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ORIGINAL ARTICLE

A comparison between preterm and full-term infants' preference for faces☆

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KEYWORDS
Model of visual recognition;
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Abstract

Objective: Visual preference for faces at birth is the product of a multimodal sensory experience experienced by the fetus even during the gestational period. The ability to recognize faces allows an ecologically advantageous interaction with the social environment. However, perinatal events such as premature birth, may adversely affect the adequate development of this capacity. In this study, we evaluated the preference for facial stimuli in preterm infants within the first few hours after birth.

Methods: This is a cross-sectional observational study of 59 newborns, 28 preterm and 31 full-term infants. The babies were assessed in the first hours of life, with two white boards in the shape of a head and neck: one with the drawing of a face similar to the human face (natural face), and one with the drawing of misaligned eyes, mouth and nose (distorted face). After the newborn fixated the eyes on the presented stimulus, it was slowly moved along the visual field. The recognition of the stimulus was considered present when the baby had eye or head movements toward the stimulus.

Results: The preterm infants, in addition to showing a lower occurrence of orientation movements for both stimuli, on average (1.8 ± 1.1 to natural faces and 2.0 ± 1.2 for distorted ones) also showed no preference for any of them ($p = 0.35$). Full-term newborns showed a different behavior, in which they showed a preference for natural faces ($p = 0.002$) and a higher number of orientations for the stimulus, for both natural (3.2 ± 0.8) and distorted faces (2.5 ± 0.9).

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Conclusion: Preterm newborns recognize facial stimuli and disclose no preference for natural faces, different from full-term newborns.

PALAVRAS-CHAVE
Reconhecimento visual de modelos;
Percepção visual;
Recém-nascido;
Prematuro;
Nascimento a termo

Uma comparação entre recém-nascidos prematuros e a termo na preferência por faces

Resumo

Objetivo: A preferência visual por faces ao nascimento é produto de uma experiência sensorial multimodal vivenciada pelo feto ainda no período gestacional. A habilidade de reconhecer faces possibilita uma interação ecologicamente vantajosa com o ambiente social. Entretanto, eventos perinatais, como o nascimento prematuro, podem prejudicar o desenvolvimento adequado dessa habilidade. Nesse trabalho, avaliamos a preferência por estímulos faciais de recém-nascidos prematuros nas primeiras horas após o nascimento.

Métodos: Trata-se de um estudo observacional transversal realizado com 59 recém-nascidos, 28 prematuros e 31 nascidos termos. Os bebês foram avaliados, nas primeiras horas de vida, com duas pranchas brancas em formato de cabeça e pescoço: uma com o desenho de uma face similar ao rosto humano (face natural), e outra com o desenho de olhos, boca e nariz desalinhados (face distorcida). Após o recém-nascido fixar o olhar no estímulo apresentado o mesmo era lentamente movimentado ao longo do campo visual. O reconhecimento do estímulo foi considerado presente quando o bebê apresentou movimentos dos olhos ou cabeça em direção ao estímulo.

Resultados: Os recém-nascidos prematuros além de apresentarem menor ocorrência de movimentos de orientação para ambos os estímulos, em média ($1{,}8 \pm 1{,}1$ para faces naturais e $2{,}0 \pm 1{,}2$ para faces distorcidas), também não apresentaram preferência por qualquer um deles ($p = 0{,}35$). Diferente foi o comportamento dos recém-nascidos a termo que apresentaram preferência por faces naturais ($p = 0{,}002$) e um número maior de orientações para o estímulo, tanto para faces naturais ($3{,}2 \pm 0{,}8$) quanto para faces distorcidas ($2{,}5 \pm 0{,}9$).

Conclusão: Recém-nascidos prematuros reconhecem os estímulos faciais e não apresentam preferência por faces naturais, diferente de recém-nascidos a termos.

Introduction

Despite the visual cortical area immaturity and the consequent limitation in visual skills, newborns have an innate preference for visual stimuli that resemble faces. This ability is essential to guide the child's interactions in the social environment.[1]

Unlike most other objects, faces are processed in a holistic or configural manner in the visual system and are processed in their entirety, while other objects are processed as aggregates of independent elements.[2] This is probably due to the fact that many socially relevant information sources depend on the integration from several facial regions, such as judgments of facial expressions and intentionality.[2]

The configural processing of faces depends on a subcortical system known as CONSPEC, which operates since birth and is sensitive to basic information on the visual characteristics of faces of the same species.[3] This system guides the preference for facial patterns (eyes aligned above the nose and mouth) from high contrasts up to the first months of life,[4–6] before a second system, termed CONLERN, completes its maturation.[3,4] The development of the CONLERN system depends on the visual experience with human faces.[3,4,7] These two systems interact during the postnatal development of the visual system.[8] The CONSPEC guides the development of CONLERN;[3] any impairment in its function may affect cortical specialization for faces and, thus, adversely influence the subsequent processing of social stimuli.[4]

Experiments that investigate these two systems in full-term newborns with gestational age >40 weeks are widely found in the literature.[1,4,5,8–10] However, although preterm infants are capable of completing all elements of a visual assessment protocol, including those with complex answers,[6,11] no study has assessed the preference for faces in preterm infants in the first few hours of life.

Some studies[12–14] demonstrated an association between preterm birth and several neurocognitive disorders, associated in one way or another to the processing of facial stimuli, such as autism[12,13] and prosopagnosia,[14] the inability to recognize faces.

An orientation by social stimuli may be a critical control point for predicting the trajectory of social cognitive development.[15]

However, a hypothesis discussed in the present study is that the orientation by social stimuli at birth may be a product of a multimodal sensory experience that the fetus can

experience even during the gestational period,[16,17] which could be hindered in preterm infants due to the lack of intrauterine experience. Considering this perspective, this study aimed to assess the preference for facial stimuli in preterm newborns in the first hours of life.

Methods

Sample

This was a pragmatic, cross-sectional, observational study that measured the prevalence of facial recognition in two groups of infants, preterm and full-term. The study was conducted between July 2014 and December 2015, with a convenience sample from Maternidade Escola Januário Cicco (Natal, RN, Brazil) and Maternidade Escola Hospital Ana Bezerra (Santa Cruz, RN, Brazil). Sample recruitment was carried out from the admissions at the two hospitals during the study period. The choice of a pragmatic experimental design was due to its practicality and the possibility of supplementing the study with an epidemiological and cultural context.[18]

Parents or guardians of newborns of both genders with up to 48 h of life, with 33–41 weeks of gestational age, were invited to participate in the study. Gestational age calculated by the last menstrual period. When this was not possible, data from the obstetric ultrasonography performed in the first trimester of pregnancy was considered.

Infants born between 33 and 36 weeks and six days of gestation were grouped in the preterm group and infants born between 37 and 41 weeks in grouped in the full-term group.

Hemodynamically unstable newborns (receiving invasive and/or non-invasive mechanical ventilation, use of vasoactive drugs), with intraventricular hemorrhage grade III and IV, Apgar score at 5 min <5, and whose funduscopic exam presented abnormal results were excluded from the study. The study was approved by the Research Ethics Committee of UFRN/FACISA (Protocol No. 658.852/2014) and all mothers or guardians signed the free and informed consent form.

Stimulus

To assess facial recognition, the authors adapted the methodology described by Goren et al., by removing one of the boards from the set to reduce the test application time for preterm babies, who tended to fall asleep during the assessment.[19] Therefore, the stimuli consisted of two white boards shaped as a head and neck (0.17 m × 0.19 m) with a black outer edge. One contained a drawing similar to the human face (aligned eyes above the nose and mouth) and the other the drawing of a distorted face (misaligned eyes, mouth, and nose).

Procedure

The test was performed with the participation of two researchers in a well-lit and quiet room located in the hospital and the newborns were placed in the supine position on the examiner's lap (Fig. 1A). The stimulus was presented at 15° and 30° angles, to the right and left of an imaginary arch with a radius of 0.25 m and centered on the newborn's head.

The examiner was blinded to the type of stimulus presented, which was handed with the face side (natural or distorted) inverted by the assistant. After the newborn's gaze was fixated on the stimulus, it was slowly moved along the visual field. The assistant recorded on a form the examiner's opinion regarding the recognition or not of the stimulus by the newborn. Each board was moved only once to each side; stimulus recognition was considered present when the baby showed eye or head movements toward the presented stimulus.[19] The examiner was previously trained to ensure the reproducibility of the stimulus presentation angles. A black PVC arch with angle markings

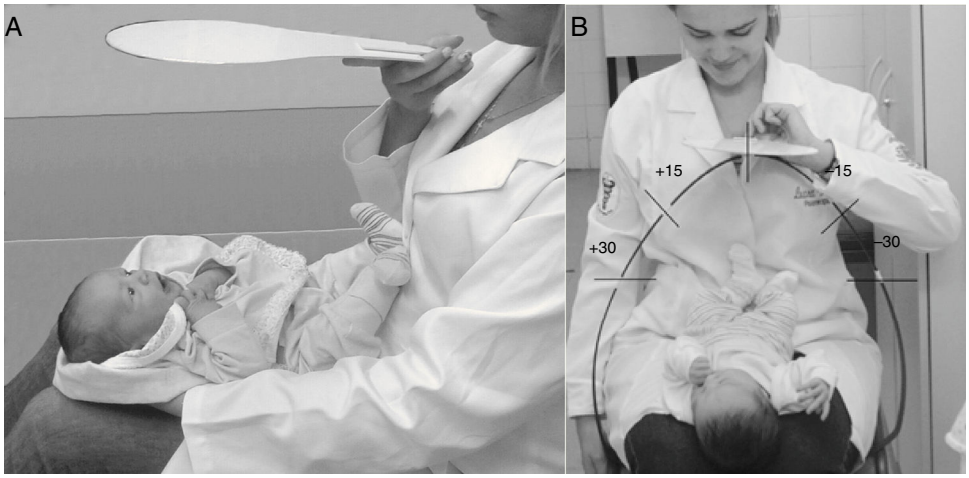

Figure 1 (A) Position of the newborn and the researcher during the experiment. The newborns were positioned in the supine position on the researcher's lap and the stimulus was presented at a distance of 0.25 m from the newborn. (B) The examiner was trained to ensure the reproducibility of the stimulus presentation angles. A black PVC arch with angle markings was used during the training with five newborns not included in the study.

Table 1 Mean values, standard deviations, and minimum and maximum values of the sample's general characteristics.

	Preterm	Full-term	*p*
Total of newborns	28	31	–
Gender (male/female)	14/14	20/11	–
Hours of life at the assessment	30 ± 11.89 (10–48)	21 ± 12.13 (2–47)	0.55
Gestational age (weeks)	35 ± 1.11 (33–36)	39 ± 1.13 (37–41)	0.02
Weight (g)	2044.00 ± 380.54 (1260–2904)	3396.13 ± 482.64 (2755–4900)	0.37
Apgar 1st minute	8 ± 1.91 (4–9)	9 ± 0.95 (4–9)	0.16
Apgar 5th minute	8 ± 0.90 (6–10)	9 ± 0.58 (7–10)	0.15

$p < 0.05$ indicates a statistically significant differences between groups, Student's *t* test.

was used during training (Fig. 1B) with five newborns that were not included in the study.

The statistical analysis considered the presence or absence of response (1 and 0, respectively) for each of the four positions evaluated. Performance comparison in the two groups regarding recognition of stimuli (natural and distorted face) was assessed with paired *t*-test, with a significance level of $\alpha = 00{:}05$.

Results

During the study period, 73 newborns were assessed; of these, 14 were excluded (four had gestational age <33 weeks, three had more than 48 h of life, four were on mechanical ventilation, and three had Apgar at 5 min <5). Of the 59 infants who were included in the study, 28 were allocated in the PRETERM group (14 girls) and 31 in the FULL-TERM group (11 girls). Table 1 shows a summary of the overall characteristics of the sample.

Both groups recognized the two stimuli presented. However, newborns from the preterm group, in addition to showing a lower occurrence of orientation movements for both stimuli, on average (1.8 ± 1.1 for natural faces and 2.0 ± 1.2 for distorted) (Fig. 2), showed no preference for either of them ($p = 0.35$). In turn, the newborns from the full-term group showed a preference for natural faces ($p = 0.002$) and a higher number of orientation movements for the stimulus, both for natural (3.2 ± 0.8) and distorted faces (2.5 ± 0.9) (Fig. 2).

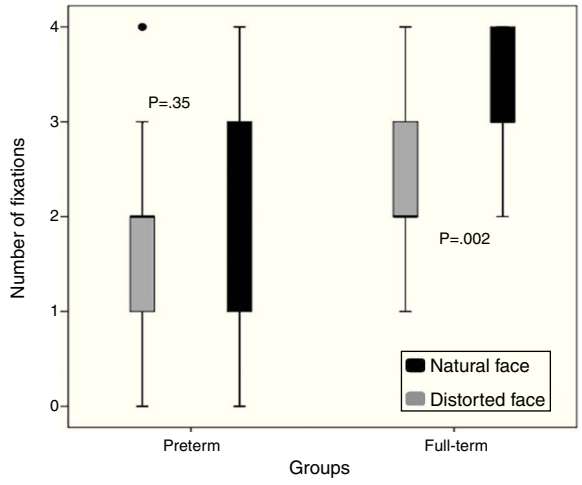

Figure 2 Number of fixations per natural and distorted facial stimuli in both groups of infants: preterm and full-term.

Discussion

The results indicate that preterm babies do not have a visual preference for natural faces, different from newborns born at term.

The ability to identify faces is an essential skill for newborns, considering their almost complete dependence on their caregivers.

Turati et al. evaluated the facial preference of infants born at term at 3 months of age.[20] The results demonstrate that these babies show a visual preference for facial images presented in a correct orientation, when compared with inverted faces. Another study of infants born at term, assessed within 24 h of life, used two stimuli similar to human faces, the first with three black squares aligned with the eyes and mouth and a second also with three black squares, but with the position of eyes and mouth inverted. The results showed a preference for the stimulus similar to the human face.[5]

Goren et al., in their experiments, established that babies born at term have some specific information about the disposition of the features that constitute the face within one hour after birth; more specifically, infants with nine minutes of life prefer faces to other stimuli.[19] However, all these studies assessed full-term infants;[4,5,19,20] the interruption of the subcortical system caused by preterm birth may have important consequences for the development of the mechanism involved in the preference for social stimuli.[14,21]

Studies of the visual function of facial recognition also carried out with preterm infants, albeit at a different age than that of the present study, showed that these infants have an inability to recognize faces, corroborating the present results.[12,14] The authors of those studies discuss the fact that prosopagnosia can be a serious neurological disorder that leads to social disability, due to the difficulty in making friends and participating in social activities of daily living.[12,14]

A possible reason for these results is the fact that preterm birth exposes a system with incomplete development. For instance, Takeshita et al. demonstrated the importance of haptic exploration by the baby in brain maturation during the last trimester of gestation.[22] The stimuli from the tactile exploration of the fetus' own face during pregnancy helps

refine the circuits responsible for the visual discrimination of faces.[16] In the last trimester of pregnancy, fetuses have a higher frequency of coordinated movements of the upper body toward the face.[17]

However, in the present study, a psychophysical experiment was performed, with a single exposure of the natural face stimulus; the response was not filmed, which may limit the discussion of the results.

The repetition of the same stimulus could have provided additional information to the newborn and the recording could have assisted in judging the response. Considering that the repeated presentation of an unknown stimulus could lead to visual habituation, the authors decided for a single exposure; however, an experiment with the orientation of the oculomotor system was performed. This approach was chosen because the authors understand that the CONSPEC mechanism is oriented by the oculomotor system[4,19] and such procedure could be used even in newborns admitted at the hospital a few hours after birth, being a useful tool for the diagnosis of possible neurocognitive alterations.

The video recording of the experiment was attempted with different camera positions, during the training phase with the five infants not included in the study, but none of the positions was enough to catch eye movement without arousing the newborn's interest. Then, the authors decided to include a second researcher to present the cards face down to the examiner, which made the examiner's judgment blinded to the type of stimulus presented. However, it is important to emphasize that this is the first study that showed differences in orientations for social stimuli between preterm and full-term infants, within a few hours of life after birth. Frie et al. [14] demonstrated similar results with 27 preterm infants, but the latter were assessed at 6 months of corrected age and 10 months of chronological age. Therefore, the authors believe that the present results are particularly important in light of the possible consequences that this lack of orientation in preterm infants can have on the development of the system specialization to process social stimuli.

Despite the limitations of the present study, the results indicate that preterm infants did not show a preference for natural faces; however, further studies are required, with larger samples and different prematurity profiles to reach more definitive conclusions.

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Conflicts of interest

The authors declare no conflicts of interest.

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