How infants’ sleep affects morning mood: A sleep diary study in Brazil and the UK

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Declarations of interest

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Highlights

* Cross-cultural study directly comparing infant sleep patterns in Brazil and UK
* Babies in Brazil go to bed over 2 hours later than in UK and more likely to cosleep.
* Earlier bedtimes biggest determinant of longer sleep in both countries.
* Morning happiness and energy levels are high with some dependence of sleep.
* UK parents own sleep looked at and affected by night waking but not sleep duration.

Abstract

Infant sleep duration has been related to mood in infants and parents but rarely is this done using sleep diaries or state (versus trait) measures of mood. This study reports the results two studies of parents in São Paulo, Brazil (114 infants, mean age = 13.8 months, range = 2-27m) and the United Kingdom (147 infants, 10 months, range = 7-13m). Parents provided background demographic data and general information on their child’s sleep. Sleep diaries measures bedtimes and durations, night time wakes, feeds and diaper changes. In addition, parents rated infants’ morning happiness and energy of their baby on a 10 point scale. We used a systematic comparison of multiple different linear models predicting sleep duration from subsets of the diary variables. In Brazil, the best model ( R2=26%) was a 6 factor model invol bedtime, household size, diaper state and other variables. However, a simple model including just bedtime as a predictor was nearly as good (R2=21%) A similar pattern was found in the UK where best model (R2=46%) had 7 factors but the single factor bedtime explained most of the variance (R2=43%). Infants’ happiness and energy levels were less clearly explained, being linked to multiple factors. But notably, temperament was not important. Finally, in the UK parents sleep quality and morning moods were collected and were shown to be most strongly affected by the number of night wakings. These results show that despite large cultural differences in infant sleep practices, the same factors predict both sleep duration and morning mood.

*Keywords:* infant sleep; sleep diary; mood; temperament

Word count: 9730

Infant sleep patterns and problems are among greatest the worries of new parents. Many concerns may simply reflect perceived cultural norms about what is ‘normal’ infant sleep (Barry, 2021). Nonetheless, research shows sleep quantity and quality are important for infant development – infant sleep is positively associated with physical and cognitive development (Ednick et al., 2009; Tham et al., 2017) and with measures of infant temperament (Sorondo & Reeb-Sutherland, 2015; Spruyt et al., 2008). In turn, poor infant sleep can affect parents own sleep and mental health (Sadeh et al., 2010). Even the perception of poor sleep can increase parents stress (Sinai & Tikotzky, 2012). Despite this, infants typically wake in a good mood (Mindell & Lee, 2015). The present study aims to use sleep diaries with families of infants in Brazil and the United Kingdom to investigate how temperament and sleep duration and disturbances relate infant sleep patterns and morning mood.

Parental diaries are cheap and simple to administer. They represent a good compromise between sleep questionnaires and more objective measures like actigraphy and somnography (Camerota et al., 2018; Hall et al., 2015). By asking parents to record sleep onset, wake time and night disturbances each morning for an extended period, diaries average are less susceptible to parental biases. Additionally, they capture intra-individual variations allowing investigation of a wider range of sleep variables such as night disturbances like wakes and diaper changes. Sleep diaries also allow investigation of how an individual night’s sleep might relate to an infant’s mood in the morning. Mood has been linked to infant sleep (Mindell et al., 2018; Mindell & Lee, 2015) but, to our knowledge, has not been investigated with nightly data.

Mindell and Lee (2015) had parents of 1351 infants (age 3-13 months) in Brazil complete a version of the Brief Infant Sleep Questionnaire (Sadeh, 2004) and assess their infant’s typical mood over the previous two weeks with morning, daytime and bedtime mood on a five point scale (from very fussy to very happy). They found that mood at all three times of day was negatively correlated with perceived sleep problems and number of night wakings. They found that morning mood positively correlated with longer night-time sleep and later waking whereas earlier bedtime was not correlated with morning mood. They also found that 77% of babies were ‘very happy’ in the morning compared to only 20% at bedtime. Taken together these results from a large sample suggest a direct relationship between infant sleep and their mood. However, because the study used a sleep questionnaire and retrospective average measures of mood, it is susceptible to parental biases. Finally, the study did not collect any measures of infant temperament which might have been a mediating variable.

The relationship between infant temperament and sleep is complex. In some cases, infants with an ‘easy’ temperament will have longer sleep (Kaley et al., 2012; Spruyt et al., 2008) while Jian and Teti (2016) found a more complex pattern where an easy temperament increased sleep only when mothers were more emotionally available. Conversely, a ‘difficult’ temperament can lead to poor sleep consolidation (Touchette et al., 2005, 2009). Examining two large cohorts from the United Kingdom and the Netherlands, Netsi and colleagues found that reactivity at 6 months was not directly associated with greater night wakings or sleep duration but was a moderator of the effects of maternal depression (Netsi et al., 2015). Morales-Muñoz and colleagues found that negative affectivity and self-regulation at six months predicted sleep problems at 12 months but surgency/positive affectivity did not (Morales-Muñoz et al., 2020). Hoiwever, caution must be used if temperament at one age is used as predictor of sleep at another as temperament itself is only moderately stable over the first few years of life (Bates & Rothbart, 2006; Planalp & Goldsmith, 2020). Additionally, multiple studies find no associations (DeLeon & Karraker, 2007; Martini et al., 2017; Morrell & Steele, 2003).

A wide range of other variables can affect infant sleep. Theoretical approaches to infant sleep, like the Transactional Model (El-Sheikh & Sadeh, 2015; Sadeh et al., 2010), advise that context matters at multiple levels. As well as internal variables like age and temperament, sleep can be affected by immediate context such as sleep location, home environment and family situation. Social context like parents work routines and cultural expectations such as typical bedtime and wake time, attitudes to sleep settling and night feeding (Lin et al., 2019; Mindell et al., 2015).

A rarely studied aspect of immediate context is diaper type and state. Lukowski and colleagues ran a 6 week long experimental intervention where they compared groups of Chinese infants sleeping in traditional cloth diapers or in high absorbency disposable diapers. Sleep diaries showed that disposable diapers led to fewer sleep disruptions and diaper changes while actigraphy showed these infants sleeping a greater proportion of the night. Notably, the infants in the disposable diapers showed greater positive affect at the end of the intervention (Lukowski et al., 2015).

The objective of the present study investigate how infant sleep is related to morning mood using sleep diaries to capture night by night variations to number of wakes, diaper changes and other disturbances. We will investigate how components of temperament relate to sleep duration and morning mood but based on the inconsistent results reported above we do not make any predictions about relationships. We predict that infant morning mood will be improved by longer, less interrupted sleep. We will also investigate if diaper quality affects sleep and mood. Finally, we will test samples in Brazil and the United Kingdom to allow an examination of cultural factors.

**Study 1 – Brazil**

**Method**

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

**Participants**

The participants were 114 mothers and infants from middle class and lower middle class backgrounds in southern central São Paulo. The babies had a mean age of 13.8 months (range = 2-27 months) and 51 were female. A further three were excluded; one had a respiratory condition, one was too old (825 days) and one had only 2 sleep diary entries. The mothers mean age was 29.6 years (*SD* 6.3), 14 (12%) had completed college, 65 had completed high school, 23 completed secondary school, 12 who did not complete secondary school. They were recruited by a professional market research agency who also conducted the in-person data collection. Parents were not paid for their participation but were given several weeks supplies of free diapers at the end of the study.

A power calculation showed that 109 participants were needed for a linear regression model with up to eight predictors to detect a medium effect size (f2=.15) with an alpha level of .05 and a power of .80 (G\* Power 3.1.9, Faul et al., 2009).

The study was conducted according to the guidelines in the Declaration of Helsinki and procedures were approved by the Ethics Committee of the Birkbeck, University of London. Written informed consent was obtained from all parents or guardians prior to data collection.

**Measures**

All parents provided basic demographic info about themselves and their babies and completed a screening questionnaire that asked if their baby had any health problems. They were asked what diaper brand they were currently using and ad a further set of market research questions about diaper purchasing which was not used for this study.

Temperament was assessed using the very short form of the revised Infant Behavioral Questionnaire (IBQ-R - Gartstein & Rothbart, 2003) that had been translated into Brazilian Portuguese (Klein et al., 2009). This consists of 37 items that ask about the frequency of various behaviours in the preceding week on a seven point scale from 1 = Never to 7 = Always. Items are combined to give three subscales. These are Surgency or Positive Affectivity (for example “How often during the last week did the baby smile or laugh when given a toy?”), Negative Affectivity (for example “At the end of an exciting day, how often did your baby become tearful?” and Effortful Control or (for example “When showing the baby something to look at, how often did s/he soothe immediately?”).

Parents perceptions of infant sleep were assessed using a version of the Brief Infant Sleep Questionnaire (BISQ - (Sadeh, 2004) that had been translated into Brazilian Portuguese (Nunes et al., 2012). This instrument is designed for screening sleep problems in infants and toddlers and includes questions asking parents to estimate typical bedtime, day and night sleep durations, the number of naps and nighttime wakes and whether they feel their child has a sleep problem.

The sleep diary consisted of 10 pages each with 14 questions , one page to be completed each morning. It asked parents for the bedtime and wake time for the previous night, the number of wakes and whether baby was fed or changed in the night. It asked parents to rate the baby’s morning happiness on scale from 0 to 10 where 0 = “very unhappy” (“nenhum pouco feliz”) and 10 = “very happy” (“muito feliz”) and the baby’s energy level (Scale 0-10) where 0 = “very tired” (“muito cansado”) and 10 = “very energetic” (“muito disposto”). A further question asked how giggly the baby was and to report the first thing to make them laugh that day. This data was not analyzed in the present study. The diary in English and Portuguese is included in the online materials.

**Procedure**

On Day 0 all participants were visited in their homes by a professional market researcher and written informed consent was obtained. The researcher who was unaware of the hypotheses of the study, guided the parent through the initial questionnaire, the BISQ and the IBQ-R. The parents were given a paper copy of the sleep diary and asked to complete it every morning when their baby woke for 10 consecutive nights. At the end of the diary period the researcher returned to collect the completed diary and gave parents several week supply of diaper and other baby products to thank them for their participation.

# Data analysis

All analysis was performed using the R statistics language (Version 4.0.4; R Core Team, 2021) and the CRAN packages glmulti, version 1.0.8 (Calcagno, 2020) for general linear modelling, apaTables, version 2.0.8 (Stanley, 2021) for model output and tidyverse, version 1.3.0 (Wickham et al., 2019) for data manipulation and graphing. The complete anonymized data and the analysis scripts data and the code to generate all figures are provided in the online materials (Blinded Ref, 2021).

**Results**

The questionnaire and diary data were transcribed and tabulated. After exclusion of one baby with just 2 diary entries out of 10, diary compliance was good with an average of 9.9 entries per participant. For each diary entry sleep durations were derived from provided sleep and wake times (not accounting for any nighttime wakes as no timings were available for these). For questionnaire data wake times were derived from bedtimes plus nighttime sleep and wake durations. A full table of descriptive statistics is provided as Table 1. To account for multiple comparisons, we chose to use a significance level of p = .001 throughout our analysis. All t-tests are two-tailed.

*Comparing diary and questionnaire data*

To investigate how well parental estimates of infant sleep parameters matched the more accurate data from diary entries, we took averages of each parameter from individual diaries and correlated with that parents corresponding questionnaire values. The main results are shown in Table 2. Parental estimates of bedtimes were similar, averaging 22:02 (SD 1h 16m) from the diary and 21:52 (SD 1h 2m) from the questionnaire, t(113) = 1.0, p = .2. The correlations between the two was Pearson’s r = .49, [.39; .62], p < .001, meaning that individual estimates of bedtime only moderately predicted average diary bedtime. Average sleep duration from the diary was 9h 47m (SD 1h 10m) and from the questionnaire was 9h 40m (SD 2h 04m), t (113) = 0.5, p = .6, with a correlation of r= .31, [.13; .47], p < .001. The average diary wake up time averaged 07:48 (SD 1h 14m) and 07:32 (SD 2h 14m) on the questionnaire, t(113) = 1.0, p = .2. The correlation was r = .38, [.21; .53], p < .001. Caution must be used when comparing waking time and sleep duration as these use derived values. Additionally, some parental estimates of ‘night sleep duration’ were very low, some as low as 2.5 hours. These parents may have interpreted the question as referring to duration of sleep periods. Notably, all five of these parents answered 5 hours or less that they did not consider their baby’s sleep a problem. Finally, the number of night wakings averaged 0.93 (SD 1.13) in the questionnaire and 0.86 (SD 0.93) in the diary, t(113) = 0.7, p = .5. These estimates correlated with r = .52, [.38; .65], p < .001.

*Linear models of sleep duration and morning mood.*

Next, we wished to discover the best predictors of sleep duration and morning mood using the night by night data from the sleep diaries. First, we investigated sleep duration. Preliminary analysis showered that none of the temperament factors were significantly correlated with sleep duration (Table 2) so we excluded these as potential predictor variables for sleep duration. We used the ‘glmulti’ package in R (Calcagno, 2020) to systematically compare the range of simple linear models of sleep duration. Variables included age, household size, where baby slept, if baby had a bedtime routine, bedtime, number of wakes, if baby was fed during night, morning diaper state, if diaper changed, average daytime sleep (from questionnaire) and diaper quality. Diaper quality was classified by absorbency based on questionnaire responses such that 57 infants were in more absorbent premium diapers and 57 were in less absorbent ordinary diapers. Only simple models without interactions were considered. The best model included bedtime, age, household size, where baby slept, diaper state and diaper changed as variables but not the number of wakings, daytime sleep or if baby was fed during night. This model had an R2 = .261 with F(6, 1129) = 66.5 and an Akaike information criterion score of 3958. The full model is given in Table 3. For comparison, we also show a simple model of just a single predictor of bedtime. This model had an R2 = .214 with F(1, 1134) = 310.0 and an Akaike information criterion score of 4017. This indicates that bedtime is the most substantial predictor of sleep duration.

We ran similar analyses for predictors of morning happiness and energy level. In these analyses we also included sleep duration and the temperament factors as potential predictors. The best model for predicting morning happiness is shown in Table 4 and had an R2 = .134 with F(9, 1126) = 19.4 and an Akaike information criterion score of 4097. Similar to the model of sleep duration, this model included bedtime, household size, where the baby slept and diaper state. It additionally included diaper quality, number of night wakings and length of day sleep but not age, night feeding or any of the temperament variables. A simple model with just sleep duration as a single predictor was a very poor fit for the data with an R2 = .008 with F(1, 1134) = 10.7 and an Akaike information criterion score of 4234. We conclude that morning happiness has many contributing factors. The best model for predicting morning energy level is shown in Table 5 and had an R2 = .324 with F(11, 1124) = 50.6 and an Akaike information criterion score of 4890. The best model included sleep duration, age, household size, sleep location, night wakes and feeds and all three diaper variables. But did not include bedtime or any of the temperament variables. A simple model with just hours of sleep as a single predictor had an R2 = .043 with F(1, 1134) = 50.7 and an Akaike information criterion score of 5277. Again, we conclude that morning energy has many contributing factors.

**Discussion**

Data from the 114 10-day infant sleep diaries was correlated with parental estimates from a sleep questionnaire (completed prior to the diary period). The correlations were of medium size suggesting that parents have moderate idea of their infants sleep patterns. This corroborates previous research recommending that sleep questionnaires function primarily as a tool for identifying sleep problems (Del-Ponte et al., 2020; Morrell, 1999; Sadeh, 2004). The sleep diary data was analysed using linear model comparison. This showed that nightly sleep duration is best predicted by primarily by bedtime the previous evening but withs small contributions from the household size (babies slept longer in homes with fewer people), sleep location (babies slept longer in separate room) and diaper changed (slept longer after a change). Babies also slept longer in wet and soiled diapers which is likely to be correlational rather than causal. Moreover, this best model only explained 26% of the total variance suggesting that there is a lot of unaccounted variation in infants night by night sleeping patterns.

The best fitting model of infant morning happiness contributions from a range of factors (Table 4) and only explained 13% of variance in happiness scores. This may reflect a ceiling effect in that infants were on average waking up very happy (8.2 out of 10). This corroborates the findings of Mindell and Lee's (2015) Brazilian questionnaire survey using more precise diary measures. The best model of morning energy levels explained 33% of the variance. This model had also contributions from many parameters (Table 5). One notable contrast between these two models was their opposite weightings of diaper state. Wet or soiled diapers contributed negatively to infants morning happiness but positively to their morning energy.

Finally, no aspects of infant temperament were related to infant sleep duration which was in line with some research (DeLeon & Karraker, 2007; Martini et al., 2017; Morrell & Steele, 2003). Our study showed that temperament is also not related to morning happiness or energy.

**Study 2 – United Kingdom**

For study 2 we wished to extend our findings by looking at a different population and culture. We decided to run a version of our study in the United Kingdom. But based on the results of our first study, we made a few changes. First, we wished to have a more systematic look at the effect of diaper quality. In the Brazil study, there was a positive effect of sleeping in more absorbent diapers but families used their own favored brands so this was not randomly assigned. In the UK, we make diaper type a within-subjects experimental variable. Each infant will wear three different diaper brands. To accommodate this the diary period will increase to three weeks. And to increase consistency we narrow the age range to infants of 7 to 15 months.

Additionally, we ask parents to report on their own nightly sleep and morning mood. Theoretically, it is believed that infants sleep has a direct effect on parent’s own sleep and mental state and that the link is bidirectional (Sadeh et al., 2010). This is supported empirically by studies relating infant sleep problems to parental mood (Hiscock & Wake, 2002; Matthey & Črnčec, 2012). However, mood has usually been looked at retrospectively rather on a night by night basis and does not always relate to infant sleep (Pennestri et al., 2018). By using diary measures we hope to take a more fine-grained look at the link.

**Method**

**Participants**

The participants were 147 mothers and infants from middle class and lower middle class backgrounds in southern England. The babies had a mean age of 10.2 months (range = 7-15 months) and 73 were female. Three other infants were excluded on grounds of age (less than 200 days old). The mothers mean age was 29.8 years (*SD* 5.2). They were recruited by a professional market research agency who also conducted the in-person data collection. Parents were not paid for their participation but were given several weeks supplies of free diapers at the end of the study. The diapers for the experimental conditions were also provided.

**Design**

Study two had a 3x3 mixed design with each infant wearing a different one of three diaper brands A, B and C for each of three consecutive weeks (within subject variable) with order counterbalanced ([A,B,C], [B,C,A], [C,A,B]). All three brands were widely sold in the UK. Of these A and B were premium brands with higher absorbency, while C was standard brand with lower absorbency. The sleep diary was completed for all 21 nights. These effects were incorporated into our linear modelling.

**Measures**

The infant measures were largely identical to study 1 but using the English language versions of all measures (IBQ-R, BISQ and sleep diary). Due to an error, we did not collect parents’ education level. In addition, we asked parents to complete a sleep diary of their own sleep over the period of the experiment. Each night they were asked for their bedtime, sleep time, wake time and getting up time. They were asked how many times they were woken by their baby and how many other times they woke up independently. Finally, they rated their sleep quality, their own happiness and energy level each morning (all on a scale of 0 to 10).

**Procedure**

Procedure was broadly the same as Brazil study. A trained market researcher visited parents in their homes at start of study to complete preliminary questionnaires, provide the paper diaries and sets of diapers for the duration of the study. They informed the parent which product to use each week, writing this on the diary to remind them. At the end of the diary period the researcher returned to collect the completed diary and gave parents several week supply of diaper and other baby products to thank them for their participation.

**Results**

Data were tabulated and analysed as before. Compliance was good with parents complete the diary an average of 20.8 out of 21 nights. The descriptive statistics are shown in Table 1.

*Comparing UK and Brazil*

We ran tests to compare variables between the two countries so find any differences using two-tailed tests and significance level of .001. Due to our selection criteria, infants were younger in the UK, t(259) = 6.40, p < .001 but parents did not differ significantly in age. Household size was smaller in the UK but this did not reach significance, t(259) = 2.72, p = .007, d = 0.34. Sleeping arrangements were significantly different, chi sq (7) = 152.33, p < .001. Most notably there was very little co-sleeping in the UK (2%) versus in Brazil (39%). Sleep routines were much more common in the UK where only 4% had no sleep routine compared to 56% in Brazil chi sq (5) = 170.89, p < .001. Slightly fewer UK parents were happy with the infants sleep (81% vs 95%)

UK infants went to bed, slept longer, woke earlier.. Based on the more accurate diary data we saw UK infants going to bed 2 hours 20 minutes earlier, t(4195) = 59.44, p < .001, d = 1.83. They slept 1 hour 13 minutes longer, t(4195) = 28.29, p < .001, d = 0.87 and woke 1 hour3 minutes earlier than Brazilian babies. t(4195) = 27.39, p < .001, d = 0.85. The amount of day sleep and number of night time wakes were not significantly different. UK babies were rated as less happy (7.8 vs 8.2), t(4195) = -7.84, p < .001, d = -0.24 but they more energetic, t(4195) = 4.38, p < .001, d = 0.14. In temperament, average negative affectivity was lower in UK babies (3.9 vs 4.8) t(259) = -7.16, p < .001, d = -0.89 but surgency and effortful control did not differ.

*Comparing diary and questionnaire data*

As before we correlated parental estimates with averages from diaries. The main results are shown in Table 2. The pattern was similar to Brazil with moderate correlations for most variables. One notable difference was a very high correlation between happiness and energy in UK infants, r = .85, CI 95% [.83; .86], p < .001. As in Brazil, there was no correlation between sleep duration and any temperament factors.

*Linear models of sleep duration and morning mood.*

The same linear modelling approach was used as in Study 1. The best model of sleep duration from diaries had an R2 = .462 with F(7, 3053) = 375.0 and an Akaike information criterion score of 7440. The full model is given in Table 6. Factors included bedtime, age, household size and others. However, a simple model with just a single predictor of bedtime had an R2 = .434 with F(1, 3059) = 2350 and an Akaike information criterion score of 7584. Showing that most of the variance was explained by changes in bedtime alone.

The best model of morning happiness from diaries had an R2 = .130 with F(13, 3047) = 34.9 and an Akaike information criterion score of 11939. The full model is given in Table 7. Number of wakes, sleep duration and whether diaper was changed were the biggest factors, but many factors also gave small contribution including surgency and effortful control. A simple model with just a single predictor of bedtime had an R2 = .019 with F(1, 3059) = 60.5 and an Akaike information criterion score of 12279.

The best model of energy from diaries had an R2 = .107 with F(13, 3047) = 27.9 and an Akaike information criterion score of 12224. The full model is given in Table 8. Number of wakes, sleep duration and whether diaper was changed were the biggest factors but many factors also gave small contribution including surgency and effortful control. A simple model with just a single predictor of bedtime had an R2 = .018 with F(1, 3059) = 55.9 and an Akaike information criterion score of 12489. This model is highly similar to model of happiness, as expected given their very high correlation.

*Relating parental sleep and mood to infant sleep*

Finally, we looked at parents’ own sleep, happiness and energy and how this correlated to infant sleep diary parameters of infant bedtime, sleep duration, number of night wakes and happiness. We did not include baby energy level as this correlated so strongly with baby happiness, nor any of the other parameters which might only indirectly affect the parents. We chose to look at parental reports of happiness (M = 7.2, SD = 2.0), energy (M = 6.5, SD = 2.2), and their subjective measure of sleep quality (M = 6.6, SD = 2.2), their total sleep duration (M = 7h56, SD = 1h30) and their own total number of wakes (M = 2.2, SD = 2.6). This final number consisted of the number of times they were woken by their baby and the number of times they woke independently. Table 9 reports the means, standard deviations, and all pairwise correlations with 95% confidence intervals. This analysis showed that parents happiness and energy were positively correlated with infant happiness (and energy) and that like their infants, UK parental happiness and energy were very highly correlated (r =79%). Parental sleep quality was very highly correlated with parental energy (r = 86%) and happiness (r = 74%) so it showed same pattern as parent energy in how it related to other variables. Parental measures were not correlated with infant bedtime and only small correlation with infants’ sleep duration. However, they were negatively affected by the number of infants wakes.

**General Discussion**

In summary, the results of study 2 indicated that UK infants go to bed earlier and sleep longer than Brazilian babies. They have more night wakings despite being more likely to sleep separate to their parents in their own room. UK parents were far more likely to have a sleep routine although more were unhappy with their infants sleep. UK babies were less happy but more energetic in the mornings. Using linear modelling of diary data, we found that UK infant sleep duration was affected by similar factors to Brazil but the model was dominated by bedtime. Neither happiness or energy level were particularly well explained by sleep parameters with the best models only explained low amounts of variance with many parameters contributing. The best models of happiness and energy were highly similar, due to the very high correlation between these two factors in the diaries. Finally, parents own sleep and mood were not related to infant bedtime or sleep duration but were affected by number of night-time wakings.

We saw the large cultural differences in bedtimes with UK infants put to bed 2 hour 20 minutes earlier than in Brazil. This is in line with other studies of these cultures (Mindell et al., 2015; Mindell & Lee, 2015; Netsi et al., 2017) but is the first time it has been confirmed in a direct comparison with diary studies. UK infants woke only 1 hour3 minutes earlier implying with sleep durations 1 hour 13 minutes longer. The infants both slept similar length during the day so Brazilian babies appear to sleep less per 24 hours (11h53 vs 12h45). This could be a real effect but there are several alternative explanations. First, it may be age related as the Brazilian sample as older on average (13.8 months vs 10 months) but our own linear modelling data and other studies do not see such large age related drops (see for example Netsi et al., 2017). Alternatively, the UK babies may be spending less time asleep during the night. This could be consistent with UK babies seeming to wake more often during the night. But this also points to one limitation of the present study, in that we did not collect timings of night awakening so sleep durations are approximate. To settle the question comparable 24 hour actigraphy recording would be recommended in any future research.

Differences in sleep duration may also be related to differences in sleeping arrangements such as household size and sleep location. Both of which were found to be different between the UK and Brazil and were picked out as factors by our linear modelling. In both countries we found that smaller household size resulted in more sleep. This suggests that infants sleep may be disturbed by other members of the household. Larger household size usually indicates the presence of older children and thus infants shorter sleep in these cases could be due to demands of caring (needing to get ready for school by certain time). We also saw that infants slept more was in a room of their own and less when sharing a room and least when co-sleeping. Infants having separate rooms which was more common in the UK and co-sleeping which was virtually absent in the UK.

Sleep routine did contribute to the model of sleep duration in the UK and morning happiness in Brazil. But this data is hard to interpret as we did nott collect detailed data on what sleep routines looked like. Nor did we ask about sleep training, this could have been a cross cultural difference, as ignoring crying is more common in European cultures (Maute & Perren, 2018) and sleep routines do seem to have positive benefits from infants and parents (Mindell et al., 2009, 2018). Routine might be investigated by looking at night by night variability. However, we did not look at variance in individual bedtimes or other sleep parameters in either country. This analysis would be possible with a diary study but our study is likely to be underpowered for investigating a second order measure like intra-individual variability (Bei et al., 2016).

The relationship between sleep and mood seemed consistent across both samples. Firstly, temperament measures were not significantly linked to sleep duration in either case and played only a very minor role in predicting morning mood in the UK sample (variance <= 1%). This suggests temperament is not an important aspect of typical infant sleep. This is contrary to some previous findings (Kaley et al., 2012; Spruyt et al., 2008; Touchette et al., 2005, 2009). It could be that temperament is only a factor when sleep is already problematic. Future research could investigate this. Beyond temperament we found that infants’ morning happiness was not strongly related to sleep factors with the best models only explaining 10-13% of the variance. Small contributions were found from sleep duration, night wakes and diaper changes. The good news however is that this may be due ceiling effects as infants generally woke up in very happy mood. Morning energy level showed a very similar pattern in the UK were it strongly correlated with happiness. This was not the case in Brazil suggesting possible cultural differences in how the question was interpreted. In the Brazil sample, the best model of energy explained 33% of the total variance. Energy and sleep duration were affected by diaper absorbency and state contradicting a small scale study by Zotter and colleagues (2007) and corroborating previous findings that compared cloth and disposable diapers (Lukowski et al., 2015). This suggests that diaper variables ought to be included in future diary studies of infant sleep.

In our UK study we also looked a parent’s sleep and mood by having parents complete diary entries about their own sleep. We found strong relationship between maternal morning mood and infant sleep. Our analysis showed that parents sleep quality, morning happiness and energy were strongly correlated with each other and with infants happiness. Parental sleep and mood was not affected by infant bedtime and showed only small correlation with infants’ sleep duration. They were mostly strongly affected by the number of infants wakes. These findings challengex previous research where maternal mood has not related to infant sleep (Pennestri et al., 2018) and supports findings from intervention studies (Hiscock et al., 2008, 2014). However, previous studies look at trait measures while the current study investigates state mood. To our knowledge, this is the first time that mood has been investigated as a state variable. Further research is needed especially in intervention studies. This does point to one limitation of our study, in that all our results are correlational or come from simple linear models. These models do not capture interaction effects or demonstrate clear causality. The true relationships are likely to be more complex so more sophisticated modelling approaches An alternative approach might be to use structural equation modelling (e.g. Mindell et al., 2014)

In conclusion, our two studies were well powered and use detailed night by night data to find a range of differences and commonalities in infant sleep in Brazil and the UK. Sleep duration was primarily related to earlier bedtime but this must be considered in cultural context. Our study provided circumstantial evidence supporting the transactional model view that environmental context is important to infant sleep (El-Sheikh & Sadeh, 2015). We showed that parental mood and sleep quality do not depend on infant sleep duration but are affected by the number of night time disturbances. Finally our data showed a complex relationship between infant sleep quality and morning mood but that parents can potentially improve morning happiness and energy by minimising night-time disturbances and using more absorbent diapers. These effects are small as, on most mornings, infants do wake up happy.

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Table 1: *Descriptive statistics for Brazil and UK studies. Final columns test for difference between the two sample, reporting p-value, test and value with degrees of freedom and where appropriate Cohen’s d. To account for multiple comparisons a significance level of .001 was used.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | Brazil  N = 114 | | UK  N = 147 | | | Difference  Brazil vs UK | | | | |
|  | | | | *M* | *SD* | *M* | | *SD* | p | Test (df) | d | |
| Infant Age (days) | | | | 420 | 199 | 310 | | 52 | **< .001** | t(260) = 6.40 | 0.79 | |
| Mother Age (years) | | | | 29.6 | 6.3 | 29.8 | | 5.2 | .756 | t(260) = 0.31 | 0.04 | |
| Household Size | | | | 4.33 | 1.71 | 3.87 | 1.08 | | .007 | t(259) =2.72 | 0.34 | | |
| Sleeping arrangements | | Own Room  Room with sib  Parents room  Cosleep | | 25 (22%)  10 (9%)  35 (30%)  44 (39%) | | 83 (56%)  10 (7%)  51 (35%)  3 (2%) | | | **< .001** | chi sq (7) = 152.33 | - | | |
| Sleep routine | | | Not yet  Kind of  Yes | 64 (56%)  5 (4%)  45 (40%) | | 6 (4%)  34 (23%)  107 (73%) | | | **< .001** | chi sq (5) = 170.89 | - | |
| Happy with baby’s sleep? | | | Yes  No  Unsure | 108 (95%)  3 (2.5%)  3 (2.5%) | | 119 (81%)  15 (10%)  13 (9%) | | | **< .001** | chi sq (5) = 342.15 | - | |
| Bedtime | | | Questionnaire  Diary | 21:53  22:02 | 1h 16m  1h 22m | 19:33  19:42 | | 1h 8m  1h 17m | **< .001**  **< .001** | t(259) = 15.5  t(4195) = 59.44 | 1.92 1.83 |
| Waketime | | | Questionnaire†  Diary | 06:46  07:48 | 2h 27m  1h 03m | 06:22  06:45 | | 2h 3m  0h 52m | **< .001**  **< .001** | t(259) = 4.27  t(4195) = 27.39, | 0.53 0.85 | | | |
| Duration | | | Questionnaire  Diary† | 8h 49m  9h 47m | 2h 01m  1h 10m | 10h 16m  11h 00m | | 1h 37m  1h 06m | **< .001**  **< .001** | t(259) = 6.42  t(4195) = 28.29 | 0.79  0.87 | | | |
| Num Wakes | | | Questionnaire  Diary | 0.93  0.86 | 1.13  1.16 | 1.49  1.29 | | 1.66  1.59 | **< .001** .003 | t(258) = 3.07  t(4195) = 8.44 | 0.38  0.26 | | | |
| Day Sleep | | | Questionnaire | 2h 6m | 67m | 1h 45m | | 43m | .155 | t(259) = -1.43 | -0.13 | | | |
| Happiness  (max 10) | | | Diary | 8.2 | 1.6 | 7.8 | | 1.8 | **< .001** | t(4195) = -7.84 | -0.24 | | | |
| Energy  (max 10) | | | Diary | 7.2 | 2.5 | 7.5 | | 1.9 | **< .001** | t(4195) = 4.38 | 0.14 | | | |
| IBQ  (max 8) | Surgency  Negative Affect  Self-Regulation | | | 5.1  4.8  5.2 | 1.1  1.1  0.8 | 5.4  3.9  5.4 | | 0.7  1.0  0.8 | .059  **< .001**  .183 | t(259) = 1.90  t(259) = -7.16  t(259) = 1.27 | 0.24  -0.88  0.18 | | | |

† - derived measure, see results for explanation.

Table 2

*Pairwise correlations for Brazil and UK studies showing Spearman’s Rho, 95% confidence interval and p value for each comparison. To account for multiple comparisons significance threshold of .001 was used.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Brazil | | |  | UK | |  |
|  | *r* | *[95% CI]* | | *p* | *r* | *[95% CI]* | *p* |
| Bedtime  (Diary vs Questionnaire) | .49\*\*\* | [.34; .62] | <.001 | | .55\*\*\* | [.43; .66] | <.001 |
| Night Sleep Duration  (Diary vs Questionnaire) | .35\*\*\* | [.18; .50] | <.001 | | .54\*\*\* | [.42; .65] | <.001 |
| Night Sleep Duration vs  Age (Dairy) | .04 | [-.09; .03] | .172 | | .13\*\*\* | [.09; .16] | <.001 |
| Day Sleep Duration vs  Age (Questionnaire) | -.32\*\*\* | [-.38; -.27] | <.001 | | -.12 | [-.28; .04] | .145 |
| Day vs Night Sleep Duration (Questionnaire) | -.07 | [-.25; .12] | .455 | | .16 | [-.01; .31] | .058 |
| Night Sleep Duration vs  Num Wakes (Questionnaire) | -.47\*\*\* | [-.60; -.32] | < .001 | | -.24 | [-.39; -.08] | .004 |
| Night Sleep Duration vs  Number Wakes (Diary) | -.03 | [-.09; .03] | .306 | | .-10\*\*\* | [-.13; -.06] | <.001 |
| Night Sleep Duration vs Happiness (Diary) | .10\*\*\* | [.04; .15] | .001 | | .14\*\*\* | [.10; .17] | <.001 |
| Night Sleep Duration vs  Energy (Diary) | .21\*\*\* | [.15; .26] | < .001 | | .13\*\*\* | [.10; .17] | <.001 |
| Happiness vs Energy  (Diary) | .34\*\*\* | [.29; .39] | <.001 | | .85\*\*\* | [.83; .86] | <.001 |
| Night Sleep Duration vs  Surgency (Diary) | .13 | [.02; .37] | .029 | | -.05 | [-.21; .11] | .527 |
| Night Sleep Duration vs  Negative Affect (Diary) | .15 | [-.03; .33] | .106 | | -.13 | [-.29; .03] | .107 |
| Night Sleep Duration vs  Self-Regulation (Diary) | .10 | [-.08; .28] | .273 | | -.06 | [-.22; .10] | .432 |

\*\*\* indicates p<.001

Table 3

*Regression results for Brazil sleep diaries using hours sleep as the criterion. The first block shows a simple model featuring just bedtime as a predictor. The second block shows the best fitting model found by the glmulti model comparison algorithm, see results for details.*

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Predictor | *b* | *b*  95% CI | *sr2* | *sr2*  95% CI | | *r* | | Fit | | Difference | |
| (Intercept) | 15.20\*\* | [14.59, 15.81] |  |  | |  | |  | |  | |
| Bedtime | -0.54\*\* | [-0.60, -0.48] | .21 | [.17, .25] | | -.46\*\* | |  | |  | |
|  |  |  |  |  | |  | | *R2*  = .214\*\* | |  | |
|  |  |  |  |  | |  | | 95% CI[.17,.25] | |  | |
|  |  |  |  |  | |  | |  | |  | |
| (Intercept) | 14.57\*\* | [13.90, 15.24] |  |  | |  | |  | |  | |
| Bedtime | -0.56\*\* | [-0.62, -0.50] | .22 | [.18, .26] | | -.46\*\* | |  | |  | |
| Age | 0.00\*\* | [0.00, 0.00] | .01 | [-.00, .02] | | .04 | |  | |  | |
| Household Size | -0.06\* | [-0.11, -0.01] | .00 | [-.00, .01] | | -.11\*\* | |  | |  | |
| Sleep location | -0.13\*\* | [-0.21, -0.05] | .01 | [-.00, .01] | | -.07\* | |  | |  | |
| Diaper state | 0.36\*\* | [0.22, 0.50] | .02 | [.00, .03] | | .14\*\* | |  | |  | |
| Diaper changed | 0.33\*\* | [0.16, 0.51] | .01 | [-.00, .02] | | .05 | |  | |  | |
|  |  |  |  |  | |  | | *R2*  = .261\*\* | | Δ*R2*  = .047\*\* | |
|  |  |  |  |  | |  | | 95% CI[.22,.30] | | 95% CI[.03, .07] | |
|  |  |  |  | |  | |  | |  | |  | |

*Note.* A significant *b*-weight indicates the semi-partial correlation is also significant. *b* represents unstandardized regression weights. *sr2* represents the semi-partial correlation squared. *r* represents the zero-order correlation. Due to a limitation of the apaTables package higher significance levels are not indicated.

\* indicates *p* < .05. \*\* indicates *p* < .01.

Table 4

*Regression results for Brazil sleep diaries using morning happiness from diary entries as the criterion.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Predictor | *b* | *b*  95% CI | *sr2* | *sr2*  95% CI | *r* | Fit | Difference |
| (Intercept) | 7.30\*\* | [6.74, 7.86] |  |  |  |  |  |
| Sleep duration | 0.09\*\* | [0.04, 0.15] | .01 | [.00, .02] | .10\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .009\*\* |  |
|  |  |  |  |  |  | 95% CI[.00,.02] |  |
|  |  |  |  |  |  |  |  |
| (Intercept) | 9.99\*\* | [8.81, 11.17] |  |  |  |  |  |
| Sleep duration | 0.06\* | [0.00, 0.13] | .00 | [-.00, .01] | .10\*\* |  |  |
| Bedtime | -0.06 | [-0.13, 0.01] | .00 | [-.00, .01] | -.09\*\* |  |  |
| Household Size | -0.15\*\* | [-0.20, -0.09] | .02 | [.01, .04] | -.19\*\* |  |  |
| Number of night wakes | -0.13\*\* | [-0.21, -0.06] | .01 | [-.00, .02] | -.11\*\* |  |  |
| Sleep location | 0.14\*\* | [0.05, 0.23] | .01 | [-.00, .02] | -.09\*\* |  |  |
| Sleep routine | -0.14\*\* | [-0.24, -0.04] | .01 | [-.00, .02] | -.11\*\* |  |  |
| Daytime sleep | -0.24\*\* | [-0.32, -0.17] | .03 | [.01, .05] | -.21\*\* |  |  |
| Diaper quality | 0.38\*\* | [0.19, 0.56] | .01 | [.00, .02] | .11\*\* |  |  |
| Diaper state | -0.45\*\* | [-0.60, -0.30] | .03 | [.01, .04] | -.18\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .134\*\* | Δ*R2*  = .125\*\* |
|  |  |  |  |  |  | 95% CI[.09,.16] | 95% CI[.09, .16] |
|  |  |  |  |  |  |  |  |

\* indicates *p* < .05. \*\* indicates *p* < .01.

Table 5

*Regression results for Brazil sleep diaries using morning energy from diary entries as the criterion.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Predictor | *b* | *b*  95% CI | *sr2* | *sr2*  95% CI | *r* | Fit | Difference |
| (Intercept) | 4.00\*\* | [3.11, 4.89] |  |  |  |  |  |
| Sleep duration | 0.33\*\* | [0.24, 0.42] | .04 | [.02, .07] | .21\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .043\*\* |  |
|  |  |  |  |  |  | 95% CI[.02,.07] |  |
|  |  |  |  |  |  |  |  |
| (Intercept) | -1.08\* | [-2.06, -0.10] |  |  |  |  |  |
| Sleep duration | 0.27\*\* | [0.19, 0.35] | .03 | [.01, .04] | .21\*\* |  |  |
| Age | 0.00\*\* | [0.00, 0.00] | .01 | [-.00, .01] | .28\*\* |  |  |
| Household Size | -0.20\*\* | [-0.28, -0.12] | .01 | [.00, .03] | -.03 |  |  |
| Number of night wakes | 0.36\*\* | [0.25, 0.48] | .02 | [.01, .04] | .12\*\* |  |  |
| Nightfeed (yes/no) | 0.95\*\* | [0.65, 1.25] | .02 | [.01, .04] | .23\*\* |  |  |
| Sleep location | 0.73\*\* | [0.59, 0.86] | .07 | [.04, .09] | .35\*\* |  |  |
| Diaper quality | 0.87\*\* | [0.61, 1.13] | .03 | [.01, .04] | .06 |  |  |
| Diaper state | 0.60\*\* | [0.38, 0.81] | .02 | [.01, .03] | .28\*\* |  |  |
| Diaper changed | 0.67\*\* | [0.39, 0.95] | .01 | [.00, .02] | .30\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .327\*\* | Δ*R2*  = .284\*\* |
|  |  |  |  |  |  | 95% CI[.28,.36] | 95% CI[.24, .33] |
|  |  |  |  |  |  |  |  |

\* indicates *p* < .05. \*\* indicates *p* < .01.

Table 6

*Regression results for UK sleep diaries using sleep duration as the criterion*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Predictor | *b* | *b*  95% CI | *sr2* | *sr2*  95% CI | *r* | Fit | Difference |
| (Intercept) | 16.71\*\* | [16.48, 16.94] |  |  |  |  |  |
| Bedtime | -0.74\*\* | [-0.77, -0.71] | .43 | [.41, .46] | -.66\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .434\*\* |  |
|  |  |  |  |  |  | 95% CI[.41,.46] |  |
|  |  |  |  |  |  |  |  |
| (Intercept) | 15.85\*\* | [15.50, 16.21] |  |  |  |  |  |
| Bedtime | -0.72\*\* | [-0.75, -0.69] | .39 | [.36, .41] | -.66\*\* |  |  |
| Age | 0.00\*\* | [0.00, 0.00] | .00 | [.00, .01] | .13\*\* |  |  |
| Household Size | 0.06\*\* | [0.03, 0.09] | .00 | [.00, .01] | -.01 |  |  |
| Sleep routine | -0.13\*\* | [-0.19, -0.08] | .00 | [.00, .01] | -.24\*\* |  |  |
| Daytime sleep | 0.10\*\* | [0.06, 0.13] | .01 | [.00, .01] | .06\*\* |  |  |
| Number of wakes | -0.07\*\* | [-0.09, -0.05] | .01 | [.00, .01] | -.10\*\* |  |  |
| Diaper changed | 0.06 | [-0.01, 0.13] | .00 | [-.00, .00] | -.05\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .462\*\* | Δ*R2*  = .028\*\* |
|  |  |  |  |  |  | 95% CI[.44,.48] | 95% CI[.02, .04] |
|  |  |  |  |  |  |  |  |

\* indicates *p* < .05. \*\* indicates *p* < .01.

Table 7

*Regression results for UK sleep diaries using sleep morning happiness as the criterion*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Predictor | *b* | *b*  95% CI | *sr2* | *sr2*  95% CI | *r* | Fit | Difference |
| (Intercept) | 5.25\*\* | [4.61, 5.88] |  |  |  |  |  |
| Sleep duration | 0.23\*\* | [0.17, 0.29] | .02 | [.01, .03] | .14\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .019\*\* |  |
|  |  |  |  |  |  | 95% CI[.01,.03] |  |
|  |  |  |  |  |  |  |  |
| (Intercept) | 5.88\*\* | [4.70, 7.05] |  |  |  |  |  |
| Sleep duration | 0.19\*\* | [0.13, 0.25] | .01 | [.01, .02] | .14\*\* |  |  |
| Age | -0.00\*\* | [-0.00, -0.00] | .00 | [-.00, .01] | -.03 |  |  |
| Household size | -0.10\*\* | [-0.15, -0.04] | .00 | [-.00, .01] | -.06\*\* |  |  |
| Sleep location | 0.22\*\* | [0.13, 0.32] | .01 | [.00, .01] | .00 |  |  |
| Sleep routine | -0.26\*\* | [-0.38, -0.14] | .00 | [.00, .01] | -.09\*\* |  |  |
| Sleep during day | 0.11\*\* | [0.04, 0.18] | .00 | [-.00, .01] | .07\*\* |  |  |
| Number of wakes | -0.31\*\* | [-0.35, -0.26] | .06 | [.04, .07] | -.26\*\* |  |  |
| Night feed | 0.14\*\* | [0.05, 0.23] | .00 | [-.00, .01] | -.06\*\* |  |  |
| Diaper type | -0.09\* | [-0.16, -0.02] | .00 | [-.00, .00] | -.05\* |  |  |
| Diaper state | -0.14\* | [-0.26, -0.02] | .00 | [-.00, .00] | -.03 |  |  |
| Diaper changed | -0.31\*\* | [-0.46, -0.16] | .00 | [.00, .01] | -.14\*\* |  |  |
| SURGENCY | 0.24\*\* | [0.15, 0.34] | .01 | [.00, .01] | .11\*\* |  |  |
| EFFORTFUL | 0.14\*\* | [0.06, 0.22] | .00 | [-.00, .01] | .12\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .130\*\* | Δ*R2*  = .110\*\* |
|  |  |  |  |  |  | 95% CI[.11,.15] | 95% CI[.09, .13] |
|  |  |  |  |  |  |  |  |

\* indicates *p* < .05. \*\* indicates *p* < .01.

Table 8

*Regression results for UK sleep diaries using morning energy level as the criterion*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Predictor | *b* | *b*  95% CI | *sr2* | *sr2*  95% CI | *r* | Fit | Difference |
| (Intercept) | 5.00\*\* | [4.35, 5.66] |  |  |  |  |  |
| Sleep duration | 0.23\*\* | [0.17, 0.29] | .02 | [.01, .03] | .13\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .018\*\* |  |
|  |  |  |  |  |  | 95% CI[.01,.03] |  |
|  |  |  |  |  |  |  |  |
| (Intercept) | 5.37\*\* | [4.15, 6.58] |  |  |  |  |  |
| Sleep duration | 0.18\*\* | [0.12, 0.24] | .01 | [.00, .02] | .13\*\* |  |  |
| Age | -0.00\*\* | [-0.00, -0.00] | .00 | [-.00, .01] | -.02 |  |  |
| Household size | -0.10\*\* | [-0.16, -0.04] | .00 | [-.00, .01] | -.06\*\* |  |  |
| Sleep location | 0.18\*\* | [0.08, 0.28] | .00 | [-.00, .01] | -.00 |  |  |
| Sleep routine | -0.36\*\* | [-0.50, -0.23] | .01 | [.00, .01] | -.10\*\* |  |  |
| Sleep during day | 0.15\*\* | [0.07, 0.22] | .00 | [-.00, .01] | .07\*\* |  |  |
| Number of wakes | -0.30\*\* | [-0.34, -0.25] | .05 | [.03, .06] | -.23\*\* |  |  |
| Night feed | 0.17\*\* | [0.08, 0.27] | .00 | [-.00, .01] | -.04\* |  |  |
| Diaper state | -0.11 | [-0.24, 0.01] | .00 | [-.00, .00] | -.02 |  |  |
| Diaper changed | -0.26\*\* | [-0.42, -0.10] | .00 | [-.00, .01] | -.13\*\* |  |  |
| SURGENCY | 0.22\*\* | [0.11, 0.32] | .00 | [.00, .01] | .10\*\* |  |  |
| NEG\_AFFECT | 0.12\*\* | [0.05, 0.19] | .00 | [-.00, .01] | -.00 |  |  |
| EFFORTFUL | 0.08 | [-0.01, 0.16] | .00 | [-.00, .00] | .09\*\* |  |  |
|  |  |  |  |  |  | *R2*  = .107\*\* | Δ*R2*  = .089\*\* |
|  |  |  |  |  |  | 95% CI[.08,.12] | 95% CI[.07, .11] |
|  |  |  |  |  |  |  |  |

\* indicates *p* < .05. \*\* indicates *p* < .01.

Table 9

*Relating parent and infant sleep in UK sample. Means, standard deviations, and correlations with confidence intervals*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | *M* | | *SD* | | | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 1.Baby bedtime | 19:45 | | 1:00 | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 2. Baby sleep duration | 11h00 | | 1h06m | | | -.66\*\*\* | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
|  | |  | | | [-.68, -.64] | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 3. Baby number wakes | 1.29 | | 1.59 | | | -.01 | | | -.10\*\*\* | | |  | | |  | | |  | | |  | | |  | | |  | | |
|  | |  | | | [-.05, .02] | | | [-.13, -.06] | | |  | | |  | | |  | | |  | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 4. Baby happiness | 7.75 | | 1.81 | | | -.08\*\*\* | | | .14\*\*\* | | | -.26\*\*\* | | |  | | |  | | |  | | |  | | |  | | |
|  | |  | | | [-.11, -.04] | | | [.10, .17] | | | [-.29, -.23] | | |  | | |  | | |  | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 5. Parent happiness | 7.20 | | 1.97 | | | .03 | | | .10\*\*\* | | | -.31\*\*\* | | | .52\*\*\* | | |  | | |  | | |  | | |  | | |
|  | |  | | | [-.00, .07] | | | [.06, .13] | | | [-.34, -.28] | | | [.49, .55] | | |  | | |  | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 6. Parent.energy | 6.51 | | 2.22 | | | .03 | | | .11\*\*\* | | | -.41\*\*\* | | | .48\*\*\* | | | .79\*\*\* | | |  | | |  | | |  | | |
|  |  | |  | | | [-.00, .07] | | | [.07, .14] | | | [-.44, -.38] | | | [.45, .51] | | | [.77, .80] | | |  | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 7. Parent.sleep quality | 6.57 | | 2.22 | | | .04\* | | | .13\*\*\* | | | -.51\*\*\* | | | .47\*\*\* | | | .74\*\*\* | | | .86\*\*\* | | |  | | |  | | |
|  | |  | | | [.00, .07] | | | [.09, .16] | | | [-.54, -.48] | | | [.44, .50] | | | [.73, .76] | | | [.86, .87] | | |  | | |  | | |
|  |  | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 8.Parent.number wakes | 2.15 | | 2.61 | | | | -.03 | | -.10\*\*\* | | | .76\*\*\* | | | -.18\*\*\* | | | -.33\*\*\* | | | -.44\*\*\* | | | -.54\*\*\* | | |  | | |
|  | | | |  | | [-.07, .00] | | | | [-.13, -.06] | | | [.75, .78] | | | [-.21, -.15] | | | [-.37, -.30] | | | [-.47, -.41] | | | [-.57, -.52] | | |  | | |
|  |  | | | |  | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 9. Parent sleep duration | | 7h56 | | 1h30 | | | -.03 | | | .23\*\*\* | | | .06\*\*\* | | | .05\*\* | | | .10\*\*\* | | | .10\*\*\* | | | .10\*\*\* | | | .05\*\* | | |
|  | | |  | | [-.06, .01] | | | | [.19, .26] | | | [.03, .10] | | | [.02, .09] | | | [.07, .14] | | | [.06, .13] | | | [.06, .13] | | | [.02, .09] | | |
|  |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |

*Note.* *M* and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014).

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