

# Mother's stress, mood and emotional involvement with the infant: 3 months before and 3 months after childbirth

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**Abstract** Adverse effects of maternal anxiety and depression are well documented, namely on the foetus/child behaviour and development, but not as much attention has been given to the mother's emotional involvement with the offspring. To study mother's prenatal and postpartum stress, mood and emotional involvement with the infant, the State-Trait Anxiety Inventory, the Edinburgh Postnatal Depression Scale and the Mother-to-Infant Bonding Scale were filled in and cortisol levels were measured, 3 months before and 3 months after childbirth, in a sample of 91 Portuguese women. From pregnancy to the postpartum period, mother's cortisol levels, anxiety and emotional involvement toward the child decrease. No significant change was observed regarding mother's depression. Mother's depression predicted a worse emotional involvement before childbirth, while mother's anxiety predicted a worse emotional involvement with the infant after childbirth. Additionally, pregnant women with a worse emotional involvement with the offspring are at risk of poorer emotional involvement with the infant and higher anxiety and depression at 3 months postpartum. It should be given more attention to mother's poor emotional involvement with the offspring during pregnancy, as it interferes with her emotional involvement with the infant and her psychological adjustment 3 months after childbirth.

**Keywords** Anxiety · Cortisol · Depression · Mother's emotional involvement · Postpartum · Pregnancy

## Introduction

Anxiety and depression in women, during both pregnancy and the postpartum period, have been matters of great concern. Research has shown several adverse impacts of the woman's psychological maladjustment during the transition to parenthood, namely, on the couple's relationship (e.g. Figueiredo et al. 2008; Lovisi et al. 2005; Pajulo et al. 2001) as well as on the foetal (e.g. DiPietro et al. 2002; Monk et al. 2000), neonatal (Field et al. 2004; Field et al. 2006), child (e.g. Van den Bergh and Marcoen 2004), and adolescent (Pawlby et al. 2008; Van den Bergh et al. 2005) development of the offspring. In the present study, we will focus particularly on the impact of mother's anxiety and depression, both before and after childbirth, on the emotional involvement with the infant, a dimension that is seldom studied.

Rates for anxiety and depression are high during pregnancy and the postpartum period, although a decrease in these rates, from the time before childbirth until after, has been noticed recently (e.g. Andersson et al. 2006; Buist et al. 2003; Chee et al. 2005; Figueiredo et al. 2006; Heron et al. 2004; Lee et al. 2007; Limlomwongse and Liabsuetrakul 2006; Perren et al. 2005). For example, anxiety and depression were prevalent in 29.2% of the pregnant women versus 16.5% of the postpartum women in a recent study by Andersson et al. (2006) with 1,555 Swedish women. Similarly, an increase during pregnancy and a decrease after childbirth in cortisol levels have also been reported in the literature (Field et al. 2004; Kammerer et al. 2006; Obel et al. 2005; Storey et al. 2000; Weerth and Buitelaar 2005). Elevated cortisol levels have also been found in women exhibiting psychological distress during pregnancy (Diego et al. 2006; Field et al. 2004; Field et al. 2006).

Empirical studies have reported high anxiety rates in more than 25% of the pregnant women (Britton 2005;

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Rondo et al. 2003; Ross et al. 2003; Ross and Mc Lean 2006; Sutter-Dalay et al. 2004). Anxiety levels seemed to be higher during pregnancy when compared with the postpartum period (Andersson et al. 2006; Buist et al. 2003; Heron et al. 2004; Lee et al. 2007). Additionally, studies account for depression in more than 15% of the pregnant women (Andersson et al. 2006; Chee et al. 2005; Dietz et al. 2007; Field et al. 2008; Figueiredo et al. 2007a; Edhborg et al. 2005; Marcus et al. 2003; Westdahl et al. 2007; Nicholson et al. 2006; Ross et al. 2004; Wu et al. 2002). Findings have shown these rates diminishing from the first to the third pregnancy trimester (Perren et al. 2005) and from pregnancy to the postpartum period (Andersson et al. 2006; Chee et al. 2005; Figueiredo et al. 2006; Heron et al. 2004; Limlomwongse and Liabsuetrakul 2006; Perren et al. 2005).

Developmental tasks throughout the transition to parenthood involve some important changes in the significant relationships of the mother and father, specifically with each other, with the extended family and with the offspring (Cowan and Cowan 2000). At first, mothers and fathers accept the pregnancy and the gestation of the child. Then, they begin imagining how the infant is/will be and how they will be/want to be as parents. So, they begin establishing a relationship with the infant (e.g. Ammaniti 1991; Stern 1995) as well as being emotionally involved with him/her (e.g. Rubin 1984). The mother and father's relationship with the offspring, which starts during pregnancy, has, from the beginning, an emotional dimension—also called prenatal attachment (e.g. Cranley 1981; Shieh et al. 2001). The mother loves her unborn child through developmental tasks which include acceptance, incorporation, bonding and giving of herself (Bloom 1995; Rubin 1984). The mother and father become emotionally involved, as they progressively invest their emotions in the infant, as well as investing in the relationship with him/her. This will prepare them for the presence of the child in their real lives. First, they develop the mental space and the necessary emotional availability, so that afterwards they will receive the infant in their day-to-day life, have a relationship with and be attached to her/him.

Prenatal relationship and attachment facilitates the parents' initial reaction to the newborn (Cranley 1981; Reading et al. 1984; Shin et al. 2006), as well as the adequate interaction and care (Bloom 1995; Caccia et al. 1991), necessary to the child's survival (Bowlby 1958). However, other than the fact that the relationship between the mother and the infant begins well before childbirth, we do not know much about prenatal attachment (Fuller et al. 1993).

Maternal emotional involvement with the infant starts as early as the first weeks of gestation, and generally grows as the pregnancy progresses (Bloom 1995; Caccia et al. 1991; Grace 1989; Fleming et al. 1997a; Heidrich and Cranley

1989; Ji et al. 2005; Reading et al. 1984; Righetti et al. 2005; Rustico et al. 2005; Zachariah 1994). Particular events such as feeling the foetus's movements or seeing the foetus in an ultrasound exam seem to improve prenatal attachment (Ekelin et al. 2004; Ji et al. 2005; Kohn et al. 1980; Kowalcek et al. 2003; Lawson and Turriff-Jonasson 2006; Rustico et al. 2005). Ultrasound scans give the parents-to-be a clearer image of their unborn child, as their perception of the foetus evolves from that of an anonymous object into an individual (Kowalcek et al. 2003).

Nevertheless, some researchers have suggested that childbirth is the critical moment for maternal bonding, which is established from this instant (Klaus and Kennell 1976; Klaus et al. 1995). Authors noticed positive changes in the mother's emotional involvement with the offspring after delivery only (Fleming et al. 1997a), or a significant enhancement in the presence of the interaction with the child from delivery to 1 year postpartum (Moehler et al. 2006; Taylor et al. 2005). Additionally, some studies have shown that not all mothers are emotionally involved with the neonates immediately after childbirth, specifically after a painful or difficult delivery (Robson and Kumar 1980; Newton and Newton 1962). However, other studies observe that most mothers are emotionally involved with the newborn from the first days after delivery (Figueiredo et al. 2007b, 2009; Risk et al. 2001).

Several factors seem to interfere negatively with the mother's emotional involvement with the infant, particularly depression both before (Figueiredo et al. 2007a; Lindgren 2003) and after delivery (Edhborg et al. 2005; Feldman et al. 1999; Figueiredo et al. 2007c; Moehler et al. 2006; Nagata et al. 2003; Reck et al. 2006; Taylor et al. 2005). In spite of that, Honjo et al. (2003) did not find any association between mother's depression and attachment to the child in the first pregnancy trimester.

Adverse effects of anxiety on mother's emotional involvement with the child are not as obvious in the literature. During pregnancy, difficulties in the mother's emotional involvement with the offspring may be caused by stress (Cranley 1981; Hsu and Chen 2001). Several empirical evidences have demonstrated that parental anxiety diminishes after ultrasound exams, while prenatal attachment improves (Garcia et al. 2002; Segdmen et al. 2006). Simply seeing the infant or being reassured that he/she is in good health (Garcia et al. 2002; Salisbury et al. 2003; Zlotogorski et al. 1995) may reduce parental anxiety and allow attachment to increase (Kleinveld et al. 2006, 2007; Segdmen et al. 2006). Both before and after childbirth, parental high anxiety regarding the infant's survival seems to interfere negatively with their availability to bond and invest the child emotionally (e.g. Feldman et al. 1999). Conversely, studies have reported higher cortisol levels in women related to elevated emotional involvement

with the newborn (Fleming and Corter 1988; Fleming et al. 1997b; Giardino et al. 2008), but associations between these variables has not been as explored.

Both anxiety and depression are quite prevalent in women during pregnancy and the postpartum period (e.g. Andersson et al. 2006), with several documented negative effects on the offspring (e.g. Pawlby et al. 2008). However, the impact of anxiety and depression on the mother's emotional involvement with the infant is a dimension that has not been so thoroughly studied.

The purpose of this study was to examine the mother's cortisol levels, anxiety, depression and emotional involvement with the infant both before and after childbirth, specifically (1) differences in the mother's cortisol levels, anxiety, depression and emotional involvement with the infant between 3 months before childbirth and 3 months after and (2) predictors of the mother's emotional involvement with the infant considering mother's cortisol levels, anxiety and depression 3 months before and 3 months after childbirth.

According to previous literature, we will expect a decrease in mother's anxiety (e.g. Lee et al. 2007) as well as on mother's depression (e.g. Heron et al. 2004) and cortisol levels (e.g. Kammerer et al. 2006) while an increase in mother's emotional involvement with the offspring from before to after childbirth (e.g. Fleming et al. 1997a). We will also expect mother's depression (e.g. Edhborg et al. 2005) and anxiety (e.g. Hsu and Chen 2001) to interfere negatively while mother's cortisol levels (e.g. Giardino et al. 2008) to be positively associated with the mother's emotional involvement with the offspring, both before and after childbirth.

## Method

### Sample

The sample was composed of 91 primiparous women, aged between 16 and 40 years old [88.7% between 19 and 39 years (mean=27.2 years)]. Almost all participants were Caucasian (98.9%) and Catholic (90.7%). Most mothers had completed compulsory education (grade 9) (79.5%), were employed (72.2%) and were married or living with the father-to-be (88.7%). The majority of participants were living with their partner only (80.2%), but some were either living with both the partner and other relatives (9.9) or living alone (9.9%) (see Table 1). Most mothers had a caesarean (47.2%) or an instrumental delivery (15.3%), and only 37.5% had a vaginal delivery.

Half of the infants were female (51.5%) and the other half male (48.5%). They were born with a gestational age ranging from 34 to 40 weeks (6.2% had 37 or less), and their weight at birth ranged from 2,060 g to 3,970 g (9.0% below 2,500 g).

**Table 1** Socio-demographics

	Mothers (n=91) (%)
Age (years)	
16–18	10.3
19–28	49.5
29–39	39.2
≥40	1.0
Education (grade)	
<9	20.5
9–12	56.6
>12	22.9
Occupation	
Employed	72.2
Unemployed	21.6
Student	4.2
Housewife	2.0
Marital status	
Married	59.8
Living with partner	28.9
Single	11.3
Cohabitation status	
Only with the partner	80.2
With the partner and other relatives	9.9
Without the partner	9.9

### Procedures

This research was conducted according to the prevailing ethical principles. A specific approval request for this research was required and obtained from the Hospital Ethical Commission. The participants were randomly selected in an Obstetrics Outpatient Hospital Unit (Porto, Portugal), and the exclusion criteria were not reading or writing Portuguese and multiple gestations. The aims and the procedures of the study were explained to the contacted mothers, and 90% of them agreed to participate after signing an informed consent form. Between weeks 21 and 28 of gestation (3 months before childbirth), the participants answered socio-demographic questions, filled in the questionnaires and supplied a 24-h urine sample. All of these procedures were repeated 3 months after childbirth.

The urine samples were stored frozen at  $-20^{\circ}\text{C}$  and then analysed in the laboratory, using the cortisol ADVIA Centaur that consisted of a competitive immunoassay using direct chemoluminescent technology. The procedure followed was: (1) take a 20 nL sample; (2) add 50 nL of Lite reagent and 250 nL of Solid Fase and incubate at  $37^{\circ}\text{C}$  for 5 min; (3) separate, aspirate and wash the recipient with reagent water; (4) add the same amount of acid and basic reagent to initiate the chemoluminescent reaction. Few

samples (1.0%) had to be excluded from the study due to insufficient ( $\leq 600$  ml) 24-h volume.

## Measures

### *State-trait anxiety inventory*

The State-Trait Anxiety Inventory (STAI, Spielberg et al. 1970) is composed of two 20-item self-report scales for measuring anxiety that differentiates between the temporary condition of “state anxiety” (STAI-S, anxiety in a specific situation) and the more general and long-standing quality of “trait anxiety” (STAI-T, anxiety as a general trait). This instrument has been administered in several studies, both during pregnancy (Austin et al. 2007; Kleinveld et al. 2006) and the postpartum period (Skari et al. 2002, 2006).

The Portuguese version used in this study showed good internal consistence (Trait and State Cronbach alpha=0.87 and 0.88). Authors advise using a score equal to or higher than 45 to screen high-anxiety states (Biaggio et al. 1976). Only STAI-S results will be reported here.

### *Edinburgh postnatal depression scale*

The Edinburgh Postnatal Depression Scale (EPDS, Cox et al. 1987) is a self-report questionnaire composed of ten items scored in a four-point Likert scale (0–3) designed to assess pregnancy and postpartum depression. This scale addresses the intensity of depressive symptoms within the previous 7 days and has been administered in several studies, both with pregnant and postpartum women, including in Portugal (Areias et al. 1996a, 1996b; Augusto et al. 1996; Figueiredo et al. 2006; Figueiredo et al. 2007c; Gorman et al. 2004). Numerous studies have used this instrument, both during pregnancy (Eberhard-Gran et al. 2003; Heron et al. 2004; Pajulo et al. 2001; Rich-Edwards et al. 2006; Rich-Edwards et al. 2006; Ross et al. 2003) and/or the postpartum period (Eberhard-Gran et al. 2004; Limlomwongse and Liabsuetrakul 2006; Edhborg et al. 2005; Moehler et al. 2006; Taylor et al. 2005).

The EPDS Portuguese version showed good internal consistency (Cronbach alpha=0.85) and test–retest reliability (Spearman correlation=0.75) (Figueiredo et al. 2006, 2007c). A score equal to or higher than 10 was indicated to screen for a major depressive episode, with a sensibility of 65% and specificity of 96% (as EPDS cut-off 11 showed a sensibility of 45% and specificity of 96% and EPDS cut-off 12 a sensibility of 35% and a specificity of 96%) (Areias et al. 1996a, b).

### *Bonding scale*

The Bonding Scale—a validated and extended Portuguese version of the ‘New Mother-to-Infant Bonding Scale’

(Taylor et al. 2005)—is a self-report scale composed of 11 items in a four-point Likert scale [from 0 (not at All) to 3 (very much)], aiming to assess the mother’s emotional involvement with the infant (Figueiredo et al. 2005). Mothers are asked about the intensity of their emotions, in a time they felt closer to the infant. In the Portuguese version, three items were added (Mad, Sad and Fearful) to the original scale (composed of eight items: Loving, Resentful, Neutral or Felt Nothing, Joyful, Dislike, Protective, Disappointed and Aggressive).

In the Portuguese version, the scale is composed of three subscales. The ‘Positive Bonding’ includes three items (Loving, Protective and Joyful) and measures positive emotional involvement. A score equal to or higher than 3 in the Positive Bonding subscale means the mother presented elevated positive emotions toward the infant. The ‘Negative Bonding’ includes six items (Mad, Aggressive, Sad, Resentful, Dislike and Disappointed) and evaluates negative emotional involvement. Scores equal to or higher than 1 in the Negative Bonding subscale show the mother presented elevated negative emotions toward the child. The ‘Bonding Not Clear’ subscale includes two items (Fearful, Possessive and Neutral or Felt Nothing) and indicates the presence of emotions not clearly related to emotional involvement. A score equal to or higher than 2 in the Not Clear Bonding subscale means the mother strongly presented not clear emotions toward the infant (Figueiredo et al. 2005).

This instrument showed only reasonable scores of internal consistency (alpha of Cronbach=0.61 for the antenatal version and 0.75 for the postnatal version), as obtained with the original scale (alpha of Cronbach=0.71) (Taylor et al. 2005), but good test–retest reliability (Spearman correlation=0.49;  $p < 0.01$ ) (Figueiredo et al. 2005).

## Statistical analysis

1. In order to study differences in cortisol levels of the mother between 3 months before childbirth and 3 months after, STAI-S, EPDS and Bonding mean, paired samples *t* tests were conducted.
2. For the purpose of identifying predictors of cortisol levels, STAI-S, EPDS and Bonding scores of the mother 3 months before childbirth, several separate stepwise linear regression analyses were conducted. In the regression analyses performed to identify predictors of the mother’s cortisol levels 3 months before childbirth, the independent variables entered were the STAI-S, EPDS and Bonding results from 3 months before childbirth. To identify predictors of mother’s STAI-S results 3 months before childbirth, the independent variables entered were cortisol levels, EPDS

and Bonding results at 3 months before childbirth. To identify predictors of mother's EPDS results 3 months before childbirth, the independent variables entered were cortisol levels, STAI-S and Bonding results at 3 months before childbirth. To identify predictors of mother's Bonding results 3 months before childbirth, the independent variables entered were cortisol levels, STAI-S and EPDS results 3 months before childbirth.

3. For the purpose of identifying 3 months after childbirth predictors of 3 months after childbirth mother's cortisol levels, STAI-S, EPDS and Bonding scores separate stepwise linear regression analyses were conducted. In the regression analyses performed to identify predictors of mother's cortisol levels 3 months after childbirth, entered independent variables were 3 months after childbirth STAI-S, EPDS and Bonding scores. To identify predictors of 3 months after childbirth mother's STAI-S results entered independent variables were 3 months after childbirth cortisol levels, EPDS and Bonding results. To identify predictors of 3 months after childbirth mother's EPDS results entered independent variables were 3 months after childbirth cortisol levels, STAI-S and Bonding results. To identify predictors of 3 months after childbirth mother's Bonding results entered independent variables were 3 months after childbirth cortisol levels, STAI-S and EPDS results.
4. For the purpose of identifying 3 months before and 3 months after childbirth predictors of 3 months after childbirth mother's cortisol levels, STAI-S, EPDS and Bonding results, separate hierarchical stepwise linear regression analyses were conducted. In the first model, entered independent variables were cortisol levels, STAI-S, EPDS and Bonding results 3 months before childbirth (as presented in 2). In the second model,

independent variables were 3 months after childbirth cortisol levels, STAI-S, EPDS and Bonding results (as presented in 3) were added.

**Results**

Mother's stress, mood and emotional involvement with the infant: differences between 3 months before and 3 months after childbirth

Slightly over half of the pregnant women (51.7%) had cortisol levels above normative values ( $\geq 90 \mu\text{g}/24 \text{ h}$ ) 3 months before childbirth, while only 18.3% had these levels 3 months after delivery. One in four of the pregnant women had a STAI-S  $\geq 45$  (25.0%) or an EPDS  $\geq 10$  (26.7%) at the third pregnancy trimester, while 15.4% of the women had a STAI-S  $\geq 45$  and 26.7% an EPDS  $\geq 10$  at 3 months postpartum. Moreover, it was noticed that mother's cortisol levels and anxiety, but not mother's depression, decreased from 3 months before to 3 months after childbirth (see Table 2).

Furthermore, most pregnant and postpartum women showed to be emotionally involved with their offspring at a higher rate before than after delivery (as a Total Bonding  $\geq 2.5$  was observed in 88.5% of the mothers before and in 73.1% of the mothers at 3 months postpartum). Also, a considerable number of mothers presented elevated positive emotions toward the infant (Positive Bonding  $\geq 3$ ) during pregnancy (50.6%), but no more than 1.5% at 3 months postpartum. More mothers showed elevated negative emotions toward the child (Negative Bonding  $\geq 1$ ) 3 months before (34.1%) than 3 months after delivery (4.5%). Also, strong not clear emotions (Not clear

**Table 2** Mother's cortisol, STAI-S, EPDS and Bonding 3 months before and 3 months after childbirth (paired sample *t* test)

	3 months before	3 months after	<i>t</i>	<i>P</i>
	Mean (SD)	Mean (SD)		
Cortisol	100.31 (38.58)	61.26 (50.52)	3.688	0.000
STAI-S	38.67 (11.17)	34.48 (10.19)	2.019	0.049
EPDS	6.82 (3.39)	7.04 (5.04)	0.855	0.396
Positive bonding	2.69 (0.43)	1.88 (0.32)	17.629	0.000
Negative bonding	0.09 (0.19)	0.09 (0.24)	-0.223	0.825
Not clear bonding	0.74 (0.52)	0.70 (0.50)	0.000	1.000
Total bonding	2.69 (0.21)	2.50 (0.18)	8.443	0.000

**Table 3** Predicting variables for (A) 3 months before childbirth mother's cortisol, STAI-S, EPDS and Bonding (stepwise linear regression analysis) and (B) 3 months after childbirth mother's cortisol, STAI-S, EPDS and Bonding (stepwise linear regression analysis)

	Model	$R^2$	$B$	$F$	$P$
<b>(A) 3 months before</b>					
Cortisol	N/S				
STAI-S	EPDS	0.576	0.759	74.803	0.000
EPDS	STAI-S	0.576	0.759	74.803	0.000
Positive bonding	EPDS	0.140	-0.375	8.977	0.004
Negative bonding	EPDS	0.124	0.352	7.757	0.007
Not clear bonding	EPDS	0.114	0.337	7.047	0.010
Total bonding	EPDS	0.276	-0.526	20.994	0.000
<b>(B) 3 months after</b>					
Cortisol	N/S				
STAI-S	EPDS	0.662	0.722	70.509	0.000
	Bonding	0.699	-0.214	40.706	0.044
EPDS	STAI-S	0.662	0.814	70.509	0.000
<b>Positive bonding</b>	N/S				
Negative bonding	STAI-S	0.289	0.538	14.661	0.000
Not clear bonding	STAI-S	0.250	0.500	12.026	0.001
Total bonding	STAI-S	0.301	-0.549	15.530	0.000

Bonding $\geq 2$ ) were present in only a few mothers, before (2.3%) and after delivery (3.0%). Additionally, the mother's emotional involvement with the infant decreased from pregnancy to 3 months after delivery as well. Although a decrease in both positive and total bonding results from pregnancy to 3 months postpartum was observed, no significant time differences were obtained for mother's

negative and not clear emotions toward the offspring (see Table 2).

Predictors of mother's stress, mood and emotional involvement with the infant 3 months before and 3 months after childbirth

No significant predictors were identified for mother's cortisol levels, either 3 months before or 3 months after childbirth, when considering mother's anxiety, mood and emotional involvement with the infant. Similarly, cortisol was not a significant predictor for mother's anxiety, depression or emotional involvement with the offspring, during pregnancy or the postpartum period (see Table 3).

Mother's prenatal anxiety was associated with depression, since mother's prenatal depression predicted mother's anxiety 3 months before childbirth, which explains 57.6% of the variance. In the same way, mother's postnatal anxiety was also associated with depression, but mother's involvement with the infant was a significant predictor too: mother's postpartum anxiety was predicted by mother's depression and by worse emotional involvement with the infant 3 months after delivery, both explaining 69.9% of the variance (see Table 3). When considering variables from both 3 months before and 3 months after childbirth, mother's postnatal anxiety was predicted by mother's prenatal emotional involvement with the infant and postpartum depression: a worse emotional involvement with the offspring 3 months before and more depressive symptoms 3 months after childbirth predicted mother's postpartum anxiety, which explains 65.7% of the variance (see Table 4).

Mother's prenatal depression was associated with anxiety: higher levels of anxiety predicted more depressive symptoms 3 months before childbirth, explaining 57.6% of the variance. Similarly, mother's postpartum depression

**Table 4** Three months before (before) and 3 months after (after) childbirth predicting variables for 3 months after childbirth mother's cortisol, STAI-S, EPDS and Bonding (hierarchical stepwise linear regression analysis)

	Model	$R^2$	$R^2$ change	$B$	$F$	$P$ (Model 1)	$P$ (Model 2)
Cortisol	N/S						
STAI-S	Bonding (before)	0.114	0.144	-0.075	5.262	0.029	0.500
	EPDS (after)	0.657	0.535	0.792	32.644		0.000
EPDS	Bonding (before)	0.144	0.141	-0.083	5.389	0.027	0.455
	STAI-S (after)	0.679	0.537	0.789	32.808		0.000
Positive bonding	N/S						
Negative bonding	Bonding (before)	0.291	0.291	-0.243	13.526	0.001	0.164
	STAI-S (after)	0.429	0.138	0.475	12.001		0.009
Not clear bonding	STAI-S (after)	0.159	0.159	0.399	6.254		0.018
Total bonding	Bonding (before)	0.152	0.153	0.095	5.945	0.020	0.622
	STAI-S (after)	0.290	0.138	-0.475	6.549		0.018

Model 1: 3 months before (before) childbirth predicting variables. Model 2: 3 months after (after) childbirth predicting variables added

was associated with anxiety as well: again, anxiety predicted depressive symptoms 3 months after childbirth, which explains 66.5% of the variance (see Table 3). When considering as predictors the variables from both 3 months before and 3 months after childbirth, the mother's postpartum depression was predicted by mother's prenatal emotional involvement with the offspring and mother's postpartum anxiety: worse emotional involvement with the offspring 3 months before childbirth and higher anxiety 3 months after childbirth predicted more postpartum depressive symptoms, which explains 67.9% of the variance (see Table 4).

During the antenatal period, mother's depression was associated with worse emotional involvement as well as with the presence of a less positive but also a more negative and a not clear emotional involvement with the offspring. As shown in Table 3, mother's prenatal depression predicted a poorer emotional involvement (explaining 27.6% of the variance), in addition to less positive emotions (explaining 14.0% of the variance), but more negative emotions (explaining 12.4% of the variance) and more not clear emotions (explaining 11.4% of the variance) toward the foetus 3 months before childbirth.

During the postnatal period, mother's anxiety was associated with a worse emotional involvement (explaining 30.1% of the variance) as well as with a more negative (anxiety predicted more negative emotions, explaining 28.9% of the variance) and a higher not clear emotional involvement with the infant 3 months after childbirth (anxiety predicted more not clear emotions, explaining 25.0% of the variance). Thus, none of the considered variables predicted mother's postnatal positive emotional involvement with the infant (see Table 3).

When considering the variables from both 3 months before and 3 months after childbirth as predictors (see Table 4), mother's prenatal emotional involvement was associated with both mother's postnatal emotional involvement—as a poorer emotional involvement with the infant 3 months before childbirth predicted a worse emotional involvement with the infant 3 months after childbirth, explaining 15.2% of the variance—and mother's postnatal negative emotional involvement with the child—as mother's poorer emotional involvement with the infant 3 months before childbirth predicted more negative emotions toward the infant 3 months after childbirth, explaining 29.1% of the variance. Furthermore, mother's postnatal anxiety was associated with her emotional involvement with the infant 3 months after childbirth—as mother's anxiety predicted a worse emotional involvement with the infant 3 months after childbirth, explaining 29.0% of the variance, as well as with mother's postnatal negative emotions—since mother's anxiety predicted more negative emotions toward the infant 3 months after childbirth, explaining 42.9% of the variance, and not

clear emotional involvement—as mother's state anxiety predicted more not clear emotions toward the infant 3 months after childbirth, explaining 15.9% of the variance. Therefore, none of the considered variables predicted mother's postnatal positive emotional involvement with the infant.

## Discussion and conclusion

In this study, we observed that, despite the presence of anxiety and depression in many of the pregnant and postpartum women, most mothers were able to be emotionally involved with their offspring, both before and after delivery. Nevertheless, a decrease in mother's emotional involvement, cortisol levels and state anxiety were noticed from 3 months before childbirth to 3 months after, while no change was observed in depression.

High and subsequently lowered mother's anxiety from pregnancy to 3 months postpartum was also observed by others (e.g. Andersson et al. 2006; Buist et al. 2003; Heron et al. 2004; Lee et al. 2007), but the absence of a significant decline in mother's depression is contrary to what literature more recently informs (Andersson et al. 2006; Chee et al. 2005; Figueiredo et al. 2006; Heron et al. 2004; Limlomwongse and Liabsuetrakul 2006; Perren et al. 2005). Furthermore, the decrease in mother's cortisol levels from pregnancy to the postpartum period has been consistently reported in the literature (e.g. Field et al. 2004; Kammerer et al. 2006; Obel et al. 2005; Storey et al. 2000; Weerth and Buitelaar 2005), but an increase in the mother's emotional involvement with the infant was equally expected, according to previously published data (e.g. Fleming et al. 1997b; Taylor et al. 2005).

Presented results illustrate the mother's emotional involvement with the offspring since before childbirth as well as differences in mother's emotional involvement between the times before until after childbirth. Mother's emotional involvement and positive emotions toward the infant are higher 3 months before childbirth than 3 months after. Thus, results seem to point out that the “imaginary child” is more positively invested by the mother during pregnancy than the “real child” after delivery. Hypothetically, it is easier for the mother to express—namely positive—emotions before birth when the child is not already there. Conversely, the 3-month-old infant is somewhat less idealised, and the mother takes into account difficulties that may have occurred, as well as the child as he/she is, instead of as she imagined the child to be (inversely to what occurs during pregnancy). Therefore, at this stage emotions are not so extreme; they are mediated by the interaction, rendering the emotional involvement apparently poorer.

In the present study, and contrary to our initial expectations, state anxiety and depression did not predict cortisol levels of the mother, and cortisol levels did not predict the mother's

emotional involvement with the child, neither 3 months before nor 3 months after childbirth. Therefore, these results do not support reported higher cortisol levels in both depressed/anxious mothers (e.g. Field et al. 2006; Field et al. 2008) and mothers who are more emotionally involved with the child (e.g. Fleming and Corter 1988; Fleming et al. 1997b; Giardino et al. 2008). Cortisol awakening response and diurnal cortisol profiles has been studied in postpartum women, and high levels of cortisol awakening were related with adverse early life experiences (Gonzalez et al. 2009). However, studies did not report differences in daily cortisol levels, when pregnant or postpartum depressed or anxious women were compared to non-depressed or non-anxious women (Shea et al. 2007; Nierop et al. 2006). No differences obtained in mother's cortisol levels may be dependent of the method used (24-h urinary cortisol).

The mother's state anxiety is predicted by mother's depression as much as the reverse, both 3 months before and 3 months after childbirth, suggesting comorbid anxiety and depression in women during pregnancy and the postpartum period, as pointed in recent studies (e.g. Field et al. 2003; Heron et al. 2004; Wenzel et al. 2005). Moreover, mother's anxiety and depression, 3 months after childbirth, are also predicted by prenatal emotional involvement with the infant, which points out that pregnant women with a poor emotional involvement with the offspring are at risk for postpartum anxiety and depression. More than mother's prenatal anxiety or depression, poor emotional involvement with the offspring seems to predict anxiety and depression during the postpartum period, given empirical support to the supposed importance of prenatal attachment on the mother's psychological adjustment and quality of the interaction with and care of the infant after childbirth (e.g. Fuller et al. 1993; Kemp et al. 1990; Wiberg et al. 1989). In order to advance the understanding of women's world and interpersonal psychological difficulties during pregnancy and the postpartum period, more attention should be given to the context of the relationship with the child, established since pregnancy.

Previous studies have demonstrated a negative effect of mother's prenatal depression (e.g. Lindgren 2003) or anxiety (e.g. Cranley 1981; Hsu and Chen 2001; Garcia et al. 2002; Segdmen et al. 2006) on the mother's attachment with the foetus as well as a negative effect of the mother's postpartum depression (Edhborg et al. 2005; Feldman et al. 1999; Figueiredo et al. 2007b; Moehler et al. 2006; Nagata et al. 2003; Reck et al. 2006; Taylor et al. 2005) or anxiety (Feldman et al. 1999) on the mother's emotional involvement toward the child after delivery. Nevertheless, they did not generally consider these two relevant dimensions and periods together, that is anxiety and depression, and the prenatal and the postpartum period. The results of the present study give a more comprehensive picture of the dimensions

implicated in the mother's difficulties to be emotionally involved with the infant, both before and after childbirth, providing specific cues for intervention. Besides, as has been more recently pointed out by other authors (e.g. Austin et al. 2007; Heron et al. 2004; Matthey et al. 2003), it is important to take into account both mother's anxiety and depression, when significant psychological difficulties during pregnancy and the postpartum period are targeted.

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