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AN INVESTIGATION OF THE INFLUENCE OF A FIGURE-GROUND UPON THE PERCEPTION OF IT'S CONSTITUENT ELEMENTS

Thesis for the Degree of M. A.

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Sidney W. Weatherhead

1948

THESIS

This is to certify that the

thesis entitled

"An investigation of the influence of a figure-ground upon the perception of its constituent elements"

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Sidney W. Weatherhead

has been accepted towards fulfillment of the requirements for

Master ~~of Arts~~ degree in ~~Psychology~~

Maurice R. Denny
Major professor

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AN INVESTIGATION OF THE INFLUENCE OF A FIGURE-GROUND UPON THE PERCEPTION OF IT'S CONSTITUENT ELEMENTS

BY

SIDNEY W. WEATHERHEAD

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The Problem and It's Setting

The present study is an attempt to test the hypothesis that the perception and learning of a constituent part of a total field will be facilitated when the field and the part have identical characteristics and inhibited when these characteristics are not identical.

This hypothesis was formulated as a restatement of a hypothesis derived from the emergent behavior theory of social science developed by Mr. Hugo Engelmann of Michigan State College. The following statements are taken from an unpublished paper by Mr. Englemann:

> "The construction of a unified theoretical social science seems to demand the acceptance of the theory of configurational emergentism as a description of behavioral dynamics. This theory asserts that every behavior pattern must be considered at the same time as an emergent at the intersection of two or more, less complex behavior patterns, and as a differentiation from a more complex field. Every behavior pattern must also be considered a new differentiation and a new emergent at the time of its occurrence, regardless of how many times an identical behavior pattern has been performed before by the same single biological organism. If this biological organism has performed this behavior pattern before we may speak of a repetitive pattern, otherwise of a non-repetitive pattern."

> "The hypothesis selected for experimental investigation can be stated as follows. The newly emerging non-repetitive behavior pattern re-emerges as a repetitive behavior pattern, because it constitutes a behavior pattern of such a nature that if it intersects with a different or identical behavior pattern, a new differentiating field emerges in which the original non-repetitive behavior pattern can again emerge as a repetitive behavior pattern at a higher level of complexity."

The task of the author was simply one of unbiased experimentation to lay bare the facts as to what visual pattern would emerge most readily and to discover the possible reasons for its emergence. (Visual patterns were used to represent the intersecting behavior patterns discussed by Mr. Englemann). The goal was either to substantiate the theory or to supply data for its possible revision.

Antecedent to this investigation are many experiments on form perception. However, past experimentation is not directly related to the problem under investigation although it does furnish a background from which the results of this experiment might be predicted.

Most of the experiments in the past have been performed with the purpose of substantiating or demolishing some tenet of Gestalt Theory. These experiments have in general led to positive evidence for the following laws of field organization (6).

1. Law of Pragnanz: Psychological organization moves toward good gestalt, e.g., stability, simplicity, and regularity.
2. Law of Proximity: Old impressions are less well recognized and recalled than new ones because the recent trace is nearer in time to the present active process.
3. Law of Closure: Closed areas are more stable than unclosed ones, and therefore more readily form figures in perception.

4. Law of Similarity: Similar items (form, color, etc.) or similar transitions (alike in steps separating items) tend to form groups in perception.

5. Law of good Continuation: Organization in perception tends to occur in such a manner that a straight line will continue as a straight line, a circle as a circle, etc.

In general, Gestalt Theory has been based on the assumption that experience is made up of definite configurations in which a figure protrudes from a more or less undifferentiated background. It is further postulated that "A structure once present in experience creates favorable conditions for its own reappearance or that of a similar structure (5)." In traditional Gestalt Theory figure and ground present two aspects of a total field one of which predominates while the other sets it off.

In the configurational emergentist theory here postulated, the concern is not with a clearly perceived form and an undifferentiated background but rather the emphasis is upon the relationships existing between two or more patterns of behavior experienced simultaneously one of which may emerge from a more complex field.

The experimental set up used in this investigation provides for part-whole relationships in that there is a homogeneous ground for the more complex configuration out of

which the small figure differentiates. As an example the triangle would perhaps serve best. The intersecting phenomena are the three lines of the triangle, the differentiating field is the background field. In a triangle made up of triangles the intersecting phenomena are triangles which intersect in such a way that in the differentiating field the spatial arrangement of a triangle appears. As far as the little triangle in this situation is concerned it differentiates from a field which in turn differentiates from a still larger field and has the same structural properties as the emergent phenomenon (the little triangle) which emerges at the intersections of other phenomena, i.e., lines. The intersections are not thought of as taking place between the large and the small figure. The large figure constitutes a field and not an intersecting phenomenon. The difference with traditional gestalt experiements lies in the fact that the ground in our experiment for the small figure is a highly organized and form-like field.

Our problem is to determine whether or not the parts will be recognized more effectively when emerging from a figure-ground of identical form characteristics than when emerging from a figure-ground of different form characteristics.

Apparatus

Thirty-six slides each consisting of a different combination of figure-ground were used. Every large figure was made up of every small figure and each small figure had it's counterpart in each large figure - see Figure 1. Six figures were used and each figure (large) was made up of every other figure (small). The unidimensional ratio of large figure to small figure as drawn is 8½ inches to 1 inch. Therefore, the ratio of large figure area to small figure area is $(8\frac{1}{2})^2/1$. The figures when projected upon the screen were about the same size as before photographic reduction to a size suitable for the making of the slides.

The slides were made by placing the positive photographs on stiff white cardboard which furnished a homogeneous background on which the field and it's elements appear.

A Balopticon opaque projector was used to project the designs upon a white canvass. The projector was placed 133 inches from the screen. The aperture was opened to maximal width. The lens was adjusted to give such a focus that the perception of the small figure was liminal. After proper adjustment was obtained the lens was kept at this point throughout the experiment. A thumb-tack was placed on the canvass as a fixation point. Exposure time was controlled by means of a Keystone tachistoscopic fixture called a Flashmeter. Each design was exposed for exactly 1/5th of a second.

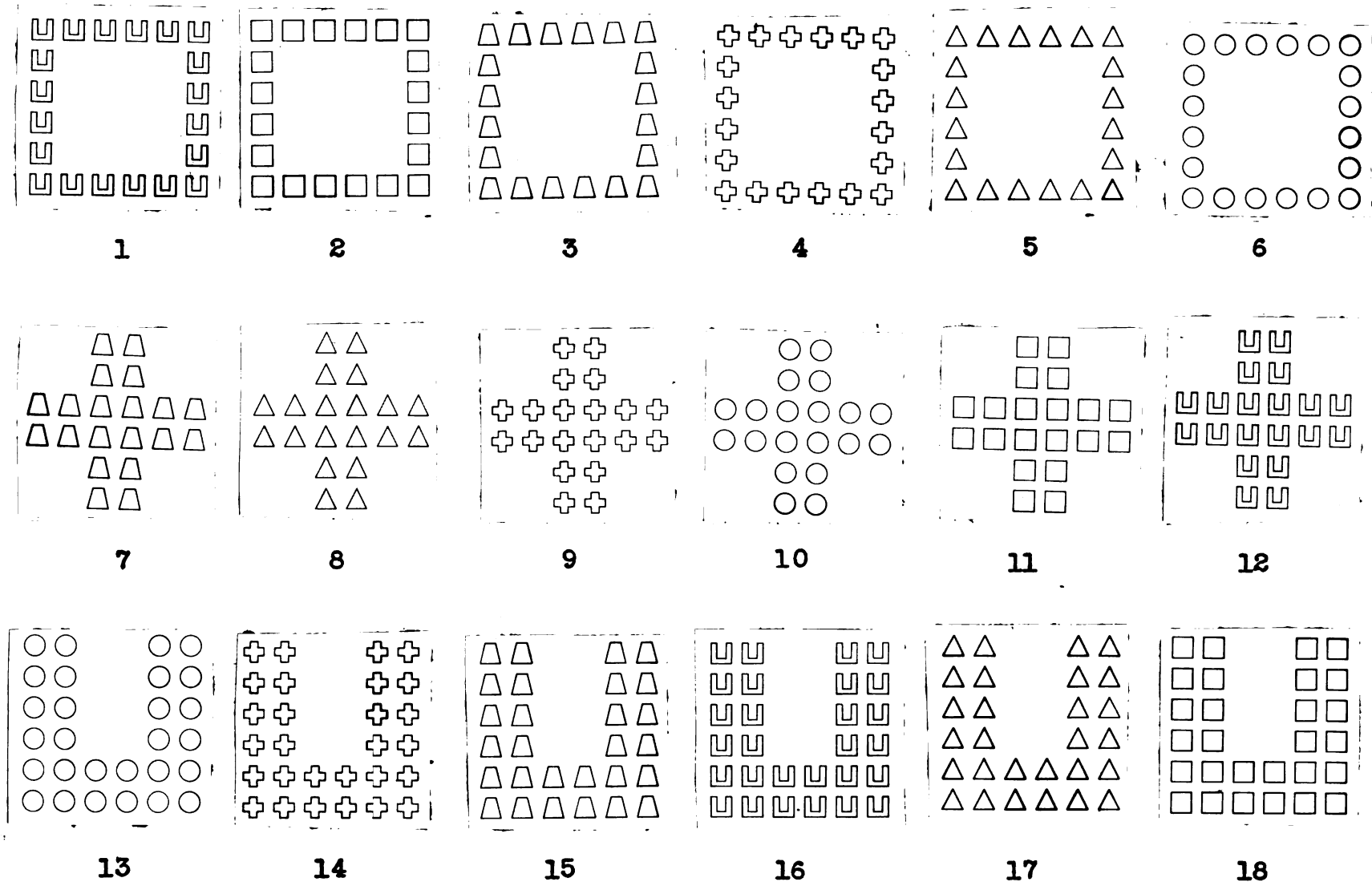


Figure I. The Designs in Numerical Order

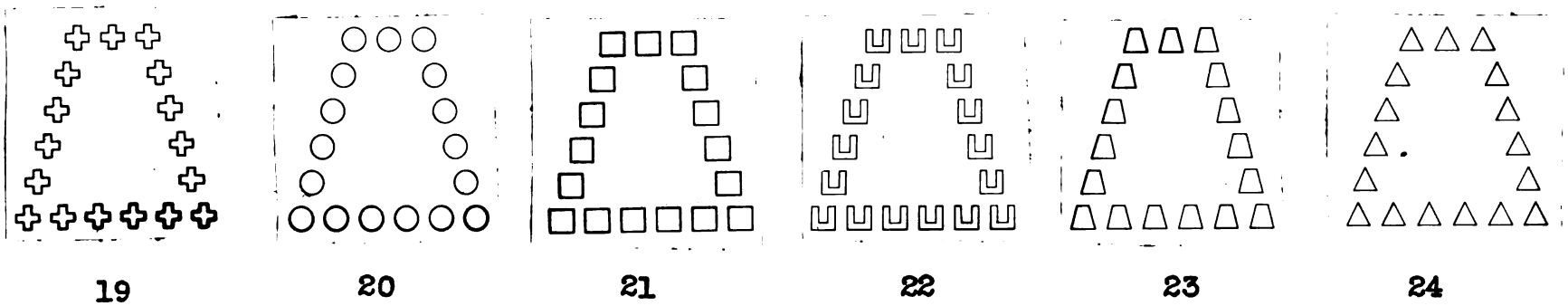
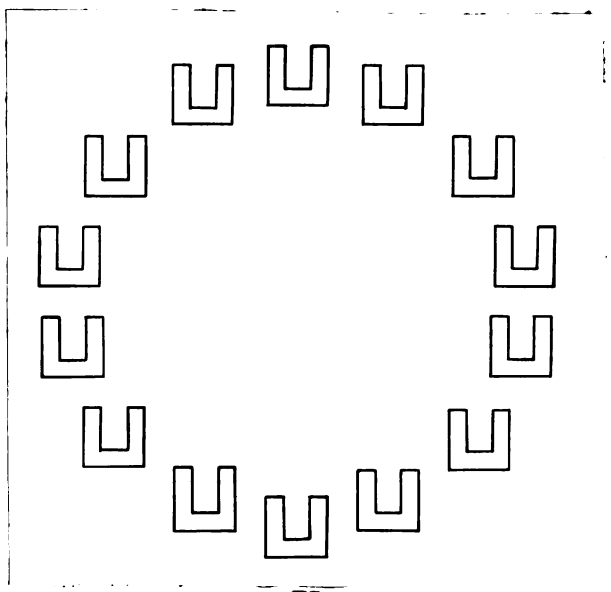


Figure 1. Continued



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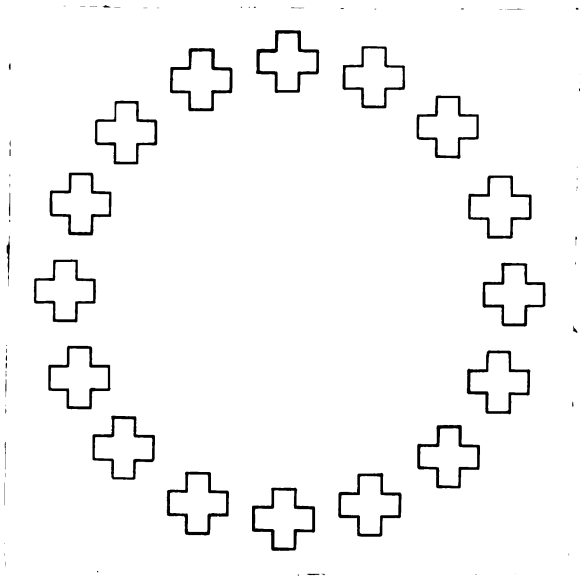

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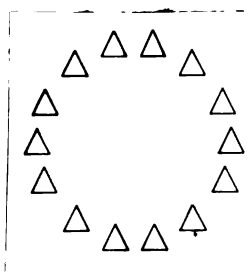

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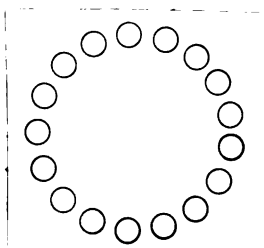

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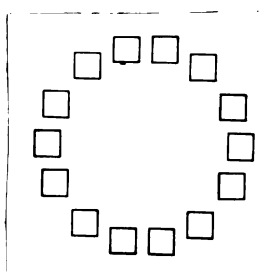

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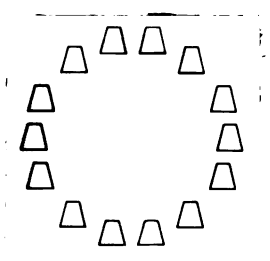

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Figure I. Continued

Procedure

Forty-one college students were used as subjects. Most of these subjects were undergraduate psychology majors and a few were graduate psychology majors. The subjects were seated approximately from eight to sixteen feet away from the screen. They were tested in groups of from three to fifteen members. A record blank - see Figure 2 - was handed to each subject. The following directions were then read:

> "Listen carefully. You will be shown a series of designs. Each design will consist of a large figure made up of numerous small figures. Each design will be shown for only a fraction of a second. You are to try and observe both the large figure and the small figures in each design.
>
> On the record sheet that has been given to you place a check under the figures you observe during each trial. You are to check the large figure observed under the correct figure in the column headed LARGE FIGURE. You are to check the small figure observed under the correct figure in the column headed SMALL FIGURE. Thus for each exposure you will have two checks to record, one for the large figure observed and one for the small figure observed.
>
> If you are in doubt as to what the large figure is or what the small figure is, then guess. But, do your best to record two checks for each exposure.

Each exposure was preceded by the commands: "Ready;" "Watch;" and then the design was flashed. Just before the experiment was started for each group, the illumination of the room was dimmed to twilight vision conditions.

The slides were numbered as shown in Figure 1. These numbers were then picked at random in the order presented in Table I. This random order made up the first series.

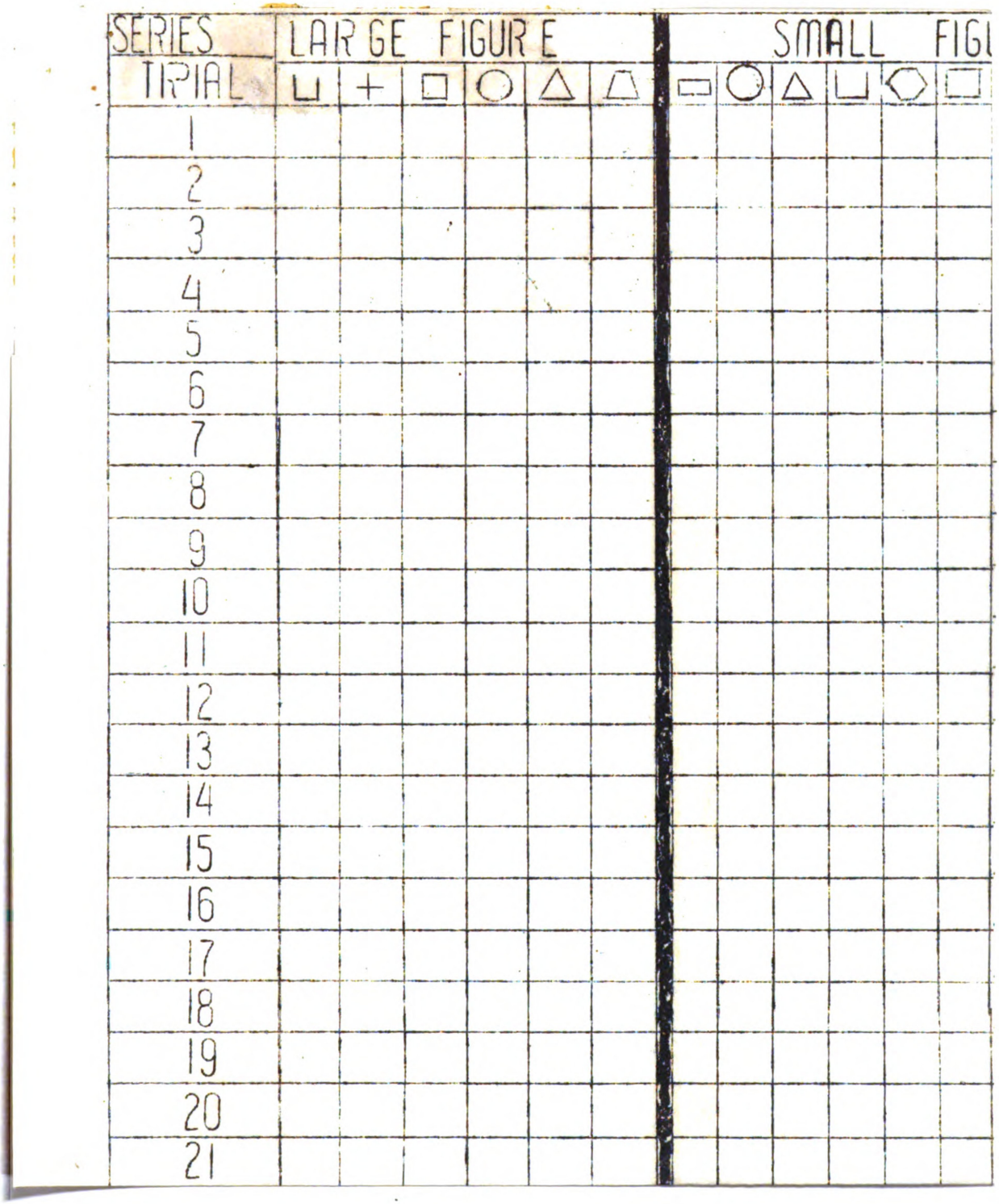


Figure 2.

Form Used By Subjects to Record the Figures Seen

Table I.

Order of Presentation of Stimulus Cards by Groups and Individual Designs.*

Series	Groups in Order Exposed					
	I.	II.	III.	IV.	V.	VI.
I.	10,26, 30, 3, 25, 5,	11,28, 31,35, 18,34,	2,14, 29,17, 12,7,	32,23, 36,16, 24,1,	19,22, 27,20, 13, 9,	4,33, 8,21, 15,6,
II.	IV.	III.	II.	V.	VI.	I.
III.	V.	III.	II.	IV.	I.	VI.

* Note: Numbers refer to numbered designs in Figure 1.

This order was divided into six groups of six designs each. The groups were then picked in two different random orders making up the arrangement for trials two and three. The order within the separate groups remained constant but the groups themselves were always arranged in random order.

It should be noted that the slides made up of a large circle and a small cross and a large circle and a small U were, by error, made up into slides containing figures too large for use in the experiment. However, the slides were left in the experiment to serve as interesting relief exposures to keep the interest and morale of the subjects at maximum. But, in analysing the data these two slides were eliminated. Because of this certain comparisons could not be made.

Discussion of Results

The data, consisting of 8,856 responses, has been analyzed several different ways and the results obtained are discussed below. An analysis of the data reveals the following information.

In Table II. we see that there is no evidence in support of the hypothesis, although, as will be indicated later, a more detailed analysis of the data shows that the evidence against the hypothesis is not particularly conclusive.

The small figure was seen correctly in combination with an identical field 54% of the time. The small figure was seen correctly in combination with a field different in character 60% of the time.

This is a difference of 6% against the hypothesis in a situation where the perceptibility is roughly 50% accurate or liminal, that is, in a situation presumably optimal for the disclosure of a variable relevant to the perception of the small figure. The 6% difference against the hypothesis is significant beyond the 1% level of confidence, as based upon the standard error of the difference between two uncorrelated percentages. The N's used were 738 and 3,444.

It should also be noted that the high percentage of accurate perceptions of the larger figure - see Table II - means that the variable (large figure) was potentially operative. An analysis of variance gives an F Ratio of 2.34 which is only significant between the 5% and 10% levels of confidence.

Table I I.

Percent With Which All Figures are Perceived Correctly for All 41 Subjects

Fig.-Grnd.	Series I	Series III	Difference or Learning	Total % Small Fig.	Total % Large Fig.
Small Fig. Identical	48%	51%	3%	54%	94%
Small Fig. Different	49%	61%	12%	60%	92%

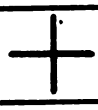
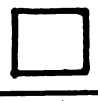
There is considerable variability in the perception of the small figures. Their perception ranged from 4% correct to 74% correct as may be seen by reference to Table III. In order of least difficult to perceive to most difficult to perceive, the small figures rank as follows: triangle, square, trapezoid, "U", circle, and cross - see Table IV. If we compare the ease with which the small figure is perceived with the accuracy with which it is perceived, as may be done by examination of the last two rows in Table III., we see that, in general, the relative order is about the same.

The accuracy with which the small figure is perceived is about the same for all figures except for the cross which was well below threshold in all respects. In other words, guessing was not an important factor in determining the results as, in general, the most perceived small figures were also seen most accurately. Also the low percentage accuracy of the cross further indicates that the data on the cross cannot be validly compared with the data on the perception of the other small figures.

The background figures are about equal in their general influence on the perception of the small figure as may be seen by inspection of the last column on the right in Table Neglecting the data for the circle background, since the data for the most difficult small figures to see are eliminated,

Table III.

Frequency Each Small Figure Is Seen Correctly With Each Large Figure Seen Correctly *

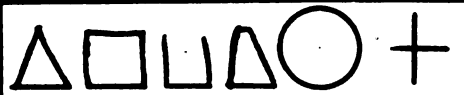
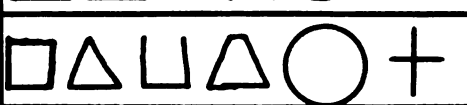
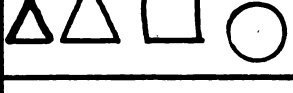
							Total Correct	Total Exposed	% Correct	
	51	6	101	16	96	62	332	738	45%	
	66	3	92	37	91	81	370	738	50%	
	64	6	97	10	88	53	318	738	43%	
	Not Used	Not Used	76	23	95	77	271	492	55%	
	68	3	98	51	108	61	389	738	53%	
	76	3	77	19	66	78	319	738	43%	
Total Correct	325	21	541	156	544	412				
Total Exposed	615	615	738	738	738	738				
% Correct	53%	4%	73%	21%	74%	56%				
% Accuracy **	59%	13%	55%	59%	66%	61%				

* Note: Each cell represents the small figure frequency for any particular figure-ground for 41 subjects for all three series.

** Note: %Accuracy was found by; Total Correct/Total Responses

Table IV

Rank of Perceptibility Compared With Position of Identical Element - Small Figure

Large Figure	Rank of Perceptibility "S"	Order of Perceptibility From High to Low	Position of Identical Element
	1		1
	2		1
	3		1
	4		4
	5		4-6
	6		6

we see that the backgrounds seem to influence the perception of the small figures in some general way in descending order as follows: triangle, cross, "U", trapezoid, and square. However, the difference in their effect is only slight - range from 43% to 55%.

Examination of Table III. shows that except for the circle, each set of small figures was seen about equally often in each background. A more specific analysis, on the other hand, indicates the possibility of some significant relationships. One such relationship is that figural contrast seems most effective when the small figures are either below or at the visual threshold. For example, the small circle which is considerably under visual threshold is seen best when the triangle - a sharply contrasting figure - serves as the background, (see Table III). The circle and the triangle appear to be highly contrasting in structure. The circle is a continuous unbroken closed figure within which every point is of equal accentuation. On the other hand, the triangle is a figure composed of three straight lines joined sharply at three distinct points all equidistant from each other. There is far more accentuation at the exact points than between the points. Furthermore, the three angles of the triangle contrast with the continuity of the circle.

When the small figure is well above threshold, there is evidence that identity of small figure and figure-ground is a factor in the perceptibility of the small figure - see bottom of Table III. The small triangle is seen best with the large triangle and the small square and trapezoid are the most often perceived small figures with the large square and trapezoid bacgrounds respectively.

Similarity - not identity - where it can be most clearly drawn, as between the triangle and the trapezoid seems to show inhibition of perception. Disregarding the cross and the circle the trapezoid is the least often figure perceived in the triangle background and the triangle is the least often seen in the trapezoid background.

From Table I. we see that, although there is not much learning from session to session, there is 9% more learning when the figure-ground is different than when identical.

Advocates of Gestalt Theory often cite the circle as a model example of good gestalt configuration. However, the circle in this experiment does not stand out over the other figures in relative perceptibility even though it is seen about as accurately as the other figures. Actually, when the cross is eliminated, the circle is seen fewer times than any other figure. This may be explained in part by the fact that the circle was quite often mistaken as a diamond.

However, in the framework of Mr. Englemann's theory it might be interpreted as follows: The variant behavior of the circle might be explained in terms of the greater complexity of the intersecting phenomena. With a triangle you have lines intersecting in a field which is a plane. If you take the circle you have one line intersecting with a plane in a field which is a more complex plane. If we consider the plane as a phenomenon more complex than a line, the difference in recognition can probably be explained.

Conclusion

In a situation presumably optimal for the disclosure of a variable relevant to the perceptibility of the small figures, the results with reference to perceptibility and learning do not support the hypothesis that the small figure will be perceived more readily when emerging from a field of identical form.

By reference to the bottom of Table III it seems that contrast is most operative when the small figures are at or below threshold and idientity to be more operative when the figures are above threshold. Therefore, further research to retest the hypothesis with all figures higher above the limen seems warranted.

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