EXPERIMENTAL STUDIES OF A PERCEPTUAL ANOMALY.

I. INITIAL EXPERIMENTS.

By M. B. SHAPIRO, M.A.,

Psychological Department, Institute of Psychiatry, Maudsley Hospital, London.

A. THE INITIAL OBSERVATION AND THE INITIAL HYPOTHESES.
1. The Observation.
2. Explanatory Hypotheses.
B. TESTING THE HYPOTHESES.
1. Experiment 1*a*.
(i) Purpose.
(ii) Subject.
(iii) Materials.
(iv) Procedure.
(v) Results.
2. Experiment 1*b*.
Description and Results.
C. THE NEW HYPOTHESES.
D. TESTING ONE OF THE NEW HYPOTHESES.
1. Experiment 2*a*.
(i) Purpose, Subject, Materials and Procedure.
(ii) Results.
2. Experiment 2*b*.
(i) The Materials.
(ii) Results.
E. DISCUSSION.
1. The Findings and Other Facts in Perception.
2. Methodological Implications of Experiments on the Single Case.
F. CONCLUSIONS.

A. THE INITIAL OBSERVATION AND THE INITIAL HYPOTHESES.

1. THE OBSERVATION.

It was noticed that, during the performance of the Kohs Blocks Test, a few patients would in some cases make the model correctly, but misoriented. Illustration 1 gives an example of such a phenomenon. The patient had to reproduce the design shown with four Kohs Blocks. His reproduction is shown. The pattern has been correctly reproduced, but has been misoriented by 45°. The pattern was never in fact misoriented to a greater extent than this.

2. EXPLANATORY HYPOTHESES.

The first step deemed to be necessary was to search for an hypothesis or set of hypotheses which would provide a basis for predicting the frequency of the appearance of the anomaly. It was decided to take Goldstein and

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press



Design to be reproduced.

Misoriented production with 4 Kohs Blocks.

ILLUSTRATION 1.

Scheerer's (4) general hypothesis that anomalies of perception are functions of figure ground relations.* Within this general hypothesis three, more precise, hypotheses have been developed about the material used in the Kohs Test. These three hypotheses provide a basis for predicting the relative frequency of appearance of the anomaly described above.

The first hypothesis is that the square orientation of a figure would tend to diminish the frequency of appearance of the anomaly, while the diamond orientation would increase it. (See Illustration 2, Cards a and d.)

The second hypothesis is concerned with the influence of the factor of congruence between figure and ground. Where figure and ground are of the same shape and similarly oriented they are said to be congruent. (See Illustration 2, cards a and c.) The hypothesis states that the congruent figure-ground arrangements of the material would tend to decrease the frequency of the appearance of an anomaly, while an incongruent arrangement would increase the frequency. Cards b and d in Illustration 2 would be said to be incongruent.

The third hypothesis is concerned with the relative influence of congruence and orientation of figure. Where the influence of congruence and figure orientation are in conflict the influence of the figure orientation is more potent.

These three hypotheses make it possible to build up a definite order of frequency of appearance of the anomaly. The patient ought to produce the anomaly least frequently for figure-ground combination " a " (Illustration 2), more frequently for combination " b," still more frequently for " c," and most frequently for combination " d."

This predicted order was in fact developed by Goldstein and Scheerer (4). The order was not expressed in terms of the relative frequency of appearance of anomalies, but in terms of time, i.e. Card " a " would presumably take the least time, Card " b " more time than " a," and so on. The experiments

* Throughout this paper the word " figure " applies to the design which the subject has to reproduce with the Kohs Blocks. The word " ground " applies to the card in which the design has been placed.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

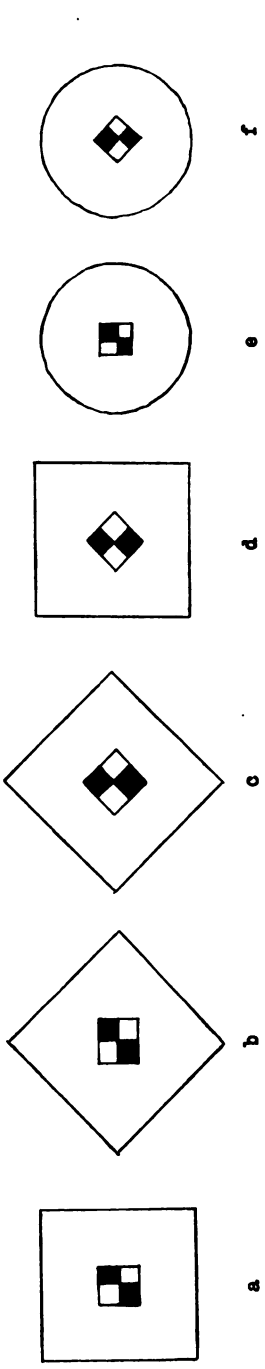


ILLUSTRATION 2.—The cards shown in this illustration will be indicated by the letters shown beneath them, both in the text and in the tables.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

described in this paper, therefore, cannot be regarded as direct tests of the Goldstein-Scheerer hypotheses.

B. Testing the Hypotheses.

Experiment 1*a*.

(i) *Purpose.*—To test the three hypotheses stated above by seeing whether the actual order of frequency of appearance of the anomaly agreed with the predicted order.

(ii) *Subject.*—The subject chosen for the experiment was one of three who, in the course of psychological investigation at the Maudsley Hospital, had shown some impairment in the Block Design Test. The patient came to the hospital with a paralysis of the right arm and leg, which was diagnosed as hysterical. This condition gradually improved, but not completely, during the patient's stay. The patient was a woman of 32, her Wechsler test quotient was 90, with a performance score of 92, and a verbal score of 91.

(iii) *Materials.*—The figures chosen for this experiment were all sub-tests of the Goldstein Scheerer Block Design Tests. The particular figures chosen were those in which the patient had failed in one of the earlier stages of the subtest, but had later successfully completed according to the criteria laid down in the instructions for the Goldstein Scheerer Block Design Test.*

In this way designs which were obviously too easy or too difficult were ignored, and only those which were near the "limen" of failure were used. The figures selected in this way are shown in Illustration 3. Each figure was placed on white cardboard grounds of three different shapes, producing figure ground combinations of six types as shown in Illustration 2. The actual designs used are shown in Illustration 3 under the heading Experiment 1*a*. These three figures will be referred to in future as they are numbered in Illustration 3, i.e. Figs. 1, 2 and 3.

The reason for the square and diamond oriented grounds is obvious. They are essential for the examination of the Goldstein-Scheerer hypotheses. The circular ground was introduced to see what a circle would produce rather than a square or a diamond. Its introduction had no clear theoretical foundation. For purposes of this paper the results for the circular ground will not be analysed, though the results will be given.

The figures were 1 in. square. The square and diamond grounds were 6 in. square, and the circular ground was 6 in. in diameter.

* Each sub-test in the Goldstein-Scheerer Block Design is given in successive stages. First it is given with figure meaning, 1-in. square. If the patient fails at this stage the same figure is given again, but this time it is 2 in. square, and is in fact life size. If there is failure at this stage the figure is presented a third time on the same scale as the first, but lined so as to make clear the division of the design into four 1 in. squares. Failure here is followed by the presentation of the life-size figure, which this time is lined like the previous one. The fifth stage consists of the experimenter making an actual model with the four blocks for the subject to copy. Failure here is followed by the experimenter making up three models with the blocks, one of which is correct, and the subject is asked to point to the one that matches the design correctly.

If the subject succeeds at any one of these stages the first original one is immediately presented. If the patient succeeds this time the sub-test is completed. If he fails, the sub-test is continued at the next stage.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

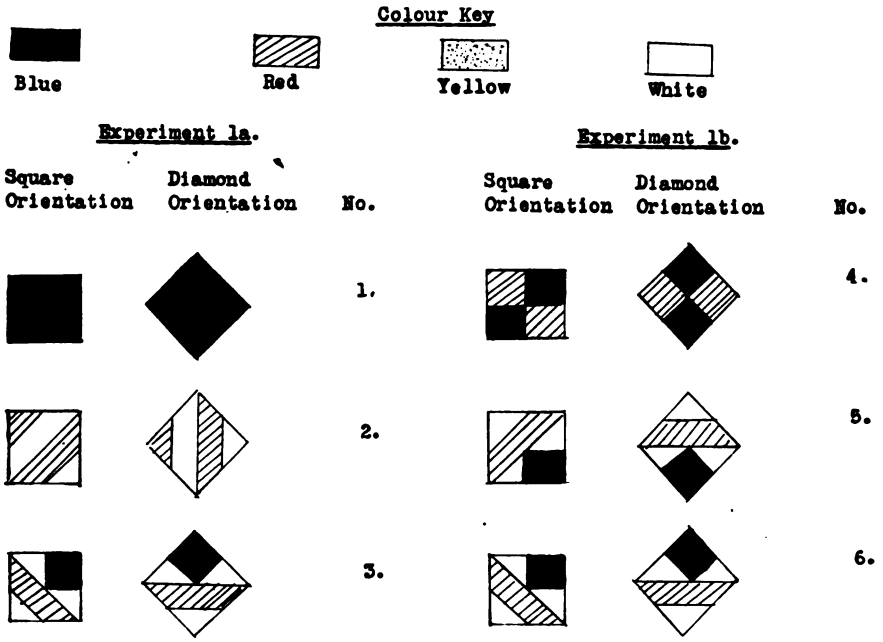


ILLUSTRATION 3.—Showing the designs of the figures used in Experiments 1a and 1b.

(iv) *Procedure.*—Six figure-ground combinations were presented to the subject. (See Illustration 2.)

The subject was given four Kohs blocks and told to make, with the blocks, a design like the one presented to her. Combinations a, b, c and d are those whose difficulties are predicted by the Goldstein-Scheerer hypotheses. From now on figure-ground combinations will be referred to as " cards."

When the subject had completed the figure with her blocks she was asked " Is that right ? " If she assented, the watch was stopped, her actual production and time recorded. A trial was not regarded as completed until the subject assented to the question. A time limit of three minutes was fixed. This is the standard Goldstein-Scheerer procedure.

The patient's results were recorded in a manner calculated to provide no obvious cues. The experimenter always did the same amount of writing, regardless of whether the patient had reproduced the figure correctly or incorrectly, a standard notation being used.

At no time were the patient's errors discussed with her. Nor at that time were any other female patients being subjected to similar experiments, so that discussion in the wards was eliminated. On two occasions, when she was asked to state what her difficulties were, she pointed to some trivial blemish in the design, or to the fact that the blocks she used could not be made exactly level with each other. She never mentioned her actual error, the misorientation of the figure.

In deciding, for any one figure, the order of presentation of the cards, the effects of fatigue, perseveration and learning had to be considered. An attempt was made to equate the effect of these factors by the use of the Latin Square Design.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

Such designs are provided by Fisher and Yates (3). In this particular experiment three figures were used. Each figure was presented on six different grounds, making a total of six different types of card. It was decided, therefore, to use a 6×6 Latin Square for each figure. For example, a random choice of one of Fisher's 6×6 tables results in the following scheme being chosen, in which the order and number of trials is indicated. (Each letter stands for a card as in Illustration 2) :

a	b	c	d	e	f
b	c	f	a	d	e
c	f	b	e	a	d
d	e	a	b	f	c
e	a	d	f	c	b
f	d	e	c	b	a

In this way the patient had, for the one design, 36 trials, and for any single card, 6 trials.

(v) *Results.**—The results are shown and analysed in Tables I, II and III.

TABLE I.—*Showing the Number of Times the Misorientation Appeared for each Design. Experiment 1a.*

Card.	Figure No.			Total trials.	Total anomalies.
	1	3	3		
a	0	3	5	18	8
b	5	6	5	18	16
c	2	0	0	18	2
d	0	1	0	18	1
Totals	7	10	10	72	27
e	0	3	4	18	7
f	0	1	0	18	1

For key to figures see Illustration 3.
For key to cards see Illustration 2.

TABLE II.—*Order of Increasing Frequency of Appearance of the Anomaly for each Type of Card. Experiment 1a.*

Predicted order.	Actual order (in terms of increasing frequency).
a	d
b	c
c	a
d	b

For key to cards see Illustration 2.

* *Acknowledgment.*—The treatment of the data was designed and carried out by Mr. A. Lubin, of the Statistical Laboratory, Institute of Psychiatry. He has also given invaluable aid in the discussion of the methodological and psychological problems encountered in the course of the investigation described here.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

TABLE III.—*Number of Misorientations. Experiment* 1*a.*

Figure orientation.	Ground shape: Diamond.	Ground shape: Square.	Totals.
Square	16	8	24
Diamond	2	1	3
Totals	18	9	27

No. of misorientations:
Congruent total = 10
Incongruent total = 17
Total trials .. .. = 72
Trials per cell .. .. = 18

Table III can be expressed in terms of the percentages of trials in which the misorientation appeared. This is shown in Table IV.

(i) The actual order of frequency of appearance of the anomaly is almost completely opposite from that predicted, the rank correlation being −·8 (Table II). The reasons for this become clearer in paragraphs (ii), (iii) and (iv) below.

(ii) The influence of the figure was completely opposite to that predicted by the first hypothesis. This stated that the square oriented figure would produce fewer anomalies than the diamond oriented figure. Actually the square oriented figure produced significantly more anomalies at the 1 per cent. level than the diamond oriented figure (see Tables IV and V).

(iii) The influence of congruence was not exactly according to expectation. It appeared to play no part whatever in the production of the rank order illustrated in Table II above. However, it was strong enough for the congruent cards to produce 19·4 per cent. less anomalies than the incongruent cards, a difference which is significant at the 5 per cent. level only if the one tail test is used (see Tables IV and V).

(iv) The relative influence of congruence and figure where the two clashed was contrary to expectation. The square oriented figure in the diamond ground produced anomalies 89 per cent. of the trials, while the diamond oriented figure in the square ground (Card c) produced anomalies only 5·6 per cent. of the trials (see Table IV). No tests of significance were made. It will be remembered that the third hypothesis stated that where figure and congruence

TABLE IV.—*Experiment* 1*a. Misorientations as Percentage of Trials.*

Figure orientation.	Ground shape. Diamond.	Ground shape. Square.	Totals.
Square	88·9	44·4	66·7
Diamond	11·1	5·6	8·3
Totals	50·0	25·0	37·5

Congruent per cent. = 27·8 Trials per cell .. .. = 18
Incongruent per cent. = 47·2

S.D. = ·474. Where proportion of misorientations = p and $q = 1 - p$, the

S.D. = $\sqrt{pq}$ = $\sqrt{\cdot 375\ (\cdot 625)}$.

37·5 is the best estimate of the proportion of misclassifications on the null hypothesis that there is no effect of figure, ground or congruence.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

TABLE V.—*Experiment 1a.*

	Difference (in per cent. misorientation).	S.D. difference.	*t* ratio.	Level of significance.
Square minus diamond ground	−25·0	11·4	−2·193	5%*
Square minus diamond oriented figure	58·4	11·4	5·123	1%*
Congruent, minus incongruent cards	−19·4	11·4	−1·702	5%†

Formula for S.E. differences = S.D. $\sqrt{\frac{1}{N_x}+\frac{1}{N_y}} = \sqrt{\frac{2}{36}} = \sqrt{\cdot 055556} = \cdot 235703$.

Where S.D. = already found S.D. of misorientations in Table V.
Nx = Total trials for 1 pair of cards compared.
Ny = Total trials for the other pair of cards compared.
* Two-tail test. † One-tail test.

TABLE VI.—*Total Number of Misorientations for each Card of each Figure. Experiment 1b.*

Card.	Figure No. 4	5	6	Total trials.	Total anomalies.
a	2	2	5	18	9
b	6	6	6	18	18
c	2	3	1	18	6
d	0	0	0	18	0
Totals	10	11	12	72	33
e	2	4	3	18	9
f	0	0	2	18	2

For key to figures see Illustration 3.
For key to cards see Illustration 2.

TABLE VII.—*Experiment 1b. Observed Number of Misorientations.*

Figure orientation.	Ground Shape: Diamond.	Square.	Totals.
Square	18	9	27
Diamond	6	0	6
Totals	24	9	33

Number of misorientations :
Congruent cards = 17. Incongruent cards = 18. Trials per cell .. .. = 18.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

TABLE VIII.—*Experiment* 1*b*. *Misorientations as Percentage of Trials.*

Figure orientation.	Ground shape. Diamond.	Square.	Totals.
Square	100·0	50·0	75·0
Diamond	33·3	0·0	16·7
Totals	66·7	25·0	45·8

Congruent per cent. = 41·7. Trials per cell .. .. = 18.
Incongruent per cent. = 50·0.

S.D. = $\sqrt{pq} = \sqrt{\cdot 458\ (\cdot 542)} = \sqrt{\cdot 248236} = \cdot 498233.$

TABLE IX.—*Experiment* 1*b*.

	Difference (in per cent. misorientation).	S.E. difference.	*t* ratio.	Level of significance.
Square minus diamond ground	−41·7	11·7	−3·564	<1%*
Square minus diamond oriented figure	58·3	11·7	4·983	<1%*
Congruent minus incongruent cards	−8·3	11·7	−0·709	Not significant†

$$\sqrt{\frac{1}{N_x} + \frac{1}{N_y}} = \sqrt{\frac{2}{36}} = \sqrt{\cdot 055556} = \cdot 235703$$

* Two-tail test. † One-tail test.

were in conflict the influence of figure would always be greater than that of ground.

EXPERIMENT 1*b*.

Description and Results.

Because the results of Experiment 1*a* were so much the reverse of expectation, the experiment was repeated with three more figures, and with the same subject. The results were almost exactly the same as in the first experiment. The same order of frequency of appearance of the anomaly was found. As before, the square oriented figure produced significanctly more anomalies than the diamond oriented figure, and the relative influence of figure and congruence were reversed significantly. The only change observed from Experiment 1*a* was that this time the influence of congruence was very small, the respective percentages of anomalies being 42 for the congruent cards and 50 for the incongruent. All the data are given in Tables VI, VII, VIII and IX and the designs used in Illustration 3.

C. THE NEW HYPOTHESES.

Four new hypotheses were developed to explain these results. The first hypothesis was that it was the orientation of the line of symmetry of a figure

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

which determined the relative frequency of appearance of the anomaly, and not the outline of the figure. The line of symmetry is the line which divides the pattern of the figure into two perfectly mirrored halves, as shown in Illustration 5. Where the line of symmetry is parallel with the vertical axis of the visual field, then the frequency of the appearance of the anomaly will be minimized. Where it is at an angle to the vertical axis of the visual field, then the frequency of the appearance of the anomaly will be maximized.

This symmetry hypothesis was deduced from an examination of the figures used in Experiments 1*a* and 1*b*. It was found that inadvertently all the figures used in these experiments, except one, possessed diagonal symmetry. The exception, Fig. 1, possessed both diagonal and rectangular symmetry.

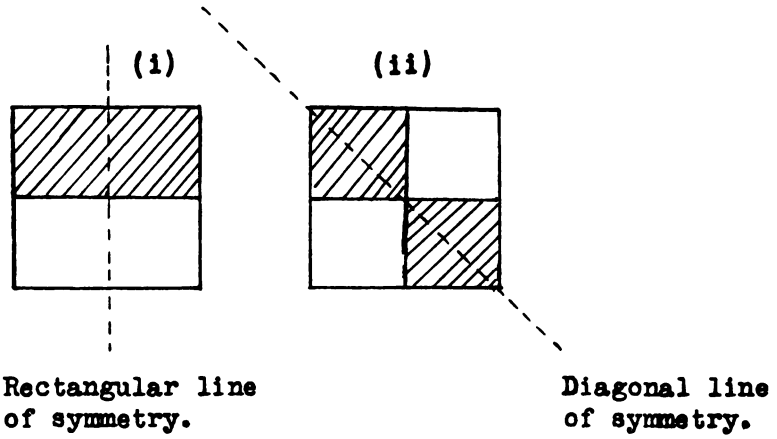


ILLUSTRATION 5.

Illustration 5 shows a figure of diagonal symmetry. Inspection of this figure shows that in the square orientation the line of symmetry is at 45 degrees to the vertical axis of the visual field, while in the diamond orientation the line of symmetry would be parallel to that axis. It will be remembered that, contrary to the Goldstein-Scheerer hypothesis, it was the square oriented figure which produced more anomalies than the diamond oriented figure. The symmetry hypothesis stated above was deduced from these facts.

The second hypothesis developed was that it was the shape of the ground which encouraged or discouraged the appearance of the anomaly. The diamond-shaped ground had increased the frequency of the appearance of the anomaly, while the square-shaped ground decreased this frequency. This hypothesis is an expression of the fact that in both experiments the square ground produced fewer anomalies than the diamond ground. The difference was significant at the 5 per cent. level in the first experiment (Table V), and at the 1 per cent. level in the second experiment (Table IX).

The additional influence of congruence could not, however, be ruled out, as it had produced a difference at the 5 per cent. level in the first experiment.

The third new hypothesis was that where figure and ground were in conflict the effects of the figure would be more potent than that of the ground. In

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

both experiments the figure produced more anomalies than the ground (Tables V and IX).

The fourth hypothesis was that the relative frequency of appearance of the anomaly was determined by an additive relation between figure and ground. This hypothesis makes it possible to recreate the order of frequency of appearance of the anomaly found in Experiments 1*a* and 1*b*. For illustration let us take the cards in Illustration 2.

It will be seen that the figure on the cards possesses diagonal symmetry. On the basis of the additive hypothesis the card producing the anomaly least frequently must be Card d because it possesses the two characteristics making for the non-appearance of the anomaly: vertical line of symmetry in the figure plus a square ground.

The card producing the greatest number of anomalies would be Card b. This is because it possesses the two characteristics making for the appearance of the anomaly—an angled line of symmetry in the figure and diamond ground.

Cards a and c each possess one characteristic making for the appearance of the anomaly and one making for its non-appearance. They will, therefore, produce fewer anomalies than Card b and more anomalies than Card d. Their relative order depends on hypothesis three, which states that when figure and ground are in conflict the influence of figure will be greater than that of ground. Therefore Card a produces more anomalies than Card c. The order of increasing frequency built in this way would then be: 1st, Card d; 2nd, Card c; 3rd, Card a; 4th, Card b.

If the symmetry hypothesis is correct then it should be possible to predict a new order of frequency of appearance of the anomaly for figures of rectangular symmetry. The effects of the orientation of the figure ought now to be reversed.

Where before a square oriented figure facilitated the appearance of the anomaly, it would now inhibit its appearance. Where before a diamond oriented figure inhibited the appearance of the anomaly, it would now be facilitated in its appearance. Assuming that the other three new theories would still hold, the following order of frequency of appearance of the anomaly would be predicted:

Card a
b (For equivalent cards see
d Illustration 2.)
c

D. Testing One of the New Hypotheses.

Experiment 2*a*.

(i) *Purpose, subject and materials.*—(a) The purpose of this experiment was to test the new symmetry hypothesis by seeing if the new predicted order of frequency of appearance of the anomaly agreed with the found order.

(b) *The subject.*—The same subject as in Experiments 1*a* and 1*b* was used.

(c) *The material.*—The designs chosen for this experiment were cards in Goldstein-Scheerer, whose main lines of symmetry were *rectangular*, and not

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

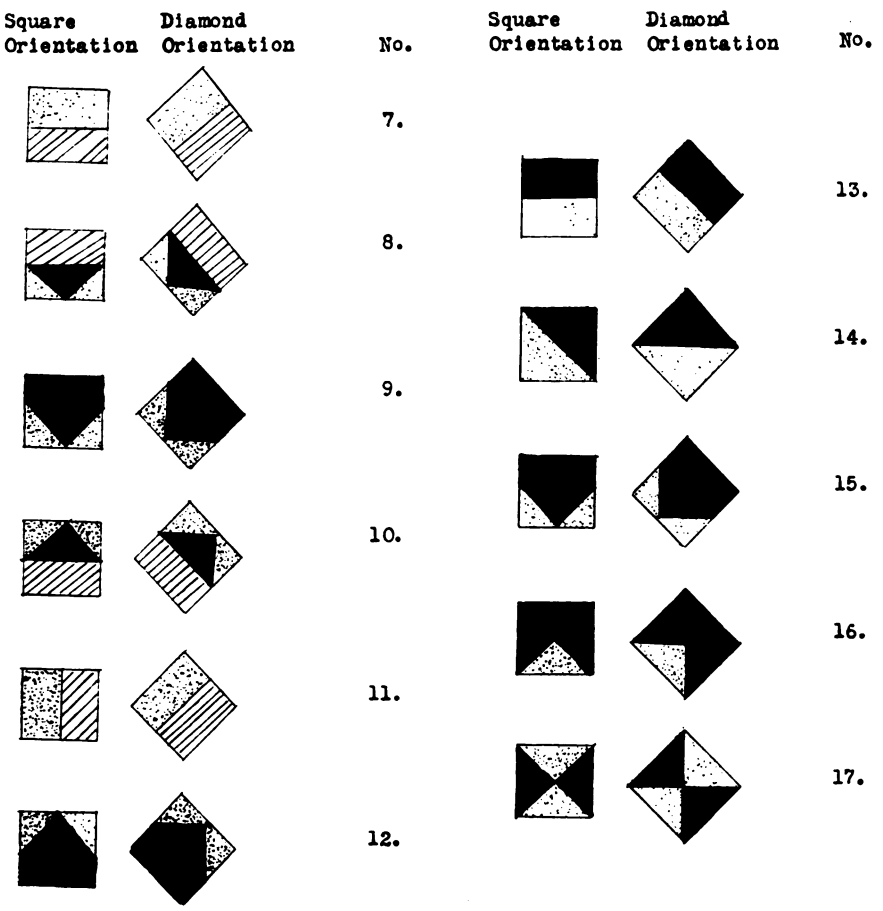


ILLUSTRATION 4.—Showing the designs of figures used in Experiments 2*a* and 2*b*.

diagonal. The three designs which fell into this category are shown in Illustration 4.

(d) *Procedure.*—Each figure was presented on the same six types of ground as in the first experiment, the order for each card being determined by a randomly chosen 6×6 Latin Square. In order to increase the reliability of the finding each figure was presented twice, but rotated 90° or 180° as shown in Illustration 4.

(i) The agreement between the predicted and found order was perfect. This is shown by Tables XI and XII. However, the difference between Cards c and d was so small that there might in fact be no real differences.

(ii) The predicted change in the effect of figure was found. The square oriented figure now produced the anomaly 18 per cent. of the trials as against 47 per cent. of the trials for the diamond orientation. This difference was significant at beyond the 1 per cent. level. (See Tables XIII and XIV.)

(iii) The difference between the diamond and the square ground was in the predicted direction, the diamond ground producing anomalies 38 per cent.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

TABLE X.—*Total Number of Misorientations for each Card for each Figure. Experiment 2a.*

Card.	Figure No. 7	8	9	10	11	12	Total anomalies.
a	1	0	0	1	0	2	4
b	3	1	2	0	2	1	9
c	4	2	2	2	6	2	18
d	0	1	4	3	4	4	16
Totals	8	4	8	6	12	9	47

For key to designs see Illustration 4.
For key to cards see Illustration 2.

TABLE XI.—*Order of Increasing Frequency of Appearance of the Anomaly for each Type of Card. (Based on Figure Symmetry Hypothesis.) Experiment 2a.*

Observed order.	Predicted order (in terms of increasing frequency).
a	a
b	b
d	d
c	c

For key to cards see Illustration 2.

TABLE XII.—*Experiment 2a. Frequency of Appearance of the Anomaly.*

Figure orientation.	Ground Shape. Diamond.	Square.	Totals.
Square	9	4	13
Diamond	18	16	34
Totals	27	20	47

Congruent cards = 22. Incongruent cards = 24.
Each cell represents 36 trials. The total number of trials is 144.

TABLE XIII.—*Experiment 2a. Misorientation as Percentage of Trials.*

Figure orientation.	Ground Shape. Diamond.	Square.	Totals.
Square	25·0	11·1	18·1
Diamond	50·0	44·4	47·2
Totals	37·5	27·8	32·6

Congruent per cent. = 30·6. Trials per cell .. .. = 36.
Incongruent per cent. = 34·7.

S.D. $= \sqrt{pq} = \sqrt{\cdot 326\ (\cdot 674)} = \sqrt{\cdot 219724} = \cdot 468747$

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

TABLE XIV.

	Difference (in per cent. misorientation).	S.E. difference.	*t* ratio.	Level of significance.
Square minus diamond ground	−9·7	7·8	−1·244	Not significant*
Square minus diamond oriented figure	−29·1	7·8	−3·731	<1%*
Congruent minus incongruent cards	−4·1	7·8	−0·526	Not significant*

$$\sqrt{\frac{1}{N_x} + \frac{1}{N_y}} = \sqrt{\frac{2}{72}} = \sqrt{\cdot 027778} = \cdot 166667$$

* One-tail tests.

of the trials and the square ground 27 per cent. The difference was not significant, even by the one-tail test.

(iv) The relative influence of figure and ground was in the expected direction. A square oriented figure in a diamond ground (Card b) produced anomalies for 25 per cent. of the trials, while a diamond oriented figure in a square ground (Card d) produced anomalies on 44 per cent. of the trials.

(v) No significant difference was found between congruent and incongruent cards. Congruent cards produced the anomaly 31 per cent. of the trials, while incongruent cards produced the anomaly for 35 per cent. of the trials.

EXPERIMENT 2*b*.

(i) *The materials*.—In view of the possible operation of chance effects, it was decided to repeat the experiment on the same subject. Space forbids a detailed description of this experiment. Suffice it to say that four of the figures with rectangular symmetry were used, two of which (Numbers 16 and 17) were invented and two (Numbers 13 and 15) repeated from Experiment 2*a*. As a measure of control one figure of diagonal symmetry was inserted into the experiment. This was invented. Figs. 13, 15, 16 and 17 in Table XV are of rectangular symmetry, while Fig. 14 is the control figure of diagonal symmetry.

(ii) *Results*.—An assessment of the results is complicated by the fact that the patient failed in some of the early trials on the new designs. The term failure is used when the patient does not complete the design in three minutes. This is the Goldstein-Scheerer criterion of failure. In one case the patient produced an incorrect design rather than a misoriented design.

The data has, therefore, been tabulated in three ways :

(i) In strict accordance with the statement of theory in Section C above, i.e. every case of a misorientation is shown, and nothing more (Table XV, i).

(ii) Every case of failure is shown, whether it be of misorientation, failure to complete in three minutes, or incorrect reproduction (Table XV, ii).

(iii) The number of anomalies shown by each card only after all failures had ceased, i.e. a degree of learning had taken place (Table XV, iii).

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

In each case implications of the total results were found to be essentially the same. The total scores gave an order of frequency of appearance of the anomaly for each type of card, which was consistent with the new theory.

The results of three ways of tabulating the data are given in Table XV below. Only the results in Table XV, iii, were analysed in the subsequent Tables XVI, XVII and XVIII.

The results obtained are in conformity with the four hypotheses stated in Section C above. Tables XV (iii), XVI, XVII and XVIII analyse the data obtained for the figures of rectangular symmetry. The influences of figure, ground, and their relative influence when in conflict are all in the expected direction.

Estimates of significance are at the 1 per cent. level for figure symmetry, and at the 5 per cent. level for square ground compared with diamond ground.

The results of Fig. 14, the figure of diagonal symmetry, are also in accordance with the hypothesis. This is shown by the analysis of the data in Tables XIX, XX and XXI. An effective control is thus provided for this test of the symmetry hypothesis. This is because a figure of diagonal symmetry,

TABLE XV. *Experiment 2b.* (i) *Misorientations only.*

Card.	Figure No. 13	14	15	16	17	Totals for 13, 15, 16 and 17.
a .	0	9	0	0	1	1
b .	0	7	1	2	1	4
c .	9	3	9	10	6	34
d .	6	3	9	4	6	25
Totals	15	22	19	16	14	64

(ii) *Total Failures.*

a .	0	10	0	2	1	3
b .	0	12	1	2	2	5
c .	9	5	9	10	9	37
d .	6	6	9	4	7	26
Totals	15	33	19	18	19	71

(iii) *Misorientation only.* (After all failures have ceased.)

a .	0	5	0	1	0	1
b .	0	7	1	1	0	2
c .	8	3	7	8	4	27
d .	4	1	6	4	2	16
Totals	12	16	14	14	6	46

For key to figures see Illustration 4.
For key to cards see Illustration 2.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

when used in the same experiment with figures of rectangular symmetry, has still given results consistent with the symmetry hypothesis, i.e. the same order of frequency is found as in Experiments 1*a* and 1*b*.

TABLE XVI.—*Experiment 2b* (*Rectangular Symmetry*). *Frequency of Appearance of the Misorientation.*

Figure orientation.	Ground shape. Diamond.	Ground shape. Square.	Totals.
Square	2	1	3
Diamond	27	16	43
Totals	29	17	46

(From Table 15 (iii), Figs. 13, 15, 16 and 17.)

Congruent cards = 28 Total trials per cell = 60
Incongruent cards = 18 Total trials = 240

TABLE XVII.—*Experiment 2b* (i) (*Rectangular Symmetry*). *Misorientations as Percentage of Trials.*

Figure orientation.	Ground shape. Diamond.	Ground shape. Square.	Totals.
Square	3·3	1·7	2·5
Diamond	45·0	26·7	35·8
Totals	24·2	14·2	19·2

(From Table XV (iii.))

Trials per cell = 60 Congruent per cent. .. .. = 23·3
Incongruent per cent. .. .. = 15·0

$$\text{S.D.} = \sqrt{pq} = \sqrt{\cdot 192}\ (\cdot 808) = \sqrt{\cdot 155136} = \cdot 393873$$

TABLE XVIII.—*Experiment 2b* (ii) (*Rectangular Symmetry*).

	Difference (in per cent. misorientation).	S.E. difference.	*t* ratio.	Level of significance.
Square minus diamond ground	−10·0	5·1	−1·961	<5%*
Square minus diamond oriented figure	−33·3	5·1	−6·529	<1%*
Congruent minus incongruent cards	8·3	5·1	1·627	Not significant*

(From Table XV (iii.))

$$\sqrt{\frac{1}{N_x} + \frac{1}{N_y}} = \sqrt{\frac{2}{120}} = \sqrt{\cdot 016667} = \cdot 129101$$

* One-tail test

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

TABLE XIX.—*Experiment 2b* (i) (*Diagonal Symmetry*).

Figure orientation.	Ground shape. Diamond.	Ground shape. Square.	Totals.
Square	7	5	12
Diamond	3	1	4
Totals	10	6	16

(From Table XV (iii), Fig. 14).

Total trials = 60 Congruent = 8
Trials per cell = 15 Incongruent = 8

TABLE XX.—*Experiment 2b* (ii) (*Diagonal Symmetry*).

Figure orientation.	Ground shape. Diamond.	Ground shape. Square.	Totals.
Square	46·7	33·3	40·0
Diamond	20·0	6·7	13·3
Totals	33·3	20·0	26·7

(From Table XV (iii), Fig. 14.)

Congruent % = 26·7 Incongruent % = 26·7

S.D. = $\sqrt{pq}$ = $\sqrt{\cdot 267\ (\cdot 733)}$ = $\sqrt{\cdot 195711}$ = ·442392

TABLE XXI.—*Experiment 2b* (ii). (*Diagonal Symmetry*).

	Difference (in per cent. misorientation).	S.E. difference.	*t* ratio.	Level of significance.
Square minus diamond ground	—13·3	11·4	−1·167	Not significant*
Square minus diamond oriented figure	26·7	11·4	2·342	<1%*
Congruent minus incongruent cards	0	11·4	0	Not significant*

(From Table XV, iii, Fig. 14.)

$$\sqrt{\frac{1}{N_x} + \frac{1}{N_y}} = \sqrt{\frac{2}{30}} = \sqrt{\cdot 066667} = \cdot 258200$$

* One-tail test.

E. DISCUSSION.

In evaluating the results it is necessary to do two things. First of all, it is necessary to indicate any relationships between the facts reported here and other facts in the field of perception. Secondly, it is necessary to examine the methodological implications of the experiments reported here.

1. THE FINDINGS AND OTHER FACTS OF PERCEPTION.

It is not the aim, at this stage, to present an exhaustive study of the relevant literature. The intention here is merely to indicate the possibility that the

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

phenomena studied in this paper are related to other facts of perception in normals. Three examples will be given.

First of all, there is at least one finding which appears to be related to the symmetry hypothesis. This is Bakay and Schiller's (1) finding that normal subjects, when faced with a figure which they were asked to turn into any position, almost invariably turned the figure into a position in which the lines of symmetry were parallel with either the vertical or horizontal axis of the visual field.

The second example indicates the possibility that the influence of diamond and square grounds is related to the different psychophysiological properties of the perceived diamond and square. Koffka reports that Hartmann found that the critical fusion rate for a flickered plain square increases when it is turned into the diamond position (5).

The third example indicates that there is in normals a relationship between the orientation of a design and its perceptual distortion. This can be demonstrated by the Poggendorf illusion (Illustration 6). It is minimized when the interrupted line A B is in a vertical or a horizontal position, and maximized when the line A B is $\pm 45°$ to the vertical or horizontal position (2).

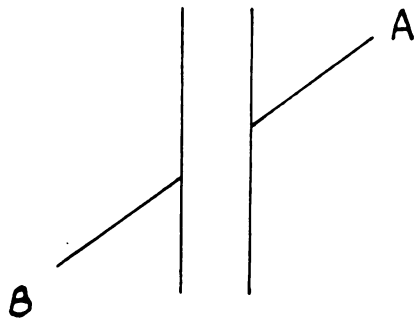


ILLUSTRATION 6.

Findings such as these indicate the possibility of subsuming under the same general laws anomalies shown by psychiatric patients and perceptual anomalies found in normals. This possibility has already been demonstrated by Teuber and Bender (7).

2. METHODOLOGICAL IMPLICATIONS.

The validity and usefulness of the investigation of the single case would seem to depend on three main criteria. The first one is that the phenomena concerned must be brought under control. Thus, in the case reported here, the relative frequency of the appearance of the anomaly was related to precise and definable conditions of organization of the stimulus field.

The second criterion is that the hypotheses developed must make possible precise predictions of behaviour or experience under new conditions and

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

predictions of phenomena which have not been observed before. For example, in the case reported here it was possible to reverse the effect of the orientation of the figure on the basis of the symmetry hypothesis, and to create new designs whose effects on the patient were correctly predicted.

The development of the power of prediction in the single case over a wide range of phenomena is surely just as valid an aim for science as the demonstration of an hypothesis in a large number of cases. Which of these courses is taken must depend on the investigator's purpose, and the particular stage of development of the branch of knowledge concerned.

When such predictive power is developed, the findings cannot be ascribed to mere chance, nor can they be said to be capable of application only to the particular case, for any general theory must cover this case as well. For example, the finding in these experiments that a notion of summative relations between figure and ground, and not Gestalt relations, allowed prediction, is a finding of which Gestalt theory must now take account. An exception has been found to the Gestalt theory which can provide a pivotal point for further experimental inquiry.

The third criterion is that the hypothesis developed must provide at least the beginnings of an explanation of the phenomenon concerned. It must be directed at answering the question, " How did the phenomenon occur ? " In the experiments reported here, we obtain some idea of the conditions affecting the patient's performance on the Block Design Test. This lays the basis for the development of hypotheses concerned with the actual processes involved.

Thus, one may conclude that the considerations affecting the validity and fruitfulness of the experimental attack on the single case are the same as those affecting the use of many cases. These are the considerations of control, predictive power, and concern with process. Control is achieved when it is possible so to manipulate the situation that the behaviour of the subject always changes in a predicted way. Thus in Experiment 1*a* Card b invariably produced the anomaly, while card d never did. This is an extreme example, but it illustrates the point.

Once an event has been brought under experimental control a variety of things can be done about it. A large range of questions can be asked, such as : Does the phenomena occur in different people and in different nosological groups ? Do similar phenomena occur in other aspects of perception and in other modalities ? A variety of interesting facts can be gathered. If, however, the concern is with process, then the main effort would be directed at the development and the experimental testing of how the phenomenon actually occurred.

Further examples of experiments with the single case can be found in an article by J. Zubin (8), and some of the statistical problems involved have been discussed in the *Journal of Clinical Psychology* (6).

F. Conclusions.

1. One conclusion emerging from these experiments is that it is possible for figure and ground to maintain their separate characteristics when entering into relationships with each other, and that their relationship is summative,

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

and not Gestalt-like in character. The conception of congruence between figure and ground did not account for the observed rank order of frequency of misorientations, or in any consistent manner for the results. The findings appear to be in complete disagreement with the following quotation from Koffka (5)—" It has been said : The whole is more than the sum of the parts. It is more because summing is a meaningless procedure, whereas the whole-part relationship is meaningful."

It must be pointed out, however, that the Goldstein-Scheerer hypotheses were not initially devised to predict the frequency of the appearance of anomalies. They commit themselves only to the time taken to reproduce a given design correctly with the Kohs Blocks. The experiments described in this paper therefore do not directly contradict the Goldstein-Scheerer hypotheses. They were only shown to be inadequate as a basis for the prediction of the frequency of misorientations.

2. The second general finding is that the more obvious " phenomenal " notions of good form or " pregnanz " are not very useful for precise investigation. Goldstein and Scheerer believe that a design which is squarely oriented has a better form than one which is diamond oriented. In fact, it was found that for the patient in question it was the line of symmetry which determined which orientation of design would produce more anomalies. But the line of symmetry itself could also be subsumed under the notion of " good form." This lack of precision of conception is brought out by Koffka's own definition. On page 110 (5) he states " psychological organization will always be as good as the prevailing conditions allow. In this definition the term ' good ' is undefined. It embraces such properties as regularity, symmetry, simplicity, and others." We have thus a definition in which the most important term is explicitly undefined.

3. Thirdly, as has been noted in Section E (1) above, these experiments indicate the possibility that abnormal perceptual function is subject to general laws similar to those of normal function. For the clinical psychologist, knowledge of these laws and of the way in which abnormal function differs as well as resembles the normal, is one of the most important objectives.

4. Fourthly, as they stand the results do not indicate whether the perceptual anomaly shown by the patient was in any way related to her left-sided hysterical disorder. The examination of all the patients in whom this anomaly is found will enable us to develop on this question theories which are capable of being tested by experiment. We already have experimental data on nine other patients, and this data will be duly examined.

5. Finally, and most important of all, it has been proved possible, by manipulation of visual material, to control experimentally the relative frequency of appearance of an anomaly of spatio-motor function. It has been possible to maximize its frequency of appearance and to minimize it almost to zero. Secondly, it has been possible to reverse the apparent conditions under which the anomaly appeared. Where before it appeared for a square oriented figure, it now appeared for a diamond oriented figure and vice versa. To begin to control a phenomenon in relation to explicit hypotheses is to lay the basis of understanding it.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press

Further investigation should not be confined merely to the initial observation, to doing what might be called "perceptual tricks" with psychiatric patients. The aims for further investigation must be to subsume the data obtained under the most general laws of function, thus giving the widest possible range of predictive power in both normals and abnormals, and to provide a possible basis for an experimental definition of the dysfunction involved in the disorder of some psychiatric patients.

Bibliography.

(1) Bakay, E., and Schiller, P. H. (1948), "Manipulative Correction of Visually Presented Figures," *Amer. J. Psychol.*, **61**, 468–486.
(2) Carr, H. A. (1935), *An Introduction to Space Perception.* New York: Longmans, Green & C.
(3) Fisher, R. A., and Yates, F. (1948), *Statistical Tables for Biological Agricultural and Medical Research.* Edinburgh: Oliver & Boyd.
(4) Goldstein, K., and Scheerer, M. (1941), "Abstract and Concrete Behaviour: An Experimental Study with Special Tests," *Psychol. Monog.*, **53**, 151.
(5) Koffka, K. (1935), *Principles of Gestalt Psychology.* London: Kegan Paul.
(6) Symposium, "Statistics for the Clinician," *J. Clin. Psychol.*, (1950), **6**, 1–76.
(7) Teuber, H. L., and Bender, M. D. (1949), "Alterations in Pattern Vision following Trauma of Occipital Lobes in Man," *J. Gen. Psychol.*, **40**, 37–57.
(8) Zubin, J. (1948), "Objective Studies of Disordered Persons" from *Methods of Psychology*, by T. G. Andrews, pp. 595–623. London: Chapman & Hall.

https://doi.org/10.1192/bjp.97.406.90 Published online by Cambridge University Press