Developmental Psychology
1981, Vol. 17, No. 1, 82-86

0012-1649/81/1701-0082$00.75

Perception of Symmetry in Infancy

Marc H. Bornstein, Kay Ferdinandsen, and Charles G. Gross
Princeton University

Symmetrical visual patterns, particularly vertically symmetrical ones, are preferred and processed faster than asymmetrical patterns by adults. We have found that 4-month-old infants show no preference for symmetry, but they process vertically symmetrical patterns more efficiently than horizontally symmetrical or asymmetrical ones. By 12 months, infants prefer vertical symmetry to horizontal symmetry and asymmetry. Thus, preference for symmetry seems to develop late, whereas recognition of vertical symmetry is innate, matures very quickly, or is learned very early.

Aristotle, in Book XIII of *The Metaphysics* (in Smith & Ross, 1908), and Charles Darwin, in *The Descent of Man* (1913, p. 141), both noted that people prefer symmetrical patterns. Moreover, the past century of psychological research has repeatedly demonstrated that symmetrical stimuli are not only preferred but are consistently detected faster, discriminated more accurately, and often remembered better than asymmetrical ones (e.g., Adams, Fitts, Rappaport, & Weinstein, 1954; Arnheim, 1974; Berlyne, 1971; Garner & Sutliff, 1974; Gibson, 1929; Koffka, 1935; Pomerantz, 1977; Valentine, 1925).

These phenomena are usually thought to reflect the information redundancy in symmetrical stimuli (see Attneave, 1954, 1955, 1957; Garner, 1970). However, vertically symmetrical patterns are preferred and processed more efficiently than horizontally symmetrical or repeated patterns even when the amount of information is identical across the three types of patterns. Thus, there seems to be something perceptually special about vertical symmetry (e.g., Deregowski, 1971; Fitts & Simon, 1952; Fitts, Weinstein, Rappaport, Anderson & Leonard, 1956; Goldmeier, 1972; Julesz, 1971; Mach, 1885/1959; Munsinger & Forsman, 1966; Palmer & Hemenway, 1978; Szilagyi & Baird, 1977). Perhaps the fact that particularly important stimuli are vertically symmetrical—notably parents, progeny, predators, and prey—contributes to the unique status of vertical symmetry.

How does the special perceptual nature of symmetry arise? Is it a product of extensive visual experience and thus absent in early infancy? Or, is it a product of evolution and perhaps present in infancy? Developmental studies have shown that children older than about 4 years—the youngest studied to date—prefer symmetry and process it more efficiently (Boswell, 1976; Chipman & Mendelson, 1975; Paraskevopoulos, 1968), and cross-cultural developmental reports show similar findings (Bentley, 1977; Deregowski, 1972). In three experiments, we examined whether this perceptual advantage was characteristic of young infants. In one preliminary experiment we studied infants' looking at vertically symmetrical and asymmetrical patterns, and in the second and third experiments we compared vertically symmetrical, horizontally symmetrical, and asymmetrical patterns.

This research was supported by the Spencer Foundation.

We thank C. Bruce, R. Desimone, and C. Fisher for comments, and C. Besson, P. Bree, S. Lewis, N. Nielson, and M. A. Opperman for assistance.

Requests for reprints should be sent to Marc H. Bornstein, who is now at the Department of Psychology, New York University, 6 Washington Place, New York, New York 10003.

Experiment 1

Method

In the first experiment, 13 4-month-olds were seen in the laboratory on two occasions 1 week apart. They were seated in an infant chair facing a white screen on which either a symmetrical or an asymmetrical geometric pat-

tern was projected. The two patterns were constructed of the same number of line segments and were equivalent in perimeter, contour, and area; they were red and subtended approximately 15° × 25° of visual angle. All stimuli were shown for 180 sec, thereby permitting the infants continuous viewing. Six babies saw the symmetrical stimulus on their first visit and the asymmetrical one on their second; 7 saw the asymmetrical first. The infants' looking was video recorded, and the duration of their looking was subsequently measured from the videotapes by observers unaware of which stimulus was presented. (For a more complete explanation of the methods, see Bornstein, Gross, & Wolf, 1978.) The interobserver reliabilities in judging looking time in Experiments 1–3 averaged better than .90.

Results and Discussion

Preference. Relative preference for the two stimuli was assessed by comparing the amount of time the infants initially looked at them at the beginning of each exposure. The infants showed no statistically reliable preferences. For example, in the first 30 sec the babies looked at the symmetrical pattern for an average of 18.50 sec and at the asymmetrical pattern for an average of 17.10 sec, $t(12) < 1$. The results were similar to other preference measures such as amount of looking in the initial 20 or 50 sec and the duration of the initial two or five looks.

Habituation. Processing of the two stimuli was assessed by comparing the rate and amount of habituation of looking to each stimulus over the full duration of the 180-sec exposure period. (Habituation in infants has been conceived to be roughly analogous to encoding in adults; for rationales, see Bornstein, 1980; Cohen & Gelber, 1975; Tighe & Leaton, 1976.) The 180-sec period was first divided into 18 10-sec segments. Then a baseline equal to the mean looking time in the first 3 segments was established for each child, and looking time during each segment was converted to a percentage of the baseline. In this way it was possible to track continuously the infant's pattern of interest in and perception of the stimulus during presentation. The babies habituated faster to the symmetrical stimulus than to the asymmetrical one. For example, an habituation criterion of three consecutive 10-sec segments in which looking time was ≤ 50% of the baseline was attained in half as many segments (6.1) for the symmetrical stimulus as for the asymmetrical one (12.8), $t(12) = 2.37$, $p < .025$. Other baselines, such as looking in the initial 20 sec, and other habituation criteria, such as 2 consecutive segments ≤ 40% of baseline or 4 out of 5 consecutive segments ≤ 50% of baseline, showed similar statistically reliable results.

The babies also showed a greater amount of habituation to the symmetrical stimulus as measured by the difference in looking between the initial and final 30 sec of presentation (symmetrical, 12.51 sec, and asymmetrical, 6.14 sec, $t(12) = 1.93$, $p < .05$).

Neither sex nor session order was a significant variable in these measures. Further, the state of the infants did not significantly vary within or between sessions as measured by the babies' response to a test figure at the beginning and end of each experimental session.

In summary, although 4-month-old infants did not show a clear preference, they habituated faster and more to symmetry than to asymmetry.

Experiment 2

Experiment 2 repeated the first using a new group of infants with a new set of stimuli that included horizontally symmetrical as well as vertically symmetrical and asymmetrical patterns. New stimuli were used to test the generality of the results of Experiment 1. Horizontal stimuli were included to differentiate symmetry generally from the potentially special properties of vertical symmetry.

Method

In the second experiment, 18 4-month-olds were seen in the laboratory on three occasions at 1-week intervals. On a given visit, the infants saw one of two vertical patterns, one of two horizontal patterns or one of two asymmetrical patterns for 240 sec. Examples of these patterns are shown on the abscissa of Figure 1: The vertical stimuli were the one shown on the left and a 90° clockwise rotation of the one shown in the middle; the horizontal stimuli were the one shown in the middle and a 90° counterclockwise rotation of the one shown on the left; the asymmetrical stimuli were the one shown on the right and its 90° counterclockwise rotation. The stimuli were constructed of identical components and were therefore identical in perimeter, contour, and area; they were red and subtended approximately 21° × 21°. Across the three visits, each infant saw each type of

symmetry once. Pattern order was balanced across subjects. The apparatus, methods, and measures were the same as in Experiment 1.

Results and Discussion

Preference. The babies did not look preferentially at any of the three types of symmetry. For example, in the initial 30 sec, the babies looked at the vertical patterns an average of 21.37 sec, at the horizontal an average of 18.71 sec, and at the asymmetrical an average of 18.23 sec, multiple $ts(17) \leq 1.74$. Again, other preference measures (as used in Experiment 1) showed similar results.

Habituation. The babies habituated faster to the vertical patterns than to the horizontal or asymmetrical patterns, but the rates of habituation to the horizontal and asymmetrical patterns did not differ. For example, the mean number of 10-sec segments required to reach the criterion of three consecutive segments in which looking time was ≤50% of the baseline was 8.9 for the vertical stimuli, 15.8 for the horizontal stimuli, and 15.7 for the asymmetrical stimuli. The number for vertical was reliably less than for horizontal, $t(17) = 2.70$, $p < .01$, and asymmetrical, $t(17) = 2.54$, $p = .01$, but horizontal and asymmetrical were equivalent, $t(17) = 0$ (see Figure 1). Again, other baselines and habituation criteria (as used in Experiment 1) showed similar results.

The amount of habituation between the beginning and end of the 4-min exposure period was also greater for the vertical patterns than for the horizontal and asymmetrical ones, which did not differ from each other; the difference between looking time in the initial and final 30 sec was 15.41 sec for the vertical, 7.10 sec for the horizontal, and 5.97 sec for the asymmetrical. The decrement to vertical was reliably more than to horizontal, $t(17) = 3.94$, $p < .001$, and asymmetrical, $t(17) = 2.64$, $p < .01$, but horizontal and asymmetrical were equivalent, $t(17) = .31$.

There were no differences in preference or habituation within each pair of stimuli with similar axes of symmetry. Further, neither sex, session order, nor infant state ever influenced the results.

In summary, 4-month-old infants did not show a clear preference for any type of symmetry, but they habituated more quickly and to a greater degree to vertically symmetrical patterns than to either horizontally symmetrical or asymmetrical ones.

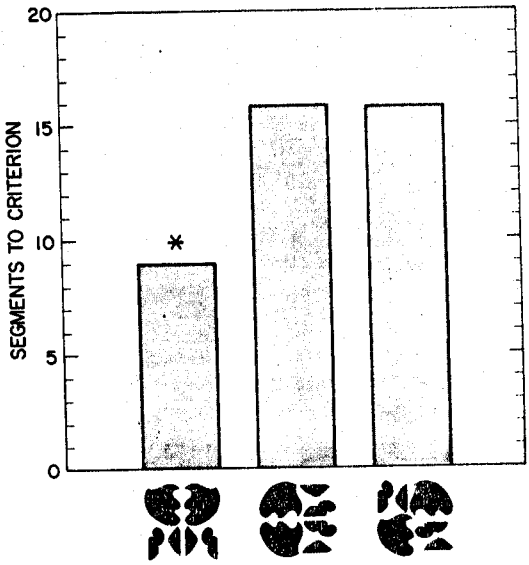

Figure 1. Mean number of 10-sec segments prior to reaching criterion for habituation to the vertically symmetrical, horizontally symmetrical, and asymmetrical stimuli. (The asterisk indicates that the 4-month-olds habituated significantly faster to vertical symmetry than to horizontal symmetry and asymmetry.)

Experiment 3

In the first two experiments, we measured preference by comparing looking time at stimuli presented one at a time. In Experiment 3, we studied choice between simultaneously presented pairs of stimuli in infants of two ages.

Method

In Experiment 3, 15 4-month-olds and 15 12-month-olds saw, for periods of 10 sec each, vertically symmetrical, horizontally symmetrical, and asymmetrical stimuli identical to those used in Experiment 2. The vertical stimuli were the one shown on the left and a 90° counterclockwise rotation of the one shown in the middle; the horizontal stimuli were the one shown in the middle and a 90° counterclockwise rotation of the one shown on the left; the asymmetrical stimuli were the one shown on the right and its 90° counterclockwise rotation (see Figure 2). Each stimulus type was shown paired with every other one four times in presentation schedules that

counterbalanced stimuli for lateral position and randomized order across infants.

Results and Discussion

As in Experiments 1 and 2, 4-month-olds failed to show a preference; these babies looked the same amounts of time on the average at vertical symmetry (2.36 sec), horizontal symmetry (2.57 sec), and asymmetry (2.45 sec), multiple $ts(14) \leq 1.34$ (see the lower panel of Figure 2). Together, these results replicate those of Spears (1964) and Fantz, Fagan, and Miranda (1975), who also found no preference for vertically symmetrical patterns in young infants.

By contrast, however, the 12-month-olds reliably preferred vertical symmetry (1.94 sec) to horizontal symmetry (1.62 sec), $t(14) = 1.77$, $p < .05$, and asymmetry (1.67 sec), $t(14) = 1.83$, $p < .05$, but they looked equally between horizontal symmetry and asymmetry, $t(14) = .35$ (see the upper panel of Figure 2). At both ages, first looks followed the same pattern as total looking, but at neither age did sex, session order, or infant state affect the results. In summary, a preference for vertical symmetry seems to develop between 4 and 12 months of age.

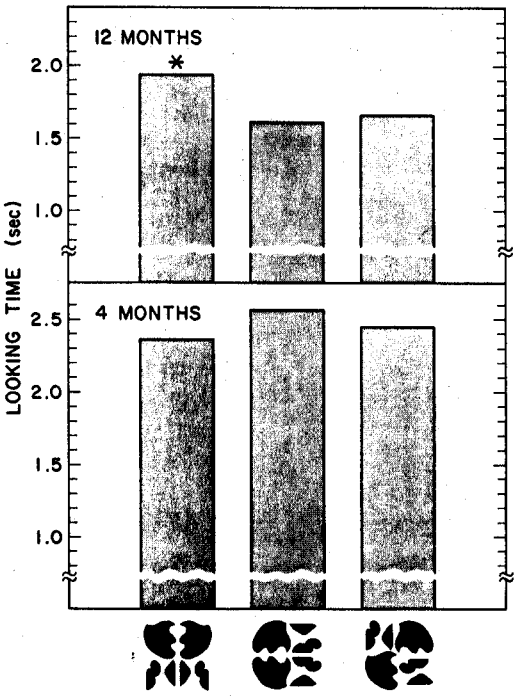

Figure 2. Mean looking time of 4-month-old and 12-month-old infants at vertically symmetrical, horizontally symmetrical, and asymmetrical stimuli. (The asterisk indicates that the 12-month-olds significantly preferred vertical symmetry to horizontal symmetry and asymmetry.)

General Discussion

Younger infants habituate fastest and most to vertical symmetry, though a preference for vertical symmetry is not evident until infants are older. These developmental differences require separate explanations for preference and processing.

The faster and greater habituation to vertical symmetry demonstrated in the first two experiments indicate that young infants can perceive some types of stimulus organization (vertical symmetry) but not others (horizontal symmetry). This perceptual bias for vertical symmetry could have its origins in the bilateral symmetry of the visual system, as Mach (1885/1959) speculated; alternatively, the processing advantage for vertical symmetry may be tied to the fact that infants (like children and adults) naturally treat as *particularly* equivalent those patterns that are lateral mirror images of one another, that is, those that are symmetric about the vertical meridian, since such patterns in nature tend always to be twin aspects of the same thing, and it would, consequently, be more adaptive to treat them the same (see Bornstein et al., 1978; Gross & Bornstein, 1978).

The later development of preference for vertical symmetry demonstrated in Experiment 3 implies that this preference may be a product of maturation, of experience in a visual environment dominated by symmetries (especially vertical ones), or perhaps of an appreciation of the advantages provided earlier in life by the information redundancy in symmetry.

The results of all three experiments support the view that vertical has a special status in early perceptual development (Braine, 1978). Whether innate, early maturing, or based on experience, the special quality of verticality generally may derive from the importance of the vertically symmetrical body and face; as Pascal observed, "our no-

tion of symmetry is derived from the human face" (cited in Auden & Kronenberger, 1962, p. 12).

References

Adams, O. S., Fitts, P. M., Rappaport, M., & Weinstein, M. Relations among some measures of pattern discriminability. *Journal of Experimental Psychology*, 1954, *48*, 81–88.

Aristotle. *The metaphysics*. In J. A. Smith & W. D. Ross (Eds.), *The works of Aristotle* (Vol. 8). Oxford, England: Clarendon Press, 1908.

Arnheim, R. *Art and visual perception*. Berkeley: University of California Press, 1974.

Attneave, F. Some informational aspects of visual perception. *Psychological Review*, 1954, *61*, 183–193.

Attneave, F. Symmetry, information, and memory for patterns. *American Journal of Psychology*, 1955, *68*, 209–222.

Attneave, F. Physical determinants of the judged complexity of shapes. *Journal of Experimental Psychology*, 1957, *53*, 221–227.

Auden, W. H., & Kronenberger, L. (Eds.), *The Viking book of aphorisms*. New York: Viking, 1962.

Bentley, A. M. Symmetry in pattern reproduction by Scottish and Kenyan children. *Journal of Cross-Cultural Psychology*, 1977, *8*, 415–424.

Berlyne, D. E. *Aesthetics and psychobiology*. New York: Appleton-Century-Crofts, 1971.

Bornstein, M. H. Two kinds of perceptual organization near the beginning of life. In W. A. Collins (Ed.), *Minnesota symposia on child psychology* (Vol. 14). Hillsdale, N.J.: Erlbaum, 1980.

Bornstein, M. H., Gross, C. G., & Wolf, J. Z. Perceptual similarity of mirror images in infancy. *Cognition*, 1978, *6*, 89–116.

Boswell, S. L. Young children's processing of asymmetrical and symmetrical patterns. *Journal of Experimental Child Psychology*, 1976, *22*, 309–318.

Braine, L. G. A new slant on orientation perception. *American Psychologist*, 1978, *33*, 10–22.

Chipman, S. F., & Mendelson, M. J. The development of sensitivity to visual structure. *Journal of Experimental Child Psychology*, 1975, *20*, 411–429.

Cohen, L. B., & Gelber, E. R. Infant visual memory. In L. B. Cohen & P. Salapatek (Eds.), *Infant perception* (Vol. 1). New York: Academic Press, 1975.

Darwin, C. *The descent of man*. London: Murray, 1913.

Deregowski, J. B. Symmetry, Gestalt and information theory. *Quarterly Journal of Experimental Psychology*, 1971, *23*, 381–385.

Deregowski, J. B. The role of symmetry in pattern reproduction by Zambian children. *Journal of Cross-Cultural Psychology*, 1972, *3*, 303–308.

Fantz, R. L., Fagan, J. F., III, & Miranda, S. B. Early visual selectivity as a function of pattern variables, previous exposure, age from birth and conception, and expected cognitive deficit. In L. B. Cohen & P. Salapatek (Eds.), *Infant perception* (Vol. 1). New York: Academic Press, 1975.

Fitts, P. M., & Simon, C. W. Some relations between stimulus patterns and performance in a continuous dual-pursuit task. *Journal of Experimental Psychology*, 1952, *43*, 428–436.

Fitts, P. M., Weinstein, M., Rappaport, M., Anderson, N., & Leonard, J. A. Stimulus correlates of visual pattern recognition: A probability approach. *Journal of Experimental Psychology*, 1956, *51*, 1–11.

Garner, W. R. Good patterns have few alternatives. *American Scientist*, 1970, *58*, 34–42.

Garner, W. R., & Sutliff, D. The effect of goodness on encoding time in visual pattern discrimination. *Perception & Psychophysics*, 1974, *16*, 426–430.

Gibson, J. J. The reproduction of visually perceived forms. *Journal of Experimental Psychology*, 1929, *12*, 1–39.

Goldmeier, E. Similarity in visually perceived forms. *Psychological Issues*, Monograph 29, 1972, *8*(1), pp. 1–135.

Gross, C. G., & Bornstein, M. H. Left and right in science and art. *Leonardo*, 1978, *11*, 29–38.

Julesz, B. *Foundations of cyclopean perception*. Chicago: University of Chicago Press, 1971.

Koffka, K. *Principles of Gestalt psychology*. New York: Harcourt, Brace, 1935.

Mach, E. [*The analysis of sensations*] (C. M. Williams, trans.). New York: Dover, 1959. (Originally published, 1885.)

Munsinger, H., & Forsman, R. Symmetry, development, and tachistoscopic recognition. *Journal of Experimental Child Psychology*, 1966, *3*, 168–176.

Palmer, S. E., & Hemenway, K. Orientation and symmetry: Effects of multiple, rotational, and near symmetries. *Journal of Experimental Psychology: Human Perception and Performance*, 1978, *4*, 691–702.

Paraskevopoulos, I. Symmetry, recall, and preference in relation to chronological age. *Journal of Experimental Child Psychology*, 1968, *6*, 254–264.

Pomerantz, J. R. Pattern goodness and speed of encoding. *Memory & Cognition*, 1977, *5*, 235–241.

Spears, W. C. Assessment of visual preference and discrimination in the four-month-old infant. *Journal of Comparative and Physiological Psychology*, 1964, *57*, 381–386.

Szilagyi, P. G., & Baird, J. C. A quantitative approach to the study of visual symmetry. *Perception & Psychophysics*, 1977, *22*, 287–292.

Tighe, T. J., & Leaton, R. N. (Eds.), *Habituation*. Hillsdale, N.J.: Erlbaum, 1976.

Valentine, C. W. *An introduction to the experimental psychology of beauty*. London: Jack, 1925.

Received April 29, 1980 ■