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Research Report

Maternal oxytocin response predicts mother-to-infant gaze



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ABSTRACT

The neuropeptide oxytocin is importantly implicated in the emergence and maintenance of maternal behavior that forms the basis of the mother–infant bond. However, no research has yet examined the specific association between maternal oxytocin and maternal gaze, a key modality through which the mother makes social contact and engages with her infant. Furthermore, prior oxytocin studies have assessed maternal engagement primarily during episodes free of infant distress, while maternal engagement during infant distress is considered to be uniquely relevant to the formation of secure mother–infant attachment. Two patterns of maternal gaze, maternal gaze toward and gaze shifts away from the infant, were micro-coded while 50 mothers interacted with their 7-month-old infants during a modified still-face procedure. Maternal oxytocin response was defined as a change from baseline in the mother's plasma oxytocin level following interaction with her infant. The mother's oxytocin response was positively associated with the duration of time her gaze was directed toward her infant, while negatively associated with the frequency with which her gaze shifted away from her infant. Importantly, mothers who showed low/average oxytocin response demonstrated a significant decrease in their infant gaze during periods of infant distress, while such change was not observed in mothers with high oxytocin response. The findings underscore the involvement of oxytocin in regulating the mother's responsive engagement with her infant, particularly in times when the infant's need for access to the mother is greatest.

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1. Introduction

While the neuropeptide oxytocin has been recognized for its functions in parturition and milk ejection for many decades, there exists now a substantial literature underscoring the role of oxytocin in regulating social behaviors (see reviews, Benarroch, 2013; Feldman, 2012; Meyer-Lindenberg et al., 2011). A sizable number of studies have implicated oxytocin in maternal care (Febo et al., 2005; Pedersen et al., 2006; Strathearn et al., 2009b), pair bonding (Ross et al., 2009; Schneiderman et al., 2012), interpersonal trust (Van IJzendoorn and Bakermans-Kranenburg, 2012), emotion recognition (Lischke et al., 2012; Perry et al., 2013), and empathy (Hurlemann et al., 2010; Rodrigues et al., 2009). Oxytocin has been characterized as a “hormone of affiliation” (Insel, 1992) and the oxytocinergic system has received attention as a key neural substrate of maternal caregiving, involved in the emergence and maintenance of maternal behaviors (Feldman, 2012; Strathearn, 2011). Many important advances in this regard have come from animal models (Francis et al., 2002; Keverne and Kendrick, 1992; Maestripieri et al., 2009; Pedersen et al., 2006; Williams et al., 2001), and they have been extended to human subjects over the past decade, revealing both parallel and divergent findings.

In humans, peripheral oxytocin levels are higher in pregnant and parturient women than non-pregnant women (Feldman et al., 2007; Gordon et al., 2008). Oxytocin levels show high intra-individual stability over the course of pregnancy (Feldman et al., 2007; Levine et al., 2007) and early motherhood (Gordon et al., 2010), suggesting that they may constitute a trait-like characteristic that underpins the expression of maternal behavior. Prospective and cross-sectional studies have demonstrated that maternal oxytocin levels are systematically associated with naturally occurring variations in maternal behavior, with high plasma oxytocin levels during pregnancy and postpartum predicting increased maternal behavior in the postpartum months (Atzil et al., 2011; Feldman et al., 2007; Gordon et al., 2010). Interaction with their young in the postpartum period further stimulates oxytocin response in mothers (Feldman et al., 2010a, 2010b), though significant inter-individual variations have been found (Strathearn et al., 2012), as with the baseline oxytocin levels. These natural variations in maternal oxytocin response have systematically predicted differences in the quality of maternal care provided by mothers (Feldman et al., 2010a, 2010b).

Quality provision of maternal care and formation of secure attachment bonds are of particular importance in the early postpartum months, given their long-term effects on the development of the offspring (Fonagy et al., 2007; Kochanska and Kim, 2013; Sroufe et al., 2005; Weinfield et al., 2004). It is well established that sensitive and responsive maternal behavior has direct bearings on the child's life-long capacity for social adaptation and stress regulation (Kochanska, 2001; Mayes, 2006; Mikulincer and Shaver, 2007; Schore, 2001). One important channel through which maternal sensitive responsiveness is communicated is mother-to-infant gaze. Gaze is a central modality through which mothers signal their availability, establish mutual engagement, and initiate regulation of infant arousal, particularly in times of infant distress (Beebe et al., 2010; Slee, 1984). Infants are highly sensitive to their

mothers' gaze (Stern, 1974) and begin to join in mutual gaze with their mothers as early as 3 months of age, which serves as a basis for the mother–infant synchrony that subsequently emerges in other modalities (e.g., touch, vocalization, facial expression; Colonnese et al., 2012; Feldman, 2007; Lavelli and Fogel, 2013; Tronick et al., 1980).

Despite its significance, the specific association between maternal gaze and maternal oxytocin has not yet been examined. Previous studies have measured maternal gaze, but only as part of a composite of maternal behaviors (also encompassing touch, vocalization, and affect; e.g., Atzil et al., 2011; Feldman et al., 2007, 2010b; Gordon et al., 2010). Furthermore, while attachment literature has underscored that maternal sensitivity to infant distress uniquely contributes to optimal socioemotional outcomes in the child (Leerkes et al., 2009; McElwain and Booth-LaForce, 2006), prior studies have examined maternal oxytocin only in relation to indices of maternal synchrony during episodes of positive affect and have not considered episodes of distress (Atzil et al., 2011; Feldman et al., 2010b, 2011).

In our previous functional magnetic resonance imaging (fMRI) study (Strathearn et al., 2009b), we demonstrated that mothers' peripheral oxytocin responses predicted their blood oxygenation level-dependent (BOLD) brain responses to their own infants' faces. The greater the mothers' oxytocin responses during interactions with their infants, the greater was their activation in regions known to be rich in oxytocin receptors (i.e., hypothalamic/pituitary region) when viewing their infants' faces in the scanner. In the present study, we extended our line of investigation to the mother's actual gaze behavior during real-time interaction with her infant. We sought to examine the relationship between maternal oxytocin response and mother-to-infant gaze during periods of infant non-distress as well as distress.

Mother–infant dyads were observed during 50-min semi-structured interaction sessions. Maternal oxytocin response was defined as any change in the mother's oxytocin level following interaction with her infant compared to baseline. Two patterns of maternal gaze, duration of maternal gaze toward and frequency of gaze shifts away from the infant, were coded during a well-validated interaction paradigm, a modified still-face procedure (MSFP; Koos and Gergely, 2001). The MSFP is a three-phase procedure, during which the mother interacts freely with the infant in phases 1 and 3, but is instructed to maintain a neutral ‘still face’ during phase 2, suddenly depriving the infant of maternal contingency and inducing stress in the infant (Koos and Gergely, 2001; Tronick et al., 1978; Fig. 1). The experimental manipulation reliably produces changes in the infant's level of distress: infants display clear signs of distress during phase 2, which have been shown to carry over to phase 3 (Haley and Stansbury, 2003; Mesman et al., 2009). The MSFP thereby offers an opportunity to examine the mother's behavior in the absence and presence of signals of infant distress. We hypothesized that maternal oxytocin response would be positively associated with maternal gaze toward the infant, and negatively associated with maternal gaze shifts away from the infant. We further predicted that this association would become more pronounced during periods of infant distress than non-distress, in phase 3 compared with phase 1 of the MSFP.

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