THE SYMMETRY OF CONSTRUCTED PATTERNS

By

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INTRODUCTION

THE opinion is sometimes expressed that patterns constructed by socially maladjusted individuals (e.g. in woodcarving, needlework, arrangement of flowers, etc.) are less symmetrical than those of the adequately adjusted. It is even held that the amount of asymmetry bears some relationship to the degree of maladjustment. Evidently, other factors besides maladjustment are involved in this question. The primary aim of the inquiry reported here was to investigate the effects of differences in sex, intelligence and level of social adjustment on the symmetrical construction of patterns. The technique employed for this purpose was akin to that of the mosaic test of Lowenfeld (1949) but of a more delimited character and with simplified material.

It is well-known that the term "symmetry" denotes two distinct concepts, a rather indefinite aesthetic notion and a precise geometrical one, which has various applications in different sciences. The former corresponds to the first part of the definition in Fowler's *Concise Oxford Dictionary* (1934): "(beauty resulting from) right proportion between the parts of the body or any whole, balance, congruity, harmony, keeping." The latter corresponds to the second and third parts of the same definition. For the purpose of this inquiry the geometrical concept and the third part of the Concise Oxford definition were adopted: "repetition of exactly similar parts facing each other or a centre." It is probably true that many statements about symmetry in the patterns of the socially maladjusted relate to the aesthetic concept but this notion is so subjective and so insusceptible of accurate treatment that a strict adherence to the geometrical concept seemed likely to be much more fruitful.

MATERIAL AND INSTRUCTIONS

The material to be arranged in patterns comprised pieces of cardboard cut into three shapes and painted with poster paint of three colours. The shapes were circles of radius 1 cm., equilateral triangles of side 2·5 cm., and squares of side 1·8 cm. It was necessary to make the triangles substantially smaller in area than the circles and squares if they were not to be perceived as markedly larger. The poster paints were Winsor & Newton's poster red, poster green and lamp black. There were twelve pieces of each shape; four were painted red, four green and four black. Systematic selections from this stock were presented to the subjects, for construction into patterns, in a constant order as follows:

Item	Description	No. of Pieces
I	All greens	12
II	All circles	12
III	All triangles	12
IV	All reds	12
V	All squares	12
VI	All blacks	12
VII	All greens and reds	24
VIII	All circles and triangles	24
IX	All reds and blacks	24
X	All circles and squares	24
XI	All triangles and squares	24
XII	All greens and blacks	24
XIII	All pieces	36

The subjects were required to construct their patterns on a square of stiff white paper having a green border 1 cm. thick painted with Winsor & Newton's poster green. The white square contained by the border had a side of 20 cm. The pieces for each item were presented to the subjects in segregated heaps of each kind, e.g. for item I: green circles, green triangles and green squares. The standard instructions were: "I am going to give you some of these coloured pieces and I want you to make them into a pattern in this frame. You know what a pattern is, don't you? Don't try to make a picture with them, make a pattern. Use all the pieces given to you. Don't place any piece on top of another piece but place the pieces so that they touch. You must be able to go from any one piece to any other without jumping over a space." If the subject did not know what is meant by "pattern", the administrator secured his understanding by pointing to various patterned objects in the room, e.g. clothing, upholstery, etc. No time-limits were imposed and no subject was hastened in any way. A separate record-sheet was kept for each subject. The pattern that he produced for each item was recorded as soon as he had completed it. This was carried out by means of simple conventions which made it possible for the same pattern to be set up again whenever necessary and for the symmetry of all patterns to be systematically analysed and marked at a later convenient time.

Subjects

All subjects were in-patients of Netherne Hospital. In the primary comparison (effects of sex, intelligence and social adjustment) it was decided to consider two levels of intelligence and two of social adjustment. The former were defined in terms of score on the Wechsler-Bellevue vocabulary: *bright*, having a score of 32 or more, and *dull*, having a score from 18 to 25 inclusive. The latter were defined in terms of likelihood of discharge to the outside community; *convalescent*, recent patients who had completed their treatment and were awaiting discharge in a convalescent villa, and *parole*, well-behaved chronic patients on parole, who had been in hospital at least three years and were very unlikely to be discharged in the near future. It was thought convenient to have ten subjects for each possible combination of sex, intelligence-level and adjustment-level, i.e. eighty subjects in all. Convalescent and parole patients of each sex were obtained from the charge-nurses or sisters of appropriate wards and tested with the Wechsler-Bellevue vocabulary. Those of the defined intelligence-levels were asked to construct patterns. This procedure was continued until each category had the requisite number of cases. In order to determine consistency of performance the parole patients and the first ten available convalescent patients were asked to construct patterns on a second occasion after an interval of approximately two months (mean interval 59·4 days, S.D. 10·7, range 35-86).

It seemed of value to extend the inquiry to patients showing a more outspoken pathology of behaviour and it was decided to sample the following classes: (*a*) oligophrenics, (*b*) senile dements, (*c*) cases of determinable organic brain-disease, (*d*) chronic patients showing marked habit-deterioration and under continuous supervision. Again it was thought convenient to have ten male and ten female patients of each class. These were obtained, as in the previous instance, from the charge-nurses or sisters of appropriate wards until the requisite numbers were secured in each category. For the first three classes the neuro-psychiatric diagnoses in the case-histories were accepted as authoritative. The cases of determinable organic brain-disease were:

	Males	Females
Dementia Paralytica	6	2
Huntington's Chorea	—	4
Cerebral Atrophy	3	4
Cerebral Carcinoma (Secondary)	1	—

The distributions of the various categories of subjects as to age and Wechsler-Bellevue vocabulary-score are shown in Table I. The vocabulary responses of the habit-deteriorated patients could not be satisfactorily scored. None of the mean differences between male and female patients of the same category is statistically

TABLE I

Distributions of Ages and Vocabulary-Scores

Categories	Ages			Vocabulary-Scores		
	Mean	S.D.	Range	Mean	S.D.	Range
Less Pathological						
Male Bright Convalescent ..	39·7	11·8	20–59	35·2	2·4	32–41
Female Bright Convalescent	35·4	11·8	21–58	35·0	2·7	32–40
Male Dull Convalescent ..	38·9	12·5	16–53	22·1	2·3	19–25
Female Dull Convalescent ..	30·8	7·6	20–43	21·1	1·9	18–24
Male Bright Parole	41·7	12·1	20–62	34·2	2·4	32–38
Female Bright Parole ..	48·8	10·8	25–63	34·7	2·1	32–38
Male Dull Parole	43·9	14·7	22–61	21·8	1·8	18–24
Female Dull Parole	44·0	9·2	21–53	21·5	1·8	19–24
More Pathological						
Male Oligophrenic	38·8	7·4	28–54	11·1	3·9	5–16
Female Oligophrenic ..	45·2	13·5	24–61	12·2	3·7	7–17
Male Senile Dement ..	76·1	5·4	67–84	19·2	10·3	0–37
Female Senile Dement ..	75·3	6·1	63–86	15·0	10·6	4–32
Male Determinable Organic	46·7	11·3	27–65	22·8	7·6	6–38
Female Determinable Organic	53·2	9·7	34–64	19·0	7·8	1–32
Male Habit-Deteriorated ..	39·7	9·1	30–58	—	—	—
Female Habit-Deteriorated ..	53·3	7·5	40–67	—	—	—

significant except that for age in the habit-deteriorated class ($t=3\cdot469$, 18 d.f.). Four patients refused to construct patterns (two male senile dements and two female habit-deteriorated chronics) and others were substituted for these. The Ishihara test indicated that two patients were colour-blind (a male bright convalescent and a male organic) but, as both were able to sort out the 36 pieces according to colour without a single error, they were not excluded from the inquiry.

QUANTIFICATION

It was observed that six broad levels of performance in regard to symmetry could be distinguished in the patterns:

(1) There was perfect symmetry about both the vertical and the horizontal axes and, in addition, (*a*) the pattern remained unchanged when rotated through an angle of 90 degrees in its own plane and (*b*) the four quadrants derived from bisection along each of the two oblique axes were identically interchangeable (*entire symmetry*, e.g. Fig. 1, A);

(2) There was perfect symmetry about the vertical and horizontal axes but neither of the preceding added conditions was satisfied (*double symmetry*, e.g. Fig. 1, B);

(3) There was perfect symmetry about one axis, vertical, oblique or horizontal (*single symmetry*, e.g. Fig. 1, C);

(4) The pattern was for the most part symmetrical but a very few pieces were not symmetrically placed (*imperfect symmetry*, e.g. Fig. 1, D);

(5) A few pieces were symmetrically placed but most were asymmetrical (*rudiments of symmetry*, e.g. Fig. 1, E);

(6) There was no vestige of symmetrical placement in the pattern (*absolute asymmetry*, e.g. Fig. 1, F).

There were also several complicating phenomena which are discussed below. The most important of these was *balanced reversal:* one side of an axis was inversely symmetrical with the other, i.e. the pattern would be symmetrical about a particular axis if one side were rotated through 180 degrees in the plane perpendicular both to the axis and to the plane of the pattern (e.g. Fig. 3, C). Balanced reversal had to be rather carefully distinguished from another type of reversal, *duplication* (e.g. Fig. 2, C), since it arose under quite different circumstances. In duplication, symmetry about a particular axis would derive from rotation of one side through 180 degrees either in the plane of the pattern or in the plane perpendicular to that of the pattern but parallel to the axis. Rotations making balanced reversal symmetrical do not have this effect on duplication and vice versa, as may be readily confirmed in Figs. 2, C, and 3, C.

Many scientists have followed Mach (1906) in identifying *vertical*, *horizontal* and *centric* as the fundamental categories of symmetry. In constructed patterns, however, two or three distinct possibilities could be regarded as showing centric symmetry. A more convenient quantification is attained if axial symmetry, capability of rotation without change and reversal are taken as the basic elements. It was decided to score symmetry of shape and symmetry of colour separately and to apply the following additive system of marking:

(*a*) 2 marks for perfect symmetry about the vertical axis, 1 mark for imperfect symmetry about the vertical axis;

(*b*) 2 marks for perfect symmetry about the horizontal axis, 1 mark for imperfect symmetry about the horizontal axis;

(*c*) $\frac{1}{2}$ mark to a whole pattern showing rudiments of symmetry;

(*d*) 1 additional mark to a pattern that was entire;

(*e*) $\frac{1}{2}$ mark, in addition to the mark under (*a*), for balanced reversal about the vertical axis;

(*f*) $\frac{1}{2}$ mark, in addition to the mark under (*b*), for balanced reversal about the horizontal axis.

Balanced reversal was given a greater weight than direct symmetry because its production seemed to be a more complex behaviour. A subject's score for each item was the sum of his marks under each letter. The maximum score was 5 per item, 65 for the whole series.

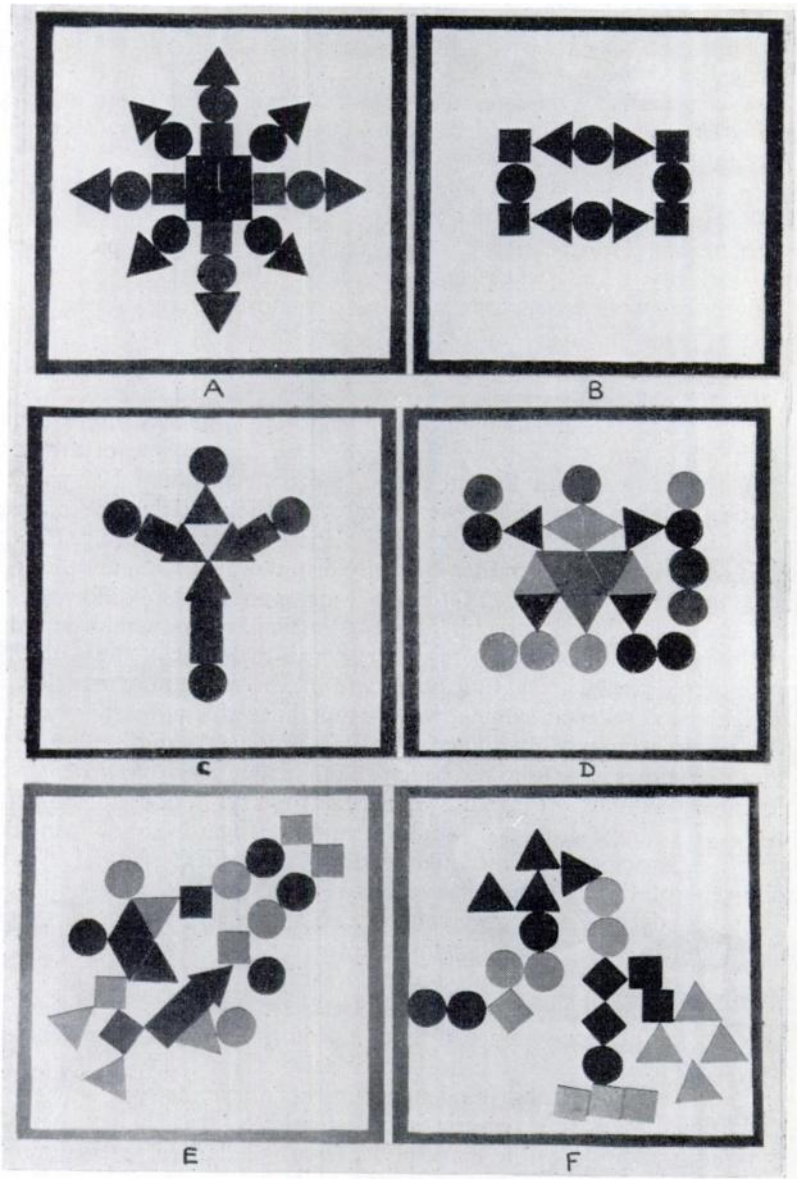

FIG. 1.—Levels of Symmetry.

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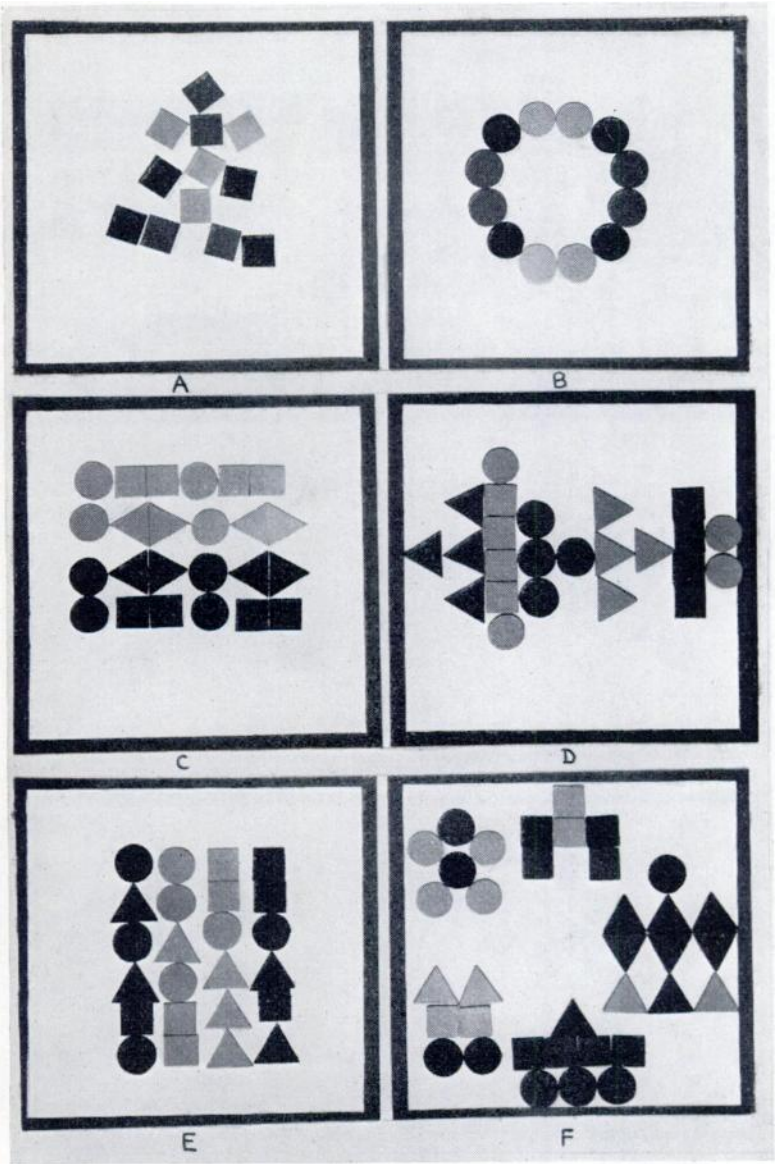

FIG. 2.—Special Behaviours.

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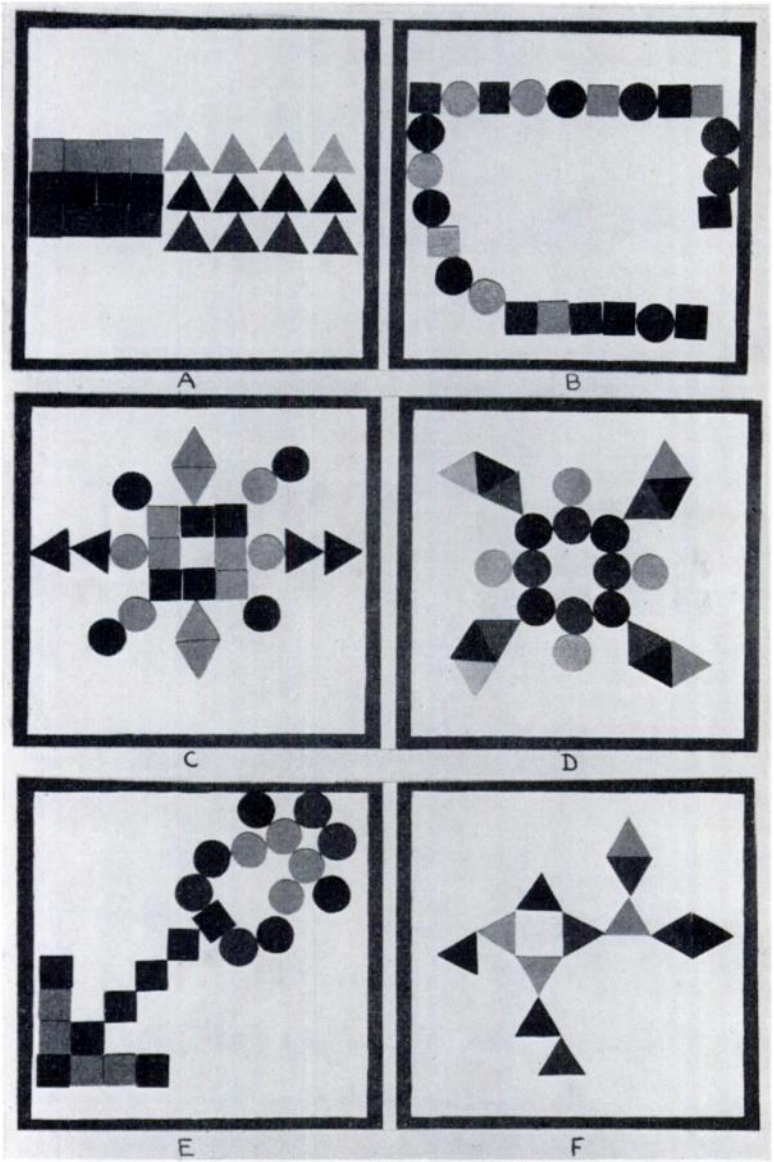

FIG. 3.—Special Behaviours (*continued*).

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Certain details about the scoring require elucidation. The distinction between imperfect symmetry and rudiments of symmetry was necessarily fixed at an arbitrary point. Patterns with defective symmetry about a particular axis were considered to be at the level of imperfect symmetry if at least five-sixths of the pieces were symmetrically placed. Otherwise they were considered to be at the level of rudiments of symmetry. Therefore, a pattern received a score for imperfect symmetry if it had 1-2 asymmetrical pieces in items I-VI, 1-4 such pieces in items VII-XII or 1-6 such pieces in item XIII. Patterns showing *oblique symmetry* (e.g. Fig. 3, E) were scored as if they were vertical or horizontal patterns rotated through 45 degrees. Duplication about an axis was credited neither as perfect symmetry nor as reversal. In *semi-entire symmetry* (e.g. Fig. 3, D), where the pattern remains unchanged when rotated through an angle of 90 degrees but the four quadrants derived from double oblique bisection are not identically interchangeable unless one side of the pattern is reversed, two $\frac{1}{2}$-mark credits were given under (*e*) and (*f*) but no mark was given under (*d*).

The scoring system appeared to be an adequate method of quantifying the facts of symmetry in this situation and was successfully applied to all the patterns obtained. Although the system is entirely objective there is some liability to inaccuracy through neglecting aspects of a pattern; therefore, all marks were checked by a second independent scorer. One or two initial problems were soon overcome. The most obstinate of these was to decide what positional relations constituted *pure symmetry of colour* (e.g. Fig. 2, E). Such relations evidently could not be determined in the straightforward spatial manner applicable to pure symmetry of shape or joint symmetry of shape and colour. The most convenient method of dealing with the problem was to regard triangles and squares as replaced by circles of the same colour. The obtained pattern was scored as symmetrical for colour to the same extent that the substituted one was for shape and colour. A second problem was that some patterns were conceived as symmetrical but in fact placed very carelessly so that spatially they did not satisfy the definition (*careless placement*, e.g. Fig. 2, A). These were scored as if the actual placement were no less symmetrical than its conception. Still another problem was that the higher levels of symmetry could be attained in a rather complex way or very simply by *circular* or *linear placement* of pieces (e.g. Fig. 2, B). It was debated whether to score symmetry achieved by very simple placement at a lower level than the more complex forms. It was decided, however, to hold to a strictly geometrical concept of symmetry and to mark such patterns accordingly, even in extreme cases of linear placement where the symmetrical parts round an axis were half-pieces only. These difficult cases were infrequent and sporadically distributed for the most part, so that the results were not greatly modified by them.

The foregoing may be exemplified by citing the marks given to the patterns reproduced in the figures. The score for shape-symmetry is quoted first and that for colour-symmetry after it in brackets (in the figures the lightest shading represents green, the darkest black, the intermediate red):

	A	B	C	D	E	F
Figure 1 ..	5 (5)	4 (4)	2 (2)	1 ($\frac{1}{2}$)	$\frac{1}{2}$ ($\frac{1}{2}$)	0 (0)
Figure 2 ..	2 (2)	5 (4)	3 (1)	2 (2)	0 (4)	$\frac{1}{2}$ ($\frac{1}{2}$)
Figure 3 ..	0 (2)	$\frac{1}{2}$ (0)	5 (5)	5 (5)	2 (2)	$\frac{1}{2}$ (0)

Reliability of Scores

The eighty less pathological and the eighty more pathological subjects were taken separately in calculating split-half (odd-even) product-moment correla-

tions for the shape-scores and colour-scores. Item XIII was ignored in these correlations; the half-total scores were divided by three and rounded to the nearest integer for convenience in computation. The obtained correlations were corrected in the customary way by the Spearman-Brown prophecy-formula. The split-half correlation for shape-symmetry was ·954 in the less pathological and ·970 in the more pathological patients. The split-half correlation for colour-symmetry was ·837 in the less pathological and ·930 in the more pathological patients. The difference between the latter correlations is statistically very significant when tested by the z-distribution of Fisher (1950); the ratio of the z-difference to the standard error is 2·82. The explanation of this difference is discussed below. The patterns of the fifty less pathological subjects to whom the series was re-administered after two months were available for test-retest (repetition) correlations. Here and in all subsequent statistical examinations (except those involving ranks) the total symmetry-scores were divided by five and rounded to the nearest integer. The test-retest correlation for shape-symmetry was ·951, for colour-symmetry ·858. Such correlations are hardly likely to be lower in a normally adjusted population. It is reasonable to conclude that the degree of symmetry shown by an individual in the construction of patterns is a highly consistent behaviour on a particular occasion and a highly stable one over a moderate lapse of time.

Relationship Between Shape-Scores and Colour-Scores

The product-moment correlation between shape-scores and colour-scores (uncorrected for attenuation) was ·718 in the less pathological and ·890 in the more pathological subjects. The difference between the correlations is statistically very significant when tested by the z-distribution (ratio of z-difference to standard error 3·19). The interpretation of this is discussed at a later point. There was a predominating tendency for colour-scores to be lower than shape-scores. This is most clearly indicated in terms of the ratio of the former to the latter (*colour-shape ratio*). In the total sample of 160 patients 24 had a colour-shape ratio of ·40 or below, 37 of ·60 to ·41, 65 of ·80 to ·61, 27 of 1·0 to ·81, and 7 above 1. Individual differences in the colour-shape ratio are discussed below.

Effects of Sex, Intelligence-level and Adjustment-level

The mean total uncoded scores for all categories of subjects in both shape-symmetry and colour-symmetry are set out in Table II. The effects on shape-scores and colour-scores of sex, intelligence-level and adjustment-level in the less pathological subjects are indicated by the analyses of variance in Table III, which also contains the analysis of covariance allowing for the regression of colour on shape. The effects of sex and adjustment-level are not statistically significant: that of intelligence-level on both shape-scores and colour-scores is highly significant. The ratio-test for homogeneity of variance (Snedecor, 1946) indicates that the effect of intelligence-level is not on dispersions but on means only; the F-ratio for shape is 1·347, for colour 1·014, 39 by 39 d.f. The effect of intelligence-level on colour-scores still remains highly significant when allowance is made for the functional dependence of colour-symmetry on shape-symmetry. This is fairly decisive evidence that the major factor determining the level of symmetry at which patterns are constructed is the intelligence of the individual making them. In so far as level of colour-symmetry is independent of level of shape-symmetry it is also determined in the main by the intelligence of the constructing individual.

TABLE II

Mean Symmetry-Scores (Uncoded Total Scores)

Categories	Shape-Symmetry		Colour-Symmetry	
	Male	Female	Male	Female
Less Pathological				
Bright Convalescent	47·1	46·0	38·2	39·4
Dull Convalescent	41·6	32·6	29·5	24·4
Bright Parole	50·4	39·7	42·9	34·8
Dull Parole	27·6	29·8	19·0	20·4
More Pathological				
Oligophrenic	29·6	12·7	23·8	7·8
Senile Dement	19·3	16·5	13·0	14·7
Determinable Organic	30·8	13·7	19·8	6·2
Habit-Deteriorated	13·4	4·7	11·1	4·2

TABLE III

Analyses of Variance and Covariance: Less Pathological Subjects (Coded Scores)

Factors	d.f.	Analyses of Variance: Shape-Score Mean Squares	Analyses of Variance: Colour-Score Mean Squares	Analysis of Covariance: Colour on Shape: Cross-Product Sums	Analysis of Covariance: Colour on Shape: Errors of Estimate Mean Squares
Sex (S)	1	16·20	2·81	6·74	0·25
Intelligence (I) ..	1	96·80*	137·81*	115·50	63·73*
Adjustment (A) ..	1	11·25	5·51	2·87	4·79
S-I Interaction ..	1	0·45	0·62	0·53	0·35
S-A Interaction ..	1	0·20	0·32	4·76	−2·49
I-A Interaction ..	1	7·20	9·12	13·10	1·81
Triple Interaction ..	1	14·45	7·80	—	—
Error	72	5·67	6·57	—	—
Pooled Error	73	5·77	6·68	122·90	6·09

The probable distributions of populations may be inferred from the means in Table II by Snedecor's method. The 95 per cent. fiducial semi-interval is 3·4 for shape and 3·6 for colour; the 99 per cent. semi-interval is 4·5 for shape and 4·8 for colour. The male and female bright convalescent and male bright parole appear to belong to one population; the male dull convalescent and female bright parole to a second; the male dull parole and female dull convalescent and parole to a third. The anomalous position of the male dull convalescent and female bright parole is noteworthy. It might be taken to suggest that the effects of intelligence, although of predominant importance, can to some extent be offset by favourable or unfavourable combinations of sex and adjustment. Male sex with convalescent adjustment would then be a favourable combination raising scores above the expectation according to intelligence and female sex with parole adjustment an unfavourable combination lowering scores beneath expectation. This suggestion acquires some plausibility in the sequel, at any rate in regard to sex.

* Statistically significant beyond 1 per cent. level.

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Effects of Severe Behavioural Pathology

In dealing with the more pathological categories of subjects it was thought appropriate to include in the comparison only the dull convalescent and parole patients as a standard of reference. The effects on shape-scores and colour-scores of sex and pathological class are indicated by the analyses in Table IV.

Table IV

Analyses of Variance and Covariance: More Pathological Subjects Plus Dull Convalescent and Parole (Coded Scores)

		Analyses of Variance		Analysis of Covariance: Colour on Shape	
Factors	d.f.	Shape-Score Mean Squares	Colour-Score Mean Squares	Cross-Product Sums	Errors of Estimate Mean Squares
Sex	1	73·67†	33·07*	49·35	0·58
Pathological Class ..	5	51·96†	22·49†	172·65	−0·05
Interaction	5	7·93	9·30	36·90	2·75
Error	108	6·24	4·82	514·00	1·20

Differences in sex and pathological class have each statistically significant effects on shape-symmetry and colour-symmetry. When allowance is made, however, for the regression of colour-symmetry on shape-symmetry the significance of the effects on colour disappears. The ratio-test for homogeneity of variance in the case of sex (F-ratio for shape 1·059, for colour 1·170, 59 by 59 d.f.) indicates that the effect of sex-difference is not on dispersions but on means only. Consideration of the means in Table II shows that in five of the six comparisons for shape and in four of those for colour the female mean is below the male, usually very substantially so. The evidence suggests that, within the limits set by intelligence, female sex is a factor tending to lower the level of symmetry at which patterns are constructed. The effect is inhibited by a favourable combination of intelligence and adjustment and accentuated by more severe pathology. The interpretation of this finding is discussed later.

The effects of pathological class occasion more difficulty than those of sex. Bartlett's test for homogeneity of variance (Snedecor, 1946) indicates that the samples differ significantly in this regard (chi-squared for shape 13·60, for colour 27·08, 5 d.f.) so that the effects may operate either on dispersions alone or on dispersions and means. The differences in variance (the dull parole and habit-deteriorated samples were considerably less dispersed than the other four) arose no doubt partly from unusual sampling chances and partly from the over-wide neuro-psychiatric classifications employed. There was no clear evidence that means were proportional either to ranges or to ranges squared so that neither logarithmic nor square-root transformations seemed definitely appropriate, cf. Kempthorne (1952). In the circumstances it appeared best to use a distribution-free statistic and to compare the classes separately within each sex. The U-test of Mann and Whitney (1947) was employed, taking U as having mean 50 and S.D. 13·23; with equal groups this test is equivalent to Wilcoxon's T-test. Samples were taken as probably belonging to different populations if U exceeded 76·45 or were less than 23·55. With minor irregularities this procedure indicated distinctions of populations closely similar to those suggested by the means in

* Statistically significant at 1 per cent. level.
† Statistically significant beyond 1 per cent. level.

Table II. In the males the samples belonged to three populations: (1) dull convalescent; (2) dull parole, oligophrenics and organics; (3) senile dements and habit-deteriorated. In the females the samples also belonged to three populations: (1) dull convalescent and parole; (2) oligophrenics, senile dements and organics; (3) habit-deteriorated.

Provided some major anomalies are overlooked these data suggest that: (*a*) oligophrenics construct patterns at a lower level of symmetry than dull subjects, as would be expected if intelligence is the chief factor in symmetry-level; (*b*) determinable organic brain-disease of the types included in this sample reduces the level of symmetry at which patterns are constructed to that of oligophrenics; (*c*) senile dementia and the undetermined pathology leading to the behavioural status of the patients here described as habit-deteriorated reduce the level of symmetry in patterns below that of oligophrenics. There are four major anomalies: the positions of the male dull convalescent, the male oligophrenics, the male organics and the female senile dements. The relatively high scores of the male dull convalescent were discussed in the last section and provisionally attributed to the favourable combination of sex and adjustment-level; the difference from the male dull parole might, however, be merely a sampling error. The question of the male oligophrenics is of some theoretical importance and is considered in the next paragraph. The high mean scores of the male organics arose from four cases of dementia paralytica in whom therapy had arrested the disease at a fairly early point. The female senile dements evidently derived from two sharply divergent populations, since three had symmetry-scores in the range 38-54 and the remaining seven in the range 0-8; probably the first three were not true senile dements but belonged to some other class of elderly patients, cf. Roth and Hopkins (1953). Further sampling with more stringent definitions of neuro-psychiatric categories would establish how far these anomalies constitute objections to the suggestions made in the previous paragraph.

The male oligophrenics present a more far-reaching problem. Four of these had scores for shape-symmetry of 61, 56, 51 and 40 respectively. The remainder had scores in the range 9-26. The cases of the first two (scores 61 and 56), who ranked 4th equal and 10th equal in the total male sample, were regarded as crucial and considered in detail. Their high scores were attained by patterns of some complexity, not by simple procedures such as circular or linear placement. The most obvious explanation was that they were misclassified as oligophrenics but this could not be sustained. One had been tested four years previously with the Terman-Merrill Scale (L Version) and scored an I.Q. of 52; he was retested with the M Version and scored an I.Q. of 53. The other was tested for the first time with the L Version and scored an I.Q. of 52. The Terman-Merrill performance of each was self-consistent and unscattered; the responses of each showed marked defect in memory, judgment and reasoning. Moreover, the entire life-history of each before and after admission to hospital was in accord with a diagnosis of oligophrenia and with nothing else. It is possible that their oligophrenia was not genetically determined but arose from the pervasive effects of severe linguistic disability; no data of any sort were found that would substantiate this. The evidence already adduced that intelligence is the chief determinant of the symmetry-level at which patterns are constructed is too strong to be rebutted by these exceptional cases. The formulation most closely corresponding to the facts would appear to be the following: the procedures necessary to achieve a high level of symmetry in patterns are much more likely to be followed by persons of high than those of low ability but it is quite possible

for persons of very low ability indeed to follow them. The distinguishing features of oligophrenics that attain a high symmetry-level constitute a problem for another investigation. It is noteworthy that all who did so here were males. It is also of interest that Diamond and Schmale (1944) found that in the mosaic test some oligophrenics did better and were more ingenious than their normal subjects.

Distribution of Symmetry-Levels

The facts just considered in terms of total symmetry-scores for shape and colour are presented in another form in Table V, showing the mean numbers of

Table V

Mean Numbers of Items at Given Levels

Categories	Symmetry					
	Entire	Double	Single	Im-perfect	Rudi-ments	Absent
Less Pathological						
Male Bright Convalescent ..	5·5	3·4	3·0	0·3	0·3	0·5
Female Bright Convalescent	4·1	4·5	3·2	0·5	0·4	0·3
Male Dull Convalescent ..	2·9	5·4	2·4	0·9	0·2	1·2
Female Dull Convalescent ..	2·2	3·1	3·3	0·9	1·9	1·6
Male Bright Parole	4·2	6·5	2·2	0·1	0·0	0·0
Female Bright Parole ..	3·5	2·9	4·8	0·8	0·9	0·1
Male Dull Parole	0·5	2·7	5·5	2·2	1·7	0·4
Female Dull Parole	1·1	2·1	5·3	2·5	1·6	0·4
More Pathological						
Male Oligophrenic	2·0	4·0	1·3	1·4	3·9	0·4
Female Oligophrenic ..	0·2	1·2	1·4	0·9	6·9	2·4
Male Senile Dements ..	0·1	1·8	3·4	2·3	2·3	3·1
Female Senile Dements ..	1·3	1·1	0·8	0·9	3·4	5·5
Male Determinable Organic	1·9	2·1	4·2	1·2	2·5	1·1
Female Determinable Organic	0·4	1·2	2·7	1·2	0·9	6·6
Male Habit-Deteriorated ..	0·0	1·5	2·8	0·8	4·2	3·7
Female Habit-Deteriorated ..	0·0	0·8	0·4	0·3	2·7	8·8

items at a given symmetry-level in each category of subjects. In calculating these quantities an item was credited with its highest symmetry-level in either shape or colour and along either the vertical, the horizontal or an oblique axis. The complication of reversal was ignored. The mean total in each category is of course 13. The significance of differences between the sexes and amongst the pathological categories at each level was tested primarily by analyses of variance but, if the hypothesis of homogeneity of variance had to be rejected, by Mann-Whitney U-tests. The trends suggested by the means were borne out with minor irregularities.

There were very significant sex-differences in regard to double symmetry, which was commoner in males, and absolute asymmetry, which was commoner in females. Entire symmetry inclined to be commoner in males but the difference did not reach statistical significance. These trends point in other terms to the conclusion that female sex is a factor tending to lower the symmetry-level at which patterns are constructed. In the less pathological males and females the lower symmetry-levels were uncommon and most patterns involved entire, double or single symmetry. Only in the dull parole did the defective forms of symmetry play a part of any consequence. Among the males the modal per-

formance was entire symmetry in the bright convalescent, double symmetry in the bright parole and dull convalescent, single symmetry in the dull parole. Among the females the modal performance was double symmetry in the bright convalescent and single symmetry in the other three categories, most markedly in the dull parole. Entire symmetry showed a steady fall in both sexes from bright convalescent through bright parole and dull convalescent to dull parole. These facts underline the importance of intelligence as a determinant of symmetry-level. In the more pathological categories the lower levels of symmetry predominated except in the male oligophrenics and organics. The male oligophrenics displayed two modes, one at double symmetry and one at rudiments of symmetry, suggestive of two populations. The male senile dements and organics were each scattered with modes at single symmetry but the seniles had a second near-mode at absolute asymmetry. The male habit-deteriorated had rudiments of symmetry as their modal performance. The female oligophrenics also had their mode at rudiments of symmetry, the other female categories at absolute asymmetry. While not reflecting all details of the conclusions suggested by the total symmetry-scores these findings corroborate them in indicating that oligophrenics usually perform at a lower level of symmetry than dull subjects and that severe behavioural pathology tends to reduce the symmetry-level of patterns to that of oligophrenics or below it.

TABLE VI

Frequencies of Special Behaviours

Behaviours	Occurrence in Total Sample and its Divisions					Occurrence in Divisions of Less Pathological Sample				Excess Occurrence (over 3)
	Tot.	L.P.	M.P.	M.	F.	B.	D.	Conv.	Par.	
A. *Unrelated to Pathology*										
1. Careless placement ..	34	14	20	14	20	5	9	9	5	0
2. Overstepping frame ..	7	4	3	4	3	1	3	0	4	0
3. Placing frame diagonally	12	8	4	6	6	3	5	0	8†	0
4. Circular placement ..	37	22	15	17	20	8	14	15	7	4
5. Duplication	14	9	5	8	6	2	7	4	5	1
6. Pure horizontal	11	6	5	8	3	1	5	3	3	3
7. Pure colour	12	5	7	4	8	1	4	3	2	1
8. C-S Ratio above 1 ..	7	2	5	3	4	2	0	1	1	—
9. C-S Ratio ·4 or less ..	24	10	14	12	12	2	8*	7	3	—
B. *Characteristic of L.P.*										
1. Balanced reversal ..	38	36†	2	20	18	24*	12	23*	13	8
2. Semi-entire	15	14†	1	4	11*	9	5	9	5	1
3. Oblique	26	23†	3	10	16	11	12	15	8	0
4. Aesthetic asymmetry ..	7	7†	0	1	6	5	2	4	3	3
C. *Characteristic of M.P.*										
1. Fragmentation	27	8	19*	12	15	1	7*	4	4	7
2. Segregation	29	8	21†	17	12	3	5	5	3	16
3. Linear placement ..	18	5	13*	4	14†	0	5	2	3	8
4. C-S Ratio above ·8 ..	34	6	28†	13	21	6*	0	2	4	—
Total number in sample ..	160	80	80	80	80	40	40	40	40	160

Abbreviations: Tot.=total sample; L.P.=less pathological sample; M.P.=more pathological sample; M.=male; F.=female; B.=bright; D.=dull; Conv.=convalescent; Par.=parole; C-S=colour-shape.

* Difference in frequencies statistically significant beyond 5 per cent. point.
† Difference in frequencies statistically significant beyond 1 per cent. point.

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Special Behaviours

In the construction of the patterns a number of special behaviours occurred the frequencies of which it seemed desirable to count in addition to scoring for symmetry-levels. Several of these have already been defined and exemplified. The complete list is set out in Table VI. The table presents the number of subjects exhibiting each behaviour in the total sample; the less versus the more pathological and male versus female within the total sample; bright versus dull and convalescent versus parole within the less pathological subjects. The significance of differences was tested by chi-squared (with Yate's correction) if all expected frequencies were above 5, otherwise by the exact binomial-product method (Fisher, 1950). These behaviours occurred sporadically for the most part but certain subjects displayed some of them as a characteristic, or even a preferred, reaction. The extent of this for each behaviour is shown in the last column of Table VI, where it is arbitrarily taken that a subject exhibited excess occurrence of a behaviour if he displayed it in more than three items.

The special behaviours are arranged in three broad classes: those unrelated to degree of pathology, those characteristic of the less and those characteristic of the more pathological. In the first group, *careless placement* (Fig. 2, A), *circular placement* (Fig. 2, B), *duplication* (Fig. 2, C) and the *colour-shape ratio* have already been described. *Pure horizontal symmetry* (Fig. 2, D) and *pure colour-symmetry* (Fig. 2, E), are self-explanatory. In *overstepping the frame* the pattern finally offered by the subject extended over the green border; Fig. 3, E, would be an example of this if it were constructed along the vertical or horizontal axes. In *placing the frame diagonally* the subject rotated the square frame to the diagonal or "diamond" position and then constructed the pattern so that what was oblique in relation to the standard position of the frame was vertical or horizontal in relation to the constructing subject and *vice versa*. This is perhaps connected with the rotation phenomenon discovered by Shapiro (1951, 1952, 1953). In the second group *balanced reversal* (Fig. 3, C), *semi-entire symmetry* (Fig. 3, D) and *oblique symmetry* (Fig. 3, E) have already been described. *Aesthetic asymmetry* (Fig. 3, F) was the term applied to instances where the subject constructed the pattern according to a careful non-symmetrical plan. This was the only special behaviour whose occurrence could not be ascertained with complete objectivity. It was judged to occur in largely or entirely asymmetrical patterns where the placement of pieces suggested deliberate and critical selection. The evidence for its occurrence was strengthened if in other items the subject had constructed complex symmetrical patterns. In the third group, *linear placement* (Fig. 3, B) has already been mentioned. Here the subject merely added one piece to another in straight lines or simple curves. In *fragmentation* (Fig. 2, F), the pattern was asymmetrical as a whole but composed of separate parts, each symmetrical in itself. This behaviour was contrary to the instructions if the separate pieces did not touch, which was usually the case. In this eventuality objection was raised to the behaviour at its first occurrence but not thereafter if the subject persisted in it. In *segregation* (Fig. 3, A) the subject kept the pieces in his pattern as carefully segregated according to kind as they were when given to him.

The only significant sex-differences in the special behaviours are that semi-entire symmetry and linear placement are commoner in females. Aesthetic asymmetry is also commoner in females but the difference does not quite reach statistical significance. The findings on symmetry-level might suggest that differences between the less and the more pathological would also be reflected, within the less pathological sample, between the bright and the dull. This is

unequivocally so, however, only in the case of fragmentation. In balanced reversal the difference is reflected both between the bright and dull and between the convalescent and parole. The colour-shape ratio presents paradoxical results. Although a high ratio is outstandingly commoner in the more than the less pathological it is also significantly commoner in the bright than the dull. A low ratio is significantly commoner in the dull than the bright. The explanation of this paradox is discussed below. Ratios in excess of 1 are distributed without significant differences. In linear placement the difference between the less and more pathological is reflected between the bright and dull to an extent that is almost statistically significant. The other behaviours show no differences between bright and dull. The parole show a significantly greater tendency than the convalescent to diagonal placing of the frame, a difference rather difficult to interpret.

It may be noted here that in both duplication and balanced reversal inversion of colour predominated over inversion of shape. Thus with the less pathological sample 98 instances of balanced reversal occurred in the 36 subjects showing the behaviour: 6 were of shape only, 59 of colour only, 33 of shape and colour jointly. Balanced reversal was much commoner along two axes (74 instances) than one axis (24 instances). Oblique symmetry in this sample occurred with almost equal frequency along one axis (13 instances) or two axes (17 instances).

Differences Amongst Items

In accordance with strict methodology, a comparison of the effects of different items is precluded by the fact that presentation was in a constant order and therefore item effects were confounded with ordinal effects. Nevertheless the differences between kinds of items were so clear-cut, consistent and readily explicable that it seemed desirable to record them and discuss the results of a

Table VII

Mean Scores per Item

Description of Item	No. of Item	Means: Less Pathological Subjects: Shape	Means: Less Pathological Subjects: Colour	Means: More Pathological Subjects: Shape	Means: More Pathological Subjects: Colour
Three Shapes One Colour					
All greens	I	3·30	3·41	1·26	1·39
All reds	IV	3·18	3·31	1·40	1·82
All blacks	VI	3·24	3·33	1·62	1·72
One Shape Three Colours					
All circles	II	3·86	2·45	2·28	0·96
All triangles	III	3·08	2·14	1·29	0·71
All squares	V	3·32	2·24	2·22	0·90
Three Shapes Two Colours					
All greens and reds	VII	2·75	2·24	1·10	0·89
All reds and blacks	IX	2·72	2·11	1·04	0·93
All greens and blacks	XII	2·76	2·22	0·85	0·68
Two Shapes Three Colours					
All circles and triangles	VIII	2·83	1·82	1·02	0·75
All circles and squares	X	2·76	1·88	1·04	0·68
All triangles and squares	XI	2·82	1·99	0·98	0·66
Three Shapes Three Colours					
All pieces	XIII	2·51	1·82	0·88	0·49

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tentative statistical analysis. The mean symmetry-scores per item are set out in Table VII, the items being grouped in their various kinds. The mean scores for the less and the more pathological subjects are given separately. Bartlett's test showed that an assumption of homogeneity of variance could be sustained for the less pathological subjects (chi-squared for shape 10·90, for colour 19·97, 12 d.f.) but had to be rejected for the more pathological. Comparison therefore was confined to the less pathological but the mean scores of the more pathological displayed the same general tendencies with some irregularities. Analyses of variance indicated that the mean scores per item differed very significantly for both shape-symmetry and colour-symmetry in the less pathological sample (F-ratios: shape 4·145, colour 9·221, d.f. 9 by 79). The 95 per cent. fiducial semi-interval was ·35 for shape and ·37 for colour, the 99 per cent. was ·46 for shape and ·49 for colour.

The foregoing limits suggest, in regard to shape-symmetry, that item II belongs to one population, the remaining 12-piece items to a second and the 24-piece items to a third. More doubtfully, the 36-piece item XIII may belong to a fourth population. Observation of performances and the statements of subjects concurred that circles were easiest and triangles most difficult to arrange. This quite certainly accounts for the significantly higher score on item II. The remaining differences show a very definite relationship to the number of pieces in the item. Ordinal effects are clearly of negligible importance. Practice or familiarization effects would lead to a progressive raising of scores and fatigue or boredom effects would hardly result in sharp drops only at the point where the number of pieces is increased. The data leave undetermined the relative importance of total number of pieces and number of kinds of pieces but, pending empirical investigation, the latter seems likely to have played much the greater rôle. The general conclusion appears to be that higher levels of shape-symmetry are more easily attained with some shapes than others, notably with circles, and become more difficult of attainment in proportion to the number and diversity of pieces presented.

In regard to colour-symmetry the fiducial limits suggest that the populations are: (1) three shapes and one colour; (2) one shape and three colours, three shapes and two colours; (3) more doubtfully, two shapes and three colours, three shapes and three colours. While the differences here show a fundamental dependence on the number of pieces in the item, there is palpably present a modifying factor that was absent in the case of shape-symmetry. This is readily identified as the fact that shape-symmetry is easier of attainment than colour-symmetry so that items in which the level of shape-symmetry entails the same level of colour-symmetry (e.g. three shapes and one colour) tend to score more highly than items in which the subject is directly confronted with the task of patterning according to colour (e.g. one shape and three colours). In a more complex way this fact enters into the other differences also. It is noteworthy that the higher levels of colour-symmetry are not attained significantly more easily with one colour than another.

Most of the special behaviours tended to be evoked more frequently by one kind of item than another. Over-stepping the frame and placing it diagonally both occurred principally in the later, more difficult items, especially XIII. Circular placement occurred most frequently when circles were involved, particularly with item II, and was especially rare with item III. Duplication occurred most often with items of the same shape and different colours (II, III, V); it was much rarer with items of different shapes and the same colour or with the more complex items. Pure horizontal symmetry occurred most often

with the early 12-piece items. Balanced reversal was much more frequent with the later complex items than the 12-piece ones, but oblique symmetry was commonest with items II and III. Aesthetic asymmetry occurred chiefly with the later items. Fragmentation was considerably most common with item I, evidently because objection was raised at that point. Segregation was most frequent with items of the same shape and different colours, especially item II. Linear placement was somewhat commoner in the earlier items.

Methods of Construction

Throughout the foregoing account regard has been paid only to the final product. The latter is of course, the result of a dynamic process, an individual operating on presented material. A highly provisional analysis is offered here of the procedures in construction. The facts in this matter are considerably harder to ascertain than in the case of the final product, since external observation must be supplemented by hazardous inferences and self-observation is notoriously difficult in such activities. The only statement that can be made with complete confidence is that there are marked individual differences in methods of approach and working.

It would appear that the final pattern is rarely, if ever, something clearly conceived in advance towards which the subject systematically works. Only repeated practice would bring this state of affairs about. One is apt to regard the final product as in some curious way a direct expression of the subject's individuality. Its relationship to the subject, however, is nearly always indirect. It is the result of a series of interactions between, on the one hand, the subject's preferences and sets and, on the other hand, the possibilities offered by the material. In these interactions chance elements play quite a considerable rôle.

The whole process of construction is most conveniently regarded as a succession of choices made by the subject. The *first choice* is in the interpretation of the instruction: "make a pattern." As the data show, most subjects understand this to mean that the pieces are to be placed symmetrically. A few able and aesthetically sophisticated subjects take it that the pieces are to be arranged asymmetrically in aesthetically satisfying relations. At the other extreme, intellectually defective or disorganized subjects respond to the instruction merely by shuffling the pieces about, placing them in long lines or arbitrarily conglomerating them, all procedures leading to absolute asymmetry. The *second choice*, if the subject has decided on symmetrical placement, is whether to pair in relation to one axis or aim at some more complex correspondence. Pairing about one axis is a straightforward procedure to analyse. The only complication is that some subjects work along the axis in relation to which they are pairing while others work along the opposite axis. The procedures in aiming at more complex correspondences, such as double or entire symmetry, offer much greater difficulty to the analyst of the performance. It is in these that individual differences are most prominent. Some subjects work systematically round a centre, others with alternating attention to each axis, still others with simultaneous awareness of both axes and also of the possibility of rotation. Any of these procedures may finally result either in double or in entire symmetry. Subjects quite often change from one procedure to another and back again. The two choices just named, together with various lesser preferences, e.g. for entirety, reversal, etc., constitute the individual's initial and fundamental set in accordance with which he works. All subjects display a strong perseverative tendency to deal with each item in the same general manner. This is an important factor underlying the high reliability coefficients. In certain subjects the

perseverative tendency is opposed by a much weaker need to vary the procedure or act differently in at least a few items. This brings about the sporadic appearance of most special behaviours.

A *third choice* arises when the subject's mode of procedure encounters difficulty in the material. The fact that the number of pieces in an item is limited, the presentation of four and only four identical pieces of each kind, the ruling that every piece must be used, all form obstacles to the subject's procedure in symmetrical placement. Some procedures and preferences meet difficulties more rapidly or more frequently than others. It is here that chance factors are quite extensively involved. When the subject finds obstacles in the material to the symmetrical construction of his pattern he may choose to add the discrepant pieces asymmetrically, to destroy what he has done and begin again (often at a lower level), or to modify his pattern so that the discrepant pieces can be incorporated into it symmetrically. The first alternative leads to imperfect symmetry. The level termed rudiments of symmetry arises rather when a subject who has embarked on symmetrical construction becomes dismayed at an early point by the general difficulties of the task. Balanced reversal may be carried out either as a deliberate variation or as a means of dealing with difficulties in the material.

When all pieces are arranged some subjects survey and check their product. Others leave it uncritically and are at once ready for the next item. Further personal differences and preferences in working may be listed here. Certain subjects show a definite preference for beginning with one shape or colour rather than another. Many subjects like to include and work round a central blank space in their patterns but others eschew this. Similarly there are subjects who like and subjects who avoid arranging pieces in long, projecting arms. Preferences of these sorts interact with the possibilities of the material to make the task less or more difficult. Some subjects resort to trial arrangements of the pieces, though most do not. Sub-vocal verbal formulations in general play little part in the procedure but some subjects rely on them to a great extent. A nice judgment of relative distance in the placement of pieces comes very easily to some persons and is very troublesome to others. Some subjects are strongly aware of the border within which the pattern is being constructed and relate their work continually to it; others are virtually oblivious of the border.

Discussion

The major findings in this inquiry have been: that when mental-hospital patients are required to construct patterns they generally do so symmetrically; that the symmetry-level of such patterns can be rationally quantified; that the scores so obtained show a high degree of reliability; that the intelligence-level of subjects is the most important single factor in determining the symmetry-level of their patterns but that nevertheless certain patients of very low ability can attain a high symmetry-level; that severe behavioural pathology lowers the symmetry-level of constructed patterns; that it is doubtful whether more moderate degrees of maladjustment have any effect; that females tend to attain a lower symmetry-level than males, a difference accentuated by severe behavioural pathology; and that colour-symmetry, though showing a moderately high correlation with shape-symmetry, is definitely harder for most subjects to achieve. Matters that require further discussion are: the rôle of intelligence; the effect of social maladjustment; the sex difference; and some problems connected with colour-symmetry.

The abler patients construct patterns at a higher symmetry-level than the

less able for several reasons, it would seem. At the beginning they set themselves a harder task. They find it easier to take into simultaneous account a number of different considerations. They perceive a greater variety of relations in the material and adapt their patterns more readily to the limitations of the available pieces. At the end they check more carefully what they have produced. As already remarked, a further investigation would be necessary to establish how it is that, in contradiction to the foregoing, certain oligophrenics can also attain the highest symmetry-levels. While symmetry-level scored in the manner of this investigation shows so marked a dependence on intelligence, it is noteworthy that in the mosaic test Himmelweit and Eysenck (1945) found aesthetic ability, as rated by six judges, to have no significant correlation with intelligence. A rather different point is that, if a larger number of aesthetically sophisticated subjects had been included in the bright sample, aesthetic asymmetry would probably have been much more prominent and the close relation of symmetry-level to intelligence correspondingly diminished.

The starting point of the inquiry was a suggested relationship between amount of asymmetry in patterns and degree of social maladjustment in the individual. Such a suggestion would seem to imply that the individual symbolizes in his patterns a lopsidedness in his personality or in his relationship with the community. The findings, however, indicate that if there is any relationship between social maladjustment and asymmetry it is an indirect one, mediated through impairment of cognitive functioning. Level of social adjustment in the less pathological sample had no influence on symmetry-level except doubtfully as an interactive factor with sex. The lower symmetry-scores of the more pathological sample evidently arose from cognitive inefficiency in the instances of the oligophrenics, seniles and organics. While the habit-deteriorated might be regarded as the extreme case of social maladjustment they of course also showed marked cognitive disorganization. Their performance was so closely parallel to that of the other three categories of severe behavioural pathology that their cognitive inefficiency seems much more likely than their maladjustment to be the direct and essential factor occasioning low symmetry-levels. The facts could be definitively ascertained, however, only by a careful isolation from each other of the two variables cognitive disorganization and social maladjustment.

The sex-differences in symmetry-scores obviously cannot be a matter of intellectual capacity. They seem to arise from a difference in values. Males prize a strict adherence to geometrical symmetry more highly than females do. Females prefer looser and less regular arrangements. This can readily be verified in everyday life by contrasting male and female behaviour in the arrangement of furniture in rooms, the laying of tables, the setting out of notes or records, and many other matters. Such statements of course refer to average tendencies; there are individual exceptions in each sex. Whether the difference is biologically based or a cultural matter or both must be left an open question here. The difference in relative values would appear to underlie all the sex-differences found. For example, the difference in oligophrenics would seem to be that males at that level make a greater effort than females to achieve symmetry in their patterns. With the organics and the habit-deteriorated symmetry-level is less vulnerable to impairment in males than in females because the former consider it of greater importance. This suggests a general hypothesis that highly valued capacities are more resistant to the effects of intellectual deterioration than less esteemed ones. Another aspect of the difference in values is that the higher forms deviating from rigid symmetry, e.g. semi-entire symmetry, tended to be commoner in females.

Various peculiarities in regard to colour-symmetry have been recorded in the preceding account. The split-half correlation for colour-symmetry was significantly lower in the less than the more pathological subjects. At the same time shape-scores and colour-scores showed a significantly higher intercorrelation in the more pathological subjects. A high colour-shape ratio characterized the more as against the less pathological subjects, but, paradoxically, within the latter category it characterized the bright against the dull. The fact was noted that colour-symmetry is harder to attain than shape-symmetry. The complete position, however, seems to be this: in the bright, shape-scores and colour-scores tend to coincide at a high level of symmetry; in the dull, colour-scores tend to fall below shape-scores because they are more difficult to attain; in the cognitively defective or impaired, however, shape-scores are at such a low level of symmetry that any difference from colour-scores tends to be eliminated. In other words, there is a curvilinear relationship between cognitive efficiency and the colour-shape ratio. This explains the facts cited above in regard to the correlation of shape with colour and to the colour-shape ratio. The finding in regard to split-half correlations probably arises because the colour-scores of the more pathological tend to be stable at a low level from item to item but in the dull members of the less pathological sample they tend to fluctuate in level in accordance with the possibilities of an item. The immediate reason for the greater difficulty of colour-symmetry appears to be that subjects attend primarily to shape and only secondarily to colour; more remotely, this derives from the general predominance of shape over colour in visual perception. Workers with the mosaic test, e.g. Wertham and Golden (1941), Diamond and Schmale (1944), have found that schizophrenics make a notably greater use of shape than colour in constructing their patterns. In the conditions of this inquiry, however, there was no evidence that a low colour-shape ratio characterized schizophrenics. The less pathological sample comprised 45 patients diagnosed as schizophrenics, 33 diagnosed as definitely not schizophrenics, and 2 of questionable status. There were no statistically significant differences between the schizophrenics and the non-schizophrenics in regard to mean shape-score, mean colour-score or colour-shape ratio.

The general relationships of visual perception are reflected in the construction of patterns not only in the predominance of shape over colour but also in the predominance of vertical over horizontal symmetry, cf. Gibson (1950) and Vernon (1952). Here it might be added that, as observed by Bunzel (1938), the construction of symmetrical artifacts is an almost universal human characteristic, only occasionally varied by excursions into asymmetry. Bunzel also notes the close dependence of ceramic and textile patterns on a relatively high degree of conceptual thinking. With these facts of a wider background the present findings are appropriately concordant.

SUMMARY

1. Patterns were obtained from mental-hospital patients of various categories by a technique akin to that of the mosaic test but simpler and more delimited.
2. An objective method of quantifying the level of symmetry was devised.
3. The symmetry-scores so obtained showed a high degree of reliability.
4. Inquiry was made into the effects on symmetry-level of differences in sex, intelligence and degree of social adjustment among relatively well-behaved patients. The effects of severe behavioural pathology were also investigated. Intelligence was shown to be the major factor in determining symmetry-level. Females tended to have lower symmetry-scores than males. Degree of social adjustment had no significant effect. Severe behavioural pathology tended to lower symmetry-scores and this was interpreted as essentially a cognitive phenomenon.

5. Various findings in regard to the relationship between symmetry of shape and symmetry of colour were recorded.

6. The reasons for the findings were discussed.

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REFERENCES

BUNZEL, R., *in* BOAS, F., *General Anthropology*, 1938, 562. Boston, Heath.
DIAMOND, B. L., and SCHMALE, H. I., *Amer. J. Orthopsychiat.*, 1944, **14**, 237.
FISHER, R. A., *Statistical Methods for Research Workers*, 1950, 11th ed., 96, 240. Edinburgh, Oliver and Boyd.
FOWLER, H. W., *et al.*, *The Concise Oxford Dictionary of Current English*, 1934, 3rd ed., 1240, s.v. Symmetry. Oxford, Clarendon Press.
GIBSON, J. J., *The Perception of the Visual World*, 1950, 148. Boston, Houghton Mifflin.
HIMMELWEIT, H. T., and EYSENCK, H. J., *Brit. J. Med. Psychol.*, 1945, **20**, 283.
KEMPTHORNE, O., *The Design and Analysis of Experiments*, 1952, 154. London, Chapman and Hall.
LOWENFELD, M., *Amer. J. Orthopsychiat.*, 1949, **19**, 537.
MACH, E., *Die Analyse der Empfindungen*, 1906, 5th ed., 87, 96. Jena, Fischer.
MANN, H. B., and WHITNEY, D. R., *Ann. Math. Statist.*, 1947, **18**, 50.
ROTH, M., and HOPKINS, B., *J. Ment. Sci.*, 1953, **99**, 439.
SHAPIRO, M. B., *J. Ment. Sci.*, 1951, **97**, 90.
Idem., *J. Ment. Sci.*, 1952, **98**, 605.
Idem., *J. Ment. Sci.*, 1953, **99**, 394.
SNEDECOR, G. W., *Statistical Methods*, 1946, 4th ed., 221, 249. Ames, Iowa, State College Press.
VERNON, M. D., *A Further Study of Visual Perception*, 1952, 83. Cambridge, University Press.
WERTHAM, F., and GOLDEN, L., *Amer. J. Psychiat.*, 1941, **98**, 124.