

Infant-holding bias variations in mother–child relationships: A longitudinal study

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This longitudinal study examined the associations between maternal depressive symptoms and infant holding bias in a sample of $N = 43$ women during three prospective sessions: during pregnancy, two months after childbirth, and when the child was 19 months of age. The majority of mothers (65.8% on average) held their children on the left side of their body at all three sessions; approximately 30% demonstrated a change in their preference, in particular between the pre- and first post-natal session. Examination of reciprocal associations between holding bias and depression revealed that prior and concurrent depression did not predict changes in holding-side biases, whereas women's holding preferences when their infant was two months old predicted change in pre- to postnatal depressive symptoms; women favouring a right-sided holding bias were significantly more likely to report increased depressive symptoms across the perinatal period, whereas a left-sided holding bias was associated with decreased depressive symptomatology.

Keywords: Holding-side bias; Mother–child relationships; Longitudinal study; Depression.

Holding is essential for the development of mother–child relationships, in particular, to protect, nurse, nurture, and transport. Although holding is a type of mothering behaviour with evolutionary and cross-species bases (Salk, 1960; Westergaard, Lussier, Suomi, & Higley, 2001), we have very little knowledge about the basis for this behaviour, if it changes over time, or its association with critical other factors (e.g., maternal depression) with known effects on the mother–infant relationship. The most studied aspect of this maternal behaviour is

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the prevalence and generalizability of a holding side bias. Numerous studies have reported a clear preference for holding an infant or young child on the left side of the body (see [Harris, 2007](#); [Scola, 2009](#), for reviews). This left-bias posture occurs in approximately 70% of the general population ([Reissland, Hopkins, Helms, & Williams, 2009](#); [Salk, 1960](#)), across various cultures (e.g., [Saling & Cooke, 1984](#)), among both men and women ([Nakamichi & Takeda, 1995](#); [Scola & Vauclair, 2010b](#); [Vauclair & Scola, 2009](#)), and in nonhuman primates ([Manning & Chamberlain, 1991](#)).

Explanations for why humans typically display a left-sided holding bias are tentative, though there is evidence that the behaviour is more adaptive for both mother ([Vauclair & Scola, 2009](#)) and child ([Scola & Vauclair, 2010a](#)). Several hypotheses have been put forward to explain the left bias (see [Scola & Vauclair, 2010a](#), for a review). The role of dominant handedness was an obvious first factor thought to explain holding preferences. Although holding an infant on the left may be adaptive, insofar as it leaves the holder's dominant hand free (the right hand in 90% of cases; [Annett, 1985](#)), most studies have shown that handedness is not a primary variable in explaining the left bias ([Donnot, 2007](#); [Harris, Almerigi, & Kirsch, 2000](#); [Scola & Vauclair, 2010a](#)).

A second hypothesis for explaining infant-holding biases refers to hemispheric specialization for processing emotions, namely that people process emotional stimuli better when perceived in the left visual field, with its preferential associations with right hemisphere processes ([Vauclair & Donnot, 2005](#)). The right hemisphere is known to play an important role in controlling the perception of emotional information ([Bryden & Levy, 1983](#)), thus greater involvement of the right hemisphere in the regulation of emotional exchanges between parent and child may explain the observed left-holding bias. Various studies (e.g., [Bourne & Todd, 2004](#); [Harris et al., 2000](#); [Vauclair & Donnot, 2005](#)) have demonstrated that right hemispheric specialization in the perception of emotions (measured by the chimeric-face task) predicts infant-holding preferences. Holding on the left is assumed to be associated with better comprehension of emotional stimuli presented to the left visual and auditory fields, which are under right cerebral control. Nevertheless, other recent studies ([Donnot & Vauclair, 2007](#); [Vauclair & Scola, 2009](#)) found no significant link between the perception of emotions in one's visual field and holding bias in large samples of mother-child dyads. As such, hemispheric specialization in the perception and processing of emotions may be a partial, albeit inconsistent explanation for a left-sided holding bias.

Beyond handedness and emotion processing asymmetries, other factors such as maternal mental health may account for holding biases. As early as 1960, [Salk](#) stressed the importance of the mother-child relationship in determining infant-holding biases, noting that mothers who were separated from their infants at birth tended not to hold their infants on their left side during and following reunion ([Salk, 1973](#)). Mothers who were separated from their children for 24 hours had no

side preference for holding them, whereas mothers who were separated from their children from 1 to 7 days showed a right-holding bias.

De Château (1983) and Bogren (1984) observed that more stress about one's pregnancy, impending delivery, and potential relationships with their child were linked to women's right holding bias. Reissland et al. (2009) studied 79 mothers between 3 and 14 months after childbirth and found that maternal stress was significantly associated with holding bias: just 58% of highly stressed mothers held on the left, as opposed to 86% of non-stressed mothers. Although no association between depressive symptomatology and holding bias was found in the study by Reissland and colleagues, such associations have been reported in other studies. For example, Weatherill et al. (2004) studied infant-holding biases in relation to mothers' depressive symptoms and found that depressed mothers showed a non-significant right-sided bias in contrast to non-depressed mothers who showed a significant left-sided bias 12 months after birth. More recent studies (Donnot, Vauclair, & Bréjard, 2008; Vauclair & Scola, 2008, 2009) reported a significant relationship between infant-holding biases and the presence of depressive symptoms in mothers immediately after an infant's birth.

Although a definite link between right hemispheric specialization and a left-sided holding bias has not been confirmed, that depressive symptoms have been linked to dysfunctions of the right hemisphere (Heller & Nitschke, 1998) is suggestive of possible links between holding biases, maternal mood dysregulation, and, ultimately, mother-child outcomes (Laurent, Ablow, & Measelle, 2011). Specifically, the presence of depressive symptoms may lead to a reduction in a mother's left-sided holding bias or even a tendency to hold on the right side. Furthermore, mothers who prefer holding on the right may display more depressive symptoms than mothers who hold on the left. However, before we can attach more weight to these possibilities, a number of critical issues should be examined, in particular issues associated with the timing of maternal postnatal depressive symptoms as well as the prospective associations between depression and holding biases over time. The days following birth are a sensitive period for mothers, who undergo emotional swings caused by hormonal changes and fatigue due to parturition. Thus, depending on the maternal experience during this period, it is possible that depressive symptoms may lead to alternations in natural holding side preferences. Alternatively, it may also be the case that a right-sided holding preference may predispose some women to increased depressive symptomatology. Either way, the potential risks to the developing mother-infant relationship are real (Vauclair & Scola, 2009). Presently, we know of no study that has investigated the prospective associations between women's holding side preferences and their depressive symptoms across the perinatal period.

The main goal of the present study was to examine prospective associations between women's holding bias and depression symptoms in a sample of 43 mother-child dyads at three different time points. The first session took place

during pregnancy. It is both interesting and challenging to investigate the way future mothers think they will hold their infant and then later to compare it with real holding practices. Also, as holding is often studied via a test of imagination (Harris et al., 2000), we were interested in seeing whether we would see significant changes between imagined and actual holding. Importantly, antenatal maternal depression has been shown to be predictive of both disturbances in mother–infant relationships as well as negative affect in infants (Goodman & Gotlib, 1999). The second session occurred two months after delivery. Several studies suggest that the early postnatal period represents a sensitive period for exposure to maternal depression, predicting disturbances in the mother–child relationship and eventual depression in their offspring (Goodman & Gotlib, 1999). The third session occurred at 19 months after delivery at an age when changes in a child’s weight and mobility/posture might lead to changes in holding side preferences (i.e., shift to one’s dominant hand for added strength). In sum, the objectives of this study were twofold: (1) to examine the proportions and stability of holding-side bias across the perinatal period; and (2) to examine the prospective associations between depressive symptoms and holding-side preferences to see if one predicted change in the other.

METHOD

Participants

In the present study, 43 French Caucasian mothers ($M_{\text{age}} = 29.79$ years, range = 22–37) who were interviewed: (1) during pregnancy ($M = 6.5$ months gestation, range = 5.2–8.2); (2) after the birth of their infant ($M = 2.56$ months, range = 1.4–4.3); and (3) when the child had reached the age of 18.7 months (range = 16–26). Of the sample, 65% of the women were primiparous, 23% of mothers underwent a Caesarean section ($n = 10$), and all of the infants were born at term (i.e., after 37 weeks). Twenty-two of the newborns were male (51%). Mothers were recruited by advertisements posted in maternity wards or on the internet, or through midwives and gynaecologists. All mothers volunteered to participate in the study. The experiment was conducted in compliance with the ethical standards of the APA and the French code of ethics for psychologists.

Procedures

In the first session, women completed: (1) a questionnaire about holding preferences; (2) a handedness questionnaire; (3) the STAI Trait-Anxiety scale (Spielberger, Gorsuch, & Luschene, 1970); (4) the STAI State-Anxiety scale (Bruchon-Schweitzer & Paulhan, 1993; Spielberger et al., 1970); and (5) the CES-D depression scale (Radloff, 1977). During the second and third sessions,

infant-holding preferences were observed in vivo. As well, mothers again completed the holding preferences, State-Anxiety, and CES-D questionnaires.

The usual cut-off point of CES-D is 16, above which participants are considered as clinical depressed. In this study, like in previous studies (Donnot et al., 2008; Vauclair & Scola, 2009), we used CES-D as a continuous variable because we were more interested in quantifying depressive symptoms than in identifying clinically depressed participants.

Holding questionnaire and observation of mother–child dyads with a situation scenario. To evaluate the mothers' preferred holding side in the first session, we used one task of imagination (Harris et al., 2000) and the holding questionnaire. During the second and third sessions, this questionnaire was preceded by a direct observation of the mother's holding (see next paragraph). This questionnaire has been validated through several studies (e.g., Donnot, 2007; Donnot & Vauclair, 2007; Harris et al., 2000; Vauclair & Donnot, 2005; Vauclair & Scola, 2008, 2009) and it assesses whether the newborn is preferentially held on the left or right side of the mother's body. We included several settings such as the holding position used in several holding scenarios: when the mother soothes her infant and when she holds her infant most often. Holding bias scores were computed by considering side preferences in these holding scenarios. A negative holding bias score indicated a general left-side preference and a positive score a general right-side preference, but this score was dichotomized for the analyses. During the first session, holding could not be observed and therefore, we proposed the imagination task to mother by asking them to: "Close your eyes and imagine that you are holding a young infant—say about three months of age—in yours arms. Try to visualize the infant's face, its eyes, mouth, arms, and body. To help you imagine, put yourself in the position you would use to support the baby's head and body. Turn your head to the side so you can look directly to the baby's face". We then noted the holding side.

For the second and the third session we directly observed mothers' actual holding side. The mothers were instructed to: "Pick up your baby/child as you would if he/she were feeling distressed or if he/she had started crying. Now, show me how you would hold him/her in your arms". Test of imagination and holding observation were always completed before the holding questionnaire was administered.

The handedness questionnaire. We administered the Edinburgh Handedness Questionnaire (Oldfield, 1971) to assess whether the participants were right-handed, left-handed or ambidextrous; this 10-item scale yields a laterality score of between -10 (left handed) and $+10$ (right handed), with middle range scores (-2 to $+2$) reflecting ambidextrousness.

RESULTS

Descriptive statistics and intercorrelations

The descriptive statistics of our sample and central study variables are presented in [Table 1](#). Although the sample was almost right-handed (two mothers were left handed) and reported a corresponding preference on the Edinburgh Handedness Questionnaire for using their right hand for most activities, approximately two-thirds of the sample reported or were observed showing a left-sided holding preference with their infants at all three sessions. Although the left-sided preference was present at all three points, the difference in proportion of left- to right-sided biases was statistically significant at Sessions 1 and 2, $\chi^2(43) = 5.23$ and 5.23 , $p = .022$, respectively, but not at Session 3, $\chi^2(43) = 2.81$, $p = .093$.

In terms of depression, the sample as a whole scored in the subclinical range on the CES-D, though considerable variability in mean depression symptom scores at each time point was suggestive of reasonably diverse levels of depressive symptoms during the pre- to postnatal periods (2 of 3 intercorrelations were $< .5$).

Holding-side and depressive symptom changes between sessions

As anxiety yielded no significant results in any statistical models presented in the following analyses, this variable will not be presented. Changes in holding-side preferences were examined, with the numbers of women reporting or actually exhibiting left- versus right-sided biases at all three sessions shown in [Table 2](#). On average, 28% of all of the mothers investigated changed their holding side from one session to the next, with 32.5% of the women changing between the first and second sessions, compared to 23.5% of the women changing between the second and third sessions. Specifically, between Sessions 1 and 2, of the 29 women who reported a prenatal left-sided bias, seven (24.1%) were observed as having a right-sided bias at Session 2; of the 14 women reporting a prenatal right-sided bias, seven (50%) were observed as having a left-sided bias at Session 2, $\chi^2(43) = 2.88$, $p < .08$. Between Sessions 2 and 3, of the 29 women who reported a left-sided bias at Session 2, six (21.8%) were observed as having a right-sided bias at Session 3; of the 14 women reporting a right-sided bias at Session 2, four (28.6%) were observed as having a left-sided bias at Session 3.

Changes in mean levels of depressive symptom scores (reported in [Table 1](#)) on the CES-D were examined next. As with holding side biases, the most significant change in mothers' symptoms of depression occurred between the prenatal and first postnatal sessions. Specifically, t -tests revealed that women reported a significant decline in level of depressive symptomatology between the prenatal session and Session 2, when their infant was approximately 2 months old, $t(42) = 2.21$, $p = .032$. Between Session 2 and Session 3, when children

TABLE 1
Descriptive statistics and intercorrelations

Variables	Intercorrelations (<i>r</i>)										
	<i>M</i>	<i>SD</i>	Range	1	2	3	4	5	6	7	8
1. Infant weight at S2	3.13	0.59	2-5	—							
2. Infant weight at S3	11.15	1.21	9-14	.26	—						
3. Mother's handedness ^a	8.63	3.56	- 4-10	.08	.09	—					
	<i>N</i>	%									
4. Left holding side preference at S1			29	67.4		-.04	.11	-.15			
5. Left holding side preference at S2			29	67.4		.00	.29*	-.19	.30*		
6. Left holding side preference at S3			27	62.8		-.09	.20	-.08	.29*	.49**	
	<i>M</i>	<i>SD</i>	Range								
7. Depression symptoms at S1	12.21	7.11	2-31	-.20	-.10	.06	.04	.15	.10		
8. Depression symptoms at S2	9.95	8.28	0-44	-.07	.11	.02	.03	.33*	.22	.63**	
9. Depression symptoms at S3	11.07	8.08	0-34	-.09	-.21	-.08	-.01	-.01	.04	.36*	.48**

Notes: *N* = 43, S1 = prenatal assessment session; S2 = second assessment session when infant was 2;56 months; S3 = third assessment session when child was 18;7 months. **p* < .05; ***p* < .001.

^a Handedness scored from - 10 (completely left handed) to 10 (completely right handed) on the Edinburgh Handedness Scales.

TABLE 2
Distribution of holding-side changes between the first and second sessions and third and second sessions

	<i>Distribution of holding sides during the second session (S2)</i>		
	<i>Right side</i>	<i>Left side</i>	
Distribution of holding sides during the first session (S1)*	Right side	7 (50%)	7 (50%)
Distribution of holding sides during the third session (S3)**	Left side	7 (24.1%)	22 (75.9%)
	Right side	10 (71.4%)	6 (20.7%)
	Left side	4 (28.6%)	23 (79.3%)

Notes: *32.55% of mothers changed holding side. **23.2% of mothers changed holding side.

were typically 19 months old, there was no change in depression symptoms, $t(42) = -0.81, p = .39$. Across the entire Session 1 to Session 3 period, there was no change in depressive symptoms, $t(42) = 0.87, p = .40$.

Despite an overall decrease in the average level of depressive symptomatology from the prenatal period, the early postpartum period is often fraught with considerable risk for some new mothers. Accordingly, we examined the depression data further and found that although 62.8% of women ($N = 27$) reported decreased symptomatology between Sessions 1 and 2, 37.2% of the women ($N = 16$) reported increased depressive symptoms levels. Of women reporting increased symptom levels between Sessions 1 and 2, 43.8% ($N = 7$) went from subclinical to clinical levels on the CES-D (score of 16 or greater). Inversely, 10 of 19 women (52.6%) went from clinical to subclinical levels between Sessions 1 and 2. In sum, although we found a mean level decrease in depressive symptoms between the pre- and early postnatal period, a moderate number of women in this sample reported clinical range symptoms of depression, with many of these women showing increased severity from the pre- to immediate postnatal period.

Do symptoms of depression predict change in holding bias across time?

We used autoregressive logistic regression models to determine whether women's prior and current symptoms of depression predicted change in holding side bias between Sessions 1 and 2 as well as between Sessions 2 and 3. All the subsequent binomial logistic regressions assess the effect on the holding side (left or right) with respect to the prior holding side (in order to control for holding side change) and the depression score. The results of these tests are presented in Table 3. The following predictors were tested. In the first model, with our measure of holding

side preference at Session 2 serving as criterion, women's holding side preference at Session 1 (auto-regressive term), infant's weight in kilograms at Session 2, women's handedness score on the Edinburgh Handedness Questionnaire, and women's CES-D scores as Sessions 1 and 2 were entered simultaneously. In the second model, with our measure of holding side preference at Session 3 serving as criterion, women's holding side preference at Session 2 (auto-regressive term), infant's weight in kilograms at Session 3, women's handedness score, and women's CES-D scores as Sessions 2 and 3 were entered simultaneously as predictors.

As shown in Table 3, women's prior and current depressive symptomatology were not significantly associated with changes in holding side preference. In fact, the autoregressive term in the second model was the only significant predictor in either model, showing that there was significant stability in holding preference between Sessions 2 and 3.

Do changes in holding bias predict symptoms of depression across time?

We used auto-regressive multiple-regression models to determine whether women's prior and current holding side preferences predicted change in women's symptoms of depression between Sessions 1 and 2 as well as between Sessions 2 and 3. In the first model, with women's CES-D score at Session 2 serving as criterion, women's CES-D score at Session 1 (auto-regressive term), infant's weight in kilograms at Session 2, women's handedness score on the Edinburgh Handedness Questionnaire, and women's holding side preference at Sessions 1 and 2 were entered simultaneously. In the second model, with women's CES-D score at Session 3 serving as criterion, women's CES-D score at Session 2 (auto-regressive term), infant's weight in kilograms at Session 3, women's handedness score, and women's holding side preference at Sessions 2 and 3 were entered simultaneously as predictors.

As shown in the first model in Table 4, women's prenatal depressive symptom score significantly predicted their first postnatal depression score, suggesting considerable continuity in levels of depressive symptomatology. Of the remaining predictors tested, only women's holding side preference at Session 2 predicted change in levels of depressive symptoms. Specifically, although prenatal holding preferences did not predict change, women observed showing a right-sided holding preference two months postnatally were more likely to have the same level of depression between Sessions 1 and 2, $t(13) = -0.03$; $p = .98$ ($M = 13.71$ vs. $M = 13.78$). By contrast, women observed showing a left-sided bias at two months postnatally were more likely to report significant declines in depressive symptoms, $t(28) = 3.56$, $p < .01$ ($M = 11.48$ vs. $M = 8.1$). Moreover, the left-sided and right-sided biased women reported the same level of depression at S1, $t(41) = -0.93$, $p = .34$ ($M = 11.48$ vs. $M = 13.78$) but not at S2, as left-

TABLE 3
 Logistic regressions: Depression symptoms predict changes in holding side preferences between Sessions 1 and 2 and Sessions 2 and 3

Model/Predictors	Change in Holding from S1 to S2			Change in Holding from S2 to S3			
	B	95% CI	p	Model/Predictors	B	95% CI	p
Holding side at S1	3.20	0.62 to 16.52	.16	Holding side at S2	12.45	1.85 to 83.69	.009
Infant weight at S2	0.99	0.28 to 3.58	.99	Infant weight at S3	1.19	0.64 to 2.21	.59
Mother handedness ^a	0.60	0.34 to 1.05	.09	Mother handedness ^a	1.10	0.89 to 1.36	.37
Depression symptoms at S1	0.10	0.86 to 1.15	.90	Depression symptoms at S2	1.00	0.89 to 1.12	.97
Depression symptoms at S2	1.11	0.98 to 1.25	.12	Depression symptoms at S3	1.03	0.92 to 1.15	.61
	$\chi^2(38) = 15.66, p = .008, R^2 = .35$				$\chi^2(38) = 11.73, p = .039, R^2 = .33$		

Notes: N = 43. S1 = prenatal assessment session; S2 = second assessment session when infant was approximately 2 months; S3 = third assessment session when child was approximately 19 month.

^a Mother handedness scored from -10 (completely left handed) to 10 (completely right handed) on the Edinburgh Handedness Scales.

TABLE 4
Multiple regressions: Holding preference predicts change in depression symptoms between Sessions 1 and 2 and Sessions 2 and 3

Model/Predictors	Change in Symptoms from S1 to S2			Change in Symptoms from S2 to S3			
	B	95% CI	p	Model/Predictors	B	95% CI	p
Depression symptoms at S1	0.69	0.48 to 0.99	.000	Depression symptoms at S2	0.56	0.28 to 0.84	.000
Infant weight at S2	0.79	-2.70 to 4.29	.99	Infant weight at S3	-1.53	-3.41 to 0.36	.18
Mother handedness	0.23	-0.39 to 0.86	.46	Mother handedness	-0.48	-1.17 to 0.21	.17
Holding side preference at S1	-0.89	-5.28 to 3.50	.68	Holding side preference at S2	-10.54	-10.54 to 1.92	.17
Holding side preference at S2	5.08	0.24 to 9.90	.04	Holding side preference at S3	-4.31	4.01 to 6.34	.65
	$F(5, 37) = 6.52, p = .000, R^2 = .40$				$F(5, 37) = 3.91, p = .014, R^2 = .34$		

Notes: N = 43. S1 = prenatal assessment session; S2 = second assessment session when infant was approximately 2 months; S3 = third assessment session when child was approximately 19 months.

^a Mother handedness scored from -10 (completely left handed) to 10 (completely right handed) on the Edinburgh Handedness Scales.

sided women reporting less depressive symptoms at S2, $t(41) = -2.20$, $p < .05$ ($M = 8.10$ vs. $M = 13.79$).

In the second model shown in [Table 4](#), only women's CES-D score at Session 2 was associated with their depression score at Session 3, when their infant was 19 months old; none of the other predictors predicted change in depressive symptoms between Sessions 2 and 3.

DISCUSSION

A preference for holding an infant on the left versus right side of the body was anticipated by women while pregnant and then observed at both postnatal sessions. Moreover, a significant number of mothers changed their holding side bias between the first and second session, suggesting that some women may not have accurately predicted their holding side preference while pregnant. Mothers, who during pregnancy thought they would hold on the right side of their body, tended to change holding side more frequently over time compared with expectant women who thought they would hold their infant on their left side. Although for approximately two-thirds of the women, this was their first pregnancy, most women seemed already to have a sense that they would hold their infant on the left-side. This may be innate, owing to evolutionary pressures that select for adaptive mothering behaviours ([Salk, 1960](#)), or learned, perhaps through prior experience or observation of other parents. That more women changed to a left-side holding bias is consonant with either interpretation and may also reflect the beneficial effects of mother–infant attunement. In a separate sample of high-risk new mothers, we found greater psychophysiological attunement between mothers and infants in securely attached dyads ([Laurent et al., 2011](#)), the dominant proportion of whom (73%) show a left-sided holding bias ([Measelle, March 2011, personal communication](#)).

Interestingly, as infants grew, both in age and weight, a slight decrease in the left-sided bias was observed by the third assessment (when children were nearly 19 months of age). This result is consistent with data reported in the literature ([Dagenbach, Harris, & Fitzgerald, 1988](#)) and likely reflects changes in both children's physical characteristics and, possibly, emotional processes between mother and child. As infants gain size and weight, mothers may have to use their strongest arm when holding or carrying their child; as all but two women in the present study were predominantly right handed, this might account for the change to a right-sided holding preference among some. Alternatively, a left-sided holding bias may facilitate more efficient socioemotional communication given that infants' receive greater input into their left visual field when held on the left side ([Vauclair & Donnot, 2005](#)). However, as infants become more verbal and less dependent on face-to-face gaze as the basis for emotional communication, these features and the improvement of communicative skills along with other changes may reduce the need for left-side holding. Nevertheless, despite possible

issues of handedness, child weight, or expanded channels of mother–child communication, the left-sided holding bias remained stable across time for a majority of mothers.

The second central aim of this study was to investigate the prospective associations between holding-side preferences and women's depressive symptomatology. We found no evidence that prior or current depressive symptomatology predicted change in holding-side bias, either between pregnancy and two months postpartum or between two and 19 months postpartum. This lack of association may simply reflect a general stability (i.e., lack of change) in women's left-sided holding bias across time. However, changes in holding preferences may actually be relatively independent of depressive symptoms. Although we did find that higher depressive symptoms at two months postpartum were associated with a greater right-sided holding, changes in holding-side preferences may reflect factors other than depression. For example, right to left changes may constitute efforts to correct or improve levels of synchrony in the mother–infant relationship (Laurent et al., 2011). Left to right changes may be due to other types of affective disturbance. For example, De Château (1983) found right-sided holding increased as maternal anxiety increased. As such, symptoms of apprehension, dread, and restless rather than sadness, rumination, impaired motivation, and psychosomatic symptoms may be more likely to drive holding-side changes. The focus of the present study was depressive symptoms in new mothers, but all above mentioned variables could be tested in future works.

We did find that holding-side bias predicted change in depressive symptoms between the prenatal to two month postnatal period, though not change in depressive symptoms between two and 19 months postpartum. Interestingly, it was not women's prenatal expectations of their likely holding-side bias that predicted change in depression. Instead, we found that women reporting right-sided biases at two months postpartum reported significant increases in their depressed mood between the pre- to early postnatal period. For these women, holding their infant on the right side may reflect problems they themselves are having or emergent problems in their relationship with their newborn infant. Although the hormonal imbalances of parturition have been linked to elevations in postpartum depression (Murray & Cooper, 1997), so have early behavioural challenges been associated with mothering (Goodman & Gotlib, 1999). Though beyond the scope of this investigation, it is worth speculating that these types of problems may co-occur with or result from right-sided holding tendencies. Already by two months postpartum, these pressures may contribute to increases in postpartum depression.

It is also worth noting that some women who were elevated in their depressive symptomatology prenatally but who reported left-sided biases at two months postpartum, showed a significant decline in their depressive symptoms across the pre- to early postnatal period. Goodman and Gotlib (1999) have speculated that while biological and psychosocial features of pregnancy can exert upward

pressure on prenatal symptoms of depression, early success with the demands of mothering may well buffer mother (and child) from mood problems.

Even as this work provides some answers about the stability of holding-side biases in expectant women who become mothers as well as about possible reciprocal associations between perinatal changes in holding preferences and depressive symptoms, it also raises questions that should be pursued. One major question still unanswered is why do humans generally exhibit a left-sided bias (e.g., Bourne & Todd, 2004; Donnot & Vauclair, 2007; Harris et al., 2000). An appropriate explanation of holding preferences can best be provided by studies in ecological conditions involving parents and their children. A second question concerns the role of infant temperament. As far as we know, no study has reported such measures but we do believe that the way the infant behaves and reacts should be considered as it is likely to influence mother holding.

Finally, the precise association between holding biases and depression, be it at one time or across time, will require a larger and more clinically heterogeneous sample. It remains to be seen whether holding preferences are related to changes in all forms of depression (e.g., depressive episodes defined primarily by low mood, rumination, anhedonia, somatic/vegetative features). However, our results point to an important neonatal period of risk, both for mother and for the developing mother–infant relationship. In sum, our results add further evidence to the normative and potentially adaptive nature of a left-side holding preference, especially during the early prenatal period. As well, these results suggest that some women exhibiting a right-sided holding preference with their newborn may be vulnerable to clinically meaningful elevations in depressive symptomatology.

Manuscript received 5 October 2012

Revised manuscript accepted 27 March 2013

First published online 15 May 2013

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