Infants' Perception of Natural and Distorted Arrangements of a Schematic Face

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MAURER, DAPHNE, and BARRERA, MARIA. *Infants' Perception of Natural and Distorted Arrangements of a Schematic Face.* CHILD DEVELOPMENT, 1981, 196–202. The techniques of visual preference and of habituation were used to test the ability of 1- and 2-month-olds to discriminate various arrangements of the features of the human face. We showed infants schematic drawings of a human face with the features (1) arranged naturally, (2) arranged symmetrically but scrambled, and (3) arranged asymmetrically and scrambled. 2-month-olds discriminated among all 3 arrangements; 1-month-olds appeared not to discriminate between any of them. 2-month-olds also showed a preference for a natural arrangement of the features, but 1-month-olds did not. Thus, by 2 months infants may recognize how the features of a natural human face are arranged and generalize that knowledge to schematic faces.

For years psychologists have tried to determine when infants first realize how the features of the human face are naturally arranged. Their usual strategy has been to show infants schematic drawings of faces with the features arranged naturally or unnaturally, and then to see if the infants look longer at the natural arrangement than at the others.

Most investigators have found a preference for a natural arrangement only in infants 4 months old or older (Haaf 1974; Haaf & Bell 1967; Haaf & Brown 1976; Hershenson, Munsinger, & Kessen 1967; Koopman & Ames 1968; Lewis 1969; Sigman & Parmelee 1974; Wilcox 1969; Weiffenbach, Note 1; but see also Fantz 1961, 1966).[1] Apparently, how long an infant younger than 4 months looks at a facelike stimulus depends not on its realism but on its amount of contour (Haaf 1974; Haaf & Brown 1976).

However, infants younger than 4 months might be able to discriminate natural from unnatural arrangements, but not yet prefer one to the other. Indeed, studies of infants' scanning suggest infants probably can make this discrimination by the time they are 2 months old. Although we have no data on how infants scan schematic faces, when 2-month-olds scan a variety of other figures including the human face, they look longer at the internal details of the figure than at its edges (Hainline 1978; Haith, Bergman, & Moore 1977; Maurer & Salapatek 1976; Salapatek 1975). In addition, when they look at a face, they look longer at the eyes than at any other feature (Hainline 1978; Haith et al. 1977; Maurer & Salapatek 1976). If 2-month-olds scan schematic faces similarly, then they might notice when the eyes are displaced; that is, they might discriminate natural from unnatural arrangements of a face's features.

In contrast, the scanning studies suggest that 1-month-olds probably cannot make that discrimination. One-month-olds rarely look inside a figure, even if it is a face (Hainline 1978; Haith et al. 1977; Maurer & Salapatek 1976; Salapatek 1975). Instead, they almost always

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[1] Thomas and Jones-Molfese (1977) report a significant preference for a normal to a scrambled arrangement in 2-month-olds. However, the scrambled arrangement had only one eye, so the results can also be interpreted as a preference for greater contour.

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fixate on the edge—the hairline or chin. Consequently, 1-month-olds should not notice changes in the arrangement of a face's internal features.

In the experiments reported below we tested the ability of 1- and 2-month-olds to discriminate among various arrangements of a face's internal features. We used three schematic drawings of a face with the features (1) arranged naturally, (2) arranged symmetrically but scrambled, and (3) arranged asymmetrically and scrambled.

To test these discriminations, in experiment 1 we used the traditional technique of visual preference, but in experiment 2 we used habituation, a technique we suspected would be more sensitive.

Experiment 1

The purpose of experiment 1 was to determine whether 1- and 2-month-old infants show a preference for a natural arrangement of the features of the human face. Although Fantz (1961, 1966) found a preference for a natural arrangement in 2-month-olds, most other investigators have failed to find any preference at these ages (Haaf 1974; Haaf & Brown 1976; Koopman & Ames 1968; Wilcox 1969). Moreover, most previous studies have used trials of a fixed duration, which can cut short an infant's fixation on a stimulus and obscure his preferences. Therefore, we used an "infant control procedure" (Horowitz 1975) in which each stimulus is presented for as long as the infant is judged to look at it.

Method

Subjects.—The subjects were 20 1-month-olds ($\bar{X}$ age = 36 days, range 30–42 days; 11 males, 9 females) and 15 2-month-olds ($\bar{X}$ age = 66 days, range 61–70 days; 9 males, 6 females), all full-term and with no known abnormalities. An additional six babies did not complete the experiment because they cried ($N = 3$) or fell asleep ($N = 3$).

Stimuli.—The three stimuli are shown in figure 1. All were life-size white ovals centered on a gray background and containing cutouts of the internal features of a human face. These features were either arranged naturally (stimulus *A*), arranged symmetrically but scrambled (stimulus *B*), or arranged asymmetrically and scrambled (stimulus *C*). The stimuli were presented on slides and projected to 22.8 × 15 cm (28° × 19° when viewed from 46 cm). The set of three stimuli was presented twice, each time in random order.[2]

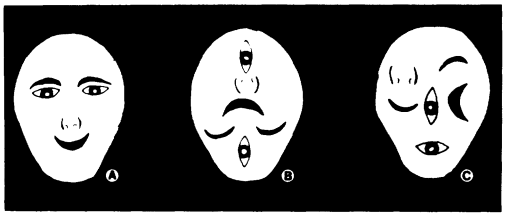

FIG. 1.—The stimuli used in experiments 1 and 2

Apparatus.—The baby sat in an infant seat facing a 42 × 28.5-cm rear-projection screen mounted in a black wood frame. Two observers stood behind the screen and watched the infant's eyes through small holes in the black frame on either side of the screen. Also behind the screen were timers, a slide projector, a shutter which could occlude the projector, and various controlling equipment.

Procedure.—An experimenter placed the baby in the infant seat and adjusted the seat so the baby's eyes were 46 cm from the screen. Then the experimenter turned off the room lights and turned on white noise. During these preparations, a slide not included in this experiment was projected onto the screen to amuse the baby.

The procedure was similar to the infant control procedure described by Horowitz (1975). On each trial one of the three stimuli was projected onto the screen. Two observers independently judged when the infant was fixating the stimulus by noting whether the stimulus was reflected near the center of the infant's pupil. Each observer timed the period from when the infant first fixated the stimulus to when the infant first looked away from the stimulus. After both observers had stopped timing, the shutter in front of the projector closed for 10–15 sec and the observers wrote down the fixation times they had observed. Then the projector was advanced to the next slide and the shutter was opened, exposing the next slide. One observer never knew which slide the infant was viewing (nor were the

[2] Mixed with these stimuli were four additional stimuli, each presented twice, in random order.

corneal reflections of the stimuli distinctive enough to allow her to figure that out).

To measure the interobserver reliability, for each baby we calculated the Spearman rank-order correlation between the times recorded by the two observers. The mean correlation was .95 (range .68–1.00).

Results

For each baby we calculated the mean of the looking times recorded by the two observers on each trial and calculated a score for each stimulus by taking the mean of the two trials on which the stimulus was presented. Then for each age group we used a Friedman two-way analysis of variance to compare the scores for the three stimuli.[3] Figure 2 shows the mean score for each stimulus averaged across the subjects in each age group.

The Friedman test on the data from the 1-month-olds showed that the scores for the three stimuli were not significantly different, $\chi^2(2) = 0.30$, $p > .80$. In fact, half the babies looked longer at the asymmetrically scrambled arrangement than at the natural arrangement.

The data from the 2-month-olds showed a different picture: The Friedman test indicated that the scores for the three stimuli were significantly different, $\chi^2(2) = 6.93$, $p < .05$. Wilcoxon tests of matched pairs showed that the 2-month-olds looked significantly longer at the natural arrangement than at either of the scrambled arrangements (asymmetrically scrambled: $T[15] = 16$, $p = .01$, $\alpha^1 = .017$, with α^1 set by Ryan's [1960] procedure and $\alpha = .05$; symmetrically scrambled: $T[15] = 13$, $p < .01$, $\alpha^1 = .033$).[4] Of the 15 2-month-olds, 12 looked longer at the natural arrangement than at the asymmetrically scrambled arrangement; 11 looked at it longer than at the symmetrically scrambled arrangement. The 2-month-olds looked equally long at the two scrambled arrangements, $T(15) = 53$, $p > .05$.

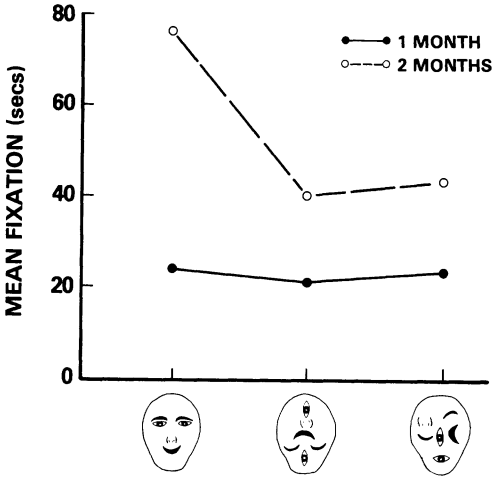

FIG. 2.—The mean fixation time on each stimulus in the preference study (experiment 1).

Discussion

One-month-old infants showed no evidence of preferring a natural arrangement of the features of a face. This outcome is exactly what studies of scanning had led us to expect. Since 1-month-olds rarely look inside faces (Hainline 1978; Haith et al. 1977; Maurer & Salapatek 1976), they should not have noticed how the features of a natural face are arranged.

In contrast, 2-month-olds looked longer at the natural arrangement than at either of the two scrambled arrangements. This preference was presumably made possible by the development of internal scanning. Studies of scanning show that unlike 1-month-olds, 2-month-olds spend long periods looking at the internal features of various figures including faces (Hainline 1978; Haith et al. 1977; Maurer & Salapatek 1976; Salapatek 1975). The 2-month-olds in this study may already know where the internal features of a face are located and may have generalized that knowledge to the two-dimensional schematic faces we used.

Two other studies have reported a preference for a naturally arranged face in 2-month-

[3] We used nonparametric statistics because measures of time are not distributed normally and because the variances for the two ages were quite different.

[4] Ryan (1960) suggests a procedure for making a series of posttests and assuring that the overall level of significance does not exceed α. The experimenter first sets the desired α and then calculates an adjusted α level, α^1, for the comparison of the two most extreme groups. The difference between them is considered significant only if the probability of the observed difference is less than or equal to α^1. If it is, further comparisons are made with a readjusted level of α^1. When, as in these experiments, there are three possible comparisons and α is chosen as .05, α^1 for the first comparison is .017; for the other two comparisons, it is .033.

old infants. In one each stimulus was presented for 120 sec (Fantz 1961); in the other it was presented until the end of the infant's first fixation (Fantz 1966). It is possible that a preference becomes apparent at this age only if the infants are exposed to the stimuli for such long periods of time. That is suggested by the fact that in our study the mean length of fixation exceeded 40 sec on every stimulus and by the fact that other investigators who did not find a preference used a short trial of a fixed length, usually 30 sec or less (Haaf 1974; Haaf & Brown 1976; Koopman & Ames 1968; Wilcox 1969).

Experiment 2

In experiment 1 there was no evidence infants could discriminate between two scrambled arrangements. Nor was there any evidence 1-month-olds could discriminate between any of the arrangements. There are two possible interpretations. The infants might not yet be able to make those discriminations, or else they might be able to make them, but not reveal that ability in a preference test.

To find out which interpretation was more likely, in experiment 2 we tested for the discrimination with a different technique, habituation. An infant should be more likely to show that he sees two arrangements as different if, instead of looking for a preference, we were to first habituate him to one arrangement and then note whether he looks longer at a novel arrangement than at the "habituated" one. This method has been used successfully with 4- and 5-month-olds to study the discrimination of natural from unnatural arrangements (Caron, Caron, Caldwell, & Weiss 1973). However, no one has used habituation to test younger infants' ability to make such discriminations. In experiment 2 we habituated infants to one of the scrambled arrangements used in experiment 1, and then tested them with the other scrambled arrangement, as well as with the natural arrangement.

Method

Subjects.—The subjects were 24 1-month-olds ($\bar{X}$ age = 37 days, range 32–41 days) and 18 2-month-olds ($\bar{X}$ age = 63 days, range 56–70 days), all full-term and with no known abnormalities. Half the infants at each age were male. An additional 17 subjects were not included because they cried ($N = 9$) or slept ($N = 7$), or because of a procedural error ($N = 1$).

Stimulus, apparatus, and procedure.—The three stimuli were identical to those of experiment 1, as were the apparatus, the position of the baby, and the procedure for observing fixations.

The asymmetrically scrambled arrangement (stimulus *C* in fig. 1) was presented repeatedly until the length of the infant's fixations decreased by more than half. The exact criterion of habituation was that the mean length of the infant's fixations on two sets of three consecutive trials (if set 1 were trials 6, 7, and 8, then set 2 would be trials 7, 8, and 9) be less than half the mean length of his fixations on the first three trials. Two observers estimated the length of the fixation on each trial; we used the longer estimate in these calculations.[5]

After the infant reached the criterion of habituation, he was given a test. The test consisted of two trials with each stimulus: the scrambled arrangement to which he had been habituated, the other scrambled arrangement, and the natural arrangement. The order of the stimuli during the first presentation was counterbalanced across subjects. The order during the second presentation was always the inverse of the first (e.g., if an infant first saw *ABC*, he would then see *CBA*). We used the inverse because then decreases in infants' looking over trials would be likely to affect all stimuli equally. During the test, one observer never knew which slide the infant was viewing.

For each baby we calculated the Spearman rank-order correlation between the looking times recorded by the two observers. The mean correlation was .98 (range .81–1.00).

Results

For each baby we calculated the mean of the looking times recorded by the two observers on each trial and calculated a score for each stimulus by taking the mean of the two trials on which it was presented during the test. Then

[5] Had we used the mean rather than the longer estimate, it would have been more likely that an infant would have been deemed habituated even though one observer thought he was not.

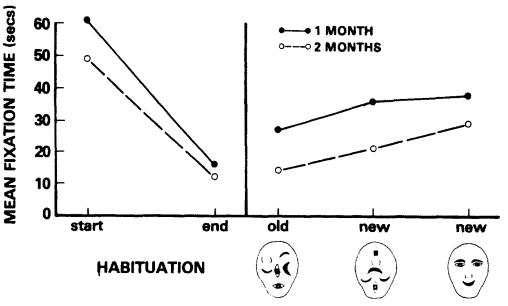

FIG. 3.—The mean fixation time on each stimulus during and following habituation (experiment 2).

for each age group we used a Friedman two-way analysis of variance to compare the scores for the three stimuli.[6] Figure 3 shows the mean score for each stimulus averaged across the subjects in each age group.

A Friedman test on the data from the 1-month-olds showed that the scores for the three stimuli were not significantly different: $\chi^2(2) = 1.0$, $p > .05$. Thirteen of the 24 1-month-olds looked longer at the natural arrangement than at the habituated arrangement, but 11 did the opposite. Fifteen looked longer at the novel scrambled arrangement than at the habituated one, but nine did the opposite.

A Friedman test on the data from the 2-month-olds showed that the scores for the three stimuli were significantly different, $\chi^2(2) = 20.11$, $p < .001$. Wilcoxon tests of matched pairs showed that during the test the 2-month-olds looked significantly less at the scrambled arrangement to which they had been habituated than at either the natural arrangement, $T(18) = 2$, $p < .01$, $\alpha^1 = .017$, with α^1 set by Ryan's procedure and $\alpha = .05$, or the novel scrambled arrangement, $T(18) = 21$, $p < .01$, $\alpha^1 = .033$. Of the 18 2-month-olds, 17 recovered to the natural arrangement and 16 to the novel scrambled arrangement. In addition, the 2-month-olds looked longer at the natural arrangement than at the novel scrambled one, $T(18) = 29$, $p < .02$, $\alpha^1 = .033$. Twelve of the 18 2-month-olds showed this effect.

Discussion

Unlike the preference test of experiment 1, the habituation procedure made clear that 2-month-olds not only can discriminate natural from scrambled arrangements of a face but also can discriminate between two different scrambled arrangements, one arranged symmetrically and the other asymmetrically. As we had suspected, the habituation procedure proved the more sensitive technique.

In addition to a clear ability to distinguish arrangements, 2-month-olds appear to prefer the natural arrangement of the features of a human face: They looked at it longer than at the other novel stimulus, a symmetrically scrambled arrangement. Like experiment 1, this suggests that by 2 months an infant may have learned how the features of a natural face are arranged and may be able to generalize that knowledge to two-dimensional schematic drawings like the ones we used.

We cannot tell what feature or features the 2-month-old processed in these experiments. It seems unlikely that they processed all the features, since Caron et al. (1973) found infants were 5 months old before they appeared to notice changes in features in the lower half of a schematic face. The 2-month-olds in our experiments could have discriminated among the arrangements because they noticed a change in the location of just one feature, and they could have picked out the natural arrangement by noticing that one and only one feature was in its proper place.

In contrast, the 1-month-olds in experiment 2 showed no evidence of discriminating various arrangements of the features of a human face, even after habituation to one arrangement. This was true even though both novel arrangements were symmetrical and the habituated arrangement was not. Analogous re-

[6] See n. 3 above.

[7] Note that even newborns can discriminate among stimuli which differ in the number of internal elements or their size (Fantz, Fagan, & Miranda 1975). The brief periods of time young infants spend looking inside figures might be sufficient for such gross discriminations or infants might be able to make them with peripheral vision. However, newborns and 1-month-olds appear not to be able to discriminate among stimuli which differ more subtly in internal details (Fantz & Miranda 1975; Milewski 1976).

sults have been reported for the discrimination of shape. One-month-olds do not seem to discriminate between two different small shapes surrounded by identical frames (Milewski 1976).[7] Yet 1-month-olds can discriminate among such small shapes if they are presented alone without a surrounding frame (Milewski 1976). We are currently investigating whether 1-month-olds can also discriminate among different arrangements of a face's features if those features are presented unframed.

These experiments suggest that there are developmental changes in discrimination which are well correlated with the developmental changes in scanning noted in other studies. One-month-olds appeared not to discriminate between various arrangements of features which were framed by identical ovals, and they rarely look inside figures (Hainline 1978; Haith et al. 1977; Maurer & Salapatek 1976; Salapatek 1975). In contrast, 2-month-olds discriminated between arrangements framed by identical ovals; they also scan figures extensively and spend long periods of time looking at their internal features (Hainline 1978; Haith et al. 1977; Maurer & Salapatek 1976; Salapatek 1975). Additional research is needed to confirm within individual infants this apparent correlation between changes in scanning and changes in discrimination.

Reference Note

1. Weiffenbach, J. Schematic faces and their symmetric and asymmetric rearrangements as elicitors of infant looking. Paper presented at the meetings of the American Psychological Association, New Orleans, September 1974.

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