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Emotional sensitivity for motherhood: Late pregnancy is associated with enhanced accuracy to encode emotional faces

R.M. Pearson *, S.L. Lightman, J. Evans

Academic Unit of Psychiatry, University of Bristol, Bristol, UK
Henry Wellcome Laboratories for Integrative Neuroscience and Endocrinology, University of Bristol, Bristol, UK

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ABSTRACT

Previous research suggests that female sex hormones can increase the sensitivity of women's emotion processing systems. The largest rises in sex hormone levels in a woman's life are from early to late pregnancy. The current study, therefore, investigated whether changes in emotion processing are seen across pregnancy. Hypervigilant emotion processing has been implicated in the aetiology of anxiety. Therefore enhanced emotion processing across pregnancy has implications for women's vulnerability to anxiety. Ability to encode facial expressions of emotion was assessed in 101 women during early pregnancy and again in 76 of these women during late pregnancy. Symptoms of anxiety were measured using a clinical interview (The CIS-R). Consistent with previous research, the presence of anxiety symptoms was associated with greater accuracy to encode faces signalling threat (fearful and angry faces). We found that women had higher accuracy scores to encode emotional expressions signalling threat or harm (fearful, angry and disgusted faces) but also a more general negative emotion (sadness) during late, compared with early, pregnancy. Enhanced ability to encode emotional faces during late pregnancy may be an evolutionary adaption to prepare women for the protective and nurturing demands of motherhood by increasing their general emotional sensitivity and their vigilance towards emotional signals of threat, aggression and contagion. However, the results also suggest that, during late pregnancy, women's emotion processing style is similar to that seen in anxiety. The results have implications for our understanding of normal pregnant women's processing of emotional cues and their vulnerability to symptoms of anxiety.

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Introduction

Little is known about women's emotion processing ability during pregnancy specifically. Yet, large rises in sex hormones from early to late pregnancy result in neuroendocrinological changes that influence emotion processing systems. For example, rises in estrogen have been shown to facilitate fear conditioning and increase corticotropin-releasing hormone mRNA expression in the amygdala, a key emotion processing neural center (Jasnow et al., 2006). Survival of our species relies on the protection and nurturing of vulnerable young. As such, it may be of evolutionary advantage for women to be particularly sensitive towards emotional stimuli and hypervigilant towards emotional signals of threat by late pregnancy. Hypervigilant processing of emotional signals, however, is thought to be causally involved in the development of anxiety disorders (Mogg and Bradley, 1998). A shift towards hypervigilant emotion processing during pregnancy could, therefore, have important implications for women's emotional state and vulnerability to anxiety. The current study investigated whether women's processing of emotional signals increases across pregnancy. The research contributes to our understanding of women's emotional and cognitive state during normal pregnancy.

Estrogen, progesterone and cortisol levels rise dramatically from early to late pregnancy. Plasma estradiol rises from less than 1 ng/mol before 14 weeks of pregnancy to over 15 ng/mol after 34 weeks (Lauritzen and Klopper, 1983). Corresponding progesterone rises are from 2.5 ng/ml to over 150 ng/mol and for cortisol levels 15 mg% to over 30 mg % (Peterson, 1983). This increase in total cortisol, however, is in response to a doubling of the level of cortisol binding globulin which is itself stimulated by the increased level of estrogen (Lindsay and Nieman, 2005). The levels of active "free" cortisol therefore, remain relatively unchanged (Peterson, 1983). There will be some small individual variation. However, all women will have much higher levels of estrogen, progesterone and total cortisol during late, compared with early, pregnancy.

Whilst many studies have failed to find changes in cognition across pregnancy (Crawley et al., 2003; Janes et al., 1999), other studies have provided evidence for performance differences on more specific cognitive tasks in pregnant compared to non-pregnant women (see (Henry and Rendell, 2007) for a review). Much is still unknown about the influence of pregnancy on cognition. However, substantial evidence suggests that sex hormones influence cognitive and emotion

* Corresponding author. Academic Unit of Psychiatry, Cotham House, Cotham Hill, Bristol BS6 6JL, UK. Fax: +117 9546672.
E-mail address: Rebecca.Pearson@bristol.ac.uk (R.M. Pearson).

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processing systems. Dendritic spine density is increased in the rat amygdala and hippocampus, during the high estrogen stage of the oestrous cycle and following both pregnancy and hormonal treatment which mimics pregnancy (Kinsley et al., 2006). Furthermore, increases in sex hormone levels have been associated with increased activity in neural structures, such as the amygdala, (Goldstein et al., 2005; Jasnow et al., 2006), the hippocampus (Spencer et al., 2008) and the prefrontal cortex (Keenan et al., 2001) along with neurotransmitter systems such as the serotonin system (Rubinow et al., 1998). These neural structures and pathways have been specifically associated with processing of emotional stimuli (Harmer et al., 2003; Morris et al., 1998).

Behavioral studies provide evidence that women's processing of emotion is influenced by their menstrual cycle stage (Pearson and Lewis, 2005). In particular, accuracy scores to encode fearful faces were found to be positively correlated with mean estrogen levels at each stage of the cycle (taken from published figures of approximate levels of estrogen at each menstrual cycle stage). Although hormone levels were not measured in this study, this association suggests that the reported differences in fear recognition relate to changes in estrogen levels across menstrual cycle stages(Pearson and Lewis, 2005). Biases towards encoding emotional faces as expressing fear, anger and disgust have also been linked to higher progesterone levels across the menstrual cycle (Derntl et al., 2008a). In light of such findings we predicted that, due to large rises in estrogen and progesterone, emotion processing will enhance across pregnancy.

The current study measured vigilance towards emotional signals as displayed by facial expressions. Facial expressions of emotion are an essential and powerful component of human communication and social interaction. Expressions of emotion convey essential survival information to fellow humans. For example, disgust expressions signal contamination, fearful expressions signal an external threat and angry expressions convey intention to attack, a threat in itself. Neuroimaging studies have provided evidence that facial emotional expressions signalling threat (fear and angry faces) evoke responses from neural systems that are central to our threat responses (Morris et al., 1998). Furthermore, ability to assign emotional categories to others' facial expressions is a vital skill, which will direct how an individual perceives their environment. Disruption to one's ability to encode emotions has been associated with a number of clinical and social functioning disorders including, obsessive compulsive disorder (Berle and Phillips, 2006), major depression (Leppanen et al., 2004) autism (Golarai et al., 2006), bipolar disorder and schizophrenia (Addington and Addington, 1998). This suggests that responses on emotion encoding tasks are related to real life behaviors.

The current study assessed pregnant women's ability to encode facial expressions of emotion, during their first trimester (before the placenta takes control of the pregnancy from the corpus leutum and thus before substantial rises in estrogen and progesterone have taken place (Lauritzen and Klopper, 1983; Little and Billar, 1983)) and again at the end of their third trimester (where estrogen and progesterone peak). In line with evolutionary theory and reported changes across the menstrual cycle, we predicted that women's ability to encode emotional facial expressions will be greater during late compared with early pregnancy. In menstrual cycle studies, however, effects were found for specific emotional expressions (fear, anger and disgust) and it is of particular survival importance for mothers to become hypervigilant processors of signals of threat and harm. We, therefore, also explored whether enhanced emotion processing is specific to emotional expressions that signal threat and harm (fearful, angry and disgust expressions) or generalised to negative emotions, such as sadness, which do not communicate such specific risks.

Emotional vigilance during late pregnancy, however, may have implications for women's emotional state. Symptoms of anxiety during pregnancy are common within normal populations of women (Heron et al., 2004). A mother's level of anxiety during pregnancy is negatively associated with her infant's emotional and behavioral development even after controlling for the mother's postnatal mood (Bergman et al., 2007; Glover and O'Connor, 2002; O'Connor et al., 2002; O'Connor et al., 2003). Understanding common symptoms of anxiety in normal women, during pregnancy specifically, is therefore important for infants' development and future population health.

Early cognitive models of anxiety suggest that anxiety develops as a consequence of cognitive biases towards threatening information (Beck and Rush, 1985). Empirical studies have since provided evidence for such biases in anxious individuals (Eysenck et al., 1991; Mogg et al., 1989; Mogg et al., 2007). Greater attentional allocation towards fearful and angry faces (Georgiou et al., 2005; Mogg et al., 2007) and enhanced accuracy to encode facial expressions of fear (Surcinelli et al., 2006) have been associated with anxiety. Training healthy individuals to attend to threat increases their anxiety levels (Mathews and Mackintosh, 2000; Mathews and MacLeod, 2005). This finding suggests that cognitive biases towards threat can cause anxiety. We have hypothesised that late pregnancy is associated with hypervigilant processing of emotional signals including threat signals. If this prediction is correct, women's emotion processing during late pregnancy will resemble emotion processing associated with, and thought to cause, increased anxiety. The current study, therefore, also measured anxiety across pregnancy. Consistent with previous research findings, we hypothesised that enhanced encoding of fearful and angry expressions will be associated with anxiety symptoms during pregnancy.

Method

Sample

101 pregnant women were recruited through community midwives based in North Bristol at the 8- to 10-week booking appointment. Women were invited to participate if they were less than 12 weeks pregnant and the midwives felt they were able to speak English to the level needed to read the information sheet. Midwives were asked not to invite women to the study if, when asked as part of routine booking appointment questions, women revealed a history of mental illness (taken as ever having seen a psychiatrist). The study was approved by The South East Research multi site NHS Research Ethics Committee and Research Governance approval was given by North Bristol Trust. All participants gave informed consent.

Measures

Clinical interview schedule (CIS-R)

The CIS-R is a self administered, computerised interview that establishes the severity of 14 symptoms which constitute anxiety and depression disorders using algorithms based on ICD-10 criteria (Lewis et al., 1992). Each symptom is scored on a scale from 0 to 4, according to the severity (frequency, duration and unpleasantness) of the symptom experienced. The CIS-R is widely used to detect common mental heath disorders in the UK including use in the National Surveys of Psychiatric Morbidity (Bebbington et al., 2003) .The interview has been fully standardised and the interview is equally reliable whether conducted by a lay or clinically trained interviewer (Lewis et al., 1992). Initial reliability studies for the CIS-R were conducted in primary health care clinics, a correlation between CIS-R scores on initial and repeated interviews was 0.9 and a reliability estimate of 0.79 was found using a confirmatory factor analysis model (Lewis et al., 1992). The CIS-R was also validated against clinical judgments of trained psychiatrists and the correlation between CIS-R score and clinical judgment was 0.77 (Lewis et al., 1992). The CIS-R is designed for and has been widely used within community samples (Brugha et al., 2003; Brugha et al., 2005a; Lewis et al., 2003; Targosz et al., 2003) including repeated use at baseline and follow up (Brugha

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