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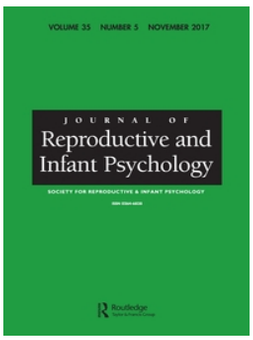

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Antenatal mother–infant bonding scores are related to maternal reports of infant crying behaviour

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ABSTRACT

Objective: To assess the relation between antenatal mother–infant bonding scores and maternal reports of infant crying behaviour.

Background: Crying is normal behaviour and it is important for parent–infant bonding. Even though bonding starts antenatally, the relation between antenatal bonding scores and infant crying behaviour has never been studied.

Method: A secondary analysis was performed on data that were gathered in a large prospective study within our region. Bonding was assessed using an antenatal bonding questionnaire at 32 weeks gestational age. The crying behaviour of infants was assessed with three questions at six weeks postpartum. Crying was termed excessive (EC+) when mothers perceived the crying to be 'every day', 'often' or 'very often', and with 'crying episodes lasting more than 30 minutes'; in other words, when mothers scored high on all three questions. The relation between bonding and crying was examined using a multiple logistic regression analysis, including adjustment for relevant variables, especially maternal depression as measured with the Edinburgh Depression Scale.

Results: In total, 894 women were included of whom 47 reported EC+ infants (5.3%). Antenatal bonding scores were significantly related to the reporting of crying behaviour, even after adjustment for relevant variables ($p = 0.02$). Each extra point on the bonding scale reduced the EC+ risk with 14% (OR = 0.86, 95% CI [0.76–0.97]).

Conclusion: Mothers with lower antenatal bonding scores were more likely to report an EC+ infant. Future research should further explore the concept of antenatal bonding, its relation with EC and risks associated with EC.

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Antenatal; mother–infant; bonding; crying; depression

Introduction

In the 1980s excessive crying (EC) was the most common first complaint brought to physicians by parents (Forsyth, 1989). Nowadays, EC is still the reason for 10–20% of the paediatric consultations at the age of two weeks to three months (Akhnikh, Engelberts, van Sleuwen,

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L'Hoir, & Benninga, 2014) and there is evidence linking it to maternal anxiety and depression, infant adaptive and behavioural problems, and even to child abuse (Evanoo, 2007; Halpern & Coelho, 2016). A better understanding of EC and its risk profile can contribute to the management of this important societal problem.

Crying is important, physiologically driven behaviour, meant to maintain the caregivers' proximity to infants in order to assure nutrition, protection and parent–infant contact (Barr, 1990). Therefore, every infant cries, starting from the moment he or she is born and continuing according to a universal pattern: crying peaks around six weeks postpartum and declines about four months postpartum. This universality suggests innate programming (Evanoo, 2007; Ludington-Hoe, Cong, & Hashemi, 2002). Much remains to be learned about the how and why of this programming, in other words, about how this specific crying pattern contributes to the infant–caregiver relationship. However, human evolutionary history has shown that optimal parental care is likely to be reduced or withdrawn when child-rearing circumstances are unfavourable, and especially when infants appear less dependent of their caregiver. Such an environment of uncertain parental care constitutes a strong selective pressure on the human infant, including its cry signal, which can influence the behaviour of potential caregivers (Soltis, 2004). Therefore, evidence suggests that the crying peak has evolved to signal vigor to avoid the withdrawal of parental care at a time when infants transit from totally parent-oriented and parent-dependent to somewhat more explorative and self-regulative human beings in order to ensure the continuation of parental investment in offspring (Sameroff, 2010; Soltis, 2004). The crying signal can thus be considered a communicative cue for caregivers to respond to (Ludington-Hoe et al., 2002), and as such, crying is important for the process of caregiver–infant bonding (Kommers, Oei, Chen, Feijs, & Bambang Oetomo, 2016). Suboptimal bonding might therefore affect the crying behaviour of infants and vice versa.

The relation between crying and bonding has previously been assessed. Akman et al. (2006) reported that significantly more mothers with excessively crying infants (EC+) had an insecure attachment style as measured with the Adult Attachment Scale compared to mothers of infants with normal crying behaviour (EC–). Yalçin et al. (2010) reported similar findings using the Postpartum Bonding Questionnaire (PBQ). This suggests that crying is indeed associated with bonding.

The development of the mother–infant bond starts antenatally (Alhusen, 2008). Mothers associate their unborn child with positive feelings, such as warmth, joy and happiness (Keller, Lohaus, Völker, Elben, & Ball, 2003), especially during the second half of pregnancy when the fetus becomes more human to the mother (Brandon, Pitts, Denton, Stringer, & Evans, 2009). Nonetheless, to the best of our knowledge, there are no published papers about the relation between antenatal bonding and crying. We hypothesised that mothers with lower antenatal bonding scores would be more likely to experience the crying behaviour of their infant as excessive: the lower the score the greater the risk.

Data on both antenatal mother–infant bonding as well as infant crying behaviour were gathered in a large prospective study within our region. That study, the HAPPY study, aimed to provide a Holistic Approach to Pregnancy and the first Postpartum Year (Truijens et al., 2014). Participating mothers were asked three questions about the crying behaviour of their infants at six weeks postpartum. Additionally, mothers had been asked to fill in the Pre- and Postnatal Bonding Scale (PPBS) at 32 weeks gestational age (Cuijlits, van de Wetering, Truijens, Spek, & Pop, 2016).

Moreover, due to the holistic approach of the HAPPY study, several possibly influential variables were also investigated, such as the infant's gender, nutrition and his or her health condition including atopic features and gastro-intestinal functioning (Akhnikh et al., 2014; Evanoo, 2007; Savino et al., 2004). These are frequently examined infant-related variables influencing crying behaviour (Akhnikh et al., 2014). Maternal variables such as her educational level, age and mood were also assessed (Breslau, Davis, & Prabucki, 1988). Especially the latter is considered an essential confounder. A depressed maternal mood has been described to affect both self-reporting, mother–infant bonding and the crying behaviour of infants (Bolten, Fink, & Stadler, 2012; Breslau et al., 1988; Radesky et al., 2013).

The aim of this study was to assess whether a relation exists between antenatal bonding scores and the reporting of the crying behaviour of infants after adjustment for relevant infant-related and mother-related variables at different points in time, in order to contribute to the risk profile for EC and the management of this important problem.

Methods

Participants and procedure

Women who were included in the HAPPY study during its first year (April 2013–2014, N = 1,147) received the PPBS at 32 weeks of gestational age in order to validate that questionnaire. According to the HAPPY protocol, these women had also received several other questions and questionnaires regarding their obstetric history, lifestyle, health status, socio-economic status and mood at 12, 22 and 32 weeks gestational age (Truijens et al., 2014). Furthermore, they were followed-up at set time points in the postpartum period to investigate their wellbeing and the wellbeing of the infant, including three questions about the infant's crying behaviour in the sixth week postpartum (Truijens et al., 2014). An overview of the relevant assessments is shown in Figure 1. For more information on the HAPPY protocol, its in- and exclusion criteria, measurements and objectives, see Truijens et al. (Truijens et al., 2014).

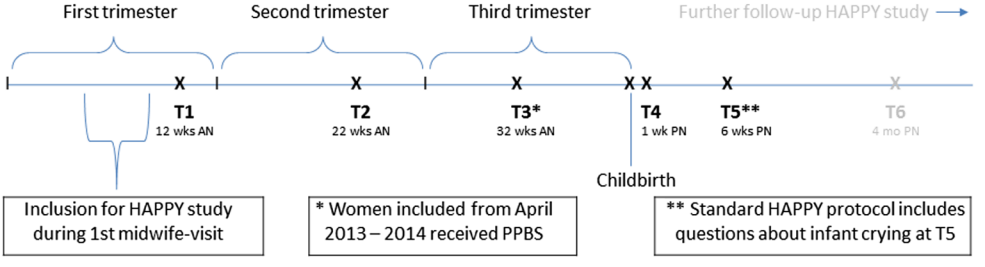

Figure 1. Timeline of the protocol of the current study within the protocol of the HAPPY study. The entire antenatal (AN) period is shown divided into the first, second and third trimester and separated from the postnatal (PN) period by the moment in time (X) representing childbirth. Specific time points during the HAPPY study are indicated by T1,T2, etc. Questions or questionnaires belonging to the HAPPY study are sent to participants at these times. These include questions about the crying behaviour of infants to all participating women at T5 (indicated with **). The Pre- and Postnatal Bonding scale (PPBS) on the other hand was sent to a subset of women included in the HAPPY study at T3 (32 weeks (wks) gestational age, indicated with an *) in order to validate that questionnaire.

For the current study, all women who completed the PPBS and all other questionnaires relevant for this study were eligible. Women giving birth preterm, or giving birth to an infant with a severe congenital anomaly or syndrome were excluded. Baseline characteristics of all included women can be seen in Table 1. A comparison between these women and the entire HAPPY sample revealed no significant differences regarding age, education and mental health scores at 12 weeks of pregnancy. The Medical Ethics Committee of the Máxima Medical Centre, Veldhoven, the Netherlands approved the HAPPY study. A written informed consent was obtained from all participants.

Assessments

Dependent variable: crying assessment at six weeks postpartum

At six weeks postpartum, women were asked three questions about the crying behaviour of their infants; one quantitative, one qualitative and one semi-qualitative question (see the appendix). Infants were termed 'excessive criers' when their mothers scored high on all three questions, i.e. when mothers reported their infants to (1) have a daily crying routine, with (2) one or more crying episodes lasting more than half an hour, which mothers interpreted as (3) crying often or very often. To examine the robustness of the maternal reports, we investigated the relation between the answers to the questions about crying and a question about efforts to soothe infants by swaddling them. Swaddling is the age-old practice of wrapping infants tightly in blankets to restrict their movements in an attempt to calm them (Evanoo, 2007). Mothers that swaddled their infant 'always or never', and mothers swaddling their infant 'depending on their crying behaviour' were identified.

Independent variable: antenatal bonding assessment at 32 weeks pregnancy

Antenatal bonding was assessed with the PPBS data gathered in the HAPPY study. The PPBS is a five-item bonding scale containing only positive statements to describe maternal feelings toward her unborn child. It showed to be a robust instrument with excellent psychometric properties (Cuijlits et al., 2016). The five items were: 'Over the past four weeks, I can describe my feelings toward my baby in my belly to be loving (item 1), happy and joyful (item 2), the most beautiful thing that ever happened to me (item 3), extraordinary (item 4), and blissful (item 5)'. Women had to answer on a four-point Likert scale from 'not at all' (score 0) to 'very much' (score 3). A higher score on this scale with a range from 0–15 reflected better bonding.

Confounding variable – maternal depression

Depressive symptoms were assessed using the Edinburgh Depression scale (EDS) and the Edinburgh Postnatal Depression Scale (EPDS). These are 10-item questionnaires, previously validated for use during pregnancy (Bergink et al., 2011) and in the postpartum period (Cox, Holden, & Sagovsky, 1987), and currently used extensively in over 40 countries worldwide including the Netherlands (Pop, Komproe, & van Son, 1992). In the HAPPY study, EDS scores were obtained at 12, 22 and 32 weeks of gestation and EPDS scores at one and six weeks postpartum. In the current study, the 32-week EDS score (the score at the time of the antenatal bonding assessment) and a grand mean (GM) of the antenatal EDS scores at 12, 22 and 32 weeks (GM EDS) were used to determine antenatal depressive symptomatology. Both the EPDS scores at one week and six weeks postpartum were used to determine postnatal

Table 1. Characteristics of all 894 included women and their infants together, and the comparison between women reporting their infant to cry excessively at six weeks postpartum (EC+) and women not reporting their infant to cry excessively (EC−) at six weeks postpartum.

	Total (n = 894)		EC+ (n = 47)		EC− (n = 847)		p-value	
	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)	n (%)	T	X^2
Demographic features								
Age (in years)	30.6 (3.7)		30.8 (4.0)		30.6 (3.7)		0.69	
Educational level								0.31
Low–medium		329 (37)		14 (30)		315 (37)		
High[a]		565 (63)		33 (70)		532 (63)		
Marital status								0.56
With partner		888 (99.3)		47 (100)		841 (99.3)		
Single		6 (0.7)		0		6 (0.7)		
Life style habits during pregnancy								
Alcohol +		48 (5.4)		4 (8.5)		44 (5.2)		0.33
Smoking +		51 (5.7)		1 (2.1)		50 (5.9)		0.28
BMI	23.8 (3.9)		23.1 (3.1)		23.8 (4.0)		0.22	
Obstetric features – pregnancy								
Unplanned pregnancy		45 (5)		2 (4.3)		43 (5.1)		0.80
Parity								0.56
Primiparous		420 (47)		24 (51)		396 (46.8)		
Multiparous		474 (53)		23 (49)		451 (53.2)		
Prev. misc/abort.		248 (28)		9 (19)		239 (28)		0.18
Obstetric features – delivery								
Mode of delivery								0.26
Non-instr.		767 (86)		41 (87)		726 (86)		
Instr. assist.		63 (7)		5 (11)		58 (6.8)		
C-section		64 (7)		1 (2)		63 (7.4)		0.20
GA at birth (wk)	39.9 (1.1)		39.9 (0.8)		39.9 (1.1)		0.84	
Psychological characteristics – pregnancy								
Depression in hist.		129 (14)		7 (15)		122 (14)		0.93
Score on PPBS[b]	**12.4 (2.4)**		**11.5 (2.3)**		**12.4 (2.4)**		**0.01**	
EDS 32 wks GAc	4.9 (4.2)		5.4 (4.3)		4.9 (4.2)		0.42	
GM EDS scorec	4.7 (3.4)		5.4 (3.8)		4.6 (3.4)		0.15	
Psychological characteristics – postpartum								
EPDS 1wpp	**4.6 (4.2)**		**6.1 (4.7)**		**4.5 (4.1)**		**0.01**	
EPDS 6wpp	**5.0 (4.4)**		**7.4 (4.6)**		**4.9 (4.3)**		**<0.001**	
Infant related parameters								
Gender								0.39
Boy		446 (49.9)		21 (43)		427 (50.5)		
Girl		448 (50.1)		26 (57)		420 (49.5)		
Birth weight (g)	3532 (436)		3583 (420)		3530 (437)		0.41	
Breastfed at 6wpp		**427 (47.8)**		**15 (32)**		**412 (49)**		**0.03**
On reflux meds		**29 (3.2)**		**8 (17)**		**21 (2.5)**		**<0.001**
On defecat. meds		**25 (2.8)**		**4 (8.5)**		**21 (2.5)**		**0.02**
>1 fever episodes		84 (9.4)		5 (11)		79 (9.3)		0.76
Daily coughing		22 (2.5)		4 (6)		19 (2.2)		0.08
Skin rashes		**153 (17)**		**17 (36)**		**136 (16)**		**<0.001**

Abbreviations: SD, standard deviation; T, t-test value; X^2, chi-square test value; Prev. misc/abort., previous miscarriage / abortion; Non-instr., non-instrumental, spontaneous delivery; Instr. assist., Instrumentally assisted delivery, C-section, Cesarean Section; GA, Gestational age (weeks); hist., history; PPBS, Pre- and Postnatal Bonding Scale; EDS, Edinburgh Depression Scale; GM EDS, Grand Mean – EDS (mean of EDS scores at GA 12+22+32); EPDS, Edinburgh Postnatal Depression scale; 1wpp / 6wpp, one or six weeks postpartum; meds, medication; defecat., defecation.

[a]Bachelor or Master's degree

[b]higher score reflects better bonding

[c]higher scores reflects more depressive symptomatology. Bold: Significance as defined by $p<0.05$.

depressive symptomatology. Total scores range from 0 to 30. Higher scores indicate more depressive symptomatology.

The EPDS scores correlated significantly with the PPBS scores in the expected direction. However, the effect size was low, demonstrating that the PPBS does not represent the same as the inverse outcome of the depressive mood score (Pearson's $r = -0.20$, $p < 0.05$).

Relevant mother-related and infant-related variables

Relevant variables such as the maternal age, parity and education, as well as the infant's gender, gestational age, birth weight and nutrition (breast milk or formula feeding) were retrieved from the HAPPY database. In addition, maternal reports about gastro-intestinal dysfunctioning and atopic features of infants were gathered. A gastro-intestinal dysfunction was 'diagnosed' when infants were in need of medication for either reflux or constipation and atopic constitution was 'diagnosed' when mothers reported skin rashes or coughing not related to any infection to be present 'very often' or 'continuous'. A possible association between multiple periods of fever and crying was examined as well.

Statistical analyses

Statistical analyses were performed using the Statistical Package of Social Sciences (SPSS, version 22, IBM, Chicago, Illinois, USA). As a first step, women were divided into an EC+ and EC– group. Differences between these two groups were analysed at a univariate level with t-tests comparing the means and standard deviations (SD) for continuous variables and χ^2 statistics for categorical variables, including swaddling behaviour. All variables except swaddling are displayed in Table 1 and considered significant and relevant for entering into a multivariate analysis if $p<0.05$. Additionally, mothers were categorised into three groups and the percentages of EC+ babies within these groups were calculated to visualise the pattern of the relation between bonding scores and crying. Suboptimal bonding was defined as more than 1 SD below the average PPBS score (corresponding to the 15th percentile), optimal bonding as more than 1 SD above the average PPBS score (corresponding to the 75th–100th percentile) and normal bonding as between −1 SD and +1 SD (corresponding to the 16–74th percentile). Also, because maternal depression was considered a very important determinant of PPBS scores based on the literature, the relation between infant crying and maternal depression was evaluated throughout time using a GLM-ANOVA (Radesky et al., 2013).

Finally, a multiple logistic regression analysis was performed (OR; 95% CI) with EC+/- as the dependent variable, antenatal bonding as the independent variable, and adjustment for the variables that were significantly related to the dependent variable at a univariate level.

Results

In total, 995 of the 1,147 women (87%) who received the PPBS returned it completed, of whom 101 were excluded based on the exclusion criteria. Of the resulting 894 women, 47 (5.3%) reported the crying behaviour of their infant to be excessive according to our definition (EC+). Swaddling was common for 36% of the EC+ group (N = 17), compared to 15% (N = 131) in the EC– group (χ^2 (1) = 13.8, $p<0.001$). As can be seen in Table 1, several other characteristics were significantly different when comparing the EC+ group to the EC– group,

including the score on the PPBS. The mean score was 12.4 (SD 2.4) for the 847 EC– women and 11.5 (SD 2.3) for the 47 EC+ women (t = 2.56, $p = 0.013$, Cohen's d 0.38, reflecting a small to moderate effect size). When categorising women into three groups (PPBS scores more than one SD below the mean, scores between one SD below the mean and one SD above the mean, and scores more than one SD above the mean), women with the lowest PPBS scores reported a 3.1 times higher EC+ percentage (χ^2 (2) = 6.69, $p = 0.035$) than women with the highest scores, 9.3% versus 3% respectively, see Figure 2.

The EPDS scores at six weeks postpartum were also significantly related to crying (Table 1). The mean EPDS score was 4.9 (SD 4.3) for the 847 EC– women and 7.4 (SD 4.6) for the 47 EC+ women (t = 3.62, $p = 0.001$, Cohen's d 0.56, reflecting a moderate effect size). A GLM-ANOVA showed that women with EC+ infants had a significantly different pattern of depressive symptomatology throughout pregnancy and up until six weeks postpartum (see Figure 3). Mean scores were continuously higher and increased more for the EC+ group (F = 10.9, $p = 0.001$).

In addition to the bonding and depressive symptomatology scores, four other variables showed a significant difference between the EC+ and the EC– group as shown in Table 1. A multiple logistic regression analysis with EC+/- as dependent variable and antenatal bonding as independent variable showed that the effect of bonding persisted when adjusting for depressive symptomatology and those other variables (OR = 0.86, 95% CI [0.76–0.97]), as can be seen in Table 2. The OR implies that each point scored on the PPBS reduced the chance of reporting an EC+ infant by 14%. Additional persisting effects ($p<0.05$) on EC were found for maternal depressive symptomatology at six weeks postpartum (OR = 1.09, 95% CI [1.02–1.17]) and four infant-related parameters. The latter were reflux medication (OR = 6.31, 95% CI [2.49–16.02]), skin rashes (OR = 2.58, 95% CI [1.34–4.98]), constipation medication (OR = 3.37, 95% CI [1.00–11.34] and being breastfed at six weeks postpartum (OR = 0.49, 95% CI [0.25–0.95]. A proxy of the total variance predicted by this model was 5–16%, as reflected by the Cox-Snell and Nagelkerke coefficient (0.05 and 0.16 respectively).

Discussion

The relation between antenatal bonding scores and infant crying

The aim of the current study was to investigate the relation between maternal antenatal bonding scores and the crying behaviour of infants at six weeks postpartum within a multifactorial model. In total, 5.3% of the mothers reported their infant to cry excessively according to our definition. The mean antenatal bonding score of the mothers in the EC+ group was significantly lower compared with the EC– group mean score. This difference persisted after adjusting for several infant-related and mother-related variables, including antenatal and postnatal depressive symptoms. In fact, a multiple logistic regression analysis demonstrated that each point increase on the PPBS reduced the risk of reporting an EC+ infant by 14% (OR 0.86, $p = 0.016$) which is interesting seeing that excessive crying is a costly complaint for health care, sometimes even leading to child abuse (Evanoo, 2007; St James-Roberts & Conroy, 2005). For clinical practice, these findings thus suggest that identifying women with poor antenatal bonding could be worthwhile for educational purposes and risk profiling.

The findings were obtained in a sample comparable to the total Dutch population when regarding obstetric features (parity, mean age, term of gestation) (The Netherlands Perinatal

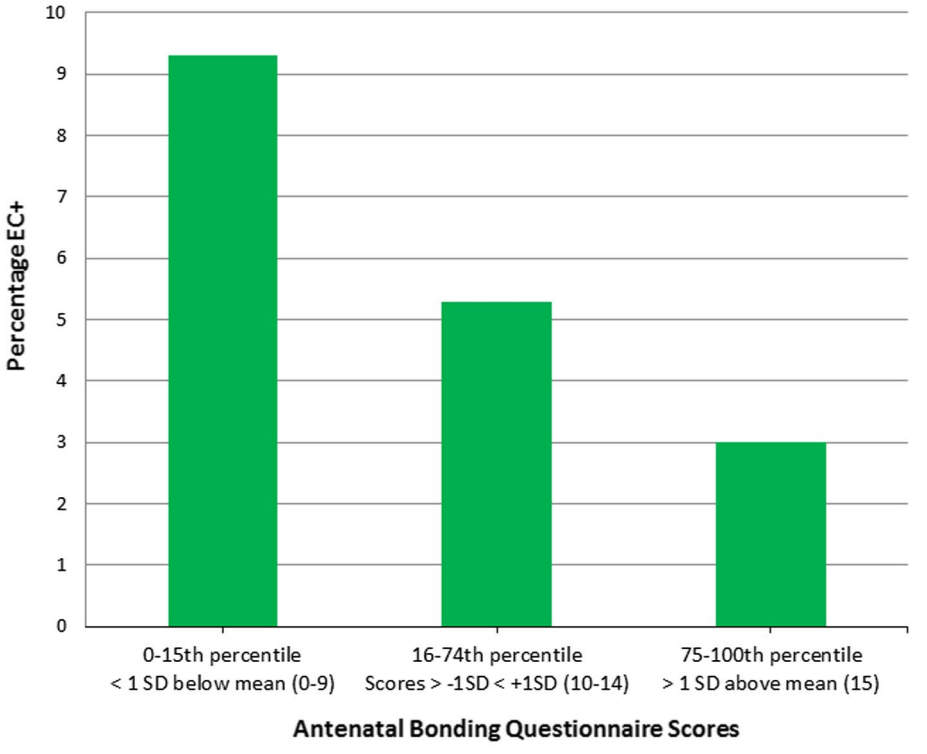

Figure 2. Percentages of infants that cry excessively (EC+) when categorising mothers into three groups according to their antenatal bonding scores. Three groups are formed: mothers scoring more than one standard deviation (SD) below the average, corresponding to the 15th percentile, mothers scoring between −1 SD and +1 SD, corresponding to the 16–74th percentile, and mothers scoring more than one SD above the average score on the Pre- and Postnatal Bonding Scale (PPBS), corresponding to the 75–100th percentile. PPBS scores < −1 SD: 0–9, N = 129; scores between −1 SD and +1 SD: 10–14, N = 530; scores > +1 SD: 15, N = 235. Percentages of EC+ infants differed significantly between the three groups, they were 9.3, 5.3 and 3.0% respectively (χ^2 (2) = 6.69, p = 0.035).

Registry, 2014) and mental health scores as measured by the EDS (Bergink et al., 2011). Nevertheless, differences existed between this sample and the Dutch population regarding ethnic diversity (women were Caucasian only) and the level of education. In this sample, 63% of the women were highly educated (aged 20–42), in comparison to approximately 44% of all Dutch women between 25 and 35 years (Dutch Central Bureau for Statistics, 2012), which might reduce the generalisability. Generally for instance, the percentage of EC+ infants reported in studies (15–30%) is higher than the percentage reported in our study (5.3%) (Akhnikh et al., 2014; Johnson, Cocker, & Chang, 2015), which could be due to the new measurement of EC used by us.

Since the early 1950s, the most widely used measurement is Wessel's quantitative 'rule of three', saying that crying is excessive when lasting for three hours, during three days a week, for over three weeks (Akhnikh et al., 2014). However, in 1962 another classic definition for EC was introduced by Brazelton stating that any amount of crying that worries parents is excessive (Brazelton, 1962). Since crying is considered a communicative cue in the

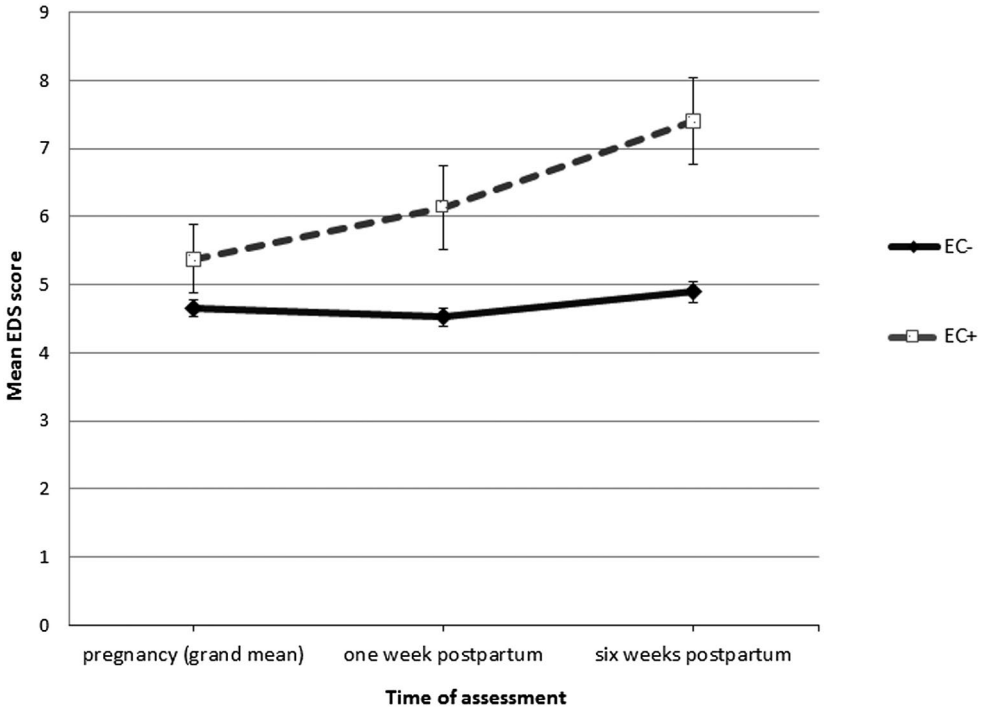

Figure 3. The difference between the mean EDS scores of the mothers in the EC+ and EC− group throughout time as calculated with a repeated measurement analysis of variance. The y-axis reflects the mean EDS score and the x-axis the measurement intervals. The difference between the repeatedly measured EDS scores in the EC+ and EC− group was statistically significant ($F = 10.9$, $p = 0.001$). The included intervals were (1) antenatally, (2) immediately postpartum and (3) six weeks postpartum. For the antenatal interval, the grand mean of three EDS scores at three different moments during pregnancy was used (12 weeks, 22 weeks and 32 weeks).

Table 2. The odds ratios (OR), 95%-confidence intervals (95% CI) and *p*-values of having an excessively crying infant (dependent variable) as measured by maternal reporting at six weeks postpartum (multiple logistic regression analysis, $N = 894$).

Parameter	OR	95% CI	*p*-value
Mother related variables			
Score on antenatal bonding questionnaire	0.86	0.76 – 0.97	**0.016***
GM EDS score	0.94	0.85 – 1.05	0.278
EPDS score at one week postpartum	1.01	0.93 – 1.08	0.744
EPDS score at six weeks postpartum	1.09	1.02 – 1.17	**0.005***
Infant related variables			
Reflux medication (yes/no)	6.31	2.49 – 16.02	**<0.001***
Breastfed at 6 weeks postpartum (yes/no)	0.49	0.25 – 0.95	**0.034***
Skin rashes (yes/no)	2.58	1.34 – 4.98	**0.005***
Constipation medication (yes/no)	3.37	1.00 – 11.34	**0.050***

Abbreviations: OR, odds ratio; CI, Confidence interval, GM EDS, grand mean Edinburgh Depression Scale (the mean of the 12, 22 and 32 week gestational age EDS score); EPDS, Edinburgh Postnatal Depression Scale.
*Significance as defined by *p*-value<0.05.

mother–infant dialog, and not only the duration, but also the perception of a cue can be disturbing, both a qualitative and a quantitative definition seem justified.

Lucassen et al. systematically analysed EC+ incidences and reported varying cumulative incidences (5–19%) depending on the definition of EC (Lucassen et al., 2001). High incidences

were found when using purely quantitative definitions, whereas qualitative definitions yielded low EC+ incidences of about 5% (Lucassen et al., 2001). In the current study, we used three semi-qualitative, semi-quantitative questions that were asked routinely within the HAPPY study as part of its holistic examination of the wellbeing of mother and infant. Only those infants of women scoring high on all three questions were considered EC+. In agreement with the literature, the EC+ percentage based on the quantitative part of the measurement was 16%, whereas the qualitative part reduced the EC+ percentage to 5.3%. It seems that mothers are less inclined to report high scores for qualitative questions about their infant's crying behaviours. A quantitative definition could thus overestimate the percentage of EC, especially with a cut off for crying episodes considered to be excessive at merely 30 min. Nonetheless, the combination of the questions appears to be relevant. Together the questions assess both the possibility of an actual increase in the amount of crying due to suboptimal bonding, and, since both variables were measured using maternal reports, also a possible association between the mother's antenatal and postnatal perceptions of her infant and his or her cues, without an actual increase in crying duration. As previously stated, not only the actual duration of crying, but also the perception of crying can disturb the mother–infant dialog and defining excessiveness can therefore be valid based on both measures. Moreover, the validity of the EC+ measure is supported by the fact that swaddling, in an attempt to soothe infants, was significantly more common in the EC+ group.

When dividing this EC+ group into three subgroups, the EC+ percentage significantly increased in mothers that were categorised into the group with the lowest PPBS scores, in other words, the mothers experiencing the least positive feelings such as joy and blissfulness toward their fetus. These women reported their infant to cry excessively 3.1 times more than women scoring highest on the PPBS did and this effect persisted after adjustment for several important variables. The most essential variable that was adjusted for, was maternal depressive symptomatology (Breslau et al., 1988).

Variables

Maternal depressive symptomatology affected the reporting of EC. Women in the EC+ group constantly had higher mean depressive scores ($p = 0.001$). Interestingly, as opposed to bonding, the antenatal effect of mood on the reporting of infant crying was not significant. The effect of mood was the strongest at six weeks postpartum, the moment that crying behaviour was assessed. This could reflect the fact that EC also influences (depressed) mood instead of only the other way around.

Other important variables that were adjusted for were infant-related. Those variables were investigated as quantifiable outcomes whenever possible. For symptoms difficult to recognise and therefore difficult to quantify, such as constipation and reflux, prescribed medication was used to define the problem. In the current study, the prescription of constipation medication was associated with a 3.4-fold risk of having an EC+ infant ($p = 0.05$), whereas medication for reflux was associated with a 6.3-fold risk of having an EC+ infant ($p<0.001$). However, this should be interpreted with caution. Health professionals often treat crying babies who regurgitate or demonstrate back arching with antacid medication without further diagnostics (Hassall, 2012). In the current study only a fairly modest 3.2% of the neonates received reflux medication, even though its prescription has substantially increased

over the past decades from about 0.5% in 2004 to over 10% in some countries in 2013 (Hassall, 2012).

In infants with skin rashes, EC+ was reported 2.5 times more ($p<0.01$). An atopic constitution can cause itching, which might indeed lead to EC (Alanne, Nermes, Söderlund, & Laitinen, 2011). This is supported by the fact that maternal milk can protect against atopic constitution and has been reported to reduce EC (Ludington-Hoe et al., 2002). In the current study, breastfeeding halved the risk of reporting an EC+ infant. Nonetheless, findings on the relation between breastfeeding and EC are not unanimous (Akhnikh et al., 2014; Johnson et al., 2015) and some limitations need to be taken into account to interpret the findings of this study.

Limitations and strengths

The scale used to assess antenatal bonding is considered a valid tool with excellent psychometric properties. However, it has not been used often before. Moreover, a new measurement was used to assess and define the crying behaviour of infants. Therefore, even though the timing of that assessment was in line with literature (at six weeks postpartum (Barr, 1990; Soltis, 2004)), comparing the findings in this study to those in other studies is difficult. Furthermore, antenatal depression was measured several times, but antenatal bonding was measured only once. To compensate for this, we calculated the effects of a mean antenatal EDS score (GM EDS) and the EDS score at 32 weeks gestational age (the time of the antenatal bonding assessment) and adjusted for the score demonstrating the strongest relation with crying. Finally, the EC– group was significantly larger than the EC+ group, but when comparing an EC- subsample of 47 women matched to the 47 EC+ women regarding age and EPDS scores at six weeks postpartum, the difference in the mean antenatal PPBS score remained (12.4 versus 11.5). Overall, the sample size of this study can thus be seen as a strength. Additional strengths are the total variance that could be explained by the model (16%) and the adjustment for several important variables, after which the difference in PPBS scores between the EC+ and EC– group remained. The effect size of this difference was only small to moderate with a Cohen's d of 0.38, but a moderate effect is considered an effect visible to the naked eye of a careful observer and small is not so small as to be trivial (Sullivan & Feinn, 2012). The findings of this study are therefore interesting for future research.

Conclusion

In this study, antenatal mother–infant bonding was significantly related to the reporting of infant crying behaviour at six weeks postpartum, even after adjustment for several other important variables including maternal depressive symptomatology. This warrants future research to further explore a possible relation between antenatal bonding, EC and its associated risks.

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Appendix

Question	Answers	Pt	Distribution (n, (%))	
1. Does your baby cry a lot / a little? My baby cries...'Kunt u aangeven of uw baby veel/ weinig huilt? Mijn baby huilt…'	Hardly ever	1	148 (16.6%)	Skewness: 0.70
	Sometimes	2	450 (50.3%)	
	Regularly	3	219 (24.5%)	Kurtosis: 0.59
	Often	**4**	60 (6.7)	
	Very often	**5**	17 (1.9%)	
2. Does your baby have a crying routine or a crying hour? 'Heeft uw baby een huiluurtje?'	No not at all	1	176 (19.7%)	Skewness: 0.37
	Hardly	2	289 (32.2%)	
	Yes, but not every day	3	60 (6.7%)	Kurtosis: −0.75
	Yes, every day at different times	**4**	150 (16.8%)	
	Yes, every day, at a set time	**5**	219 (24.5%)	
3. How long are the crying episodes averagely? 'Hoe lang huilt uw baby dan gemiddeld?'	My baby doesn't have cry episodes	1	273 (30.5%)	Skewness: 0.23
	Less than 15 min	2	243 (27.2%)	
	15 – 30 min	3	238 (26.6%)	Kurtosis: −1.2
	More than 30 min	**4**	140 (15.7%)	

Questions translated in English and the original Dutch questions. (1) Qualitative question (2) Semi-qualitative, semi-quantitative. (3) Quantitative question. **Bold**: Answers suggesting EC+ infant. Infants were termed EC+ when mothers reported a bold answering option for all three questions.