



Maternal sensitivity moderates the impact of prenatal anxiety disorder on infant mental development

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ABSTRACT

Background: Animal studies have shown that postnatal rearing style can modify the association between prenatal stress exposure and offspring neurodevelopmental outcomes. However, little is known about how parenting quality impacts the association between maternal prenatal anxiety and development in human infants.

Aim: This prospective study examined the impact of maternal prenatal anxiety disorder and maternal caregiving sensitivity on cognitive and psychomotor development in healthy, full-term, 7-month-old infants.

Measures: Women completed a clinical interview during the third trimester of pregnancy to assess anxiety symptoms meeting DSM-IV diagnostic criteria. At infant age 7 months, maternal sensitivity to infant distress and non-distress were observed and coded during the still-face procedure. Maternal postnatal (concurrent) anxiety and depression were also assessed at this time. Infant mental and psychomotor development was assessed at infant age 7 months using the Bayley Scales of Infant Development II.

Results: Analyses were based on 77 mother–infant dyads. Maternal sensitivity to infant distress moderated the association between maternal prenatal anxiety disorder and infant mental development, $F(1, 77) = 5.70, p = .02$. Whereas there was a significant positive association between sensitivity and mental development among infants whose mothers were anxious during pregnancy, sensitivity had little impact on mental development among infants of control (non-anxious) women. Results were independent of prenatal depression and postnatal anxiety and depression. A caregiving moderation effect was not found for infant psychomotor development, $p > .10$.

Conclusions: These findings are consistent with a cumulative risk model suggesting that maternal prenatal anxiety and quality of maternal care act in concert to shape infant outcomes.

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1. Introduction

Animal studies provide strong support for a causal link between maternal stress during pregnancy and suboptimal neurodevelopmental outcomes in offspring. In non-human primate models, stress in early or mid-gestation is linked to impaired motor development, shorter attention span, and delayed cognitive development in offspring [1,2]. In rodents, various forms of gestational stress, including restraint and foot shock, can induce memory and learning deficits in offspring (for reviews, see Refs. [3,4]). Much less is known about the impact of maternal prenatal stress on neurodevelopmental outcomes in human infants. Retrospective studies suggest that major stressful events experienced during pregnancy (e.g., natural disasters) can have a negative impact on children's development. In one study,

prenatal stress exposure during an ice-storm uniquely accounted for 11% and 12% of the variance in toddlers' mental and language abilities, respectively – as measured by the Bayley Scales of Infant Development [5]. These findings were independent of obstetric complications, gestational age at birth, birth weight, maternal postnatal depression and socio-economic status. Similar results were reported by Bergman and colleagues [6]. They found that retrospectively reported prenatal stressful life events accounted for 17% of the variance in cognitive ability (as assessed by the Bayley Scales) in infants aged between 14 and 19 months. Studies like these have made an important contribution to our understanding of outcomes associated with exposure to prenatal stress. However, they are typically based on extreme stressors and are subject to the limitations of retrospective reporting.

A number of recent studies have reported prospective associations between maternal stress in pregnancy and neurodevelopmental outcomes in infants and young children. For example, Huizink, De Medina, Mulder, Visser and Buitelaar [7] examined maternal reports of pregnancy-specific anxiety and daily hassles in a sample of nulliparous women. High levels of pregnancy-specific anxiety at 27–

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28 weeks gestation or high occurrence of daily hassles earlier in pregnancy (15–17 weeks gestation), predicted an average decline of eight points in infant mental and psychomotor development assessed using the Bayley Scales eight months after birth. These effects remained significant after adjusting for a large number of covariates. Maternal prenatal anxiety has also been linked to neurodevelopmental outcomes in toddlerhood. Brouwers and colleagues reported a significant negative association between elevated state anxiety assessed at 32 weeks gestation and mental development (but not psychomotor development) at child age two years [8].

Taken together, the findings described above are consistent with the notion of prenatal programming, the process by which the development of the fetus is altered due to changes in the uterine environment. Interestingly, however, there is also evidence from animal studies suggesting that the period of sensitivity during which programming may occur extends beyond the prenatal period. Specifically, rearing quality has been shown to be an important characteristic of the postnatal environment that can have long-term organisational effects on offspring development. A number of studies with rodents and non-human primates have shown that ordinary variations in maternal care can modify both behavioural and biological outcomes associated with exposure to prenatal stress [9–13].

The role of sensitive, responsive caregiving in supporting child development is well documented in the human attachment literature. Maternal sensitivity requires that mothers accurately interpret and contingently respond to their infant's cues, provide appropriate stimulation, and moderate levels of infant arousal [14,15]. Through interactions with caregivers, infants learn strategies for controlling and managing behaviour and emotions that, in turn, contribute to adaptive socio-emotional functioning, particularly the development of secure attachment relationships [14] and the achievement of autonomous and self-regulated behaviour [16,17]. While sensitive caregiving in general is important for the development of self-regulation, there is evidence to suggest that sensitivity to infant distress is a key and unique factor in children's early social-emotional adjustment [18–20]. Indeed, it has been proposed that sensitivity in response to fearful, anxious or distressed infant behaviours may be a better predictor of attachment security than sensitivity displayed in non-stressful contexts [21].

It is not yet known, however, whether the quality of postnatal caregiving moderates the association between prenatal stress and developmental outcomes in human infants. Although most studies account for the effects of maternal postnatal mood and anxiety, few have concurrently assessed the quality of the caregiving relationship. In one study, Bergman, Sarkar, Glover and O'Connor [22] found that attachment classification (insecure/resistant) moderated the effect of prenatal stress on laboratory-assessed fearfulness in children aged seventeen months, after controlling for postnatal stress and other social and demographic covariates. However, quality of caregiving was inferred from the child's attachment classification, stressful life events rather than anxiety were assessed, and life events during pregnancy were assessed retrospectively in the postnatal period. In another prospective study of forty-seven women, Kaplan, Evans and Monk [23] reported that maternal sensitivity, but not maternal prenatal psychiatric status, predicted heart rate variability and responsiveness in four month-old infants. Interestingly, maternal sensitivity was shown to moderate the impact of prenatal psychiatric diagnosis on infants' resting cortisol levels.

The present prospective study makes a novel contribution to the literature by examining the impact of maternal sensitivity on mental and motor development in infants exposed to maternal prenatal anxiety. A modified version of the still-face procedure was employed for the observation of mother–infant interaction because it provides a developmentally appropriate context for assessing dyadic distress management under controlled laboratory conditions [24]. We

predicted that maternal sensitivity to infant distress would moderate the relationship between prenatal anxiety diagnosis and infant outcomes such that infants whose mothers were anxious during pregnancy, and who were also insensitive caregivers would obtain less optimal scores on indices of development.

2. Methods

2.1. Participants and recruitment

One hundred and forty-nine predominantly middle-class, Caucasian women were recruited during their first prenatal health care visit at a large obstetric hospital in Sydney, Australia ($M = 15.09$ weeks gestation, $SD = 4.22$ weeks gestation). English-speaking women with singleton, uncomplicated pregnancies, and with no known substance/alcohol abuse problems or chronic psychiatric disorders (e.g., bipolar disorder, schizophrenia) were eligible to participate. Women meeting inclusion criteria were screened to select a sample in which women at highest and lowest risk for perinatal anxiety disorder were equally represented. Screening was based on the antenatal risk questionnaire (ANRQ) [25] routinely administered to all women during their first prenatal clinic visit. The ANRQ asks about psychosocial risk factors known to be associated with the onset of perinatal distress, including recent life stresses, social support, tendency to worry, and self-esteem. It is a short form of the Pregnancy Risk Questionnaire [26], a screening tool validated against the Composite International Diagnostic Interview [27] for the identification of women at risk for postnatal mood disorders. One hundred and forty-nine women were enrolled in the study of whom 56.4% ($n = 84$) were identified as “high risk” using a cut-off score of 23 on the ANRQ. The project was approved by the relevant institutional ethics review committees and all women provided informed, written consent.

2.2. Study design and procedures

Maternal demographic details, medical history, and prenatal mood and anxiety data were collected during the third trimester of pregnancy ($M = 36.95$ weeks, $SD = .76$ weeks). Obstetric data were obtained from hospital medical records. The postnatal follow-up was conducted when infants were seven months old and included i) a laboratory-based, mother–infant face-to-face interaction sequence (still-face procedure) and ii) a home visit for the conduct of infant developmental assessments and the collection of data relating to maternal postnatal symptoms of anxiety and depression.

2.3. Measures

2.3.1. Maternal anxiety and depression

Women who met criteria for a DSM-IV anxiety disorder at any time during the last six months of pregnancy were identified using the Mini-Plus International Neuropsychiatric Interview (MINI-Plus) version 5.0.0 [28]. The MINI-Plus is a short, structured, interview containing questions addressing the intensity, frequency, duration, and degree of distress associated with specific symptoms. Symptoms associated with panic disorder, agoraphobia, social phobia, post-traumatic stress disorder, and generalised anxiety disorder were assessed in the current study. The MINI-Plus is a reliable and valid instrument [29,30] that demonstrates good concordance with both the Structured Clinical Interview for DSM diagnoses [31] and the Composite International Diagnostic Interview for ICD-10 [32].

The MINI-Plus was also used to assess for the presence of confounding symptomatology: *prenatal depression* (major depression, minor depression and dysthymia during the last six months of pregnancy), *postnatal anxiety disorder* (symptoms associated with panic disorder, agoraphobia, social phobia, post-traumatic stress disorder, and generalised anxiety disorder from birth through to the

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