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Infant Crying Problems and Symptoms of Sleeping Problems Predict Attachment Disorganization at 18 Months

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Abstract

Early symptoms of sleeping problems and crying problems may occur at the same time, are highly stressful for parents and are likely to be associated with infant-mother attachment. This longitudinal study examined the associations among infant crying, symptoms of sleeping problems, and attachment while considering the influence of maternal sensitivity and depressive symptoms. 105 healthy full-term infants (42.9% female) were assessed for crying and symptoms of sleeping problems at 3 and 18 months via a structured parental interview. Maternal sensitivity was measured through researcher observation, and attachment was measured at 18 months using the Strange Situation procedure. It was found that infant crying and symptoms of sleeping problems were not linked to the organized patterns of secure or insecure (avoidant versus resistant) attachment. However, when disorganized attachment was considered, there were direct links found from infant crying and symptoms of sleeping problems at 3 months ($\beta = .22, p < .05$) and 18 months ($\beta = .21, p < .05$). Thus, crying and symptoms of sleeping problems as early as 3 months may indicate disruption in the coherence of infants' relationship to their caretakers.

Keywords: crying, sleeping, maternal sensitivity, attachment, infancy

Introduction

Being able to self-regulate is a critical skill that infants develop as it allows them to self-soothe in response to changes in sensory stimuli and regulate sleep states (Papoušek, 2011). Difficulties in self-regulation such as excessive crying and sleeping disturbances are often labelled as infant regulatory problems and are among the most common problems reported by parents (Hemmi, Wolke, & Schneider, 2011). Infants typically experience either crying or sleeping problems; however, studies of both community (Wolke, Meyer, Ohrt, Riegel, 1995) and clinical samples (Papoušek, Schieche, & Wurmser, 2007) found that a third of infants with crying problems also had symptoms of sleeping problems. During the early months of infancy, the co-existence of crying and symptoms of sleeping problems may become burdensome for parents (Barr et al., 2014; Fujiwara, Barr, Brant, & Barr, 2011; Lee, Barr, Catherine, & Wicks, 2007; Talvik, Alexander, & Talvik, 2008), disrupt sensitive parenting behavior (Papoušek et al., 2007; Sadeh, Tikotzky, & Scher, 2010) and increase maternal depressive symptoms (Hiscock & Wake, 2001; Petzoldt, 2017). Consequentially less sensitive parenting and the impact of maternal depressive symptoms could adversely affect the development of a secure mother-infant attachment (De Wolff & van Ijzendoorn, 1997; van Ijzendoorn, Goldberg, Kroonenberg, & Frenkel, 1992).

Crying and Early Symptoms of Sleeping Problems

During the first 3 months of life fussing and crying follows a predictable pattern and infants who fuss and cry for more than 3 hours for at least 3 times during a week are often labelled as “colicky” (Wessel, Cobb, Jackson, Harris, & Detwiler, 1954). By 12 weeks of age the average fussing and crying time reduce to around 70 minutes per 24 hours (Wolke, Bilgin, & Samara, 2017). Those who continue to fuss and cry for more than 2 hours per day beyond 3 months of age are considered as having a crying problem (Schmid, Schreier,

Meyer, & Wolke, 2011; Schmid & Wolke, 2014). Further, the mother's perception of crying as distressing and whether it is easy or difficult to soothe the infant are further symptoms to consider when defining crying problems (Reijneveld, Brugman, & Hirasing, 2001; Schmid et al., 2011; Wake et al., 2006).

According to several researchers, the definition of sleeping problems during infancy includes night-awakenings, sleep-onset latency and short duration of uninterrupted sleep (Beijers, Jansen, Riksen-Walraven, & de Weerth, 2011; Galland, Taylor, Elder, & Herbison, 2012; Iglowstein, Jenni, Molinari, & Largo, 2003; Richman, 1981; Sadeh, Mindell, & Rivera, 2011; Zuckerman, Stevenson, & Bailey, 1987). Parents consider their infants' sleep as problematic if they have frequent night wakings and difficulties falling asleep (Bruni et al., 2014). Hiscock and Fisher (2015) argue that the most useful definition for sleeping problems is parental perception (i.e., if the parent thinks infant's sleep is problematic). Based on the literature, our definition of the symptom of sleeping problems is based on sleep onset latency, frequency of night waking, the longest duration of uninterrupted sleep and mother's perception of night waking as distressing.

During the first few months of life all infants wake up during the night for feeding which is an adaptive mechanism (Lozoff, Wolf, & Davis, 1985) whilst the sleep-wake cycle is still in the process of establishment (Sidor, Fischer, Eickhorst, & Cierpka, 2013). As such, a clinical diagnosis of a sleep problem is not considered before 6 months of age (Galland et al., 2012; Goodlin-Jones, Burnham, Gaylor, & Anders, 2001; Mindell, 1993). Early symptoms of sleeping problems, however, may be markers for emerging sleeping problems (St James-Roberts et al. 2016) since those, which appear during early infancy may persist into later life (Mindell, Sadeh, Kohyama, & How, 2010; Pollock, 1992; Simard, Nielsen, Tremblay, Boivin, & Montplaisir, 2008). There is increasing evidence that the ability of infants to settle themselves back to sleep when they wake during the night at 3 months of age

(St James-Roberts, Roberts, Hovish, & Owen, 2015) predicts later sleep efficiency and a lower rate of sleeping problems at 6 months of age (St James-Roberts, 2012; St James-Roberts, Roberts, Hovish, & Owen, 2016). Thus, precursors of sleeping problems may be identified in the early months of infancy.

The prevalence of crying and sleeping problems varies according to the definitions applied (Reijneveld et al., 2001), with crying problems ranging from 0.6 -12.8% at 3 to 4 months of age (Smarius et al., 2017; Wake et al., 2006; Wolke et al., 2017), and sleeping problems ranging from 10 - 30% at 4 to 6 months (Armstrong, Quinn, & Dadds, 1994; Byars, Yolton, Rausch, Lanphear, & Beebe, 2012; Schmid & Wolke, 2014).

Several longitudinal studies showed that co-existing crying and sleeping problems result in adverse negative impacts on behavior such as externalizing problems in childhood, adolescence and even into adulthood (Bilgin et al., 2018; Choe, Sameroff, & McDonough, 2013; Hyde, O'Callaghan, Bor, Williams, & Najman, 2012; Price, Wake, Ukoumunne, & Hiscock, 2012; Sheridan et al., 2013; Sidor et al., 2013; Sivertsen et al., 2015). In contrast, there is only emerging evidence of adverse associations between the existence of crying problems and symptoms of sleeping problems during the early months of life and difficulties with mother-infant attachment formation (Sadeh et al., 2010; Simard, Chevalier, & Bedard, 2017).

Infant Regulatory Problems and Attachment

Bowlby's (1969) attachment theory has suggested that infants internalize early disruptive experiences with their caregivers, which endure throughout development and influence their psychosocial functioning. Developing this theory, Ainsworth, Blehar, Waters, and Wall (1978) identified three types of attachment patterns: secure, insecure-resistant, and insecure-avoidant. Infants who are securely attached seek comfort from their caregivers, and once comforted continue exploring their environment (Ainsworth et al., 1978). In contrast,

infants who are insecurely attached either avoid their caregiver or are extremely focused on the caregiver but cannot be comforted. Main and Solomon (1990) further proposed that collectively, these three patterns of attachment employ an 'organized' system for managing stressful situations. A fourth category was added called disorganized attachment (D) reflecting a disruption in the organization of attachment behavior and a breakdown of organized strategies (Main & Solomon, 1990; van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999). Explanations for the development of disorganized attachment have been attributed to abusive parenting behaviors or maltreatment (Crittenden & Ainsworth, 1989; Van IJzendoorn et al., 1999), from parents' unresolved traumatic experiences (Main & Hesse, 1990) and child neurodevelopmental problems (Pipp-Siegel, Siegel, & Dean, 1999).

Whilst maternal sensitivity is consistently cited as a major factor associated with the formation of secure attachment strategies (Bakermans-Kranenburg, IJzendoorn, & Kroonenberg, 2004; De Wolff & van IJzendoorn, 1997; van IJzendoorn & Bakermans-Kranenburg, 2004), other factors such as income and young maternal age have also been found to influence the development of attachment through their proximal and distal influence on maternal sensitivity (Belsky, 1999; Cummings & Davies, 2002; Lickenbrock & Braungart-Rieker, 2015; Moss, Cyr, & Dubois-Comtois, 2004). To illustrate, older mothers have been found to be more sensitive to their infants' needs in comparison to younger mothers (Bornstein, Putnick, Suwalsky, & Gini, 2006), and breastfeeding has been shown to be associated with more sensitive parenting and secure attachment (Tharner et al., 2012). Conversely, having low socioeconomic status, parental depression or family dysfunction (Conger & Donnellan, 2007), or having multiple births (Golombok et al., 2007) are all associated with less sensitive parenting.

Parenting behaviors are crucial for the development of their infant's self-regulatory abilities (Cassidy, 1994; Papoušek et al., 2007), with infant success in self-regulation

dependent on how parents respond to those needs (Sadeh et al., 2010). Sadeh and Anders' (1993) transactional model of sleep and wake regulation suggests that sleeping problems originate from bidirectional interactions between the infant and his/her environment (i.e., parent-infant interactions). Thus, in the case of problems in self-regulation such as co-existence of crying and symptoms of sleeping problems, insensitive parenting behavior may be either a precursor to or an outcome of these problems and is likely to influence the formation of optimal parent-infant attachment (Anders, 1994).

From the point of attachment theory, crying behavior is considered as a pre-attachment behavior, which elicits proximity to the parent as well as parental care (Bowlby, 1971), and decreases if the mother is prompt to respond to the crying behavior (Bell & Ainsworth, 1972). Research so far has been mixed in finding associations between early infant crying behavior and infant attachment. Ainsworth et al. (1978) found a significant association between early crying behavior and infant's attachment to their mother at 12 months of age. However, Stifter and Bono (1998) found no significant difference between infants with (or without) colic at 3 to 5 weeks of age and attachment patterns at 18 months old. A third study, van Ijzendoorn and Hubbard (2000) conducted a detailed assessment of cry duration by assessing infants 12 times across the first 9 months of life. Similar to the findings by Stifter and Bono (1998), there was no significant association between duration of crying and attachment types. Nevertheless, both of these studies were underpowered, which might have failed to detect a statistically significant effect. Furthermore, they analysed crying within the normal range rather than excessive crying and we know that excessive infant distress is highly challenging to mothers and increases the risk of maternal depression (Petzoldt, 2017). Furthermore, the studies did not consider disorganized attachment relationships.

Several studies have examined the association between sleep and attachment (Adams, Stoops, & Skomro, 2014; Beijers et al., 2011; Belanger, Bernier, Simard, Bordeleau, & Carrier, 2015; Higley & Dozier, 2009; Morrell & Steele, 2003; Scher, 2001; Zentall, Braungart-Rieker, Ekas, & Lickenbrock, 2012). Attachment theory suggests that infants' sleep patterns during night-time may influence their attachment (Bowlby, 1969) since in many Westernized countries, night-time is a time of separation from the caregiver and night waking signals a demand for contact with the caregiver. This claim was supported in a study looking at the association between maternal sensitive parenting behaviors during night time and attachment patterns (Higley & Dozier, 2009). Findings of this study revealed clear differences between secure and insecure infant-mother dyads in which mothers of secure infants were more in tune with their baby's signals and provided more consistent responses compared to mothers of insecure infants.

Since sleep is best facilitated in safe environments (Dahl, 1996) and maternal sensitivity at bedtime promotes feelings of security and trust in infants (Teti, Kim, Mayer, & Countermine, 2010), those who feel secure may fall asleep easily, may not wake up very often. Even if they do wake, they may be less anxious and so easily fall back to sleep, whereas infants who have problems settling to sleep and wake up frequently during the night are likely to be more anxious about night-time separation. Indeed, a recent meta-analysis of 16 studies found that sleep problems were significantly associated with both secure and in particular, insecure-resistant attachment (Simard et al., 2017). However, this meta-analysis study did not evaluate disorganized attachment and the majority of included studies assessed sleep on 12-month old infants or older. If sleeping patterns are manifested as a function of attachment patterns, then those with disorganized attachment may be more likely to show the most problematic sleeping patterns. However, longitudinal studies on the association between sleeping problems and disorganized attachment have reported inconsistent findings. For

example, no association between night-waking at 6 months (Beijers et al., 2011) or 7 months (Zentall et al., 2012) and disorganized attachment at 12 months of age was found. On the other hand, Pennestri et al., (2015) reported that shorter periods of uninterrupted sleep at 12 months was associated with disorganized attachment at 36 months (Pennestri et al., 2015). Thus, the association between sleeping problems and disorganized attachment remains unclear.

Although a reasonable number of studies have assessed sleep in relation to attachment and a few studies have examined crying in relation to attachment, no studies have investigated the association between the co-existence of crying and symptoms of sleeping problems and infant's attachment patterns. Co-existence of crying and symptoms of sleeping problems during the early months may be an indication of disorganization in stressful situations, consequently relating to a disorganized strategy in infant-mother attachment relationship formation. Knowing that insecure and disorganized attachment are linked to behavioral problems (Fearon et al., 2010; Groh et al., 2012), attachment patterns may be important mediators between early crying and symptoms of sleeping problems and later behavioral outcomes (Kim, Chow, Bray, & Teti, 2017; Sivertsen et al., 2015).

Crying and Symptoms of Sleeping Problems, Maternal Depression & Infant Attachment

As previously outlined, other factors may be important to consider in the assessment of the association between early crying and symptoms of sleeping problems and later infant-mother attachment. In particular, maternal depressive symptoms have been associated with early crying and sleeping problems (Petzoldt, 2017; Petzoldt, Wittchen, Einsle, & Martini, 2016). Increased levels of crying during early infancy and mothers' inability to soothe their infant have been found to increase depressive symptoms in the mothers' of both healthy infants (Radesky et al., 2013; Vik et al., 2009) and clinically referred infants (Maxted et al.,

2005; Petzoldt, 2017). Similar findings have been reported in relation to sleeping problems. Mothers who reported sleeping problems in their infant had higher scores in maternal depression (Lam, Hiscock, & Wake, 2003) and early maternal depressive symptoms increase the risk for the development of later infant sleep problems (Simard, Lara-Carrasco, Paquette, & Nielsen, 2011). Additionally, associations between maternal depressive symptoms and insecure attachment have been reported (Field, 2010; Goodman et al., 2011; van Ijzendoorn et al., 1992). It is suggested that the reason for the impact of maternal depression on infant attachment could be due to depressed mothers typically being less sensitive in comparison to mothers who are not depressed (Coyne, Low, Miller, Seifer, & Dickstein, 2007). Indeed, in a recent study, it was shown that depressed mothers were less responsive to their infants' crying in comparison to healthy mothers (Esposito, Manian, Truzzi, & Bornstein, 2017).

Current Study

Existing studies provide some support for an association between early crying and sleeping problems and attachment. Although several studies investigated infant sleeping patterns in relation to attachment, there are only two investigations of the relationship between crying duration and attachment with both being underpowered. The majority of the existing studies focused on sleeping or crying symptoms after 6 months while only three studies reported on regulatory problems before 6 months of age (Beijers et al., 2011; Stifter & Bono, 1998; van IJzendoorn & Hubbard, 2000). To the best of our knowledge, this is the first study to assess the association between co-existing crying and symptoms of sleeping problems and attachment patterns. The aim of the present study was to investigate the link between co-occurring early crying and sleeping problems in the first 3 months of life and attachment insecurity and disorganization at 18 months of age. We hypothesized that early crying and symptoms of sleeping problems (i.e., multiple regulatory problems) might be

associated with a higher rate in insecure attachment and particularly disorganized attachment classification.

Method

Participants and Design

Participants were recruited from three hospitals in East England and assessed longitudinally at 3, 6 and 18 months of age. The initial sample comprised 115 Full-Term (FT) healthy 3-month-old infants and their caretakers. Retention rates were high: 93.9% of the sample (N=108) remained at 6 months and 91.3% of the sample (N=105) at 18 months. Power based on this sample size was 80%. There were four exclusion criteria: 1) those born with a congenital malformation or admitted to a special care baby unit; 2) parents who had very limited English (as interviews would have been difficult); 3) those due to be given up for adoption after birth; and 4) mothers who were considered not medically fit to take part.

Infant and mother characteristics of the study sample are shown in Table 1.

-INSERT TABLE 1 ABOUT HERE-

Ethical Considerations

Ethical approval was given by the University of Hertfordshire and the NHS ethical review boards of the Addenbrookes Hospital, Cambridge; Luton and Dunstable Hospital, Luton; and Queen Elizabeth II Hospital, Welwyn Garden City. Written informed consent was obtained from all caretakers.

Measures

Early regulatory problems. Mothers were asked to report on infant's crying and sleeping problems at 3 and 18 months via a structured interview (See Appendix 1). Measurement of

sleeping problems at 3 months reflects early symptoms of sleeping problems rather than being indicative of a specific problem at that age (St James-Roberts et al., 2015). The interview was developed for the purposes of this study and used adapted items from the following measures: Infant Sleep Habits Questionnaire (Seifer, 1992); Infant Sleep Questionnaire (Morrell, 1999); and Crying Pattern Questionnaire (St James-Roberts & Halil, 1991; Wolke, Meyer, & Gray, 1994). Definitions of crying and sleeping problems were derived from the literature (Bilgin & Wolke, 2016; Dahl & Sundelin, 1986; St James-Roberts, 1998) and are shown in Table 2.

-INSERT TABLE 2 ABOUT HERE-

In order to measure crying behavior up to 18 months of age, mothers were asked to report how many minutes their infant fusses/cries during an average day. Moreover, they reported on how easy or difficult it was to soothe their baby when it was crying (1= very easy; 5= very difficult), which was divided into two categories (0= easy to soothe if scored \leq 3; 1= difficult to soothe if scored \geq 4). Lastly, they reported on whether their infants' crying/fussing was distressing or not (0= not at all, 1= a little, 2=very distressing), again divided into two categories: (0= not distressing if scored \leq 1; 1= very distressing if scored 2).

In order to measure sleeping problems up to 18 months of age, mothers were asked to report on the following four questions: 1) how many times their infant usually woke up at night, 2) how long it took the mother to settle the infant to sleep in minutes, 3) the longest sleep duration without waking up at night in minutes and 4) how distressful it is when their baby wakes up at night, which was scored on a 3-point scale (0= not at all, 1= a little distressing, 2= very distressing), and divided into two categories (0= not distressing if scored \leq 1; 1= very distressing if scored 2).

The questions regarding crying were validated in a previous study, which compared interview results with 7-day 24 hours a day diary data in 237 infants (Wolke et al., 1994).

Findings of this study revealed moderate to good associations ($r=0.51-0.68$) between the crying interview and the diary data. Furthermore, Popp et al. (2016) reported good to excellent inter-rater reliability for the interview (ICC= 0.86-0.97).

Participants' scores on crying and sleeping problems were summed to create an overall crying and sleeping problems score. The overall crying and sleeping problems score could range from 0 to 7.

Attachment insecurity and disorganization. Attachment insecurity and disorganization were assessed at 18 months with the strange situation procedure (SSP), a widely used and well-validated laboratory procedure to measure the quality of attachment (Ainsworth et al., 1978). During the SSP, infants experience separations and reunions with the attachment figure to elicit attachment behavior. The researchers were trained by Dr. Elizabeth Carlson and all recordings were coded at the Institute of Child Development, University of Minnesota. All coders were blind to child and family characteristics and regulatory problems and 32% of the recordings were randomly selected for inter-rater reliability assessment. Cohen's Kappa revealed substantial inter-rater agreement ($\kappa=0.76$).

First, infants were classified as secure (B), insecure-avoidant (A) and insecure-resistant (C) based on the pattern of scores on four 7-point scales: proximity seeking behavior, contact maintaining behavior, avoidance of the caregiver and resistance using the scoring systems outlined in the manuals of Ainsworth et al. (1978). A categorical variable was then created to measure attachment insecurity: 0= secure versus 1= insecure. Attachment disorganization scores were coded according to Main and Solomon's (1990) continuous scale of attachment disorganization on a 9-point scale (1= no signs of disorganization, 5= border, 9= high levels of disorganization). Those scoring ≥ 6 were considered as disorganized attachment; those scoring 5 were given either a primary or a secondary disorganized classification depending

on the particular case; and those scoring <5 were classified as having organized attachment. Signs of disorganized attachment include contradictory behavior such as avoidance and resistance at the same time or puzzling behavior without an apparent reason. For the current analysis, a categorical variable was created: 0= organized versus 1= disorganized.

Maternal sensitivity. Maternal sensitivity was observed at 3 and 18 months of age. Maternal sensitivity at 3 months was measured with the Mother-Infant Structured Play Assessment (MISPA; Wolke, 1999). MISPA is an observational assessment tool, which includes an 8-minute, semi-structured face-to-face mother-infant play interaction composed of 5 episodes. Episodes 3 to 5 followed the Still Face interaction paradigm (Tronick, Als, Adamson, Wise, & Brazelton, 1978) to assess infant reaction to the Still Face situation and repair of the interaction. Maternal, infant and mother-infant joint behaviors were coded on 5-point scales adapted from the following established coding schemes: The Play Observation Scheme and Emotion Ratings: POSER (Wolke, 1986); The Emotional Availability Scales: EAS (Biringen, 1993); The Infant and Caregiver Engagement Phases: ICEP (Weinberg & Tronick, 1998). For the current study, maternal behavior ratings during the play situations (first 2 episodes) prior to the Still Face situation were utilised (Bilgin & Wolke, 2017). After 4 months of training on the 5-point coding system, two coders blind to child characteristics and study aims rated 20 recordings; the remaining videotapes were coded by one of the coders. Firstly, infant behaviors were coded, followed by maternal behaviors and finally the mother-infant joint behaviors. The 7 sub-scales assessing maternal behavior were factor analysed using principal component analysis with varimax rotation. The analysis yielded 2 factors explaining a total of 42.4% of the variance for the entire set of variables. For the purposes of this study, we used the first factor, which was labelled as ‘maternal sensitivity’ and includes the following subscales: sensitivity (1= highly insensitive; 5= highly sensitive), positive facial emotion expression (1= none; 5= very much), and stimulation level (1=low; 5= high). All subscales

had primary loadings of over 0.60. The scores of these three scales across the 3 episodes before the still-face paradigm were summed to yield the maternal sensitivity measure. The inter-rater reliability scores for each item were substantial ($\kappa_{\text{positive emotion}} = 0.76$, $\kappa_{\text{sensitivity}} = 0.76$, $\kappa_{\text{stimulation level}} = 0.78$) and the overall internal consistency of the maternal sensitivity factor was also substantial ($\alpha_{\text{maternal sensitivity}} = 0.73$).

At 18 months, maternal sensitivity was assessed with The Play Observation Scheme and Emotion Ratings (POSER; Wolke, 1986; Bilgin & Wolke, 2017a), which is a tool to measure mother-infant interaction in two play situations (unstructured and structured play). The unstructured play session included mother and infant play with a shape-sorter toy in any way they liked for 2.5 minutes. In the structured play session, the researcher demonstrated how to play with the little people trailer and asked mothers to play with their infant according to the structured instructions (i.e., teach your child how to play with the Little People trailer), again for 2.5 minutes. The videotaped mother-infant play session was coded with The Play Observation Scheme and Emotion Ratings (POSER), which included items to measure maternal, infant and mother-infant joint behaviors. Two trained coders, blind to child characteristics, independently rated both sessions. Each session was viewed three times, focusing firstly on maternal behaviors, followed by infant behaviors and then joint mother-infant behaviors. The seven sub-scales relating to maternal behavior were factor analysed using principal component analysis with varimax rotation. The analysis yielded 2 factors explaining a total of 64.1% of the variance for the entire set of variables. The first factor, which included amount of expressed positive emotion (1= none; 5= very much), sensitivity (1=highly insensitive; 9= highly sensitive), appropriateness of play (1= very inappropriate play; 9= very appropriate play), was labelled as maternal sensitivity. All subscales had primary loadings of over 0.60. The inter-rater reliability of each maternal behavior items had excellent agreement ($\kappa_{\text{positive emotion}} = 0.93$, $\kappa_{\text{sensitivity}} = 0.90$, $\kappa_{\text{appropriateness of play}} = 0.91$). The sum

of these three subscales in the unstructured and structured play situation generated the maternal sensitivity score, which also had excellent overall internal consistency ($\alpha_{\text{maternal sensitivity}} = 0.90$).

Maternal Depressive Symptoms. At 6 months, mothers completed the Edinburgh Depression Scale (Cox, Holden, & Sagovsky, 1987), which is a widely used 10-item screening tool to assess postnatal depression. Each item was rated on a 4-point scale, for example: '*In the past 7 days, I have been able to laugh and see the funny side of things*' (0= As much as I always could, 1= Not quite so much now, 2= Definitely not so much now, 3= Not at all). Individual scores were summed up to create a continuous depression score, which ranged from 0 to 30. A score of above 13 indicates the likelihood of suffering from depression.

Additional control variables. Family's income during a year (0=Low: £0- £25k; 1= Middle: £25k- £40k; 2= Upper >£40k), maternal age, multiple birth (twins), and breastfeeding were chosen as control variables due to their association with attachment patterns (Lickenbrock & Braungart-Rieker, 2015). In addition, breastfeeding has been shown to relate to both regulatory problems and attachment classifications (Tharner et al., 2012). Based on maternal report about how they fed their infant, a categorical variable was used to differentiate between infants who were breastfed and those who were bottle-fed or mixed-fed at 3 months.

Statistical analysis

Two separate path analyses were conducted using MPlus (Version 7, Los Angeles, CA) (Muthén & Muthén, 1998-2015) to examine the association of crying and sleeping problems, maternal sensitivity and depression variables with each other and their direct and indirect (mediated) associations with insecure attachment and disorganized attachment. Insecure and disorganized attachments were both categorical variables whereby an increasing score reflects a higher frequency of insecure and disorganized attachment. Model fit was assessed with the Root Mean Square Error of Approximation (RMSEA) and Comparative Fit Index

(CFI) as they are less sensitive to the impact of sample size (Fan, Thompson, & Wang, 1999). A model is considered to have a good fit if the RMSEA value is below 0.05 (Hu & Bentler, 1999) and CFI value is above 0.90 (Bentler, 1990). Standardized coefficients corrected for all other associations were used in the path analysis. These analyses also controlled for breastfeeding, income, maternal age and multiple birth.

Results

Descriptive Analyses

Of the 105 infants, 76 (72.4%) were classified as securely attached, 6 (5.7%) as insecure-avoidant, 5 (4.8%) as insecure-resistant and 18 (17.1%) as disorganized. The bivariate correlations among the crying and sleeping problems variables at 3 months and 18 months are presented in Table 3, and the bivariate correlations among all study variables are shown in Table 4.

-INSERT TABLES 3 & 4 ABOUT HERE-

Associations between early crying & sleeping problems and insecure attachment at 18 months

The path model had a good fit with the data for insecure attachment (RMSEA=0.05, CFI=0.90).

Maternal sensitivity at 3 months ($\beta = -.23$, $SE = .10$, $p < .05$), maternal depressive symptoms at 6 months ($\beta = .20$, $SE = .11$, $p < .05$) and maternal sensitivity at 18 months ($\beta = -.18$, $SE = .10$, $p < .05$) had direct effects on insecure attachment at 18 months. There was no direct impact of crying & sleeping problems at both 3 and 18 months on insecure attachment at 18 months. Nevertheless, crying & sleeping problems at 3 months had a small indirect impact ($\beta = .04$, $SE = .01$, $p < .05$) on insecure attachment via increasing maternal depressive symptoms (Figure 1).

-INSERT FIGURE 1 ABOUT HERE-

Associations between early crying & sleeping problems and disorganized attachment at 18 months

The path model had a good fit with the data for disorganized attachment (RMSEA= 0.05, CFI= 0.94). Crying & sleeping problems at 3 months ($\beta=.22$, $SE= .10$, $p< .05$) had direct effects on disorganized attachment at 18 months. Furthermore, there was a concurrent association between crying & sleeping problems and disorganized attachment at 18 months ($\beta=.21$, $SE= .10$, $p< .05$). Maternal sensitivity at both 3 months and 18 months and maternal depressive symptoms at 6 months did not have a direct effect on disorganized attachment at 18 months. However, maternal depressive symptoms at 6 months had a small indirect impact ($\beta=.04$, $SE= .01$, $p< .05$) on disorganized attachment via increasing crying & sleeping problems at 18 months (Figure 2).

-INSERT FIGURE 2 ABOUT HERE-

Discussion

The aim of the current study was to investigate the association between early crying and symptoms of sleeping problems, and insecure or disorganized attachment at 18 months. The major finding revealed that crying problems and symptoms of sleeping problems at 3 months are associated with disorganized attachment at 18 months. No evidence was found of crying problems and symptoms of sleeping problems influencing insecure attachment at 18 months directly, however, crying and symptoms of sleeping problems at 3 months were associated with increased maternal depression symptoms at 6 months and had a small but significant indirect effect on insecure attachment.

This study found a 17% prevalence of disorganized attachment which is very similar to population estimates of 15% reported across samples in a previous meta-analysis study (Van Ijzendoorn et al., 1999). Our findings highlight that infant crying and symptoms of

sleeping problems as early as 3 months are related to disorganized attachment in a stressful separation and reunion situation. This finding is in agreement with a previous study, which showed that infants who followed a pattern of going to bed late, cried during the night frequently and had short durations of uninterrupted sleep from 6 to 36 months formed disorganized attachment by 36 months of age (Pennestri et al., 2015).

There are two plausible explanations. First, knowing that how mothers think about their infants' crying and sleeping behavior influences their response to these behaviors (Hiraoka & Nomura, 2016; Tikotzky & Sadeh, 2009), it may be argued that mothers of infants with disorganized attachment have negative thoughts about their infants' behavior (Bigelow et al., 2018). Thus, the co-existence of crying and symptoms of sleeping problems might trigger frightening and anxious maternal responses (Out, Pieper, Bakermans-Kranenburg, & van Ijzendoorn, 2010; Reijneveld, van der Wal, Brugman, Sing, & Verloove-Vanhorick, 2004) that interfere with adaptive infant attachment development, consequently leading to the formation of disorganized attachment (Granqvist et al., 2017; Reijman, Foster, & Duschinsky, 2018).

A second explanation for this finding can be made under the guidance of the cascade model of development (Masten & Cicchetti, 2010), which postulates that dysfunction in one domain can progress into another domain along the development of psychopathology. Both crying and sleeping problems and disorganized attachment represent an inability of self-regulation, the former being at a physiological level and the latter being at a relationship level. Therefore, early crying and symptoms of sleeping regulatory problems may lead to negative behavioral outcomes in childhood and adolescence (Hyde et al., 2012) by predisposing infants to disorganization in mother-infant attachment relationship, which in turn may increase the risk of developing behavior problems. This would suggest a mediation model or cascade of events leading to behavior problems. Two separate meta-analytic

investigations have indicated that both multiple regulatory problems (Hemmi et al., 2011) and disorganized attachment (Fearon, Bakermans-Kranenburg, van Ijzendoorn, Lapsley, & Roisman, 2010) put infants at increased risk of externalizing problems. Alternatively, early regulatory problems may impact both on the early attachment of the infant to the mother and set the infant on a trajectory of behavioral dysregulation, increasing the odds of developing behavior problems (Winsper & Wolke, 2014). Future research including assessments of crying and sleeping problems, infant attachment and childhood behavior problems may clarify whether multiple regulatory problems affect both attachment and behavior or whether the early infant-parent attachment relationship mediates the relationship between crying and sleeping problems and behavior problems.

Lower maternal sensitivity at 3 and 18 months was significantly associated with insecure attachment at 18 months. This is consistent with findings from a systematic analysis, which found that when an intervention successfully increases maternal sensitivity, it also increases attachment security (Bakermans-Kranenburg, van Ijzendoorn, & Juffer, 2003). In particular, when mothers of irritable infants received an intervention to increase their sensitive parenting at 6 months, their infants were more likely to form secure attachment at 12 months of age (van den Boom, 1994). Moreover, the impact of the intervention was still evident at 18 months and 42 months of age (van den Boom, 1995). Thus, the current study provides further support for the importance of maternal sensitivity throughout infancy in the development of secure attachment.

There were no significant direct associations between crying and sleeping problems and formation of insecure attachment, but there was a small indirect association between crying and sleeping problems and insecure attachment via higher levels of maternal depressive symptoms at 6 months. Our finding is in accordance with Simard et al. (2017) who found no association between sleep and secure attachment when sleep was assessed

before 15 months of age. Further, our finding is consistent with attachment theory, which postulates that the development of insecure attachment patterns is predominantly explained by mothers' ability to be sensitive to their infants' cues rather than infant-related characteristics (Ainsworth et al., 1978; Bowlby, 1969). Research shows that infants' susceptibility to develop insecure attachment occurs more often in cases where parents are unable to show sensitive parenting due to a clinical problem (e.g., depression) (Murray, 1992; van Ijzendoorn et al., 1992).

The indirect association between comorbid crying and symptoms of sleeping problems at 3 months and insecure attachment at 18 months via maternal depression is consistent with evidence from two lines of research. First, there is convincing evidence that shows a significant association between both crying and sleeping problems and maternal depression. A recent systematic review reported that maternal depression is associated with excessive crying both concurrently and subsequently (i.e., excessive crying increases maternal depression at the later assessment) (Petzoldt, 2017). Furthermore, the majority of studies found an association between infant sleeping problems and maternal depression although the direction of this association is inconclusive (Bayer, Hiscock, Hampton, & Wake, 2007; Hiscock & Wake, 2001; Sadeh et al., 2010; Warren, Howe, Simmens, & Dahl, 2006). Second, a meta-analysis by Atkinson et al., (2000) found a significant association between maternal depression and increased insecure attachment. Thus, converging evidence provides support for an indirect relationship between comorbid crying and sleeping problems and insecure attachment via higher levels of maternal depressive symptoms.

Our findings revealed no association between maternal sensitivity and maternal depressive symptoms. Whilst this conflicts with other previous findings (Bernard, Nissim, Vaccaro, Harris, & Lindhiem, 2018; Field, 2010), results from another meta-analysis found only a marginal association between maternal depression and sensitive parenting (Lovejoy,

Graczyk, O'Hare, & Neuman, 2000) suggesting there may be other important factors in explaining the association between maternal sensitivity and maternal depression. Further, co-existence of crying problems and symptoms of sleeping problems could moderate the association between maternal sensitivity and maternal depression. Therefore, including both crying problems and symptoms of sleeping problems may have buffered the degree of the association between maternal sensitivity and maternal depression.

A particular strength of this study is the measurement of important covariates (i.e., breastfeeding, income, maternal age and multiple birth) and the detailed assessment of crying and sleeping problems during early infancy. Furthermore, attachment was classified by experienced independent coders blind to child characteristics and study hypotheses. The study also has some limitations. First, the assessment of crying and sleeping problems via maternal reports may be subject to social desirability bias compared to direct observation or diary recordings (St. James-Roberts & Wolke, 1988). However, the interview assessment used for this study has previously been shown to have high inter-rater reliability and good discriminative validity (Popp et al., 2016). Mothers who perceive their infants as having problems may be more likely to interact with them differently than mothers who do not perceive any problems, and consequently, this could contribute to the increased risk of the infant developing disorganized attachment. Future studies should aim to examine crying and sleeping problems with objective measures such as diary or actigraphy. Second, a diagnosis of sleeping problems are not usually made before 6 months of age (Zuckerman et al., 1987); hence our assessments at 3 months reflect early symptoms of sleeping problems rather than a sleeping problem diagnosis. Third, we were unable to control for the impact of difficult infant temperament on the association between co-existent crying problems and symptoms of sleeping problems and attachment, which has been proposed to play a critical role in the development of attachment patterns (van den Boom, 1997; Vaughn & Bost, 1999). This

explanation, however, is not fully supported as empirical studies reveal weak and mixed findings (Ispa, Fine, & Thornburg, 2002; van IJzendoorn & Bakermans-Kranenburg, 2004). Fourth, the current study did not include co-sleeping as a covariate. Since it has been shown that infants who co-sleep with their parents are more likely to cry when waking in comparison those who sleep in a separate room (Mao, Burnham, Goodlin-Jones, Gaylor, & Anders, 2004), it is essential for future studies to investigate the impact of co-sleeping on the association between co-existence of crying and symptoms of sleeping problems and attachment. Fifth, we were unable to examine the associations between crying and sleeping problems and insecure-resistant and insecure-avoidant attachment separately. This was not statistically viable due to statistical power limitations but would be a useful aspect to explore in further research as associations with prolonged infant night waking, and insecure resistant attachment, in particular, have been reported (Beijers et al., 2011; Zentall et al., 2012). Finally, we were unable to include the race/ethnicity information of the participants, which limits the generalizability of our findings.

Conclusions

This longitudinal study found that co-occurrence of early crying problems and symptoms of sleeping problems could predict disorganized attachment. Findings of the current study indicate that these problems may alter the social relationship of infants to their mother independent of maternal sensitivity. Clinicians should be aware that co-occurring crying problems and symptoms of sleeping problems as early as 3 months of age put infants at an increased risk of attachment problems and this may warrant early intervention. In particular future research should explore how early problems in crying and sleeping and disorganized attachment are associated with existing or future externalising problems.

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Table 1. Descriptive characteristics of infants and mothers

	Total Sample (N= 105)
Gender: N (%) (Male/Female)	60 (57.1%)/45 (42.9%)
Birth weight (g): M (range)	3205.1 (1820-4380)
Gestational Age (weeks): M (range)	38.9 (37-42)
Multiple births/twins: N(%)	35 (30.4%)
First born: N(%)	39 (37.1%)
Maternal Age (years): M (SD)	30.7 (5.9)
Married: N(%)	83 (79%)
Income (GBP): N (%)	
£0- £25k	38 (36.5%)
£25k- £40k	25 (24.1%)
>£40k	41 (39.4%)
Maternal Education: N (%)	
<10 years	4 (3.7%)
10 years	68 (63.6%)
>10 years	35 (32.7%)
Breastfeeding: N (%)	
3 Months	31 (29.5%)
Maternal Depression score (EPDS): M (SD)	6.3 (4.4)
Maternal Sensitivity: M (SD)	
3 Months	3.9 (0.6)
18 Months	6.1 (1.4)

Table 2. Regulatory Problems Definition

	Definition at 3 Months	Definition at 18 Months
Crying		
1) Duration of Crying AND/OR	More than or equal to 180 mins	More than or equal to an hour
2) Easy or difficult to soothe AND/OR	Infant is difficult or very difficult to soothe	Infant is difficult or very difficult to soothe
3) Mother thinks the crying is distressing	Mother thinks the crying is very distressing	Mother thinks the crying is very distressing
Sleeping		
1) The duration it takes for mother to settle the infant for sleep AND/OR	Longer than 30 minutes	Longer than 30 minutes
2) The frequency of infant waking up AND/OR	2 times or higher	2 times or higher
3) The longest period of sleep which infant has had without waking AND/OR	Less than 5 hours	Less than 5 hours
4) Mother thinks night waking is distressful	Mother thinks night waking is very distressful	Mother thinks night waking is very distressful

Table 3. Pearson Correlations between Variables used in the Definition of Crying and Sleeping Problems

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3 Months														
1. Duration of Crying	1													
2. Easy or difficult to soothe	0.31**	1												
3. Mother thinks the crying is distressing	0.28**	0.29**	1											
4. The duration it takes mother to settle infant to sleep	0.12	0.22*	0.11	1										
5. Frequency of night waking	0.07	0.05	-0.07	0.20*	1									
6. Longest period of sleep without waking	-0.29*	0.06	0.02	0.00	-	1								
7. Night waking is distressful for the mother	0.30**	0.13	0.31**	-0.07	-0.01	-0.07	1							
18 Months														
8. Duration of Crying	0.19*	0.18	-0.05	0.07	0.03	-0.18	0.02	1						
9. Easy or difficult to soothe	0.32**	0.40**	0.11	0.27**	-0.08	-0.01	0.12	0.34**	1					
10. Mother thinks the crying is distressing	0.14	0.27**	0.26**	0.27**	0.02	-0.11	0.31**	0.22*	0.36**	1				
11. The duration it takes mother to settle infant to sleep	0.20*	0.09	0.12	0.05	0.27**	-0.11	0.29**	0.17	0.02	0.17	1			
12. Frequency of night waking	0.13	-0.04	-0.05	0.14	0.02	-0.19	0.01	0.28**	0.02	0.05	0.19	1		
13. Longest period of sleep without waking	-0.04	0.04	0.03	-0.19	-0.22*	0.29**	0.08	0.01	0.01	-0.02	-0.21*	-0.59**	1	
14. Night waking is distressful for the mother	0.06	0.17	0.22*	0.04	-0.14	-0.07	0.13	0.18	0.17	0.39**	0.10	-0.01	-0.10	1

*p< .05, **p< .01, ***p<.001

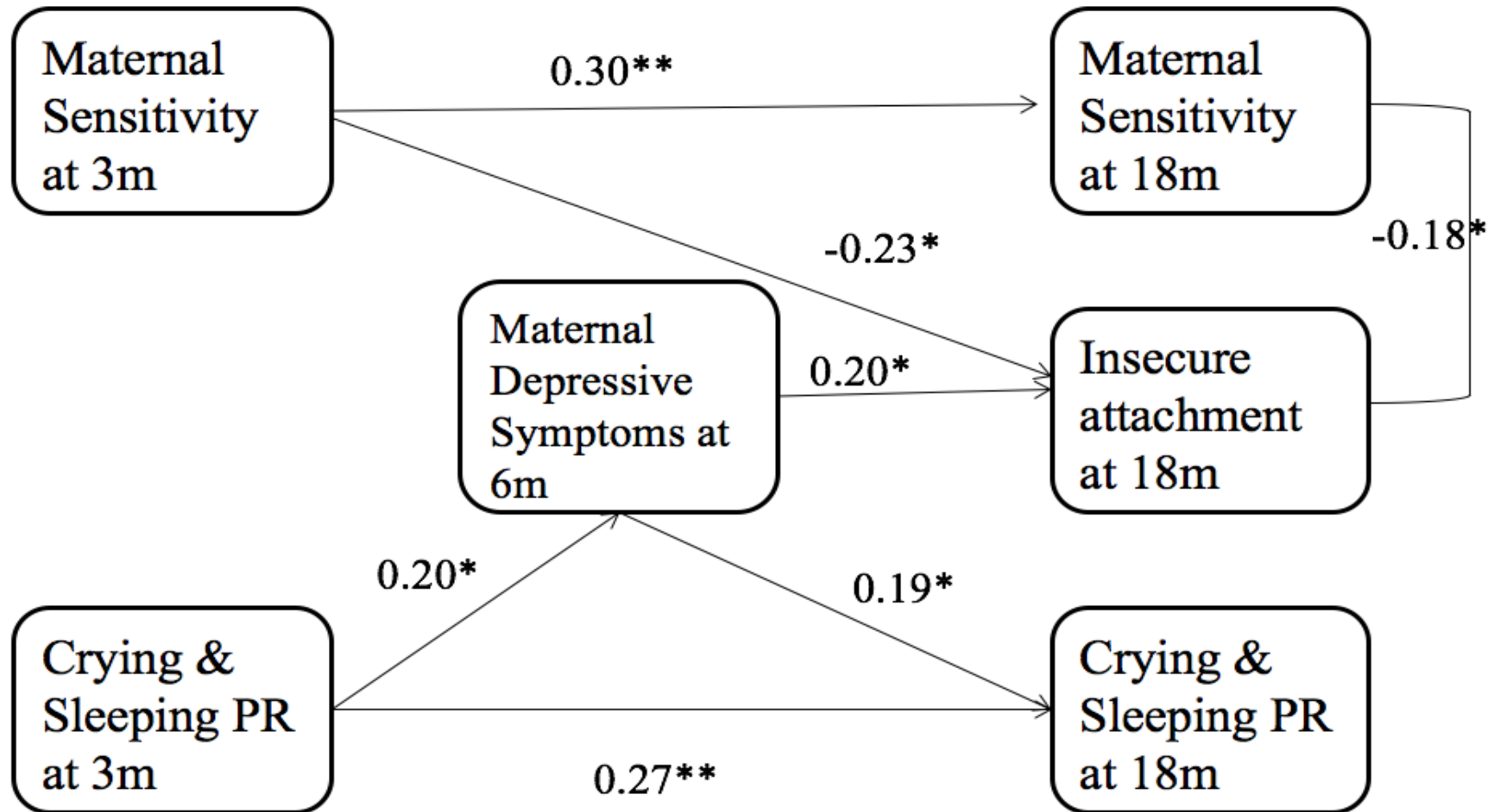
Table 4. Bivariate correlations among study variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Income	1											
2. Maternal Education	0.41**	1										
3. Maternal Age	0.31**	0.30**	1									
4. Multiple Birth	-0.07	0.12	-0.26**	1								
5. Breastfeeding	.06	0.16	0.06	-0.06	1							
6. Crying & Sleeping Problems at 3 Months	-0.07	0.15	0.02	0.18	-0.22*	1						
7. Maternal Sensitivity at 3 Months	0.36**	0.33**	0.27**	-0.19*	0.14	-0.02	1					
8. Maternal Depressive symptoms at 6 months	-0.25*	0.02	-0.17	-0.03	-0.14	0.21*	-0.02	1				
9. Crying & Sleeping Problems at 18 Months	0.03	-0.002	-0.07	-0.09	-0.05	0.29**	-0.14	0.20*	1			
10. Maternal Sensitivity at 18 Months	0.10	0.29**	0.32**	-0.12	0.15	0.003	0.33**	-0.16	0.02	1		
11. Insecure Attachment at 18 Months	-0.05	-0.08	-0.02	-0.05	0.09	0.06	-0.26*	0.25*	0.13	-0.21*	1	
12. Disorganized Attachment at 18 Months	-0.19*	0.03	-0.02	-0.03	0.01	0.19*	-0.12	0.13	0.23*	0.12	0.74**	1

Please note that sleeping problems at 3 months refer to the symptoms of sleeping problems not a diagnosis.

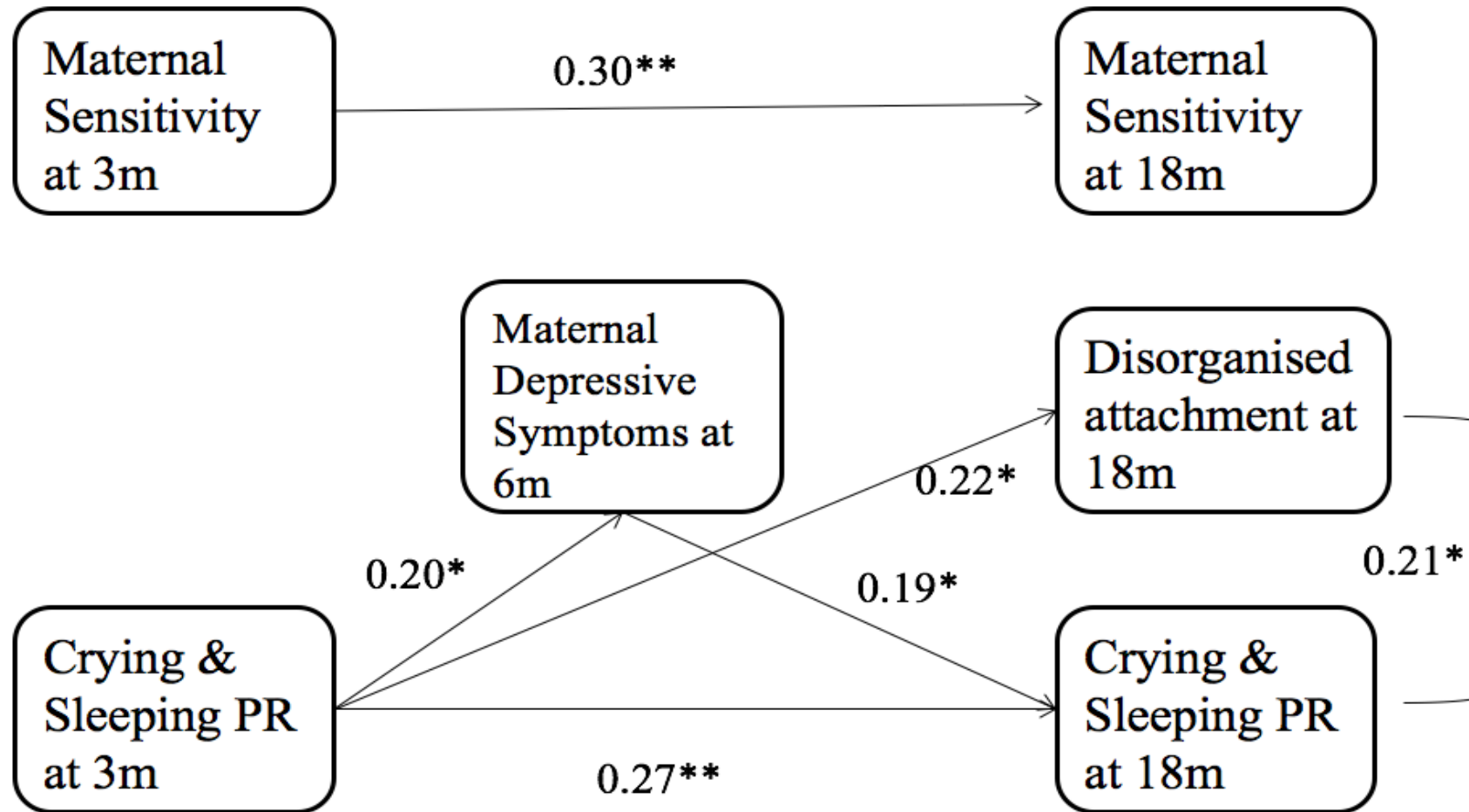
**p<0.01, *p<0.05

Figure 1. Associations between crying and sleeping problems, maternal sensitivity, maternal depression and insecure attachment at 18 months



* $p < 0.05$; ** $p < 0.01$

Figure 2. Associations between crying and sleeping problems, maternal sensitivity, maternal depression and disorganized attachment at 18 months



* $p < 0.05$; ** $p < 0.01$