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

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Abstract

Infant sleep problems are among new parents greatest concerns. Even when sleep.

Sleep quantity and quality are recognised as important for infant development. But it remains an under-researched topic. Previous research has looked at the relationship between sleep and temperament and found that increased sleep length correlated with increased approachability and adaptability.

The present study uses sleep diaries with samples of parents and infants in Brazil (N=115) and

the United Kingdom (N =147) to investigate what factors besides duration may influence sleep quality. We looked at how sleeping arrangements, night-time disturbances and diaper quality effected sleep duration and how these factors combined to influence morning mood. Using linear models we find that in both samples infant bedtime is best predictor of sleep duration.

*Keywords:* keywords

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For example, one study used the naturally occurring wakening of cloth diapers vs commercial diapers as a proxy measure of manipulated sleep disruption (Lukowski et al., 2015).

Recent generations of British and American parents have been advised by pediatric health professionals that sleeping with their babies is "wrong" (e.g., Spock andRothenberg 1985; Sturgess 1977; Wright 1972). (Ball et al., 1999) Camerota et al. (2019) state that around 40% of reviewed infant sleep studies use only subjective, parent-report measures, such as a sleep diary or sleep questionnaires as indicators for infant sleep (Camerota et al., 2019). However, research has shown that parents are not very good at estimating their infants’ sleep, often under- or overestimating- their infants’ sleep compared to more objective measures (Camerota et al., 2018; Sadeh, 1994).

BISQ is thought to have good validity, as established by Sadeh (2004) who compared to actigraphy and sleep diaries.

Infants sleep a great deal but with many wakings.

And Ought to mention NSF sleep report (night wakings a proxy for sleep efficiency)

Infants sleep affects parents sleep. But little research investigates this.

Study of sixteen female subjects in a sleep lab for two weeks, found that subjective

sense of good sleep was primarily related to sleep continuity Åkerstedt, Hume, Minors, and Waterhouse (1994)

Ought to mention NSF sleep report (night wakings a proxy for sleep efficiency)

Studies often ask parents if infants slept well. Here we are interested in whether the infants seemed happy in the morning. A more objective measure of infant emotional & behavioural state that might be useful correlate of sleep quality. Did Mindell use this?

Because

. Temperament itself is complex construct with many different s typically assessed using versions of the Infant Behavioural Questionnaire (Gartstein & Rothbart, 2003; Putnam et al., 2006). A parent report measure which divides it into three constructs – self-regulation, negative affectivity & positive affectivity. All three have been related to infant sleep. Self-regulation (also known as orienting or effortful control) is

For instance, reactive infant temperament has been associated with shorter sleep  
duration and more night wakenings (Netsi et al., 2017) and an easy temperament (e.g.,  
increased approachability or low distractibility) was associated with longer overall  
objectively and parent-reported sleep duration (Kaley et al., 2012; Spruyt et al., 2008).  
Higher infant surgency (or an easy temperament) also moderated the impact of maternal  
emotional availability on sleep duration, suggesting a potential role of infant  
temperament on maternal mood and on sleep (Jian & Teti, 2016). Specifically, for infants  
with high surgency, higher maternal emotional availability was associated with higher  
sleep duration. No such effects were found for low surgency or the other subdimensions

For example, Mindell and colleagues (2010) report crosscultural differences in sleep duration and parent-reported sleep problems (Mindell et al.,  
2010). These differences in sleep duration are likely related to cross-cultural differences  
in *how* infants are put to sleep and availability of parents at bedtime and at night. Studies  
found that Brazilian infants and toddlers and children from Asian countries had  
systematically later bedtimes (by almost 2 hours) than were reported in European/US  
samples (Mindell et al., 2010; Netsi et al., 2017)

(Bayer et al., 2007; Mindell et al., 2009, 2014; Mindell & Lee, 2015)

**Method**

We report how we determined our sample size, all data exclusions (if any), all

40 manipulations, and all measures in the study.

**Participants**

The participants were 115 mothers and infants from middle class and lower middle class backgrounds in southern central São Paulo. They were recruited by Developers A further two participants were excluded because the infant was born prematurely (1) or had a respiratory condition (1). The mothers mean age was 29.5 years (*SD* 6.3), they came from middle class and lower middle class backgrounds, 14 (12%) had completed college, 65 had completed high school, 24 completed secondary school, 12 who did not complete secondary school.

Middle class & lower middle class families recruited in southern central São Paulo 117 mothers & babies (53 female, mean age = 13.9 months, range = 2-27m)

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.

This brief section describes the people who participated in your study. (They should be called “participants,” not “subjects,” by the way.) Mention the number of participants, the percentage of female and male participants, the mean age (where “mean” is abbreviated M), and their ethnicity or cultural background. Any other demographic information would be appropriate here.

Research Design

Experimental studies often have a section in the Method describing the design of the study. Typically the independent variables in the study would be described here. For example, the study might involve a 2-by-2 design with one independent variable being treatment/control conditions and the other independent variable being biological sex. It would be helpful to

describe dependent variables in this subsection as well.

**Measures**

On Day 0 all participants Family info Baby age Baby health screening Sleep

46 arrangements What diaper brand? Temperament (IBQ-R)

47 For 10 days participants kept a diary of infant sleep and morning mood

48 (Supplementary Materials 1).

49 Amount of sleep. How was diaper in morning? Number of times woke up. Feed?

50 Change? Morning Happiness (Scale 1-10) Morning Energy (Scale 1-10)

describe reliability and validity in the Results section (see below). However, you would only do this for a scale-development project.

**Procedure**

about the procedure.

# Data analysis

We used R (Version 3.5.3; R Core Team, 2019) and the R-packages *checkpoint* (Version 0.4.5; Corporation, 2018), *papaja* (Version 0.1.0.9842; Aust & Barth, 2018), *RevoUtils*  (Microsoft Corporation, 2018b, 2018a), and *RevoUtilsMath* (Microsoft Corporation, 2018a) for all our analyses. The complete anonymized data and analysis scripts can be found

**Results**

The Rstats package glmulti was used to compare linear models predicting sleep

59 duration from diary variables. The best fitting linear model accounted for 27% of variance.

60 Bedtime, diaper absorbency, diaper change, diaper morning state were significant factors.

However, a simple model with just bedtime as a factor had R2 = 23%

Infant sleep problems are among new parents’ greatest concerns and the importance of sleep quantity and quality for infant development is an under researched topic. This project reports the results a survey of parents in São Paulo, Brazil. The mothers of 117 infants (53 5 female, mean age = 13.9 months, range = 2-27m) provided background demographic data, general information on their child’s sleep and completed the appropriate version of the short 67 infant behaviour questionnaire (IBQ-R, Rothbart & Gartstein, 2000; EBQ, Putnam & Rothbart, 2006

). They also completed a 10 day sleep diary indicating the time babies went to sleep and woke up, night time wakes, feeds and diaper changes and the morning happiness 70 and energy of their baby on a 10 point scale.

Preliminary analysis indicated that overall infants were in bed for an average of 9h46 +/- 1h12 and woke up happy (mean score 8.2 +/-1.55) and energetic (mean score 7.2 +/-2.50). A regression analysis showed that babies’ morning energy level was positively affected by the number of night time wakings (beta=0.32, p<.001) and total sleep (beta=0.42, p<.001). By contrast happiness was negatively affected by night time wakings (beta=-0.31, p<.001) but showed an interaction between total sleep and diaper quality (total sleep: beta=0.13, p<.003, interaction beta=-0.14, p<.02). These patterns are shown in Figure 1. Sleep and morning mood were also affected by sleeping arrangements and infant temperament (not shown).

79 Overall, the data showed a complex relationship between infant sleep quality and morning

80 mood but that parents can potentially improve morning mood by minimising night-time

81 disturbances and using more absorbent diapers.

*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 and plotted in Figures 1a-1d. 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 (Figure 1a). 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 (Figure 1b). 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 (Figure 1c). Caution must be used when comparing waking time and sleep duration as these use derived values. Additionally, as can be seen in Figure 1c 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 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,

82 **Discussion**

83 Infant nighttime sleep duration primarily predicted by bedtime. Duration not affected

84 by age, nighttime feeding or number of wakes and shows only small effects related to diaper.

85 Infant temperament does not appear to affect sleep or morning mood Babies morning energy

86 increases with amount of sleep. Happiness increases only in absorbent diapers

A recent meta-analysis by Tomfohr-Madsen and colleagues (2020) revealed that  
the higher the neighbourhood SES of the child, the longer the objectively as well as  
subjectively reported sleep duration (Tomfohr-Madsen et al., 2020).

For example,  
Matenchuk et al. (2019) found that 3-months old infants slept 40 minutes longer on  
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average if the mother had a university degree (Matenchuk et al., 2019).

Sleep less in more dense urban environments (Bottino et al., 2012) and in areas of higher SES

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the higher the neighbourhood SES of the child, the longer the objectively as well as  
subjectively reported sleep duration (Tomfohr-Madsen et al., 2020).

Climate Future studies should collect detailed geo

April 27° / 18°

We were interested in typical sleep and did not set out to investigate sleep problems

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Table 1: *Descriptive statistics for Brazil and UK studies*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Brazil  N = 115 | | UK  N = 147 | | Difference  Brazil vs UK | | | | |
|  | | *M* | *SD* | *M* | *SD* | p | Test (df) | | | d |
| Infant Age (days) | | 419 | 198 | 310 | 52 | < .001 | t(260) = 6.40 | | | 0.79 |
| Mother Age (years) | | 29.5 | 6.3 | 29.8 | 5.2 | .756 | t(260) = 0.31 | | | 0.04 |
| Sleeping arrangements | Own Room  Room with sib  Parents room  Cosleep | 25 (22%)  10 (9%)  35 (30%)  45 (39%) | | 83 (56%)  10 (7%)  51 (35%)  3 (2%) | | < .001 | chi^2(7) = 152.47 | | | - | |
| Sleep routine | Not yet  Kind of  Yes | 64 (56%)  5 (4%)  46 (40%) | | 6 (4%)  34 (23%)  107 (73%) | | < .001 | chi^2(5) = 170.32 | | - | | |
| Bedtime | Questionnaire  Diary | 21:53  22:02 | 1h 16m  1h 22m | 19:33  19:42 | 1h 8m  1h 17m | < .001  < .001 | t(260) = 15.57  t(4197) = 59.51 | 1.92 1.84 | | |
| Waketime | Questionnaire†  Diary | 07:46  07:48 | 2h 27m  1h 03m | 06:22  06:45 | 2h 3m  0h 52m | < .001  < .001 | t(260) = 4.06  t(4197) = 27.44, | 0.50 0.85 | | |
| Duration | Questionnaire  Diary | 9h 53m  9h 47m | 1h 49m  1h 10m | 10h 16m  11h 00m | 1h 37m  1h 06m | t(260) = 6.54,  p < .001, d = 0.81 | t(4197) = 28.32, | p < .001, d = 0.87 | | |
| Num Wakes | Questionnaire  Diary | 0.94  0.86 | 1.13  1.16 | 1.49  1.29 | 1.66  1.59 | t(259) = 3.03,  p = .003, d = 0.37 | t(4197) = 8.41, | p < .001, d = 0.26 | | |
| Day Sleep | Questionnaire | 2h 6m | 67m | 1h 8m | 61m | t(260) = -1.03, | p = .306, d = -0.13 |  | | |
| Happiness  (max 10) | Diary | 8.2 | 1.6 | 7.8 | 1.8 | t(4197) = -7.86, | p < .001, d = -0.24 |  | | |
| Energy  (max 10) | Diary | 7.2 | 2.5 | 7.5 | 1.9 | t(4197) = 4.35, | p < .001, d = 0.13 |  | | |
| IBQ  (max 8) | Surgency  Negative Affect  Effortful Control | 5.2  4.9  5.2 | 1.1  1.1  0.8 | 5.4  4.0  5.4 | 0.7  1.0  0.8 | t(260) = 1.76,  p = .079, d = 0.22 | t(260) = -6.75,  p < .001, d = -0.83 | t(260) = 1.45,  p = .149, d = 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.*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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 Number Wakes (Questionnaire) | -.47 | [-.60; -.32] | < .001 | | -.24 | [-.39; -.08] | .004 |
| Night Sleep Duration vs Number Wakes (Dairy) | -.03 | [-.09; .03] | .306 | | .-10 | [-.13; -.06] | <.001 |
| Night Sleep Duration vs Happiness (Dairy) | .10 | [.04; .15] | .001 | | .14 | [.10; .17] | <.001 |
| Night Sleep Duration vs Energy (Dairy) | .21 | [.15; .26] | < .001 | | .13 | [.10; .17] | <.001 |
| Night Sleep Duration vs Surgency  (Diary) | .13 | [-.06; .30] | .176 | | -.05 | [-.21; .12] | .568 |
| Night Sleep Duration vs Negative Affect (Diary) | .11 | [-.07; .29] | .235 | | -.13 | [-.29; .03] | .104 |
| Night Sleep Duration vs Effortful Control (Diary) | .12 | [-.06; .30] | .191 | | -.07 | [-.23; .10] | .431 |