Effects of array organization on same-different judgments

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Two experiments investigated the role of array organization in the simultaneous matching task. Multielement arrays of letters were arranged in either "good" or "poor" configurations and subjects were asked to determine whether all the letters were the same or if at least one was different. Correct "different" responses were slower when the letters were presented in good configurations than in poor configurations. Correct "same" responses, however, were not affected by the organizational quality (goodness) of the array. This effect of pattern goodness on matching performance was not affected by the confusability of the letters being compared, the relative eccentricity (spread) of the configuration, or the ratio of different letters present on different trials. The results suggest an *encoding* stage locus for the effect of pattern goodness and provide evidence supporting a two-process model of same-different judgments.

Psychologists have devoted considerable attention to the processes underlying the human capacity to categorize two or more entities as "same" or "different." Much of the controversy has centered on the question of whether a single process underlies "same" and "different" judgments (e.g., Posner & Boies, 1971) or whether two separate processes are responsible for the two types of judgments (e.g., Bamber, 1969; Tversky, 1969). At the heart of the issue is the fact that "same" judgments are often made more quickly than are "different" judgments. Since it would seem that "different" judgments could be made as soon as one differing aspect is detected but "same" judgments would require an exhaustive inspection of stimulus attributes, the advantage for "same" responses constitutes a paradox. Single-process models have attempted to account for this paradox by invoking concepts such as response bias or stimulus "priming" (Posner & Boies, 1971), while two-process models have chosen to attribute differences between the speed of "same" and "different" judgments to characteristics of the independent processes responsible for them. Investigators, seeking to support or negate one model or another, have explored the effects of a wide variety of stimulus manipulations. Among the most popular have been the familiarity of the stimuli being compared (e.g., Egeth & Blecker, 1971), the number of dimensions upon which stimuli differ (e.g., Nickerson, 1967), and the number of stimuli which must be compared (e.g., Beller, 1970). Unfortunately, the great wealth of available data has not provided evidence for a single best theoretical model.

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A stimulus variable which has received relatively little attention, however, is that of stimulus structure or organization. Only a few studies have examined the possible role of structural factors in the same-different paradigm. Hock (1973) presented subjects with pairs of dot patterns which were either both symmetrical or both asymmetrical, and looked at the effect of symmetry on "same" and "different" responses. For some subjects, there was no effect of symmetry on either "same" or "different" responses, but for other subjects, "same" responses to symmetrical patterns were faster than "same" responses to asymmetrical patterns. Hock hypothesized two types, or modes, of processing: *analytic* processes, which examine and compare stimulus features independently, and *structural* processes, which organize the features into a well-formed whole. It was suggested that "different" responses are based solely on analytic processes, but that "same" responses can result from either analytic or structural processing. Conditions which favor structural processes, such as when stimuli are symmetrical, can therefore sometimes facilitate "same" responses by allowing a more rapid comparison process.

Fox (1975) has also advanced a structural hypothesis for judgments of sameness. Unlike Hock, who was interested in the symmetry of the units being compared, Fox explored the effects of symmetry of the total visual array. He found that "same" responses to letter pairs exhibiting vertical bilateral symmetry (e.g., TT or AA) were faster than same responses to letter pairs lacking this quality (e.g., GG or LL). The effect was even greater for pairs of geometric forms than for letter pairs. The results were interpreted as suggesting that subjects are able to utilize display symmetry as a *structural diagnostic*. By this is meant that the presence of display symmetry along the vertical axis can signal the occasion

for a "same" response, making further analysis and comparison of stimulus features unnecessary. Since vertical display symmetry occurs only for some "same" pairs and never for different pairs, its detection always signals the presence of physically identical stimuli. On the other hand, the absence of vertical display symmetry would not necessarily indicate that the stimuli are different, since some "same" pairs do not exhibit vertical display symmetry (e.g., LL). Diagnosticity then benefits only "same" responses and might represent a possible explanation for fast "same" judgments.

A study by Egeth, Brownell, and Geoffrion (1976), however, suggested that, if diagnosticity can be employed at all, its use is restricted to cases where the stimuli involved are less "codable" than the letters of the alphabet. They found no advantage for same letter pairs with vertical display symmetry over same letter pairs without it. The role of diagnosticity in the simultaneous matching task, then, is yet to be precisely delineated.

A recent study by Hershenson and Ryder (Note 1) has demonstrated effects of display organization for "different" responses. These authors found that correct "different" responses were slower to pairs of stimuli possessing display symmetry (e.g., RЯ or LJ) than to pairs without this quality (e.g., RL or ЯJ). They interpreted their results by suggesting that pairs of stimuli are initially perceived or processed as single, whole configurations. Before the elements of the pair can be compared, the perceiver must "break apart" the larger whole. The presence of display symmetry enhances the tendency to process the pair as a single unit and therefore can be detrimental to performance.

While there have been attempts to examine effects of display organization on same-different judgments then, the evidence at present is less than compelling. The structural diagnosticity hypothesis of Fox suggests a distinctly indirect role of display organization which has consequences for "same" responses only. And, as Egeth et al. (1976) have suggested, diagnosticity may be operational only when "uncodable" stimuli are used. Hershenson and Ryder (Note 1) argue for a more direct role of display organization on visual matching performance. Unfortunately, however, an alternative interpretation of their results is possible. Letter pairs such as RЯ may be more difficult to judge as different than pairs such as RL because (1) display organization (symmetry) impedes a consideration of elements as individual units or (2) the elements share more features. Simply reversing or inverting a letter should not change entirely its constituent features, particularly if one considers spatial interrelationships of letter components as a type of featural information. Correctly classifying RЯ as different, then, could take longer than a pair such as RL, because the elements R and Я share features whereas the elements R and L do not.

The present experiments were designed to permit an

examination of the direct influence of display organization on both "same" and "different" judgments. Multi-element arrays of letters arranged in either "good" or "poor" configurations (Garner & Clement, 1963) are employed, and subjects must determine whether all of the letters are the same or if at least one is different from the rest. Response type (same vs. different) and level of array organization (good vs. poor) are therefore orthogonal factors. Furthermore, the definition of array organization is not tied to the featural characteristics of individual elements but, rather, to the elements' spatial interrelationships. The design permits independent assessments of array organization, response type, and element similarity (number of features in common) as well as the opportunity to examine their potential interdependencies.

That pattern "goodness" can play an important role in perceptual processing has been well demonstrated in other experimental paradigms. Garner and Sutliff (1974), for example, used a choice reaction time task and found that response latencies to good patterns were faster than those to poor patterns. The authors attributed their results to an *encoding* advantage for good patterns. A similar conclusion was drawn by Bell and Handel (1976), who used a backward masking paradigm and found that good patterns could be reproduced more accurately than poor patterns. The advantage for good patterns disappeared at interstimulus intervals long enough to preclude masking, suggesting that the effect of pattern goodness was on rate of *encoding* rather than on retention.

Both the Bell and Handel (1976) and the Garner and Sutliff (1974) studies demonstrated facilitative effects of pattern goodness on processing. It should be noted, however, that both of these tasks required subjects to be primarily concerned with the whole form or pattern of elements rather than the elements themselves. When individual elements must be considered, the presence of pattern goodness is apparently less than facilitative. In a study by Pomerantz and Garner (1973), subjects sorted through decks of cards bearing five-element patterns, separating those with a predesignated target letter from those without the target letter. Sorting time was affected by pattern size and target discriminability but was not affected by the goodness of the pattern. Using the closely related forced-choice detection task, however, Banks and Prinzmetal (1976) found detection performance to be impaired when the target letter grouped together with distractors to form a good pattern or "Gestalt." The pattern goodness effect here is clearly detrimental to performance.

Pattern goodness, then, has been shown to affect processing in several different ways, depending on the characteristics and demands of the particular task employed. Exactly how it might affect performance in the same-different task is the question the first experiment is intended to address.

EXPERIMENT 1

Method

Subjects. Fourteen volunteer undergraduates from psychology classes at Iowa State University served as experimental subjects. All had normal or corrected-to-normal vision.

Stimuli. Each stimulus consisted of nine letters typewritten on Mylar and prepared as a slide for presentation in a Kodak Carousel slide projector. Only the capital letters C and O were used, and the nine letters of each stimulus were arranged in one of the two configurations illustrated in the top row of Figure 1 (configurations G1 and P1). These configurations were formed by placing letters in 9 of the 25 cells of an imaginary 5 by 5 matrix. Configuration G1 is a "good" pattern according to the criteria provided by Garner and Clement (1963), in that any reflection or 90° rotation will produce the same pattern. Configuration P1 is a "poor" pattern, since the operations of reflection and rotation will result in eight different patterns. The two configurations therefore represent different levels of pattern goodness or different degrees of Gestalt organizational quality.

The configurations were also selected on the basis of their comparable levels of element eccentricity (spread) to insure that the pattern goodness variable was not confounded with retinal eccentricity. Defining the distance from the center of one cell of the imaginary matrix to the center of a flanking cell as one unit, the distance of each element from the center of the matrix was measured. The mean element distance for each configuration was computed by summing the nine element distances and dividing by nine. The obtained mean distances of 1.517 and 1.504 units for G1 and P1, respectively, show the two to be closely equated on the variable of pattern (and retinal) eccentricity. It should be noted that there is more variability in the distances of elements in the poor configuration ($\sigma^2 = .515$) than in the good configuration ($\sigma^2 = .364$) and it is therefore at least conceivable that the two differ in their susceptibility to inter-element interference or lateral masking effects. We will see later however, with the results of Experiment 2, that this factor appears not to play an important role.

One half of the total 144 stimuli presented consisted of nine letters which were all the same (all Cs or all Os). The other half consisted of some combination of the two letters and called for a different response. Half of both the same and different stimuli were arranged in the good configuration and the other half in the poor configuration. One half of the stimuli with different letters had a 1:8 letter ratio (one C and eight Os, or vice versa), while the other half displayed a 4:5 letter ratio. For stimuli with a 1:8 ratio, the lone letter appeared twice in each of the nine positions of each configuration, once as a lone C in a field of Os and once as a lone O in a field of Cs. For stimuli with a 4:5 letter ratio, both Cs and Os appeared in all positions of both configurations with equal frequency.

Apparatus and Procedure. The stimuli were presented with a Kodak Carousel slide projector equipped with a Lafayette tachistoscopic shutter (Model 43016). They were projected onto a Kodak black glass rear-projection screen, and subjects viewed them from a position 2 m directly in front of the screen. A padded head support was employed to insure that viewing distance remained constant for all subjects on all trials. Response latencies were measured with a Lafayette digital clock-counter (Model 54417-A). The clock began running simultaneously with stimulus onset and stopped when the subject responded by depressing one of two levers marked "same" and "different." Half of the subjects used their dominant hands to respond "same" and their nondominant hands to respond "different." Hand assignments were reversed for the other half of the subjects.

Subjects were instructed to fixate the center of the screen following the "ready" signal from the experimenter. About 1 sec later, a stimulus slide was presented and it was the subject's task to determine whether the nine letters shown were all the same or if at least one was different from the rest, and to respond by

Figure 1. The four configurations used in the experiments. G1 and G2 are "good" configurations and P1 and P2 are "poor" configurations. Only G1 and P1 were used in Experiment 1, whereas all four were used in Experiment 2.

depressing the appropriate switch. The instructions to subjects emphasized the importance of both speed and accuracy.

The stimulus configurations subtended a maximum visual angle of 6° both horizontally and vertically. Individual letters subtended visual angles of about 34' horizontally and about 45' vertically. Approximately 48' separated letters which were horizontal or vertical neighbors and about 1°09' separated diagonal neighbors.

Each subject received an initial 36 practice trials, which represented all of the levels of all factors used in the experiment. The subject was not aware that these trials were for practice purposes.

Design. The design was a balanced 2 by 2 factorial with repeated measures on all factors. The two levels of configuration goodness (good vs. poor) were factorially combined with the two levels of response type (same vs. different). The primary analysis evaluated only these two factors; the two types of different trials (those with a 1:8 letter ratio and those with a 4:5 ratio) were ignored. The impact of this variable was evaluated with a separate analysis. Stimuli representing the various combinations of factor levels were presented in random order with the restriction that no more than four same trials or four different trials be consecutively presented. Presentation was in two blocks of 72 trials with a short break between blocks. Block presentation order was reversed for half of the subjects.

Results and Discussion

Response latencies and error rates from Experiment 1 are shown in Table 1. The primary analysis of variance performed on correct response latencies found

Table 1
Response Latencies and Error Rates from Experiment 1

Response Type	Configuration	
	Good (G1)	Poor (P1)
Same	640 (.030)	648 (.040)
Different	667 (.085)	629 (.052)
1-8	705 (.120)	658 (.071)
4-5	629 (.051)	601 (.032)

Note—Error rates are in parentheses.

Figure 2. Mean response latencies as functions of configuration goodness and response type for Experiment 1.

no main effect of response type; mean same response latency did not differ from mean different response latency, $F(1,13) = 0.18$, n.s. There was a significant main effect of configuration as the mean response latency to good configurations was longer than the mean to poor configurations, $F(1,13) = 4.44$, $p < .05$. However, a significant interaction between configuration goodness and response type [$F(1,13) = 11.28$, $p < .01$] revealed the main effect of configuration goodness to be solely a function of correct different responses. This interaction is illustrated in Figure 2. A Newman-Keuls stepwise comparison of means showed that the mean latency for different responses to the good configuration (667 msec) was significantly longer than the different-poor mean (629 msec) and the same-good mean (640 msec) at a .05 level of confidence. No other comparisons reached significance.

The overall error rate was .052, and a breakdown of error rate by experimental condition is found in Table 1. As can be seen, error rates reflect the same general pattern of results as do response latencies with higher error rates associated with longer response latencies. The four error rates associated with the significant interaction shown in Figure 2 were analyzed with sign tests. False "same" (subject responded "same," correct answer was "different") responses to the good configuration were more common than any other type of error at a .05 level of confidence. No other test approached significance.

The results demonstrate a substantial effect of configuration goodness on performance in the same-

different task. The interaction shown in Figure 2 shows that while "same" responses appear to be unaffected by the level of configuration goodness, there is a prominent effect of this variable on goodness responses. Apparently differences between elements are more difficult to discern when those elements are arranged in an organized or good configuration. This outcome parallels the results of Hershenson and Ryder (Note 1) and, in general, corroborates their organizational hypothesis.

A second analysis of variance was performed on correct different responses only. As was found in the primary analysis, correct different responses to the good configuration were slower than correct different responses to the poor configuration, $F(1,13) = 33.9$, $p < .001$. Response latencies to arrays containing only one different letter were significantly longer than latencies to arrays with a 4:5 letter ratio, $F(1,13) = 65.6$, $p < .001$. This result might reflect the operation of a serial self-terminating comparison process. When the ratio of different letters is 4:5, fewer comparisons, on average, will have to be made before a difference is detected than when only one different letter is present. Of some interest is the fact that the number of different letters factor did not interact with configuration goodness, $F(1,13) = 1.81$, $p < .20$, mean square error = 749. The absence of an interaction here suggests that configuration goodness has its effect on performance at some level of processing other than that of feature comparison. Since most models or explanations of same-different judgments have concentrated their theoretical efforts on comparison stage processes, the possibility that configuration goodness does not operate at this stage of processing seemed sufficiently important to warrant further investigation.

EXPERIMENT 2

The elements used in Experiment 1 (C and O) are visually confusable (they share features), and it is possible that this could have contributed to the obtained effects of configuration goodness. If configuration goodness does not operate at the feature comparison stage of processing, however, it should make no difference whether the elements being compared are confusable (share features) or nonconfusable (do not share features). A second experiment was designed to incorporate a variable of element confusability. A confusable element condition was provided by using the letters C and O, while the letters X and O were used to provide a nonconfusable element condition. Level of element confusability should be expected to have a major impact on performance through its effect on comparison processes. If, however, configuration goodness does not operate at the feature comparison level of processing, then element confusability should not be expected to influence the relationship between configuration goodness and response type.

In addition to the incorporation of an element con-

fusability factor, Experiment 2 also employs additional exemplars of good and poor configurations. Thus, the second experiment was designed to serve a dual purpose: (1) to provide evidence for the possible locus of the configuration goodness effect, and (2) to assess the generalizability and reliability of the pattern goodness effects obtained in the first experiment.

Method

Subjects. Eight volunteer undergraduates with normal or corrected-to-normal vision were used as subjects for Experiment 2, and each served in two experimental sessions.

Stimuli. Stimuli were again nine-letter arrays typewritten in capitals and prepared for presentation as slides. Two good configurations and two poor configurations were used, and the set of four is shown in Figure 1. Configurations G1 and P1 are, of course, the configurations used in Experiment 1, while G2 and P2 are new configurations which parallel G1 and P1 on the variable of pattern goodness. Like configuration G1, configuration G2 is a good pattern in that it reproduces itself when reflected or rotated in 90° steps. Like P1, configuration P2 is a poor pattern as it results in eight different patterns when reflected or rotated. As were configurations G1 and P1, configurations G2 and P2 are equated for element eccentricity with respective mean element distances of 1.885 and 1.890 units. While they are comparable to each other in this regard, they are not comparable to configurations G1 and P1, as they exhibit greater element eccentricity than the two previously used patterns. The use of additional configurations, then, has introduced a new experimental variable into the design, i.e., configuration eccentricity. The four configurations used in Experiment 2 represent the factorial combination of two levels of configuration goodness (good vs. poor) and two levels of configuration eccentricity (low vs. high).

It was noted earlier that configurations G1 and P1 differ in element distance variability and therefore might be differentially susceptible to effects of lateral masking. It is possible, then, that the effects attributed to pattern goodness in Experiment 1 are, instead, attributable to this factor. The original pair of configurations were characterized by greater element distance variability for the poor pattern ($\sigma^2_{P1} = .515$) than for the good pattern ($\sigma^2_{G1} = .364$). This relation, however, is reversed for configurations G2 and P2, with greater element

distance variability for the good pattern ($\sigma^2_{G2} = .987$) than for the poor pattern ($\sigma^2_{P2} = .758$). If the pattern goodness effects found in Experiment 1 owe their character to lateral masking differences between G1 and P1, then we should expect an opposite effect of pattern goodness for the two new (high-eccentric) configurations. If, instead, pattern goodness operates the same way for both low-eccentric and high-eccentric configurations, we may safely conclude that it is, indeed, pattern goodness and not vulnerability to lateral masking effects which is responsible for the results.

One half of the total 576 stimuli for the experiment were constructed using the letters C and O and were used as the confusable element condition, while the other half were comprised of the letters X and O and served as the nonconfusable element condition. The 288 stimuli of each confusability level were comprised of equal numbers of the four configurations, and, of course, one half of the stimuli for each configuration presented nine letters which were the same and the other half some combination of two letters. As in Experiment 1, one half of the stimuli presenting two different letters exhibited a 1:8 ratio and the other half a 4:5 ratio.

Procedure and Design. The apparatus and basic experimental procedure were the same as those of Experiment 1. Each subject received a total of 576 trials in two blocks of 288 on consecutive days. Letter confusability was blocked by session, with half of the subjects responding to trials presenting confusable letters (C and O) on the first day and to nonconfusable letters (X and O) on the second day. The reverse order was used for the other half of the subjects. Before each session, subjects received 36 practice trials representing all factor combinations used in that session.

The design was a 2 by 2 by 2 by 2 balanced factorial with configuration goodness, configuration eccentricity, element confusability, and response type as the factors. With the exception of element confusability, which was blocked over the two sessions, trials representing the various combinations of factors were presented in a random order. The 288 trials of each session were presented in two blocks of 144 trials, and block order was reversed for half of the subjects.

Results and Discussion

Response latencies and error rates obtained under the various experimental conditions of Experiment 2 are presented in Table 2. Again, two analyses of response

Table 2
Response Latencies and Error Rates from Experiment 2

Response Type	Configuration				Configuration Type	
	G1	P1	G2	P2	Good	Poor
Confusable Letters (C-O)						
Same	595 (.024)	602 (.032)	632 (.035)	640 (.049)	614 (.030)	621 (.040)
Different	639 (.066)	617 (.038)	637 (.049)	620 (.021)	638 (.057)	619 (.030)
1-8	676 (.090)	647 (.049)	689 (.084)	665 (.043)	683 (.087)	656 (.045)
4-5	603 (.044)	587 (.028)	585 (.014)	575 (.000)	594 (.028)	581 (.014)
Nonconfusable Letters (X-O)						
Same	479 (.014)	479 (.038)	485 (.028)	497 (.028)	482 (.021)	488 (.033)
Different	502 (.028)	482 (.028)	508 (.034)	480 (.012)	505 (.030)	481 (.019)
1-8	523 (.055)	501 (.044)	537 (.041)	498 (.014)	530 (.049)	499 (.028)
4-5	481 (.000)	463 (.014)	478 (.021)	462 (.007)	480 (.010)	462 (.010)
Confusable and Nonconfusable Letters Combined						
Same	537 (.020)	541 (.035)	559 (.032)	569 (.039)	548 (.026)	555 (.037)
Different	571 (.047)	550 (.033)	573 (.040)	550 (.016)	572 (.044)	550 (.025)
1-8	600 (.073)	574 (.045)	613 (.063)	582 (.028)	607 (.068)	578 (.037)
4-5	542 (.021)	525 (.021)	532 (.018)	519 (.004)	537 (.019)	522 (.012)

Note—Error rates are in parentheses.

latencies were performed—one which assessed both “same” and “different” responses while ignoring the ratio of different letters, and a second which looked only at “different” responses and which did include different letter ratio as a variable. The results of the former analysis will be reported first.

The interaction between configuration goodness and response type was again significant, $F(1,7) = 26.0$, $p < .005$, and is illustrated in Figure 3. Newman-Keuls comparisons of the four means involved in the interaction showed that the mean different response latency to good configurations was significantly longer than the other three means at a .05 level of confidence. No other comparisons approached significance. A comparison of this interaction with its counterpart from Experiment 1 (see Figure 2) reveals a striking similarity and speaks to the reliability and generalizability of the obtained effects. The addition of the two new exemplars of good and poor configurations did not alter the relationship between pattern goodness and response type. There was not even a hint of a three-way interaction between configuration goodness, response type, and configuration eccentricity, $F(1,7) = 0.34$, n.s. This finding indicates (1) that the pattern goodness effects found in Experiment 1 are not restricted to the particular configurations employed there, and (2) that these effects are indeed attributable to pattern goodness and not to differences in susceptibility to effects of lateral masking.

Both the main effects of eccentricity [$F(1,7) = 16.5$, $p < .005$] and letter confusability [$F(1,7) = 73.9$, $p < .001$] were significant. Response latencies were longer to high-eccentric than to low-eccentric configurations and longer when letters were confusable than when nonconfusable. The effect of confusability was quite marked and would seem to reflect the need for a longer or more extensive comparison stage when the entities being compared share many features. Differences between letters could be detected sooner or with greater ease when several differences are present. When few differences exist (i.e., when letters are confusable), on the other hand, detecting them will require more time. The detection of “sameness” is likewise slowed because the subject knows that a real difference is more apt to be overlooked when the letters are very similar and therefore will proceed with greater caution.

In addition to the main effect of eccentricity, the two-way interaction between eccentricity and response type [$F(1,7) = 17.4$, $p < .005$] and the three-way interaction between eccentricity, response type, and letter confusability [$F(1,7) = 8.90$, $p < .02$] were also significant. The latter interaction is illustrated in Figure 4. From the figure, it is apparent that eccentricity affected performance only for “same” responses when letters were confusable. That the eccentricity effect is dependent upon the level of element confusability suggests that it shares with that variable the comparison stage as its locus of operation. That it affects only “same” responses is somewhat surprising in that it would seem

Figure 3. Mean response latencies as functions of configuration goodness and response type for Experiment 2.

that the detection of differences would also be more difficult or slower when elements occupy less favorable retinal locations. Nevertheless, the effect is restricted to “same” responses and offers theoretical implications which will be discussed in the final section of this paper.

While letter confusability and eccentricity did affect

Figure 4. Mean response latencies as functions of configuration eccentricity, letter confusability (C-O = high, X-O = low), and response type for Experiment 2.

matching performance, it is important to note that their effects had no impact on the role played by configuration goodness. Neither the Configuration Goodness by Confusability, $[F(1,7) = 0.28]$ nor the Configuration Goodness by Eccentricity, $[F(1,7) = 0.47]$ interactions even approached significance. To the extent we are correct in assuming that confusability and eccentricity operate at the comparison stage of processing then, there is support here for the contention that pattern goodness operates at some other stage of processing. We will return to this point later.

A second analysis of variance evaluated only correct "different" responses and incorporated the ratio of different letters as a variable. As in Experiment 1, response latencies were longer to good configurations than to poor configurations $[F(1,7) = 28.8, p < .001]$ and longer to arrays with only one different letter than to those with a 4:5 letter ratio $[F(1,7) = 85.7, p < .001]$. Also significant was the main effect of letter confusability $[F(1,7) = 61.5, p < .001]$ and the interaction between confusability and different letter ratio $[F(1,7) = 10.3, p < .02]$. The effect due to the ratio of different letters present was apparently augmented by the presence of confusable letters, and since both of these variables ostensibly affect comparison processes, their interaction is rather predictable. There was again no suggestion of an interaction between different letter ratio and configuration goodness $[F(1,7) = 0.99, p < .60, \text{mean square error} = 1.471]$.

The overall error rate for Experiment 2 was .032, and the error rates associated with the various experimental conditions are shown in Table 2. Again, higher error rates tend to be associated with longer response latencies. The four error rates associated with the means of the interaction between configuration goodness and response type were evaluated with sign tests, and no test reached an acceptable level of significance.

GENERAL DISCUSSION

The results of the present experiments present a convincing argument for the importance of array structure in the simultaneous matching task. The psychological processes involved in correctly judging a group of elements to be the same or different are sensitive not only to the characteristics of individual elements, but also to the elements' spatial interrelationships. Although the task would seem to require only a consideration of element features, performance is nonetheless influenced by organizational properties of the composite visual array. Modelers of same-different judgments can simply no longer ignore such properties in their theoretical formulations.

Although the present experiments are the first to directly implicate pattern goodness as an important variable in the matching paradigm, there have been other studies which have obtained similar evidence. The Hershenson and Ryder (Note 1) finding, for example,

of longer different response latencies to vertically symmetrical letter pairs than to vertically asymmetrical letter pairs accords nicely with the detrimental effect of pattern goodness on different responses found in the present experiments. Yet another example of the potentially harmful effects of array organization on different responses was reported by Wolff (1971). In this study, subjects were required to classify pairs of horseshoe stimuli as same or different. The important finding for present consideration was that different responses to mirror-image pairs (e.g., $\cap$ or $\subset$) averaged 75 msec longer than different responses to non-mirror-image pairs (e.g., ξ or $\cup$). Here, again, the detection of element differences is hampered by the presence of a larger, organized whole. The importance of array structure for "different" responding, then, seems to be well substantiated.

Exactly how does pattern goodness affect matching performance? A definitive answer to this question must await the results of further investigation, but some of the present findings do bear on the issue. For example, knowing *where* in processing pattern goodness operates would greatly facilitate an understanding of *how* it might operate. In this vein, the important outcome of the present experiments was the total independence of the pattern goodness effect from the roles played by several other experimental variables. In Experiment 2, the effects of pattern goodness on response type were essentially identical for two different levels of letter confusability and two different levels of configuration eccentricity. Also, in both experiments, the effect of pattern goodness on different responses was the same whether arrays contained only one different letter or were comprised of four of one letter and five of the other. Since the most plausible site for the effects of confusability, eccentricity, and different letter ratio would be the comparison stage of processing, it seems very likely that pattern goodness operates elsewhere, either prior to comparisons at the encoding stage or following comparisons at the response selection stage.

Unfortunately the present results do not provide a basis for favoring one of these alternatives over the other. Available evidence from other sources, however, seems to point to an encoding stage locus for the role of pattern goodness. As was mentioned earlier, the facilitative effects of pattern goodness on choice reaction time (Garner & Sutfill, 1974) and on reproduction of backward-masked patterns (Bell & Handel, 1976) were interpreted by their respective authors as reflecting an *encoding* advantage for good patterns. And the Banks and Prinzmetal (1976) finding of an impairment in forced-choice detection when a target is embedded in an organized configuration was interpreted to result from configurational effects on an early perceptual "parser." This parser organizes information from the entire visual field into groups which can then be considered by an "analyzer" stage of processing. Detection is impaired when the "parsing" process groups the target together with distractors.

Evidence from divergent sources, then, has converged on a similar conclusion: that pattern goodness operates early in processing at the encoding stage. So, although the present effects of pattern goodness may be regarded as occurring at either the encoding or the response stage, outside evidence seems clearly to favor an explanation of the results directed at the encoding stage of processing.

Assuming an encoding stage locus for the effects of pattern goodness, there are probably several ways in which it might affect matching performance, and a couple of possibilities will be considered here. The presence of a larger, organized pattern might possibly slow or impair the detection of element differences by temporarily forcing an allocation of processing capacity to a consideration of the larger pattern instead of to individual elements. Encoding the array as a single pattern would be dysfunctional in the same-different task where the identities of individual elements must be discerned. This is essentially an attentional hypothesis and attributes the pattern goodness effect to some sort of misappropriation of processing capacity.

The results might also be addressed with the perceptual "parsing" hypothesis advanced by Banks and Prinzmetal (1976). From this view, difficulties in detecting differences between elements of a good configuration would arise when the "parser" fails to segregate the letters into nine individual units. If two different letters are incorrectly grouped together before being sent on to the "analyzer" (comparator?) stage, that difference will not be detectable. When this happens, that information will have to be returned to the parser to be "regrouped" into individual units. On the occasion when this regrouping is not undertaken, the existing difference will not be detected and an error will occur.

There remains, of course, one important question: Why does pattern goodness affect only different responses? In both experiments there was a notable absence of any pattern goodness effect on "same" judgments. How can a variable have such a dramatic impact on one type of response and virtually no effect on the other type? It becomes necessary at this point to consider the distinction between one-process and two-process theoretical models of same-different judgments. If a single processing mechanism is assumed to be responsible for both "same" and "different" judgments, the selective effect of pattern goodness on "different" judgments is indeed difficult to understand. One would expect to see either a similar effect on both types of judgments or some sort of tradeoff resulting from the favoring of one judgment over the other. If, however, separate mechanisms are assumed to underlie "same" and "different" judgments, it is not surprising to find variables whose effects are restricted to only one type of judgment. In the present study, two such variables were isolated: pattern goodness, which affected only "different" responses, and eccentricity,

which was found in Experiment 2 to affect only "same" responses. The results, then, seem to favor a two-process model of same-different judgments. The above-mentioned accounts of how pattern goodness might impair difference detection are applicable only for "different" judgments; they cannot explain why "same" judgments are unaffected. They need not, however, since a separate mechanism is assumed to be responsible for judgments of "sameness."

Finally, it should be noted that the multielement arrays employed in the present experiments are somewhat atypical of those that have been used in the simultaneous matching task. More commonly, two elements are presented and the subject must decide whether the two are the same or different. Although the results here were obtained using several elements in each display, they carry significant implications for the two-element case as well. Typically, the two elements have been arranged to be horizontally or vertically adjacent. This, combined with the fact that elements are generally approximately equal in size (e.g., the set of capital letters), results in the presence of a somewhat organized or symmetrical display configuration. Often, the overall shape of the display is roughly rectangular and in some cases even approximately square. The present results indicate that, to the extent to which the structure of the total visual array is organized or symmetrical, there exists a disadvantage for detecting differences between the elements which comprise that array. The unwitting employment of symmetrical display configurations in the two-element case could be at least partly responsible for the commonly found speed advantage for same responses. If so, it might better be termed a "slow different" phenomenon rather than a "fast same" phenomenon. Whether organization does indeed operate in this fashion in the two-element case is a matter for future investigation.

REFERENCE NOTE

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