63.50	62.75
Li	70.25	65.25	60.75	67.00	63.75	64.00	68.00	62.00
Mo	66.00	64.50	59.50	64.50	58.25	63.25	67.75	56.00
Lo	76.00	74.50	81.25	75.00	77.00	69.75	75.50	73.00
Yo	58.25	68.25	57.75	55.00	62.75	71.25	61.50	60.25
Ki	79.25	81.25	74.50	81.00	82.00	80.00	76.75	74.50
Zu	55.50	58.00	54.00	54.75	54.50	58.00	60.00	48.00
$\bar{X}$	65.10	65.83	61.25	62.54	62.75	64.83	64.48	59.58

<u>O</u>	LRl	LRr	LR(r)	LR(1)	LLl	LLr	LL(r)	LL(1)
Ha	60.50	60.00	57.75	63.00	57.75	61.25	60.00	55.50
Le	60.25	60.25	53.50	56.25	59.50	61.25	58.25	58.50
Al	68.50	64.00	58.50	60.00	65.75	69.25	63.00	59.50
Ne	60.75	58.25	60.00	66.00	58.75	60.75	62.50	53.00
Lu	57.25	55.25	52.00	55.00	51.50	50.50	61.50	57.50
Po	76.25	69.50	62.50	67.00	65.25	72.25	63.50	63.75
Li	67.25	65.50	65.00	63.75	64.75	63.75	68.75	65.25
Mo	68.50	65.50	65.00	69.50	65.50	66.25	68.25	57.00
Lo	70.00	75.25	74.50	71.25	75.00	74.50	72.25	71.50
Yo	67.00	62.75	61.25	64.50	67.00	65.75	64.00	61.75
Ki	91.75	75.50	74.50	86.25	74.25	72.00	83.25	76.50
Zu	54.50	63.50	54.50	51.25	56.50	59.50	58.00	57.25
$\bar{X}$	66.88	64.60	61.58	64.48	63.46	64.75	65.27	62.25

ROOM USE ONLY

ROOM NO. 111

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03175 7937