

Supplementary information

Systematic uncertainties on estimated cosine model parameters

Systematic uncertainties of the estimated infant cosine model parameter X , $\Delta_{LIDS}^{\text{sys}}(X)$, were assessed by computing the absolute difference between the median value per participant obtained with the default settings and the median value for the same participant with a modified setting. In this study, we investigated systematic uncertainties from the following alternative settings:

1. Inactivity signal processing:
 - a. Smoothing: Inactivity data smoothed using a centered moving average with a window length of 30 minutes, as used in the original LIDS study.
 - b. Smoothing kernel resolution: Inactivity data smoothed using a Gaussian kernel with a standard deviation ranging from 2.5 to 10 minutes.
 - c. Sampling resolution: Inactivity data resampled to a 10-min resolution, the resolution in the original LIDS study. However, since smoothing data with 10-min wide bins with a Gaussian kernel with a 5-min resolution is inefficient, a centered moving average with a window length of 30 minutes was used instead, both for the original and the resampled data.
2. Linear trend in LIDS harmonic model: LIDS parameter estimated with a model without linear trend, as in the original LIDS study.
3. Sleep bout fusing: unfused sleep bouts as well as with a maximal time gap of 5 minutes.

LIDS cycle length

In infants, the source of systematic uncertainties on the LIDS cycle length estimates with the greatest magnitude is the smoothing procedure. LIDS smoothed with a 30-min long moving average window yielded longer LIDS cycle length estimates (6 min ($IQR = [3, 12]$) at 3 months, 6 min ($IQR = [2, 15]$) at 6 months and 3 min ($IQR = [0, 10]$) at 12 months). Similarly, a smoothing using a wider Gaussian kernel ($\sigma = 10$ min) led to longer LIDS cycle length estimates (8 min ($IQR = [4, 16]$) at 3 months, 10 min ($IQR = [4, 22]$) at 6 months and 4 min ($IQR = [2, 17]$) at 12 months). No sleep bout fusing or a fusing with a time gap of 5 minutes appeared to decrease the LIDS cycle length estimates (-2 min ($IQR = [-6, +0]$) at 3 months, -3 min ($IQR = [-8, +0]$) at 6 months and -2 min ($IQR = [-6, +0]$) at 12 months). This observation was compatible with the increase in LIDS bout duration (61 min, $IQR = [20, 130]$) with the bout fusing, which in turn produces longer LIDS cycle length estimates (cf. Table S6). A smoothing with a narrower Gaussian kernel (2.5 min), a lower sampling bin width (10 min) of the sleep bouts, as well as the addition of a linear trend in the LIDS oscillatory model had marginal effects on LIDS cycle length estimates.

Other LIDS characteristics

As expected, the main source of systematic uncertainty of the amplitude estimates originated from the sampling frequency: 11.1 LIDS unit ($IQR = [9.6, 12.8]$) at 3 months, 10.7 LIDS unit ($IQR = [9.3, 12.4]$) at 6 months and 10.8 LIDS unit ($IQR = [9.4, 12.6]$) at 12 months with a lower resampling resolution (10 min), compared to estimates produced with the original frequency (1 min). Since the resampling was performed via summation over aggregated epochs, the mean LIDS levels, and therefore the LIDS amplitude, increased almost linearly with the resampling resolution. In addition, the smoothing resolution was the second largest source of systematic uncertainties for the LIDS amplitude. Compared to the default smoothing resolution, a lower temporal resolution yielded lower LIDS amplitude; a wider Gaussian kernel leads to -4.1 LIDS unit ($IQR = [-5.1, -3.3]$) at 3 months, -3.0 LIDS unit ($IQR = [-3.9, -2.2]$) at 6 months, -2.6 LIDS unit ($IQR = [-3.3, -2.1]$) at 12 months and a 30-min long moving average window to -3.5 LIDS unit ($IQR = [-4.3, -2.6]$) at 3 months, -2.5 LIDS unit ($IQR = [-3.3, -1.8]$) at 6 months and -2.1 LIDS unit ($IQR = [-2.7, -1.6]$) at 12 months. This effect was expected; the lower the temporal resolution (i.e. the larger the smoothing kernel), the higher the loss of temporal specificity. LIDS levels were spread over larger time periods and therefore decreased. This observation emphasized that the LIDS level fluctuations are temporally localized and not random as expected for rhythmic processes. Other sources of potential systematic uncertainties had marginal effects on the LIDS amplitude estimates.

Similarly to the LIDS amplitude, the LIDS offset was affected by the resampling frequency: -28.8 LIDS unit ($IQR = [-33.5, -24.6]$) at 3 months, -25.6 LIDS unit ($IQR = [-29.4, -21.3]$) at 6 months and -26.7 LIDS unit ($IQR = [-29.7, -24.6]$) at 12 months for a lower resampling frequency ($1/10 \text{ min}^{-1}$). Another prominent source of systematic uncertainty derived from the model parametrization; obviously, the addition of a linear trend in the LIDS model, compared to the original model, modified the LIDS characteristic estimated by the offset. In the current model, the offset represented the LIDS level at the beginning of the sleep bout while, in the original model, it represented the overall mean LIDS level. As the LIDS levels decreased overnight, the mean LIDS levels were lower than the LIDS levels at the beginning of the sleep bout: -7.1 LIDS unit ($IQR = [-9.7, -4.5]$) at 3 months, -6.1 LIDS unit ($IQR = [-7.8, -4.0]$) at 6 months, -5.4 LIDS unit ($IQR = [-7.9, -3.4]$) at 12 months. The decrease of this systematic effect over the time points (from -7.1 to -5.4 LIDS unit) was consistent with the concomitant increase of the LIDS slope (cf. Table S6).

Summary statistics for participants and sleep bouts

Table S1 provides information about the number of participants as a function of their family members enrolled in this study. In addition, Table S3 describes the number of sleep bouts identified in parents, as well as their duration, across the three assessment time points. As for infants, the median number of sleep bouts per night decreased from 4–5 to 1 when fusing and cosine fit quality criteria were applied. In parallel, the median sleep bout duration per night increased from 0.8h to 5.8h at 3 months and from 0.9h to 6.9h at 12 months. This new duration is most likely more representative of the expected average sleep duration in young adults.

Supplementary figures

Lomb-Scargle periodogram

Figure S1 shows the distributions of the LIDS cycle length, estimated with the Lomb-Scargle periodogram method for two different cycle detection ranges.

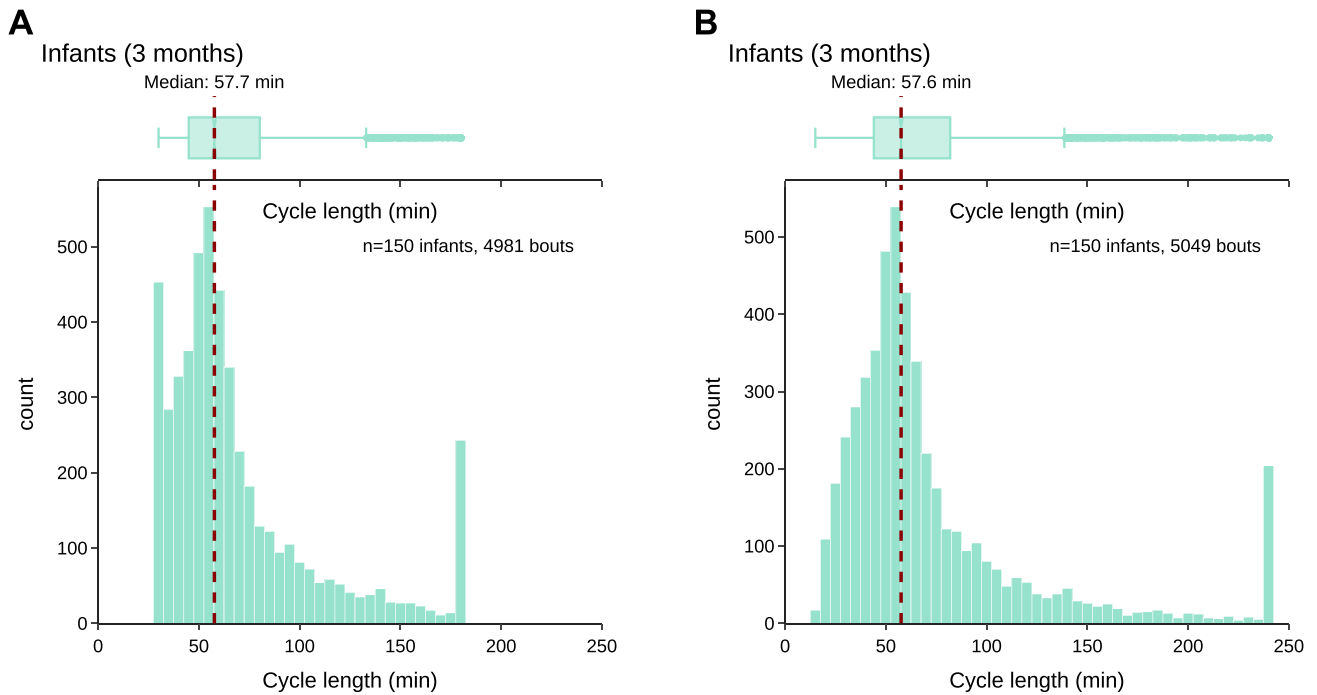


Figure S1. Lomb-Scargle determined cycle lengths of the LIDS rhythm in infants at 3 months. Distribution of estimated cycle length of the full infant sleep bout sample at 3 months as determined by Lomb-Scargle periodogram analysis with two different detection ranges: (A) 30-180 min and (B) 15-240 min cycle lengths. Boxplots are Tukey boxplots with whiskers spanning all data within 1.5 times the inter-quartile range. Spikes at a cycle length of 30, 180 and 240 minutes are due to bouts with an estimated cycle length at the limits or outside of the detection range.

Inactivity profiles

Figure S2 shows the infant inactivity profiles across the first year of life.

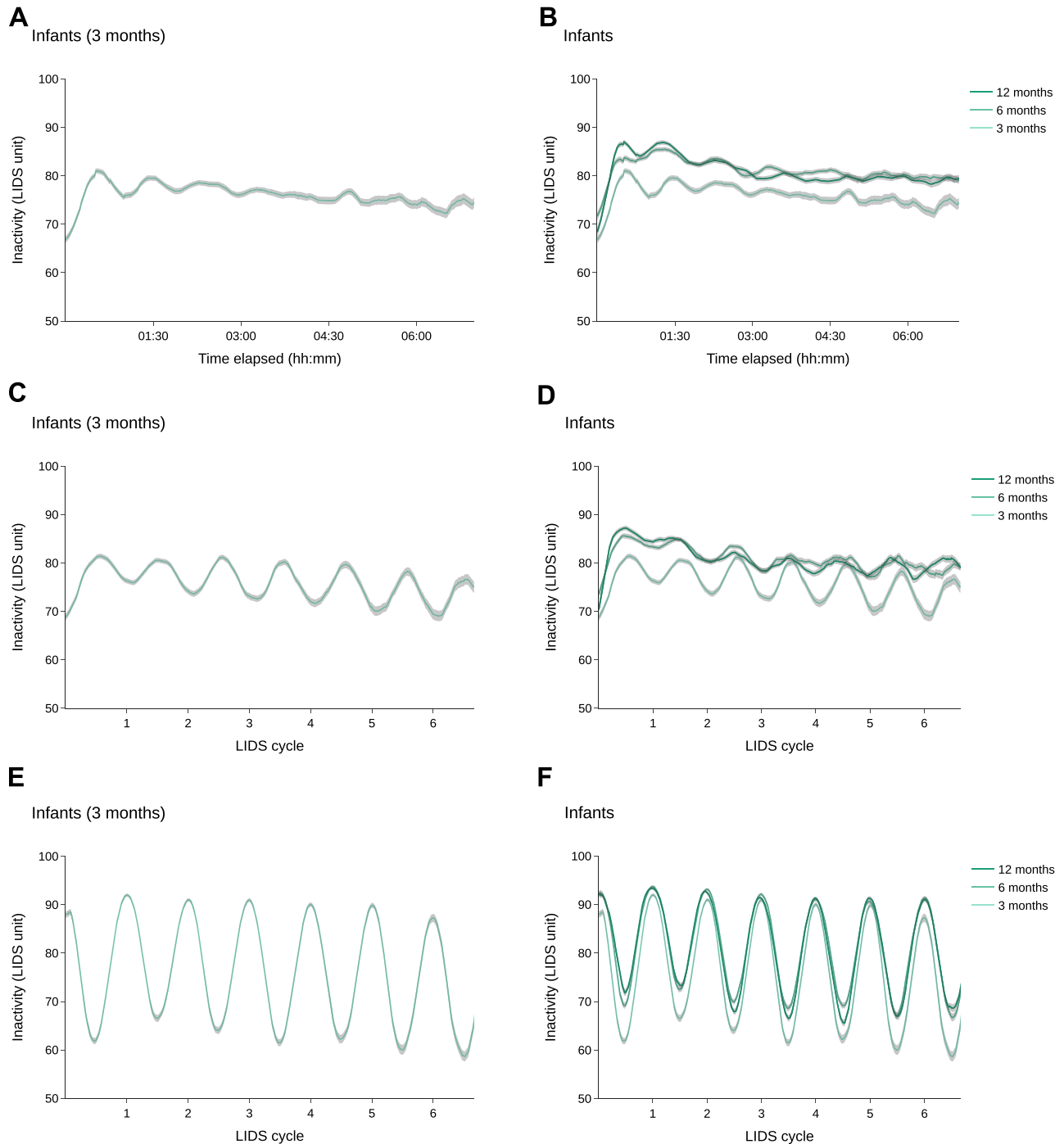


Figure S2. Infant inactivity profiles across the first year of life. Average profiles (\pm SEM) of infant inactivity during sleep at 3 months (left) and all 3 time points (right). (A,B) "Raw" profiles, where inactivity was averaged across sleep bouts by absolute time since bout onset. (C,D) Period-normalized profiles, where inactivity was averaged by time normalized to each bouts' LIDS period. (E,F) Phase-aligned and period-normalized profiles, where inactivity was averaged by time normalized to each bout's LIDS period after phase-alignment according to each bout's LIDS phase.

Systematic uncertainties on estimated cosine model parameters

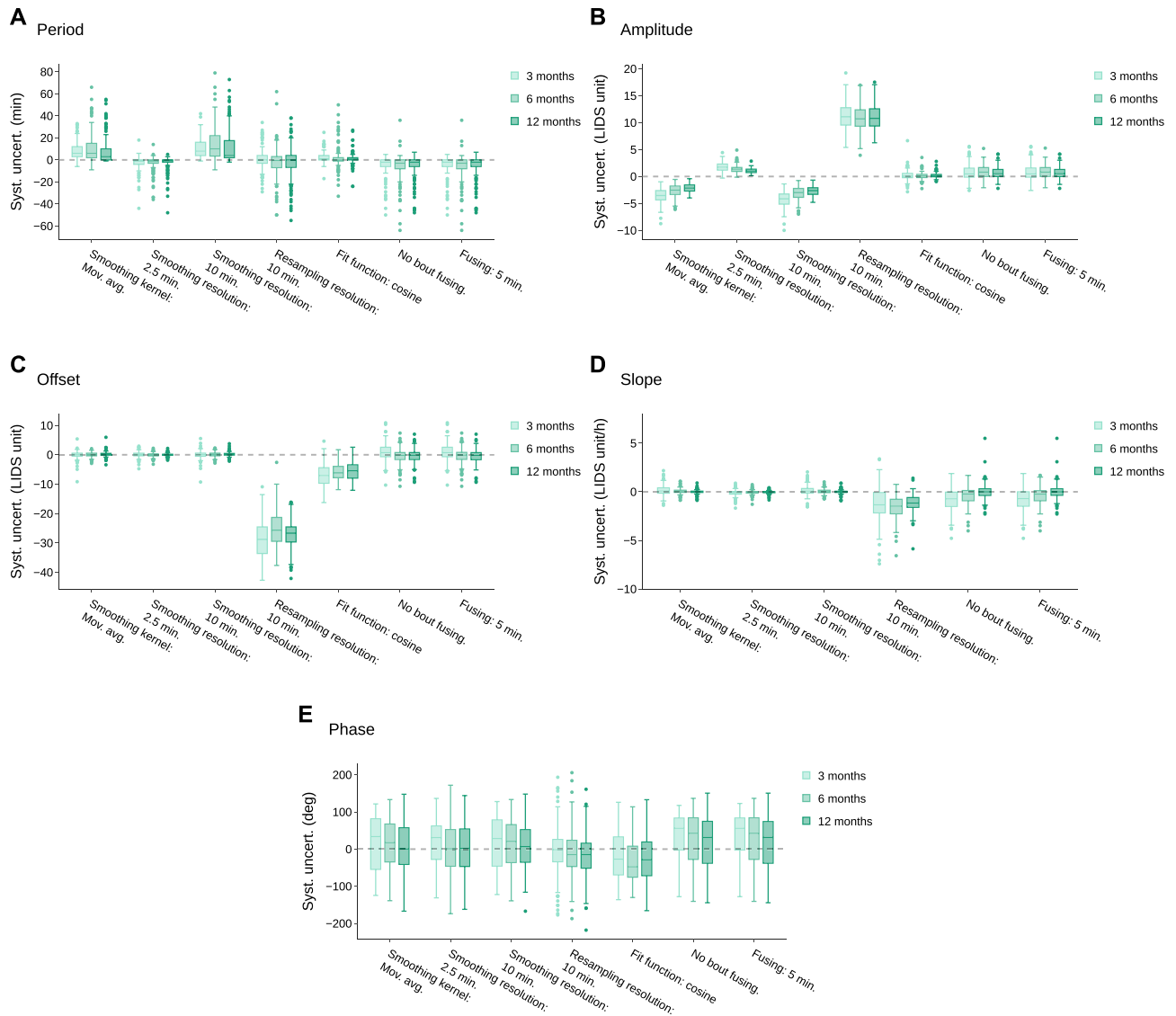


Figure S3. Systematic uncertainties of LIDS parameter estimation in infants. The systematic influence of key data processing choices on LIDS parameter estimation. Displayed are differences between the individual median values obtained with the default processing choice to the individual median values obtained with the altered settings indicated. All LIDS parameter estimates were performed via cosine fitting (A:period, B:amplitude, C:offset, D:slope and E:phase). Boxplots are Tukey boxplots with whiskers spanning all data within 1.5 times the inter-quartile range.

Supplementary tables

Summary statistics for participants and sleep bouts

Table S1. Data availability per family. Number of families for which data were available for analysis as a function of contributing family members at time points 1 (3 months) to 3 (12 months). Abbreviations: I, infant; M, mother; F, father

Family contribution	I only	M only	I + M	I + F	I + M + F	Total families I + any parent	Total families I only or I + any parent
Time point							
3 months	73	0	51	3	23	77	150
6 months	86	0	44	1	17	62	148
12 months	88	1	40	0	15	55	144

Table S2. Infant sleep bout summary statistics. Number and duration of actigraphically-identified nighttime sleep bouts of infants after fusing of bouts within 15 minutes of each other (excluding those comprising > 20% wake from fusing).

		Time points		
		3 months	6 months	12 months
Sleep bouts after fusing (< 20% wake)				
Sleep bouts (n)				
Total		3496	2408	1742
Total/infant	Median [IQR]	23 [19,27]	17 [12,19.25]	11 [9,15]
Total/infant/night	Median [IQR]	2 [2,3]	2 [1,2]	1 [1,2]
Bout duration (h)				
Total		13423	12920	12137
Total/infant	Median [IQR]	92.3 [81.1,99.6]	92.7 [80.2,101.0]	90.0 [74.3,101.2]
Total/infant/night	Median [IQR]	9.5 [8.3,10.5]	10.1 [9.2,10.9]	10.4 [9.6,11.1]
Median/infant/night	Median [IQR]	4.0 [2.4,5.5]	5.4 [4.2,9.9]	9.7 [5.2,10.8]

Table S3. Parent sleep bout summary statistics. Number and duration of actigraphically-identified nighttime sleep bouts of parents before and after processing and application of inclusion criteria. "Identified bouts" refers to sleep bouts as detected by the modified Sadeh algorithm. "Fused bouts" refers to sleep bouts available after concatenation of bouts within 15 minutes of each other (after exclusion of those comprising > 20% wake from fusing). "Analyzed bouts" refers to the final set of sleep bouts used in the inactivity analysis after filtering for a 90-min minimum duration and a cosine fit offset outside of extreme values. Numbers were split between mothers and fathers to highlight differences in analyzed bouts. Abbreviation: IQR, interquartile range

		Time points		
		3 months	6 months	12 months
Identified bouts				
Sleep bouts (n)				
Total		4933	3517	2738
Total/parent/night	Median [IQR]	5.0 [3.0,7.0]	4.0 [3.0,6.0]	4.0 [3.0,5.0]
Bout duration (h)				
Total		8088	6340	5256
Total/parent	Median [IQR]	83.3 [72.2,89.7]	81.2 [73.8,87.3]	77.2 [69.6,84.4]
Median/parent/night	Median [IQR]	0.8 [0.4,1.7]	1.0 [0.5,2.0]	0.9 [0.5,2.5]
Fused bouts (fused if within 15 min; < 20% wake)				
Sleep bouts (n)				
Total		1792	1288	1028
Total/parent/night	Median [IQR]	2.0 [1.0,2.0]	2.0 [1.0,2.0]	1.0 [1.0,2.0]
Bout duration (h)				
Total		7606	5984	5005
Total/parent	Median [IQR]	79.4 [68.4,85.8]	77.6 [68.9,83.1]	72.4 [66.2,80.3]
Median/parent/night	Median [IQR]	4.3 [3.0,7.4]	4.8 [3.5,7.7]	5.4 [3.7,7.7]
Analyzed bouts (fused if within 15 min; > 90 min; 1 <offset< 99)				
Sleep bouts (n)				
Total		1226	935	747
Total/parent/night	Median [IQR]	1 [1,2]	1 [1,2]	1 [1,1]
Bout duration (h)				
Total		6490	5353	4454
Total/parent	Median [IQR]	66.6 [53.4,77.2]	69.9 [56.5,77.3]	63.9 [57.7,71.2]
Median/parent/night	Median [IQR]	5.8 [3.8,8.1]	6.7 [4.2,8.2]	6.9 [4.8,8.0]
Median/mother/night	Median [IQR]	5.2 [3.6,8.1]	6.6 [4.0,8.2]	6.9 [4.6,8.0]
Median/father/night	Median [IQR]	7.1 [4.4,8.2]	6.9 [5.1,8.0]	7.2 [5.6,7.8]

Table S4. Statistical comparison of LIDS parameters between infants and parents at 3 months. Bayesian generalized mixed model analysis with random intercept per family: estimated mean, standard deviation and limits of the credible interval of posterior distributions for fixed and random effects. Statistically significant effects are shaded in gray. Reference levels for categorical fixed effects: Infant for Role. Abbreviations: Std, standard deviation; HDI, highest density interval.

LIDS parameter		Mean	Std.	95% HDI: lower limit	95% HDI: upper limit
Period (min)	Intercept	55.32	0.99	53.36	57.20
	Duration (h)	1.98	0.19	1.60	2.34
	Role[Parent]	-7.33	2.11	-11.47	-3.21
	Duration (h) Role[Parent]	4.08	0.37	3.35	4.79
	$\sigma_{1 Family\ ID}$	4.58	0.64	3.37	5.88
	$\sigma_{Role Family\ ID}[Parent]$	6.82	1.50	3.83	9.75
Amplitude (LIDS unit)	Intercept	20.35	0.27	19.81	20.86
	Duration (h)	-0.92	0.03	-0.98	-0.85
	Role[Parent]	-10.48	0.47	-11.39	-9.55
	Duration (h) Role[Parent]	0.65	0.06	0.53	0.75
	$\sigma_{1 Family\ ID}$	2.18	0.15	1.88	2.48
	$\sigma_{Role Family\ ID}[Parent]$	2.60	0.28	2.07	3.16
Offset (LIDS unit)	Intercept	77.57	0.51	76.60	78.59
	Duration (h)	1.06	0.07	0.92	1.20
	Role[Parent]	10.67	0.84	8.99	12.26
	Duration (h) Role[Parent]	-0.70	0.12	-0.95	-0.47
	$\sigma_{1 Family\ ID}$	2.92	0.27	2.42	3.46
	$\sigma_{Role Family\ ID}[Parent]$	2.56	0.48	1.62	3.51
Slope (LIDS unit/h)	Intercept	-3.81	0.19	-4.17	-3.43
	Duration (h)	0.20	0.03	0.15	0.25
	Role[Parent]	3.06	0.30	2.46	3.63
	Duration (h) Role[Parent]	-0.18	0.04	-0.27	-0.10
	$\sigma_{1 Family\ ID}$	0.49	0.09	0.31	0.66
	$\sigma_{Role Family\ ID}[Parent]$	0.26	0.15	0.00	0.52
Phase (rad)	Intercept	7.73	2.93	1.69	12.82
	Duration (h)	-0.07	0.32	-0.63	0.63
	Role[Parent]	-3.89	3.50	-10.19	3.55
	Duration (h) Role[Parent]	0.02	0.35	-0.72	0.65
	$\sigma_{1 Family\ ID}$	8.59	2.70	3.87	13.86
	$\sigma_{Role Family\ ID}[Parent]$	4.53	2.91	0.00	9.66

Statistical results

Table S5. Predicted LIDS parameters for infants and parents at 3 months. Predictions from Bayesian generalized mixed model analysis with random intercept per family: mean estimated value and limits of its credible interval, defined as its 95% Highest Density Interval (HDI), for infants and parents separately. Estimates were produced for sleep bout durations of 4.8h and 5.8h, which correspond to the median per night at 3 months in our dataset, for infants and parents respectively. The estimated cycle length for sleep bouts of 7.5h is also provided for reference.

LIDS parameter	Role	Sleep bout duration (h)	Estimate	95% HDI: lower limit	95% HDI: upper limit
Cycle length (min)	Infant	4.8	61.70	56.47	67.13
	Infant	5.8	63.68	58.15	68.96
	Infant	7.5	67.05	61.74	72.86
	Parent	4.8	74.59	67.73	81.54
	Parent	5.8	80.66	73.72	87.67
	Parent	7.5	90.97	83.66	98.22
Amplitude (LIDS unit)	Infant	4.8	18.16	16.69	19.66
	Infant	5.8	17.25	15.76	18.75
	Infant	7.5	15.69	14.18	17.20
	Parent	4.8	8.07	6.93	9.24
	Parent	5.8	7.80	6.65	8.97
	Parent	7.5	7.34	6.17	8.56
Offset (LIDS unit)	Infant	4.8	84.81	81.70	88.11
	Infant	5.8	85.87	82.75	89.16
	Infant	7.5	87.67	84.45	90.88
	Parent	4.8	91.46	89.13	93.89
	Parent	5.8	91.82	89.39	94.16
	Parent	7.5	92.42	90.02	94.87
Slope (LIDS unit/h)	Infant	4.8	-3.10	-3.81	-2.35
	Infant	5.8	-2.89	-3.61	-2.16
	Infant	7.5	-2.55	-3.28	-1.83
	Parent	4.8	-1.02	-1.78	-0.30
	Parent	5.8	-1.00	-1.74	-0.27
	Parent	7.5	-0.97	-1.71	-0.25

Table S6. Statistical analysis of LIDS parameters in infants at 3, 6 and 12 months. Bayesian generalized mixed model analysis with random intercept per infant and time point: estimated mean, standard deviation and limits of the credible interval of posterior distributions for fixed and random effects. Statistically significant effects are shaded in gray. Reference levels for categorical fixed effects: 3 months for time point, female for sex and separate room for sleep location. Abbreviations: Std, standard deviation; HDI, highest density interval.

LIDS parameter		Mean	Std.	95% HDI: lower limit	95% HDI: upper limit
Cycle length (min)	Intercept	52.14	4.89	42.82	62.04
	Time point[6 months]	-0.08	0.69	-1.45	1.26
	Time point[12 months]	4.70	0.93	2.85	6.51
	Sex[Male]	1.34	0.74	-0.08	2.83
	Bout duration (h)	1.01	0.07	0.87	1.15
	Night sleep (% , x10)	0.18	0.66	-1.13	1.47
	Sleep location[Separate bed]	0.97	0.72	-0.43	2.40
	Sleep location[Attached cot]	0.61	1.06	-1.49	2.66
	Sleep location[Parents' bed]	2.94	0.89	1.16	4.64
	σ_1 Subject ID	3.64	0.96	2.94	4.34
	$\sigma_{\text{Time point}}$ Subject ID[6 months]	2.72	0.99	0.60	4.62
$\sigma_{\text{Time point}}$ Subject ID[12 months]	3.11	0.82	1.46	4.73	
Amplitude (LIDS unit)	Intercept	18.98	1.69	15.63	22.27
	Time point[6 months]	-2.27	0.23	-2.71	-1.83
	Time point[12 months]	-1.57	0.32	-2.19	-0.93
	Sex[Male]	-0.28	0.33	-0.92	0.38
	Bout duration (h)	-0.61	0.02	-0.64	-0.57
	Night sleep (% , x10)	0.03	0.23	-0.41	0.49
	Sleep location[Separate bed]	-0.21	0.27	-0.73	0.31
	Sleep location[Attached cot]	-0.72	0.37	-1.45	-0.02
	Sleep location[Parents' bed]	-0.90	0.33	-1.53	-0.27
	σ_1 Subject ID	1.88	0.13	1.63	2.15
	$\sigma_{\text{Time point}}$ Subject ID[6 months]	1.43	0.16	1.12	1.73
$\sigma_{\text{Time point}}$ Subject ID[12 months]	1.57	0.17	1.24	1.91	
Offset (LIDS unit)	Intercept	77.03	3.27	70.81	83.58
	Time point[6 months]	3.22	0.44	2.38	4.10
	Time point[12 months]	1.50	0.63	0.27	2.72
	Sex[Male]	-0.79	0.51	-1.77	0.21
	Bout duration (h)	0.93	0.05	0.83	1.02
	Night sleep (% , x10)	-0.07	0.45	-0.94	0.81
	Sleep location[Separate bed]	0.14	0.50	-0.83	1.14
	Sleep location[Attached cot]	0.14	0.71	-1.20	1.56
	Sleep location[Parents' bed]	0.81	0.59	-0.32	2.02
	σ_1 Subject ID	2.55	0.23	2.13	3.00
	$\sigma_{\text{Time point}}$ Subject ID[6 months]	1.30	0.55	0.08	2.21
$\sigma_{\text{Time point}}$ Subject ID[12 months]	1.73	0.57	0.50	2.81	
Slope (LIDS unit/h)	Intercept	-3.32	0.68	-4.61	-1.99
	Time point[6 months]	0.65	0.09	0.46	0.83
	Time point[12 months]	0.83	0.12	0.60	1.06
	Sex[Male]	-0.06	0.09	-0.23	0.12
	Bout duration (h)	0.15	0.01	0.12	0.17
	Night sleep (% , x10)	-0.03	0.09	-0.21	0.15
	Sleep location[Separate bed]	0.11	0.09	-0.08	0.29
	Sleep location[Attached cot]	0.17	0.14	-0.11	0.46
	Sleep location[Parents' bed]	0.34	0.11	0.13	0.56
	σ_1 Subject ID	0.37	0.05	0.28	0.46
	$\sigma_{\text{Time point}}$ Subject ID[6 months]	0.29	0.12	0.03	0.48
$\sigma_{\text{Time point}}$ Subject ID[12 months]	0.12	0.08	0.00	0.28	
Phase (rad)	Intercept	10.32	19.72	-32.63	46.16
	Time point[6 months]	-2.54	2.81	-8.05	2.39
	Time point[12 months]	-4.18	3.64	-10.93	3.59
	Sex[Male]	1.27	2.36	-3.41	5.92
	Bout duration (h)	-1.13	0.24	-1.63	-0.65
	Night sleep (% , x10)	0.45	2.39	-3.84	5.79
	Sleep location[Separate bed]	1.16	2.67	-3.76	6.54
	Sleep location[Attached cot]	-1.04	4.50	-9.64	8.13
	Sleep location[Parents' bed]	0.66	3.02	-5.49	6.95
	σ_1 Subject ID	7.34	4.46	0.00	16.27
	$\sigma_{\text{Time point}}$ Subject ID[6 months]	3.02	1.88	0.00	6.27
$\sigma_{\text{Time point}}$ Subject ID[12 months]	2.78	2.22	0.00	7.33	

Table S7. Relationship between infant LIDS cycle length and sleep bout duration - statistical analysis of the first 3 hours of long bouts. Bayesian generalized mixed model analysis of infant LIDS cycle length in bouts >5 hours based on parameter estimates for the first 3h of each sleep bout ($n = 4357$ bouts): estimated mean, standard deviation and limits of the credible interval of posterior distributions for fixed and random effects. Statistically significant effects are shaded in gray. Reference levels for categorical fixed effects: 3 months for time point, female for sex and separate room for sleep location. Abbreviations: Std, standard deviation; HDI, highest density interval.

LIDS parameter		Mean	Std.	95% HDI: lower limit	95% HDI: upper limit
Cycle length (min)	Intercept	57.04	4.59	48.03	66.01
	Time point[6 months]	-0.96	0.61	-2.16	0.21
	Time point[12 months]	3.05	0.83	1.46	4.68
	Sex[Male]	-0.09	0.68	-1.41	1.25
	Bout duration (h)	-0.16	0.08	-0.31	-0.01
	Night sleep (% , x10)	0.56	0.62	-0.67	1.77
	Sleep location[Separate bed]	0.18	0.65	-1.10	1.43
	Sleep location[Attached cot]	0.19	0.97	-1.79	2.03
	Sleep location[Parents' bed]	0.86	0.79	-0.65	2.45
	$\sigma_{1 \text{Subject ID}}$	3.31	0.31	2.71	3.93
$\sigma_{\text{Time point} \text{Subject ID}[6 \text{ months}]}$	1.02	0.67	0.00	2.21	
$\sigma_{\text{Time point} \text{Subject ID}[12 \text{ months}]}$	1.01	0.69	0.00	2.27	

Table S8. Statistical analysis of infant LIDS parameters at 12 months including breastfeeding status. Bayesian generalized mixed model analysis with random intercept per infant: estimated mean, standard deviation and limits of the credible interval of posterior distributions for fixed and random effects. Statistically significant effects are shaded in gray. Reference levels for categorical fixed effects: female for sex, no for breastfed and separate room for sleep location. Abbreviations: Std, standard deviation; HDI, highest density interval.

LIDS parameter		Mean	Std.	95% HDI: lower limit	95% HDI: upper limit
Cycle length (min)	Intercept	41.22	10.06	21.13	60.88
	Sex[Male]	0.58	0.96	-1.25	2.51
	Bout duration (h)	1.00	0.11	0.78	1.22
	Breastfed[Yes]	2.47	1.04	0.41	4.49
	Night sleep (% , x10)	1.92	1.21	-0.46	4.33
	Sleep location[Separate bed]	1.13	1.17	-1.09	3.50
	Sleep location[Parents' bed]	3.15	1.33	0.57	5.80
	σ_1 Subject ID	3.89	0.59	2.80	5.09
Amplitude (LIDS unit)	Intercept	16.61	3.61	9.77	23.93
	Sex[Male]	-0.28	0.34	-0.95	0.37
	Bout duration (h)	-0.38	0.03	-0.43	-0.32
	Breastfed[Yes]	0.02	0.37	-0.71	0.73
	Night sleep (% , x10)	-0.13	0.44	-0.98	0.73
	Sleep location[Separate bed]	0.27	0.41	-0.55	1.07
	Sleep location[Parents' bed]	-1.11	0.46	-2.03	-0.22
	σ_1 Subject ID	1.71	0.14	1.44	1.99
Offset (LIDS unit)	Intercept	80.72	6.05	69.18	92.85
	Sex[Male]	-0.67	0.56	-1.79	0.42
	Bout duration (h)	0.31	0.06	0.19	0.43
	Breastfed[Yes]	1.40	0.62	0.18	2.60
	Night sleep (% , x10)	0.40	0.73	-1.08	1.78
	Sleep location[Separate bed]	-0.88	0.70	-2.32	0.43
	Sleep location[Parents' bed]	-0.68	0.79	-2.24	0.83
	σ_1 Subject ID	2.60	0.26	2.10	3.10
Slope (LIDS unit/h)	Intercept	-1.63	1.18	-3.92	0.69
	Sex[Male]	-0.16	0.11	-0.37	0.06
	Bout duration (h)	0.12	0.02	0.08	0.16
	Breastfed[Yes]	-0.12	0.12	-0.35	0.11
	Night sleep (% , x10)	-0.10	0.14	-0.38	0.19
	Sleep location[Separate bed]	0.10	0.13	-0.17	0.35
	Sleep location[Parents' bed]	0.51	0.15	0.20	0.81
	σ_1 Subject ID	0.44	0.06	0.33	0.56
Phase (rad)	Intercept	7.82	21.38	-32.37	49.83
	Sex[Male]	0.58	1.82	-3.00	3.82
	Bout duration (h)	-1.41	0.52	-2.27	-0.84
	Breastfed[Yes]	1.18	2.84	-4.52	6.60
	Night sleep (% , x10)	0.51	2.43	-4.04	5.48
	Sleep location[Separate bed]	-0.41	2.22	-4.61	4.09
	Sleep location[Parents' bed]	0.88	3.30	-5.39	7.73
	σ_1 Subject ID	4.46	6.52	1.78	5.88

Table S9. Statistical analysis of parental LIDS parameters across time points. Bayesian generalized mixed model analysis with random intercept by family and random slopes per time point: estimated mean, standard deviation and limits of the credible interval of posterior distributions for fixed and random effects. Statistically significant effects are shaded in gray. Reference levels for categorical fixed effects: 3 months for time point, mother for role and separate room for sleep location. Abbreviations: Std, standard deviation; HDI, highest density interval.

LIDS parameter		Mean	Std.	95% HDI: lower limit	95% HDI: upper limit
Cycle length (min)	Intercept	50.03	2.26	45.83	54.72
	Time point[6 months]	-1.85	1.63	-5.05	1.30
	Time point[12 months]	-1.82	1.96	-5.57	2.08
	Role[Father]	-4.72	2.25	-9.09	-0.29
	Role*Time point[6 months, Father]	1.31	3.36	-5.46	7.74
	Role*Time point[12 months, Father]	6.77	3.74	-0.56	14.06
	Bout duration (h)	5.87	0.23	5.40	6.33
	Infant sleep location[Separate bed]	1.77	1.96	-1.94	5.78
	Infant sleep location[Attached cot]	6.34	2.34	1.78	10.88
	Infant sleep location[Parents' bed]	3.88	2.12	-0.36	7.89
	σ_1 Family ID	3.95	1.10	1.73	6.16
	$\sigma_{\text{Time point}} $ Family ID[6 months]	2.15	1.54	0.00	5.07
	$\sigma_{\text{Time point}} $ Family ID[12 months]	3.54	2.12	0.00	7.20
Amplitude (LIDS unit)	Intercept	9.44	0.33	8.79	10.08
	Time point[6 months]	-0.24	0.21	-0.66	0.16
	Time point[12 months]	-0.28	0.26	-0.80	0.23
	Role[Father]	-0.50	0.23	-0.94	-0.07
	Role*Time point[6 months, Father]	0.51	0.33	-0.15	1.14
	Role*Time point[12 months, Father]	0.63	0.37	-0.10	1.35
	Bout duration (h)	-0.27	0.02	-0.31	-0.22
	Infant sleep location[Separate bed]	0.26	0.30	-0.34	0.83
	Infant sleep location[Attached cot]	0.65	0.37	-0.06	1.41
	Infant sleep location[Parents' bed]	1.38	0.35	0.68	2.05
	σ_1 Family ID	1.25	0.14	0.99	1.53
	$\sigma_{\text{Time point}} $ Family ID[6 months]	1.08	0.20	0.70	1.47
	$\sigma_{\text{Time point}} $ Family ID[12 months]	1.09	0.20	0.72	1.50
Offset (LIDS unit)	Intercept	90.30	0.63	89.04	91.51
	Time point[6 months]	-0.27	0.35	-0.94	0.44
	Time point[12 months]	-1.07	0.46	-1.98	-0.16
	Role[Father]	-1.17	0.50	-2.13	-0.19
	Role*Time point[6 months, Father]	-1.45	0.74	-2.89	-0.02
	Role*Time point[12 months, Father]	-0.30	0.83	-1.93	1.34
	Bout duration (h)	0.22	0.06	0.11	0.33
	Infant sleep location[Separate bed]	-0.28	0.52	-1.29	0.71
	Infant sleep location[Attached cot]	-0.09	0.62	-1.30	1.14
	Infant sleep location[Parents' bed]	-1.63	0.59	-2.81	-0.51
	σ_1 Family ID	2.19	0.26	1.71	2.71
	$\sigma_{\text{Time point}} $ Family ID[6 months]	0.59	0.38	0.00	1.27
	$\sigma_{\text{Time point}} $ Family ID[12 months]	0.98	0.51	0.00	1.82
Slope (LIDS unit/h)	Intercept	-0.97	0.18	-1.33	-0.61
	Time point[6 months]	0.19	0.10	-0.02	0.39
	Time point[12 months]	0.19	0.12	-0.05	0.44
	Role[Father]	0.09	0.14	-0.18	0.36
	Role*Time point[6 months, Father]	-0.05	0.21	-0.47	0.35
	Role*Time point[12 months, Father]	-0.12	0.23	-0.55	0.36
	Bout duration (h)	0.04	0.02	0.01	0.08
	Infant sleep location[Separate bed]	-0.10	0.13	-0.35	0.16
	Infant sleep location[Attached cot]	-0.21	0.16	-0.53	0.10
	Infant sleep location[Parents' bed]	-0.01	0.15	-0.30	0.29
	σ_1 Family ID	0.44	0.06	0.32	0.57
	$\sigma_{\text{Time point}} $ Family ID[6 months]	0.15	0.10	0.00	0.33
	$\sigma_{\text{Time point}} $ Family ID[12 months]	0.21	0.13	0.00	0.43
Phase (rad)	Intercept	3.61	3.69	-3.54	10.99
	Time point[6 months]	-0.93	4.24	-9.27	7.17
	Time point[12 months]	2.42	3.24	-3.48	9.64
	Role[Father]	-2.36	2.34	-6.97	1.70
	Role*Time point[6 months, Father]	5.18	7.28	-9.66	19.16
	Role*Time point[12 months, Father]	-2.19	5.96	-14.55	9.37
	Bout duration (h)	0.07	0.29	-0.41	0.63
	Infant sleep location[Separate bed]	2.19	3.05	-4.04	8.25
	Infant sleep location[Attached cot]	-6.61	6.47	-19.60	5.37
	Infant sleep location[Parents' bed]	0.34	4.13	-8.00	8.30
	σ_1 Family ID	7.16	2.34	2.85	11.86
	$\sigma_{\text{Time point}} $ Family ID[6 months]	6.48	3.24	0.02	12.17
	$\sigma_{\text{Time point}} $ Family ID[12 months]	3.35	2.76	0.00	8.78

Table S10. Statistical analysis of mothers' LIDS parameters at 12 months including breastfeeding status. Bayesian generalized mixed model analysis with random intercept per family: estimated mean, standard deviation and limits of the credible interval of posterior distributions for fixed and random effects. Statistically significant effects are shaded in gray. Reference levels for categorical fixed effects: no for breastfeeding; separate room for sleep location. Abbreviations: Std, standard deviation; HDI, highest density interval.

LIDS parameter		Mean	Std.	95% HDI: lower limit	95% HDI: upper limit
Cycle length (min)	Intercept	49.37	4.07	41.48	57.46
	Bout duration (h)	4.83	0.55	3.78	5.90
	Breastfeeding[Yes]	6.69	3.16	0.51	12.89
	Infant sleep location[Separate bed]	8.61	4.31	0.03	17.03
	Infant sleep location[Parents' bed]	6.04	3.86	-1.56	13.55
	$\sigma_1 _{\text{Family ID}}$	4.89	2.36	0.00	8.67
Amplitude (LIDS unit)	Intercept	10.20	0.53	9.13	11.23
	Bout duration (h)	-0.47	0.06	-0.59	-0.35
	Breastfeeding[Yes]	0.42	0.49	-0.54	1.42
	Infant sleep location[Separate bed]	0.88	0.67	-0.45	2.16
	Infant sleep location[Parents' bed]	1.79	0.62	0.54	2.99
	$\sigma_1 _{\text{Family ID}}$	1.45	0.21	1.06	1.85
Offset (LIDS unit)	Intercept	87.96	1.22	85.51	90.32
	Bout duration (h)	0.39	0.15	0.09	0.68
	Breastfeeding[Yes]	1.42	0.87	-0.29	3.13
	Infant sleep location[Separate bed]	-1.55	1.19	-3.84	0.82
	Infant sleep location[Parents' bed]	-2.75	1.10	-4.89	-0.60
	$\sigma_1 _{\text{Family ID}}$	2.20	0.43	1.39	3.06
Slope (LIDS unit/h)	Intercept	-0.73	0.32	-1.34	-0.08
	Bout duration (h)	0.05	0.04	-0.03	0.13
	Breastfeeding[Yes]	-0.51	0.20	-0.92	-0.14
	Infant sleep location[Separate bed]	0.18	0.26	-0.34	0.70
	Infant sleep location[Parents' bed]	0.29	0.26	-0.21	0.79
	$\sigma_1 _{\text{Family ID}}$	0.45	0.10	0.24	0.66
Phase (rad)	Intercept	-0.06	7.60	-14.33	15.23
	Bout duration (h)	0.75	1.11	-1.34	2.63
	Breastfeeding[Yes]	-1.64	4.58	-11.03	7.10
	Infant sleep location[Separate bed]	2.61	6.63	-10.30	16.29
	Infant sleep location[Parents' bed]	-0.04	5.99	-12.09	11.40
	$\sigma_1 _{\text{Family ID}}$	8.33	3.75	2.34	16.49