"Pattern Goodness" and Alternatives in Perceptual Discrimination

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"PATTERN GOODNESS" AND ALTERNATIVES IN PERCEPTUAL DISCRIMINATION[1]

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This study was aimed to re-examine the relation between the configurational effects in perceptual discrimination and the number of alternatives. In the first experiment, the relation between those effects and R & R subset size, which was the number of alternatives indicated by Garner, was investigated. Sixteen subjects were required to rank forty pairs of five dot patterns according to the discrimination difficulty. The results showed that R & R subset size could not fully account for the differences in discrimination difficulty. In the following experiment, the relation between those effects and the number of perceived alternatives, which were indicated by the variability of percepts, was investigated. Subjects were required to rank ten sets according to the variability. Each set was made up of four patterns constructed of five elliptic elements of the same configuration and different orientation. The results showed that the number of perceived alternatives was closely related to those effects. It was discussed that perceptual alternatives have two types, Garner-Imai type and Metzger type.

Key words: configurational effects, pattern goodness, perceptual alternatives, five dot pattern, discrimination difficulty, variability of percepts.

INTRODUCTION

The figure constructed of some elements is perceived not only as a set of individual elements but also as an organized whole. Koffka (1935) stated that the psychological organization will always be as "good" as the prevailing conditions allow. But the term "good" was undifined. Since then, the psychological organization related to "goodness" has been studied.

Garner (1962) hypothesized that better patterns were perceived to have fewer alternatives than poorer patterns and considered that the number of alternatives for individual pattern was related to the size of psychologically inferred subset to which that pattern belongs. Garner & Clement (1963) considered "goodness" as the configurational property, and they, using five dot patterns in a 3×3 imaginary matrix, tested that hypothesis by a goodness rating task and a free classification task in which each subject sorted all 90 patterns into groups according to a similarity criterion.

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They substantiated the hypothesis in that better patterns were sorted into smaller groups than poorer patterns, and defined goodness as the objective quantity of stimuli by using reflection and rotation (R & R subset size), and proved that their objective measure could account for the subjective goodness rated by subjects (see Garner, 1974).

On the other hand, Imai et al. (1976) defined the structure of patterns as invariant properties for some cognitive transformations, and considered goodness as judgements based on those structures. And they proved that theory could better account for the rated goodness than Garner's theory (see Imai, 1984).

Further, it was found that better patterns had the better performance than poorer patterns in perceptual discrimination, recognition memory, paired-associates learning, and so on, and those configurational effects were named "effects of pattern goodness" (Clement, 1967 ; Clement & Varnadoe, 1967 ; Checkosky & Whitelock, 1973 ; Hock, 1973 ; Garner, 1974 ; Garner & Sutliff, 1974 ; Bell & Handel, 1976 : Millspaugh, 1978 ; Pomerantz, 1979 ; Howe & Brandau, 1983).

However, the previous studies had a defect. In the discrimination task, the similarity between two patterns to be discriminated is known to affect the performance (King et al., 1979). The similarity among pairs should be equal, but this point was not taken into account in almost all of the psevious studies.

In the present study, "effects of goodness" were re-examined in detail by taking this point into account.

Experiment I

In the first experiment, taking the similarity into account, "effects of goodness" were re-examined by analyzing the relation between the discrimination difficulty and R & R subset size which was the number of altervatives indicated by Garner. The discrimination difficulty among pairs of patterns was obtained by subjects' direct judgements of rank instead of by reaction times to be required to discriminate.

Method

Subjects : Sixteen Tohoku University undergraduates served as *Ss*.

Stimuli : Each stimulus was the pair of the original pattern on the left and the transformational pattern on the right on a 5.5×12.0 cm white card. The original and the transform were separated horizontally by 7.0 cm. Fig. 1 shows originals and transforms.

Originals were ten patterns, five good (R & R subset size 4, #1 to #5) and five poor (R & R subset size 8, #6 to #10), taken from a larger set described by Garner & Clement (1963). Each pattern was constructed of 5 dots set into spaces in a 3×3 (9-spaces) imaginary matrix. The dots were 2.25 mm in diameter and were separated both vertically and horizontally by 4.00 mm, as shown in Fig. 2.

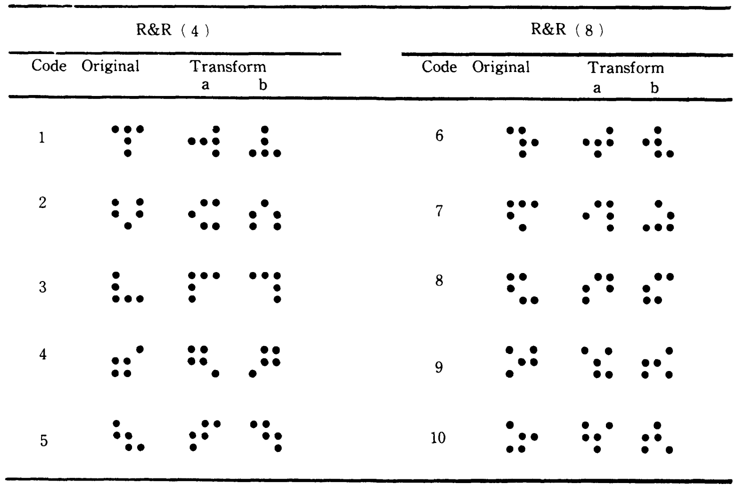

Fig. 1. Stimuli used in experiment I. Each pair was constructed of the original and the transform.

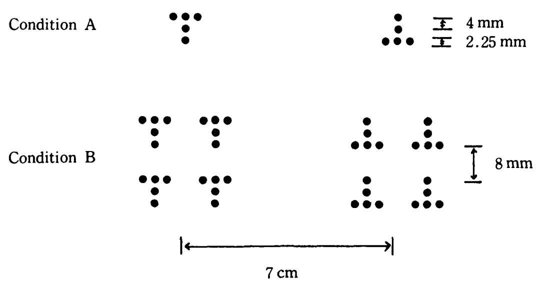

Fig. 2. Two conditions used in experiment I. In condition A, a single five dot pattern was presented. In condition B, four five dot patterns were presented.

Two kinds of transforms were provided for each original. One of them was produced by the 90°-rotation of the original and the other by the rotation and/or reflection of the original. The former transform and the original made up the pair a and the latter transform and the original made up the pair b. All pairs met the restriction that overlapping dots were two or three when the original was superposed on the transforms. Thus the similarity between the original and the transform were controlled with respect to the level of the whole and of elements.

Two conditions were provided about the number of patterns, as shown in Fig. 2. In one condition, a single five dot pattern was presented as the original and the transform (condition A). In the other, four five dot patterns in a square were presented (condition B). They were separated both vertically and horizontally by 8.00 mm.

Procedure: *S* ranked forty pairs of patterns according to the discrimination difficulty between the original and the transform. *S* was instructed that the discrimination difficulty referred to the difficulty in finding out the difference between the original and the transform.

Half of *Ss* ranked the stimuli of condition A, then that of condition B. The remainder ranked the stimuli in the reverse order. After that, *S* inserted the one set (condition A or B) into the other (condition B or A) according to the discrimination difficulty. *S* was allowed to give the same rank to pairs, if necessary.

Results and Discussion

The forty weights (scores) for pairs and sixteen scores for subjects were obtained by applying the dual scaling (see Nishisato, 1982) to the rank order data. The dual scaling is the procedure which provides the optimal weights and multidimensional analysis of categories data, maximizing reproductibility of individual responses. The percentages of the variance acounted for by solution 1 and 2 were 72.8% and 5.5%, respectively. All of sixteen scores for subjects were positive values in solution 1 (0.32 to 0.44). These data thus showed little individual difference with respect to the criteria of judgements.

Fig. 3 shows the location of the forty weights for pairs in solution 1. The larger weights indicate the eassier discrimination.

As shown in Fig. 3, the different degree of discrimination difficulty was obtained for pairs.

Comparison between pairs a and b in condition A. If the similarity is controlled, it will be predicted that the degree of discrimination difficulty is equal between a and b. In effect, almost all of the configurations showed little differences between a and b, though the configuration of #5 had rather larger difference than the others. This indicates that the effects of similarity were much weeker than the configurational effects in pairs of the present expmiment.

Analysis on individual configuration in condition A. If the differences in discrimination difficulty depend on R & R subset size, it will be predicted that the

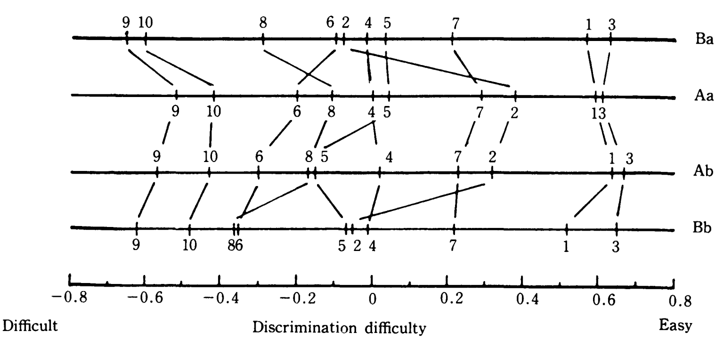

Fig. 3. The weights of discrimination difficulty for pairs.

degree of discrimination difficulty coincides with R & R subset size shown Fig. 1. That is, configurations of #1 to #5 and those of #6 to #10 will have equal discrimination difficulty, respectively, and the former will be easier to discriminate than the latter. These predictions proved true roughly in that configurations of R & R subset size 4 showed a tendency to have easier discrimination than those of R & R subset size 8. However, contrary to the prediction, the difference in discrimination difficulty was found both among configurations of #1 to #5 and those of #6 to #10. Moreover, the configuration of #7 had easy discrimination in spite of that of R & R subset size 8.

Comparison between condition A and B. If the differences in discrimination difficulty depend on R & R subset size, it will be predicted that relative discrimination difficulty among configurations is equal between condition A and B, because R & R subset size for each configuration is equal between A and B. In effect, configurations of #2 and #8 showed larger dificrences between A and B than the others both in pair a and pair b.

From the results in this experiment, it was shown that R & R subset size could not fully account for the differences in difficulty in perceptual discrimination.

Experiment II

It was shown that R & R subset size could not fully account for the differences in discrimination difficulty in the experiment I. This suggests two possibilities : (1) the number of alternatives relating to the configurational effects is not always referred to R & R subset size, and (2) the organization does not always have relation to the number of alternatives.

In the following experiment, the relation between the configurational effects and the number of perceived alternatives were investigated. For that purpose, the patterns constructed of elliptic elements were used, and the variability of percepts was ranked among ten sets of configurations in the experiment I. The variability indicates the number of alternatives, because the more variable are configurations in the patterns of elliptic elements, the more ambiguous are configurations in the patterns of dot elements, and the ambiguity refers to the number of alternatives.

Method

Subjects : *Ss* were sixteen undergraduates who had served in the experiment I.

Stimuli : Ten original patterns in the experiment I were used as stimuli (see Fig. 4). They were constructed of elliptic elements instead of dots in this experiment.

Ten sets of patterns were used, each of which was made up of four patterns of the same configuration and of different element orientations.

Each pattern was placed in the center of a 8×14 cm white card. The ellipses were 4.0 mm and 2.0 mm in major and minor axes, respectively. They were separated

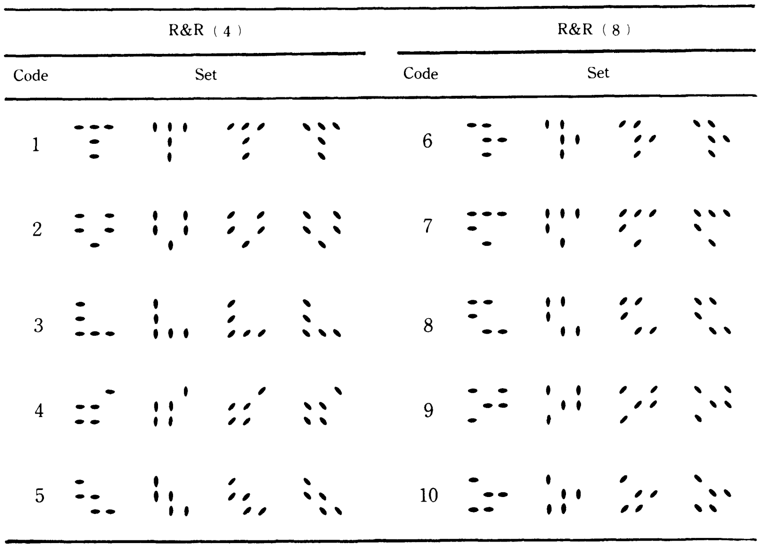

Fig. 4. Stimuli used in experiment II. Each set was made up of four five ellipse patterns.

both vertically and horizontally by 6.5 mm.

Procedure : S ranked ten sets of patterns according to the variability of percepts. *S* was instructed that the variability of percepts referred to the degree of diference of percepts among four patterns in a set. *S* was allowed to give the same rank to sets, if necessary.

Results and Discussion

The ten weights (scores) for sets and sixteen scores for subjects were obtained by applying the dual scaling to the rank order data. The percentages of variance accounted for by solution 1 and 2 were 76.5% and 8.3%, respectively. All of sixteen scores for subjects were negative values in solution 1 (−0.45 to −0.29). These data thus showed little differences with respect to the criteria of judgements.

Fig. 5 shows the location of the ten weights for sets in solution 1. The larger weights indicates the less variable percepts.

If the configurational effects have relation to the number of alternatives, it will be expected that configurations of more difficult discrimination in condition A of the

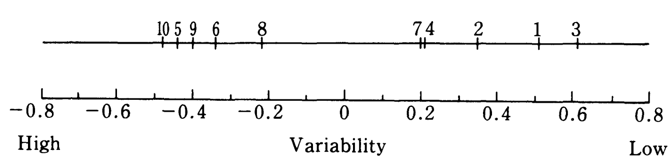

Fig. 5. The weights of variability for sets.

experiment I are more variable than those of easier discrimination. As expected, the discrimination difficulty shown in Fig. 3 was highly correlated with the variability shown in Fig. 5. Therefore, it was concluded that the configuratinal effects related closely to the number of alternatives.

General Discussion

Bear's study

Bear (1973) investigated the relation between goodness and the number of alternatives. He measured the predictability of a given dot in a given pattern as the percentage of subjects who indicated that dot as one "implied or suggested" by the subpattern composed of the remaining four dots of the pattern, and the predictability of each five dot pattern, which indicates the number of alternatives, as the mean of predictabilities of five dots constituting that pattern.

Compaired the discrimination difficulty shown in Fig. 3 with the predictability shown in Fig. 6, it was found that the discrimination difficulty corresponded to the predictability in better configurations, but not in poorer configurations. The present author interpreted these results as that Bear obtained the number of alternatives sufficiently in better configurations, but not in poorer configurations, because he obtained only the *most* "implied or suggested" dot to be added. In order to obtain the number of alternatives adequately, it was necessary to make subjects indicate not only the most "implied or suggested" dot but also the least one.

Consequently, Bear's study also supported that the configurational effects related to the number of alternatives, although his experiment had an incomplete point.

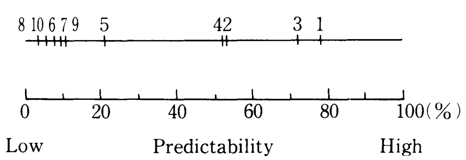

Fig. 6. The predictability for configurations used in experiment I. (Data from Bear, 1973.)

Two types of alternatives

Next, considering the perceived alternatives indicated in the experiment II, they seem to have two types.

Garner-Imai type. In the sets of symmetrical configuration. Two patterns out of four had also symmtry with respect to elliptic element orientation and brought about the similar percepts. In the others of asymmetrical configuration, four patterns were perceived differently each other.

Therefore, it is considered that the symmetrical configurations (#1 to #5) were perveived to have fewer alternatives than the asymmetrical (#6 to #10), because the number of alternatives are considered to be related to the number of percepts. This type of alternatives probably has relation to the transformations of reflection and rotation proposed by Garner & Clement (1963) and Imai et al. (1976). The author named it "Garner-Imai type".

Metzger type. Metzger (1953) reported that the line bridging between dots and the global contour constructed of them were perceived (not thougt) in patterns constructed of some elements and Gestalt laws applied to the bridging lines as well as the "real" lines. This indicates two points. (1) The shorter distance between dots makes them better-organized and makes the bridging line between them more conspicuous. In the arrangement of the present experiments, where five dot pattern in a 3×3 imaginary matrix were used, the vertical and horizontal bridging lines are more conspicuous than the oblique ones, as shown in Fig. 7a, because the latter have length of $\sqrt{2}$ times of that of the former. (2) The bridging lines, when arranged in a straight line or in parallel, become better-organized and more conspicuous, as shown in Fig. 7b. Consequently, the bridging lines arranged in a straight line (or in parallel) vertically and/or horizontally bring about the much more conspicuous global contour, and the

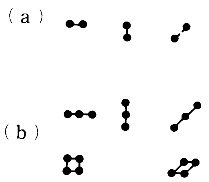

Fig. 7. The conspicuity of the bridging line.

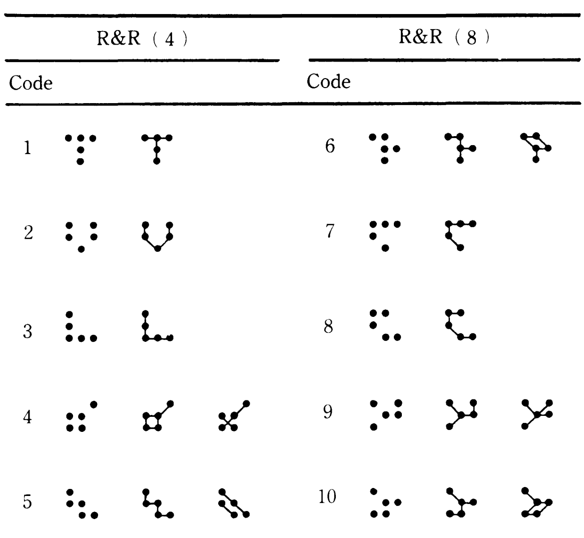

Fig. 8. The bridging lines predicted for configurations used in experiment I.

competitive conspicuous bridging lines bring about an alternate global contour.

Fig. 8 shows bridging lines predicted from above points for each configuration.

In sets of one global contour, the similar percepts were seen among four patterns, being little affected by element orientation. In the sets of some global contours, four patterns were perceived differently, being much affected by the element orientation.

Therefore, it is considered that the configurations of one global contour (#1, #2, #3, #7, and #8) were perceived to have fewer alternatives than the some (#4, #5, #6, #9, and #10) because the number of alternatives are considered to be related to the number of percepts. This type of alternatives has relation to the bridging lines and global contour reported by Metzger. The author named it "Metzger type".

The number of alternatives is considered to be related to the combination of both types.

In conclusion, the configurational effects in perceptual discrimination were not fully accounted for by the number of alternatives defined by R & R subset size. However, those effects closely related to the number of perceived alternatives indicated by the variability of percepts. It seemed that perceptual alternatives have two types, Garner-Imai type and Metzger type.

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