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Temperamental Resistance to Control Increases the Association Between Sleep Problems and Externalizing Behavior Development

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Abstract

This study examined the moderating effects of temperamental resistance to control on the link between development of sleep problems and development of externalizing behaviors over a 5-year period. Resistance to control was assessed with mothers' retrospective reports of temperament in infancy, provided when children were 5 years of age. Sleep problems were assessed with mother reports on an annual basis from age 5 to age 9. Externalizing behaviors were assessed with teacher reports on an annual basis from age 5 to age 9. A cross-domain latent growth curve model indicated that sleep problem trajectories were positively associated with externalizing behavior trajectories only for children high in resistance to control. In addition, resistance to control was positively associated with initial (age 5) sleep problems and initial (age 5) externalizing behaviors. The authors speculate that the development of sleep problems promotes the development of behavior problems for resistant children, whose self-regulatory abilities are especially tenuous. Implications for prevention and treatment of conduct problems are considered.

Keywords

sleep problems; externalizing behavior; temperament; self-regulation; childhood

Sleep problems and daytime sleepiness are common in childhood. Kahn et al. (1989) reported that 43% of school-age children experienced persistent sleep problems, with 14% specifically experiencing persistent trouble sleeping. Sleep problems are also moderately stable in childhood (Gregory & O'Connor, 2002; Mindell, 1993). Kataria, Swanson, and Trevathan (1987) reported that the large majority of children in their sample with sleep problems continued to have sleep problems at follow-up 3 years later. Although many parents overlook sleep problems or underestimate the importance of good sleep habits for their children's well-

being (National Sleep Foundation, 2004; Stein, Mendelsohn, Obermeyer, Amromin, & Benca, 2001), children's sleep may be an important link between aspects of family functioning and children's adjustment (El-Sheikh, Buckhalt, Mize, & Acebo, 2006).

Various methods have revealed links between sleep and externalizing problems. Using sleep problem items from the Child Behavior Checklist (CBCL; Achenbach, 1991a), Gregory and O'Connor (2002) found that sleep problems (e.g., sleeps less than other children, is tired during the day, nightmares) at age 4 predicted parent-reported aggression and attention problems in mid-adolescence. However, the reverse was not true. Sleep problems led to the development of externalizing behaviors, but externalizing behaviors did not lead to sleep problems. Using a sleep questionnaire rather than the CBCL to assess sleep problems, Gregory, Eley, O'Connor, and Plomin (2004) found modest predictive associations between age 3 to 4 sleep problems and age 7 mother-reported conduct problems, controlling for age 3 to 4 conduct problems. In a cross-sectional study, Lavigne et al. (1999) found that sleep amount as assessed by parental diary was negatively correlated with aggression and with a greater likelihood for diagnosis of oppositional defiant disorder, even controlling for socioeconomic status, age, and gender. Bates, Viken, Alexander, Beyers, and Stockton (2002) found that disrupted sleep patterns measured by parental diary were associated with teacher-reported behavior problems in preschool, even after controlling for family stress and parenting practices. Finally, Aronen, Paavonen, Fjällberg, Soininen, and Törrönen (2000) found that low sleep amount, assessed by activity monitors, was associated with externalizing problems in elementary school. Whether sleep problems have been measured using actigraphs or parent report, and behavior problems measured using parent report, teacher report, or psychiatric diagnostic criteria, sleep problems have consistently shown an association with externalizing adjustment in childhood. Of special methodological interest for the present study, Aronen and colleagues found that an actigraphic measure of total amount of time asleep per night was associated with Item 76 from the CBCL, "sleeps less than most other children." Specifically, children who slept less than most other children (according to the CBCL item) averaged 38 fewer min of "true" sleep than other children ($p = .013$). This supports the plausibility of parent report on sleep items from the CBCL as a measure of children's sleep problems.

Mechanisms responsible for the association between sleep problems and conduct problems are not established, but there are some interesting suggestions. Weissbluth (1989) suggested that sleep loss elevates stress hormone levels in the brain, which in turn interfere with attentional management and behavioral regulation. Dahl (1996) suggested that sleep loss interferes with the brain's ability to coordinate behavioral responses, especially in complex social situations. Consistent with Dahl's suggestion, Sadeh, Gruber, and Raviv (2002) found that experimental, partial sleep deprivation hinders children's performance on the continuous performance task, a measure thought to tap executive attentional processes (see also Randazzo, Muehlbach, Schweitzer, & Walsh, 1998). Both Weissbluth's conceptualization and Dahl's conceptualization share the premise that diminished self-regulation, in terms of attentional, emotional, and behavioral management, mediates the effects of sleep loss on adjustment. These conceptualizations would suggest that children whose self-regulatory abilities have been compromised by sleep problems are less likely than other children to generate well-planned and well-executed responses to complex or challenging social demands.

Temperament and Sleep Problems

Sleep problems and behavioral adjustment may share links with children's basic personality characteristics. Studies have found that mother reports of difficult temperament, theoretically characterized by high levels of negative emotionality (Rothbart & Bates, 1998), are associated with mother-reported sleep problems (Atkinson, Vetere, & Grayson, 1995; Carey, 1974; Owens-Stively et al, 1997; Sadeh, Lavie, & Scher, 1994; Schaefer, 1990; Van Tassel, 1985;

Weissbluth, Davis, & Poncher, 1984; Weissbluth & Liu, 1983; Zuckerman, Stevenson, & Baily, 1987). In addition, a tendency to become distressed in response to unfamiliar situations has also been found to be associated with sleep problems (Scher, Epstein, Sadeh, & Tirosh, 1992; Van Tassel, 1985). Novosad, Freudigman, and Thoman (1999) even suggested that sleep problems contribute to the emergence of adverse temperament traits. This is plausible because, in theory, temperament traits, although relatively stable and biologically based, are also developmentally dynamic. Fearfulness and effortful control of attention continue to develop during the first few years of life (Rothbart & Bates, 1998).

Of special interest for the present study, Zuckerman et al. (1987) found that mother-reported behavior management problems were positively associated with mother-reported persistent sleep problems in toddlers. These problems could well have been rooted in temperament. Unmanageability, or resistance to control, is theoretically characterized by several basic temperament dimensions. In terms of reactivity, resistance to control is thought to reflect strong attraction to reward stimuli and/or weak response to punishment. In terms of self-regulation, it is thought to reflect deficits in vigilance and in effortful control of attention (Bates, Pettit, Dodge, & Ridge, 1998).

It should be noted that several studies have failed to demonstrate temperament–sleep links, especially when “objective” measures of sleep, such as actigraphs, have been used to measure sleep problems (Keener, Zeanah, & Anders, 1988; Scher, Tirosh, & Lavie, 1998). This inconsistency may be due in part to differences in the type of information gathered by parent reports and actigraphs. Parents' reports about children's sleep are, naturally, likely to be more influenced by events they can see—for example, bedtime resistance, daytime sleepiness, and timing of bedtime and wake time—whereas actigraph measures are likely to be more responsive to less easily observed qualities of sleep and nighttime activity—for example, latency to fall asleep, frequency of night wakings, and restlessness.

The aforementioned temperament concepts also show links to behavioral adjustment, both concurrently and prospectively (Bates, 1989; Eisenberg et al., 2001; Murray & Kochanska, 2002; Rothbart & Bates, 2006). However, in addition to direct main-effects-type links between temperament and behavior problems, there are also more indirect, interaction-effect-type links involving temperament. Temperament and children's experiences appear to interact in the development of externalizing behaviors (Bates & Pettit, 2006; Rothbart & Bates, 2006). The effect of a given environmental characteristic depends in part on a particular temperament trait or vice versa. For example, Bates et al. (1998) found that temperamental resistance to control (unmanageability) had a general association with externalizing behavior but was more strongly predictive of externalizing behaviors for children whose parents were observed to be low in control than for children whose parents were high in control. This is useful in showing that resistance to control predisposes to, but is not equivalent to, externalizing behaviors.

The Current Study

As mentioned, associations between sleep problems and behavioral adjustment are of a modest size. On the basis of the growing evidence of temperament–experience interactions, we wondered whether differences in temperament could explain why some children seem to experience behavior problems in conjunction with sleep problems but others do not. More specifically, based on prior research supporting the importance of regulation-relevant temperament traits as moderators of experience (Bates & Pettit, 2006), we asked whether children with temperamental profiles characterized by poor inhibitory control and/or high approach tendencies, as reflected in high resistance to control, would be less capable of effectively managing the stress of sleep loss than children with lower resistance to control. We thought sleep problems might be more strongly associated with behavior problems in high-

resistant children because high-resistant children may have a smaller self-regulatory “reservoir” to draw from than that of low-resistant children. Support for this argument was reported by Bates, Viken, and Williams (2003), using the sample described in Bates et al. (2002): Preschoolers' sleep problems were more strongly associated with behavior problems in children high in resistance to control than in children low in resistance.

The current study expands on this work by using a prospective longitudinal design to investigate the association between the developmental trajectories of sleep problems and externalizing behaviors. There have been few longitudinal studies of this relation, so the developmental processes linking sleep and adjustment are not well understood. We asked how changes in sleep problems are associated with changes in externalizing behavior problems. We hypothesized that sleep problems would predict growth in behavior problems. We also hypothesized that changes in sleep problems would be more strongly associated with changes in externalizing behavior among high-resistant compared with low-resistant children. Finally, for the sake of completeness, we considered relations between resistance to control and both sleep problems and externalizing behavior.

Method

Participants

Participants were from the Child Development Project (CDP; Dodge, Bates, & Pettit, 1990). CDP participant families were originally recruited from three cities (Nashville and Knoxville, TN, and Bloomington, IN) during kindergarten preregistration in 1987 and 1988. Three hundred eighty-nine participants provided complete data (66% of the complete CDP sample). Full information maximum-likelihood (FIML) estimation (described later) was used to accommodate missing data, meaning that all participants with temperament data ($N = 556$) were included in the model. The 556 participants included in the model were 52% male, 48% female, 81% European American, 17% African American, and 2% from other ethnic backgrounds. The average Hollingshead (1979) score for the sample was 39.6, and 25% of the participant families were included in the two lowest Hollingshead categories, indicating that the sample was predominantly middle-class but included a broad range of socioeconomic backgrounds. Local institutional review boards approved all research measures and procedures. Parents signed statements of informed consent, and child participants assented before participating. Research assistants described to parents and children their rights as research participants and answered any questions.

Participants with missing data were compared with participants with complete data in terms of SES, externalizing behavior, sleep problems, and resistance to control at age 5 (see Table 1). The groups differed significantly only on SES ($p < .05$), with families with missing data lower in SES than families with complete data. Further analysis of missing data patterns using SPSS Missing Value Analysis provided additional evidence that data were not missing completely at random. Specifically, participants who had teacher-report data at age 7 had greater mother-reported sleep problems from ages 5 to 9 than participants who were missing teacher-report data at age 7 ($p < .05$). Listwise deletion is inappropriate when data are not missing completely at random (Schafer & Graham, 2002). Thus, we chose to use FIML estimation to accommodate missing data, because this approach performs well when data are missing at random (MAR). Although we assumed that data were MAR, there is no definitive way to test this assumption. However, Schafer and Graham noted that in many situations, FIML estimation is likely to produce valid estimates even when data are missing not at random.

Procedure and Measures

Data collection for the CDP began the summer before the participants entered kindergarten (at around age 5), and follow-up collections were conducted when children were 5, 6, 7, 8, and 9 years of age. Mothers completed a retrospective measure of infant temperament when children were 5 years of age and measures of child adjustment from ages 5 to 9. Measures of sleep problems were derived from a subset of questions included as part of the measure of adjustment (described later). Teachers rated children's adjustment at ages 5 to 9 years.

Temperamental resistance to control—Mothers completed the Retrospective Infant Characteristics Questionnaire (RICQ) as an estimate of early temperament. Resistance to control was measured by four items reflecting early unmanageability as expressed in unresponsiveness to prohibitions and impulsiveness in explorations. For example, one item asked the degree to which the child persisted in playing with objects when told to leave them alone, and another asked the degree to which the child continued going even when told “stop,” “come here,” or “no–no” (see Bates et al., 1998, for complete items). Items were rated on a 7-point scale, and item scores were averaged to create a resistance to control score. Resistance to control has shown adequate cross-age continuity from 13 to 24 months of age in another sample ($r = .55, p < .05$; Bates & Bayles, 1984), and from 30 to 42 months of age in a small, ongoing pilot study of toddlers' self regulation ($r_s = .39$ to $.60, p_s = .09$ to $.04$). The resistance scale also has shown external validity in terms of its association with externalizing behaviors (Rothbart & Bates, 1998) and in its association with effortful control ($r = -.44, p < .05$) on the Child Behavior Questionnaire (Rothbart, Ahadi, Hershey, & Fisher, 2001) in the pilot study just mentioned. Supporting the validity of retrospective report of temperament, concurrent ratings of resistance to control in infancy were associated with retrospective ratings at age 10 years ($r = .34, p < .01$; Bates et al., 1998). The scale used here had adequate internal consistency ($\alpha = .83$) and was approximately normally distributed (skew = $-.07, SD = .104$; kurtosis = $.197, SD = .207$).

Sleep problems—Three items (“overtired,” “trouble sleeping,” “sleeps less than most children”) that are part of the CBCL but not included in the Externalizing or Internalizing scales were averaged to create the sleep problem scale. Gregory and O'Connor (2002) and Stoléru, Nottelmann, Belmont, and Ronsaville (1997) have used a scale that included these items plus an additional three items (“experiences nightmares,” “talks or walks in sleep,” “sleeps more than most other children”). We excluded these items on the basis of factor analysis and in an attempt to focus as much as possible on sleep loss and daytime sleepiness. The sleep problems scale had moderate internal consistency at each of the ages (alphas ranging from $.48$ to $.58$), appropriate for the small number of items. The sleep problem scales were nonnormally distributed (skew = 1.950 to $2.935, SD = .103$ to $.113$; kurtosis = 3.673 to $9.940, SD = .205$ to $.226$).

Externalizing behavior problems—Teachers completed the Teacher Report Form (Achenbach, 1991b), in which they rated the degree to which 34 items describing aggressive and rule-breaking behaviors described the child's behavior during the past year. Item scores were summed according to Achenbach (1991b) to create the externalizing problems scale. The empirically derived measures of externalizing behavior have shown adequate levels of reliability and validity. The externalizing scales were non-normally distributed (skew = 2.053 to $2.233, SD = .102$ to $.113$; kurtosis = 4.048 to $5.172, SD = .204$ to $.225$).

Results

Preliminary Analyses

Means and standard deviations are reported in Table 1. Gender was modestly negatively correlated with externalizing behavior scores at every year, indicating that girls exhibited fewer externalizing behaviors than boys. In addition, gender was modestly positively correlated with sleep problem scores at age 6, indicating that girls had more sleep problems than boys at this age. Resistance to control was modestly positively correlated with sleep problems at ages 5, 6, and 8, and with externalizing behaviors at ages 5 through 9, indicating that children high in resistance to control were likely to show elevated levels of sleep problems and externalizing behaviors. Externalizing behavior scores were moderately positively correlated between all years, and sleep problem scores were also moderately positively correlated between all years. Sleep problem scores and externalizing behavior scores were not significantly correlated.

Cross-Domain Latent Growth Curve Model (GCM)

Hypotheses were evaluated using a cross-domain latent GCM (Willett & Sayer, 1996). This GCM specifies the relationships existing between two developmental processes unfolding over the same period of time. This model is useful for determining whether children who experience growth in one domain of interest also are likely to experience growth in a second domain of interest. In the current study, the GCM was used to test whether growth in sleep problems was related to growth in behavior problem trajectories and whether this relationship was dependent on early resistance to control.

Two approaches can be used to test moderation in structural equation models with latent variables. One approach is to divide the moderator variable into groups for multiple-group estimation. This approach has the advantage of computational simplicity, because multiple-group structural equation modeling is a straightforward extension of single-group structural equation modeling. A second approach is to estimate continuous latent interaction effects. This approach is much more computationally demanding than the multiple-group approach and does not produce fit indices, because such indices have not yet been developed. However, model fit can be evaluated by comparing the interaction model to a nested model. In addition, because this approach utilizes the full, continuous distribution of the moderator variable, the power to detect interactions is maximized.

Given that temperamental resistance to control is considered to be a dimensional individual-differences characteristic, we used the continuous, latent interaction approach to test how resistance to control moderates the association between growth in sleep problems and externalizing behaviors. The computer program Mplus uses the “latent moderated structural equations” (LMS) approach to estimating latent interaction effects. This method is the only approach to latent interactions that explicitly takes into account the nonnormal distributions introduced by interaction effects (Klein & Moosbrugger, 2000; Moosbrugger, Schermelleh-Engel, & Klein, 1997). Klein and Moosbrugger showed that LMS estimation is unbiased and more efficient than alternative approaches to estimating latent interactions.

Models were estimated with Mplus 3.01 (Muthén & Muthén, 1998–2004) using maximum-likelihood estimation with robust standard errors and nonnormal-adjusted fit statistics, thus correcting for the biasing effects of nonnormality. Three models were estimated. The first, the unconstrained growth model, included only the two growth curves and the covariances between the intercept and slope variables. This model provided estimates of the mean intercept and annual growth values for sleep problems and externalizing behaviors. It was important for evaluating the fit of the GCMs and the developmental characteristics of sleep problems and externalizing behaviors. The second model, the main effects model, was identical to the

unconstrained model except that all latent growth variables were regressed on resistance, and slope of externalizing behaviors was regressed on (rather than being allowed to covary with) slope of sleep problems. This model was estimated in order to evaluate the associations between sleep problems and externalizing behaviors and the main effects of resistance to control without considering the moderating effect of resistance to control. This main effects model also was useful because it provided fit indices that were not provided in the interaction model, thus providing some means for evaluating whether the interaction model was well specified. The third model, the interaction model, was identical to the main effects model except for the addition of the moderating effect of resistance to control on the association between slope of sleep problems and slope of externalizing behaviors. This model tested whether children who were high in resistance to control showed an increased association between their sleep problems development and their externalizing behavior development.

The unconstrained GCM fit the data adequately: Satorra–Bentler adjusted $\chi^2(41, N = 556) = 63.951, p = .01$, comparative fit index (CFI) = .983, root-mean-square error of approximation (RMSEA) = .031. Means and variances of the intercepts of sleep problem and externalizing behavior were significant (see Table 2). Mean values and variances of slopes of sleep problems and externalizing behaviors were also significant (see Table 2). On average, participants showed decreasing sleep problems and increasing externalizing behaviors at school across the 5-year period. In addition, significant individual differences were apparent in intercepts and growth rates of sleep problems and externalizing behaviors. All covariances between latent growth variables were nonsignificant except for the covariance between the intercept and slope of sleep problems ($b = -0.006, p < .01$). These results showed that neither the intercept nor the slope of sleep problems was associated with the intercept or slope of externalizing behaviors. However, the intercept of sleep problems was negatively associated with the slope of sleep problems, indicating that children who showed greater sleep problems at age 5 showed larger declines in sleep problems between ages 5 and 9.

The main effects model also fit the data adequately: Satorra–Bentler adjusted $\chi^2(47, N = 556) = 73.951, p = .001$, CFI = .982, RMSEA = .031. Like the unconstrained model, the covariance between intercept and slope of sleep problems was negative and significant. Also significant were the paths from resistance to control to the intercepts of both sleep problems and externalizing behaviors ($b = 0.038, p < .001$, and $b = 1.012, p < .01$, respectively). No other associations between variables were significant, including the main effect of slope of sleep problems on slope of externalizing behaviors. This model indicated that children who were higher in resistance to control were also higher in age 5 sleep problems and externalizing behaviors.

The interaction model's fit could not be evaluated independently because of a lack of available fit indexes. However, on the basis of the adequate fit of the main effects model, we assume this model, which introduced additional parameters, also fit the data adequately. In addition, because the main effects and interaction models are nested, the improvement in model fit achieved by including the interaction parameter could be evaluated using a log likelihood difference chi-square test. This test was significant, $\chi^2(1, N = 556) = 4.11, p = .04$, indicating that the interaction model fit better than the main effects model. Before the interaction model was estimated, the resistance to control variable was centered. This meant that the main effect of sleep problem slope on externalizing behavior slope would be estimated at the mean level of resistance to control and, thus, would represent the effect of sleep problem slope on externalizing behavior slope for children who were at the mean of resistance to control. As with the main effects model, the covariance between intercept and slope of sleep problems was negative and significant, and the paths from resistance to control to the intercept of sleep problems and the intercept of externalizing behaviors were positive and significant. These results indicated that children who were higher in resistance to control were also higher in age

5 sleep problems and externalizing behaviors. They also indicated that children who were higher in age 5 sleep problems experienced larger declines in sleep problems from age 5 to age 9. Also like the previous models, the main effect of sleep problem slope on externalizing behavior slope was nonsignificant. However, the moderating effect of resistance to control on the effect of sleep problem slope on externalizing behavior slope was positive and significant ($b = 4.067, p = .012$), indicating that the positive effect of sleep problem slope on externalizing behavior slope became larger with increasing levels of resistance to control. In other words, growth in sleep problems and externalizing behavior was more strongly linked for children who were high rather than moderate or low in resistance to control. Figure 1 shows standardized parameter estimates for the interaction model.

We used Jaccard and Turrissi's (2003) approach to probe the interaction effect. We centered resistance to control at two predesignated values (1.5 standard deviations above and below the mean) in order to estimate the value and significance of the effect of sleep problem growth on externalizing behavior at high and low levels of resistance to control. The effect of sleep problem growth on externalizing behavior growth was positive and significant at high levels of resistance to control (1.5 standard deviations above the mean), but not at the mean or low levels of resistance to control (see Figure 1).

We also wanted to identify at what level of resistance to control the positive association between sleep problem growth and externalizing behavior growth reached significance. Therefore, the interaction model was estimated several times with resistance to control centered at various values above the mean, until a "threshold of significance" could be located (Bauer & Curran, 2005). It was found that the effect of sleep problem growth on externalizing behavior growth was positive and significant ($p < .05$) at a value of 4.67 or above on the RICQ resistance to control scale (0.96 standard deviations above the mean). In our sample, 15% of children scored beyond this threshold of significance. In summary, the effect of growth in sleep problems was significantly positively related to growth in externalizing behaviors for children who were about 1 standard deviation above the mean or higher in resistance to control.

The interaction effect also suggested the possibility that at some low value of resistance to control the association between sleep problem growth and behavior problem growth became significantly negative. To test this possibility, we estimated the interaction model several more times with resistance to control centered at various values below the mean in an attempt to locate a second threshold of significance. However, we found the effect of sleep problem growth on externalizing behavior growth was nonsignificant even at the lowest possible level of resistance to control.

The interaction model tested whether slope of sleep problems interacted with resistance to control to predict slope of externalizing behaviors. However, because the slopes of sleep problems and externalizing behaviors were concurrent, there was a possibility that our model was misspecified, and resistance to control instead moderated the effects of externalizing behavior growth on sleep problem growth. This alternate interaction model would imply that growth in externalizing behaviors leads to growth in sleep problems depending on a child's resistance to control. This possibility was tested by estimating this alternate interaction model. Neither the main effect of slope of externalizing nor the interaction between resistance to control and slope of externalizing behaviors was significant ($b = 0.006, p = .38$, and $b = 0.002, p = .50$, respectively). Resistance to control was not found to interact with growth in externalizing behaviors to predict growth in sleep problems. In addition, the fit of this alternate interaction model was worse than the fit of our interaction model (based on a comparison of log likelihood values), providing support for our interaction model as originally specified.

Discussion

The results of a cross-domain latent GCM supported our hypotheses that resistance to control would be positively associated with initial sleep problems and externalizing behaviors at age 5. The model also supported our hypothesis that resistance to control would moderate the association between the development of sleep problems and the development of externalizing behaviors from age 5 to age 9. Specifically, sleep problem growth and externalizing behavior growth were significantly positively associated for children who were approximately 1 standard deviation above the mean or higher in resistance to control. Our findings indicate that highly resistant children were more likely to show higher initial levels of sleep problems and externalizing behavior problems than low-resistant children at age 5, but they were not more likely to show changes on these dimensions from age 5 to age 9.

Of special interest for a developmental account, however, our findings indicated that children who were high in resistance to control were more likely to show an association between growth in sleep problems and growth in externalizing behaviors. Temperamentally resistant children whose sleep problems were increasing at a faster rate (or decreasing at a slower rate) showed externalizing behaviors that were increasing faster (or decreasing slower). This could mean that growing sleep problems produced growing conduct problems among children who were temperamentally prone to dysregulation. It is also possible that growing conduct problems produced growing sleep problems in temperamentally resistant children, although our analyses do not support this possibility. Finally, the correlated slopes could merely indicate a consistent linkage between sleep and adjustment for resistant children. This final possibility could reflect the influence of a third variable, such as family chaos, that produces sleep problems and conduct problems in temperamentally resistant children.

Surprisingly, no main effect associations were observed between sleep problems and behavior problems. Instead, our findings suggest that sleep problems and behavior problems are not uniformly associated for all children, and, given the temperament–sleep interaction effect, that individual differences in temperament are important in determining the magnitude of this association. It is also possible that the lack of linear associations between sleep and behavior problems was due to the elimination of shared method variance achieved by using mother-reported sleep problems and teacher-reported behavior problems or was due to the use of a nontraditional measure of sleep problems with limited reliability, which might have diminished the true association. Nonetheless, we interpret our primary finding, that the association between growth in sleep problems and behavior problems is moderated by resistance to control, as extending and refining, rather than contradicting, previous findings.

We speculate that sleep problems are positively associated with behavior problems as a result of their effects on self-regulation. Sadeh and colleagues' (2002) finding that children who experienced partial sleep deprivation did not perform as well as non-sleep-deprived children on the continuous performance task provides evidence that sleep loss impairs self-regulation. In addition, Weissbluth (1989) and Dahl (1996) have provided compelling arguments that sleep impairs coordination of attention, emotion, and behavior control, especially in complex situations. We suggest that children with lower baseline abilities to self-regulate, such as those who are impulsive and unmanageable, are more likely than other children to express sleep-problem-induced impairments of moment-by-moment self-regulation that affect their daytime adjustment. It is also possible that sleep problems contribute to cumulative impairment in the development of self-regulatory skills. This possibility will have to be studied in future research; neither the present study's results nor prior research can clearly address it.

Limitations

Four additional limitations of the present study should be considered. First, sleep was assessed using several items from the CBCL rather than an actigraph or detailed sleep diary. The three items used to create the sleep problems scale may represent different kinds of sleep problems for different children and thus did not provide a highly specific measure of sleep difficulties. Although our approach was not ideal, it has been shown to produce meaningful findings in other studies (e.g., Gregory & O'Connor, 2002), and at least one item, "sleeps less than most other children," is correlated with sleep as measured with actigraphs (Aronen et al., 2000). Related to this limitation, our sleep problems index had low reliability, which may have reduced power to detect statistically significant associations in our data. Nevertheless, associations were observed. Furthermore, we speculate that the practical implications of the findings would be very much the same if the findings had come from actigraphic measures of sleep problems rather than parent report; in both cases, interventions likely would encourage parents to establish bedtime routines that promote consistent and adequate sleep in their children. Second, our measure of resistance to control was retrospective. It is possible that mothers with children who exhibit behavior problems or show significant bedtime resistance at age 5 are more likely to recall their child as being unmanageable in infancy, thereby introducing error into our measure of temperament. Third, mothers were the source of both temperament and sleep problems data, thus potentially inflating the true association between sleep and resistance to control. It is not likely, however, that this common method variance would influence the moderating effect of temperament. Instead, the presence of error in our measures of resistance to control and sleep problems would work against our ability to detect significant moderation. Fourth, the generalizability of the findings is less clear for low-SES families, because these families were less likely than higher SES families to provide complete data for the current study. It is possible that the findings would be different in a larger sample of low-SES families. These possibilities should be considered in future research.

Implications and Future Directions

Our findings could eventually have implications for prevention and intervention. If it continues to be found that sleep problems have greater implications for adjustment in unmanageable children, parents of such children could use this information to prevent the development of behavior problems. Also, clinicians could use this information by focusing more heavily on improving the sleep habits of temperamentally unmanageable children with behavior problems. It is a goal in treatment to make interventions more closely tailored to the predispositions of the specific child under consideration. It may seem unlikely that a child could have a temperamental disposition to be manageable (low resistant) and yet also show externalizing behavior problems. However, the correlation between resistant temperament and later externalizing behavior, although robust, is of modest size. As Bates et al. (1998) suggested, one possible process associated with the profile of temperamental manageability and high externalizing behavior is excessive parental control of the child. The current results suggest that interventions to improve sleep would likely be less promising for this group than for the somewhat more normative profile of temperamentally resistant plus behavior problem children.

Much additional work must be done before the findings can be practically useful. Future research could measure sleep and behavior problems on more frequent occasions in an attempt to better understand the developmental process accounting for the predictive link between sleep and adjustment. In addition, future research should include measures of self-regulation in order to evaluate whether self-regulation mediates the association between sleep problems and externalizing behavior problems. Future research could also include experimental work in which the effects of sleep-directed treatments are compared for high- and low-resistant children. Such research could provide evidence not only that sleep is more involved in the

etiology of behavior problems among temperamentally predisposed children but that it is a more effective target for intervention for these children.

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Figure 1. Structural equation model showing standardized estimates of relationships between resistance to control (RTC), sleep problems, and externalizing behaviors from ages 5 to 9 years. The coefficients under γ in the box are estimates of the path from sleep problem slope to externalizing behavior slope at different levels of RTC. Intercept = intercept.

Table 1

Means, Standard Deviations, and Intercorrelations Between Variables

Variable	M	SD	% missing	1	2	3	4	5	6	7	8	9	10	11	12
1. Gender	—	—	0												
2. Resistance to control	3.580	1.124	0–.08												
3. Sleep problem 5 years	.207	.346	0.07		.11*										
4. Sleep problem 6 years	.170	.321	13.10*		.16**										
5. Sleep problem 7 years	.144	.291	18.07		.08										
6. Sleep problem 8 years	.152	.314	17.03		.12**		.55**								
7. Sleep problem 9 years	.150	.331	14.06		.08		.51**	.70**							
8. Externalizing 5 years	5.749	8.675	1–.14**		.12**	.40**	.39**	.53**	.71**						
9. Externalizing 6 years	6.609	9.664	7–19**		.18**	.03	–.01	.07	.03	.00	.56**				
10. Externalizing 7 years	7.023	10.419	11–.15**		.10**	–.04	–.03	.03	.03	.02	.55**	.57**			
11. Externalizing 8 years	6.626	10.094	14–20**		.11**	–.02	–.03	.03	.01	.02	.52**	.57**	.61**		
12. Externalizing 9 years	6.585	10.084	19–.23**		.18**	.00	.01	.01	–.01	–.03	.51**	.56**	.58**	.63**	—

* $p < .05$, two-tailed.
** $p < .01$, two-tailed.

Table 2
Significance Tests of Means and Variances of Growth Curve Parameters (Unconstrained Model)

Parameter	Mean estimate	SD	z	Variance estimate	SD	z
Sleep problem intercept	0.190	0.013	14.574**	0.065	0.011	6.119**
Sleep problem slope	−0.014	0.004	−3.701**	0.004	0.001	4.696**
Externalizing intercept	6.061	0.356	17.020**	47.570	5.941	8.007**
Externalizing slope	0.222	0.106	2.101*	1.610	0.646	2.493*

* $p < .05$, two-tailed.
** $p < .01$, two-tailed.