Chapter 13

Symmetry Based on Figure Halves

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It is now a well-established fact that bilateral or mirror symmetry is spontaneously perceived when the axis of such symmetry is vertical (e.g., Mach, 1897/1959, 1898; Goldmeier, 1936, 1972; Attneave, 1955; Rock and Leaman, 1963; Arnheim, 1974; Garner and Sutliff, 1974). When the axis is in some other orientation, such as horizontal or oblique, we are not apt to perceive symmetry or, if we do, the impression of equality on two sides that is characteristic of such perception is not very striking.

A related aspect of the vertical symmetry effect that concerns us here bears on the equality of the two halves of the figure on either side of the axis of symmetry. Regardless of the figure's orientation in a frontal plane, these halves are equal in their retinal and thus in their cortical projection. But suppose the figure is slanted in the third dimension so it is no longer the case that the two halves will project equally because the image of the half on the far side of the axis will be foreshortened more than the half on the near side of the axis? If the symmetry effect is based on a low level of processing closely correlated with the proximal input, one might predict that it will be eliminated under these conditions. But if it is based on the perception of the equality of the two halves of the figure, then, given shape constancy operations, the two halves will appear to be equal and, if so, the impression of symmetry will be maintained. In that event, the effect would be based on a higher, post-constancy, level of processing.

If the perception of symmetry depends upon constancy operations that lead to the perception of an axis orientation as vertical or to the veridical perception of the width of the halves of a figure slanted in depth, then it can be regarded as an example of perceptual causality or perceptual interdependency, i.e., a state of affairs in which one perception depends upon or is linked to another (see Gogel, 1973; Hochberg, 1974; Epstein, 1982; Rock, 1983). The question we ask is this: does the spontaneous impression of symmetry about a vertical axis depend upon the perception of the slant

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of the figure and the achievement of veridical perception of the size of its two halves?

In a recent study, Locher and Smets (1992) compared symmetry detection in two- and three-dimensional volumetric dot patterns. The patterns were displayed orthogonally and non-orthogonally to the viewer's line-of-sight (in the investigation the forms were rotated) with full depth cues available. Because there were no differences in detection accuracy between the two- and three-dimensional patterns, they concluded that depth does not provide perceptually useful information about a pattern's symmetry. However, their subjects performed more poorly in the non-orthogonal condition.

In our present study, we assume that if shape constancy governs symmetry perception then the availability of depth cues should be critical. Therefore, a full depth-cue and a reduced depth-cue condition were included in this study, as was a measure of shape constancy. By manipulating these depth conditions, and having conditions where the subjects view the display screen at an angle, rather than the patterns being rotated, our intent was to determine the role of depth information in symmetry discrimination, and ultimately test the perceptual causality hypothesis.

Methods

Subjects

Sixty-four normally sighted subjects or subjects with corrected vision of at least 20/20 (Snellen visual acuity) between the ages of 18 and 27 yr were recruited.

Stimuli

There were 8 pairs of closed polygon holistic stimuli and 8 pairs of multi-element stimuli used for testing. Two additional sets of each pattern type were used to train subjects. Examples of these stimuli are illustrated in Fig. 13.1. By "pair" we only mean that for each particular pattern there was a version of it that was symmetrical and a version of it that was asymmetrical. However, the figures were seen one at a time and the symmetrical and asymmetrical versions of each pattern were randomly presented and, therefore, rarely shown one after the other but rather separated by many other figures. When viewed at a 65 deg angle, objectively symmetrical stimuli projected an asymmetrical retinal image and objectively asymmetrical stimuli projected a symmetrical retinal image. To maximize the retinal asymmetry while maintaining the slant within the range of shape constancy, we chose a slant angle of 65 deg, which has been found to be adequate for shape constancy under full cue conditions (King et al., 1976).

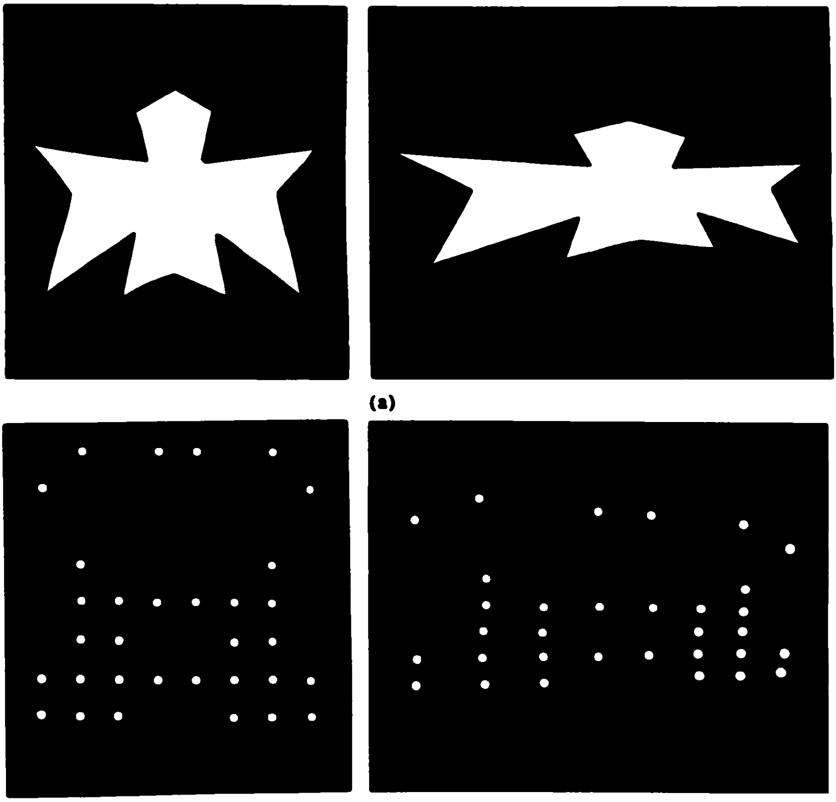

Figure 13.1
Examples of symmetrical and asymmetrical pairs of holistic (a), and multi-elemental stimuli (b).

The holistic figures were adapted from stimuli originally employed by Rock and Leaman (1963), Palmer and Hemenway (1978), and Fisher et al. (1981). The multi-elemental dot patterns were adapted from Royer (1981) and Fisher and Bornstein (1982). All figures were photographed with Kodalith film, and developed into slides. Two Kodak 4600 Carousel Slide Projectors back-projected slides of all stimuli onto a translucent screen. Both the projectors and the screen were hidden from the view of the observer behind a black partition. When projected onto the screen, the figures appeared white on an opaque black background. The figures subtended an average visual angle of approximately 4 deg. The average luminance of the figures was 6.1 cd m^{-2}. The projector luminance was increased by approximately 0.33 in the reduced-cue conditions to compensate for the decreased light entering the eye through the pinholes that were used in these conditions.

Design and Procedure

The 64 subjects, both men and women, were randomly assigned to one of four groups of 16 subjects each. The four groups included: the full-cue, 0 deg group; the full-cue, 65 deg group; the reduced-cue, 0 deg group; and the reduced-cue, 65 deg group.

Symmetry Identification. Prior to each experimental session, all subjects were instructed to label the figures presented to them as simply "symmetrical" or "asymmetrical." To insure that subjects understood the terms symmetrical and asymmetrical, two sets of asymmetrical and symmetrical forms (not used later in actual test trials) representing examples of the multi-element and closed polygonal patterns were shown in the vertical plane, outside the testing room prior to testing. All subjects identified all 4 training forms correctly.

In the full-cue conditions, the figures were viewed through either of two 15.3-cm apertures, both at 1.5 m from the screen. The screen was stationary and the depth tilt was produced by viewing the screen through the aperture straight ahead or the other one set at a 65 deg angle to the center of the screen. Through the apertures, subjects had full depth information concerning the orientation of the projector screen. In the reduced-cue conditions, both apertures were covered with black plastic and equipped with 1 mm pinholes. Subjects viewing the stimuli through the pinhole monocularly (with an eye patch over the non-dominant eye) saw only the white stimulus figure on a black background; they did not see the edges of the projector screen. Subjects in all conditions had their heads held in place by a chin-rest. To avoid dark adaptation, subjects were exposed to a low-luminance, diffuse light between trials that did not cause glare or localized light-adaptation effects.

Without binocular cues to depth or differential blur from far or near regions of the slide, reduced-cue subjects had only the retinal image on which to base their judgments of symmetry. By contrast, in the full-cue (binocular) condition, the subject had full view of the screen with both eyes and he or she could see its edges. Thus both binocular depth information and cues from the screen edge of the orientation of the screen were available to the full-cue subject.

Each subject saw 8 vertically symmetrical and 8 vertically asymmetrical holistic figures along with 8 vertically symmetrical and 8 vertically asymmetrical multi-element forms, presented in random order. All 32 stimuli were presented in blocks of two stimulus durations: 100 ms and 1 s. The order of the two exposure durations was counterbalanced across subjects, totaling 64 trials. A fixation point, projected from a third projector, appeared in the center of the screen immediately preceding each stimulus presentation so that the subject's gaze was localized.

Shape Constancy. Subjects from both the full-cue, 65 deg group and the reduced-cue, 65 deg group were tested for shape constancy following the standard 64 trial session. Subjects from these two groups received an additional 32 trials: eight trials (4 holistic and 4 multi-element figures) at each of two durations (1 s and 100 ms) in each of two viewing positions (0 deg and 65 deg) for a total of 32 trials. Only symmetrical slides were used. Each subject made 16 judgments of the extent of the figures viewing them in the 0 deg frontoparallel plane and 16 in the 65 deg plane. Shape constancy was defined by the comparison of height-to-width ratios between judgments made during frontoparallel (0 deg) viewing and judgments made during 65 deg viewing. An illuminated apparatus containing two glow-in-the-dark pegs was used to measure subjects' perceptions of vertical and horizontal figural extents in both frontoparallel and rotated presentations.

Results

Symmetry Detection

Subject performance is presented in Table 13.1 in terms of mean proportion of correct objective shape identifications (with their correspond-

Table 13.1
Mean proportions and standard deviations of correct objective shape identifications

	Holistic				Multi-elemental				
	100 ms		1 s		100 ms		1 s		
Overall	Sym	Asym	Sym	Asym	Sym	Asym	Sym	Asym	Means
Full-cue, 0 deg	0.89	0.81	0.89	0.93	0.82	0.66	0.91	0.79	0.84
	(0.08)	(0.19)	(0.13)	(0.13)	(0.19)	(0.19)	(0.14)	(0.20)	
Full-cue, 65 deg	0.76	0.66	0.82	0.79	0.75	0.50	0.77	0.56	0.70
	(0.16)	(0.21)	(0.15)	(0.21)	(0.18)	(0.21)	(0.20)	(0.20)	
Reduced-cue, 0 deg	0.87	0.66	0.90	0.79	0.72	0.49	0.83	0.55	0.73
	(0.14)	(0.30)	(0.14)	(0.23)	(0.15)	(0.19)	(0.23)	(0.24)	
Reduced-cue, 65 deg	0.58	0.29	0.47	0.31	0.44	0.34	0.41	0.27	0.39
65 deg	(0.25)	(0.19)	(0.21)	(0.19)	(0.19)	(0.20)	(0.19)	(0.16)	

Note: The maximum possible proportion correct for each condition was 1.00. The number of subjects in each cell was 16. Standard deviations for each cell appear in parentheses.

ing standard deviations). A five-way ANOVA was performed with the factors of viewing condition (full-cue, reduced-cue) × type of figure (symmetrical, asymmetrical) × viewing angle (0 deg, 65 deg) × pattern type (holistic, multi-element) × exposure duration (100 ms, 1 s). Viewing condition and viewing angle were between-subjects factors; the remaining were within-subjects factors. The proportion of judgments (out of eight) that were objectively correct was the dependent measure.

Main Effects. For the between-subjects factors, significant main effects were found for viewing condition [$F(1, 60) = 96.21$, $p < 0.001$] and viewing angle [$F(1, 60) = 117.58$, $p < 0.001$]. An advantage for symmetry emerged [$F(1, 60) = 44.85$, $p < 0.001$], with more correct judgments made for symmetrical patterns (mean proportion M = 0.74) than for asymmetrical patterns (M = 0.59). Consistent with expectations based on information processing models (Attneave, 1955; Chipman, 1977; Royer, 1981), the holistic patterns were judged correctly (M = 0.71) more often than multi-element patterns (M = 0.61), [$F(1, 60) = 44.73$, $p < 0.001$], and 1 s exposure durations resulted in more correct judgments (M = 0.69) than 100 ms exposures (M = 0.64), [$F(1, 60) = 10.29$, $p < 0.002$].

If perceptual equality is responsible for the perception of symmetry when shapes are viewed from a 65 deg angle, then the number of objective judgments of symmetry and asymmetry reported by subjects in the full-cue, 65 deg condition should not differ from responses of subjects in the full-cue, 0 deg condition, while objective judgments of reduced-cue, 65 deg subjects should drop significantly. Post-hoc analysis of the significant viewing condition by viewing angle interaction [$F(1, 60) = 21.48$, $p < 0.001$] yields such findings. Table 13.2 presents the means (combining correct reports of symmetry and asymmetry) involved in the interaction. Newman–Keuls tests ($p < 0.05$) on these means yielded significantly fewer objectively correct responses for the reduced-cue, 65 deg condition than for any of the other three conditions, which in turn did not differ from one another. Moreover, subjects in these three other groups identi-

Table 13.2
Mean proportions for between-subjects factors

	Angle	
Viewing condition	0 deg	65 deg
Full-cue	0.84a	0.70a
Reduced-cue	0.73a	0.39b

Note: Means with different subscripts are significantly different from each other at the 0.05 level (Newman–Keuls).

fied the objective shape of the stimuli above chance levels [$t(15) = 10.65$, $p < 0.01$; $t(15) = 6.39$, $p < 0.01$; $t(15) = 7.10$, $p < 0.01$; for the full-cue, 0 deg, the full-cue, 65 deg, and the reduced-cue, 0 deg conditions, respectively]. By contrast, the reduced-cue, 65 deg condition produced responding below chance level [$t(15) = -3.51$, $p < 0.01$], indicating judgments influenced by, but not exclusively dependent upon, the retinal projection of the stimuli (see below).

The focus of this investigation is on performance of the subjects when they view the figures at a slant but have full depth cues available, the full-cue, 65 deg condition. Do they respond in terms of the symmetry or asymmetry, as these properties may be perceived, or in terms of how they are given within the retinal image? The mean of 0.70 correct responses clearly is in the direction of the perceptual interpretation, since responding on the basis of retinal symmetry or asymmetry would lead to the expectation of a mean close to zero (because in the latter case the subjects would always be incorrect). Moreover, the mean of 0.70 should not be compared to the value of 1.00, the maximum proportion that could be correct, because in the full-cue, 0 deg condition the mean is only 0.84. For whatever reason, that value is the level of correct responses achieved when both perceptual and retinal symmetry is present.

Shape Constancy

The baseline ratio (of height in cm to width in cm) for the two frontoparallel plane conditions turned out to fall roughly between 0.94 and 1.14, depending upon whether full or reduced cues were available and upon the type of figure and duration of exposure. The means were 1.0 with full cues available and 1.07 in the reduced-cue condition. This result corresponds rather well with the objective height-to-width ratio, which approximates 1.0.

Were the subjects able to achieve full constancy for the shapes of the figures despite their rather extreme slant of 65 deg from the frontal plane? At the 65 deg angle in the full-cue condition, the mean ratio was 1.26 across exposure duration and type of figure, which significantly differed from the full-cue, 0 deg condition mean of 1.0 [$t(15) = 5.04$, $p < 0.01$]. This increase reflects the decrease in perceived width of the stimuli relative to the judgment of width in the frontoparallel position and represents a loss of constancy.

In the reduced-cue, 65 deg condition, where of course constancy is not expected to be obtained, the ratio rises sharply to a mean of 2.03 for the two kinds of figure and two exposure interval conditions combined. Using the full-cue, 0 deg mean height-to-width ratio of 1.0 as the value for complete constancy and the value of this ratio when the figures are viewed through the artificial pupil from an angle of 65 deg of 2.03 as the value for zero constancy, we can derive a measure for the degree of constancy obtained for the mean ratio in the full-cue, 65 deg condition of 1.26. Following the formula that is generally used, we have a Constancy Ratio = (2.03 − 1.26)/(2.03 − 1.0) = 0.77, which is, of course, an appreciable but not complete degree of constancy.

Furthermore, the mean value of the height-to-width ratio obtained in the reduced-cue, 65 deg condition, of 2.03, is lower than the value to be expected in this condition if the perceived width of the figure were a function of the compression of the projected figure images relative to the unchanged image of the height of the figures. We computed this value trigonometrically to be 2.35. The departure of 2.03 from 2.35 (which we take to be the objective value indicating zero constancy) is statistically significant [$t(15) = 5.99$, $p < 0.01$]. The Constancy Ratio (2.35 − 2.03)/(2.35 − 1.0) = 0.24. Thus, it can be concluded that the reduced-cue, 65 deg condition did not succeed in completely eliminating cues to depth. This in turn undoubtedly explains why symmetry and asymmetry responses in that condition were not what would have been expected if depth perception had been entirely eliminated. For, if it had, subjects should have responded incorrectly as often as they responded correctly in the 0 deg condition. That is because symmetrical figures yielded asymmetrical retinal images and asymmetrical figures yielded symmetrical retinal images in the reduced-cue, 65 deg condition and, without depth cues, these image relations should have determined responses. If so, the expected mean proportion correct should have been 1.0–0.73 (using the mean proportion correct in the reduced-cue, 0 deg condition as baseline) or 0.27. But the mean proportion of correct responses in the reduced-cue, 65 deg condition was 0.39.

The influence of exposure duration and pattern type on shape constancy was assessed by a two-way repeated measures ANOVA. Neither the main effects nor the interaction were significant [$F(1, 31) < 1.0$]. Thus, neither exposure duration, nor pattern type significantly affected shape constancy in our experiment.

Discussion

The results give a clear answer to the main question posed in this investigation. The perception and response to symmetry or the lack of it in patterns symmetrical about their vertical axis is determined by whether or not the two halves of the pattern appear to be equal. Thus, although a figure is rotated about its vertical axis quite appreciably away from the frontoparallel plane, it will generally continue to appear symmetrical if it is symmetrical and asymmetrical if it is not. This is so despite the fact that the symmetrical figures then project an image to the retina that is asymmetrical and the asymmetrical figures project an image that is symmetrical about the vertical axis.

The data that support this claim are the results of the condition in which the subject views the figures in a plane slanted away from him or her by 65 deg with full cues to depth available. In comparison to the results when the figures are seen in the frontoparallel plane, where the mean proportion of correct responses was 0.84, the mean proportion correct in the slanted-plane condition was 0.70. But, for responses based on the retinal state of affairs, the predicted mean ought to be close to 0, since responses based on retinal symmetry or asymmetry would always be incorrect. This prediction assumes that subjects would always be "correct." However, a more likely expectation would be the difference between the proportion correct in the frontoparallel plane condition and the perfectly correct performance of 1.00, namely 1.00 – 0.84, or 0.16. So the closeness of the obtained mean of 0.70 to 0.84 and its distance from 0.16 tells the story.

Moreover, the measure of shape constancy tells us that the perceived shape of the figures seen at a slant was not fully veridical. This is what might be expected for a slant as extreme as 65 deg. Thus a symmetrical figure might be expected to appear to be slightly less than perfectly symmetrical and an asymmetrical one to appear not quite as asymmetrical as it is. Given that expectation, the slight departure of the results in the slanted-plane condition from those in the frontal-plane condition become fully understandable.

The results in the condition in which subjects viewed the figures in the slanted plane, but presumably without any cues to depth, round out the picture. Here the mean proportion correct plummets to 0.39. Thus with the only difference between the two slanted-plane conditions being the presence or absence of depth information, the responses shift from those governed predominantly by the objective state of affairs to those governed predominantly by the retinal state of affairs. This is not to imply that subjects are perceiving their retinal images in the reduced-cue condition. A better formulation would be to say that in this condition subjects tend to perceive the figures as lying in a plane orthogonal to their line of sight and thus retinal symmetry or the lack of it would have to signify objective symmetry or the lack of it.

But the responses in these conditions are not fully in accord with a "retinal" prediction. The mean of 0.39 is significantly greater than the value suggested above of 0.16, which is what we should expect in this condition were retinal symmetry or asymmetry to govern the outcome. However, a further correction in this prediction is required. The use of the artificial pupil not only reduces depth information, but also appreciably lowers the luminance level of the figures. The greater intensity of light we introduced in the two reduced-cue conditions would not have totally compensated for the loss of luminance at the eye. Thus the results of the other reduced-cue condition, in which the figures were seen in a frontoparallel plane, become relevant and useful. Here the mean proportion correct was 0.73. Therefore it is the difference between 1.00 and 0.73, or 0.27, that is the best prediction of what to expect in the reduced-cue slanted-plane condition if the retinal state of affairs governs the outcome. The obtained mean of 0.39 is still significantly greater than 0.27 [$t(15) = 3.60, p < 0.01$]. From this we can conclude that the artificial pupil did not succeed in completely eliminating cues to depth in this condition. This conclusion jibes with the fact that a slight tendency toward shape constancy was found to occur in this condition. It is possible that the asymmetrical retinal projection of the symmetrical slides served as a kind of perspective cue, suggesting a symmetrical pattern viewed at a slant.

Symmetry Bias

Subjects consistently did better with the symmetrical than with the asymmetrical patterns. They were more often correct on these trials. We believe that the finding reveals a bias. It must be borne in mind that our asymmetrical figures are deliberate distortions away from what is otherwise a symmetrical figure. Therefore, one might say that all the figures look somewhat symmetrical. The question the subject has to answer for him- or herself is rather whether a given figure looks *perfectly* symmetrical. Given some uncertainty, the subject is more likely to respond "symmetrical." A signal detection analysis supports this interpretation of a symmetrical bias. Across all conditions and stimuli, the average proportion of hits (symmetrical response when a symmetrical stimulus was presented) was 0.74, misses (asymmetrical response/symmetrical stimulus) 0.26, false alarms (symmetrical response/asymmetrical stimulus) 0.41, and correct rejections (asymmetrical response/asymmetrical stimulus) 0.59, yielding a d' of 0.87. Saying "symmetrical" when the stimulus was asymmetrical (false alarm) should have been as likely as saying "asymmetrical" when the stimulus was symmetrical (miss), if no bias were evident. However, false alarms were considerably more likely (0.41) than were misses (0.26), offering further support for a symmetrical bias, with beta = 0.82. This interpretation is supported by the further finding that the symmetrical bias increases with the difficulty of the condition.

Effects of Figure Type and Exposure Duration

We have already noted the expected finding that subjects do better with the holistic figures than with the multi-element figures. Similarly, it hardly needs to be explained that subjects would do better with the longer 1 s exposure duration than the 100 ms one. The fact is that subjects do perform better in the slanted-plane full-cue condition with the holistic figures and with the longer exposure duration. However, such figural and duration differences occur for all the other conditions as well, so that, in the absence of a significant interaction effect, we cannot say that these factors specifically affect the constancy operation. Although it is known that constancy is achievable in brief durations, there is no evidence of which we are aware that shape constancy is a function of the particular shape or pattern investigated (except perhaps some bias that improves performance when the shape is a regular one such as a circle (King et al., 1976) or one with vertical symmetry as in our experiments here). Hence our failure to find specific effects of figural characteristics and duration of exposure do not violate existing knowledge on this subject.

A Test of Perceptual Causality

Some investigators might be inclined to regard our finding of the dependency of symmetry perception on constancy operations as surprising (Locher and Smets, 1992). That is because symmetry can be detected in exposure durations of as little as 50 ms followed by a mask. In fact, for this reason, the detection of symmetry has been thought to be preattentive as determined by studies using 2-D dot patterns rotated clockwise and counter clockwise in 2-D space (Wagemans et al., 1991, 1992), whereas it would seem unlikely to many that a constancy process of taking account of depth information would be preattentive. Some might even be inclined to reverse our claim about the direction of cause and effect of perception of the plane and perception of symmetry. The argument would be that the skewed symmetry projected to the retina in our slanted-plane conditions is preattentively interpreted as bilateral symmetry and this in turn allows the correct interpretation that the plane of the figure is slanted with respect to the viewer.

Our answer to this line of reasoning is as follows. First, none of all the preattentive research of which we are aware succeeds in testing perception without attention. Either a divided attention paradigm is employed or it is assumed that texture segregation or pop-out based on brief presentations of an array of multiple items must be preattentive because the outcome entails parallel processing (Treisman and Gelade, 1980; Julesz, 1981; Beck, 1982). But the fact remains that subjects in these paradigms are attending to the array. When this is prevented by a method in which the subject is not attending to the stimulus or stimulus array to be tested, then neither texture segregation, perceptual groupings, pop-out, nor shape is perceived (Mack et al., 1992; Rock et al., 1992). Therefore it is unlikely that any overall property of shape such as symmetry would be detected preattentively. Second, it does not at all follow that, *with* attention as in our experiments and others on symmetry, depth perception and shape constancy would not be achieved in brief durations. We are inclined to believe they would because there is evidence that processes such as depth from retinal disparity and constancy are indeed achieved in very brief durations (Dove, 1841; King et al., 1976). In our experiment, depth and constancy were achieved in 100 ms presentations although the figures were not masked.

Third, there is a test of the cause-effect reversal hypothesis contained in our experiment. We refer to the condition in which the pattern on the screen is viewed through a pinhole at a 65 deg slant thus reducing depth information. For in this case, the skewed symmetry image is available and should, according to the hypothesis, yield good symmetry perception of symmetrical figures. However, the other cues allowed in the 65 deg, full-cue condition are not available in this condition, but, according to the hypothesis, they are not relevant. The result in this condition is a marked decline in correct reports of symmetry and, going along with this, a marked decline in constancy. However, there still is a small residual tendency toward constancy and there are more correct symmetry responses than would be expected from the asymmetrical image of the symmetrical figures. Therefore, as we acknowledge above, it may well be that a skewed symmetrical image is one kind of cue that the object producing it is slanted away from the frontal plane.

There is another relevant fact to consider. It concerns the subjects' responses to asymmetrical figures presented in the 65 deg full depth-cue condition. These yield a symmetrical retinal image so that there is no skewed symmetry image present. If the outcome were not based on taking account of the slant of the screen, subjects should respond "symmetrical" given the symmetrical image. However, subjects tend to respond "asymmetrical" to these stimuli seen at a slant; whereas in the reduced-cue 65 deg condition subjects tend to respond "symmetrical" to these stimuli. This finding is no doubt the result of information from retinal disparity and the interaction of appropriate accommodation and convergence. The trapezoidal image of the slanted rectangular screen may also serve as a pictorial cue to the slant of the screen.

It can be argued that our findings are not exclusively concerned with symmetrical figures. While this is undoubtedly true, it does not imply that our findings have nothing to do with symmetry per se. One of the main purposes of this study was to demonstrate that there is nothing special about the perception of symmetry beyond the perception of the equality of the halves of a figure on each side of its vertical bisector. If such perception of equality is indeed crucial, as our data suggest, then we believe that the vertical-symmetry effect is one more example of perceptual causality.

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