

GROUPING BASED ON PHENOMENAL PROXIMITY

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The question was raised whether the Gestalt law of grouping by proximity is based on proximity of stimuli on the retina or perceived proximity in phenomenal space. To tease apart these 2 possibilities an earlier experiment of Corbin was repeated in which the stimulus array is tilted back into the 3rd dimension. By including a measure of constancy for the perceived distance between points it was possible to show in 2 experiments, that the crucial factor is phenomenal proximity. This finding questions the Gestalt assumption that grouping is based on certain objectively given features within the stimulus.

The grouping of stimuli on the basis of proximity is one of the major Gestalt laws of the spontaneous organization of the visual field. Presumably, more proximal stimuli on the retina yield stronger forces of attraction between their corresponding loci of excitation in the brain than less proximal stimuli. However, it has not been demonstrated that it is the anatomical closeness within the proximal stimulus array which governs grouping. The only investigator who ever raised this question was Corbin (1942), who speculated that grouping may be accomplished on the basis of the perceived spatial relations between the points in a stimulus array, and that this phenomenally perceived proximity and retinal proximity, although usually coinciding, can be experimentally separated and thrown into conflict.

Corbin's method was to present an array of illuminated points in the dark seen as columns when in the frontal plane. A gradual lateral tilting of the stimulus configuration into the third dimension progressively foreshortened the horizontal distance between the columns as projected to the retina. Corbin reasoned that under monocular

viewing the amount of tilt required to produce a shift from a grouping of columns to one of rows could be predicted in accordance with the actual projection of the image on the retina. Under conditions where the oblique plane of the points was made visible, however, the perceived distance between the columns should remain more or less constant, and a grouping of rows should never be seen despite the severity of stimulus tilt—i.e., if grouping is based upon the *perceived* distance between points.

Since a significantly greater tilt was required to produce a shift in the perceived organization when *O* could see the slant of the array of points, but a shift under these conditions nevertheless did occur, Corbin concluded that both retinal proximity and phenomenally perceived proximity play an equally important role.

The following experiments represent an attempt to expand upon and refine Corbin's procedure. We hypothesized that if grouping is based upon phenomenally perceived proximity, the shift that Corbin obtained might have been due to the falling off of constancy, not to a limitation of the phenomenal factor in grouping. In order to test this hypothesis, we included a measure of constancy at

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various angles of stimulus tilt, which Corbin had not done.

EXPERIMENT I

Method

Apparatus.—The apparatus consisted of luminously painted glass spheres of $\frac{3}{8}$ in. in diameter, strung vertically and presented in a dark room. They were 3 in. apart vertically and 4 in. apart horizontally so that when in the frontal plane all *O*s would see columns. The spheres were strung to a frame (30 in. in height and 40 in. in width) which could be swiveled about a vertical axis at its right end so that the array could be presented at any angle from frontal-parallel (0°) to 90° if desired. The degree of slant could be read off directly from a protractor mounted to the frame. In order to eliminate the contour formed by the total array of points as a factor which might affect constancy, *S*s viewed the array through a 9-in. diameter circular aperture placed in front of it. Thus, regardless of the angle of the frame behind the aperture, *S* saw the array within a circular region.

Procedure.—Observations were made under monocular conditions and binocular conditions in a totally dark room. The monocular condition was always presented first, since otherwise a memory effect yielding some degree of constancy might have carried over from the binocular condition and spuriously obtruded itself.

The *S* was seated 10 ft. from the array. His head was centered in relation to the circular aperture. Following dark adaptation, and using either his left or right eye, *S* was asked to respond to each stimulus presentation in terms of whether he saw columns or rows. The instructions depicted the experiment as being one of esthetic judgment. It was explained that the luminous dots could be seen to fall either into columns, going up and down, or rows, going across, and that it was *S*'s initial impression to each presentation that was desired. The array was presented at 0, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, and 75° of tilt in a prearranged random order. After each judgment, *S* closed his eyes and the aperture was covered by a shield while *E* changed the angle of tilt. In this way *S* could not see the array being tilted. (Corbin's procedure was to permit *O* to rotate the array until he reported it was just as easy to see columns as rows. This method tends to encourage the operation of sets and expectations—for example, the perceived grouping at the

outset may carry over and affect the grouping at a later moment. Also, searching for the point where it "is just as easy to see columns as rows" may entail a difficult judgment about equivalence.) Following the monocular grouping judgments, the array was again presented; now at 0, 25, 35, 45, 55, 65, and 75° of tilt in a prearranged random order and a distance judgment was obtained. The *E* specified two columns (those closest to the axis of rotation) and *O* was to note the horizontal distance between them. The array was then covered and *O* indicated when a $\frac{1}{4}$ in. wide variable luminous horizontal line, located at a distance of 10 ft., appeared equal in length to the column separation. Only one grouping and extent estimate was requested per degree of tilt in each of the two conditions. For the distance judgments, ascending and descending trials were counterbalanced for the various angles of tilt. Following the distance judgments, the entire procedure was repeated using binocular vision.

Subjects.—Nine males and six females ranging in age from 15 to 57 served as *S*s. The majority, however, were high school students. Their mean age was 23.3 yr. All were naive as to the purpose of the experiment.

Results

Despite the random order of presentation, *S*s were consistent in that they did not reverse their reported grouping at angles beyond the point at which they shifted to rows. Under monocular vision *S*s saw the array as columns until, on the average, it was tilted back to an angle of 43.0° . By trigonometric computation, the retinal separation horizontally between points would equal the vertical separation at 41.4° . Hence, the result shows little evidence of any constancy effect, as expected. Under binocular vision, on the other hand, the average position at which the shift occurred was 53.3° , a value significantly different from the monocular value at the .01 level of confidence. Figure 1 shows the number of *S*s seeing a column organization at the different tilts for monocular and binocular vision. It may be noted that whereas almost all *S*s in the monocular condition had

switched to rows by 45° , only one *S* in the binocular condition had done so.

The distance measures correspondingly showed a continuous and significant decrease for each successive increment of tilt from 0° to 75° under monocular observation (see Fig. 2). (The average of the *SDs* for the seven different tilts of the array was .47 in.) For binocular observation they did not show any appreciable change until the array was tilted back to 55° or more. (The average of the *SDs* for the seven tilts was .65 in.) (It will be noted that the average perceived distance between columns is 3.1 in.—binocular—or 3.4 in.—monocular—even at 0° whereas the objective distance between column dots was previously stated to be 4 in. The discrepancy is partly due to the fact that the objective distance is given center-

to-center whereas the judgments are no doubt made interior-to-interior. The latter distance measures 3.7 in. In addition there is probably some illusion of magnitude involved wherein the thin luminous line appears longer than an equivalent separation between the columns of dots.)

It is clear that with binocular vision *Ss* were to some extent able to take slant into account in perceiving the distance between columns. The fact that constancy falls off at 55° suggests that the lateral distance between points is no longer *perceived* to be greater than the vertical distance between them. This would lead to the prediction that a grouping shift would occur at about this point. This is precisely what happened. Hence one cannot say that the shift presents evidence that retinal proximity as a determinant begins to become effective

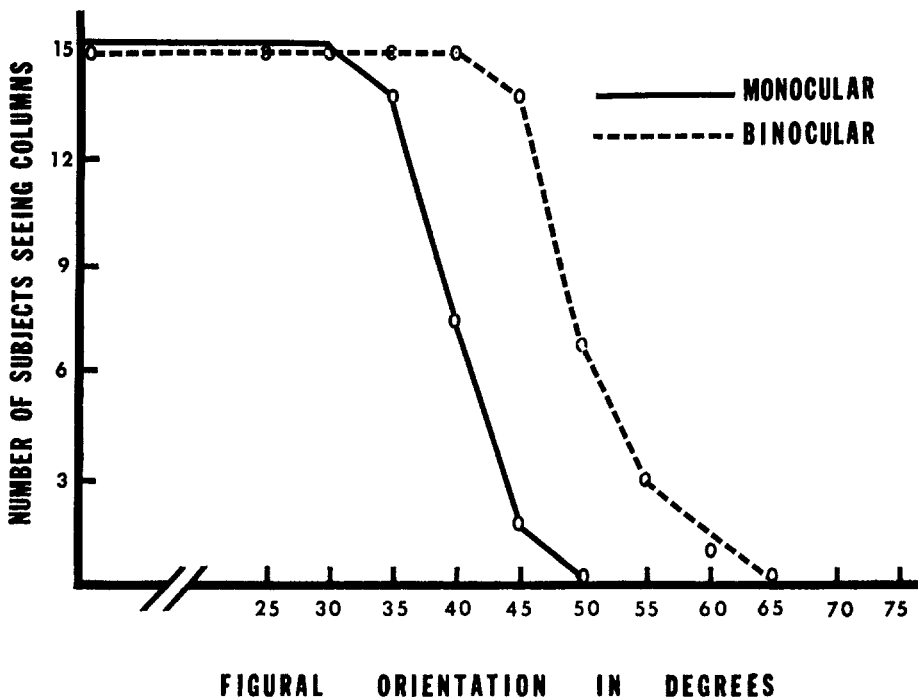


FIG. 1. Number of *Ss* seeing columns at each orientation of the array: Exp. I.

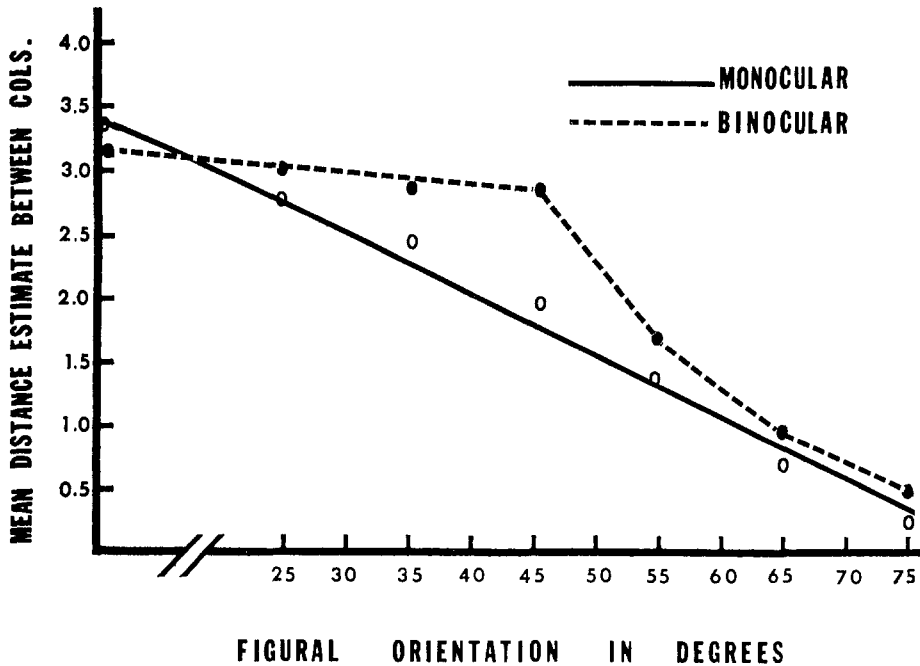


FIG. 2. Mean distance estimate between columns at each orientation of the array: Exp. I.

tive at certain angles of tilt as Corbin contended.

EXPERIMENT II

Method

Procedure.—The procedure was the same as in Exp. I except for the following three modifications:

1. In order to increase the constancy effect still further under binocular viewing, Os were permitted to view the array without the circular aperture in front of it.

2. In order to determine at what point the perceived distance between the columns equaled that between the rows, distance judgments were obtained for the vertical separation as well as for the horizontal. This necessitated the adding of an adjustable luminous vertical line to the apparatus. At each angle of tilt, then, a horizontal and vertical distance judgment was obtained. The two judgments for each angle of tilt were separated in time as part of a prearranged randomized order.

3. The order of presentation of the monocular and binocular conditions was counter-balanced between Ss. Although there was

good reason to avoid presenting the monocular condition second in Exp. I, the criticism could be made that the results for the binocular condition were influenced by practice or the like.

Subjects.—Eight naive Ss, five males and three females, served as Ss. Their mean age was 25.0 yr.

Results

The effects disclosed by the first experiment were magnified through the adoption of the modified procedure. Whereas under monocular viewing a mean of 41.9° of rotation was required to produce the transformation in figural organization, 62.5° was necessary in the binocular condition. This difference was significant beyond the .01 confidence level. Figure 3 gives the results for grouping.

As to the effect of order, although there only were four Ss in each subgroup, certain differences seem to be suggested. When the monocular con-

dition was first, the shift occurred on the average at 43.75° while the shift in the binocular condition which followed was at 68.75° . When the binocular condition was first, the shift occurred at 56.25° and the shift for monocular viewing was at 40° . Thus both orders yield a large difference between monocular and binocular viewing, but the monocular-binocular order yields a greater difference. Comparing the two conditions which came first with one another reveals an appreciable difference, but the two conditions which came second show a difference of 28.75° in the average point of shift. It is not clear why the difference is exaggerated when the monocular and binocular conditions are second, but it would seem to be due primarily to the greater effectiveness of binocular viewing when it comes second.

As in the first experiment, con-

stancy was found to prevail only under binocular viewing. Figure 4 gives the results of distance judgments. (The average of the *SDs* for the seven tilts of the array for monocular viewing was .52 in. and for binocular viewing it was .48.) It is clear that under monocular viewing the distances between columns were estimated more or less in accord with visual angle, as was the case in Exp. I. (As a matter of fact the distance judgments under monocular viewing in both experiments fell off at a rate somewhat greater than would be predicted on the basis of visual angle.) Under binocular viewing the distance between columns did not show any appreciable departure from perfect constancy until at least 55° . (In general the tendency toward constancy was stronger in Exp. II than Exp. I for the more extreme tilts.) The Wilcoxon signed-ranks test was used for execut-

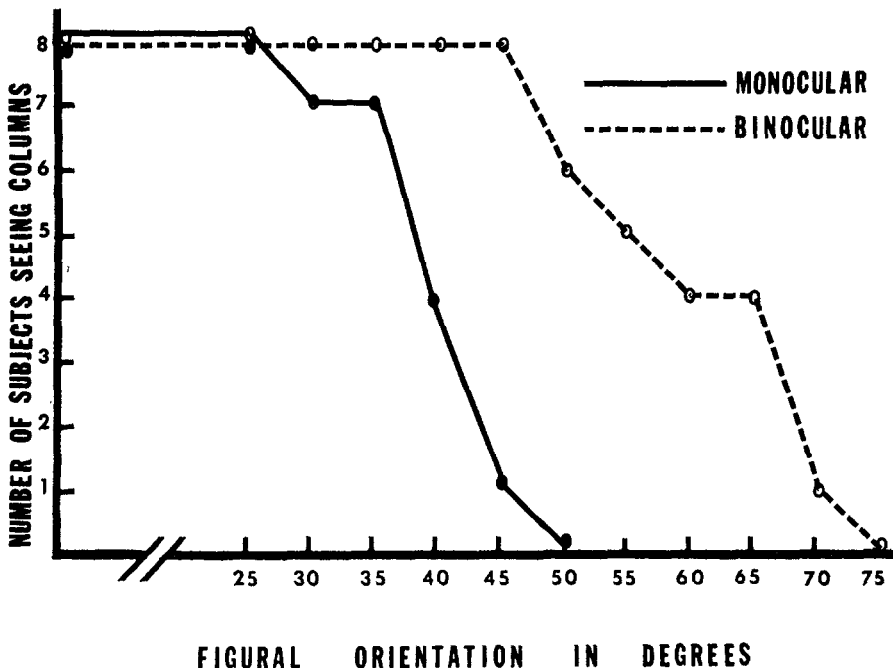


FIG. 3. Number of *Ss* seeing columns at each orientation of the array: Exp. II.

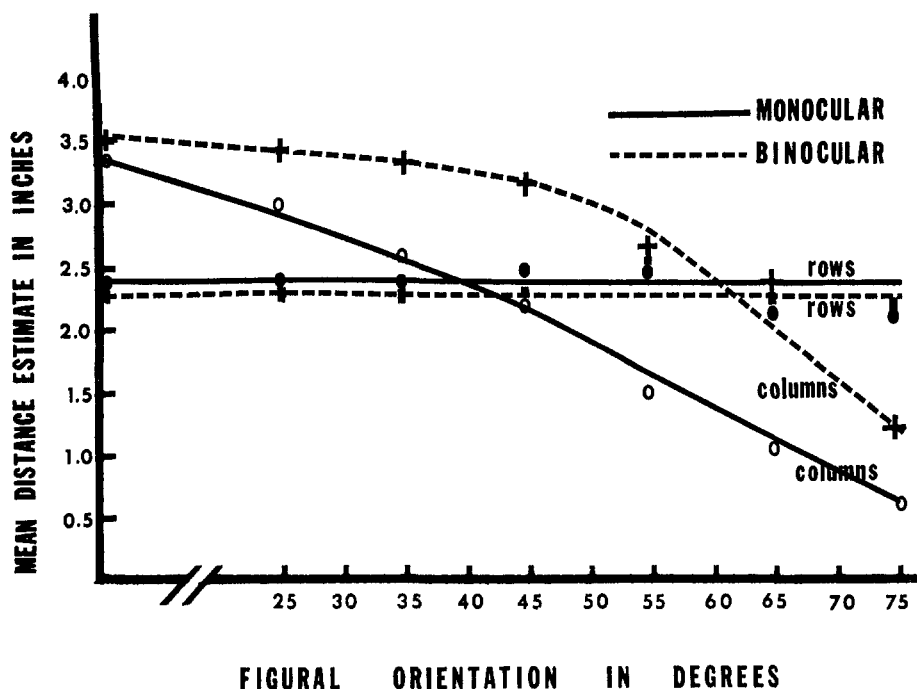


FIG. 4. Mean distance estimates between columns and between rows at each orientation of the array: Exp. II.

ing a series of multiple comparisons following the disclosure of significant main effects by the Friedman two-way analysis of variance. The .01 confidence level was pre-established as the region for the rejection of the null hypothesis. It was determined that under monocular viewing there was a significant decrement in the magnitude of the estimates for all tilts of the array 35° or more from those offered at 0° of tilt. Also there was a significant decrement in the distance estimates for virtually every successive increment in the tilt of the array. On the other hand, only the estimates at 75° of tilt in the binocular condition differed significantly from those at 0°.

The distance between rows for monocular or binocular vision remained fairly constant throughout (note that the average distance is less than the true value of 3 in.) As can

be seen, the two monocular curves cross at approximately 40° indicating that at this angle the points were perceived as equidistant in each direction and this corresponds closely with the point of shift in grouping. For binocular vision, the points were, on the average, perceived as equidistant in each direction at 62°, since the two binocular curves cross at about this point. This coincided with the point of shift in grouping. It is of significant import that not one *S* under either of the two conditions had shifted to a grouping of rows so long as the horizontal separation was perceived to be greater than the vertical extent.

To summarize these findings, whereas tilt produced a marked and continued degeneration of horizontal extent judgments in the monocular condition, constancy prevailed in the

binocular condition in that the perception of distance was veridical throughout a considerable range of tilts of the array. These differences in the perception of spatial relations coincided with predicted differences in grouping.

DISCUSSION

The results of both experiments are clear in showing that grouping is not based on the retinal distance between points. The principles of grouping play an important role in Gestalt theory. It was on the basis of these autochthonous principles that the field was held to become structured into discrete and segregated entities. Since an attempt was made at offering an alternative to empiricism, it became necessary to specify completely objective unifying factors, such as proximity or similarity. Prior to any experience, then, these objective factors must operate because they determine the way in which the field will be organized. It, therefore, now comes as quite a challenge to this approach to discover that, at least in the case of one grouping factor, it is not the contiguity of elements within the proximal stimulus that governs the perceptual outcome. Rather, grouping appears to be based upon perceived proximity which is itself the outcome of complex organizational processes involving the central integration of information about distance. The fact that Gestalt theorists played such an important role in promulgating the notion of perceptual constancy should not be allowed to confuse the present issue. When the array is tilted, the dots along the rows could be perceived to be farther apart than those along the columns because of constancy, but this does not require that *O* must see columns. In other words, regardless of how the spacing of the dots is perceived, the grouping should still be based on proximity between the elements in the retinal image according to the Gestalt notion of grouping.

We are left with an intriguing problem. Why should grouping occur on the basis

of experienced proximity rather than retinal contiguity? One answer is that we learned that stimuli which appear closer together are usually part of a common unit—i.e., grouping by proximity may be based on past experience as suggested by Brunswik and Kamiya (1953). If so, it would be paradoxical in that the grouping principles were intended as an alternative to theories which explain organized perception on the basis of past experience. Of course, the problem remains of explaining how the common unit is itself perceived as a unit in the first place.

Needless to say, it is quite possible that other principles of grouping are also based on phenomenal rather than objective factors. For example, elements which are perceived as similar may be seen as part of one unit regardless of whether the corresponding proximal stimulus elements on the retina are objectively similar. It is not too difficult to imagine how this could be tested. The same is true for certain other grouping principles.

The findings concerning grouping are similar in certain important respects to those reported recently by Rock and Ebenholtz (1962) on stroboscopic movement. These authors raised the question whether the necessary conditions for stroboscopic movement entail change of location of the stimulus on the retina (as had been assumed to be the case) or change in the phenomenal location of the stimulus. They found the latter to be the necessary condition—apparent movement is seen even where there is no change in the locus of retinal stimulation so long as the stimulus is located in two separate places in space. Concerning both studies the question may be raised as to how “phenomenal” proximity or “phenomenal” location can be held to play a causal role in perception. The answer would have to be that the brain processes underlying such experience mediate the perceptual outcome. Nevertheless, it is useful to speak of “phenomenal” factors since there may be various stimulus conditions which would

lead to the same outcome provided they share the feature of yielding the same experienced spatial relations. It is these experienced spatial relations—not spatial relations given in the retina—that seem to be crucial. In the case of stroboscopic movement, at least two different stimulus conditions yielded phi, although neither involved change of the retinal locus of the stimulus. Furthermore, if it should turn out to be correct that we have learned to see stroboscopic movement or learned to group by proximity, then it follows that the first step in the process is perceiving certain spatial relations. Hence for the time being, it is convenient to refer to the necessary stimulus conditions

in phenomenal terms. Ultimately we shall want to go beyond this way of specifying the conditions.

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