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Newborns' Preference for Faces: What Is Crucial?

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Three experiments investigated whether the presence of more elements in the upper part of a configuration (i.e., up–down asymmetry) plays a role in determining newborns' preference for facelike patterns. Newborns preferred a nonfacelike stimulus with more elements in the upper part over a nonfacelike stimulus with more elements in the lower part (Experiment 1), did not show a preference for a facelike stimulus over a nonfacelike configuration equated for the number of elements in the upper part of the configuration (Experiment 2), and preferred a nonfacelike configuration located in the upper portion of the stimulus over a facelike configuration in the lower portion of the pattern (Experiment 3). Results demonstrated that up–down asymmetry is crucial in determining newborns' face preference.

Although some studies failed to replicate the result (Easterbrook, Kisilevsky, Hains, & Muir, 1999), most literature converges to suggest that shortly after birth, a moving facelike schematic pattern elicits greater following behavior in newborns than do patterns containing the same facial features in nonfacelike arrangements (Goren, Sarty, & Wu, 1975; Johnson & Morton, 1991; Maurer & Young, 1983) and that newborns look preferentially toward facelike stimuli with features arranged naturally rather than toward facelike stimuli with features arranged unnaturally (Mondloch et al., 1999; Valenza, Simion, Macchi Cassia, & Umiltà, 1996). According to the model proposed by Johnson and Morton (1991; Morton & Johnson, 1991), these findings might be interpreted as evidence that faces are special for the newborn because human infants possess a template matching device (i.e., CONSPEC) that contains structural information concerning the visual characteristics of conspecifics and biases the visual attention of newborns toward facelike patterns. In Johnson and Morton's view, the crucial property that produces newborns' face preference is the presence of three high-contrast blobs in a triangular formation corresponding to eyes and mouth in a face-sized stimulus. Therefore, newborns' face preference would be determined by facedness, that is, by the spatial disposition of the elements within a contour (Morton, Johnson, & Maurer, 1990).

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An alternative interpretation, the sensory hypothesis, maintains that faces are not different from other visual stimuli and that they are preferred simply because their psychophysical properties match those of the sensory channels. One version of the sensory hypothesis is based on the linear system model (Banks & Ginsburg, 1985; Banks & Salapatek, 1981; Gayl, Roberts, & Werner, 1983). This model predicts infants' preferences on the basis of the Fourier transform. Any two-dimensional pattern can be described on the basis of spatial frequencies, amplitude, and orientation of its constituent sine-wave gratings. For any such pattern, two functions can be derived: the amplitude spectrum, comprising the amplitude and orientation of the component spatial frequencies, and the phase spectrum, comprising the phase and orientation of the components. The linear system model holds that newborns' pattern preferences are influenced only by the amplitude spectrum. The amplitude spectrum of the pattern is filtered through the contrast sensitivity function. The infants' contrast sensitivity function is a function that indicates the inverse of the contrast that is necessary for the subject to detect sine waves of different spatial frequencies.

This sensory hypothesis succeeded in predicting infants' preferences for a variety of patterns but failed to explain the experimental data concerning facelike stimuli (Kleiner & Banks, 1987). For this reason, Kleiner and Banks (1987) modified the original model by maintaining that in the case of two stimuli with identical amplitude spectra, the infant's visual preference is determined by the phase spectrum. However, it is still unclear if newborns prefer facelike patterns because they possess the phase spectrum of a face or if facelike patterns are preferred because they possess more general structural characteristics that are also present in stimuli other than faces.

Faces can be described as a collection of general structural properties conveyed by the phase spectra of the patterns, such as symmetry along the vertical axis, a strong vertical component, and a greater number of high-contrast areas in the upper rather than in the lower part of the configuration (Johnson & Morton, 1991). Much evidence shows that in the case of nonfacelike stimuli, newborns' preferences can be affected by structural properties (i.e., by the phase spectra of the patterns; Fantz, 1965; Simion, Valenza, Macchi Cassia, Turati, & Umiltà, 2002; Slater, Earle, Morison, & Rose, 1985; Slater & Sykes, 1977). For instance, when horizontal gratings were paired with vertical gratings, newborns preferred the horizontal ones (Farroni, Valenza, Simion, & Umiltà, 2000; Slater et al., 1985; Slater & Sykes, 1977). Because the patterns were equated for quantity of energy (i.e., for the amplitude spectrum), one can assume that orientation, which is a structural property of the stimulus conveyed by the phase spectrum (Banks & Salapatek, 1981), was the crucial factor in determining the preference for horizontal gratings.

Recently, Simion et al. (2002) demonstrated that shortly after birth, another structural property controls visual preference in the case of figures that do not contain facelike characteristics. This structural property consists of the presence of an up–down asymmetry in the distribution of five elements within a square contour. One- to 4-day-old infants were presented with three pairs of geometrical stimuli. Each pair was composed of a pattern in which more high-contrast areas (i.e., black elements) were placed in the upper than in the lower part of the configuration (an upright stimulus) and a pattern in which more high-contrast areas were located in the lower than in the upper part (an upside-down stimulus; see Figure 1). In a pair of stimuli, the elements were placed in the correct locations to form two T shapes, one upright and the other upside-down (see Figure 1, upper panel). In another pair, the upright stimulus had four elements in the upper part of the configuration, with only one element in the lower part. The upside-down stimulus had four elements in the lower part and only one in the upper part (see Figure 1, lower panel). In still another pair, the upright stimulus had all five elements in the upper part so as to form an inverted U shape. The upside-down stimulus had all the elements in the lower part so as to form an upright U shape. Newborns, regardless of the pair of stimuli employed, preferred the (upright) configuration with more elements in the upper part over the (upside-down) configuration with more elements in the lower part. Clearly, when up–down asymmetrical nonfacelike patterns are equated for quantity of energy, their structural properties can induce a visual preference in newborns.

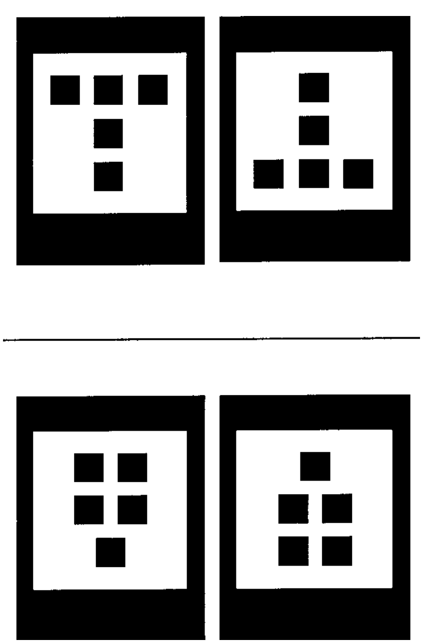


Figure 1. The nonfacelike pairs of stimuli used in the study by Simion et al. (2002). Upper panel: Five elements are placed in the correct locations to form two T shapes, one upright and the other upside-down. Lower panel: The upright stimulus has four elements in the upper part of the configuration, with only one element in the lower part. The upside-down stimulus has four elements in the lower part and only one in the upper part. From "The Origins of Face Perception: Specific Versus Non-specific Mechanisms," by F. Simion, V. Macchi Cassia, C. Turati, and E. Valenza, 2001, *Infant and Child Development, 10,* p. 62. Copyright 2001 by John Wiley & Sons, Limited. Adapted with permission.

In light of this evidence, an interesting question is whether the structural properties that are preferred shortly after birth in the case of geometrical stimuli also play a role in determining newborns' preference in the case of facelike patterns. This question appears reasonable because in the experiments in which a schematic upright face was preferred over an upside-down face, the facelike configurations presented a greater number of features in the upper than in the lower part of the stimulus (Mondloch et al., 1999; Morton & Johnson, 1991; Valenza et al., 1996). Therefore, a possible confound might have occurred in that the preferred stimulus possessed both the face-specific phase information (i.e., the specific structure of the face as defined by Morton & Johnson, 1991), and non-face-specific phase information (i.e., structural properties of the stimulus not related to facedness). The latter, too, has been found capable of eliciting a preference in newborns. This means that newborns' preference for faces may be ascribed to two different factors: the unique structure of the face (i.e., facedness) or a general structural property (i.e., up–down asymmetry). Note that the former factor is, of course, unique to faces, whereas the latter factor is not because it can be shared by a number of patterns.

The possibility that the perceptual information contained in the upper portion of the face is crucial in determining newborns' face preference is consistent with recent findings showing that the presence of patterning on the upper half of the configuration is sufficient to induce a preference similar to the one induced by an entire face. Easterbrook et al. (1999, Experiment 4) found that an entire schematic face and two normally positioned schematic eyes were tracked equally by newborns. This finding suggests that newborns respond to the upper part of a face as they respond to an entire face.

On the basis of these considerations, the present study was aimed at investigating the relative strength of facedness and up–down asymmetry in inducing newborns' preference for schematic faces. Using the visual preference technique and manipulating the location of three elements within a head-shaped contour (i.e., the same number of elements and the same contour as in CONSPEC facelike stimuli; Mondloch et al., 1999; Morton & Johnson, 1991; Valenza et al., 1996), we tested up–down asymmetry and facedness separately in Experiments 1 and 2 and directly contrasted them in Experiment 3. In Experiment 1, a nonfacelike stimulus[1]

[1] The nonfacelike patterns used in this study in fact share features with facelike patterns, the most salient of which is the contour. However, we believe these patterns can be considered nonfacelike because they lack what is, in many authors' view, and in particular in Johnson and Morton's (1991; Morton & Johnson, 1991) view, the most important feature of a facelike pattern: that is, the spatial relations between the inner blobs that characterize a face.

with more elements in the upper part (two vs. one) was compared with a nonfacelike stimulus with more elements in the lower part (two vs. one). In Experiment 2, newborns were presented with a facelike configuration and a nonfacelike configuration equated for the number of elements contained in the upper part of the stimulus. In Experiment 3, a direct comparison between facedness and up–down asymmetry was provided: A facelike configuration located in the lower portion of the pattern was contrasted with a nonfacelike configuration located in the upper portion of the stimulus.

Experiment 1

This experiment was aimed at investigating whether newborns' preference for upright configurations found by Simion et al. (2002) could be replicated using elements not in a facelike configuration. In this configuration, the three elements within the head-shaped contour were not placed in the correct locations for the mouth and eyes.

An upright stimulus with two elements located in the upper part of the configuration and one element in the lower part was compared with an upside-down stimulus with two elements in the lower part and one in the upper part. Neither stimulus had a facelike arrangement of the elements, their positions being asymmetrical across the vertical plane. The prediction was that newborns would nonetheless prefer to look at the upright rather than at the upside-down stimulus.

Method

Participants. Twenty-six healthy, full-term infants were recruited in the nursery of the Casa di Cura of Abano Terme (Padova, Italy). Nine were removed from the study because they became too fussy or cried, and 1 was removed because he showed a strong position bias, looking 90% of the time in one direction. So the final sample consisted of 16 newborns (7 girls and 9 boys) who met the screening criteria of normal delivery, a birth weight between 2,550 and 4,000 g, and an Apgar score of at least 8 at 5 min. Babies were tested during the hour preceding the scheduled feeding time only if they were awake and in an alert state. Their age at the time of testing ranged from 24 to 72 hr (M = 68 hr). Informed consent was obtained from their parents.

Stimuli. The two stimuli were generated by a Quadra Macintosh computer. They were composed of three black square elements located in a white head-shaped form (see Figure 2). One of the stimuli was an upright configuration in which two elements were located in the upper part and one element was located in the lower part. The other stimulus was an upside-down configuration with two elements in the lower part and one in the upper part. Each square element was 2.5 cm (4.8°) on each side; the head-shaped form was 18 cm (34.4°) in height and 13.5 cm (25.8°) in width. The distance between the two elements was 1.2 cm (2.3°).

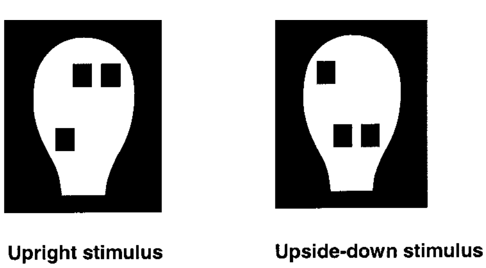


Figure 2. The pairs of stimuli used in Experiment 1. From "The Origins of Face Perception: Specific Versus Non-specific Mechanisms," by F. Simion, V. Macchi Cassia, C. Turati, and E. Valenza, 2001, *Infant and Child Development, 10,* p. 62. Copyright 2001 by John Wiley & Sons, Limited. Reprinted with permission.

Apparatus. The infant sat on the experimenter's lap at a distance of about 30 cm from a black panel with two square holes where the black screens of two computer monitors appeared. The horizontal midline of the stimuli was aligned with a red, flickering LED, which was located in the center of the panel, between the screens. At the start of each trial, the LED was used both to attract the infant's gaze and to check that the infant's sight was level with the horizontal midline of the panel during the testing session.[2] The LED subtended about 2° of visual angle. The distance between the flickering LED and the white head-shaped forms, measured from the LED to the inner edge of the form, was 9 cm (17.2°). To prevent interference from irrelevant stimuli, we limited peripheral vision by placing two black panels on both sides of the infant.

Procedure. Each trial began with the central flickering LED. As soon as the infant fixated the LED, one of the experimenters, who watched the infant's eyes by means of a video-monitor system, started the sequence of the trial by pressing a key on the computer keyboard. This automatically turned off the central LED and activated the stimuli on the screens. When the infant shifted his or her gaze from the display for more than 10 s, the experimenter turned off the stimuli, and the central LED automatically started flickering again.[3] All infants were submitted to two trials, in which the position of the stimuli was counterbalanced. Videotapes of eye movements throughout the trial were subsequently analyzed frame by frame to the nearest 40 ms by two coders (an experimenter and a student). Both coders were unaware of the kind of stimulus presented. They recorded the number of discrete looks toward each stimulus and total fixation time, that is, the sum of all fixations. Intercoder agreement was high (Pearson rs = .83 for number of looks and .97 for total fixation time).

Results and Discussion

To determine whether newborns showed a spontaneous visual preference for one of the two stimuli presented, we performed two separate analyses of variance (ANOVAs), one for each dependent variable measured, that is, number of discrete looks and total fixation time (Cohen, 1972, 1973). The ANOVAs had two within-subject factors, trial (1 and 2) and type of stimulus (upright and upside-down). The analyses revealed the following.

Number of discrete looks. Only the main effect of type of stimulus was significant, $F(1, 15) = 4.76$, $p < .05$, indicating that the number of discrete looks to the upright stimulus (M = 10, SE = 0.73, range = 8.43–11.56) was greater than the number to the upside-down stimulus (M = 8.09, SE = 0.95, range = 6.07–10.11; see top portion of Figure 3). No other sources of significance were found.

[2] In the absence of an eye-tracker, there is no guarantee that the infant's sight was always level with the horizontal midline of the panel. However, neither is there reason to suggest that the way the infant was held could have produced systematic bias in his or her line of sight. That is, if the infant's sight was not aligned with the horizontal midline of the panel, the probability that the line of sight was directed upward was equal to the probability that it was directed downward.

[3] In the three experiments reported in the present article, only 3 infants looked, on a single trial, at one of the two stimuli that were presented for less than 10 s. Most infants looked at each stimulus in each trial for much longer (M = 45.7 s; range = 3.7–113.7 s).

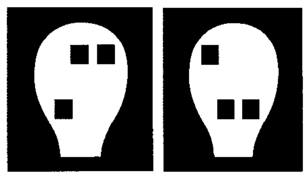
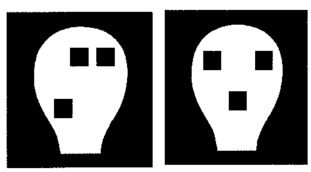
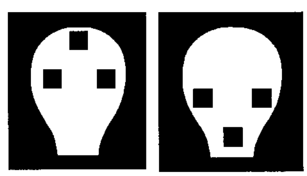
STIMULI	Total fixation time	Number of discrete looks
	53.86 s vs 37.62 s p < 0.03	10 vs 8.09 p < 0.05
	34.70 s vs 41.08 s p > 0.20	7.6 vs 8.3 p > 0.30
	44.15 s vs 22.89 s p < 0.003	10.43 vs 6.5 p < 0.01

Figure 3. Mean number of discrete looks and mean total fixation time for each stimulus in Experiments 1, 2, and 3.

Total fixation time. The main effect type of stimulus attained statistical significance, $F(1, 15) = 5.85$, $p < .03$, indicating that infants looked longer at the upright stimulus ($M = 53.86$ s, $SE = 6.35$, range = 40.32–67.40 s) than at the upside-down stimulus ($M = 37.62$ s, $SE = 4.45$, range = 28.12–47.11 s; see top portion of Figure 3). No other significant sources of significance were found. In addition, examination of the data for individual infants revealed that 10 out of 16 infants showed a greater number of looks to the upright stimulus and 13 out of 16 infants looked longer at the upright stimulus.

Overall, the results revealed that newborns looked longer at and showed a greater number of discrete looks to the upright stimulus, that is, to the pattern with a greater number of elements in the upper than in the lower part of the configuration. Thus, amplitude spectra being equal, the phase spectra of the patterns, produced by the upper versus lower positioning of the elements, constituted the crucial factor in determining newborns' preference.

The findings obtained in the present experiment with patterns composed of a head-shaped contour and three elements replicated those obtained by Simion et al. (2002) with patterns with a square contour and five inner elements. Note that even though the stimuli had the same head-shaped contour and the same number of elements as CONSPEC facelike stimuli have (Mondloch et al., 1999; Morton & Johnson, 1991; Valenza et al., 1996), the spatial relations between the inner elements were not those that characterize facedness. This means that when nonfacelike stimuli are used, a preference can be found for a stimulus with two elements rather than one in the upper part of the configuration.

Experiment 2

Experiment 2 was aimed at testing the role of facedness in inducing newborns' face preference between stimuli that were equally asymmetrical in terms of the number of elements in the upper and in the lower parts (i.e., two vs. one). One of the stimuli was the CONSPEC facelike configuration used in the experiments in which newborns' face preference was demonstrated (Mondloch et al., 1999; Morton & Johnson, 1991; Valenza et al., 1996). The other stimulus was the upright nonfacelike stimulus used in the present Experiment 1, with two elements in the upper part and one element in the lower part of a head-shaped contour. Two alternative hypotheses may be advanced. The first predicts that if newborns' preference is determined by the relations between the inner elements that produce facedness, then infants should prefer the CONSPEC facelike stimulus. If the crucial factor in inducing newborns' preference is the up–down asymmetry, then newborns should not manifest any preference because the stimuli were equated for the number of elements located in the upper and lower parts.

Method

Participants. Twenty-two healthy, full-term infants were recruited in the nursery of the Casa di Cura of Abano Terme. Six did not complete testing because of fussiness or drowsiness, and 1 was excluded from the sample because she showed a position bias, spending 95% of the time looking in one direction. So the final sample consisted of 15 newborns (8 girls and 7 boys). The screening criteria were the same as those described in Experiment 1. Babies were tested during the hour preceding the scheduled feeding time only if they were awake and in an alert state. The mean age at the time of testing was 58 hr (range = 25–84 hr). Informed consent was obtained from their parents.

Stimuli. Both stimuli were composed of three black square elements located in a white head-shaped contour (see Figure 4). One of them was the upright configuration used in Experiment 1, with two elements located in the upper part and one element located in the lower part. The other stimulus was the CONSPEC facelike stimulus, with the elements placed in the correct locations for the eyes and mouth (Mondloch et al., 1999; Morton & Johnson, 1991; Valenza et al., 1996). The size of the inner elements and the size of the head-shaped contour were the same as in Experiment 1.

Apparatus and procedure. The apparatus and procedure were the same as those of Experiment 1.

Results and Discussion

Total fixation time and number of discrete looks were entered into two separate ANOVAs with two within-subject factors, trial (1 and 2) and type of stimulus (facelike and upright).

Number of discrete looks. Neither the main effects nor the interaction attained statistical significance ($p > .30$). The mean number of looks to the facelike stimulus was 8.3 ($SE = 0.58$, range = 7–9.5), and the mean number to the upright stimulus was 7.6 ($SE = 0.60$, range = 6.2–8.8; see middle portion of Figure 3).

Total fixation time. Also in this case, no significant sources of variance were found ($p > .20$). In particular, total fixation time to the facelike stimulus ($M = 41.08$ s, $SE = 5.05$, range = 30.25–51.91 s) did not differ from that to the upright stimulus ($M = 34.70$ s, $SE = 2.83$, range = 28.63–40.77 s; see middle portion of Figure 3). Examination of the data for individual infants revealed that 11 out of 15 showed more looks to the facelike stimulus, and 9 out of 15 looked longer at the same stimulus.

Overall, newborns did not show a preference for the facelike stimulus over the nonfacelike stimulus with the same number of elements in the upper portion of the configuration. Admittedly, nonsignificant results must be interpreted with caution. However, it must be stressed that the facelike stimulus that was used here is identical to those CONSPEC stimuli that were used to demonstrate a clear-cut newborns' preference for facelike over nonfacelike patterns with fewer elements in the upper part (Mondloch et al., 1999; Morton & Johnson, 1991; Valenza et al., 1996). There can be little doubt that in the present experiment, when the CONSPEC stimulus was contrasted with a stimulus that had the same number of elements in the upper part, the preference for the CONSPEC stimulus was eliminated. It seems thus that the relations between the inner elements that produce facedness are not more salient than a general structural property consisting of the up–down asymmetrical distribution of the elements.

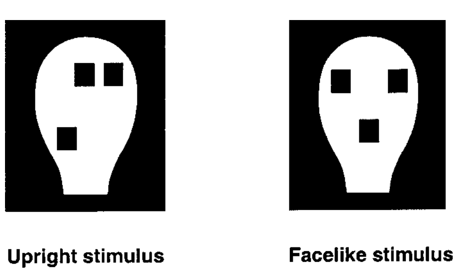


Figure 4. The pairs of stimuli used in Experiment 2.

It is interesting to note that these findings differ from those obtained in the study by Kleiner (1987), in which a preference for the phase spectrum of the face emerged when the two stimuli were equated in terms of their amplitude spectra. However, as pointed out by an anonymous reviewer, Kleiner's stimuli were different in their up–down asymmetry too. The stimulus with the phase spectrum of the face was highly asymmetrical, whereas the stimulus with a nonfacelike spectrum was almost symmetrical in either the vertical or the horizontal plane. As a consequence, the preference found by Kleiner might also be explained by virtue of the nonspecific phase information (i.e., the up–down asymmetry) that elicited a preference in Experiment 1 of the present study. On the contrary, the stimuli used in Experiment 2 were equated in terms of up–down asymmetry, and the specific phase information that characterizes faces had very little influence on newborns' response or did not affect it at all.

Experiment 3

In Experiments 1 and 2, the roles of up–down asymmetry and facedness in inducing newborns' preference were independently tested. In Experiment 3, a direct comparison between these two factors was provided. Two stimuli were contrasted with the use of the visual preference technique. In the first stimulus, three elements were located within a head-shaped contour to represent a facelike configuration. However, the elements were placed in the lower portion of the pattern. The other stimulus had three elements in the upper portion of the pattern. However, they did not form a facelike configuration.

We predicted that if newborns' face preference emerges by virtue of the specific spatial relations between the elements within facelike stimuli, newborns should prefer the configuration that preserves this relation even if the elements are all in the lower part of the pattern. Alternatively, if face preference is determined by the presence of a greater number of elements in the upper part of the pattern, then newborns should prefer the stimulus that possesses this property even if the spatial relations between the elements do not form a face.

Method

Participants. Twenty-five healthy, full-term newborns were recruited in the nursery of the Casa di Cura of Abano Terme. Ten subjects were excluded. Eight changed their state during testing, becoming too fussy or drowsy or starting to cry. Two showed a position bias, spending 90% of the time looking in one direction. So the final sample consisted of 15 newborns (6 girls and 9 boys). The screening criteria were identical to those described in the previous experiments. Babies were tested during the hour preceding the scheduled feeding time only if they were awake and in an alert state. Their age at the time of testing ranged from 23 to 82 hr ($M = 55$ hr). The parents were informed and gave their consent.

Stimuli. The stimuli were composed of three black square elements located in a white head-shaped form (see Figure 5). The dimensions of both the inner elements and the head-shaped contour were identical to those of

Figure 5. The pairs of stimuli used in Experiment 3.

the stimuli used in the previous experiments. The two stimuli differed only in the disposition of the three inner elements. Within one stimulus, the three elements were located in the lower portion of the pattern and placed in the positions representing the facelike relations defined as CONSPEC by Johnson and Morton (1991). Within the other stimulus, the three elements were located in the upper half of the pattern but did not represent a face because their position was reversed (180° rotation).

Apparatus and procedure. The apparatus and procedure were identical to those used in the previous experiments.

Results and Discussion

The dependent variables and the ANOVAs were the same as in the two previous experiments. The factor of type of stimulus had two levels: lower facelike and upper nonfacelike.

Number of discrete looks. The main effect of type of stimulus was significant, $F(1, 14) = 9.36$, $p < .01$, indicating that newborns' discrete looks were more frequent ($M = 10.43$, $SE = 1.11$, range = 8.04–12.82) to the upper nonfacelike stimulus than to the lower facelike stimulus ($M = 6.5$, $SE = 0.59$, range = 5.24–7.76; see bottom portion of Figure 3). No other sources of variance reached statistical significance.

Total fixation time. Also in this case, the main effect of type of stimulus attained statistical significance, $F(1, 14) = 14.42$, $p <$ .003. The upper nonfacelike stimulus ($M = 44.15$ s, $SE = 5.54$, range = 32.26–56.05 s) was fixated longer than the lower facelike stimulus ($M = 22.89$ s, $SE = 3.35$, range = 15.7–30.09 s; see bottom portion of Figure 3). No other significant sources of variance were found. Data on individual infants confirmed these results, indicating that 11 out of 15 newborns showed more looks to the upper nonfacelike stimulus, and 12 out of 15 looked longer at that stimulus.

On the whole, the results demonstrated that a triangular arrangement with three blobs for eyes and mouth positioned in the lower part of the configuration was less able to attract and maintain newborns' gaze than was an inverted arrangement of the blobs positioned in the upper part of the configuration. When facedness and up–down asymmetry were directly contrasted, the upper position of the elements within the contour (i.e., up–down asymmetry), rather than the spatial relations among the blobs (i.e., facedness), proved to be the crucial factor in determining newborns' preference. That is, the perceptual structural property that elicited newborns' preference was not the spatial relations between the inner elements, but rather the spatial location (upper/lower) of the inner elements within the contour.

General Discussion

The present study addressed a long-debated issue: the specificity or nonspecificity of the factors involved in newborns' face preference (e.g. Johnson & Morton, 1991; Kleiner, 1990, 1993). In particular, we investigated whether newborns' face preference is determined by the unique structure of the face (i.e., its specific phase spectrum) or by a general structural property (i.e., non-face-specific phase information) that characterizes faces as well as other configurations.

The results of Experiment 1 confirmed and extended those obtained with geometrical figures by Simion et al. (2002), demonstrating that one of the structural principles that control newborns' visual preferences is the presence of an up–down asymmetry with a higher number of elements in the upper part of the configuration. Newborns preferred an upright stimulus with two elements in the top half of the configuration and with only one element in the bottom half over the same stimulus with a reversed position of the inner elements. This happened although neither stimulus had a facelike arrangement.

Simion et al. (2002) proposed that the effect of up–down asymmetry may be related to the constraints of the newborns' visual system. Indeed, the structural properties of the pattern also have to be processed by the visual system through sensory channels. In particular, Simion et al. suggested the existence of an upper versus lower visual field difference in visual sensitivity, similar to that already observed in adults (e.g., Heywood & Churcher, 1980; Rizzolatti, Riggio, Dascola, & Umiltà, 1987; Tychsen & Lisberger, 1986). This asymmetry in visual processing might produce, in newborns, an enhancement in overall visibility of the upper elements, those that impinge on the upper, more sensitive, part of the visual field.

Perhaps that is due to the fact that the superior colliculus, a subcortical structure that strongly affects newborns' visual behavior (Atkinson, Hood, Wattam-Bell, &, Braddick, 1992; Braddick et al., 1992; Bronson, 1982; Johnson, 1990, 1995), plays a major role in visual exploration oriented toward the upper visual field (Sprague, Berlucchi, & Rizzolatti, 1973). Alternatively, the preference for the patterns with more elements in the upper portion of the configuration might be attributed to a lower rather than an upper field advantage in visual sensitivity. In fact, if newborns prefer a symmetrical pattern, the up–down symmetry is obtained only when the more salient part of the pattern is presented to the less sensitive portion of the visual field. This interpretation would be consistent with evidence showing that in adults, an advantage for the lower visual field is often found for basic perceptual properties (e.g., Rijsdijk, Kroon, & van der Wildt, 1980).

The results of Experiment 2 suggested that up–down asymmetry is also involved in newborns' preference for facelike configurations. In effect, when a CONSPEC facelike stimulus was compared with a nonfacelike configuration that presented the same number of elements in the upper portion, newborns did not show any clear-cut visual preference. This means that the facelike disposition of the elements did not significantly affect newborns' visual preference. This result is consistent with the study by Easterbrook et al. (1999), which demonstrated that newborns responded to two eyes normally positioned as they did to an entire face. The authors argued that the upper features of the face are critical in eliciting newborns' preference for faces.

In addition, Experiment 2 shed light on the results of a study by Kleiner (1987), in which newborns looked preferentially to a schematic face with both the phase and the amplitude spectra of a face, rather than to a hybrid stimulus with the amplitude spectrum of a face and the phase spectrum of a nonfacelike stimulus (Kleiner, 1990, 1993; Morton et al., 1990). Our results showed that the specific phase spectrum comprised in facelike stimuli is not preferred (or the preference is very small) when it is contrasted with stimuli equated in terms of the phase spectrum conveyed by up–down asymmetry. Thus, in line with Kleiner's (1987) results, the phase spectrum plays a role in determining newborns' preference, but the phase spectrum of the face seems not to be crucial in determining the preference.

In Experiment 3, newborns showed a preference for an inverted face over an upright face when the elements of the former were located in the upper portion of the pattern and the elements of the latter were located in the lower portion. We interpreted this finding as indicating that what determined newborns' preference was not the facelike or nonfacelike nature of the spatial relations between the inner elements, but rather the upper versus lower positioning of the inner elements within the contour.

On the basis of the results of the present study, three different proposals can be advanced concerning the perceptual information that triggers the mechanism that, according to Johnson and Morton (1991), mediates newborns' face preference (i.e., CONSPEC). It might be possible to interpret the results obtained as reflecting a preference for facelike stimuli determined by CONSPEC, with the template for what constitutes a face being very loosely defined. The results of Experiment 2 are compatible with this interpretation. If the face template was very loosely defined in terms of the relative placement of the inner elements, then any pattern with more elements in the top half than in the bottom half might activate this mechanism to more or less the same extent.

However, it appears difficult to reconcile this interpretation with the findings of Simion et al. (2002). In that study, the preference produced by the up–down asymmetry manifested itself for patterns that did not look anything like faces in terms of their structure but that also had more elements in the top half than in the bottom half. Thus, parsimony would dictate that all of these results could be explained by a general preference for vertically imbalanced patterns rather than for faces per se.

A second possibility is that CONSPEC responds to facedness, that is, to the specific structure of the face, and that, in parallel, other structural properties not specific to faces and conveyed by general mechanisms attract newborns' gaze as faces do, or even more than faces do. In support of this possibility is the fact that newborns' preference for faces vanished (Experiments 1 and 2) or even reversed (Experiment 3) when facedness was pitted against another structural property.

Johnson and Morton (1991), too, had demonstrated that a salient visual stimulus (i.e., a check pattern) was tracked by newborns further than the CONSPEC facelike stimulus. Johnson and Morton maintained that the perceptual properties of a stimulus described by the amplitude spectra of the pattern could be more powerful than CONSPEC in attracting newborns' eye and head movements. On the basis of the results of the present study, it would seem that not only the amplitude information but also the phase information of a stimulus can be more powerful than CONSPEC in producing newborns' visual preference.

However, this conclusion, along with the consideration that one of the structural properties that characterizes facelike stimuli is precisely the up–down asymmetry, leads to a third interpretation of the nature of the perceptual information that induces newborns to prefer faces. Rather than detecting the specific information conveyed by the structure of the face, the newborn's visual system might be triggered by a general structural property that faces share with other visual stimuli. According to this hypothesis, newborns orient their gaze toward faces because they belong to a broader stimulus category that is characterized by a greater number of high-contrast areas in the upper portion of the pattern. This suggests that newborns' face preference is not exclusively determined by the unique structure of the face. Rather, nonspecific structural properties, which other stimuli possess, would be crucial in determining newborns' preference for facelike patterns.

Further indications about the issue of whether the same or distinct factors govern preferences for facelike and up–down asymmetrical configurations might come from studies that will test the preference for up–down asymmetrical stimuli at other ages. Many studies demonstrated that the preference for facelike configurations disappears by 6 weeks of age (Johnson, Dziurawiec, Ellis, & Morton, 1991; Mondloch et al., 1999). It would thus be interesting to test whether the decline in face preference corresponds to a decline in the preference for up–down geometrical patterns. A disappearance of the preference for up–down asymmetrical patterns at 6 weeks of age would support the notion that the same mechanisms mediate both preferences. Alternatively, a dissociation in the time course of the preference for facelike and up–down asymmetrical patterns would suggest that different mechanisms mediate the two preferences.

A final note of caution, suggested by an anonymous reviewer, concerns the issue of the direction of the effect. Evidence gathered in the present study is compatible with two alternative interpretations. The first claims that an early preference for certain stimulus properties results in a preference for faces. An opposite explanation maintains that the meaningful experience newborn infants have with human faces drives the perceptual preference for stimuli that share similar qualities. Of course, at the moment, there is no definitive answer to this issue. In fact, the infants tested in the present study had between 1 and 4 days of experience with visual stimuli, including human faces. Thus, nothing can be said about whether such preferences are innate. Future research might also address these questions by testing these preferences immediately after birth or with special populations of infants that differ in their experience with faces (see, e.g., Le Grand, Mondloch, Maurer, & Brent, 2001).

References

Atkinson, J., Hood, B., Wattam-Bell, J., & Braddick, O. (1992). Changes in infants' ability to switch visual attention in the first three months of life. *Perception, 21*, 643–653.

Banks, M., & Ginsburg, A. P. (1985). Infant visual preferences: A review and new theoretical treatment. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 19, pp. 207–246). New York: Academic Press.

Banks, M., & Salapatek, P. (1981). Infant pattern vision: A new approach based on the contrast sensory function. *Journal of Experimental Child Psychology, 31*, 1–45.

Braddick, O., Atkinson, J., Hood, B., Harkness, W., Jackson, G., &

Vargha-Cadem, F. (1992). Possible blindsight in infants lacking one cerebral hemisphere. *Nature, 360*, 461–463.
Bronson, G. W. (1982). Structure, status and characteristics of the nervous system at birth. In P. Stratton (Ed.), *Psychobiology of the human newborn* (pp. 99–118). New York: Wiley.
Cohen, L. B. (1972). Attention-getting and attention-holding process of infant visual preferences. *Child Development, 43*, 869–879.
Cohen, L. B. (1973). A two process model of infant visual attention. *Merrill-Palmer Quarterly, 19*, 157–180.
Easterbrook, M. A., Kisilevsky, B. S., Hains, S. M. J., & Muir, D. W. (1999). Faceness or complexity: Evidence from newborn visual tracking of facelike stimuli. *Infant Behavior & Development, 22*, 17–35.
Fantz, R. L. (1965). Visual perception from birth as shown by pattern selectivity. *Annals of the New York Academy of Sciences, 118*, 793–814.
Farroni, T., Valenza, E., Simion, F., & Umiltà, C. (2000). Configural processing at birth: Evidence for perceptual organization. *Perception, 29*, 355–372.
Gayl, I., Roberts, J., & Werner, J. (1983). Linear system analysis of infant visual pattern preferences. *Journal of Experimental Child Psychology, 35*, 30–45.
Goren, C., Sarty, M., & Wu, P. (1975). Visual following and pattern discrimination of face-like stimuli by newborn infants. *Pediatrics, 56*, 544–549.
Heywood, S., & Churcher, J. (1980). Structure of the visual array and saccadic latency: Implications for oculomotor control. *Quarterly Journal of Experimental Psychology, 32*, 335–341.
Johnson, M. H. (1990). Cortical maturation and the development of visual attention in early infancy. *Journal of Cognitive Neuroscience, 2*, 81–95.
Johnson, M. H. (1995). The development of visual attention: A cognitive neuroscience perspective. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 735–747). Cambridge, MA: MIT Press.
Johnson, M. H., Dziurawiec, S., Ellis, H., & Morton, J. (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition, 90*, 1–19.
Johnson, M. H., & Morton, J. (1991). *Biology and cognitive development: The case of face recognition.* Oxford, England: Basil Blackwell.
Kleiner, K. A. (1987). Amplitude and phase spectra as indices of infants' pattern preferences. *Infant Behavior & Development, 10*, 49–59.
Kleiner, K. A. (1990). Models of neonates' preferences for facelike patterns: A response to Morton, Johnson, and Maurer. *Infant Behavior & Development, 13*, 105–108.
Kleiner, K. A. (1993). Specific versus non-specific face recognition device? In B. de Boysson-Bardies, S. de Schonen, P. Jusczyk, P. McNeilage, & J. Morton (Eds.), *Developmental neurocognition: Speech and face processing in the first year of life* (pp. 103–108). New York: Academic Press.
Kleiner, K. A., & Banks, M. S. (1987). Stimulus energy does not account for 2-month-old infants' face preference. *Journal of Experimental Psychology: Human Perception and Performance, 13*, 594–600.
Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. (2001). Early visual experience and face processing. *Nature, 410*, 890.
Maurer, D., & Young, R. (1983). Newborns' following of natural and distorted arrangements of facial features. *Infant Behavior & Development, 6*, 127–131.
Mondloch, C. J., Lewis, T. L., Budreau, D. R., Maurer, D., Dannemiller, J. L., Stephens, B. R., & Kleiner-Gathercoal, K. A. (1999). Face perception during early infancy. *Psychological Science, 10*, 419–422.
Morton, J., & Johnson, M. H. (1991). CONSPEC and CONLERN: A two-process theory of infant face recognition. *Psychological Review, 98*, 164–181.
Morton, J., Johnson, M. H., & Maurer, D. (1990). On the reasons for newborns' responses to faces. *Infant Behavior & Development, 13*, 99–103.
Rijsdijk, J. P., Kroon, J. N., & van der Wildt, G. J. (1980). Contrast sensitivity as a function of position on the retina. *Vision Research, 20*, 235–241.
Rizzolatti, G., Riggio, L., Dascola, I., & Umiltà, C. (1987). Reorienting attention across the horizontal and vertical meridians: Evidence in favor of a premotor theory of attention. *Neuropsychologia, 25*, 31–40.
Simion, F., Macchi Cassia, V., Turati, C., & Valenza, E. (2001). The origins of face perception: Specific versus non-specific mechanisms. *Infant and Child Development, 10*, 59–65.
Simion, F., Valenza, E., Macchi Cassia, V., Turati, C., & Umiltà, C. (2002). Newborns' preference for up–down asymmetrical configurations. *Developmental Science, 5*, 427–434.
Slater, A., Earle, D. C., Morison, V., & Rose, D. (1985). Pattern preferences at birth and their interaction with habituation-induced novelty preferences. *Journal of Experimental Child Psychology, 39*, 37–54.
Slater, A., & Sykes, M. (1977). Newborn infants' responses to square-wave gratings. *Child Development, 48*, 545–553.
Sprague, J. M., Berlucchi, G., & Rizzolatti, G. (1973). The role of the superior colliculus and pretectum in vision and visually guided behavior. In R. Jung (Ed.), *Handbook of sensory psychology* (Vol. 7/3, Part B, pp. 27–101). New York: Springer-Verlag.
Tychsen, L., & Lisberger, S. G. (1986). Visual motion processing for the initiation of smooth-pursuit eye movements in humans. *Journal of Neurophysiology, 56*, 953–968.
Valenza, E., Simion, F., Macchi Cassia, V., & Umiltà, C. (1996). Face preference at birth. *Journal of Experimental Psychology: Human Perception and Performance, 22*, 892–903.

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