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To Study or to Sleep? The Academic Costs of Extra Studying at the Expense of Sleep

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This longitudinal study examined how nightly variations in adolescents' study and sleep time are associated with academic problems on the following day. Participants (N = 535, 9th grade M_{age} = 14.88) completed daily diaries every day for 14 days in 9th, 10th, and 12th grades. Results suggest that regardless of how much a student generally studies each day, if that student sacrifices sleep time to study more than usual, he or she will have more trouble understanding material taught in class and be more likely to struggle on an assignment or test the following day. Because students are increasingly likely to sacrifice sleep time for studying in the latter years of high school, this negative dynamic becomes increasingly prevalent over time.

Students generally learn best when they keep a consistent study schedule and distribute their study time evenly across a number of days (e.g., Bahrick & Phelps, 1987; Dempster & Farris, 1990). Although this paced learning is ideal, the increasing demands that high school students face may make such a consistent schedule infeasible. Socializing with peers and working for pay, for example, both increase across the course of high school (Shanahan & Flaherty, 2001; Wight, Price, Bianchi, & Hunt, 2009). As they advance through high school, adolescents' academic obligations also intensify and often require more time and effort (Eccles et al., 1993). As a result, many high school students end up with irregular study schedules, often facing nights in which they need to spend substantially more time than usual studying or completing school work.

Although these nights of extra studying may seem necessary, they can come at a cost. When allocating their limited number of hours across a number of activities, adolescents often make trade-offs, sacrificing certain activities to make time for others. Among adolescents, sleep is one activity that is commonly sacrificed for additional study time (Adam, Snell, & Pendry, 2007). Indeed, study time is one of the most significant determinants of high school students' sleep time, more so than time spent with friends or family or time spent using media (e.g., computers or television; Fuligni & Hardway, 2006). Even adolescents themselves report that too much homework is a common barrier that prevents them from getting enough sleep (Noland, Price, Dake, & Telljohann, 2009). Studying is obviously a contributor to academic achievement, yet adequate sleep is also important for academics (Curcio, Ferrara, & De Gennaro, 2006). Thus, it is possible that nights of extra studying are not as effective as students think. In fact, these nights of extra studying may even be counterproductive because they are likely to also be nights of less sleep and sleep schedule irregularity, both of which can interfere with school performance (Wolfson & Carskadon, 1998).

In high school, sacrificing sleep to study may be especially problematic because, in general, high school age adolescents are chronically sleep deprived (Carskadon, 1990). Although the optimal amount of sleep varies somewhat across individuals, most adolescents need just over 9 hr of sleep each night (Wolfson & Carskadon, 1998). Only

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about 9% of high school students, however, sleep for at least the requisite 9 hr per night (National Sleep Foundation, 2006). One fourth of high school students get a borderline amount of sleep (between 8 and 9 hr per night), and the vast majority of high school students (62%) get insufficient sleep (< 8 hr per night; National Sleep Foundation, 2006).

Across the course of high school, the biologically needed hours of sleep remain constant, yet the average amount that students sleep declines (Carskadon, Acebo, & Jenni, 2004). In 9th grade, the average adolescent sleeps for 7.6 hr per night, and this time decreases to 7.3 hr in 10th grade, 7.0 hr in 11th grade, and 6.9 hr in 12th grade (National Sleep Foundation, 2006). Thus, adolescents start high school sleeping for fewer hours than they need, and this sleep deprivation worsens over the course of high school (Fukuda & Ishihara, 2001).

Presumably, when students choose to trade sleep for studying, they do so because they believe that the increased studying will help their grades. On the one hand, this strategy may be effective because, overall, study time is associated with academic achievement. On average, students who spend more time studying tend to do better on achievement tests (Fuligni & Stevenson, 1995). Students who have high grade point averages (GPAs) study for an average of about three fourths of an hour longer on weeknights than their peers who have low GPAs (Witkow, 2009). On the other hand, sacrificing sleep, even for additional studying, may be an ineffective strategy because average time spent sleeping also contributes to higher achievement. Students whose schedules include more hours of sleep per night tend to have higher grades than their peers who sleep for fewer hours (Wolfson & Carskadon, 2003). When students are sleep deprived, they experience greater fatigue at school the following day, and greater fatigue can make learning more difficult (Giannotti, Cortesi, Sebastiani, & Ottaviano, 2002). Furthermore, sleep is a key restorative process during which consolidation of learning takes place (Diekelmann & Born, 2010). Thus, additional study time, when it comes at the expense of sleep time, may not benefit achievement as much as students think.

Current Study

Most research examining studying, sleep, and achievement have focused on average study times, average sleep times, and broad indicators of academic achievement such as GPAs and test scores (e.g., Taras & Potts-Datema, 2005; Wolfson & Carskadon, 2003). Yet, average study and sleep times are the aggregated result of the daily demands on adolescents' time and the daily time-allocation choices that they make. Likewise, GPAs and test scores are the result of daily behaviors such as paying attention in class and doing well on assignments and examinations. Despite the fact that studying, sleep, and school are all daily occurrences, most previous examinations of these issues have only examined associations at the aggregate level, leaving the daily dynamics of studying, sleep, and academics unexplored.

In this longitudinal study, we examined how daily choices regarding study time and sleep time are associated with adolescents' academic behaviors at school on the following day, and how these daily dynamics changed over the course of high school. For 14 days in each the 9th, 10th, and 12th grades, we obtained daily reports of study time, sleep time, and academic functioning from an ethnically diverse sample of students. Because our data were collected among the same students over the course of many days, we could conduct within-person analyses that essentially allow participants to serve as their own control group and, therefore, control for unmeasured factors that can confound traditional, between-person analyses. In other words, we could move beyond between-person questions (e.g., do the students with the longest average study times tend to be the students with more or fewer academic problems?) and instead answer within-person, daily-level questions (e.g., when a student studies longer than usual on a particular day, what happens to this student's academic problems on the following day?). Specifically, we sought to answer the following questions: (a) Do adolescents have better or worse academic performance on days after they spent more time than usual studying and doing homework? (b) Does extra time spent studying cut into adolescents' sleep on a daily basis? and (c) Does reduced sleep either diminish any positive effects of extra studying or explain any possible negative effects of extra studying on academic performance? Furthermore, by following the same participants over multiple years of high school, we were also able to examine how the dynamics of study time, sleep time, and academic functioning change over time.

Method

Participants and Procedure

Beginning in 9th and continuing in 10th and 12th grades, we recruited students from three Los

Angeles public high schools. The first school primarily served students from Latin American and Asian backgrounds whose families had lower-middle- to middle-class educational and occupational statuses, the second school primarily served lower-middle- to middle-class students from Latin American and European backgrounds, and the third school primarily served middle- to upper-middle-class students from Asian and European backgrounds (California Department of Education, 2006). In the first two schools, we invited all students in the target grade to participate in each year of the study. Due to the large size of the third school, we invited approximately half the 9th graders to participate the first year of the study, and we only followed these students in 10th and 12th grades. At all three schools, students who had participated in earlier years but were no longer enrolled in the school were contacted in subsequent years and invited to participate by mail.

Participants were recruited during school hours in the spring semesters of each school year. Students who returned parental consent forms and provided their own assent completed an initial questionnaire, also during school hours. This questionnaire assessed students' demographic information such as their gender, ethnicity, and the countries of birth for themselves and both parents. After completing the questionnaire, students received a 14-day supply of diary checklists and were instructed to fully complete one checklist each night before going to bed over the subsequent 2-week period. Each checklist was three pages long and took about 5–10 min to complete. To monitor on-time completion of the checklists, we provided participants with 14 manila envelopes and an electronic time stamper (a hand-held device that imprints the current date and time and is programmed with a security code to prevent alterations to the correct date). Participants were instructed to seal their completed checklists into an envelope each night and to stamp the seal with the time stamper. At the end of the 2-week period, participants returned the completed materials to their school and received $30 compensation. If inspection of the data indicated that they had completed the checklists correctly and on time, participants also received two movie passes. The time-stamper monitoring and the cash and movie pass incentives resulted in a high rate of compliance: Depending on the year of data collection, participants in our sample completed 97%–99% of the possible 14 diaries (9th grade: $M = 13.79$, $SD = 1.25$; 10th grade: $M = 13.81$, $SD = 1.13$; 12th grade $M = 13.65$, $SD = 1.52$).

For this study, we examined responses from the 535 (52.1% female) Latino ($n = 193$), Asian American ($n = 233$), and European American students ($n = 109$) who reported on at least 7 of 14 days in at least 2 of the 3 years of data collection. Most of the Latino participants (82.4%) were from Mexican backgrounds, and most of the Asian American participants (67.8%) were from Chinese backgrounds. During the first wave of data collection, participants ranged in age from 13.94 to 16.22 ($M = 14.88$, $SD = 0.39$).

As a measure of socioeconomic status (SES), we combined students' reports of their parents' educational attainment and occupations. Students reported how far their mothers and fathers went in school by selecting one of the following categories: *elementary or junior high school*, *some high school*, *graduated from high school*, *some college*, *graduated from college*, or *law, medical, or graduate school*. Students' open-ended reports of their mothers' and fathers' jobs were coded into the following five categories: *unskilled* (e.g., food service worker, parking attendant), *semiskilled* (e.g., construction worker, bus driver), *skilled* (e.g., nursing assistant, mechanic), *semiprofessional* (e.g., accountant, social worker), or *professional* (e.g., attorney, dentist). The measures of parental education and occupation were each standardized and averaged to provide an overall index of SES. On average, students from European backgrounds reported higher SES ($M = 0.633$, $SD = 0.540$) than students from Asian backgrounds ($M = -0.002$, $SD = 0.788$), who in turn, reported higher SES than students from Latin American backgrounds ($M = -0.586$, $SD = 0.700$), $F(2, 529) = 104.79$, $p < .001$, $\eta^2 = .28$.

Measures

Daily study and sleep time. Each evening for 14 days, participants reported how much time (in hours and minutes) they spent studying outside of school and how much time they slept the previous night. For study time, participants first checked (yes or no) whether or not they *studied or did homework while not in school* and then gave a free response to the question: ''(If yes) for how long?'' For sleep time, participants answered the question: ''How many hours and minutes did you sleep last night (for example, 7½ hr)?'' Each year, the 14 response days spanned 10 school nights (i.e., Sunday through Thursday) and 4 weekend nights. Given that our outcome of interest occurred on school days, we only used school-night reports of study and sleep time.

In comparison to surveys that often ask participants to retrospectively report behaviors from the

previous week, month, or year, daily reports depend less on memory and therefore are less susceptible to errors of estimation. For sleep time in particular, daily reports such as ours are highly correlated with more objective measures of sleep duration, such as those derived from wrist actigraphs (i.e., watch-like devices that measure sleep by analyzing body movements) and polysomnographic recordings (Lockley, Skene, & Arendt, 1999; Wolfson et al., 2003). Furthermore, daily reports of sleep time are meaningfully associated with other daily experiences and mood (e.g., fatigue; Fuligni & Hardway, 2006). For study time, the validity of our participants' reports was indicated by the association between study time (averaged across all days and years) and students' GPAs across years ($r = .50$, $p < .001$).

Daily academic problems. On each school day, participants indicated (yes or no) whether or not they had various experiences at school. As a measure of daily academic problems, we summed participants' responses to two items: ''did not understand something taught in class'' and ''did poorly on a test, quiz, or homework'' (range = 0–2). As a control variable, we also used participants' daily responses to whether or not they ''had a test or a quiz at school.'' The validity of our measure of academic problems was indicated by the negative association between students' reports of academic problems (averaged across all days and years) and students' GPAs across years ($r = -.12$, $p = .005$).

Analytical Plan

First, we averaged daily reports of study times, hours of sleep, and academic problems from each grade and used a series of repeated measures analyses of variance to examine how students' average daily study times, average hours of school-night sleep, and average number of academic problems changed across the course of high school. Then, we estimated a series of three-level hierarchical linear models (HLMs; Bryk & Raudenbush, 1992) to examine daily-level associations between study time, sleep time, and academic problems and whether these associations changed over the course of high school.

Results

Study Time, Sleep Time, and Academic Problems Across the Course of High School

As shown in Table 1, study time did not change across the years of high school; in 9th, 10th, and 12th grades, students spent an average of just over an hour studying each school night. Sleep time, however, decreased over the course of high school. By the 12th grade, students slept for an average of 41.4 fewer minutes each school night than they did in 9th grade. Finally, the frequency of academic problems also decreased. In the 9th and 10th grades, students reported an average of one academic problem every 3 days; by the 12th grade, the frequency of academic problems decreased to one problem every 5 days.

Academic Problems After Days With Extra Study Time

To examine whether adolescents had more or fewer academic problems on days after they spent more time studying than usual, we estimated an HLM using the following equations:

$$\begin{aligned}\text{academic problems}_{t+1ij} &= p_{0ij} + p_{1ij}(\text{prior-day study time}_{tij}) \\ &\quad + p_{2ij}(\text{had a test}_{t+1ij}) + e_{tij}\end{aligned} \tag{1}$$

$$p_{0ij} = b_{00j} + b_{01j}(\text{year}_{ij}) + r_{0ij} \tag{2}$$

$$p_{1ij} = b_{10j} + b_{11j}(\text{year}_{ij}) \tag{3}$$

$$p_{2ij} = b_{20j} + b_{21j}(\text{year}_{ij}) \tag{4}$$

Table 1
Average Daily Study Time, Sleep Time, and Academic Problems Across the Course of High School

	9th Grade	10th Grade	12th Grade	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	Statistical test
Study time	1.12 (0.85)	1.10 (0.90)	1.06 (1.00)	$F(2, 732) = 0.32$, $p = .72$, $\eta^2 = .001$
Sleep time	7.63 (0.93)	7.40 (0.92)	6.94 (0.95)	$F(2, 730) = 112.45$, $p < .001$, $\eta^2 = .236$
Academic problems	0.33 (0.30)	0.32 (0.28)	0.20 (0.21)	$F(2, 732) = 27.88$, $p < .001$, $\eta^2 = .071$

Note. Both study time and sleep time are reported in hours. Academic problems could range from 0 to 2 each day.

Study time was centered within each adolescent within each year. The Level 1 (daily-level) equation is shown as Equation 1: Adolescents' academic problems on a given day are modeled as a function of their average daily academic problems (p_{0ij}), the extent to which the time they spent studying on the prior night deviated from their personal norm (p_{1ij}), and whether or not they had a test at school that day (p_{2ij}). Equations 2–4 represent Level 2 (yearly level) effects, allowing us to examine the extent to which daily academic problems and the association between prior-day study time and academic problems change over the years of high school. Years were coded as 0 = 9th grade, 1 = 10th grade, and 3 = 12th grade. This analysis also accounted for the nesting of observations within participants (Level 3), but these equations are not shown here because the model did not include any Level 3 predictors.

As shown in the first column and third row of Table 2, 9th-grade students' deviation from their average study time had no association with their academic problems on the following day. Across the course of high school, however, the association between study time and academic problems changed such that study time became increasingly associated with academic problems (see the first column and fourth row of Table 2). As shown in Figure 1, reestimating our HLM—first with year centered at 10th grade and then with year centered at 12th grade—indicated that in 10th grade, days on which students reported longer than normal study times tended to be followed by days with *more* academic problems, and this daily association was even stronger in 12th grade.

It is important to note that, in Equation 1, we controlled for students' daily reports of whether or not they had a test or quiz at school. Including this control rules out the possibility that nights of increased studying were followed by days with more academic problems only because students were both more likely to study and to have academic problems when they have tests. Thus, our results suggest that regardless of whether or not students had a test, study time became increasingly associated with academic problems such that, by 10th grade, nights with longer than average study times tended to be followed by days with more academic problems.

The Level 3 (individual-level) variance components for all effects of interest were nonsignificant. In other words, neither the 9th-grade association, nor the yearly change in the association between study time and academic problems differed across individuals. As such, we did not examine individual-level differences (e.g., gender, ethnic, or SES differences) in these associations.

Table 2
Association Between Daily Study Time and Next Day's Academic Problems, Before and After Controlling for Daily Sleep Time

	Academic problems	
	Model 1	Model 2
	b (*SE*)	*b* (*SE*)
Intercept (average academic problems in 9th grade)	0.276 (0.013)***	0.259 (0.013)***
Year (yearly change in average academic problems)	−0.040 (0.005)***	−0.010 (0.006)
Study time (association in 9th grade)	0.006 (0.008)	0.012 (0.009)
Year (yearly change in association)	0.010 (0.004)*	0.001 (0.004)
Had a test (association in 9th grade)	0.090 (0.018)***	0.107 (0.018)***
Year (yearly change in association)	0.035 (0.010)**	0.009 (0.010)
Sleep time (association in 9th grade)	—	0.003 (0.007)
Year (yearly change in association)	—	−0.010 (0.003)**

Note. Both study time and sleep time were centered at each individual's mean at each year. Year was coded such that 9th grade = 0, 10th grade = 1, and 12th grade = 3.
*$p < .05$. **$p < .01$. ***$p < .001$.

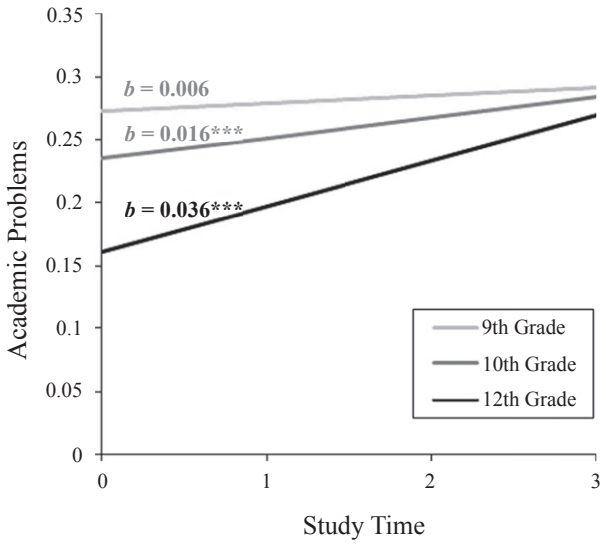

Figure 1. Associations between daily study time and next day's academic problems (controlling for whether student had a test the next day) in 9th, 10th, and 12th grades. Study time is reported in hours.
***$p < .001$.

Trade-Off Between Extra Study Time and Sleep

To examine whether extra time spent studying cut into adolescents' sleep on a daily basis, another HLM was estimated. At Level 1, students' daily sleep time was predicted by their daily study time and whether or not they had a test at school the following day):

$$\text{sleep time}_{tij} = p_{0ij} + p_{1ij}(\text{study time}_{tij}) + p_{2ij}(\text{had a test}_{t+1ij}) + e_{tij} \quad (5)$$

Study time was centered within each adolescent within each year. Potential changes in the daily-level association across the years of high school were tested using the same equations as those described in Equations 2–4 above. This analysis also accounted for the nesting of observations within participants (Level 3), but these equations are not shown here because there were no Level 3 predictors.

Results indicated that daily study and sleep time were inversely associated in ninth grade (see row 3 of Table 3); days on which students reported longer than normal study hours tended to be days on which they reported fewer hours of sleep. This association became increasingly negative across the high school years (see row 4 of Table 3 and Figure 2). As before, these analyses controlled for students' daily reports of whether or not they had a test or quiz at school, indicating that students' trade-off between studying and sleeping occurs regardless of whether or not they have a test at school on the following day. Also, as before, individual-level differences in these associations were not examined because there was no significant variability in these associations across individuals.

Table 3
Association Between Daily Study Time and Sleep Time

	Sleep
	b (*SE*)
Intercept (average sleep time in 9th grade)	7.643 (0.046)***
Year (yearly change in average sleep time)	−0.215 (0.022)***
Study time (association in 9th grade)	−0.053 (0.018)**
Year (yearly change in association)	−0.028 (0.011)*
Had a test (association in 9th grade)	−0.033 (0.039)
Year (yearly change in association)	−0.077 (0.024)**

Note. Study time was centered at each individual's mean at each year. Year was coded such that 9th grade = 0, 10th grade = 1, and 12th grade = 3.
*$p < .05$. **$p < .01$. ***$p < .001$.

Extra Study Time and Academic Problems: Mediated by the Trade-Off With Sleep?

Finally, we examined whether the yearly increasing trade-off between study time and sleep could account for the surprisingly greater number of academic problems that followed days of extra studying in the latter years of high school. In other words, we examined whether the yearly changing association between study time and sleep could account for the yearly changing association between study time and academic problems. To this end, we conducted multilevel mediation analyses using the procedure suggested by (Krull & MacKinnon, 2001). We estimated a series of HLMs in which daily academic problems were predicted by both the previous day's study time and the previous day's sleep time:

$$\text{academic problems}_{t+1ij} = p_{0ij} + p_{1ij}(\text{prior-day study time}_{tij}) + p_{2ij}(\text{prior-day sleep time}_{tij}) + p_{3ij}(\text{had a test}_{t+1ij}) + e_{tij} \quad (6)$$

$$p_{0ij} = b_{00j} + b_{01j}(\text{year}_{ij}) + r_{0ij} \quad (7)$$

$$p_{1ij} = b_{10j} + b_{11j}(\text{year}_{ij}) \quad (8)$$

$$p_{2ij} = b_{20j} + b_{21j}(\text{year}_{ij}) \quad (9)$$

$$p_{3ij} = b_{30j} + b_{31j}(\text{year}_{ij}) \quad (10)$$

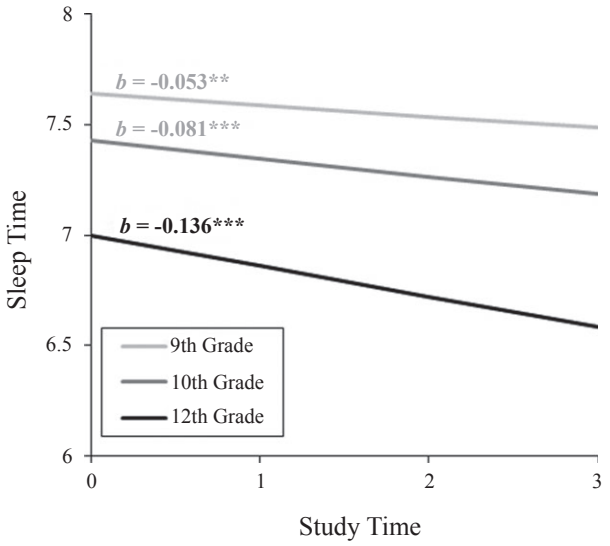

Figure 2. Daily associations between study time and sleep time (controlling for whether student had a test) in 9th, 10th, and 12th grades. Study time and sleep time are reported in hours. *$p < .01$. ***$p < .001$.

Study time and sleep time were centered within each adolescent within each year. We then compared the moderating effect of year on the association between study time and academic problems before and after controlling for sleep time (i.e., the magnitude and significance of b_{11j} from Equation 3 vs. the magnitude and significance of b_{11j} from Equation 8). As before, these models included students' daily reports of whether or not they had a test or quiz at school as a control variable.

As shown in the first column and fourth row of Table 2, without sleep time in the model, study time seems to become increasingly associated with academic problems across the years of high school. When sleep time is added to the model, however, the yearly exacerbation of the association between study time and academic problems is reduced by 90% and is no longer significant. These results suggest that study time became increasingly associated with more academic problems across high school because longer study hours were increasingly associated with fewer hours of sleep, which in turn predicted greater academic problems the following day.

Discussion

Our results suggest that, across the years of high school, the trade-off between daily study time and sleep becomes increasingly associated with academic problems. In the latter years of high school, days of extra studying tend to be followed by days with *more* academic problems. In 9th grade, days of extra studying have no association with the following day's understanding of class material or test performance; in 10th grade, however, adolescents report more such academic problems on days after they spend more time studying than usual, and this troublesome association becomes even stronger in 12th grade. The association between study time and academic problems occurs regardless of whether or not students have a test coming up and, therefore, is not simply an artifact of studying for and taking a difficult test.

Although we expected that nights of extra studying might not be as effective as students suppose (Pilcher & Walters, 1997), it was somewhat surprising that nights of extra studying would be associated with *worse* academic functioning the following day. This surprising finding, however, made more sense once we examined extra studying in the context of adolescents' sleep. As other studies have found, our results indicate that extra time spent studying cuts into adolescents' sleep on a daily basis (Adam et al., 2007). This trade-off between studying and sleeping occurs in 9th grade and becomes more dramatic in the latter years of high school. Our mediation results suggest that the reduced sleep that tends to occur on nights of extra studying is what accounts for the increase in academic problems that occurs the next day.

It is important to underscore that our results do *not* suggest that it is problematic for adolescents to spend more time studying overall. Previous studies suggest that when examining achievement differences between students, those who study more tend to earn higher grades (Keith, 1982; Witkow, 2009), and this same pattern was evident in our study. Our analyses, however, go beyond averages and do not compare the study times and achievement levels of different students. Instead, our analyses focus on daily and yearly variations within each student. Regardless of how much a student generally studies each day, our results suggest that if that student sacrifices sleep to study more than usual, he or she will have more trouble understanding material taught in class and be more likely to struggle on an assignment or test the following day.

Our findings complement sleep research that has demonstrated that students who, on average, sleep for more hours tend to have more positive academic outcomes such as higher grades and better school behaviors (Curcio et al., 2006; Wolfson & Carskadon, 2003). Our study provides additional evidence that beyond average amounts of sleep, nightly variations in sleep are associated with school functioning on a daily basis. Specifically, students who sleep less than usual on a particular night are more likely to experience academic problems on the following day, especially in the latter years of high school. It is possible that this daily effect is exacerbated by the fact that students are generally sleep deprived. That is, perhaps if students generally received adequate amounts of sleep, they would be less sensitive to daily variations. Similar to other studies (e.g., National Sleep Foundation, 2006; Wolfson & Carskadon, 1998), we found that even in 9th grade, students tend to sleep considerably less than the needed 9 hr per night, and students' sleep deprivations tends to worsen over the course of high school. Even if adolescents did receive adequate amounts of sleep, however, we would not expect the effect of irregular sleep on school functioning to disappear completely, as other studies have demonstrated that even beyond total amounts of sleep, irregular sleep schedules are associated with lower academic performance (Wolfson & Carskadon, 1998).

Given that our research suggests that it is particularly counterproductive to sacrifice sleep in service of studying, academic success may depend on finding strategies to avoid having to make such a trade-off. One such strategy might be to maintain a consistent study schedule across days. Rather than letting due dates dictate the amount one dedicates to homework and studying each day, students could distribute their total study and homework time evenly across all days of the week. In and of itself, this is a generally effective study strategy—experimental research has demonstrated that spacing study time evenly across a number of days results in better academic performance than studying in one massed session, even if the total amount of study time is the same (Kornell, 2009).

Despite efforts to maintain a consistent study schedule, high school students may still occasionally face days on which they need to spend substantially more time than usual on their school work. On these nights, our research suggests that students should make every effort not to let this extra study time disrupt their normal sleep patterns. One possibility is for students to use their school time as efficiently as possible. Many high school students have at least one period during the school day that is relatively unstructured (e.g., homeroom or study hall). If students can use this time to complete their additional work, they will be less likely to need to sacrifice sleep. Another possibility is for students to sacrifice time spent on other activities. On average, adolescents spend about an hour each day socializing with friends, about 1 hr each day helping the family, and between 1 and 2 hr each day watching television (Fuligni & Hardway, 2006; Wight et al., 2009). Presumably, adolescents are sacrificing sleep for study time to maintain the time they spend on these and other demands (e.g., paid work and extracurricular activities). Further research into the daily lives of adolescents could examine precisely how adolescents' various demands interact with study and sleep time and, therefore, offer specific activity- and time-management suggestions to adolescents and their families.

Overall, our daily approach is a particular strength of this study. First of all, collecting reports from the same students over the course of many days allowed us to conduct within-person analyses, which control for individual differences that can confound traditional between-person analyses. Second, by examining multiple facets of adolescents' lives simultaneously, our study provides a perspective that is closer to the actual decisions adolescents make on a daily basis, a perspective that may be especially important for work that hopes to inform interventions aimed at improving students' achievement. Our research suggests, for example, that intervening to increase students' study time will be counterproductive if the additional study time ends up interfering with sleep. Similarly, interventions aimed at helping students get more sleep should account for the daily demands that students face and the fact that studying seems to be one reason why students are not getting as much sleep as they need.

Importantly, we did not find evidence of individual differences in any of our findings. This suggests that the daily dynamics of studying, sleep, and academic functioning are similar across individuals regardless of demographic characteristics such as gender or ethnic background.

Limitations and Future Directions

As already discussed, a main limitation of our study is that we measured only two of the many activities that demand adolescents' time. Although we know that studying can come at the expense of sleeping, we do not know how other activities interact with studying and sleeping, or how these activities might be associated with academic functioning. Further research could use similar daily and yearly methodology to examine a wider array of activities that occupy adolescents' time over the course of high school. Such research will provide a more complete picture of adolescents' days and could identify additional daily choices that either support or hinder adolescents' achievement.

Similarly, although our daily measures of studying and sleeping are a strength of this study, our study is limited in that we only assessed the *time* adolescents spent doing these activities. We did not, for example, assess the *quality* of students' studying or sleeping. Without knowing exactly how students were spending their study time, it is unclear how study strategy might interact with study time and academic problems. It could be, for example, that adolescents study more on days when they are using a particularly ineffective study strategy. If this were the case, helping students develop more efficient study habits could reduce the number of days when they need extra study time. Sleep quality may also be an important variable to consider. It is possible that studying more than usual is associated with poorer quality of sleep (in addition to reduced sleep time). Studying more than usual may, for example, be associated with

feelings of anxiety, and anxiety is certainly associated with a reduced sleep quality (Carskadon, 2002). If this were the case, poor sleep quality may independently contribute to academic problems, and helping students sleep soundly for the hours that they do sleep may reduce the number of academic problems they experience the following day.

Finally, our study is limited in that we only utilized adolescent self-reports. Although daily diary reports generally avoid retrospective errors in recall, they are still subjective reports and, therefore, are subject to reporting biases. For sleep in particular, there are more objective ways of measuring behavior. Conducting similar daily research using a device such as an actigraph to monitor participants' motor movements throughout the day could corroborate the validity of daily self-reports of sleep and provide a wider variety of sleep measures than was included in this study (e.g., sleep duration, timing, and quality).

Conclusion

Sacrificing sleep for more studying time is a common, yet counterproductive strategy for adolescents, especially in the latter years of high school. Adolescents devote less time to sleep as they age, and when they sacrifice the precious little sleep they have for extra studying, it has negative consequences for their daily academic performance. Our results suggest that the best studying strategy for adolescents who must juggle the demands of high school is to study consistently on school days. However, as adolescents progress through high school, their time becomes an increasingly precious commodity. On the basis of the mediation results, we speculate that if adolescents do need to study more than normal, they should not sacrifice sleep, but rather some other time-consuming activity. Parents and educators concerned about adolescents' academic problems should emphasize the importance of sleep and maintaining a regular studying schedule.

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