

Newborn's Preference for Faces

Carlo Umiltà, Francesca Simion, and Eloisa Valenza

Università di Padova, Italy

Four experiments were aimed at elucidating some aspects of the preference for facelike patterns in newborns. Experiment 1 showed a preference for a stimulus whose components were located in the correct arrangement for a human face. Experiment 2 showed a preference for stimuli that had optimal sensory properties for the newborn visual system. Experiment 3 showed that babies directed their attention to a facelike pattern

even when it was presented simultaneously with a non-facelike stimulus with optimal sensory properties. Experiment 4 showed the preference for facelike patterns in the temporal hemifield but not in the nasal hemifield. It was concluded that newborns' preference for facelike patterns reflects the activity of a subcortical system which is sensitive to the structural properties of the stimulus.

Keywords: Newborns, Faces, Structure, Superior colliculus.

Even though much research has dealt with newborns' preference for facelike patterns over non-facelike patterns, there are still several controversial issues. The first concerns the very fact of whether a preference for facelike patterns can be found in infants younger than 2 months. Several studies showed that in newborns moving facelike patterns elicited greater following behavior than did non-facelike patterns (Goren, Sarty, & Wu, 1975; Johnson, Dziurawiec, Ellis, & Morton; Johnson & Morton, 1991; Maurer & Young, 1983; Morton & Johnson, 1991). The results were much less clear when the classical preferential looking procedure was used. Some studies failed to obtain a preference for facelike patterns (Hershenson, Kessen, & Munsinger 1967; Slater, 1993), whereas a study by Kleiner (1987) did find such a preference.

Assuming that a preference for facelike patterns is present in newborns, two contrasting hypotheses were proposed to explain it: the sensory hypothesis (Kleiner, 1987; Kleiner & Banks, 1987) and the structural hypothesis (Johnson & Morton, 1991; Morton & Johnson, 1991). The original version of the sensory hypothesis maintained that newborns' preference for any visual patterns would be solely determined by sensory properties. Facelike patterns are preferred over non-facelike patterns simply because they happen to have more appropriate sensory properties. Subsequently, Kleiner (1990, 1993) revised the sensory hypothesis by proposing a sequential, two-stage model. It states that facelike and

non-facelike patterns are first compared for their sensory properties, and then, if they do not differ on this dimension, their structure is compared. In this view, the structure of the facelike pattern would produce a preference only on condition that the two competing patterns are matched for their sensory properties.

In contrast, the structural hypothesis (Johnson & Morton, 1991; Morton & Johnson, 1991) maintains that the preference for facelike over non-facelike patterns in newborns is not purely based on the sensory properties of the two types of pattern, as the sensory hypothesis holds. Rather, facelike patterns would be special because the newborn possesses a device that contains information concerning the structural characteristics of the conspecifics' face. In particular, this device would be sensi-

Carlo Umiltà, MD, is Professor of Neuropsychology, Past-President of the European Society for Cognitive Psychology, and chairs the Executive Committee of the International Society for the Study of Attention and Performance. His research work concerns selective and spatial attention, and control processes.

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Correspondence concerning this article should be addressed to Carlo Umiltà, Dipartimento di Psicologia Generale, Università di Padova, via Venezia, 8, I-35131 Padova, Italy (fax +39 49 8276600, e-mail umilta@ipdunivx.unipd.it).

tive to the correct spatial arrangement of high-contrast blobs, corresponding to the relative locations of the eyes and mouth.

Johnson and Morton (1991; Morton & Johnson, 1991) also proposed that at birth preferential orienting to faces is primarily controlled by a subcortical mechanism, termed "Conspec," containing a crude specification of the arrangement of the main facial features (i. e., eyes and mouth). Cortical circuits specialized for processing faces (i. e., a mechanism termed "Conlern") would appear at around 2 months, as a result of the developing cortex being frequently exposed to faces due the activity of Conspec.

The experiments to be summarized in the present paper (for more complete descriptions of Experiments 1–3 and 4, respectively, see Valenza, Simion, Macchi Cassia, & Umiltà, in press; Simion, Valenza, Umiltà, & Dalla Barba, submitted) had three aims. The first was to show that face preference in newborns is not confined to tasks requiring the infant to follow, with the eyes, patterns that move at the periphery of the visual field. Rather, it manifests itself also when the more usual preferential looking technique is employed. The second aim was to support the structural hypothesis, by showing that the preference for facelike over non-facelike patterns is entirely attributable to the correct arrangement of the components. The third aim was to show that the preference for facelike patterns is primarily mediated by subcortical mechanisms, such as the superior colliculus.

Experiments 1–3

In these experiments an infant control, preferential looking technique was employed. Two stimuli were simultaneously presented for as long as the baby was judged to be looking at one of them.

Twenty, 11, and 15 normal, healthy newborns participated in Experiments 1, 2, and 3, respectively. All met the screening criteria of normal delivery, a birth-weight between 2600 and 4000 g, and an Apgar score of at least 8 at 5 min after birth. The range of ages at the time of test was 24–155 h postnatal.

The baby sat on the experimenter's lap, in front of two gray screens, at a distance of about 20 cm. A centrally located blinking light (about 6.5° of visual angle) was used to attract the baby's gaze at the start of each trial. The two stimuli were simultaneously projected on the right-side and the left-side screen, so that the inner

portion of their contours was at about 15° from the bulb. A video camera recorded the baby's eye movements.

On every trial, when the baby fixated it, the center light was turned off and the two stimuli were presented. Video tapes of the eye movements were subsequently analyzed by two "blind" coders, who recorded four dependent variables that could index a preference for one of the two stimuli. The dependent variables were, for each stimulus, the number of orienting responses, the duration of the first fixation, the duration of the longest fixation, and the total fixation time.

The main purpose of Experiment 1 was to confirm that a preference for a facelike pattern is present at birth. In it, the stimuli (see Figure 1) were two head-shaped, head-sized, two-dimensional, white forms, about 16 × 27 cm, with three square blobs (2.5 × 2.5 cm) as features of a human face. The fundamental spatial frequency of the blobs was 0.06 c/d. One stimulus had the blobs in the appropriate location for the eyes and the mouth. The other stimulus had an inverted position of the blobs.

Separate ANOVAs were carried out on the four dependent variables. The two within-subjects factors were position of the stimulus (left vs right) and stimulus type (facelike vs non-facelike). Three significant main effects indicated that on three variables the babies preferred the facelike over the non-facelike pattern: 8.8 vs 2.6 s ($p < 0.025$) for the duration of the first fixation, 23.7 vs 13.4 s ($p < 0.01$) for the duration of the longest fixation, and 55.6 vs 32.8 s ($p < 0.025$) for the total fixation time.

If one considers that the two stimuli had identical amplitude spectra, and thus were equivalent with regard to the saliency of their physical properties, it is clear that the results are in accord with the hypothesis that at birth there is a preference for facelike patterns, which

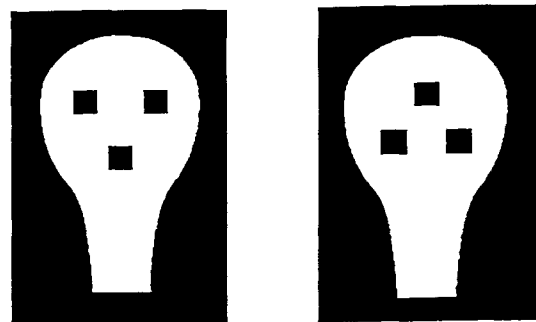


Figure 1

The two stimuli used in Experiments 1 and 4. In Experiment 4, the stimuli were presented one at a time.

depends on structural information (Johnson & Morton, 1991; Morton & Johnson, 1991). The results refuted the version of the sensory hypothesis that maintains that face preference at birth is solely determined by the sensory properties of the stimuli (Kleiner, 1987; Kleiner & Banks, 1987). However, they did not refute the revised version, which maintains that preference responses are produced on the basis of the structural information when the sensory properties are identical (Kleiner, 1990, 1993).

The internal blobs of the stimuli employed in Experiment 2 were chosen to test a preference for the peak contrast sensitivity typical of newborns (i.e., between 0.1 and 0.2 c/d, according to, e.g., Banks & Ginsburg, 1985; Slater, Earle, Morison, & Rose, 1985). It was predicted that the babies would prefer the stimulus with the optimal spatial frequency components, that is with more salient physical properties. In this experiment, two pairs of stimuli were used (see Figure 2, Panels A and B). Each stimulus had three square blobs in a triangular formation, arranged in the inverted locations for the eyes and

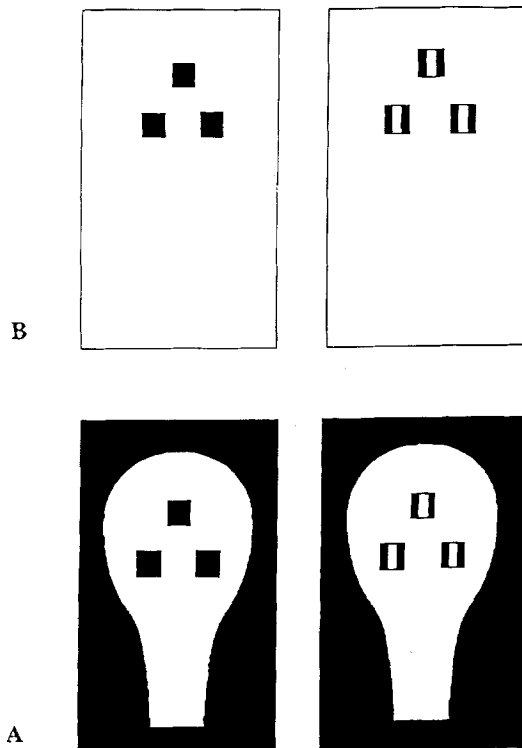


Figure 2
A The two framed stimuli used in Experiment 2. B The two unframed stimuli used in Experiment 2.

the mouth. One pair of stimuli was formed by unframed blobs whereas in the second pair the blobs were framed by the same head-shaped contour that had been employed in Experiment 1. In each pair, in one stimulus the blobs were completely black (0.06 c/d), whereas in the other stimulus the blobs were black and white striped (0.19 c/d).

Four ANOVAs identical to those performed in Experiment 1 produced three significant main effects. They indicated that the babies preferred the stimulus with striped blobs over the stimulus with nonstriped blobs: 14 vs 10 ($p < 0.05$) for the number of orienting responses, 19.4 vs 6.7 s ($p < 0.025$) for the duration of the longest fixation, and 54.1 vs 23.4 s ($p < 0.025$) for the total fixation time.

The outcome of this experiment was congruent with the sensory hypothesis, according to which visual preference would be determined by the extent to which the physical properties of the stimulus matched those of the baby's sensory channels. However, the results were not at odds with the structural hypothesis either, because facelike patterns were not presented.

Of the two stimuli employed in Experiment 3, one was a pattern with the structural configuration of a face but with nonsalient physical properties. The other was a non-facelike pattern with salient physical properties. This way, the structural and the sensory hypotheses were directly pitted against each other. If the sensorial factor were more important than the structural factor in producing response preference, newborns should show a preference for the stimulus that provided more salient visual information. If the structural factor were more important than the sensorial factor, newborns should show a preference for the facelike pattern.

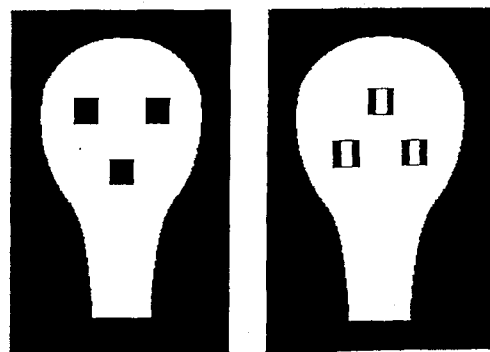


Figure 3
The two stimuli used in Experiment 3.

The stimuli (see Figure 3) were two head-shaped, head-sized white forms, with three square blobs inside. In one stimulus, namely the one that had been preferred in Experiment 1, the blobs were completely black (0.06 c/d) and were situated in the appropriate locations for the eyes and the mouth. In the other stimulus, namely the one that had been preferred in Experiment 2, the blobs were striped (0.19 c/d) and were situated in the inverted locations for the eyes and the mouth.

The four ANOVAs produced three significant main effects. They indicated that the babies preferred the pattern with a facelike structure over the stimulus with more salient blobs: 11 vs 9 ($p < 0.05$) for the number of orienting responses, 35.2 vs 23.2 s ($p < 0.05$) for the duration of the longest fixation, and 79.5 vs 49.1 s ($p < 0.025$) for the total fixation time.

The results of this experiment clearly showed that structural information could overcome a sensory-based preference. Thus, it appears that, of the two factors that govern newborns' visual preference (that is, the structural factor and the sensorial factor), the former is more powerful than the latter. Note that the outcome of Experiment 3 cannot be explained by the revised version of the sensory hypothesis (Kleiner, 1990, 1993), which maintains that, regardless of the structure, the preferred stimulus is the one that contains the more salient physical properties. Rather, even in the presence of an opposite asymmetry in visibility between the two stimuli, newborns prefer the one with the structural properties of a face. This is exactly what the structural hypothesis predicts (Johnson & Morton, 1991; Morton & Johnson, 1991).

Experiment 4

As mentioned before, Johnson & Morton (1991; Morton & Johnson, 1991) have proposed that newborns preferential orienting to faces is primarily controlled by a subcortical mechanism (i.e., Conspec) containing a crude specification of the arrangement of the eyes and mouth. Their hypothesis would be supported if the preference for faces showed a temporal-nasal asymmetry. A temporal-nasal asymmetry is evidence of retinotectal mediation (Johnson, 1990; Rafal, Henik, & Smith, 1991; Simion, Valenza, Umiltà, & Dalla Barba, 1995) because, when compared to the geniculostriate system, the retinotectal system has a greater crossed input from the contralateral eye (temporal hemifield) and a smaller direct input from the ipsilateral eye (nasal hemifield).

Fifteen newborns were tested monocularly. The range of ages at time of testing was 24–144 h postnatal. They were selected as in the previous experiments. Also the apparatus and procedure were like those already described, apart from a few minor changes. The most important departure from the procedure employed in the previous experiments was that the stimuli were presented one at a time in either the temporal or the nasal hemifield.

The stimuli were taken from Experiment 1 (see Figure 1). One had the blobs in the appropriate locations for the eyes and the mouth regions. The other was identical but with an inverted position of the blobs. At viewing distance, the head-shaped patterns subtended about 21°. The stimulus pattern was placed in the temporal or nasal visual hemifield (about 10°, inner border). There was an equal number of temporal and nasal presentations for each of the two stimuli (i. e., either the facelike or the non-facelike pattern).

An ANOVA was conducted on the number of orienting responses. In it, the two within-subjects factors were hemifield (temporal vs nasal) and type of stimulus (facelike vs non-facelike). The stimulus main effect and the interaction were significant ($p < 0.025$ and $p < 0.05$, respectively). Orienting responses were more frequent to the facelike than the non-facelike pattern (1.97 vs 1.60). This difference, however, was present in the temporal hemifield (2.13 vs 1.47) but absent in the nasal hemifield (1.80 vs 1.73).

The results of Experiment 4 confirmed, using a different experimental procedure, that newborns show a preference for facelike patterns over non-facelike patterns. The most interesting finding was, however, that facelike patterns were more efficient than non-facelike patterns in summoning the newborn's gaze in the temporal hemifield but not in the nasal hemifield. If temporal-nasal hemifield asymmetry is a marker of the activity of the retinotectal pathway (Rafal et al., 1990, 1991; Schiller, 1985; Simion et al., 1995), our data showed that in newborns the retinotectal pathway has the main role in controlling the visually guided behavior that is elicited by facelike patterns.

Conclusion

We had planned this series of experiments to show that, in newborns, face preference also manifests itself with the preferential looking technique, is attributable to the structure of the stimuli, and is mediated by the superior colliculus. It appears we met with some success.

It had been maintained that the preference for facelike patterns could be found in newborns only with moving stimuli which elicited the baby's following behavior, or with static stimuli provided that they were presented in the far periphery of the visual field (Johnson & Morton, 1991; Morton & Johnson, 1991). Contrary to this, Experiments 1 and 3 produced a clear preference for facelike patterns over non-facelike patterns with a standard preferential looking technique, when the static stimuli were not very far from the fovea.

The structural hypotheses (Johnson & Morton, 1991; Morton & Johnson, 1991) maintains that facelike patterns are special because of the structural organization of their internal features. This hypothesis does not deny that sensory factors can play a role in producing newborns' visual preferences. The sensory factors, however, would become effective only if the factor "facedness" is eliminated (e.g., the choice is between two equally facelike patterns or two equally non-facelike patterns). In its revised version (Kleiner, 1990, 1993), the sensory hypothesis does not deny that the structure of the pattern may play a role in newborns' visual preferences. However, structure is thought to become effective only if visibility is equated.

In Experiment 3, one stimulus was a facelike pattern with black blobs, that is, the same pattern that was preferred in Experiment 1. The other stimulus was a highly salient, non-facelike pattern with the inverted blobs, which was preferred in Experiment 2. The newborns showed a reliable preference for the facelike pattern. Therefore, the results of this experiment supported the structural hypothesis and disproved the sensory hypothesis in either its original or revised version.

Johnson and Morton (1991; Morton & Johnson, 1991) have maintained that the mechanism that underlies newborns' preference for facelike patterns (i.e., Conspic) is subcortical and is located in the superior colliculus. In Experiment 4, the preference for facelike patterns was present in the temporal hemifield but was absent in the nasal hemifield. Assuming that the temporal-nasal hemifield asymmetry is a marker of the activity of the retinotectal pathway (Rafal et al., 1990; Schiller, 1985; Simion et al., 1995), Experiment 4 provided evidence that in newborns the retinotectal pathway, and thus the superior colliculus, has the main role in mediating the preference for facelike patterns.

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