

Infant-holding Biases in Mothers and Affective Symptoms During Pregnancy and After Delivery

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Several authors have reported that participants have a leftward bias when holding a newborn or young infant. Our study of mothers met before and after their infant's birth sought to ascertain whether particular combinations of affective symptoms (depression, anxiety) and holding positions (horizontal versus vertical) were related to holding-side biases. Our results showed that (a) mothers displayed a significant leftward (71%) holding bias, (b) mothers with affective symptoms held their newborn on the right side and more frequently in the vertical position, and (c) hemispheric specialization for perceiving visual emotions had no significant effect on the holding-side biases of new mothers. These results suggest that maternal affective symptoms have a dominant effect on the determination of holding-side preferences, when associated with a particular holding position. Copyright © 2008 John Wiley & Sons, Ltd.

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INTRODUCTION

The main goal of this study was to search for an effect of mothers' affective states on biases for holding a newborn. Most people hold their infant on the left side of their body. Salk (1960) was the first author to describe this behaviour: about 80% of the mothers he observed held their newborn on the left side (for a review, see Donnot & Vauclair, 2005). The holding bias explored in the current study

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concerned the typical behaviour of holding a baby of about 3 months in one's arms in order to pacify him/her. Behaviours related to infant holding and carrying in general were thus excluded from our study, as we were primarily interested in the emotional interactions between mother and infant.

The left-holding bias was initially ascribed to the soothing role of the heartbeat (Salk, 1960). The heartbeat effect hypothesis is difficult to assess experimentally, and in one study that tested the effect of heart location by observing a mother with dextrocardia, the authors found that the mother still held her child on the left side (Todd & Butterworth, 1998). The left-holding bias has also been ascribed to handedness (e.g. Huheey, 1977; Manning & Chamberlain, 1991; Salk, 1960). For a right-handed person, holding an infant on the left side of the body frees the dominant hand. This choice therefore represents a significant advantage for performing various activities with the dominant hand. However, the hypothetical role of the dominant hand has been questioned in studies of left-handed men and women who, at the group level, never exhibit a right-side bias. Although their left bias is sometimes weaker than that expressed by their right-handed counterparts, most studies involving left-handed people have found the left bias to be similar to the one recorded for right-handers (e.g. Donnot, 2007; Harris, Almerigi, Carbary, & Fogel, 2001; Manning & Chamberlain, 1991; for a review, see Vauclair & Donnot, 2005).

If the heartbeat and handedness hypotheses do not adequately account for left cradling, several other factors may influence holding biases, including experience with young infants (Vauclair & Donnot, 2005), and the gender of the holder (De Château & Anderson, 1976). More recently, other hypotheses have been explored, such as a possible effect of psychopathological symptoms (e.g. the mother's depressive state: Reissland, Hopkins, Helms, & Williams, *in press*; Vauclair, & Scola, 2008; Weatherill *et al.*, 2004).

Holding Biases and Hemispheric Specialization

Several authors have explained holding-side biases as being related to the perception of emotions, on the assumption that most people perceive facial emotions better when they are presented in the left visual field (e.g. Borod, Koff, & Caron, 1983). Facial emotions represent a powerful means for mothers to monitor the emotional state of their newborn. Manning and Chamberlain (1991) hypothesized that holding-side biases were related to brain lateralization: the perception of facial expressions by way of the left eye stimulates holding on the left side. To test their assumption, Manning and Chamberlain (1991) asked female participants to hold a doll while imagining that they were holding a real newborn. This task was repeated while the participants had their left eye, right eye, or both eyes blindfolded. The authors found that when the participants' left eye was blindfolded, their left-holding bias was significantly smaller than when their right eye was masked or when neither eye was covered. These authors concluded that left-side holding had two functions: (1) the mother visually checks the well-being of her infant by means of her left visual field and thus her right hemisphere, and (2) the infant visually checks the emotional condition of his/her mother, because the more expressive (left) side of the mother's face is visible to the infant (e.g. Sackeim, Gur, & Saucy, 1978).

Other researchers have tested this assumption in other ways. Harris *et al.* (2001) examined the possible relationships between the preferred holding side and hemispheric specialization in the perception of facial emotions. These authors administered a chimeric-faces task (CFT; see Method below) and an imagined holding task to 250 male and female university students. The results

showed that left-side holders had a significantly stronger left-hemisphere bias than right-side holders.

Vauclair and Donnot (2005) tested the relationship between the preferred holding side and cerebral lateralization in the perception of facial emotions in a large group of male and female university students. The experimental protocol included a laterality questionnaire, a CFT and observation of the preferred holding side for a baby-like doll. Their results showed that 66% of the participants held the doll on the left side. There was no difference between right-handers and left-handers. More interesting was the finding that 64.2% of the participants expressed a preference for the left visual field in the CFT. However, this was only the case for those who held on the left, as participants who preferentially held the doll on the right side failed to show a preference for either visual field. Vauclair and Donnot (2005) also found significant correlations (1) between the preferred holding side and the dominant visual field for perceiving emotions, but only in female participants and in participants who had experience with infant holding. As a whole, these results argue in favour of a relationship between the perception of emotions (monitored more effectively by the right hemisphere) and a left-side preference for holding.

Bourne and Todd (2004) also tested infant holding-side biases using a CFT. All 32 male and female participants in their study were right-handed. The authors reported that only the participants who showed a dominant right hemisphere for the perception of facial emotions had a tendency to hold on the left side. By contrast, participants with no dominant hemisphere for perceiving facial emotions had a tendency to hold on the right side.

It should be noted that all the researchers who have attributed holding-side biases to hemispheric specialization investigated student populations, with the exception of Donnot and Vauclair (2007), who tested the emotional hypothesis (brain lateralization) for holding-side biases on a sample of 202 mother/child dyads in maternity hospitals (see also Donnot, Vauclair, & Bréjard, 2008). Maternal holding-side preferences and handedness were ascertained through questionnaires, and the hemispheric specialization for perceiving visual facial emotions was measured via a CFT. Donnot and Vauclair (2007) found (1) a significant left-holding bias (64%), but (2) no significant link between holding-side biases and emotional perceptual asymmetry. They interpreted this absence of any such association in terms of the specific nature of the holding relationship in mother/child dyads.

Holding-side Biases for Mothers with Affective Symptoms

If emotions are involved in the determination of holding-side biases, this begs the question of whether the mother's emotional state (positive or negative emotion) may also affect holding biases.

Bogren (1984) reported that right-holding parents expressed more concerns about pregnancy and delivery than left-holding ones. Similarly, De Château (1983) found that mothers who held on the right were more anxious about their relationship with their infant than left-holding mothers.

Weatherill *et al.* (2004) reported that mothers with depressive symptoms tended to hold their infant on the right side. In their study, the number of mothers with depressive symptoms was relatively small (14 mothers) and their scores on the depression questionnaire (Beck Depression Inventory: Beck, Steer, & Brown, 1996) were generally below the cut-off point for severe depression (Kendall, Hollon, Beck, Hammen, & Ingram, 1987). The literature has shown that

depressive symptoms can generate inattentiveness and a dysfunction of the right hemisphere (e.g. Bruder, Stewart, & McGrath, 2002; Liotti & Mayberg, 2001; Rotenberg, 2004). Given the available evidence of a possible relationship between depression and dysfunctions of the right cerebral hemisphere, we hypothesized that depressive symptoms in new mothers might affect the way they held their infants, notably in terms of a possible reduction in the left-holding bias compared with new mothers showing no affective symptoms.

Vauclair and Scola (2008) conducted a study in two maternity hospitals, on a sample of 148 mothers, in order to explore whether depressive symptoms could be related to biases expressed by the mothers when they held their newborn. To that end, an infant-holding questionnaire and the CES-D (depression scale) were administered. The results showed that (a) mothers displayed a significant leftward (68%) holding-side bias and (b) mothers with depressive symptoms tended to hold their newborn on the right side. Moreover, the latter displayed a different holding posture compared with non-depressed mothers. More specifically, mothers deemed to be non-depressed predominantly (70%) held their infant in the typical cradling posture (horizontal holding), whereas mothers judged to be depressed alternated horizontal holding postures with vertical holding ones (see Figure 1). These results suggest that the presence of affective symptoms can affect holding-side biases.

A recent study (Reissland *et al.*, in press) has brought fresh information to the field. The authors compared the cradling side of stressed mothers with that of mothers who were neither stressed nor depressed, and found that only stressed mothers expressed a right-sided cradling bias. In contrast, mothers who were only depressed preferred to cradle on the left side. Suter, Huggenberger, and Schähinger (2007) conducted an experimental study to investigate the immediate impact of stress on holding-side biases. Half the 64 female participants were randomly assigned to a stressful bilateral cold pressor test. The remaining participants performed a non-stressful control task. Before and after this intervention, cradling was assessed using a baby-like doll. Participants showed a left holding-side preference at the group level prior to the intervention. The cold pressor test significantly increased the blood pressure and the heart rate, and also reduced the left holding-side bias in the sample of female volunteers.



Figure 1. Drawing of two holding positions: left vertical holding (left) and right horizontal holding (right).

The present study was designed to highlight and explore further (1) the relationship between the way pregnant women thought they would hold their future infant and the way they actually held their infant after delivery, and thus the consistency in holding before and after delivery; (2) the relationship between holding-side and holding-position biases, and (3) the relationship between holding biases and hemispheric specialization patterns related to the perception of emotions using a CFT. We also tested (4) whether or not mothers' manual preferences determined holding-side biases (e.g. Manning & Chamberlain, 1991; Matheson & Turnbull, 1998; Salk, 1960), (5) the relationship between infant holding-side preferences and the presence of affective symptoms (depression and anxiety) in the mother, given that mothers expressing affective symptoms have been found in previous studies to hold their newborn less on the left side, and (6) the role of the holding position in relation to these affective symptoms. In effect, we distinguished between two positions (cf. Figure 1) involving different relationships in the mother/child dyads: the horizontal position that promotes visual interactions between mother and child, and the vertical position that implies fewer visual interactions but allows greater body-to-body contact.

METHOD

Participants

Seventy-six mothers were studied at two points in time: the first session took place during their pregnancy (mean duration = 6 months and 1 week) and the second session after the infant's birth (mean infant age: 2 months and 2 weeks).¹ The mean age of the mothers was 30 years (S.D. = 4.11) and 50 of them were primiparous. The principal characteristics of the infant-mother population were as follows: (a) 55% of the newborns were boys, (b) 22.37% of the mothers had undergone a Caesarean section, (c) 9.2% of the mothers were left-handed (see Results for more details), (d) their newborns had a mean weight of 3.28 kg (S.D. = 0.54), and (e) pregnancy lasted an average of 37.3 weeks (S.D. = 11.56 days).

Materials

The protocol for the first session comprised seven tests. These tests were administered to the future mothers in the following order: (1) a holding questionnaire, (2) a CFT, (3) general questions about the mother and her future child, (4) a handedness questionnaire, (5) Spielberger, Gorsuch, and Luschene's (1970) State-anxiety Scale, (6) Spielberger *et al.* (1970) Trait-anxiety Scale, and (7) the CES-D Depression Scale (Radloff, 1977).

In the second session, the holding-side bias was recorded by (1) direct observation and via the questionnaire. Then, the mothers were once again assessed on the basis of (2) general questions about their newborn, (3) the State-anxiety Scale, and (4) the CES-D scale.

Assessment of Holding Biases: Direct Observation and Questionnaire

The holding questionnaire was used to evaluate the mothers' preferred holding side, while distinguishing horizontal holding postures from vertical holding ones (see Figure 1). Horizontal holding consists in holding the newborn, which is in a

reclined position, in one's arms. The newborn's face is visible to the holder. Vertical holding consists in holding the newborn against one's shoulder, with his/her body in a vertical position. In the latter, the newborn's face is not visible to the holder and visual exchanges are thus reduced.

This questionnaire, which has been validated in several other studies (e.g. Donnot, 2007; Donnot & Vauclair, 2007; Donnot *et al.*, 2008; Harris *et al.*, 2001; Vauclair & Donnot, 2005; Vauclair & Scola, 2008), makes it possible to find out whether the newborn is preferentially held on the left or right side of the mother's body, and includes four baby-holding scenarios: when the mother is soothing her infant, when she most often holds her infant, when she is performing an activity while holding her newborn, and when she is holding another person's child. Holding bias scores were calculated by considering side preferences in the four different holding scenarios. A negative holding-side score indicated a general left-side preference and a positive score a general right-side preference. The holding-position scores were calculated in the same way.

In the first session, during pregnancy, holding biases for side and position were measured solely via the holding questionnaire.

At the start of the second session, the mothers were told to 'Pick up your baby as if he/she were feeling distressed or as if he/she had started crying. Now, can you show me how you would hold him/her in your arms?' Secondly, after this direct observation of holding (side and position), the participants were requested to fill in the holding questionnaire.

As the responses to the two measurements (observation and questionnaire) in the second session were extremely similar for holding side and position, a single score was retained.

The Chimeric-faces Task

The CFT was developed by Harris *et al.* (2001; see also Carbary, Almerigi, & Harris, 2001; Vauclair & Donnot, 2005), by pairing a smiling hemiface with a neutral hemiface. The smiling hemiface was presented either in the left or the right visual field. We randomly chose 30 pairs from the 38 pairs in the authors' original set. The stimuli were presented as a slide show, displayed on the screen of a laptop computer (15 in in diameter). Each slide was displayed for 5 s. For each trial, participants were shown two faces on each slide, one above the other. On one face, the happy smiling/neutral chimeric face was displayed in the left visual field and on the other face, the happy smiling/neutral face was displayed in the right visual field. Participants were asked to indicate orally which face looked the happier. Across the 30 trials, a left-side (left visual field) bias was assumed to reflect a greater role of the right hemisphere in the task.

General Information (Both Testing Sessions)

Various pieces of information were obtained from the mothers during the two testing sessions: (a) the number of children, (b) the mother's age, (c) the newborn's birth weight, (d) the newborn's sex and age, (e) the approximate duration of infant holding by the mother per day, and (f) the feeding mode. Additional information was collected relating pregnancy and delivery (Caesarean or vaginal). This general information was only collected for control purposes and is not included in the analysis of results.

The Handedness Questionnaire

The Handedness Questionnaire determined whether the participants were right-handed, left-handed, or ambidextrous. It was composed of nine items from the Edinburgh Handedness Inventory (Oldfield, 1971) and one item (hammering a nail) from Annett's (1985) scale.

State-trait Anxiety Inventory (STAI)

We used the French version of the STAI (Spielberger *et al.*, 1970), validated by Bruchon-Schweitzer and Paulhan (1993). One of the merits of this scale is that it independently assesses both the participant's current anxiety (state anxiety) and his/her more stable anxious temperament (trait anxiety).

The State-anxiety Inventory always has to be filled in first when both scales are administered during the same session. This scale is composed of 20 items, with scores ranging from 20 to 80. According to Spielberger *et al.*'s (1970) calibration, an adult woman (like those in our sample) is considered to be very slightly anxious if she has a score of between 20 and 29, slightly anxious for a score of between 30 and 48, and fairly anxious for a score of between 49 and 48. A score equal to or above 59 indicates a high level of anxiety.

The Trait-anxiety Scale is also composed of 20 questions about what the person generally feels. According to Spielberger *et al.*'s (1970) calibration, an adult woman is considered to be very slightly anxious with a score of between 20 and 29, slightly anxious with a score of between 30 and 48, and fairly anxious with a score of between 49 and 58. A score equal to or above 59 indicates a high level of anxiety.

CES-D Depression Scale

The CES-D scale (Radloff, 1977) translated into French by Fuhrer and Rouillon (1989) was also used. We chose the CES-D because it is less invasive than the BDI-II and more appropriate to the situation of new mothers (Wilcox, Field, Prodromidis, & Scafidi, 1998). This scale consists of 20 items that yield scores ranging from 0 to 60. A person is considered to have depressive symptoms when he/she obtains a score of 16 or more. However, not all studies use the same cut-off score for judging whether or not a person is depressive (e.g. Fuhrer & Rouillon, 1989). Consequently, this variable was treated as a continuous variable (see the Statistical Analyses section).

Procedure

The mothers were recruited either through advertisements posted in maternity wards and on the Internet, or through their midwives and gynecologists. The same experimenter carried out all the observations and testing.

The first session was scheduled at 6 months of pregnancy, in order to test the possible role of affective symptoms on holding-side biases. This first testing session started with the holding questionnaire, because it seemed to be the most neutral questionnaire and was unlikely to influence answers to the other questionnaires. The mothers then performed the CFT. The general questions and the handedness questionnaire were presented in a random order. Lastly, the two versions of the STAI and the CES-D were administered.

The second session was performed 2 months and 2 weeks after the infant's birth. This period was chosen because (1) by then, the mother had some experience in holding her newborn, (2) the postpartum blues ('baby blues') were over, and (3) these French mothers were still on maternity leave and could easily be met in their home. The second testing session began with the holding questionnaire, for the same reasons as before. One direct measure of the infant-holding bias was then taken, followed by the general questions and then the State-anxiety Scale and the CES-D. Given that these two scales refer either to the present time or to events from the previous week, and given that the period of pregnancy is very different from the period when the mother has to take care of her infant, we felt that it was relevant to administer these scales again. The Trait-anxiety Scale was not used after childbirth, however, as this scale evaluates a supposedly stable personality trait.

Statistical Analyses

For the purposes of the statistical analyses, the depression and anxiety scores were combined in a factorial analysis. A single score of affective symptom variables was thus reported, with one 'affective symptoms' variable during pregnancy and a second 'affective symptoms' variable after delivery. Depressive and anxious symptoms frequently co-occur (for review, see Scott *et al.*, 2007). This affective symptoms variable was treated as a continuous variable in the following analyses. ANOVAs were computed to verify the effects of the scores of various variables (affective symptoms, handedness) on the mothers' preferences for holding their newborn (left or right side). A chi-square calculation was used to check the distribution of the holding-side biases. In addition, chi-square of independence tests was performed to compare holding sides across the two sessions and investigate the link between holding-side preferences and holding positions. Pearson's product-moment correlation coefficient (r) was used to compute correlations between affective state and hemispheric specialization for the perception of emotions. For all these analyses, the statistical threshold of significance was set at 5%.

RESULTS

Holding-side Biases

A leftward holding bias was found in the questionnaire responses for the first session: 65.8% ($N = 47$) of the participants replied that they would hold their infant on the left side. For the second session, a leftward holding bias (71%) was also found, both in the observation and in the questionnaire. The left bias for the second session can be described as follows: 71% ($N = 54$) of the mothers held their newborn on the left side, 29% ($N = 22$) of the mothers showed no side preference or held their newborn on the right side. This left-favouring distribution was significant ($\chi(1) = 13.47, p < 0.001$).

Holding biases differed significantly across the first and second sessions ($\chi(1) = 4.57, p < 0.033$ (see Table 1). We can conclude that holding during pregnancy and actual holding after delivery were not similar, as 33% of the mothers changed their holding-side preferences.

For subsequent analyses, only the holding measure recorded during the second session (after delivery) was considered, as this period reflected the mother's actual behaviour with her newborn. The objective was to compare different variables on the real holding side and not on the holding measure obtained via the questionnaire in the first session.

Table 1. Distribution (*N* mothers) of holding preferences during pregnancy and after delivery

		1st session (holding during pregnancy)	
		Left holding side	Right holding side
2nd session (holding after delivery)	Left holding side	38	16
	Right holding side	9	13

Holding Positions and Holding-side Biases

Concerning the two holding positions, 30.3% (*N* = 23) of the mothers preferred horizontal holding, 5.2% (*N* = 4) held the newborn equally often in both positions, and 64.5% (*N* = 49) preferred vertical holding.

When we compared holding positions and holding-side biases using a chi-square of independence test ($\chi(2) = 3.66, p = 0.05$), we observed a significant relationship between the two measures, with more holding on the left in the horizontal holding position (81.5%) than in the vertical one (65.5%).

Handedness and Holding-side Biases

Our sample comprised 90.8% right-handed mothers and 9.2% left-handed mothers. This distribution is consistent with the data reported in the literature (Annett, 2004). Our right-handers clearly tended to hold on the left side (73.9%, *N* = 51), whereas fewer than half the left-handers held on the left (42.8%; *N* = 3 out of 7). Although the effect of handedness on holding side was not significant ($F(1, 74) = 3.02, p = 0.086$), as there were only seven left-handers in this study, we cannot say one way or the other whether handedness has an effect on the holding-side bias.

Perception of Emotions and Holding-side Biases

Forty-two percent of the mothers (*N* = 32) had a left visual-field preference, 19.73% (*N* = 15) had a right visual-field preference, and 38.2% had no preference on the CFT. The mothers showed a significant left visual-field advantage for the perception of facial emotions ($\chi(2) = 6.5, p = 0.039$). However, there was no significant relationship between the CFT scores and holding-side biases ($F(1, 74) = 2.28, p = 0.135$).

Affective Symptoms, Holding-side Biases and Holding Positions During Pregnancy

There was a significant ($r = 0.56, p = 0.001$) correlation between the anxiety scores (STAI) and depression scores (CES-D) during pregnancy. We therefore combined the two measures in a single variable of affective symptoms during pregnancy. This measure of affective symptoms was treated as a continuous variable, as we did not have a cut-off score for this computed variable.

The distribution of mothers with anxious or depressed symptoms is reported in Table 2.

Table 2. Scores on anxiety and depression questionnaires during pregnancy

	State anxiety during pregnancy				Trait anxiety during pregnancy				Depression during pregnancy	
	Very slightly anxious (20-29)	Slightly anxious (30-48)	Fairly anxious (49-58)	Very anxious (≥ 59)	Very slightly anxious (20-29)	Slightly anxious (30-48)	Fairly anxious (49-58)	Very anxious (≥ 59)	Depressive (> or = 16)	Non depressive (<16)
%	0	82.9	9.2	7.9	9.2	77.6	10.5	2.6	22.4	77.6
Number of mothers	0	63	7	6	7	59	8	2	17	59
Average	32.16	39.93	12.78							
S.D.	9.68	8.26	7.65							

Table 3. Scores on anxiety and depression questionnaires after childbirth

	State anxiety after childbirth			Depression after childbirth		
	Very slightly anxious (20–29)	Slightly anxious (30–48)	Fairly anxious (49–58)	Very anxious (≥ 59)	Depressive ($>$ or = 16)	Non-depressive ($<$ 16)
%	0	84.2	11.8	3.9	11.8	88.2
Number of mothers	0	64	9	3	9	67
Average		31.42			9.41	
S.D.		8.90			7.87	

The presence of affective symptoms during pregnancy had no significant effect on holding-side biases ($F(1, 74) = 0.01, p = 0.98$). Thus, these mothers showed a left-side bias similar to the bias expressed by mothers without affective symptoms. The presence of affective symptoms during pregnancy had no significant effect either on the holding position ($F(1, 74) = 1.76, p = 0.18$) or on the interaction between the holding side and position biases ($F(2, 74) = 0.85, p = 0.43$). We can therefore state that the presence of affective symptoms during pregnancy had no significant effect on the holding-side biases measured by the questionnaire during pregnancy ($F(1, 74) = 0.109, p = 0.742$).

Affective Symptoms, Holding-side Biases and Holding Positions after Delivery

The correlation between the anxiety scores (STAI) and depression scores (CES-D) after delivery was once again significant ($r = 0.54, p = 0.001$). Accordingly, the two measures were combined in a single variable of affective symptoms after delivery. This affective symptom variable was treated as a continuous variable, as we did not have a cut-off for this computed variable.

The distribution of mothers with anxious or depressed symptoms after childbirth is reported in Table 3.

The presence of affective symptoms after delivery had a significant effect on holding-side biases ($F(1, 74) = 4.83, p = 0.031$). Mothers who held their newborn on the right side had more affective symptoms than mothers who held theirs on the left side.

Although the presence of affective symptoms after delivery had no significant effect on holding positions ($F(1, 74) = 1.28, p = 0.28$), they did have a significant effect on the interaction between holding side and position biases ($F(2, 74) = 3.35, p = 0.027$): see Figure 2. Thus, the mothers who held their newborn on the right side in a vertical position had more affective symptoms after delivery than mothers who held theirs in a horizontal position and on the left side.

DISCUSSION

Summary of Results

The mothers tested in this study mainly held their newborn on the left side, in accordance with the data reported in the literature (e.g. Bourne & Todd, 2004; Donnot, 2007; Donnot & Vauclair, 2007; Harris *et al.*, 2001; Manning & Chamberlain, 1991; Matheson & Turnbull, 1998; Vauclair & Donnot, 2005; Vauclair & Scola, 2008). Holding preferences during pregnancy differed from actual holding

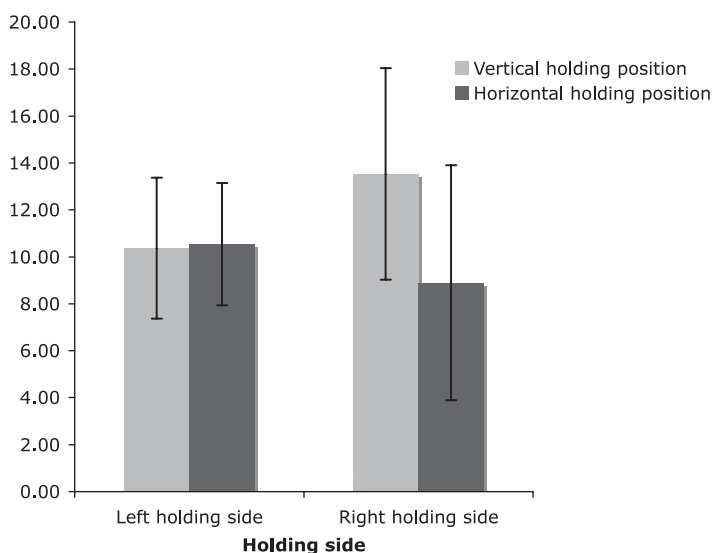


Figure 2. Mean scores and S.D. of affective symptoms (a variable combining anxiety and depression scores) as a function of holding side and holding position.

preferences after delivery. Mothers who declared during pregnancy that they would hold their newborn on the right side changed their holding side more than those who declared that they would hold theirs on the left.

The current study also showed that hemispheric specialization in the perception of emotions had no influence on the left-holding bias in this population of mothers. This finding is congruent with the results reported by Donnot and Vauclair (2007) for a population of mothers in maternity hospitals.

The holding-side bias was found to be significantly related to the presence of affective symptoms in the mothers after childbirth. On average, mothers who held their newborn on the right reported more affective symptoms than mothers who held theirs on the left.

The holding position played a dominant role in determining the left holding-side bias. Thus, in the case of mothers who preferentially held their newborn in the vertical position, their affective state (depression and anxiety) after the infant's birth was related to the holding-side bias. We did not observe any effect of affective symptoms on holding-side biases during the pregnancy period.

Interpretation of the Results and Limitations

Our results highlighted a difference between holding-side biases during pregnancy and after delivery. Some mothers declared that they would hold an infant on the left side (during pregnancy) but actually held their newborn on the right side after delivery. Other mothers did the reverse, while for others again, the holding side remained unchanged. Although it was not possible to identify the precise factors responsible for these changes or lack of changes, our results nevertheless support the hypothesis that the nature of the mother-child relationship plays a crucial role in determining holding-side biases.

The effect of the holding position on the holding side can probably be explained in terms of adaptive monitoring by the mothers. The horizontal holding position may well be the optimum position for emotional feedback between a mother and

her infant (Manning & Chamberlain, 1991), as it is the position which maximizes visual exchanges. Because most people perceive emotions better when they are presented in the left visual field (e.g. Demaree, Everhart, Youngstrom, & Harrison, 2005; Leventhal & Tomarken, 1986), this is probably the reason why more left holding occurred in the horizontal holding position than in the vertical one.

The absence of any significant effect on holding-side biases of hemispheric specialization in perceiving facial emotions is probably due to the nature of mother-child relationships. A female student cradling a doll or imagining that she is holding a newborn cannot be compared with a mother cradling her own newborn, as the participant's emotional involvement is obviously different in each context. For example, mothers have to be more attentive to their newborn and monitor his/her emotions, whereas a female participant who is requested to cradle a doll has no such monitoring to perform. As a matter of fact, hemispheric specialization has been demonstrated to play a role in the holding-side biases of student participants tested with dolls, questionnaires, or imagination tasks (e.g. Harris *et al.*, 2001; Vauclair & Donnot, 2005). However, the emotional exchanges that take place between a mother and her real infant are of a very different nature. Thus, when Donnot and Vauclair (2007) tested the influence of emotional perception on holding-side biases in maternity hospitals, they failed to find any link between hemispheric specialization (assessed with CFT) and holding-side biases.

The absence of any effect of affective symptoms on holding preferences during pregnancy can be explained by the specificity of this period. Pregnancy is associated with major physical and hormonal changes in the mother, as well as with affective modifications, which usually disappear 2 months after delivery (e.g. Nappi *et al.*, 2001). This 'disordered' state is therefore temporary and, with time, most mothers return to normal. Moreover, as our study was concerned with the assessment of infant holding by the mother, one could expect the mother's current state in the presence of her infant to have a greater effect on holding-side biases than her psychological state before the infant's birth.

The effect of affective symptoms after delivery on holding-side preferences was confirmed. Mothers with affective symptoms were less likely to hold their newborn on the left side than mothers with no affective symptoms. These results are in line with previous reports (Reissland *et al.*, in press; Vauclair & Scola, 2008; Weatherhill *et al.*, 2004). Many depressed mothers show disturbed interactions with their infant (e.g. Dumas, Lemay, & Deuwalder, 2001), spend less time looking at and touching their infant, and are less responsive to him/her (e.g. Field, 1984). Given that the left-holding bias is the spontaneous behaviour of about 70% of the population, the presence of affective symptoms can be said to reduce this holding bias.

Moreover, when both the holding side and the holding position were taken into account, affective symptoms after the infant's birth were found to have more effect on the mothers who used the vertical holding position than on those who used the horizontal holding position. This effect was also present when all the mothers were pooled (i.e. without distinguishing between their holding positions). It can be explained by the fact that (1) the women who held in the vertical position received less visual emotional feedback from their newborn (Manning & Chamberlain, 1991) and (2) holding a newborn on the right side is a less adaptive behaviour for monitoring her/his emotions than holding him/her on the left side, because emotional monitoring is usually under the control of the right hemisphere. Consequently, mothers with affective symptoms held their infant on the side where they perceived emotions less well, and also in a position that did not favour emotional exchanges with their newborn.

It can be concluded that the presence of affective symptoms may partly explain holding-side biases, according to the nature of the holding position. As described above, it would seem that these two variables could influence holding if the position used to hold the infant is also considered. Other variables, such as the mother's personality, the type of attachment formed between infant and mother, and the mother's emotional investment in her infant, are also likely to contribute to determining this complex, posturally lateralized behaviour. The limitation of this study arose from its relatively small sample of depressed or anxious mothers. We believe that further studies with a larger sample of mothers would help to explain further the influence of affective symptoms on holding-side biases and positions. Given our results, it is too early to propose a model for explaining the interaction between holding side and position preferences in the presence of affective symptoms (e.g. the facilitatory effect of emotional monitoring in the left-side horizontal holding bias). Further studies are now needed to explain why negative affects are not associated with more vertical holding in general.

Note

1. This research was conducted in accordance with APA ethical standards governing the treatment of the study sample.

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