Biological Psychology 83 (2010) 169–175

Contents lists available at ScienceDirect

Biological Psychology

journal homepage: www.elsevier.com/locate/biopsycho

Maternal trait anxiety, emotional distress, and salivary cortisol in pregnancy

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ARTICLE INFO

Article history:
Received 26 June 2009
Accepted 11 December 2009
Available online 22 December 2009

Keywords:
Prenatal stress
Pregnancy
Personality
Neuroticism
Salivary cortisol

ABSTRACT

Animal models suggest that stress-induced hormonal changes in the mother during pregnancy lead to enduring changes in the fetus and empirical links between prenatal maternal stress and negative child development have been discerned repeatedly in human studies. But the role of heritable personality traits has received little attention in the latter work. The goal of the current study was to investigate the relationship between maternal personality, psychological measures of maternal distress and maternal salivary cortisol during pregnancy. Maternal reports of personality (16 PF) and stress-related psychological measures (depression, pregnancy-related anxiety, perceived stress, negative life events) as well as salivary cortisol samples of 66 healthy pregnant women were collected in early and late pregnancy. Maternal trait anxiety proved related to all stress-related psychological measures and high anxiety predicted low baseline cortisol awakening levels in early pregnancy. Maternal trait anxiety is related to both psychological and biological stress measures during pregnancy.

A growing body of evidence links maternal emotional distress during pregnancy with negative child functioning in the behavioral, emotional, and cognitive domain (for review of the literature see: Huizink et al., 2004; Ruiz and Avant, 2005; Van den Bergh et al., 2005b; Rice et al., 2007). Prenatal programming of fetal stress reactivity is the most often suggested mechanism responsible for this association. More specifically, the fetal programming hypothesis suggests that elevated levels of maternal cortisol in response to psychological or physical stressors produce permanent alterations of the hypothalamic–pituitary–adrenal (HPA) axis of the developing fetus (Barker, 1998; Egliston et al., 2007). Consequently, such elevated stress reactivity – an individual physiological trait expected to extend across childhood into adult life (Kofman, 2002; Huizink et al., 2004; Weinstock, 2005) – contributes to negative child development (Van den Bergh et al., 2005b). Because experimental studies with animals prove generally consistent with such prenatal programming, it is assumed that the same mechanisms operate in humans.

While animal studies allow for the experimental induction of stress across randomized groups and thus afford precise control of stress exposure and other important variables, human studies on prenatal stress effects are generally limited by being observational. Due to this methodological constraint, the discerned relationship between prenatal stress and child development in human studies could be an artifact of enduring maternal personality traits, reflective of underlying heritable mechanisms given the highly heritable nature of personality (Jang et al., 1996), influencing not only maternal reports of stress during pregnancy but also the child's postnatal functioning by means of shared genes. Thus, enduring personality characteristics of mothers may account for the putative causal – and compromising – influence of prenatal stress on children's development. It is not difficult to imagine, in fact, that personality traits specifically related to stress reactivity and sensitivity (e.g., neuroticism, trait anxiety) may influence a pregnant woman's reporting and/or experiencing of prenatal stress (e.g., cortisol reactivity). If this is so, it would compromise any causal interpretation of associations linking prenatal stress with postnatal child well-being. Thus, the purpose of the research reported herein is to explore links between stress-related personality traits of pregnant women and measures of their prenatal stress, including cortisol levels. It is predicted that neuroticism/trait anxiety would be reflected in both psychological and physiological measures of prenatal stress.

Neuroticism, reflecting proclivities to experience negative affect (Costa and McCrae, 1992), to arouse quickly when stimulated and inhibit slowly, and to appraise events as stressful (Widiger et al., 1984), is one personality trait often associated with response to stress (Costa and McCrae, 1992). Behavior-genetic studies reveal it to be 40–50% heritable (Plomin et al., 1994; Jang et al., 1996; Eaves et al., 1999). Many studies chronicle links between neuroticism and psychological distress and emotional disorders (Bolger and Schilling,

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doi:10.1016/j.biopsycho.2009.12.005

1991; Kendler et al., 1993; Engelhard et al., 2006; Hettema et al., 2006). Empirical evidence also chronicles links between neuroticism and biological stress response in humans, such that high neuroticism is associated with dysregulated autonomic nervous system functioning (e.g., lower heart rate variability, see Riese et al., 2006) and altered HPA axis functioning. Highly neurotic individuals manifest a blunted cortisol response when exposed to stress (Oswald et al., 2006), a higher range of dose-dependent cortisol response after the application of naloxone, an opioid receptor antagonist (Mangold and Wand, 2006), and enhanced early morning cortisol levels 30 min after awakening (Portella et al., 2005). As it turns out, neuroticism also proves related to exposure to stressful situations, with individuals scoring high on neuroticism experiencing more stressful life events than do those scoring low (Bolger and Zuckerman, 1995; Kendler et al., 2003).

Considered together, findings such as those just summarized raise the very real possibility that maternal personality traits contribute to the phenomenological and biological experience of stress during pregnancy. Indeed, it seems eminently plausible that maternal personality may influence (1) self-reported psychological stress measures (e.g., depression, anxiety), (2) biological measures of stress (e.g., cortisol levels), and even (3) exposure and reaction to stressful situations and experiences (e.g., negative life events, natural disasters).

Surprisingly, personality measures, apart from a study by Mohler et al. (2006), have generally not been included in research on prenatal programming via prenatal maternal distress, though several well designed studies have controlled for *postnatal* anxiety and depression, two fundamental facets of neuroticism, in attempt to distinguish emotional stress experienced during fetal life and postnatal exposure (e.g., Huizink et al., 2002; O'Connor et al., 2003; Davis et al., 2004; Van den Bergh et al., 2005a). What such research designs cannot due, however, is disentangle putative effects of prenatal stress from maternal personality characteristics such as neuroticism which may influence both the predictors and outcomes of prenatal programming studies.

Given this background, the main objective of the work reported herein was to investigate the relationship between maternal personality, psychological measures of distress, and maternal salivary cortisol, all measured during pregnancy. To this end, we analyzed data from a prospective longitudinal study (see Rieger et al., 2004; Wurmser et al., 2006) in which personality, several measures of psychological distress, and the cortisol awakening response were assessed in healthy women both in early and late pregnancy. This work is thus conceptualized as a first step in exploring, eventually, the role of personality, measured prenatally, in accounting for effects of prenatal stress on child well being. Based on the preceding analysis, we expected maternal personality – specifically trait anxiety (i.e., neuroticism) – to be positively related to maternal self-report measures commonly used in the research of prenatal stress effects (perceived stress, depression, pregnancy anxiety, and negative life events) and with maternal cortisol levels of the cortisol awakening response during pregnancy.

1. Method

1.1. Overview

The present work is based on data from a prospective longitudinal study on the effects of prenatal maternal stress on early postnatal infant development employing several assessment points during pregnancy and the early postpartum period (Rieger et al., 2004; Wurmser et al., 2006). For the present study only data collected during the prenatal period was considered. Subject recruitment and data collection took place in Trier, Germany.

1.2. Sample and procedure

Subjects were recruited in collaboration with local obstetricians/gynecologists in private practice, clinic departments of gynecology and obstetrics, information centers for pregnant women, and by advertisements in local newspapers. Women that met inclusion criteria (age of 16 years or older and fluency in German) were contacted by phone and briefly informed about the study's research protocol. Exclusion criteria were: (a) severe medical complications (acute or chronic physical diseases, such as gestational diabetes, metabolic diseases, hypertension, thyroid hyper function), (b) signs of fetal malformation, (c) multi-fetal pregnancies, and (d) psychiatric problems (women were excluded if their answer to the screening question "*Are you currently suffering from a psychiatric disorder or do you receive medical or psychological treatment for psychological problems*?" was positive). After providing informed consent for participation eligible women were invited for a first assessment at 10–20 weeks gestation (early pregnancy) and a second assessment at 32–34 weeks gestation (late pregnancy).

Originally, a total of 94 women were recruited into the study. One woman was excluded due to being pregnant with twins, 6 women denied further participation after the introductory interview at first contact, 11 women did not complete the personality assessment, 5 women lacked cortisol measurements at both assessment points, 4 women were excluded due to other patterns of missing data and one woman due to extremely high cortisol levels. Consequently, data of 66 (70.2%) women were available for the present study. Comparisons between the selected sample of 66 and the 28 excluded women indicated no significant differences between the two groups on demographic, biological, or psychological variables. Eight of the 66 included women reported smoking during pregnancy with a mean consumption of 10.29 cigarettes per day ($SD = 9.16$) and eight women reported drinking alcohol during pregnancy ($M = 1.80$ times per month, $SD = 1.79$). Demographic characteristics of the complete sample and the low and high trait anxiety subgroups (split across the median) are displayed in Table 1.

Eleven women joined the study after 20 weeks of gestation and were consequently excluded from analyses of the early pregnancy as were two women lacking cortisol values for this period. Women of the remaining early pregnancy subsample ($n = 53$) were at 14.62 ($SD = 3.57$) weeks of gestation at first assessment. For the late pregnancy assessment 6 women had to be excluded due to missing cortisol values resulting in a subsample of $n = 60$. Sample sizes for the different analyses varied additionally due to different patterns of missing data.

All women were paid 200 Euro for their time and efforts in participating in the initial project. The study protocol was approved by the Ethical Committee of the University of Trier and is consistent with the revised Helsinki Declaration of 1975.

1.3. Instruments

1.3.1. Structured interviews

Structured interviews were conducted by trained female research assistants at both assessment points and inquired about sociodemographic (e.g., age, education, occupation, income, marital status) and medical information. During the interview in early pregnancy women were asked whether they were currently smoking (and if yes, how many cigarettes per day), consuming alcohol (and if yes, how often per month), and whether they experienced severe psychological stress since the beginning of the pregnancy.

1.3.2. 16 Personality Factor Questionnaire (16-PF)

The 16PF Questionnaire is a 184-item self-report instrument that measures the sixteen personality dimensions proposed by Cattell et al. (1970). Each item represents a statement (e.g., "I believe I worry less than most people") which the respondent has to rate on a three-point scale as "true", "not true", or "?" ("?" is an open answer that could stand for "unsure", "sometimes" and the like). From subject responses to the questionnaire, scores are derived for each of the sixteen personality factors of which scores for five Global Factors are computed. The Global Factors are extraversion (tendency to be sociable, assertive, active), anxiety (tendency to be easily upset, worried, overwhelmed; in the current study this global factor is referred to as trait anxiety in order to avoid confusion with other anxiety measures), tough-mindedness (tendency to focus on objectivity, to prefer logical, realistic solutions), independence (tendency to be dominant, fearless, skeptic of others), and self-control (tendency to be conscientious, restrained, organized). The 16PF Global Factor anxiety correlates with the neuroticism dimension of the NEO-FFI questionnaire (Costa and McCrae, 1992) at $r = .64$, the 16PF extraversion with the NEO-FFI extraversion at $r = .67$ and the 16PF self-control with the NEO-FFI conscientiousness at $r = .50$. Internal consistencies of the 16PF Global Factors range from $\alpha = .73$ to .87 (for Global Factor anxiety $\alpha = .84$), retest-reliabilities from $r = .83$ to .90. The validated German version of the 16PF uses "standardized ten" (sten) score scales ranging from 1 to 10, with a mean of 5.5 and a standard deviation of 2, which relates individual scores to the scores of a normative German sample of 669 adult women (Schneewind and Graf, 1998). 16PF stens of 4–7 are considered within the "average" population range. The 16PF was administered in late pregnancy.

1.3.3. Perceived Stress Scale (PSS)

The PSS (Cohen et al., 1983) is the most widely used psychological instrument for measuring the perception of stress designed to provide a global measure of context free stress. This 14-item scale assesses the frequency of experiencing a situation as unpredictable, uncontrollable, or overloading. Participants indicate on a five-point scale from "never" to "very often" how frequently they experienced subjective affective and cognitive stress reactions, subjective effectiveness of and confidence