



## Research paper

## Maternal prenatal stress and infant emotional reactivity six months postpartum



Saara Nolvi<sup>a,\*</sup>, Linnea Karlsson<sup>a,c</sup>, David J. Bridgett<sup>b</sup>, Riikka Korja<sup>a,d</sup>, Anja C. Huizink<sup>e</sup>, Eeva-Leena Kataja<sup>a,d</sup>, Hasse Karlsson<sup>a,f</sup>

<sup>a</sup> The FinnBrain Birth Cohort Study, Turku Brain and Mind Center, Department of Clinical Medicine, University of Turku, Finland

<sup>b</sup> Department of Psychology, Northern Illinois University, United States

<sup>c</sup> Department of Child Psychiatry, Turku University Hospital and University of Turku, Finland

<sup>d</sup> Department of Psychology, University of Turku, Finland

<sup>e</sup> Department of Clinical Developmental Psychology, VU University Amsterdam, Netherlands

<sup>f</sup> Department of Psychiatry, University of Turku, Finland

## ARTICLE INFO

## Article history:

Received 8 February 2016

Accepted 11 April 2016

Available online 13 April 2016

## Keywords:

Prenatal  
Depression  
Anxiety  
Reactivity  
Temperament

## ABSTRACT

**Background:** Maternal prenatal stress has been related to infant negative affect. However, it is still unclear how different sources of maternal prenatal stress such as depressive, anxiety and pregnancy-specific anxiety symptoms are associated with reactivity outcomes. This study aimed to test the associations between different sources of maternal prenatal stress and the aspects of infant emotional reactivity at six months.

**Method:** Our study population ( $n=282$ ) was drawn from the FinnBrain Birth Cohort Study. Prenatal stress was measured by questionnaires on maternal depression, general anxiety and pregnancy-specific anxiety at three time points across pregnancy (gwk 14, 24, 34). Based on the symptom scores, the sample was divided into mothers with high stress during pregnancy ( $n=110$ ) and mothers with low stress during pregnancy ( $n=172$ ). Mother-reported infant emotional reactivity and its subscales were measured six months postpartum.

**Results:** After controlling for background variables and maternal postnatal symptoms, overall negative emotional reactivity ( $\beta=0.20$ ,  $p<0.01$ ), and its aspects fearfulness ( $\beta=0.15$ ,  $p=.057$ ) and falling reactivity ( $\beta=-0.22$ ,  $p<0.01$ ), were predicted by only pregnancy-specific anxiety. No significant predictors were found for infant positive reactivity after adjusting for confounders.

**Limitations:** Mother reports of both maternal symptoms and infant reactivity were used, which might increase the risk of reporting bias.

**Conclusions:** The findings suggest that mothers experiencing stress should be provided intervention during pregnancy, and that screening should have a particular focus on pregnancy-related worries.

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## 1. Introduction

Emotional reactivity or temperament refers to biologically based individual differences in affectivity, activity and self-regulation (Rothbart and Bates, 2006). Reactivity is generally divided into dimensions of negative and positive reactivity, of which the former refers to the tendency to experience and express negative emotions in relation to stimuli, whereas the latter refers to positive forms of reactivity, such as tendency for positive emotions, higher activity level, approach behaviors and vocal reactivity. The

current evidence suggests that early individual differences in both positive and negative emotional reactivity are influenced by maternal stress during gestation, possibly through “programming” effects (Sandman et al., 2011). Specific studies of prenatal stress that examine programming influences on children’s emotional reactivity have included perceived maternal stress, symptoms of depression, anxiety or pregnancy-specific anxiety (or some combination of these sources of stress).<sup>1</sup> Collectively, these sources of prenatal stress have been found to predict higher negative

\* Correspondence to: FinnBrain Birth Cohort Study, University of Turku, Teutori, 20014 Turun yliopisto, Finland.

E-mail address: [saara.nolvi@utu.fi](mailto:saara.nolvi@utu.fi) (S. Nolvi).

<sup>1</sup> In the present study, these symptoms are collectively referred to as prenatal stress given the general way of their use as measures of prenatal stress in the current literature, and the distress nature of mother’s experience of pregnancy-specific anxiety (in comparison with pure mood symptoms).

reactivity, including negative affect (e.g. fear, sadness, and distress/frustration) in both infants (Henrichs et al., 2009; Pesonen et al., 2005; Rouse and Goodman, 2014) and young toddlers (Agrati et al., 2015; Blair et al., 2011), and more irritability and low rhythmicity (Austin et al., 2005; Della Vedova 2014; Tees et al., 2010). Consistent with this research, prenatal stress measured as the functioning of HPA-axis (e.g. maternal prenatal cortisol or corticotrophin-releasing hormone level) has been found to predict higher infant reactivity, especially negative affect (Davis et al., 2007; de Weerth et al., 2003). In some studies, prenatal stress has also been linked to overall higher reactivity covering both positive and negative reactivity (Lin et al., 2014; Pesonen et al., 2005) or activity level (Blair et al., 2011; de Weerth et al., 2003; Henrichs et al., 2009; Werner et al., 2007), suggesting that prenatal stress might affect young children's tendency not only for negative but also for positive or overall reactivity to environmental stimuli.

While prenatal programming effects on individual differences in infant reactivity are important in their own right, in light of links between infant reactivity and later psychopathology, there also are implications for models of developmental psychopathology. For example, higher negative emotional reactivity and higher activity level have been found to be associated with both internalizing and externalizing problems in childhood, including depression and anxiety, attention deficit hyperactivity disorder (ADHD), conduct disorder (CD), oppositional defiant disorder (ODD), and even autism spectrum disorders (De Pauw and Merivlede, 2010; Putnam and Stifter, 2005; Sanson et al., 2004; Sayal et al., 2014). Furthermore, both maternal psychological and physiological stress during pregnancy are related to later mental health outcomes of the child, such as depression and anxiety (Davis and Sandman, 2012; Capron et al., 2015; Pearson et al., 2013). Thus, differences in infant emotional reactivity might be one mechanism linking fetal exposure to high maternal stress and psychopathology during childhood.

However, not all studies have found evidence for an association between prenatal stress and infant emotional reactivity (Baibazarova et al., 2013; Bhat et al., 2015; Rouse and Goodman, 2014). In a few cases, opposite findings have been reported by studies wherein it is shown that prenatal stress is related to lower infant fearfulness (Möhler et al., 2006), or that infant reactivity was associated with lower, not higher, levels of maternal stress during pregnancy (Rothenberger et al., 2011). These results suggest that the effects of prenatal stress are not consistently identified, which may be related to methodological differences in timing and the measures used. However, there are two rarely considered additional possibilities that may contribute to inconsistent findings in existing works. First, most of the studies in the field have focused on broad reactivity factors such as negative affect or single subscales of negative affect such as fearfulness, but have not considered the fine-grained aspects of the emotional reactivity (e.g. sadness, fearfulness) simultaneously. In studies that have found associations with reactivity and have taken into account different reactivity attributes, prenatal stress has been associated with higher infant activity level (Henrichs et al., 2009; Werner et al., 2007), higher distress to limitation and sadness (Henrichs et al., 2009), and fearfulness (Bergman et al., 2010; Henrichs et al., 2009).

Second, the source or type of prenatal stress might also explain the different outcomes across studies in relation to prenatal stress. Some studies suggest that pregnancy-specific anxiety might be an especially strong predictor of child outcomes, such as cognitive development, anxiety and brain morphology, in comparison with other prenatal psychiatric symptoms (Buss et al., 2011, 2010; Davis and Sandman, 2010, 2012; Huizink et al., 2003). Similar results have been reported between pregnancy-specific anxiety and infant emotional reactivity, including higher infant negative affect (Huizink et al., 2002) and activity level (Gutteling et al., 2005) after

controlling for maternal depressive and general anxiety symptoms during pregnancy. However, some studies have not found associations between pregnancy-specific anxiety and infant emotional reactivity (Baibazarova et al., 2013; de Weerth et al., 2013; McMahon et al., 2013), and several have reported associations with maternal general anxiety (Austin et al., 2005; Braithwaite et al., 2013; Pluess et al., 2011; van den Heuvel et al., 2015) or depressive symptoms (Davis et al., 2007; Melchior et al., 2012; Rouse and Goodman, 2014), and infant reactivity, even in addition to pregnancy-specific anxiety (Henrichs et al., 2009). Even though there are studies that have considered many types of maternal mood or anxiety during pregnancy, most studies have focused on a single source, or type of stress, and the number of studies that have considered distinct aspects maternal prenatal distress simultaneously as predictors is small, especially with regard to simultaneous consideration of different infant reactivity attributes and the use of several assessments during the pregnancy. Investigating the relative role of pregnancy-specific anxiety (and other maternal prenatal psychological symptoms) on postnatal infant emotional reactivity might provide opportunities for more targeted screening of prenatal stress and optimizing infant developmental trajectories.

To summarize, existing work suggests that prenatal stress predicts higher negative emotional reactivity in infants, although there are some gaps in the current literature. Only a few studies have considered several fine-grained aspects of infant emotional reactivity (e.g. fearfulness, sadness). Furthermore, some studies suggest that pregnancy-related anxiety might be a distinct predictor of infant behavior in comparison with general anxiety or depressive symptoms, but the state of the research is currently mixed. The main aim of the present study is to extend this line of research by examining (1) the associations between prenatal stress and infant emotional reactivity in two groups of mothers and infants exposed to different levels of stress during pregnancy in a longitudinal birth cohort setting. Our hypothesis is that exposure to high prenatal stress will be associated with higher infant negative reactivity and all of its aspects (fearfulness, sadness, distress to limitations, and recovery from emotion), and, possibly, also to higher positive reactivity/activity level. Second, (2) the association between the type of maternal prenatal stress, including depressive, general anxiety and pregnancy-specific anxiety symptoms, and infant emotional reactivity is examined. It is hypothesized that pregnancy-related anxiety symptoms will be a predictor of infant negative emotional reactivity in addition to prenatal depressive or general anxiety symptoms. Third, we investigate (3) how different aspects of maternal prenatal stress are related to the more fine-grained aspects of reactivity (for example, if anxiety is more strongly related to infant fearfulness than other aspects of negative reactivity).

## 2. Method

### 2.1. Study design and participants

The sample consists of a subsample of Finnish families participating the FinnBrain Birth Cohort Study that was gathered from December 2011 through March 2014. All families attending the first trimester ultrasound visit (gestational week [gwk] 12) were informed about the study by a research nurse, and those giving their written informed consent were enrolled in the study. In all, 67% of those informed about the study gave consent. The study sample consists of 282 mothers who were qualified either as "cases" of psychological prenatal stress ( $n=110$ ) or "controls" ( $n=172$ ). The participant was defined as a case when she scored above the highest 94% in any two of the eight possible assessments

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