Opposed-Set Measurement Procedure: A Quantitative Analysis of the Role of Local Cues and Intention in Form Perception

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In three experiments, the durations of alternative perceptual organizations of drawings and of a three-dimensional object were used to provide quantitative measurement of local cue strength and of the viewer's intention. In Experiment 1, small (2.2') line drawings of cubes were constructed so that a local depth cue (occlusion) at an upper intersection specified the cube's orientation while the lower intersection remained ambiguous. On any trial, subjects looked at either the biased or the unbiased intersection, with instructions to try to hold one organization or another; hence, we call this general procedure the opposed-set method. The stimulus features nearest the viewer's instructed fixation and the viewer's perceptual task both had strong effects on reported durations. Experiment 2 replaced these findings with real objects (a small three-dimensional moving wire cube) as well as a drawn one. In Experiment 3, the opposed-set methodology was applied to a figural completion. The quantitative data provided by this new measurement procedure show that the whole configuration is not the effective stimulus for perception; the data thereby support a constructivist theory by posing grave problems for its strongest present competitors: the global minimum principle and the direct theory.

Perception is organized: One meaning of this phrase is that some features of what we saw can be predicted from other features of what we saw. We suggest that one of these features is the tendency to perceive the simplest of the alternative organizations for the entire stimulus pattern being considered. For example, a drawing that, taken as a whole, can be perceived either as a complex two-dimensional figure or as a simple three-dimensional object will tend to be perceived as the latter. Versions of this theoretical proposal, in which simplicity is to be measured over an entire figure or object, have been offered by Koepke (1953), Hochberg and McAlister (1953), Attneave (1954), and Leebenberg (1971).

The minimum principle has had some empirical support. Hochberg and Brooks (1960) demonstrated that when subjects were asked to rate the relative apparent tridimensionality of several different projections of a given reversible-perspective object (like various views of a Necker cube), their ratings are proportional to the measured relative complexities of the two-dimensional projections (if complexity is taken as the weighted measure of the number of angles, number of different angles, and number of continuous line segments). The complexities of the three-dimensional alternatives were kept constant in each case by comparing the various projections of any object only with each other, both in the rating procedure and in the analysis (a point that has sometimes been misunderstood; cf. Buffart, Leebenberg, & Restle, 1981, p. 247), so that this finding can be taken as quantitative support for the minimum principle (i.e., the simpler a flat object, the more it appears flat rather than three-dimensional).

Most recently, a similar quantitative index of simplicity (i.e., a coding scheme that uses angles and short line lengths as the elements into which the overall pattern is analyzed) was used by Buffart et al. (1981) to predict whether observers would report whether line drawings look like pieces fitted together in a flat mosaic or like one object partially occluding another. Because of their results, Buffart et al. concluded that under "ideal circumstances," the visual system arrives at the interpretation having the lowest information load.

None of these attempts to test the global minimum principle was designed to reject the possibility that subjects are responding to less than the whole stimulus pattern. That possibility is strongly suggested by the three-dimensional appearance of such line drawing representations as the "impossible" figures discovered by Penrose and Penrose (1958). When the contradictory corners of these figures are in close proximity, the impossible figures indeed look flat, or contradictory, but when the distance between the conflicting corners is increased so that they cannot be discerned clearly within a single glance, the figures look definitely three dimensional, even though they are in fact inconsistent (and indeed impossible) as three-dimensional solids (Hochberg, 1966). When a viewer looks at one corner of such a figure, he or she cannot easily discern the orientation of the other corners. Observation of these figures suggests that gaze direction, the storage of the information available within each glance, and the limitations on the integration of successive glances are factors that play an important role in the perceptual organization of objects (Hochberg, 1968). None of these factors was taken into account by the global minimum principle or by any of its more modern versions in the coding theories. Indeed, it has been argued that the apparent tridimensionality of impossible figures is incompatible with a global minimum principle (Hochberg, 1962, 1964, 1968) and is more compatible with a constructivist approach in which form perception entails a schematic perceptual structure that has only limited complexity constraints, and to which the separate glances make their contributions (Hochberg, 1968).

It is not clear how such might proceed with a minimum principle that is not global in its application—they simply have not addressed the issue. One may still attempt to apply simplicity or regularity to the perception of local configurations, as is proposed by Simon (1967) and by Perkins (1980), but these proposals do not offer explicit minimum principles even on a local basis, are not concerned with predicting alternative perceptual organizations and, in any case, are constructivist rather than wholistic approaches.

If appeals to "impossible" figures seem to be a weak basis for rejecting the minimum principle, consider Figure 1A, which is not an impossible figure. Figure 1A is a cube that is fixed at the intersection marked I, the orientation that faces downward and to the left (Orientation L), depicted in Figure 1B. In a cube oriented as in Figure 1B, the vertical line at Point 2 must be on the horizontal line. However, in Figure 1A, if the viewer gazes at Point 2 where the depth information is ambiguous, the depth relationship there goes reverse, and the horizontal line periodically appears to be in front of the vertical line, nearer to the viewer, as it is in the orientation that faces upward and to the

Figure 1 (A) Cube with fixed orientation at Point 1 but with no signed depth cues at Point 2. (B, C) Unambiguous representations of two alternative organizations of the cube: Both orientations are available at Point 2 of A. (D) A line drawing of a cube ambiguous as to depicted orientation.
right (Orientation R), depicted in Figure 1C (Hochberg, 1970). Whenever the horizontal line appears nearer than the vertical, the organization at Point 2 is inconsistent with the local depth cue (i.e., good continuation or interposition) at Point 1. Like other experimental observations that show that parts of a perceived object are processed independently of other parts (Dunnstein & Wertheimer, 1937; Hochberg, 1968, 1970, 1981), Figure 1A is potentially of great theoretical importance.

Before we can be clear as to what these demonstrations imply, there are many questions to be answered, some of which are quantitative in nature. We therefore undertook to develop an experimental measure of the piece-meal reversal of a partially biased Necker cube that could be used to address such questions and that would provide continuous quantitative data from each subject.

Among these questions, the first is whether perceptual reversal is really affected by the subject's direction of regard. Ellis and Stark (1978) showed that longer than average fixation durations precede reversals of Necker cubes. They found no more than an approximate association of the location of these fixations and the reversals. Guilford and Nelson (1929) showed eye movements to be unimportant under these conditions, but neither of these studies used stimuli that differed markedly in the distribution of information across the figure. Since we thought that differences in the duration of a perceptual reversal (i.e., reporting one or another percept might reflect differences in the orientation information available within each glance, we asked subjects to maintain fixations at one of two fixation points for a fixed duration of each trial. One place to which the subject's fixation was directed was chosen in an area of the cube that contained local orientation information, such as the orientation of one face (Figure 1A, whereas the second place to which fixation was directed was in a locally ambiguous area of the cube where no depth cues provided orientation information, such as Figure 2 in Figure 1A.

The second question addressed here is whether such differences in duration are dependent on local depth cues reflect changes in perceived per se or merely express the viewer's intellectual judgment about the depth information at the two fixation points. It has been shown for some time that subjects' reports of the durations with which the alternatives in a reversible figure are seen are correlated with other subjects' ratings of how strongly those alternatives are perceived (Hochberg & Brooks, 1960); but it is also true that subjects who do not know the alternatives that might be seen do not report perceiving the reversals of reversible figures (Girgis, Rock, & Egatz 1977), so reversal measures may be wholly or partially determined by subjects' judgments about what they ought to be reporting. Rather than trying to eliminate these factors, we attempted to set upper and lower limits to the input of the perceiver's intention by requiring subjects to try to "hold" an organization consistent with either Orientation L or Orientation R while maintaining fixation at one or the other intersection. We called this method the opposed-set measurement procedure, since the subjects fixated each point under two different perceptual sets.

In an earlier test of this procedure (Hochberg, 1972a; Gillam, 1972; Gillam, 1972b), the same stimulus patterns were used (Figures 1A, 1D, and a figure similar to 1C at the top intersection, but unbiased at the bottom intersection) with two designated, but unmarked, fixation points within each pattern (see Points 1 and 2 in Figure 1A). Figure 2 (A) Subjects reported the occurrence of each alternative percept by pressing one or another switch, or neither. With eight 60-second observations per cell, each of the two subjects showed significant effects of attitude, of stimulus condition, and, most important, of point to which their fixation was directed. These showed that this measurement procedure gave quantitative evidence of piece-meal reversal, a phenomenon that had been reported previously only in demonstrations. In order to be certain that our stimuli were constructed so that the amount of stimulus information present varied across the cube, we conducted a series of pilot studies in which we attempted without success to increase the biasing effects of the local cues to the point of nonreversibility. Figure 1B and the group of figures shown in Figure 2 are the extreme cases. Although we were unable to rule out reversals of the cube completely, pilot research with Figure 2A convinced us that the occlusion information present at Intersection 1 was a reasonably consistent determinant of the depth relationship there (i.e., that the horizontal line was in front of the vertical line, and that therefore this figure represented a cube facing downward and to the left). Therefore we used the series of figures shown in Figure 2 and the opposed-set measurement procedure in an attempt to measure the effects on figural organization of stimulus information and of intention.

Experiment 1

Method

Subjects. Sixteen college students participated in this experiment; 12 to fulfill a course requirement, and the other 4 were paid. All had normal (or corrected-to-normal) vision.

Stimuli. The stimuli used were variations on a 25 × 25 × 25 mm line drawing of a cube, and are shown in Figure 2. The stimuli were heavily biased toward one of the two interpretations of a Necker cube as Intersection 1 or at Intersection 2. On a version used for demonstration and not used in the experimental sessions themselves, fixation points were indicated by the numbers 1 and 2 in Figure 1A. Fixated intersections were separated by 1.8° of visual angle. The entire figure subtended a visual angle of 2.9° horizontally and 2.4° vertically.

Procedure and apparatus. Subjects were shown Figures 1A, B, and C while the experimenter instructed them on the two alternative interpretations of the ambiguous cube. Intersections 1 and 2 were pointed out to the subjects, and they were told that their primary task throughout each trial was to maintain fixation at one or the other intersection, about which they would be instructed before the beginning of each trial. They were told that before each trial they would also be instructed to try to "hold" forward (i.e., keep appearing forward) either the horizontal or the vertical line at that intersection. They were to do this solely by concentration; they were not to blink or to move their eyes in order to comply with this instruction. Subjects were cautioned not to worry about pleasing the experimenter by reporting that they were seeing what she asked them to try to see but to keep their eyes fixated and their attention directed near the point of fixation, to continue concentrating on keeping the instructed line appearing forward, and to report what they did indeed see.

Subjects reported that the horizontal or the vertical line appeared forward by pressing one of two keys; they were given the option of indicating that the drawing looked flat by removing both keys. Each subject was instructed to report the presence of both keys. The duration and latency of each key press were recorded on a PDP-11/03 computer.

Two groups of subjects participated: One group viewed Figures 2A, 2C, and 1D (the top bias group), and the other group viewed Figures 2B, 2D, and 1D (the bottom bias group). Each subject was instructed to try to maintain their particular bias on Figure 1A. The bias of the cube toward Orientation L, a cube biased toward Orientation R, and an unbiased cube. Although the pilot study referred to earlier had controlled for whether the cube was biased toward Orientation L or R, the number of subjects was small, and it seemed necessary to examine the influence of these parameters to ensure that our results were reliable.

Subjects participated in twenty-four 30-second trials with ordered stimuli, hold instructions, and fixation instructions counterbalanced within and across subjects. Two trials were run with each held instruction at each intersection on each figure. After the first trial, subjects were questioned about their ability to maintain fixation (all reported being quite successful) and were reminded that maintaining fixation was their primary responsibility throughout the experiment.

Results

Our dependent measure consisted of the mean duration of time that the subjects reported that the line they were instructed to try to hold forward was there. Although we were unable to rule out reversals of the cube completely, pilot research with Figure 2A convinced us that the occlusion information present at Intersection 1 was a reasonably consistent determinant of the depth relationship there (i.e., that the horizontal line was in front of the vertical line, and that therefore this figure represented a cube facing downward and to the left). Therefore we used the series of figures shown in Figure 2 and the opposed-set measurement procedure in an attempt to measure the effects on figural organization of stimulus information and of intention.
As Table 1 shows, for Figures 2A, B, C, & D, in both conditions, the difference between the ability to hold forward one line or the other is greater when the biased intersection is fixed than when the unbiased intersection is fixed. There are no differences between Intersections 1 and 2 in the unbiased figure, Figure 1D, thus accounting for the four-way interaction of Orientation x Fixation Instruction x Hold Instruction x Location of Bias.

Discussion

This study shows that the contribution of the factors of intention and of gaze direction in the perceptual organization of pictures can be measured. The interactions obtained indicate that where the subject is instructed to look helps determine what is reported as being perceived, even under instructions to hold one or the other organization. When subjects were instructed to fix the unbiased intersection, the depth information available at the biased intersection was considerably less effective in determining the response. While the two intersections were separated by only .18° of visual angle (approximately 5 in. [13 mm] at normal reading distance), it does not seem very plausible to attribute this difference solely to poor peripheral visibility for the unbiased intersection. Whatever its cause, however, the difference in effect should be expected in all objects of this size or greater, although in most cases the features of the objects will not have been so designed as to make the effect evident.

This finding implies one of two things (Hochberg, 1981): It may imply that the perceived organization of an object can reverse piecemeal and that the perceived organization at Intersection 2 can be different from that specified at Intersection 1. Alternatively and far less plausibly, it might imply that the biased intersection also reverses whenever the unbiased one does and that the fixed intersection (whichever it is on trial) exacerbates the greater effect on the synchronous pair. Neither alternative offers any comfort to a minimum principle.

Thus far, the stimulus objects to which we have referred were only line drawings. While research suggesting piecemeal reversal of a two-dimensional cube is certainly relevant to Gestalt demonstrations of the minimum principle and to attempts to test modern coding theories (all of which use line drawings), results with a two-dimensional stimulus simply might be irrelevant to the perception of real objects in the three-dimensional world. Direct theorists or ecological realists, like Gibson (1979), Shaw and Bransford (1977), and Turvey (1977), might claim that these phenomena occur because the information about space, distance, and orientation that is provided by the real three-dimensional object is lacking in a line drawing. We therefore designed a real object—a three-dimensional wire cube with the same orientation as Figure 1A—and presented it to view with a slight but detectable motion so as to provide spatial parallax information while maintaining the viewpoint essentially unchanged. Previous research (Howard, 1966; Mach, 1895/1959; Ulrich & Ammons, 1960) had found that perspective reversals do occur in three-dimensional objects, so it seemed reasonable to ask whether we would take to be local piecemeal effects, found in Experiment 1, also occur in the perception of real objects.

Experiment 2

Method

Subjects. Sixteen college students participated in this experiment in order to fulfill a course requirement. All had normal (or corrected-to-normal) vision. Stimuli. Figure 2A served as the two-dimensional stimulus. The three-dimensional stimulus was a cube constructed of black wire rods 2 mm thick. Each side of the cube subtended a visual angle of 2.2° both vertically and horizontally. The three-dimensional cube was biased toward the orientation depicted in Figure 1A in three ways. First, the cube was suspended from the ceiling so that it faced downward and to the left relative to the viewer's station point. Second, a piece of opaque white paper was wrapped around the upper left corner of the cube so that it extended halfway across the top of the cube and halfway down the left side of the cube. Third, the cube was hung near an air vent so as to provide motion parallax information. Peak relative velocity between the front and the back of the cube was 30 min. of arc per sec. The absolute motion at each of the intersections the subjects were instructed to fix was 8.3 min. of arc per sec. (The velocity threshold when fixating a moving stimulus is about 1° to 2 min. of arc per sec.) Procedure and apparatus. Subjects were shown Figures 1B, C, and D while the experimenter instructed them on the two alternative organizations of the ambiguous cube. They were informed that they would be participating in sixteen 30-sec trials during which they would be viewing a number of versions of those basic cubes. During each trial, they were to maintain fixation either at Intersection 1 or at Intersection 2, according to instructions given at the beginning of the trial. As in Experiment 1, it was stressed that their primary task was to maintain fixation on the assigned intersection. Subjects reported which of the two intersections appeared to be in front of the other at any given moment by pressing keys as in Experiment 1. Subjects viewed the two-dimensional stimulus monocularly and the three-dimensional stimulus binocularly, and they closed their eyes between trials. Before the experimental trials with both the two-dimensional and the three-dimensional stimuli, the experimenter pointed out the instructions that corresponded to Intersections 1 and 2 on Figure 1A and the subjects were given two trials on which to practice maintaining fixation and reporting their perceptions by pressing the response keys. Half of the subjects were to respond to the three-dimensional stimulus first and then go on to the two-dimensional stimuli; the other half were to respond to Figure 2A first and then go on to the unbiased drawing (Figure 1D). After these two practice trials, subjects were questioned about their ability to hold fixation. All indicated that they thought that they could do so satisfactorily, and they were reminded of the importance of fixation.

Two further practice trials were run: Subjects in the three-dimensional condition continued to practice on the three-dimensional cube; subjects in the two-dimensional condition now participated in two practice trials with the biased cube (Figure 2A).

Table 1

<table>
<thead>
<tr>
<th>Bias group</th>
<th>Left orientation</th>
<th>Right orientation</th>
<th>Unbiased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Figure 2A</td>
<td>Figure 2C</td>
<td>Figure 1D</td>
</tr>
<tr>
<td>I1+</td>
<td>H</td>
<td>H</td>
<td>I2</td>
</tr>
<tr>
<td>H</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>24.61</td>
<td>11.31</td>
<td>18.83</td>
<td>22.38</td>
</tr>
<tr>
<td>I1-</td>
<td>H</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>H</td>
<td>V</td>
<td>V</td>
<td>I2</td>
</tr>
<tr>
<td>24.35</td>
<td>11.31</td>
<td>18.83</td>
<td>22.38</td>
</tr>
<tr>
<td>Bottom</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Figure 2B</td>
<td>Figure 2D</td>
<td>Figure 1D</td>
</tr>
<tr>
<td>I2-</td>
<td>H</td>
<td>H</td>
<td>I2</td>
</tr>
<tr>
<td>V</td>
<td>V</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>I2+</td>
<td>H</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>H</td>
<td>V</td>
<td>V</td>
<td>I2</td>
</tr>
<tr>
<td>24.74</td>
<td>15.68</td>
<td>27.25</td>
<td>20.06</td>
</tr>
<tr>
<td>I2</td>
<td>H</td>
<td>V</td>
<td>V</td>
</tr>
<tr>
<td>20.32</td>
<td>19.67</td>
<td>20.32</td>
<td></td>
</tr>
</tbody>
</table>
Next, subjects were told that there would be a change of instruction, and the hold instructions were then inter- 
spersed, with instructions to hold left or right. All sub-
jects ran through this sequence twice: once in the two-
dimensional condition, and once in the three-dimensional condition. 

The order of the hold instructions, the fixation in-
structions, and the presentation of the two-dimensional and the 
three-dimensional stimuli were counterbalanced across subjects. 
Subjects were given an initial presentation of the two-di-

Table 2: Mean Duration of Time Spent Reporting Each 
Organization as a Function of Fixation and Intention 
for Both the 2D and 3D Cube 

<table>
<thead>
<tr>
<th>Interaction 1</th>
<th>Interaction 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>Hold H</td>
</tr>
<tr>
<td>2D condition</td>
<td>Instructed</td>
</tr>
<tr>
<td>Uninstructed</td>
<td>3.04</td>
</tr>
<tr>
<td>3D condition</td>
<td>Instructed</td>
</tr>
<tr>
<td>Uninstructed</td>
<td>2.45</td>
</tr>
</tbody>
</table>

Note: 2D = two-dimensional, 3D = three-dimensional. 
Responses are the mean duration of time spent pressing 
the horizontal (H) or vertical (V) key during a 30-
sec trial. Responses for each condition are averaged 
across subjects. 

The dependent measure consisted of the 
mean total duration of time during which 
subject reported that the wire (line) they 
were instructed to hold forward actually 
seemed to be forward. Durations during 
which neither key was depressed were neg-
ligible and nonsystematically distributed (see 
Table 2). 

An ANOVA for repeated measures with one 
between-subjects variable (order) and three 
within-subjects variables (hold instruction, 
fixation instruction, and dimension) yielded 
only one main effect, that of instruction, F(1, 
14) = 28.09, p < .0001. It was easier overall 
to hold the horizontal than the vertical wire (line) forward. 

The interaction between fixation instructions and the 
three-dimensional stimuli on a horizontal-forward-
ward interpretation. 

The interaction between fixation instructions and hold 
instructions was significant, F(1, 14) = 28.77, p < .0001, 
and confirmed the expectation that the stimulus information available 
at Interaction 1 would be responsible for a greater 
difference between the ability to hold the horizontal wire forward and the ability to hold the vertical wire forward than would the gross dimensional objects. The factors involved in 
the perception of real and pictured objects can be measured by the opposed-set method, 
which allows examination of the contributions of the 
stimulus information and of the perceivers' intentions. Furthermore, the same 
evidence of the role of local cues in deter-
mining perceptual organization that we found 
with a drawn object was obtained when sub-
jects viewed a real object. Thus, the inter-
action between the perceivers' intention and the 
local stimulus information present in a single 
glance may be considered in any theo-
retical account of perception. 

These conclusions are based on a procedure 
(researching the reversals of ambiguous 
figures) that is likely to be vulnerable to re-
response bias and demand characteristics. 

Interpretation of our results in terms of these 
figures is implausible. Even though we delib-

erately imposed response bias by instructing 
the subjects on which organization they were 
to try to see, the responses obtained reflected 
the influence of the stimulus information 
available at the instructed fixation point as 
well as the influence of orientation instruc-
tion. 

One point to note in this regard, however, is that 
the reversals of the first responses given by each subject in each con-
dition yielded results similar to those found 
with analysis of trial totals. However, we could find no evidence in an analysis of the 
second responses of an aftereffect opposite to the 
first responses, which is what one would 
expect after exposure to one of the two alter-
 natives of a reversible figure (Carlson, 
1953; Hochberg, 1950). Perhaps this was so 
because with few consecutive trials at the 
same fixation point, and no consecutive trials 
at the same fixation point with the same hold 
instructions, there was no basis for accu-
mulating strong aftereffects. Also, few of the 
first responses lasted 15 to 30 sec, durations 
which would have created conditions analog-
ous to the inspection periods used by Hoch-
berg and by Carlson.

Experiment 3 

In this last experiment, the opposed-set 
method was applied to Figure 3A, using the figures 
by Buffart et al. (1981), and to two stimuli from previous 

MARY A. PETERSON AND IULIAN HOCHBERG 

Figure 3 (A) A line drawing used by Buffart et al., 
(1981); (B) A line drawing used by Chapinis and 
McCleary (1953); (C) A line drawing used by Rathsow 
(1949). (Throughout, 1 and 2 represent the interactions 
to which subjects' fixation was directed. X and Y label 
the subparts of the figure that the subjects were in-
structed to try to hold forward.) 

studies (Figure 3B is from Chapinis & 
McCleary, 1953, and Figure 3C is from 
Rathsow, 1949). Buffart et al. had shown 
their coding that Figure 3A would be 
perceived as overlapping squares, 
that X would be perceived as completed 
behind Y in Figure 3B, and that Figure 3C 
would be ambiguous. Subjects' responses 
were in agreement with these predictions in 
the two previous studies that actually pro-
duced data (Buffart et al., 1981; Chapinis 
& McCleary, 1953). In these studies, subjects' 
Figure 3B and 3C were controlled, and 
we did not know whether the effects reported 
would also be obtained when set and fixation 
were specifically controlled. 

Method 

Subjects: Sixteen subjects viewed the figures shown 
Figure 3. Of these 16 subjects, 5 viewed two of 
the figures (3B and 3C), and one subject viewed all 3 figures. 
Six observers served as subjects for Figure 3A; eight sub-
jects viewed each of the other two figures. 

Procedure and apparatus. The stimuli were the line 
drawings shown in Figure 3. Fixation points were as in-
dicated for each figure; in all cases, they were separated 
by 1.8° of visual angle. The figures subtended 3.26° to 
5.43° of visual angle horizontally. Subjects were seated 
80 cm from the figures. 

Subjects were asked to interpret Figure 3A in one 
way: X could be a square plane occluded by another 
square plane (X), or Y could be a profile of a wing chair 
in front of a wall (X). Likewise, either X or Y could be 
in Figure 3B and 3C, and in both Figures 3B and 3C, the 
local cue of occlusion at Intersection 1 favored an 
interpretation that X was in front of Y. However, oc-
clusion information at Intersection 2 favored the op-
posite interpretation.
The opposed-set measurement procedure was used. Subjects traced Intersection I or Intersection 2 while they were asked to hold one or the other organization of the figure. The instructions given to the subjects were similar to those used in Experiments 1 and 2; again, fixation was stressed as the primary task. There were two trials at each fixation point with each hold instruction.

Results

The mean duration of time during which subjects reported that they were perceiving forward as the forward subpattern of the figure while they were attempting to hold forward was calculated for each fixation point and for each hold instruction (see Table 3).

As Table 3 shows, no overall differences were found between the ability to hold organization X forward and organization Y forward at either Intersection 1 or Intersection 2 of Figure 3A. Moreover, the difference between the ability to hold organization X forward or Y forward was greater at Intersection 1 than at Intersection 2, t(5) = 2.22. These results were not altogether surprising, since some subjects indicated that it was easier to hold the chair organization at Intersection 1, whereas other subjects indicated that the information present at that intersection was more compatible with the occluding squares interpretation. Thus, the local intersection information at Intersection 1 did not unequivocally affect the organization of the figure at that point, nor did the stimulus information present at Position 1.

In Figure 3B, the subjects held organization X forward for longer durations than they held Y forward when they were instructed to look at intersection 1, and organization Y forward was reported for longer durations than was organization X forward when subjects fixedated Intersection 2 (see Table 3). The difference between the ability to hold organization X forward and organization Y forward at the two intersections of interest was significantly different, t(7) = 3.10, p < .01.

Likewise, results with Figure 3C indicated that Intersection 1 favored organization X forward, whereas Intersection 2 favored organization Y forward; the difference between the ability to hold the two organizations at Intersections 1 and 2 was significant, t(7) = 3.73, p < .005.

Thus, results for Figures 3B and 3C are consonant with the local cues of interposition at the points to which fixation was directed.

Discussion

The simplest interpretation for the overall figure, as derived by coding theory, does not predict the subjects' responses when fixation and task are constrained. All of the subjects queried by Buffart et al. interpreted Figure 3A as occluding squares; yet our subjects were equally likely to see the chair-in-front-of-a-wall organization.

For Figure 3B, coding theory predicts that Y should be perceived to occlude X, in accordance with the ratings obtained by Chapman and McCleary (1953). Our subjects, on the other hand, were more likely to organize the figure that way only while looking at Intersection 2; when fixation was directed to Intersection 1, the interpretation that X was in front of Y was reported more often. The reason for this is clear from inspection of the figure, and it becomes more salient in the case of the following discussion.

For Figure 3C, coding theory predicts an ambiguous interpretation (i.e., Buffart et al., 1981, p. 271), would expect that half their subjects might perceive X as completed, and half might perceive Y as completed. If an unconstrained ratting method did indeed produce such results, we can now see why. Our results, which were not at all ambiguous, suggest that half of the subadjects would have attended one side, and half would have attended the other side. Alternatively, subjects might sample both sides and arrive at a balanced response according to some impression-formation calculus (see Anderson, 1954). But either of these processes would be very different from that entailed in the application of the global minimum principle.

At least some of the reasons why our procedures provide different results from those obtained with unconstrained rating methods are quite clear. Our experimental task encourages the perseverator to respond mainly to the information available within a single glance, and within the framework of a specified perceptual task. In the unconstrained rating methods more typically used, both fixation and set remain unspecified and at the mercy of whatever hypotheses the subjects form as to what the task should be. The fact that fixation and set affect the perception of such patterns in such orderly a fashion suggests that they must play their part as well when they are not explicitly controlled, and that any theory of object organization must take them into consideration if it is to be taken seriously.

General Discussion

We have shown that the relative durations with which alternative organizations are reported reflect the organization that a subject is asked to try to perceive. We also suggest that the local depth information in the immediate region that the subject is asked to fixate: We do not seem to be dealing merely with respect to perception. In summary, the quantitative data that we reported here support what previously was shown only by various demonstrations (Hochberg, 1968, 1981). Those demonstrations and our present data may be used to argue that in direct opposition to Gestalt theory, to direct theory, and to recent attempts to revise Gestalt theory in coding terms, the whole stimulus configuration cannot in general be taken as the effective determinant for perception.

The experimental conditions are admittedly constrained: On each trial, the subject is asked to look at a particular place on the object and to try to perceive one specific organization. It is possible that our results are specific to our situation, but they cannot simply be dismissed with that comment for three reasons:

1. We should note that the results obtained here are consistent with much more casual demonstrations, dating back to the Penrose and Penrose publication of 1958.

2. Any theory of perception must surely apply to the situation in which one stares for a few moments at some place in the world, trying to see whether it is one thing or another, as well as to the situation in which both gaze and set (or perceptual intention) are unconstrained.

3. Even when the gaze is unconstrained, the viewer can be picking up only one limited glance at a time, and when set is unconstrained, the viewer must be operating with some perceptual intention. Leaving set and fixation instructions unconstrained does not eliminate the contribution that those factors make to perception; it merely masks their effects and leaves them at the mercy of subjects' whims and experimenter bias (Orne, 1962).

Coding theories of figure perception and the direct theory of object and event perception must be redesigned to consider the limits on the information present within each glance, and the effects of the viewer's perceptual intentions or set. This has not been seriously attempted in such wholistic, stimulus-oriented theories. If these were done, it is not clear how these theories would then differ from schema-testing or constructivist approaches.

Reference Note


References


