Figural goodness and the predictability of figural elements*

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All 126 patterns composed of five dots distributed over the cells of a 3 by 3 matrix were examined for the predictability of their elements. The predictability of a given dot in a given pattern was measured as the percentage of Ss who indicated that dot as one "implied or suggested" by the subpattern composed of the remaining four dots of the pattern. The dots comprising a figurally good five-dot pattern were generally more predictable, one from the others, than the dots comprising a poor pattern. This finding accords with the Gestaltist conception of a good figure as one whose elements are well organized, and it is the state of affairs required by Garner's hypothesis that better figures are perceived to have fewer alternatives than poorer figures. A mechanism mediating the prediction of an element of a pattern from the other elements was suggested.

One of the enduring contributions of Gestalt psychology is the concept of figural goodness, which the Gestaltists employed to point up the fact that some patterns are "better" than others. Some sets of elements, that is, are perceived as grouped into simple, well-organized patterns, which the Gestaltists called "good" figures, while other sets of elements are perceived as grouped into complex, poorly organized patterns, which the Gestaltists called "poor" figures. The present paper reports an extension of some work on figural goodness stemming from Garner's (1962) application of information theory to pattern perception.

In Garner's line of thought, patterns are conceived as multidimensional stimuli. Given a certain number of dimensions, each with a certain number of permissible values, the total number of patterns varying across these dimensions is determinate and this set of patterns will have a particular uncertainty which is the maximum value possible for the patterns. Any subset of these patterns will be redundant, by definition, because the uncertainty of the subset will be less than the maximum value, and a smaller subset will be more redundant than a larger subset. Garner suggested that such subsets are psychologically meaningful in that a person perceives a pattern of a given type as a member of a subset of the patterns of that type. Garner further suggested that the other members of a stimulus pattern's subset are patterns perceived as alternatives to the stimulus or equivalents of it, and he proposed that a stimulus pattern perceived to belong to a small, redundant subset will be a good figure.

Considerable evidence is now available in support of the hypothesis. Garner and Clement (1963), for example, working with dot patterns, reasoned that the patterns which Ss consider "similar" to a stimulus figure should be representative of those in its subset of perceived alternatives, and they found that there were fewer of these "similar" patterns for those stimuli which Ss judged to be relatively "good" figures. Handel and Garner (1966), working with the same dot patterns, reasoned that the patterns "suggested by" a stimulus figure should be representative of those in its subset, and they found that there were fewer of these "suggested" patterns for the stimuli judged to be relatively "good" figures.

The present study was primarily concerned with an implication of Garner's hypothesis which had not been systematically examined: *In accord with the Gestaltists' conception of a good figure as one whose elements are well-organized, each element of a good figure should be strongly suggested or implied by the other elements of the figure, but this close relationship should not obtain among the elements of a poor figure.*

The proposition can be derived as follows: According to the hypothesis, a good figure is perceived as a member of a relatively small, highly redundant subset of figures. But as a necessary concomitant of this subset's high redundancy, there will exist a considerable degree of what Garner (1962) called "contingent uncertainty" or "structure" within the subset in that the dimensions of variation will be closely correlated across the patterns belonging to the subset. The value which the good figure takes on any one dimension will thus be closely specified or predicted by the values which it takes on the other dimensions, and a S should perceive this predictability or contingency or relatedness.

A poor figure, on the other hand, is perceived as a member of a larger, less redundant subset, according to the hypothesis, and such a subset will possess low contingent uncertainty in that the dimensions of

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variation will show little correlation across the patterns in the subset. The value which the poor figure takes on some dimension will thus be largely unpredictable from the values which it takes on the other dimensions, and the S should recognize this unpredictability, just as he should recognize the contingency in the former case.¹

Overview of the Present Study

The five-dot patterns employed in previous research on the perceived-alternatives hypothesis (Clement, 1964, 1967; Garner & Clement, 1963; Handel & Garner, 1966) were tested for the predictability of their elements. Each pattern was decomposed into four-dot subpatterns, and the subpatterns were presented to Ss, who were asked in each instance to "add a fifth dot suggested or implied" by the four dots already present. The proposition derived above from the perceived-alternatives hypothesis requires that each dot of a good five-dot figure be strongly implied by the other four dots.

An independent measure of figural goodness was not obtained in the present study, since the previous research on the dot patterns provided several such measures. Instead, two other measures were taken: Ss' ratings of the goodness of the subpatterns, and Ss' preferences among those patterns that complete certain of the subpatterns.

The goodness ratings of the subpatterns were addressed to the question of whether the figurally better subpatterns would elicit "add-a-dot" responses with lower uncertainty. The subpatterns are patterns in their own right, and the figurally better subpatterns should be perceived as members of smaller subsets of subpatterns with lower stimulus uncertainties, according to Garner's hypothesis. If the uncertainty of responses to a figure reflects its stimulus uncertainty, then the figurally better subpatterns should thus produce a lower response uncertainty.

The preference data permitted an assessment of the role of pattern preferences in the task which yielded the predictability data.

METHOD

Patterns and Subpatterns

The patterns examined for the predictability of their elements were composed of five dots distributed over the cells of a 3 by 3 matrix. There are 126 different patterns of this kind ($_3C_5$), and all 126 were examined.

Each pattern was decomposed into five four-dot subpatterns, each of which lacked a different one of the five dots in the original pattern. The four-dot subpatterns which were thus produced numbered 630 (126×5), but there were only 126 different subpatterns, since each subpattern was a component of five different five-dot originals.

These 126 subpatterns, like the 126 five-dot originals, can be usefully grouped into *equivalence sets* (Prokhovnik, 1959). An equivalence set consists of all patterns which are identical to one another if reflected about the vertical or the horizontal axis, if

rotated in one or more 90-deg turns, or if both rotated and reflected. For both the four-dot and five-dot figures, there were 23 equivalence sets. A representative stimulus from each set is displayed in Fig. 2 for the five-dot patterns and in Fig. 3 for the four-dot subpatterns. The labeling of the five-dot sets is that chosen by Handel and Garner (1966): A numeral, 1, 4, or 8, indicates the size of a given set, while a letter distinguishes it among the several sets of that size. The labels for the four-dot sets were chosen so that a given equivalence set of four-dot subpatterns has the same label as the equivalence set of complementary five-dot patterns. This correspondence is possible because the complements of the five-dot stimuli in a given set constitute a complete equivalence set of four-dot stimuli, which is thus the same size as the five-dot set.

Experimental Stimuli

The 126 subpatterns were printed in black on the backs of yellow IBM punch cards, in the approximate centers of the cards, and square with respect to the edges of the cards. The cards measured 18.75 x 8.25 cm, while the matrices were 30 mm on a side, with cells 10 mm square. The dots were solid circles, 6.35 mm in diam, each centered in its square.

Experimental Tasks

The subpatterns were used in three different tasks. Each task was performed by a different group of Ss, each required only brief written instructions, and each was self-paced.

Implication Task

The implication task was intended to provide data measuring the predictability of each element in each five-dot pattern. Ss performing the implication task were given a deck of 149 stimuli, the first 23 of which consisted of the two subpatterns belonging to equivalence sets of Size 1, plus one randomly chosen representative of each of the other 21 sets. The remaining 126 stimuli consisted of a second occurrence of each of the 23 representative subpatterns, inserted to yield reliability estimates, plus a single occurrence of each of the other 103 stimuli. The first 23 stimuli and the remaining 126 were presented in independently determined random orders, as described below.

Instructions to the S read in part as follows: "The deck of cards you have been given contains 149 dot patterns. (Look them over briefly if you like.) Your task is to add one dot to each pattern. The dot you add must go in one of the empty squares. But don't add just any old dot. Add a dot which is implied or suggested by the dots already in the pattern. Here is an example of what we mean by 'implied or suggested.' [This example is reproduced in Fig. 1.] . . . You don't have to draw your dot in neatly. Just make a rough circle. Please work quickly. . . There are no right or wrong answers here, of course. We just want to know which dot is suggested to you by the dots already present in each pattern."

Most Ss completed this task within 15 min.

Rating Task

The rating task was intended to provide data on the goodness of the four-dot subpatterns. Ss performing this task were given a deck containing the 126 different subpatterns. These stimuli were randomly ordered, and the instructions asked the S to indicate on a scale from 1 to 7 "how good you think each of the patterns is." A "good" pattern was defined as one which is "simple and well organized," and a "poor" pattern as one which is "complex and poorly organized." Most Ss completed this task in 20 min.

Fig. 1. Example of implication presented to Ss in the implication task. Ss were told, "In this pattern, most people find that the dots already present suggest another dot in the location shown by the arrow."

Preference Task

The preference task was intended to provide data on Ss' preferences among the five-dot patterns which could be produced by addition of a dot to a four-dot pattern. Ss performing this task were given a deck consisting of the 23 representative stimuli used in the implication task. These stimuli were randomly ordered, and the instructions asked the S to "... add one dot to each pattern ... which makes a pattern you like. ... Put the dot in the square which makes the pattern you like the best." Most Ss completed this task within 5 min.

Randomization

Ss and Tasks

Ss were assigned to perform one of the three tasks at random, except for the four foreign students who were scheduled for the preference task. For reasons completely extraneous to the present study, they were randomly reassigned to the other tasks.

Stimuli

An attempt was made, through shuffling, cutting, and sorting, to produce different random orders of the stimuli in each of the decks employed.

Subjects

Ss were volunteers who were promised \$1 for participating in what was described only as a "study on dot patterns." All were people associated with Yale University in one capacity or another, and most were students in the summer school's language courses. Sixty of the Ss were assigned to the implication task, 28 males and 32 females, with a median age of 21.7. Twenty were assigned to the preference task, 10 males and

10 females, with a median age of 19.8. Twenty were assigned to the rating task, 8 males and 12 females, with a median age of 22.0.

Missing Data

In the implication task, Ss occasionally failed to respond to a stimulus and the N per subpattern was 58 or 59 instead of 60 for 32 of the subpatterns. In the rating task, one S failed to judge one stimulus. In the preference task, data were complete.

RESULTS

Predictability of Figural Elements

The data of central interest concerned the predictabilities of the elements of the five-dot figures: Was a dot in a good pattern in fact implied by the other four dots of the pattern? A predictability score for each dot in each pattern was derived from the data of the implication task—the percentage of Ss who responded with that dot when confronted with the subpattern composed of the remaining dots in the pattern.² Predictability scores derived from the 23 representative subpatterns which were presented to Ss twice were based only on responses to the first occurrences of the subpatterns.

The predictability scores for the five dots in each pattern were averaged to obtain a single score for the pattern. These scores ranged from 96.66% for Pattern 1a to 2.68% for a pattern in Set 8h, and differences between the 23 equivalence sets accounted for 98.8% of the variance in the 126 numbers. It was thus possible to ignore differences within the sets without losing much information, and the scores for the patterns in each set were averaged to obtain a single datum per set—the mean predictability of all dots in all figures in the set. These means are given in Fig. 2 below the patterns representing the equivalence sets.

Of the 10 independent measures of figural goodness available in previous research on the dot patterns, the most straightforward are the "goodness" ratings collected by Garner and Clement (1963), Clement (1964), and Handel and Garner (1966). Ss in these studies rated the patterns for "goodness" on a 7-point scale like that used for the subpatterns in the present study, and the authors then averaged the ratings a pattern received to derive its goodness score. In each study, the equivalence sets accounted for 97% to 98% of the variance in the goodness scores, and the authors accordingly struck the mean over the patterns within each equivalence set. (The means from the Handel-Garner study are given in Fig. 2.) These mean goodness ratings for the equivalence sets correlated $-.87$, $-.87$, and $-.92$ with the present study's scores of mean predictability of elements. Thus the proposition of central interest was clearly confirmed, in that the elements of the better figures proved more predictable, one from the others, than the elements of the poorer figures.³

Uncertainty of Completions and Subpattern Goodness

The predictability scores could be arranged to show not only the predictabilities of the five dots which constitute a given pattern, as in the analysis reported above, but also the predictabilities of the five dots which complete a given subpattern. The predictabilities of the five completions of a given subpattern sum to 100% in each case, and they could thus be treated as a distribution of probabilities with a particular

uncertainty. The maximum uncertainty of the five completions of a given subpattern was $\log_2 5$, which is 2.322 bits, and the actual uncertainties ranged from 2.287 bits for a subpattern in Set 8h to 0.122 bits for a subpattern in Set 4f and another in Set 4i.⁴ The 23 equivalence sets of subpatterns accounted for 94.0% of the variance in the 126 uncertainty scores, and a mean was accordingly struck for each set. These means are given in Fig. 3 below the subpatterns representing the equivalence sets.

Fig. 3. Data on four-dot subpatterns. To the left of each subpattern, the label for its equivalence set. Below each subpattern, on the first line, the mean "goodness" rating of the subpatterns in its set and the rank of this mean rating. On the second line, the mean uncertainty of completions for the subpatterns in the set and the rank of this mean. Within each empty cell, the mean predictability score computed as described in the text.

To check on the possibility that the figurally better subpatterns produced lower uncertainties in the completion responses, as Garner's hypothesis requires on the assumption that response uncertainty reflects stimulus uncertainty, data from the rating task were employed. The "goodness" ratings received by each of the subpatterns were averaged to produce a single score per subpattern. The 23 equivalence sets accounted for 97.3% of the variance in these scores, and the mean for each set was accordingly computed. These means are also given in Fig. 3, below the subpatterns, and they correlated .78 with the mean response uncertainties of

the sets. Thus, the figurally better subpatterns did, in fact, elicit distributions of "add-a-dot" responses with lower uncertainties.

Details of the Predictability Data

The two analyses reported above employed a single score per pattern, and this score was a composite of five predictability scores—the average of the predictability scores for the five dots of a pattern or the uncertainty of the predictability scores for the five possible completions of a subpattern. These composite scores

Table 1
Analysis of Variance of Predictability Data Arranged by Five-Dot Pattern

		Total	Equivalence Sets	Stimuli Within Sets	Structural Positions Within Sets	Stimuli by Positions Within Sets	Equivalent Locations Within Stimuli Positions, and Sets
Sets of Size 1 (2 Sets)	SS	58.89	22.83		11.48	—	24.58
	Percent	100.00	38.77		19.49	—	41.74
	df	9	1		2	—	6
Sets of Size 4 (11 Sets)	SS	175,685.88	103,712.48	2,733.05	64,139.76	2,613.41	2,487.08
	Percent	100.00	59.03	01.56	36.51	01.49	01.42
	df	219	10	33	24	72	80
Sets of Size 8 (10 Sets)	SS	21,830.05	2,477.28	1,011.68	15,327.34	3,013.75	—
	Percent	100.00	11.35	04.63	70.21	13.80	—
	df	399	9	70	40	280	—

were, in turn, averaged over the patterns or subpatterns within an equivalence set, at the loss of little information from the composite scores. But the composite scores themselves "averaged out" a great deal of information, since the predictabilities of the dots constituting a pattern and the predictabilities of the completions of a subpattern varied sizeably in some cases. The predictability scores were accordingly examined datum by datum.

Data on Full Patterns

There were 630 predictability scores, one for each of the five dots in each of the 126 patterns ($630 = 5 \times 126$). The variance among these scores, when arranged in the five-dot patterns, as in Fig. 2, could be attributed to five sources of interest: (1) Equivalence sets. (2) Stimuli, which are nested within equivalence sets. (3) Structural positions, which are also nested within equivalence sets. A structural position is a position defined with respect to the complete pattern regardless of the pattern's specific orientation—e.g., the isolated corner in the stimuli of Set 4k. This dot position occurs in each of the four corners of the matrix over the four stimuli in this set, but in each stimulus it is still the isolate and occupies the same position relative to the other dots. (4) The interaction of stimuli and structural positions within equivalence sets. (5) Structurally equivalent locations, which are nested within structural locations, stimuli, and equivalence sets. Structurally equivalent locations are dot positions which constitute the same structural position under the operations of rotation and reflection—e.g., the two nonisolated corners in the stimuli of Set 4k. These two corners are structurally equivalent in that the appropriate reflection of a pattern in the set leaves the configuration of the other dots unchanged, while switching the locations of these dot positions. Structurally equivalent locations occur only for patterns belonging to sets of Size 1 and Size 4.

Analyses of variance for these five factors are displayed in Table 1, one for each size of equivalence

set. For patterns belonging to sets of Size 4 and Size 8, most of the variance was due to differences between sets and between structural positions within sets, even though these two factors had the fewest degrees of freedom of the four or five sources of variance. Thus, little information was lost in the scores averaged over structurally equivalent locations and over stimuli within sets, and these are the scores reported in the matrices of Fig. 2 for the patterns belonging to sets of Size 4 and Size 8.

For the two patterns with set sizes of 1, structurally equivalent locations, namely, the four noncentral dot positions, accounted for 42% of the variance. This figure was large only because the total variance was small, but Fig. 2 gives the unaveraged percentages for these patterns.

The scores displayed in the cells of Fig. 2 might be said to indicate the strong points and the weak points of the various patterns. A high score in a particular structural position of a particular pattern, for example, indicates that the dot in that position was perceived as highly predictable from the other four dots and thus closely related to the other four, and this dot is in this sense a strong point within the pattern. A low score in a particular structural position of a particular pattern, on the other hand, indicates that the dot in that position was perceived as largely unpredictable from the other four and thus largely unrelated to the other four, and this dot is thus a weak point of the pattern. These within-pattern differences in the predictabilities of the figural elements are discussed further in Bear (1970).

Data on Subpatterns

The 630 predictability scores could also be arranged to provide data on the four-dot subpatterns, with five scores for each of the 126 subpatterns—one for each of the five locations in which Ss could add the fifth dot to the subpattern, as in Fig. 3. Analyses of variance for the data arranged in this way are displayed in Table 2. The analyses are like those reported for the same scores when

Table 2
Analysis of Variance of Predictability Data Arranged by Four-Dot Subpattern

		Total	Equivalence Sets	Stimuli Within Sets	Structural Positions Within Sets	Stimuli by Positions Within Sets	Equivalent Locations Within Stimuli Positions, and Sets
Sets of Size 1 (2 Sets)	SS	14,700.53	00.00	00.00	14,694.96	—	5.58
	Percent	100.00	00.00	00.00	99.96	—	00.04
	df	9	1	1	2	—	6
Sets of Size 4 (11 Sets)	SS	242,906.61	00.00	00.00	241,648.63	705.44	552.62
	Percent	100.00	00.00	00.00	99.48	00.29	00.23
	df	219	10	33	24	72	80
Sets of Size 8 (10 Sets)	SS	146,070.19	00.00	00.00	135,451.91	10,618.30	—
	Percent	100.00	00.00	00.00	92.73	07.27	—
	df	399	9	70	40	280	—

arranged to provide data on the full patterns, but the five predictabilities for each subpattern must sum to 100%. There is thus no variance, except that caused by rounding error, due to differences between subpatterns within equivalence sets or to differences between equivalence sets.

As Table 2 shows, most of the variance was due to differences between structural locations within equivalence sets, and the cells of the matrices of Fig. 3 present these data averaged over structurally equivalent locations and over stimuli within sets.

The within-pattern data of Fig. 3 suggest certain "implicational principles" (Abelson, 1968) by which Ss might have computed the location of a fifth dot implied by a subpattern. Construction of a symmetrical figure seems a likely principle of this sort, as does completion of a straight line. These implicational principles are considered in the discussion section, while special data on a "preference principle" are reported immediately below.

Preference as a Basis for Implication

Another possible implicational principle is completion of the most attractive pattern which can be made from a given subpattern. Such a motivational principle, however, is incongruous with Garner's information-processing line of thought, and the preference task was included in the present study to check on the use of this principle. Ss performing this task were explicitly asked to add to a subpattern that dot which completed the pattern they "liked the best." If Ss given the *implication* instructions used a preference principle of this sort, their completions would have closely resembled those of the preference Ss. But a different state of affairs was anticipated.

A S asked to add to a subpattern a dot implied by those already present should generally construct one of the figurally better completions of the subpattern, since the dots which produce these completions should be the dots most predictable from the subpattern. (In fact, the

implication Ss produced the figurally best possible completion, as determined from the Handel-Garner ratings, more often than any poorer completion in response to 125 of the 126 subpatterns.) But previous research on pattern preferences (e.g., Dorfman & McKenna, 1966; Munsinger & Kessen, 1964; Vitz, 1966a, b) indicates that Ss find patterns of intermediate goodness the most pleasing, and thus the figurally better completions of a subpattern should frequently be "too good" for the Ss' taste. Hence, the Ss given the implication instructions should have produced the figurally better completions of a subpattern more often than the Ss given the preference instructions did.

Responses from the implication Ss could be compared with those from the preference Ss for 23 subpatterns, the 23 representative of the 23 equivalence sets. These were the first 23 stimuli to which the implication Ss responded, and the only stimuli to which the preference Ss responded. The five possible completions of each of these subpatterns were rank-ordered according to the Handel-Garner goodness ratings of their equivalence sets, with mean ranks assigned in the case of ties. The mean goodness rank of the N completions produced by the N Ss responding to a given subpattern under each set of instructions was then computed.⁵ The implication Ss' score on this measure was lower for 17 of the 23 subpatterns, indicating that the implication Ss in fact produced the figurally better completions of these 17 subpatterns more frequently than the preference Ss did.⁶ The *t* for the difference between the two means was significant at the .05 level by a two-tailed test in 11 of these 17 cases, but not in any of the 6 exceptional cases. Thus, it seems unlikely that the implication Ss employed a preference principle in computing the locations of the dots implied by the subpatterns.

DISCUSSION

Support for the Perceived-Alternatives Hypothesis

The predictability data obtained in the present study

clearly indicate that the elements of the better dot patterns were more predictable than the elements of the poorer dot patterns, in that a figure's subpatterns suggested the remaining dot of the figure more strongly in the case of the better figures. This finding accords with the Gestaltist conception of a good figure as one whose elements are well organized, and it is the state of affairs required by Garner's hypothesis that better figures are perceived to have fewer alternatives than poorer figures.

The Mechanism Mediating the Predictability Phenomenon

The predictability data thus provide further evidence for the validity of Garner's perceived-alternatives hypothesis. The most fruitful direction for future research, however, may not be a continuing attempt to validate this hypothesis, but an effort to determine the psychological mechanisms mediating the various differences between patterns which have been shown to correlate with their figural goodness—including, of course, the difference in the number of perceived alternatives. The present data, in particular, point up the need for an account of the mechanism mediating the phenomenon of predictability—the mechanism by which the S computes the location of a stimulus element “implied or suggested by those already present,” and does so in a manner which yields an element completing a good figure. Models which assume that Ss predict a figure's elements have been proposed (Vitz & Todd, 1969), but there seems to be no detailed discussion of the phenomenon in the literature on perception.

Perhaps the most relevant work here is that of Abelson (1968; Abelson & Reich, 1969), a social psychologist who has proposed that Ss employ “implicational principles” in the processing of verbal stimuli which encode propositions. Abelson's hypothetical entity is an abstract generalization held by the S, and it seems similar to the “schema” (Evans, 1967a) and to the “prototype” (Posner, 1969), but only Abelson has discussed prediction in detail. He hypothesizes that the stimulus is matched against a relevant implicational principle and any information missing from the stimulus is supplied by the principle in a form appropriate to the stimulus.

If a perceptual analog of this process occurs, the data of Fig. 3 may be useful in suggesting the specific “principles” which Ss apply to the dot patterns. The data show, for example, a tendency to complete a straight line, a tendency to infer a dot symmetrically located with respect to a dot in the input, and a tendency to connect the dots in a subpattern containing an isolated element, among others. (No one of these tendencies, it should be noted, is sufficient to explain the data.) Each of these tendencies might be fruitfully reified in the form of a hypothetical implicational principle. Such principles will have their counterparts in

the stimulus properties which the Gestaltists recognized as correlates of figural goodness, of course—good continuity, symmetry, and proximity, among others. But the data of Fig. 3 may be especially valuable because they show the relative strengths of the implicational principles underlying the stimulus correlates of figural goodness in an exhaustive set of specific instances. And these principles may mediate the perception of a complete pattern as well as the performance of an implication task.

Response Uncertainty and Figural Goodness

It should be noted, finally, that there are now at least three studies showing that better figures elicit responses with lower uncertainty than poorer figures do. The present data showed lower uncertainty of “add-a-dot” responses for the figurally better subpatterns. Similarly, for the figurally better full patterns, Handel and Garner (1966) found lower uncertainty in the response of specifying a pattern “suggested by” the stimulus, and Clement (1964) found lower uncertainty in the response of providing a one-word name for the stimulus. These data accord with Garner's hypothesis that a better figure is perceived as a member of a smaller subset of figures with a lower stimulus uncertainty on the assumption that response uncertainty reflects stimulus uncertainty.

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NOTES

1. It should be noted that the proposition of interest here was advanced by Attneave several years before Garner put forth the perceived-alternatives hypothesis. Attneave suggested that a good pattern "is a figure with some high degree of internal redundancy [1954, p. 186]," and it is clear that what he meant by this description is a figure whose elements are predictable one from the others. But Attneave's use of the concept of redundancy differed from Garner's (Evans, 1967b), and there was no inkling of the perceived-alternatives hypothesis in this earlier work.

2. The predictability score for a given dot in a given pattern

was thus based on the consensus among the Ss as to whether that dot "should" go there. To apply the group consensus measure to an individual, it must be assumed that the N single responses of the N independent Ss were representative of N independent responses from a single S.

3. The other seven measures on the dot patterns available in previous research include five which have been interpreted as reflections of the size of the stimulus figure's subset of perceived alternatives and two measures of ease of learning, a classic correlate of figural goodness. Correlations between these seven measures and the present study's mean-predictability-of-elements scores were all in the expected direction and ranged in absolute value from .78 to .93. The 55 intercorrelations among all 11 measures were all in the expected direction and ranged in absolute value from .61 to .93 (Bear, 1970).

4. The uncertainties employed for the 23 representative subpatterns which were presented twice were based only on the first occurrences of the subpatterns. The correlation of .96 between these uncertainties and those based on the second occurrences estimated the reliability of these scores.

5. Because the implication Ss responded to each of the representative subpatterns a second time, the reliability of their mean-goodness-rank scores could be estimated from the correlation of .98 between the two sets of responses.

6. The six exceptional subpatterns appeared to be cases in which the best possible completion was a pattern with "just the right amount" of intermediate goodness and thus one which the preference Ss found highly attractive (Bear, 1970, Appendix B).

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