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Maternal sensitivity is associated with configural processing of infant's cues in preterm and full-term mothers

Niccolò Butti[a], Rosario Montirosso[b,*], Renato Borgatti[a], Cosimo Urgesi[a,c]

[a] *Neuropsychiatry and Neurorehabilitation Unit - Scientific Institute, IRCCS Eugenio Medea, Bosisio Parini, Lecco, Italy*
[b] *0-3 Centre for the at-Risk Infant - Scientific Institute, IRCCS Eugenio Medea, Bosisio Parini, Lecco, Italy*
[c] *Laboratory of Cognitive Neuroscience, Department of Languages and Literatures, Communication, Education and Society, University of Udine and Scientific Institute, IRCCS Eugenio Medea, San Vito al Tagliamento, Pordenone, Italy*

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ABSTRACT

Background: Prematurity may affect mother-infant bonding and alter maternal sensitivity to infant's cues. Efficient perception of infants' facial and bodily cues is a crucial aspect of maternal sensitivity and may be challenged by prematurity, as infants' signals may not be easily intelligible. However, it is still unexplored how premature birth impacts the maternal ability to perceive infants' signals.
Aims: To investigate whether prematurity influences the perceptual sensitivity of mothers to infants' cues and, in particular, the configural processing of the faces and bodies of familiar and unfamiliar infants.
Study design: The inversion effect paradigm was used to evaluate the configural vs. detail-based processing of the face and body of own or others' infants. Preterm mothers were compared to full-term mothers with either low or high maternal sensitivity.
Participants: Forty-three healthy full-term and twenty-one preterm mothers of infants aged about six months.
Outcome measures: Maternal sensitivity during dyadic interaction, gestational age, accuracy and reaction time in a delayed matching-to-sample task of upright vs. inverted body and face stimuli (i.e., inversion effect).
Results: Preterm mothers were found to be less sensitive than the full-term ones. Higher maternal sensitivity during dyadic interaction was associated with lower inversion effect for unfamiliar as compared to own infants' bodies. However, preterm mothers and full-term mothers with low sensitivity showed comparable inversion effect in perceiving unfamiliar infants' faces or bodies.
Conclusions: Preterm birth per se does not directly affect body configural processing, but it may be associated to reduced maternal sensitivity, ultimately leading to a less refined perception of own infant's cues.

1. Introduction

Even in absence of perinatal complications, preterm birth is a risk condition for altered socio-emotional development [1,2] and for associated sensorimotor, cognitive, and behavioral disorders [3,4]. Preterm infants often need long-term hospitalization, which represents a stressful experience due to both infant's exposure to repeated stressors associated to intensive care [5] and precocious mother-newborn separation. The disruption of the normally occurring physical contact and emotional closeness between the mother and the infant may affect maternal bonding and the ability to provide adequate and contingent responses to infants' signals [6–10]. For example, several studies have documented the association between premature birth and altered maternal behavior. In particular, the mothers of preterm infants tend to look, smile, vocalize and touch their infants less than the mothers of

full-term infants [11–13]. These findings indicate that prematurity may be related to atypical parenting styles and less synchronous dyadic interactions [9,14,15]. Furthermore, previous studies have reported that the mothers of preterm infants may show less sensitivity to their infant's cues during dyadic interactions [9,12,16], although a recent meta-analysis [17] has not found consistent evidence of different levels of sensitivity of mothers of pre-term and full-term mothers as assessed with an observational measure.

Maternal sensitivity is the ability to respond promptly and in an active, warm, acceptant, appropriate and flexible way to the infant's signals and it has been considered a crucial aspect of mother-infant relationship [18–20]. Although there is no total agreement about its definition [21], most scholars consider maternal sensitivity as a dynamic process, which includes three different aspects: perception, interpretation and active response to infant's signals. [22]. Previous

research has mostly focused on the two latter aspects of sensitivity, namely the ability to understand infant's signals (i.e., interpretation) and maternal behavior (e.g., responses) [23–27]. Only a few studies have focused on the perceptual aspect of maternal sensitivity, which involves a refinement of maternal perception for infant's cues. For instance, the quality of the feeding relationship has been associated to more focused attention to preterm infants' cues during feeding [28]. In a similar vein, studies on mothers of full-term infants have documented an association between maternal sensitivity during a dyadic interaction and neural responses in areas related to emotional processing during observation of infant's cry [29,30]. Another study has demonstrated that poor parenting (in substance-using mothers) is associated to reduced activity in emotion-processing areas during perception of infant's face and cry [31]. However, the relative lack of knowledge on the neurocognitive correlates of the perceptual aspects of maternal sensitivity is quite surprising considering the importance of an efficient perceptual processing of infant's signals, especially when these may not be easily intelligible, as reported in preterm infants [1,11,32].

A recent study has directly explored the association between maternal sensitivity and the refinement of maternal visuo-perceptual processes in perceiving infants' bodies and faces [33]. Specifically, the use of configural vs. detail-based perceptual processing during observation of infant's body and face was tested using the so-called inversion effect paradigm. Configural processing uses a dynamic template representation of the relations among the different parts of a stimulus in the context of the whole stimulus configuration [34–36]. This perceptual processing is much more efficient than detail-based processing and is crucial in detecting and recognizing relevant social stimuli. Indeed, face and body recognition heavily relies on configural processing, while objects are mainly coded by detail-based analyses [37–41]. Moreover, configural processing develops more slowly than the featural (i.e., detail-based) one, suggesting that expertise with specific social stimuli results into more efficient perceptual strategies [42]. Importantly, configural processing occurs when social stimuli are presented in their upright canonical orientation, but not when they are shown upside down, since presentation of inverted stimuli disrupts the use of this perceptual strategy. Thus, a better performance is expected when stimuli are presented upright as compared to inverted (so called, inversion effect). In the inversion effect paradigm, relevant social stimuli, such as faces and bodies, are presented either upright or inverted in order to evaluate the presence of the inversion effect. As demonstrated by several studies, the greater the inversion effect, the higher the use of configural processing for both face [34] and body stimuli [41,43]. It is no coincidence that specific deficits in configural processing have been found in clinical population with problems in social competences. For instance, lower configural processing has been reported in individuals with anorexia nervosa [44] and schizophrenia [45,46] for body stimuli and in individuals with autistic spectrum disorders for both face and body stimuli [47–49]. Notably, a refinement of configural processing abilities occurs with the repeated exposure to specific kinds of stimuli [50], resulting into higher inversion effect for familiar than unfamiliar faces [51] and bodies [52]. Accordingly, greater activation of face and emotion-processing areas is detected when mothers are looking at their own child as compared to when they are looking at unfamiliar infants' pictures [53–56], particularly in those mothers who considered the relationship with their infant as positive [57]. Since configural processing facilitates the detection of subtle changes in the context of the whole face and body stimuli [34,36,40,58], thus representing a more refined perceptual strategy than the detail-based processing, an association between configural processing and maternal sensitivity should be found.

In the above mentioned study [33], the use of configural processing in perceiving familiar and unfamiliar children was investigated in full-term mothers showing low or high sensitivity during a face-to-face interaction at 6 months of age. Results suggested that mothers with high sensitivity were more engaged in configural processing of the body

postures of their own infants as compared to that of others' infants, while the configural processing of mothers with low sensitivity was not modulated by familiarity. No differences were obtained for face configural processing in either group. Hence, at least for body stimuli, a refinement of configural processing for one's own infant was associated with higher maternal sensitivity.

Here, we used the same inversion effect paradigm to investigate whether premature birth experience could affect the maternal ability to perceive more efficiently (i.e., the use of configural processing) familiar than unfamiliar infants. Moreover, since preterm birth may be associated with reduced maternal sensitivity [6,9], we controlled whether these variables (i.e., birth status and mother's behavior) exert independent or interacting effects on the configural processing of familiar and unfamiliar social stimuli. To this aim, we compared mothers of preterm infants with two groups of full-term mothers that showed high or low sensitivity to infant's cue during a dyadic interaction. Since premature birth could impact on maternal mood, with anxiety and depression representing risk-factors for early dyadic interactions [15,20,59], we also controlled for depression and anxious symptomatology. Moreover, in line with previous research on maternal sensitivity and configural processing [33], we took into account the subjective measure of maternal cognitive and emotional components of empathy. We expected that mothers of preterm infants show less selective use of configural processing of their own infant's cues as compared to full-term mothers. Furthermore, if preterm birth affects configural processing via maternal sensitivity mediation, the performance of the preterm mothers should be comparable to that of full-term mothers with low sensitivity. Conversely, if preterm birth and maternal sensitivity exert independent effects, the full-term mothers should outperform the preterm ones independently from their level of sensitivity.

2. Methods

2.1. Participants

Forty-three healthy full-term and twenty-one preterm infants aged about six months (corrected age for preterm) and their mothers participated in the study. In the preterm sample, twelve infants were twins (*N* families = 15). For the full-term infants, inclusion criteria were: full-term gestation (≥ 37 weeks), Apgar scores of at least 7 at 1 min and 8 at 5 min since birth, no congenital abnormalities, appropriate weight for gestational age, and uncomplicated prenatal, perinatal and neonatal courses. For the preterm infants, inclusion criteria were: gestational age < 37 weeks and > 28 weeks, no major brain lesions as documented by cerebral ultrasound (intraventricular hemorrhage $\leq$ grade 2 according to Papile [60], periventricular leukomalacia $\leq$ 1), no neurosensorial deficits (retinopathy of prematurity < stage 2), no genetic syndromes and/or major malformations, no postnatal pathologies. For both groups, maternal inclusion criteria were: age over 18 years, no cognitive impairments, no manifest psychiatric disorders, and no single-parent family. Moreover, all mothers were native italian speakers.

2.2. Materials and methods

2.2.1. General procedure

The procedure consisted of two sessions, which were both conducted at the participants' home. In a first session, the participating mothers were asked to sign a written informed consent and to fulfill a report including infant perinatal variables and socio-demographic characteristics. Socio-economic status (SES) was coded, according to the information provided by the mothers, based on Hollingshead's classification for parental occupation [33]. Scores ranging from 70 to 90 correspond to the upper status, scores ranging from 40 to 65 correspond to the middle status, and scores ranging from 10 to 35 correspond to the lower status. Then, pictures of infants' bodies and faces were taken for use as stimuli in the experimental tasks. Moreover, a