Bélanger, M.-È., Bernier, A., Simard, V., Desrosiers, K., & Carrier, J. (2016). Sleeping toward behavioral regulation: Relations between sleep and externalizing symptoms in toddlers and preschoolers. *Journal of Clinical Child and Adolescent Psychology*. Advanced online publication, DOI:10.1080/15374416.2015.1079782

Abstract

Objective: The aim of this study was to investigate the concurrent and longitudinal relations between sleep and externalizing symptoms among young children. Method: Sixty-four families (mostly Caucasian; 36 boys) were met twice, when children were 2 (T1) and 4 years of age (T2). At T1, children wore an actigraph monitor for a 72-hour period, and both mothers and fathers completed the Child Behavior Checklist (CBCL). At T2, both parents as well as the daycare educator filled the CBCL. Results: At T1, longer sleep duration and higher sleep efficiency was associated with fewer externalizing symptoms as assessed by mothers. Results also indicated that higher sleep efficiency at T1 was related to fewer parent-reported externalizing symptoms at T2 (while controlling for prior externalizing symptoms). Relations between sleep efficiency at T1 and externalizing symptoms as assessed by mothers at T1 and by fathers at T2 were moderated by child sex, such that links were significant among boys only. Results pertaining to educators' reports were inconclusive. Conclusions: The current study highlights the importance of rapidly treating sleep difficulties, which are associated with persistent behavioral maladjustment, perhaps especially for boys.

Keywords: child sleep, externalizing symptoms, actigraphy, preschoolers.

Sleeping toward behavioral regulation: Relations between sleep and externalizing symptoms in toddlers and preschoolers

Based on the suggestion that inadequate sleep results in inattention, irritability, and difficulty modulating impulses and emotions (e.g., Dahl, 1996), there has been much research investigating the relations between sleep difficulties and problems of an externalizing nature (aggression, conduct problems, hyperactivity, etc.) in children. Studies tackling these questions have mainly used subjective measures (often maternal reports) of child sleep, and generally found that parent-reported sleep difficulties are associated with more externalizing symptoms in children (e.g., Hiscock, Canterford, Ukoumunne, & Wake, 2007; Paavonen, Porkka-Heiskanen, & Lahikainen, 2009). However, subjective reports of child sleep are often criticized for their susceptibility to respondent biases and their reliance on parental awareness of child sleep (Sadeh, Acebo, Seifer, Aytur, & Carskadon, 1995). In contrast, the use of objective sleep measures, such as actigraphy, prevents parental biases and overcomes shared method variance with parental reports of child externalizing symptoms (Sadeh, 2011).

Recently, there have been consistent findings of relations between objective sleep variables (e.g., derived from actigraphy) and behavior problems, however mostly in school-age children (e.g., El-Sheikh, Kelly, Buckhalt, & Hinnant, 2010; Kelly & El-Sheikh, 2014). In contrast, despite the high prevalence of sleep difficulties during toddlerhood and the preschool years (Petit, Touchette, Tremblay, Boivin, & Montplaisir, 2007), little attention has been paid to the association between sleep objectively assessed and behavior problems during these periods. Furthermore, the results of these few studies are mixed, with one study reporting significant links between sleep difficulties and aggressive behaviors in preschoolers (Hatzinger et al., 2010), and two others, based on the same sample, failing to find such associations (Anders, Iosif, Schwichtenberg, Tang, & Goodlin-Jones, 2012; Goodlin-Jones et al., 2009).

Overall, the association between sleep and externalizing symptoms repeatedly found in school-age children, and often assumed to exist in the toddler and preschool years as well, appears to have been substantiated nearly exclusively by parental reports of young children's sleep (see review by Bagley & El-Sheikh, 2013), whereas there is hardly any evidence for such links when sleep is assessed objectively. Accordingly, the central aim of this study was to investigate this question with actigraphy, in a longitudinal design (allowing for stronger inference), and based on reports from mothers, fathers, and daycare educators of children's externalizing problems. Following recommendations (Dewald et al., 2010), indices of both sleep duration and sleep quality (in the current case, efficiency, which represents the percentage of time spent asleep between sleep onset and offset) are examined. Finally, the current study responds to calls for research exploring whether the relation between sleep and behavioral adjustment is modulated by individual child characteristics (e.g., Bagley & El-Sheikh, 2013), in this case child sex. To our knowledge, only one study systematically evaluated the role of child sex in the links between sleep and externalizing problems in preschoolers (Hatzinger et al., 2010), and the few studies that examined this question with school-age children and adolescents found inconsistent results (El-Sheikh et al., 2010; El-Sheikh, Bub, Kelly, & Buckhalt, 2013; Meijer, Reitz, Dekovic, Van Den Wittenboer, & Stoel, 2010).

Study aims

This study aimed to examine whether child sleep (duration and quality) as measured by actigraphy at 2 years was associated with child externalizing symptoms assessed concurrently by both parents at 2 years, and with subsequent externalizing symptoms at 4 years, as estimated by both parents and by the daycare educator. A secondary aim was to examine the moderating role of child sex in these associations. Given the results obtained in studies of school-age children, it was expected that sleep of lower duration and quality would be associated with more concurrent

and subsequent externalizing symptoms. No directional hypotheses were formulated for child sex.

Method

Participants

Sixty-four families (36 boys) living in a large metropolitan area participated in this study. Families were recruited from birth lists randomly generated by the Ministry of Health and Social Services. The parents signed a consent form that informed them on the nature and risks of participating, and they received financial compensation along with a toy for the child. Criteria for participation were full-term pregnancy and the absence of any known physical or mental disability in the child. Families were assessed twice, when children were 2 (T1; *M* = 25.35 months, *SD* = 1.11, range 23 to 28) and 4 years old (T2; *M* = 48.84 months, *SD* = .78, range 47 to 51). Prior to the first visit, mothers had completed a socio-demographic questionnaire asking about biological (weeks of gestation, birth weight, duration of breastfeeding, etc.) and socio-demographic variables (birth order, family yearly income, parental education, daycare attendance, etc.). Most parents were Caucasian (91.7 % of mothers, 79.7 % of fathers). Mothers were between 20 and 44 years old at T1 (*M* = 31.59), and fathers between 21 and 47 years old (*M* = 33.48). Both mothers and fathers had 16 years of education on average, which varied from 8 to 18 years for mothers (*M* = 15.86, *SD* = 2.39) and from 11 to 21 years for fathers (*M* = 15.57, *SD* = 2.49). Family income (in Canadian dollars) was based on categorical scores distributed as follows: 1: < 20K$ (*n* = 3); 2: 20-39K$ (*n* = 7); 3: 40-59K$ (*n* = 12); 4: 60-79K$ (*n* = 16); 5: 80-99K$ (*n* = 6); 6: 99K$ and over (*n* = 20). Mean family income for the sample was 4.15 (*SD* = 1.57), representative of the mean family income in Canada, which was $74,600 for the years of data collection. At T1, two parental couples were separated and at T2, three other parental couples were separated; there were consequently two families at T1 and five families at T2 for

whom we were unable to ask for fathers' evaluations of their child's externalizing problems because fathers were no longer involved in the study. At T2, 14 of the children were not attending daycare; there were therefore 50 children for whom it was possible to ask for daycare educators' assessments. Children who did attend daycare spent on average 35 hours per week at the daycare center (M = 35.49, SD = 10.32). Duration of the relationship between the daycare educator and the child was based on the following categorical scores: 1: < 13 months (n = 36); 2: 13-24 months (n = 10); 3: 25-36 months (n = 3); 4: 37-48 months (n = 1). Mean duration of the relationship between educators and children was 1.37 (SD = 0.69).

Procedure

At T1 (2 years), children wore an actigraph monitor for 72 hours and mothers were instructed to complete a diary of their child's sleep during the same period. In addition, both parents (when possible) were asked to complete the CBCL, described below, to assess their child's externalizing symptoms, and to return it by mail. Parents were invited to fill the questionnaires independently, and were each provided with a pre-addressed and pre-paid envelope. At T2 (4 years), both parents as well as the child's daycare educator (when applicable) were asked to fill the CBCL and to return it by mail.

Measures

Actigraphy and sleep diaries. At age 2, children wore an actigraph monitor (Mini-Mitter® Actiwatch Actigraph, Respironics) for 72 hours. Actigraphic data were analyzed initially with the automated manufacturer's scoring algorithm set at high sensitivity and a secondary "smoothing" algorithm was then applied to the nighttime data. This algorithm has been validated against videosomnography (Sitnick, Goodlin-Jones, & Anders, 2008) and home-based PSG (Bélanger, Bernier, Simard, Paquet, & Carrier, 2013). Given that location of the actigraph does

not influence the data in this age group (Bélanger et al., 2013), mothers were informed that their child could wear the actigraph either on the wrist or the ankle and were asked to report this information to the research assistant (81 % of the children wore the actigraph on the ankle). Mothers were also instructed to complete a sleep diary for the 72 hours during which their child was wearing the actigraph.

Sleep data were available for three nights for 51 participants, two nights for 8 participants, and only one night for 5 participants. Sleep data were missing because children refused to wear the actigraph for a second or third day, or had to be discarded because the maternal diary indicated that the child had been asleep in a moving object (car, stroller) or had not had a typical night (feeling sick, visitors staying late at night, etc.).

Actigraphy-derived nighttime sleep variables were: sleep duration (total number of minutes between sleep onset and offset that were scored as sleep) and sleep efficiency (sleep duration / (sleep duration + wake duration between sleep onset and offset) * 100). There was no significant difference according to the number of nights with available actigraphic data on sleep duration ($F(2,61) = .30$, $p = .74$) or sleep efficiency ($F(2,61) = .18$, $p = .83$). Therefore, children with less than three nights of actigraphy were kept in the analytic sample. Moreover, since the number of nights with available actigraphic data did not influence the results, it was not co-varied in the main analyses.

Child Behavior Checklist, 1.5-5 year version. Mothers and fathers (when living with mother) were asked to complete the 100-item Child Behavior Checklist, 1.5-5 year version (CBCL; Achenbach & Rescorla, 2000) at T1 and T2. In addition, the child's educator at daycare (when applicable) was asked to fill the CBCL at T2. The two subscales (Attention problems and Aggressive behavior) of the CBCL that represent externalizing symptoms and the overall externalizing symptoms scale were used. Adults were asked to describe the child's behavior now

or within the past two months, on a 3-point Likert scale. For the two subscales and the overall scale used in this study, Achenbach and Rescorla (2000) indicated excellent test-retest reliability and cross-informant agreement. In the current study, coefficients of internal consistency were as follows, comparable to those reported by Achenbach and Rescorla (2000): from .47 to .66 for attention problems, .84 to .95 for aggressive behaviors, and .86 to .95 for externalizing symptoms. Achenbach and Rescorla (2000) reported moderate correlations between this version of the CBCL externalizing scale and the Infant-Toddler Social and Emotional Assessment (Briggs-Gowan & Carter, 1998).

Twelve fathers at T1 and 18 mothers, 20 fathers, and 11 daycare educators at T2 failed to return the questionnaire. Families in which a respondent did not complete questionnaires did not differ from others on socio-demographics or child sleep (all *t*'s < 1.47, *ns*).

Results

Preliminary analyses

In order to have equivalent sample sizes (N = 64) for maternal, paternal, and educator reports, cases with missing values for children's externalizing symptoms were included in the analyses by estimating the missing data with multiple imputation (note that multiple imputation works well even on samples smaller than this one [down to N = 50], and with more [as much as 50%] missing data; Graham, 2009). Five imputations were used, with missing data estimated from all other data available.

We next examined whether biological and socio-demographic variables were related to the dependent variables. Only two correlations reached significance: mothers' evaluation of their child's externalizing symptoms at 2 years was negatively associated with maternal education (r = -.28, p = .025) and family income (r = -.25, p = .049). Given that maternal and paternal education and family income were inter-related (r's from .48 to .60), these three variables were

standardized and averaged into a global index of family SES, included as a covariate in all main analyses.

Table 1 presents the descriptive statistics for child sleep and externalizing symptoms. T-tests revealed that there were no significant differences between mothers' and fathers' evaluations of their children's attention, aggression, and overall externalizing symptoms at T1. At T2, one-way repeated measures ANOVAs revealed that there were significant informant differences on children's attention problems ($F(2,62) = 3.22$, $p = .047$), aggression problems ($F(2,62) = 3.52$, $p = .036$), and overall externalizing symptoms ($F(2,62) = 3.62$, $p = .032$). Post-hoc tests revealed that daycare educators' estimates of children's attention problems were marginally lower than fathers' estimates ($p = .054$), and that mothers' estimates of aggression problems and externalizing symptoms were significantly higher than daycare educators' estimates ($p = .040$ and $p = .035$).

Table 2 presents the correlations among the primary study variables. Both mothers and fathers provided relatively consistent evaluations of their children's attention, aggression, and overall externalizing symptoms across the two-year interval. Inter-parental agreement at 2 years was low, with only the correlation for the overall externalizing scale reaching statistical significance. Inter-parental agreement was higher at 4 years. Interestingly, educator assessments at age 4 were unrelated to maternal evaluations, but consistently related to paternal reports. Child sex was unrelated to T1 and T2 externalizing symptoms and to sleep variables.

Child sleep at 2 years showed some trend-level relations to concurrent maternal CBCL evaluations, and all relations with sleep became significant when considering 4-year maternal reports. With respect to paternal reports, only child aggressive behavior and overall externalizing symptoms at 4 years were associated with sleep efficiency at 2 years. Educator CBCL scores were unrelated to child sleep.

Main analyses

In order to test the interactive effects of each sleep variable (duration and efficiency) with child sex in the prediction of child externalizing symptoms, predictors were centered to their respective means and submitted to multiple regression analyses. Child externalizing symptoms (original raw values) at 2 years and 4 years were considered in separate models. Results were consistently the same for attention, aggression, and overall externalizing symptoms as reported by the same informant; accordingly, only the results pertaining to overall externalizing symptoms are displayed in the tables.

In each equation, family SES was entered in the first block (along with 2-year symptoms when predicting 4-year symptoms), followed by one aspect of child sleep (duration or efficiency) and child sex in the second block, and finally, by their interactive product in the third block. Significant interactions were decomposed and then graphed by computing predicted values of externalizing symptoms according to sleep values for boys and girls (Preacher, Curran, & Bauer, 2006). The results of these analyses are presented in Tables 3 and 4.

Table 3 shows that both sleep duration and sleep efficiency at 2 years were negatively related to child externalizing symptoms, however only as estimated by mothers. In the case of sleep efficiency, this main effect was further qualified by an interaction with child sex. Post-hoc tests (see Figure 1) revealed that sleep efficiency at 2 year was negatively associated with concurrent externalizing symptoms for boys, whereas it was unrelated to externalizing symptoms for girls.

Table 4 shows that lower sleep efficiency at 2 years was related to increases in externalizing symptoms between 2 and 4 years as assessed by both parents. In the case of paternal reports, this main effect was subsumed under an interaction with child sex, such that (see Figure 2) sleep efficiency was negatively associated with increases in externalizing symptoms for boys

but not for girls. In contrast, results were inconclusive when examining sleep duration or educators' reports.

Discussion

For several years, the results of the studies revealing that sleep relates to behavioral adjustment in school-age children and adolescents have been generalized to toddlers and preschoolers, with in fact little empirical support for this generalization, and most of it based on parental reports of child sleep. The current study aimed at addressing this gap with objective sleep assessment.

The results suggested that lower sleep efficiency, especially, assessed as early as 2 years of age, was generally related to more and increasing externalizing symptoms in children as evaluated by both parents. Specifically, toddlers with lower sleep efficiency were concurrently perceived by their mothers as presenting more externalizing difficulties. Two years later, these children were perceived by both their parents (although not their daycare educator) as presenting more externalizing difficulties, above and beyond initial levels. These findings constitute a downward extension of existing research with older children, and confirm the apprehension that toddlers not getting quality sleep may be at the onset of a developmental trajectory placing them at risk for the development of externalizing behavior problems.

The potential moderating role of child sex in sleep-related phenomena is under-studied. In the current study, when relations between sleep and externalizing symptoms were moderated by child sex, the links were stronger and significant only among boys. Furthermore, such moderations were found with sleep efficiency, not sleep duration. Thus, low sleep efficiency, specifically, may be a risk factor for higher externalizing symptoms among toddler boys, but not girls. In line with previous research, we speculate that poor sleep may induce greater vulnerability to externalizing manifestations for boys, specifically, because boys have been

observed to be more physically active, to show less frustration tolerance, and to have greater difficulty regulating emotions like anger, impulsivity and irritability than girls (Zahn-Waxler, Shirtcliff, & Marceau, 2008). Consequently, one hypothesis is that when boys are tired, they are more likely to express their fatigue through externalizing manifestations. This is suggested not only by the current results, but also by those of Hatzinger et al. (2010) and Meijer et al. (2010). Conversely, one may speculate that girls perhaps rather express their tiredness by showing internalizing symptoms (as suggested by the results of El-Sheikh et al., 2013). However, the robustness of our boy-specific findings needs to be tested before drawing firm conclusions, especially given that only two of the four main effects of sleep were qualified by an interaction with child sex.

Main and interactive effects were generally much clearer with sleep efficiency, whereas very few significant results were found with sleep duration. These findings are in keeping with the notion that sleep quality and sleep duration are two different sleep domains, which need to be considered separately (Dewald et al., 2010). Although these sleep domains overlap to some extent (and certainly do in our sample, $r = .63$, $p < .01$), their associations with behavior problems can be different (Bagley & El-Sheikh, 2013). Our results would seem to suggest that is not how long toddlers sleep that relates to the development of externalizing symptoms, but rather how well they sleep. However, studies with older children have repeatedly shown that sleep duration also plays an important role for emotion regulation and behavioral adjustment (e.g., Paavonen et al., 2009; Pesonen et al., 2010). Hence, the near lack of significant links between sleep duration and externalizing symptoms in the current study should be interpreted with caution, and may relate to individual differences in sleep needs among young children (Iglowstein, Jenni, Molinari, & Largo, 2003).

Results were also quite different across informants of child externalizing symptoms. At 2 years, significant results were found with maternal reports only, whereas at 4 years, significant relations to sleep efficiency were found for both parents' reports. This could potentially be explained by the fact that mothers are generally more involved in daily caretaking tasks with infants than fathers, and that fathers become more involved as children grow older (Bailey, 1994). Although the data of the current study (Table 1) do not suggest that mothers report more overall externalizing symptoms than fathers at age 2, nor that fathers report more externalizing symptoms at age 4 than 2, the variability in child overall externalizing symptoms does appear to be at its lowest with 2-year paternal reports. The higher variability at age 4, combined with the potential greater accuracy that would ensue from the increased paternal involvement suggested above, is likely to translate into more valid variance, and hence better opportunity to identify relations to sleep.

The analyses revealed a null pattern of findings with daycare educator reports. Nevertheless, fathers' (but not mothers') estimates of child externalizing symptoms at 4 years were clearly associated with educators' reports, suggesting that the lack of relations between child sleep and educator reports is likely to represent a substantive phenomenon, rather than resulting from educator reports being less valid. In light of data suggesting that parents of children with sleep problems experience lower-quality sleep themselves (Gau & Merikangas, 2004), one may argue that parents of children with lower sleep efficiency are more tired and irritable themselves and thus, have lower tolerance for their child's externalizing behaviors. In addition, parents and educators may have different base rates for judging externalizing problems, given that educators are more likely to compare several children of the same age (Nantel-Vivier et al., 2009).

The conclusions drawn from this work must be viewed in the context of the study's limitations. First, the availability of only one sleep assessment precludes us from teasing apart putative effects of early sleep from stability in sleep patterns. The modest size of the sample limited statistical power, and its composition (mostly college-educated and Caucasian parents) suggests that findings may not replicate in samples characterized by greater economic, biological, or psychosocial risk. Finally, the fact that not all children attended daycare, and that not all informants returned the CBCL, constitutes another limitation. However, it is reasonable to assume that this did not impact the results to a great degree, given that results of analyses on the original, non-imputed data set (not reported here) were very similar to those presented above, which is consistent with the observation that families in which a respondent did not complete the CBCL did not differ from others on socio-demographics or child sleep.

This study suggested that toddlers show fewer externalizing symptoms and smaller increases in externalizing symptoms over two years as assessed by their parents when they have higher sleep quality, and this is especially so in boys. Findings emerged longitudinally, while controlling for initial levels of symptoms, providing some degree of confidence in the robustness and directionality of associations – although cross-lagged and experimental designs are needed to demonstrate this convincingly. In fact, we would argue that similar to what has been observed among school-aged children (e.g., Kelly & El-Sheikh, 2014), the links between sleep and behavioral adjustment are probably bidirectional, starting early in life. Overall, the current findings highlight the importance of rapidly treating sleep difficulties.

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Table 1

Descriptive statistics for all main variables under study

	Mean	Standard deviation	Observed range
Child sleep at 2 years			
Sleep duration (min)	561.7	57.0	389.4-678.3
Sleep efficiency (%)	90.7	6.5	67.0-99.5
CBCL at 2 years			
Mothers			
Attention problems	2.3	1.6	0-7
Aggressive behavior	9.0	5.1	0-22
Externalizing symptoms	11.3	6.2	1-29
Fathers			
Attention problems	2.3	1.4	0-7
Aggressive behavior	8.6	4.4	1-21
Externalizing symptoms	11.2	4.9	1-25
CBCL at 4 years			
Mothers			
Attention problems	2.1	1.6	0-5
Aggressive behavior	9.6	6.3	1-26
Externalizing symptoms	11.7	7.2	1-29
Fathers			
Attention problems	2.1	1.7	0-7
Aggressive behavior	8.3	5.8	0-28
Externalizing symptoms	10.4	7.2	0-35
Educator			
Attention problems	1.6	1.4	0-8
Aggressive behavior	7.0	6.4	0-28
Externalizing symptoms	8.6	7.4	0-36

Note. Scores on the CBCL attention problems subscale can vary between 0 and 10, aggressive behavior subscale between 0 and 38, and externalizing symptoms scale between 0 and 48, with higher scores representing more symptoms.

Table 2

Zero-order correlations among all main variables under study

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1. Family SES		.03	-.01	.07	-.21^{t}	-.31*	-.31*	.00	-.08	-.13	-.31*	-.11	-.16	-.08	-.03	-.04	.04	-.04	-.03
2. C sex			-.12	.13	-.11	-.02	-.05	.19	-.04	.00	-.03	.07	.06	-.18	-.09	-.11	-.11	-.02	-.04
3. C sleep dur.				.63**	-.09	-.24^{t}	-.22^{t}	.07	.00	-.01	-.34**	-.29*	-.32**	-.07	-.11	-.10	.13	.18	.18
4. C sleep eff.					.05	-.24^{t}	-.18	-.14	-.10	-.14	-.30*	-.33**	-.35**	-.24^{t}	-.27*	-.28*	.00	-.05	-.04
CBCL: 2 years																			
5. M Att.						.57**	.73**	.20	.04	.12	.39**	.13	.20	.01	.01	.01	.00	-.04	-.03
6. M Agg.							.98**	.14	.22^{t}	.27*	.45**	.49**	.52**	.07	.22^{t}	.19	.09	.11	.12
7. M Ext.								.17	.19	.25*	.47**	.44**	.48**	.06	.18	.16	.08	.08	.09
8. F Att.									.38**	.62**	-.04	-.03	-.04	.23^{t}	.08	.12	.13	.15	.15
9. F Agg.										.92**	.13	.14	.15	.30*	.34**	.34**	.12	.05	.07
10. F Ext.											.13	.15	.16	.29*	.29*	.31*	.12	.10	.11
CBCL: 4 years																			
11. M Att.												.52**	.67**	.27*	.37**	.36**	.13	.16	.16
12. M Agg.													.98**	.16	.41**	.37**	.07	.16	.15
13. M Ext.														.20	.44**	.40**	.09	.18	.17
14. F Att.															.76**	.85**	.50**	.53**	.54**
15. F Agg.																.99**	.53**	.52**	.55**
16. F Ext.																	.55**	.55**	.57**
17. E Att.																		.73**	.80**
18. E Agg.																			.99**
19. E Ext.																			

C: Child (sex: 1= boys, 2 = girls); M: Mother; F: Father; E: Educator; dur: duration; eff.: efficiency; att.: attention problems; agg.: aggressive behavior; ext.: externalizing symptoms

$^{t}p < .10$; $^{*}p < .05$; $^{**}p < .01$

Table 3

Regression analyses predicting child externalizing symptoms at 2 years from child sleep at 2 years, child sex, and two-way interactions between child sleep and child sex (while controlling for family SES)

	Child externalizing symptoms at 2 years					
	Mothers			Fathers		
Predictors	Adjusted R^2	R^2 Change	β	Adjusted R^2	R^2 Change	β
Full-model with sleep duration as predictor						
1. Family SES	.182*	.095*	-.31*	.021	.016	-.13
2. C sex		.053	-.02		.000	.00
C sleep dur.			-.40*			-.07
3. C sex x C sleep dur.		.034	.25		.005	-.09
Full-model with sleep efficiency as predictor						
1. Family SES	.228**	.095*	-.31**	.039	.016	-.12
2. C sex		.030	-.05		.017	-.02
C sleep eff.			-.47**			-.20
3. C sex x C eff.		.103**	.44**		.005	.10

Note. N = 64. The regression coefficients shown are those in the final models, while accounting for all other main and interactive effects.
C: Child; dur.: duration; eff.: efficiency
* $p < .05$; ** $p < .01$

Table 4

Regression analyses predicting child externalizing symptoms at 4 years from child sleep at 2 years, child sex, and two-way interactions between child sleep and child sex (while controlling for family SES and for child externalizing symptoms at 2 years)

	Child externalizing symptoms at 4 years								
	Mothers			Fathers			Educators		
Predictors	Adjusted R^2	R^2 Change	β	Adjusted R^2	R^2 Change	β	Adjusted R^2	R^2 Change	β
Full-model with sleep duration as predictor									
1. Family SES	.297**	.231**	.43**	.133	.094*	-.00	.044	.001	-.02
C ext. 2 years			-.03			.30*			
2. C sex		.062^t	.11		.020	-.11		.036	-.06
C sleep dur.			-.18			-.21			.11
3. C sex x C sleep dur.		.005	-.10		.019	.19		.007	.11
Full-model with sleep efficiency as predictor									
1. Family SES	.263**	.231**	.38**	.277**	.094*	-.00	.026	.001	-.03
C ext. 2 years			-.03			.25*			
2. C sex		.075*	.05		.078^t	-.14		.003	-.04
C sleep eff.			-.40*			-.57**			-.18
3. C sex x C eff.		.015	.18		.105**	.45**		.022	.21

Note. N = 64. The regression coefficients shown are those in the final models, while accounting for all other main and interactive effects.

C: Child; dur.: duration; eff.: efficiency; ext. 2 years: externalizing symptoms at 2 years

^{t} $p < .10$; * $p < .05$; ** $p < .01$

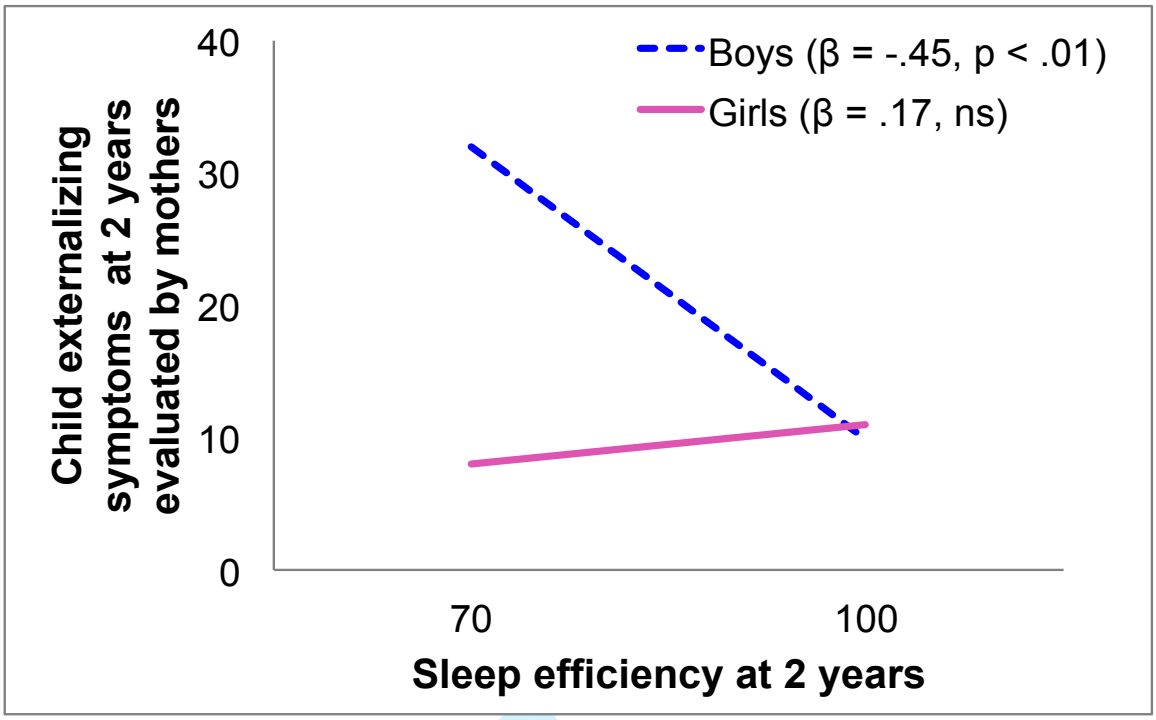

Figure 1. Links between child sleep efficiency and externalizing symptoms at 2 years as assessed by mothers for boys and girls, controlling for family SES

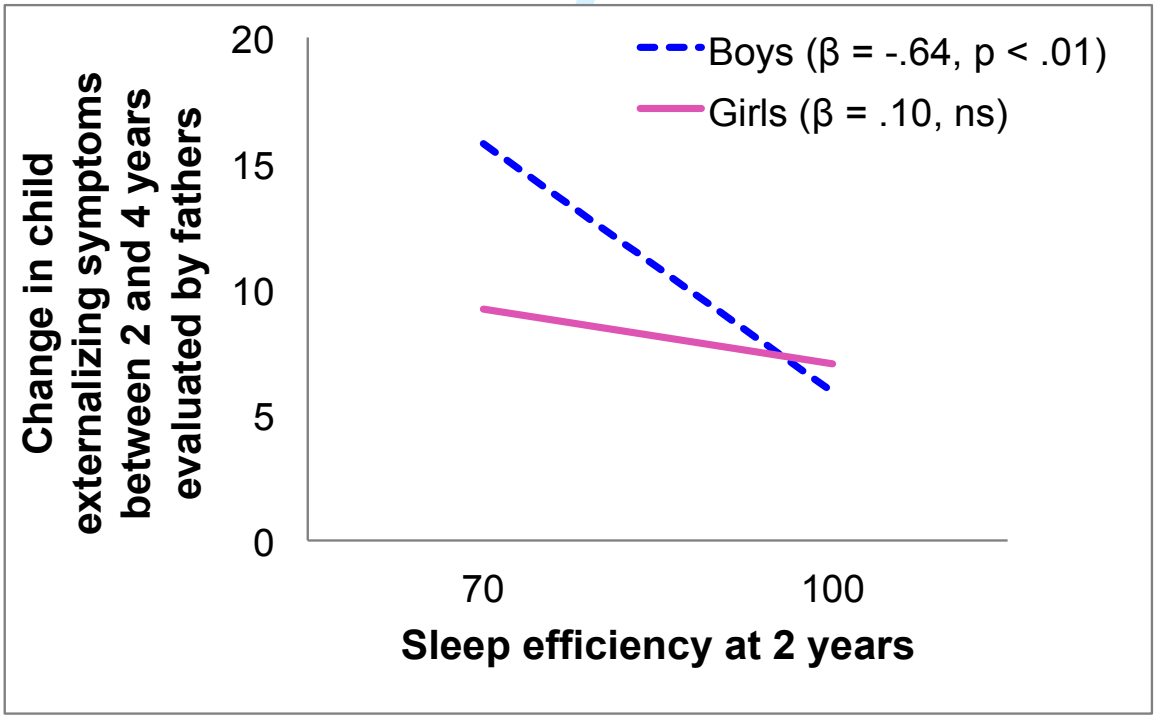

Figure 2. Links between child sleep efficiency and externalizing symptoms at 4 years as assessed by fathers for boys and girls, controlling for family SES and child externalizing symptoms at 2 years