Journal of Perinatology (2010), 1–7

www.nature.com/jp

ORIGINAL ARTICLE

Mothers seeing their VLBW infants within 3 h after birth are more likely to establish a secure attachment behavior: evidence of a sensitive period with preterm infants?

K Mehler[1], D Wendrich[2], R Kissgen[3], B Roth[1], A Oberthuer[1], F Pillekamp[1] and A Kribs[1]

[1]Department of Neonatology, Children's Hospital, University of Cologne, Köln, Germany; [2]Clinic of Child and Adolescent Psychiatry and Psychotherapy, University of Cologne, Cologne, Germany and [3]Department of Human Sciences, University of Cologne, Cologne, Germany

Objective: Close contact of mother and child in the first hours after birth is essential for the establishment of a secure attachment behavior in term infants. To date, studies investigating whether a 'sensitive period' also exists for very low birth weight (VLBW) preterm infants are lacking.

Study Design: Attachment patterns of 62 VLBW infants were assessed using the 'strange situation' setting and correlated with the time mothers saw their child for the first time. Furthermore, maternal and infant covariates possibly influencing the attachment behavior were analyzed. As maternal factors the mother's age, social status and pregnancy history were recorded and at three time points (time 1, 2 and 3 (*t*-1, *t*-2 and *t*-3)), a semi-structured interview, a depression and a social support questionnaire were performed. As infant factors neonatal basic data, ventilation time and length of hospital stay were recorded. Disease severity was scored using the clinical risk index for babies, score for neonatal acute physiology (SNAP), SNAP perinatal extension and nursery neurobiological risk score. At time points *t*-2 and *t*-3, the infants were examined using the second edition of Bayley scales of infant development.

Results: In all, 53.2% of the children showed a secure, 33.9% an insecure-avoidant, 3.2% an insecure-ambivalent and 9.7% an insecure-disorganized attachment behavior. Preterm infants whose mothers had seen them within 3 h after birth had a higher rate of secure attachment than preterm infants with no early contact (76 versus 41%, $P = 0.009$). Firstborns showed a significantly higher rate of insecure attachment behavior (93 versus 67%, $P = 0.01$). No influence on attachment behavior was shown for any other maternal or infant factor.

Conclusions: Our results support the hypothesis that the first hours after birth are a 'sensitive period' for the development of attachment behavior in VLBW infants. When a mother is enabled to see her infant shortly after birth, the 'sensitive period' right after birth may be used to help forming an important basis for the secure attachment of the preterm infant.

Correspondence: Dr K Mehler, Department of Neonatology, Children's Hospital, University of Cologne, Kerpener street 62, Köln 50924, Germany.
E-mail: katrin.mehler@uk-koeln.de
Received 26 August 2010; accepted 27 August 2010

Journal of Perinatology advance online publication, 9 December 2010; doi:10.1038/jp.2010.139

Keywords: attachment; sensitive period; VLBW infants; strange situation

Introduction

In the 1950s, John Bowlby[1] described attachment and exploratory behavior as basic control systems of child behavior. Close contact of mother and child in the first hours after birth is essential to provide optimum conditions for a maternal behavior that facilitates a secure attachment in the first year of life. The first hours are, according to Klaus *et al.*,[2] a 'sensitive period' of mother–child interaction in which the foundations of the later attachment behavior are laid. Winnicott[3] describes a state of 'primary maternal preoccupation' that helps mother and child establish a pattern of synchronized and mutually rewarding interactions that they continue in the following months.

Numerous studies have shown the positive effects of close contact between mother and child immediately after birth: when a newborn lies on the mother's belly after birth, the infant tries to find the breast and begins to suckle, body temperature of the infant is constant and the infant cries less than newborns put inside a crib.[4] The mother's higher oxytocin level facilitates maternal behavior and bonding,[5] and has anxiolytic and sedating effects. Separation after birth leads to a distress call suggesting that infants recognize physical separation from their mothers. The infants then start to cry in pulses and crying stops at reunion with the mother.[6] Similarly, animal experiments have shown that animals with close contact to the mother are more social, have lower stress levels and lower blood pressure.[7,8] Moreover, introduction of 'rooming-in' and earlier contact between mother and child in countries, such as in Thailand led to a reduction of infant abandonment.[9,10]

In very low birth weight (VLBW) preterm infants, close contact between mother and child is not routinely possible and studies investigating whether a similar 'sensitive period' also exists in VLBW preterm infants are currently lacking. To analyze the attachment patterns of VLBW preterm infants, we tested their attachment behavior using the 'strange situation' setting developed by Ainsworth and Wittig[11] in 1960s, and correlated the results with the time of first contact between mother and child and additional both maternal and infant factors. Thus, we tested the hypothesis that if mothers see their VLBW preterm infant shortly after birth, these infants will be more often securely attached at the age of 12 to 18 months of life as determined by their behavior in the strange situation setting.

Methods

This study is a *post hoc* analysis of data that was initially collected to investigate self-regulation of VLBW infants. Infants were enrolled in the study consecutively from January to December 1999. In this period, the supervising neonatologist (AK) started to take VLBW infants for a visit at their mothers at the time they were transported from the resuscitation unit to the neonatal intensive care unit (NICU). Before 1999 those visits were not carried out for fear of complications. In 1999, about half of the infants visited their mothers so that this *post hoc* analysis could be performed. Included in the original study were 85 of the total of 137 VLBW preterm infants (weight <1500 g) without malformations or inborn disorders who were cared for in the Department of Neonatology (Children's Hospital of the University of Cologne) until 36 weeks post-menstrual age. Only infants who were born in the delivery room of the University Hospital of Cologne were included in this study. Delivery room and NICU are located in the same building, but the infants had to be transported a short distance from delivery room to the NICU. Additional inclusion criteria were sufficient German language skills of the mother and a written informed consent of the parents obtained before birth by the supervising neonatologist (AK). The event of seeing the infant was not included in the consent form. The study was approved by the Ethics Committee of the University of Cologne.

The mothers were able to see their infants within 30 min to 3 h after birth after the infants were stabilized. Cesarean section was either performed using spinal or general anesthesia. Before the infants were taken to the mothers, it was made sure that the mothers were conscious and able to make contact with her baby. To prevent heat loss, the infants were wrapped in linen, but it was made sure that the mothers could at least see the face of their baby. A nasal tube (nasotracheally, if intubated, nasopharyngeal if on continuous positive airway pressure) and an orogastric tube were present in all infants at the time the mother saw her infant. The infants were held close to their mothers by the neonatologist to allow that they could see their babies *en face* and talk to the babies. If both the mothers' and infants' conditions were good enough, the mothers were encouraged to touch their babies. The neonatologist and a NICU nurse were present all the time. In all cases the same neonatologist (AK) cared for the infant and supervised the visit. The mothers were congratulated and briefly informed about the infants' conditions. Talking was restricted to a minimum to enable the mother to concentrate fully on her infant. The visit lasted between 5 and 10 min depending on the condition of infant and mother. The infants visit at their mothers could only be initiated by the supervising neonatologist. The neonatologist who supervised the visit (AK) was also responsible for the treatment of the infant and the care of the parents of all infants taking part in the study. The visit was documented in written form by AK.

All mothers participating in the study visited their children at the NICU for the first time on the second day of life, after they had recovered from the cesarean section. From the second day after birth the mothers visited their infants daily for 3 to 5 h. Kangaroo care was started between the second and fourth day after birth depending on the infants condition.

Subsequently, attachment assessments between 12 and 18 months of life (corrected age (CA)) were performed with 85 children of 52 mothers. In multiple births, all infants were included in this study and were counted as firstborn unless they already had an older sibling. A total of 20 preterm infants had to be excluded for the following reasons: death of the child ($n=1$), lack of informed consent ($n=5$) or technical problems with the videos ($n=8$). Six children were not able to be tested because of severe disabilities (four suffering from tetraspastic cerebral palsy and severe psychomotoric delay due to grade 4 intraventricular hemorrhage, two suffering from tetraspastic cerebral palsy and periventricular leukomalacia due two twin-to-twin transfusion syndrome and both children being blind). Three more children were excluded, as no data were available whether mothers saw their children or not. Thus, in total, 62 children were included in this analysis.

To assess attachment quality, the strange situation procedure developed by Ainsworth and Wittig[11] was used. The procedure confronts children in a standardized laboratory situation with separation from and 'reunion' with their mother. The reactions of the child are videotaped and rated using four scales to determine the attachment pattern. Initially, three attachment categories were differentiated: A = insecure avoidant, B = secure, C = insecure ambivalent. Main and Salomon[12] added a fourth category, D = insecure disorganized, as particularly mistreated children could not be classified using the original tripartite classification scheme. In our analysis, attachment patterns were grouped into secure (B) and insecure (A, C, D) patterns. The videos were evaluated by a blinded rater.

As possible infant factors influencing attachment, neonatal basic data (gestational age, birth weight, cesarean section,

Apgar score and neonatal complications), duration of ventilation and hospital time were recorded. The initial disease severity was scored using the clinical risk index for babies,[13] the score for neonatal acute physiology II (SNAP-II), the SNAP perinatal extension-II,[14] and the nursery neurobiologic risk score.[15] At CAs of 3 and 12 months, the infants were examined using the Bayley scales of infant development, mental developmental index and psychomotor developmental index.[16] Examining the children using the Bayley scales of infant development-II scales was part of the initial study on self-regulation.

As possible maternal factors influencing attachment, the mother's age, the social status of mother and father and the pregnancy history (planned, natural, reproductive medicine) were recorded. Although pregnancy achieved by reproductive medicine is to be considered as 'planned', we developed these three categories to test for attachment differences in infants resulting from unplanned pregnancies and to test for the influence of reproductive medicine. At the expected date of delivery (*t*-1) and at ages 3 months CA (*t*-2) and 12 months CA (*t*-3) a semi-structured interview was performed (a modified version of the clinical interview for parents with high-risk infants[17]). In addition, the ADS-L questionnaire (a German version of the Center for Epidemiological Studies Depression Scale[18]) was used at time points *t*-1, *t*-2, and *t*-3. Cutoff for apparent depression in this scale is 16. The social support questionnaire F-Sozu[19] was used at *t*-1 and *t*-3. A score of 5 indicates maximum social support.

All parameters were analyzed by descriptive statistics. Differences between groups were assessed using independent samples *t*-tests for continuous and χ^2-tests for categorical data. Logistic regression was used to assess the impact of parameters on attachment, expressed as odds ratio with 95% confidence interval. A *P*-value <0.05 was considered as statistically significant. All computation was carried out using SPSS 17.0 software (SPSS, Chicago, IL, USA).

Results

Characteristics of both cohorts of infants (those who were seen by their mothers and those who were not) are presented in Table 1 and results are summarized in Tables 2 and 3.

The infants' attachment behavior was assessed at *t*-3 at a mean CA of 12 months (range 11–19 months). In this study, 53.2% (33) of the children showed a secure attachment (B), 33.9% (21) an insecure-avoidant attachment (A), 3.2% (2) an insecure-ambivalent attachment (C) and 9.7% (6) an insecure-disorganized (D) attachment behavior. Analysis of the children's demographic data did not show any difference in attachment behavior between singletons and multiples, and neither between girls and boys. In contrast, firstborns showed a significantly higher rate of insecure attachment behavior (93% ($n=27$) versus 67% ($n=22$), $P=0.01$).

Table 1 Comparison of groups of infants and mothers (mean, standard deviation score and range)[a]

	Seen after birth (n = *34*)	*Not seen after birth* (n = *28*)
Gestational age (weeks)	28.8 ± 2.8 (23.4–34.1)	28.7 ± 9.6 (24.3–33.9)
Birth weight (g)	1057 ± 287 (560–1480)	1051 ± 236 (520–1410)
NBRS score	3.09 ± 2.9 (0–12)	3.11 ± 2.5 (0–10)
CRIB score	3.4 ± 3.8 (0–13)	3.3 ± 2.8 (1–9)
Ventilation (days)	3.5 ± 5.2 (0–23)	4.9 ± 5.5 (0–27)
Apgar, 5 min	8 (5–10)	8 (6–10)
Depression (ADS-L>16), *t*-1	8 (23.5%)	8 (28.5%)
Depression (ADSL->16), *t*-2	6 (17.6%)	3 (10.7%)
Depression (ADS-L>16), *t*-3	6 (17.6%)	4 (14.2%)
Social support, *t*-1	4.3 ± 0.5 (2.7–4.9)	3.9 ± 0.7 (2.3–5)
Bayley MDI, *t*-3	83 ± 13 (54–109)	80 ± 9 (54–90)
Bayley PDI, *t*-3	69 ± 14 (50–105)	76 ± 15 (50–118)
Time point, *t*-1 (weeks corrected age)	37.0 ± 1.5 (34–40)	37.1 ± 2.2 (34–42)
Time point, *t*-2 (weeks corrected age)	12.2 ± 1.1 (10–15)	12.7 ± 1.2 (11–14)
Time point, *t*-3 (months corrected age)	11.8 ± 0.7 (11–14)	12.1 ± 1.6 (11–19)
Multiple birth	11 (32%)	13 (46%)

Abbreviations: CRIB, clinical risk index for babies; MDI, mental developmental index; NBRS, nursery neurobiological risk score; PDI, psychomotor developmental index.
[a]No statistical significance.

In all, 37 (60%) of all children were seen by their mothers within 3 h after birth, whereas 25 (40%) had not. Mean gestational age, birth weight, Apgar, nursery neurobiologic risk score and clinical risk index for babies score as well as days of mechanical ventilation were not significantly different for both groups (Table 1). CA at time points *t*-1, *t*-2 and *t*-3 of examination was not different between both groups (Table 1). Intriguingly, preterm infants whose mothers had seen them shortly after birth had a significantly higher rate of secure attachment (early contact: secure attachment 76% ($n=25$), insecure attachment 24% ($n=8$), $P=0.009$). Moreover, mothers who had seen and touched their children shortly after birth had a higher rate of secure attachment patterns than those who had only seen them (40% versus 31%), although the difference did not reach statistical significance.

Next, a linear regression was performed, in which the factors 'seen after birth' and 'not being first child' were identified as the best predictors for secure attachment behavior (odds ratio 4.5 and 0.14, Table 4). To exclude a potential confounding by multiples, we performed a subanalysis including only the firstborn twin or triplet. In this subgroup 52 infants were included. Again, infants whose mothers has seen them shortly after birth showed a significantly higher rate of secure attachment behavior than children whose mother had not seen them (65% versus 32%, $P=0.02$).

Table 2 Possible factors influencing attachment of preterm infants; infant factors (mean, ± standard deviation score and range)

	Total population (n = *62*)	*Secure attachment* (*B;* n = *33*)	*Insecure attachment* (*A, C, D;* n = *29*)	*Statistical significance* (*t-test, χ-quadrate test*)
Gestational age (weeks)	28.7 ± 2.6 (23.4–34.1)	28.6 ± 2.5 (23.4–32.1)	29.0 ± 9.8 (24.3–24.1)	NS
Birth weight (g)	1054 ± 263 (520–1480)	1040 ± 253 (560–1480)	1071 ± 277 (520–1480)	NS
Female	34 (54.8%)	16 (50.0%)	18 (62.1%)	NS
Male	28 (45.2%)	17 (60.7%)	11 (37.9%)	NS
Cesarean section	59 (95%)	32 (97%)	27 (93%)	NS
Singleton pregnancy	35 (56.5%)	19 (59.4%)	16 (55.2%)	NS
Multiple pregnancy	27 (43.5%)	14 (43.8%)	13 (44.8%)	NS
Firstborn	49 (79.0%)	22 (66.7%)	27 (93.1%)	$P = 0.01$
Mechanical ventilation (days)	4.1 ± 5.3 (0–27)	4.4 ± 6.6 (0–27)	3.8 ± 3.5 (0–12)	NS
In-hospital time (days)	70.2 ± 31.3 (15–170)	69.8 ± 26.6 (15–139)	70.7 ± 36.4 (32–170)	NS
NBRS score	3.1 ± 2.7 (0–12)	2.9 ± 3.0 (0–12)	3.3 ± 2.3 (0–9)	NS
SNAP-II score	21.5 ± 16.9 (1–65)	23.6 ± 18.4 (4–65)	19.0 ± 15 (1–59)	NS
SNAP-PE-II score	23.0 ± 19.1 (0–67)	23.0 ± 20.3 (0–65)	23.1 ± 17.9 (0–67)	NS
CRIB score	3.3 ± 3.4 (0–13)	3.2 ± 3.3 (0–13)	3.5 ± 3.5 (0–13)	NS
Bayley motor scale, *t*-2	85.9 ± 7.6 (70–100)	87.3 ± 8.3 (70–100)	84.1 ± 6.4 (73–100)	NS
Bayley mental scale, *t*-2	94.1 ± 6.6 (77–107)	94.5 ± 6.2 (81–107)	92.4 ± 6.7 (77–107)	NS
Bayley motor scale, *t*-3	72.1 ± 15.2 (50–118)	73.5 ± 16.1 (50–118)	70.4 ± 14.1 (50–101)	NS
Bayley mental scale, *t*-3	82.4 ± 12 (54–109)	83.4 ± 11.8 (58–109)	81.3 ± 12.2 (54–102)	NS
'Seeing' after birth	37 (59.7%)	25 (75.8%)	12 (41.3%)	$P = 0.009$
'Seeing and touching' after birth	22 (35.5%)	13 (40.0%)	9 (31.0%)	NS
Breastfeeding	25 (40.3%)	16 (48.5%)	9 (31.0%)	NS

Abbreviations: CRIB, clinical risk index for babies; NBRS, nursery neurobiological risk score; NS, non-significant; PE, perinatal extension; SNAP, score for neonatal acute physiology.

Table 3 Possible factors influencing attachment of preterm infants; maternal factors (mean, ± standard deviation score and range)

	Total population (n = *62*)	*Secure attachment* (*B;* n = *33*)	*Insecure attachment* (*A, C, D;* n = *29*)	*Statistical significance* (*t-test, χ-quadrate test*)
Age of mother	31.2 ± 5.1 (21–43)	31.9 ± 5.2 (23–43)	30.3 ± 5.0 (21–40)	NS
Depression, *t*-1 (ADS-L > 16)	16 (25.8%)	8 (24.2%)	8 (27.5%)	NS
Depression, *t*-2 (ADS-L > 16)	9 (14.5%)	7 (21.2%)	2 (6.9%)	NS
Depression, *t*-3 (ADS-L > 16)	10 (16.1%)	5 (15.2%)	5 (17.2%)	NS
Social support, *t*-1 (F-Sozu scale)	4.2 ± 0.6 (2.3–5)[a]	4.2 ± 0.7 (2.3–4.9)[a]	4.1 ± 0.6 (2.8–5)[a]	NS
Social support, *t*-2 (F-Sozu scale)	4.1 ± 0.6 (2.6–5)[a]	4.2 ± 0.6 (2.7–5)[a]	4.0 ± 0.6 (2.6–5)[a]	NS
High school graduation mother	37 (59.7%)	13 (40.6%)	16 (55.2%)	NS
High school graduation father	20 (32.3%)	14 (43.8%)	6 (20.7%)	NS
Planned pregnancy	43 (69.4%)	26 (81.3%)	17 (58.6%)	NS
Natural pregnancy[b]	22 (35.5%)	14 (40.0%)	8 (27.6%)	NS
Reproductive medicine[b]	16 (25.8%)	7 (20.0%)	9 (31.0%)	NS

Abbreviation: NS, non-significant.
[a]Indicates a relatively high degree of social support.
[b]A total of 24 patients mother did not give information.

In contrast, gestational age, birth weight, cesarean section, in-hospital time and disease severity scores (clinical risk index for babies, SNAP-II, SNAP perinatal extension-II, nursery neurobiological risk score) were not significantly different for children with secure (B) or insecure (A, C, D) attachment.

Likewise, maternal factors including age of the mother, degree of depression at time points *t*-1, *t*-2, *t*-3, social support at *t*-1 and *t*-3, social status of mother and father, and pregnancy history were not significantly different between children with secure and insecure attachment and in both groups mothers felt a high

Table 4 Binary logistic regression analysis of secure attachment

Variable	*Odds ratio*	*95% CI*	P-*value*
'Seen' after birth	4.5	(1.4–14.4)	0.01
First child	0.14	(0.03–0.78)	0.02

Abbreviation: CI, confidence interval.

degree of social support. Finally, no influence on attachment behavior was shown for motor and cognitive development at the ages of 3 (*t*-2) and 12 months (*t*-3) CA (assessed using Bayley scales of infant development-II). The higher rate of breastfeeding in the secure-attachment group of preterm infants (49% versus 31%) did not reach statistical significance.

Discussion

In this study, we tested the hypothesis that a 'sensitive period' exists for preterm infants within the first hours after birth and that infants who had been seen by their mothers shortly after birth showed more secure attachment patterns at the age of 12 to 18 months of life CA.

On the basis of our data, the only significant factor influencing the development of a secure attachment pattern (apart from the known stronger tendency of firstborns to develop insecure attachment) was if mothers saw their infants within 3 h after birth. As shown in Table 4, linear regression analysis identified both 'seeing after birth' and 'not being the first child' as significant predictors for secure attachment. This finding supports the hypothesis that the first hours after birth are a 'sensitive period' for the development of attachment behavior. Although our data substantiate that this 'sensitive period' is also important for VLBW preterm infants, the existence of a 'sensitive period' in the first hours after birth for full-term infants has already been shown in several studies.[1,2,20,21] These works consistently described a period when mother and infant establish first interaction patterns, which in the course of the child's first year of life lead to the development of a secure attachment behavior. In 1972, Klaus *et al.*,[2] described that mothers who had had skin-to-skin contact with their newborn in the first 3 h after birth showed significantly more eye-to-eye contact and touched their children more often 1 month after birth. Mothers who had had skin-to-skin contact with their child after birth caressed their child more frequently later.[1,21] These observations are also supported by animal studies.[7] A more recent study by Bystrova *et al*.[20] found additional evidence for the existence of a sensitive period in full-term infants. The authors showed that skin-to-skin contact and/or breastfeeding in the first 2 h after birth had a positive effect on mother–child interaction at 1 year later, and that a separation of mother and child after birth more frequently led to dysregulated and irritable behavior of the child. This was also the case when mother and child were only separated for the first 2 h after birth. The authors postulate that this 'sensitive period', which is characterized by a special neuroendocrine situation leads, via conditioning or imprinting effects, to a subconscious learning process shaping the interaction of mother and child. This process forms the behavioral basis of mother and child in the first year, which ideally leads to a secure attachment pattern. On the basis of these observations, it was concluded that for full-term infants, an early contact of mother and child should be allowed whenever possible.[1]

The attachment behavior of preterm infants has also been analyzed in several studies using the strange situation.[22–28] In most studies, preterm infants seem to show an attachment behavior similar to full-term infants. Reports from Pohlmann and Fiese[23] and Brown and Bakeman[24] describe 50 and 75% of securely attached preterm infants, respectively. In line with these observations, 53.8% of the children showed secure attachment in our study. A meta-analysis[29] of 34 studies on attachment showed that infant factors only weakly influence the development of a secure attachment. Populations with predominantly child-related problems (preterm births,[24–27] developmental delay,[30] deafness[31] and autism[30]) showed a distribution of attachment behaviors similar to healthy full-term infant populations. In our study, we did not find a significant difference in Bayley scales of infant development-II between both groups. However, because of the limited number of patients included in this study, an influence of developmental delay on attachment behavior cannot be excluded.

Concerning the bonding behavior, several studies reported differences between mothers of preterm and full-term infants.[33–35] Korja *et al*.[33] compared bonding patterns of mothers of full-term infants with those of mothers of preterm infants using the working model of the child interview. Both groups showed a similar rate of balanced attachment representations, with significant differences in the scores for coherence, acceptance of the infant and caregiving sensitivity. Borghini *et al*.[34] found less balanced attachment representations in mothers of preterm infants, assessed at 6 and 18 months CA. Although preterm infants are not naturally more insecurely attached, they demand more sensitivity and responsiveness. In this context, it was shown that mothers with a high stress level due to the preterm birth,[36] overly anxious mothers,[37] mothers separated from their child for longer periods,[37] mothers with subclinical depressive symptoms[23] and mothers of preterm infants with neurological limitations,[23] are often limited in their attachment representations and are unable to raise the increased responsiveness and sensitivity the preterm infants need to develop a secure attachment behavior. Similarly, it was reported that maternal factors, such as maternal psychosis, affective disorder or depression[23,32] significantly reduce the rate of children with secure attachment. This might also be explained by the predominant role of maternal responsiveness and sensitivity for attachment behavior.[11] Thus, a high maternal

responsiveness might compensate for infant problems, such as preterm birth.

A secure attachment is especially important for preterm infants, as studies show differences in cognitive performance and attachment behavior at the age of four in these children[38] and less behavioral disorders in securely attached preterm infants.[39] Insecure and unresolved attachment representations also increase the risk of attention deficit hyperactivity disorders.[40]

If a mother is able to see her infant shortly after birth, this could help develop an optimal maternal attachment representation by taking advantage of the 'sensitive period'. The simple effect of just seeing her infant seems to alter the mother's behavior and emotions allowing to generate a more secure attachment as evidenced in specific behavior in the infant. This could form the basis for secure attachment under the difficult conditions of preterm birth, with prolonged separation of mother and child. The early encounter of mother and infant after birth is essential for this, especially in light of the results of Feldman *et al*.,[37] who showed that a late first contact of mother and child led to a reduction of maternal attachment behaviors and representations.

Despite of the significant influence on attachment behavior in our cohort, if mothers saw their children within 3 h after birth our study has several limitations: First, it was not initially designed to investigate the existence of a 'sensitive period' with preterm infants and thus is an exploratory study rather than an *a priori* hypothesis testing study. In addition, the design was not controlled randomized and statistical calculations of the required number of cases have not been performed. Motherly attachment representations have also not been investigated. Finally, potential confounders, such as parental socioeconomic status and paternal factors have not been evaluated.

However, on the basis of our data, we believe that an appropriate controlled-randomized hypothesis testing study analyzing the interrelation between attachment behavior and time and length of contact between mother and child should be implemented.

Conclusion

Maternal sensitivity and responsiveness are of particular importance for preterm infants in order to develop a secure attachment. Secure attachment of preterm infants to responsive mothers reduces behavioral disorders in later life. When mother and child are separated after birth, the 'sensitive period', an important phase for the development of the quality of maternal attachment, passes unused. When a mother is enabled to see her child within 3 h after birth, the 'sensitive period' right after birth may be used to help forming an important basis for the secure attachment of the preterm infant.

A secure attachment is especially important for preterm infants. This needs further and more detailed analysis in well-designed randomized trials.

Conflicts of interest

The authors declare no conflict of interests

References

1 Bowlby J. The nature of the child's tie to his mother. *Int J Psychoanal* 1958; **39**: 350–373.
2 Klaus M, Jarauld R, Kreger N, McAlpine W, Steffa M, Kennell JH. Maternal attachment: importance of the first postpartum days. *New Engl J Med* 1972; **286**: 460–463.
3 Winnicott DW. *Collected Papers: Through Pediatrics to Psychoanalysis*. New York Basic Books: New York, 1956.
4 Christensson K, Siles C, Morena L, Belaustequi A, De la Fuente PH *et al.* Temperature, metabolic adaptation and crying in healthy full-term newborns cared for skin-to-skin or in a cot. *Acta Paediatr* 1992; **81**: 488–493.
5 Uvnäs-Moberg K. Role of efferent and afferent vagal nerve activity during reproduction: Integrating function of oxytocin on metabolism and behavior. *Psychoneuroendocrinol* 1994; **19**: 687–695.
6 Christensson K, Cabrera T, Christensson E, Unäs-Moberg K, Winberg J. Separation distress call in the human neonate in the absence of maternal body contact. *Acta Paediatr* 1995; **84**: 468–473.
7 Liu D, Diorio J, Tannenbaum B, Caldji C, Francis D, Freedman A *et al.* Maternal care, hippocampal glucocorticoid receptors, and hypothalamic-pituitary-adrenal responses to stress. *Science.* 1997; **277**: 1659–1662.
8 Holst S, Lund I, Uvnas-Moberg K, Petersson M. Postnatal oxytocin treatment and postnatal stroking of rats reduce blood pressure in adulthood. *Auton Neurosci* 2002; **99**: 85–90.
9 Kennell JH, Klaus MH. Bonding: recent observations that alter perinatal care. *Pediatr Rev* 1998; **19**: 4–12.
10 O'Connor S, Vietze PM, Sherrod KB, Sandler HM, Altemeier WA. Reduced incidence of parenting inadequacy following rooming in. *Pediatrics.* 1980; **66**: 176–182.
11 Ainsworth MDS, Wittig BA. Attachment and exploratory behavior of one-year-olds in a strange situation. In B.M. Foss (Ed.) *Determinants of Infant Behavior*. Methuen: London, 1969.
12 Main M, Salomon J. Discovery of an insecure-disorganized/disoriented attachment pattern. In TB Brazelton and MW Yogman (Eds.). *Affective Development of Infancy* (pp 95–124) Ablex: Norwood; NJ, 1986.
13 Cockburn F, Cooke RWI, Gamsu HR, Greenough A, Hopkins A, McIntosh N, *et al.* The CRIB (clinical risk index for babies) score: a tool for assessing initial neonatal risk and comparing performance of neonatal intensive care units. *Lancet* 1993; **342**: 193–198.
14 Richardson DK, Corcoran JD, Escobar GJ, Lee SK. SNAP-II and SNAPPE-II: simplified newborn illness severity and mortality risk scores. *J Pediatr* 2001; **138**: 92–100.
15 Brazy JE, Eckerman CO, Oehler JM, Goldstein RF, O'Rand AM. Nursery neurobiologic risk score: important factors in predicting outcome in very low birth weight infants. *J Pediatr* 1991; **118**: 783–792.
16 Bayley N. Manual for the Bayley Scales of Infant Development 2nd edn. The Psychological Cooperation: San Antonio, TX, 1993.
17 Meyer EC, Zeanah CH, Boukydis CFZ, Lester BM. A clinical interview for parents of high-risk infants. *Infant Ment Health J* 1993; **14**: 192–205.
18 Hautzinger M, Bailer M. *ADS Allgemeine Depressions Skala*. Beltz: Weinheim, 1993.
19 Fydrich T, Sommer G, Menzel U, Höll B. Fragebogen zur sozialen unterstützung (Kurzform, SOZU-K-22). Kurzbericht. *Z Klin Psychol* 1987; **16**: 434–436.
20 Bystrova K, Ivanova V, Edhborg M, Mathiesen AS, Ransjö-Arvidson AB, Mukhamedrakhimov R *et al.* Early contact versus separation: effects on mother-infant interaction one year later. *Birth* 2009; **36**: 97–109.
21 Anisfeld E, Lipper E. Early contact, social support, and mother-infant bonding. *Pediatrics* 1983; **72**(1): 79–83.
22 Brisch KH, Bechinger D, Betzler S, Heinemann H. Early preventive attachment-orientated psychotherapeutic intervention program with parents of a very low

birthweight premature infant: results of attachment and neurologic development. *Attach Hum Dev* 2003; **5**: 120–135.

23 Pohlmann J, Fiese B. The interaction of maternal and infant vulnerabilities on developing attachment relationships. *Dev Psychopathol* 2001; **13**: 1–11.

24 Brown JV, Bakeman R. Relationships of human mothers with their infants during the first year of life: Effect of prematurity. In RW Bell & RP Smotherman (Eds.) *Maternal Influence and Early Behavior* (pp. 353–375) MTP: Lancaster, PA, 1980.

25 Frodi A, Thompson R. Infants affective responses in the strange situation: effects of prematurity and quality of attachment. *Child Dev* 1985; **56**: 1280–1290.

26 Plunkett J, Meisels S, Stiefel G, Pasick P, Roloff D. Patterns of attachment among preterm infants of varying biological risk. *JAACAP* 1986; **25**: 794–800.

27 Rode SS, Chang PN, Fisch RO, Sroufe LA. Attachment patterns of infants separated at birth. *Dev Psychol* 1981; **17**: 188–191.

28 Eaterbrooks MA. Quality of attachment to mother and to father: effects of perinatal risk status. *Child Dev* 1989; **60**: 825–830.

29 Ijzendoorn M, Goldberg S, Kroonenberg PM, Frenkel OJ. The relative Effect of maternal and child problems on the quality of attachment: a meta-analysis of attachment in clinical samples. *Child Dev* 1992; **63**: 840–858.

30 Shapiro T, Sherman M, Calimari G, Koch D. Attachment in autism and other developmental disorders. *JAACAP* 1987; **26**: 480–484.

31 Lederberg AR, Mobley CE. The effect of hearing impairment on the quality of attachment and mother-toddler interaction. *Child Dev* 1990; **61**: 1596–1604.

32 Figueiredo B, Costa R, Pacheco A, Pais I. Mother-to-infant emotional involvement at birth. *Matern Child Health J* 2009; **13**: 539–549.

33 Korja R, Savonlahti E, Haataja L, Lapinleimu H, Manninen H, Piha J, *et al*. Attachment representations in mothers of preterm infants. *Inf Behav Dev* 2009; **32**: 305–311.

34 Borghini A, Pierrehumbert B, Miljkovitch R, Müller-Nix C, Forcada-Guex M, Ansermet F. Mothers attachment representations of their premature infant at 6 and 18 months after birth. *Infant Ment Health J* 2006; **27**: 494–508.

35 Forcada-Guex M, Pierrehumbert B, Borghini A, Moessinger A, Muller-Nix C. Early dyadic patterns of mother-infant interactions and outcomes of prematurity at 18 months. *Pediatrics* 2006; **118**: e107–e114.

36 Muller-Nix C, Forcade-Guex M, Pierrehumbert B, Jaunin L, Borghini A, Ansermet F. Prematurity, maternal stress and mother-child interactions. *Early Human Dev* 2004; **79**: 145–158.

37 Feldman R, Weller A, Leckman JF, Kuint J, Eidelman AI. The nature of the mother's tie to her infant: maternal bonding under conditions of proximity, separation and potential loss. *J Child Psychol Psychiatr* 1999; **40**: 929–939.

38 Sajaniemi NEA. Cognitive performance and attachment patterns at four years of age in extremely low birthweight infants after early intervention. *Eur Child Adolesc Psychiatr* 2001; **10**: 122–129.

39 Laucht M, Esser G, Schmidt MH. Differential development of infants at risk for psychopathology: the moderating role of early maternal responsivity. *Dev Med Child Neurol* 2001; **43**: 292–300.

40 Kissgen R, Krischer M, Kummetat V, Spiess R, Schleiffer R, Sevecke K. Attachment representation in mothers of children with attention deficit hyperactivity disorder. *Psychopathol* 2009; **42**: 201–208.