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SLEEP QUALITY, SLEEP PROPENSITY AND ACADEMIC PERFORMANCE¹

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Summary.—We examined associations between measures of sleep propensity on the Epworth Sleepiness Scale, sleep quality on the Pittsburgh Sleep Quality Index and academic performance by GPA and grades in introductory psychology for 414 students. In the total sample, neither sleep propensity nor sleep quality correlated with GPA or introductory psychology grades. However, among students carrying a full course load, those reporting poor sleep quality performed less well on academic measures than those reporting a better quality of sleep. Further research is needed to assess the moderating influence of overall demands of daytime functioning on the association between sleep quality and academic performance.

Experimental studies indicate that partial or total sleep deprivation is associated with decrements in cognitive functioning (for reviews, see Pilcher & Huffcutt, 1996; Harrison & Horne, 2000). Outside the laboratory, evidence has accrued that individuals who report naturally occurring sleep deficits and who are involved in demanding activities, such as long-distance drivers and shift workers, suffer adverse effects. Another group at risk for the ill effects of sleep deprivation are high school and college students. Total sleep time decreases across the adolescent years, largely due to increasingly later bedtimes (Gau & Soong, 1995; Wolfson & Carskadon, 1998; Arakawa, Taira, Tanaka, Yamakawa, Toguchi, Kadekaru, Yamamoto, Uezu, & Shrakawa, 2001; Laberge, Petit, Simard, Vitro, Tremblay, & Montplaisir, 2001). Morning fatigue is commonly reported among young adults (Coren, 1994) and 15% of college students experience poor sleep quality (Buboltz, Brown, & Soper, 2001). Hicks, Fernandez, and Pellegrini (2001b) reported a marked decrease in sleep satisfaction in a 2000/2001 cohort of college students relative to cohorts assessed over the previous two decades, with a majority of the most recent cohort reporting dissatisfaction. Hicks, Fernandez, and Pellegrini (2001a) reported that the median length of sleep reported by college students has decreased by over one hour across the last three decades.

Given the effect of sleep deprivation on cognitive performance and evidence that students commonly experience sleep difficulties, researchers have examined whether sleep difficulties among students are associated with im-

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paired academic functioning. Link and Ancoli-Israel (1995) found that the tendency to fall asleep during the daytime was associated with lower self-reported grade point averages (GPAs) among 150 high school students. Higher GPAs, conversely, were associated with waking up later, waking up less often during the night, taking fewer naps, and sleeping somewhat longer on school nights. Kowalski and Allen (1995) found that good weekend sleep habits were associated with higher self-reported grades among 119 high school students; relationships with weekday sleep habits were not reported. Among a large sample (>3,000) of students in Grades 9 through 12, Wolfson and Carskadon (1998) reported that students with higher self-reported GPAs slept longer and went to bed earlier relative to those with lower GPAs. Kelly, Kelly, and Clanton (2001) found for a sample of 148 undergraduates that those who slept on the average less than six hours per night had lower self-reported GPAs than those who slept nine hours or more. In a sample of more than 1,000 7th–12th graders, Eliasson, Eliasson, King, Gould, and Eliasson (2002) found no association between hours of sleep on school days and self-reported GPA. Finally, Gray and Watson (2002) assessed sleep quality, sleep duration and numerous characteristics of the sleep habits of 334 college undergraduates. They found that higher self-reported GPAs were associated with earlier rising times, but no other significant associations with GPA emerged.

A limitation common to the above studies of associations between sleep characteristics and academic performance is that grades were assessed via self-report. Subjective reports of academic performance may lead to an overestimation of the association between sleep characteristics and academic functioning. However, Gray and Watson (2002) presented data attesting to the high correlation between self-reported and officially generated GPAs. Moreover, three recent studies have included objective indices of academic performance. Medeiros, Mendes, Lima, and Araujo (2001) showed that higher scores on an academic examination taken by 35 medical students were significantly associated with earlier bedtimes, longer sleep length, and less sleep irregularity; however, although scores on a standardized measure of sleep quality were obtained, their association with examination performance was not reported. Trockel, Barnes, and Egget (2000) found, using officially recorded GPAs of 200 first-year undergraduates, that lower GPAs were significantly associated with later weekday and weekend bedtimes, later weekday and weekend wake-up times, and longer hours of sleep on weekend nights. Finally, Rodrigues, Viegas, Abreu e Silva, and Tavares (2002) reported that scores on a standardized sleep propensity measure were related to examination performance among 172 medical students, with sleepier students obtaining lower grades.

A further limitation of the research concerning sleep and academic performance is the assessment of sleep-related variables using measures with unknown psychometric properties. The two standardized measures that have been employed are the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) and the Epworth Sleepiness Scale (Johns, 1991). Gray and Watson (2002) and Medeiros, *et al.* (2001) obtained scores on the Pittsburgh Sleep Quality Index along with measures of academic performance. Gray and Watson (2002) reported that sleep quality did not correlate with self-reported GPA, while Medeiros, *et al.* (2001) did not report the association between scores on the Pittsburgh Sleep Quality Index and examination performance. Rodrigues, *et al.* (2002) reported that high scores on the Epworth Sleepiness Scale were associated with poorer examination performance.

The inconsistent and at times nonsignificant associations between academic performance and standardized measures of sleep quality and sleep propensity emerging in previous research suggests that other variables may moderate the association between academic performance and sleep quality or sleep propensity. One possible moderator variable is academic workload. Associations between poor sleep quality or high sleep propensity and academic performance may be strongest among students carrying a full course load, reflecting the greater cognitive and psychological demands of such a course load and hence a heightened vulnerability to the adverse effects of poor sleep quality or of sleepiness.

In the current study we sought to explore associations between objective indices of academic performance, i.e., GPA and introductory psychology grades, and both sleep propensity as measured by the Epworth Sleepiness Scale and sleep quality as measured by the Pittsburgh Sleep Quality Index among a large number of undergraduate students. Based on suggestive findings of earlier research, we predicted that high academic functioning would be associated with low daytime sleepiness and high sleep quality. We further speculated that course load, i.e., number of courses taken by students during the academic term, would moderate the association between academic performance and sleep quality or propensity, such that only students with a full course load (defined as five or more courses in the academic term) would evidence such associations.

METHOD

Participants

Participants were 414 introductory psychology students at a university-studies college, of whom 138 were men and 267 were women; 9 participants did not specify their sex. Ages ranged from 17 to 50 years ($M=20.1$, $SD=3.8$). Across the sample 246 students, including 77 men and 162 women,

carried a full course load, defined as five or more courses during the current academic term. The remaining 168 students, including 61 men and 105 women, carried a partial course load, i.e., less than five courses during the current term.

Materials

The eight-item Epworth Sleepiness Scale (Johns, 1991) assesses general amount of daytime sleepiness by inquiring about the likelihood of falling asleep in a number of situations. Ratings of each item are made on a 4-point scale with endpoints labeled 0 = Would never doze and 3 = High chance of dozing. Responses are summed to yield a total score, ranging from 0 to 24, with higher scores indicating greater sleep propensity. Johns (1992) reported the Cronbach coefficient alpha as .73 for the Epworth Sleepiness Scale and the test-retest correlation as .82. Johns (1991) reported that the scale distinguishes sleep-disordered from nondisordered individuals. Several studies have yielded significant, low correlations between Epworth Sleepiness Scale scores and scores on an objective measure of daytime sleepiness, the Multiple Sleep Latency Test (Johns, 2000).

The 18-item Pittsburgh Sleep Quality Index (Buysse, *et al.*, 1989) measures sleep quality and sleep disturbance during the previous one-month period. The scale begins with four open-ended questions: "When have you usually gone to bed at night," "How long has it taken you to fall asleep each night," "When have you usually gotten up in the morning," and "How many hours of actual sleep did you get at night?" Following these are 14 questions rated on 4-point scales, where lower scores indicate better sleep quality. The 18 items are used to create seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component score has a range of 0 = No difficulty to 3 = Severe difficulty and each is derived from one or more of the qualitative or quantitative scale items, e.g., the sleep latency component score is derived from the second open-ended question listed above with 0 = <16 min.; 1 = 16–30 min.; 2 = 31–60 min., and 3 = >60 min. The component scores are summed to produce an overall score, ranging from 0 to 21, with higher scores reflecting poorer sleep quality. Buysse, *et al.* (1989) found a coefficient alpha of .83 and a test-retest correlation of .85. With respect to its validity, the index has distinguished between healthy and sleep-disturbed groups (Buysse, *et al.*, 1989; Carpenter & Andykowski, 1998).

Procedure

During several introductory psychology classes taught by several different instructors, students were invited to take part in a study assessing the relation between sleep and academic performance. After students provided in-

formed consent to participate, they completed the questionnaires in a counterbalanced order. They also gave their consent for the researchers to obtain, from official transcripts, their GPA for the current academic term and their grade in introductory psychology, both of which could range from 0.0 to 4.0. Introductory psychology grades were desired because grades from a current course shared by all participants may be more sensitive to associations with sleep variables than are GPAs derived from a multitude of different course combinations.

RESULTS

For all analyses, significance values were two-tailed. Fluctuations of degrees of freedom reflect missing data.

Sleep and Academic Performance Measures

Mean scores on all sleep and academic performance measures are reported in Table 1. The coefficients alpha were .73 for the Epworth Sleepiness Scale and .75 for rating scale items on the Pittsburgh Sleep Quality Index. Descriptive sleep statistics obtained from the open-ended items on the Pittsburgh Sleep Quality Index gave a mean bedtime of 11:39 PM ($SD=68$ min.), a mean sleep latency of 25 min. ($SD=23$ min.), a mean getting up time of 7:24 AM ($SD=77$ min.), and a mean number of hours slept of 6 hr. 51 min. ($SD=68$ min.).

TABLE 1
MEANS AND STANDARD DEVIATIONS FOR SLEEP AND ACADEMIC PERFORMANCE
MEASURES AND INTERCORRELATIONS AMONG MEASURES

Measure	Overall			Men			Women			Correlations ^a		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>	1	2	3
1. Epworth Sleepiness Scale	412	9.00	3.77	137	8.14	3.38	266	9.49	3.90			
2. Pittsburgh Sleep Quality Index	401	6.70	2.94	132	6.10	2.56	260	7.05	3.09	.30*		
3. GPA	382	2.67	0.73	123	2.59	0.80	255	2.71	0.69	.01	-.01	
4. Introductory Psychology Grade	376	2.49	0.90	120	2.35	0.96	252	2.56	0.87	-.03	-.01	.79†

Note.—Total scores on the Epworth Sleepiness Scale range between 0 and 24, with higher scores indicating greater sleep propensity. Total scores on the Pittsburgh Sleep Quality Index range between 0 and 21, with higher scores reflecting poor sleep quality. ^aCorrelations based on the overall sample. * $n=399$, $p<.001$. † $n=376$, $p<.001$.

Age was a significant correlate of overall scores on the Pittsburgh Sleep Quality Index ($r_{360}=.12$, $p<.03$), but not of total scores on the Epworth Sleepiness Scale or of grades. Table 1 shows that women had, on average, higher total scores than men on both the Pittsburgh Sleep Quality Index ($t_{390}=3.03$, $p<.01$) and the Epworth Sleepiness Scale ($t_{401}=3.45$, $p<.001$).

Women also had, on average, higher introductory psychology grades than men ($t_{370}=2.08$, $p<.05$). Mean GPAs did not differ between women and men in our sample.

We calculated Pearson correlations of sleep measure totals with GPA and with introductory psychology grades. Table 1 shows that no significant correlations emerged between sleep quality or sleep propensity and academic performance. Analyses were repeated controlling for age and sex; again, no significant associations emerged.

Full or Partial Course Load

We speculated that students may become more vulnerable to the effects of poor sleep quality or high sleep propensity to the extent that they are heavily involved in academic activities. We therefore contrasted students carrying a full course load with those carrying a partial course load. We first examined whether sleep quality would interact with course load to predict introductory psychology grades, such that poor sleep quality as measured with the Pittsburgh Sleep Quality Index would predict lower grades only among students carrying a full course load. The sample was first divided using a median split on total scores on the Pittsburgh Sleep Quality Index ($Mdn=6.00$). Next, we subdivided each of the low and high sleep quality groups into students carrying a partial course load and those carrying a full course load. We then conducted a 2 (good vs poor sleep quality) \times 2 (partial vs full course load) analysis of variance with introductory psychology grades as the dependent measure. The expected interaction effect emerged ($F_{1,362}=5.89$, $p<.02$), but no main effects emerged. Inspection of the means contributing to the interaction effect, and adjusting α to reflect multiple comparisons, showed that, among students carrying a full course load, introductory psychology grades were lower for those reporting poor sleep quality ($M=2.34$, $SD=0.92$, $n=93$) than for those reporting a good quality of sleep ($M=2.70$, $SD=0.78$, $n=115$; $t_{206}=3.05$, $p<.003$; two-tailed testwise $\alpha=.05/2=.025$), whereas among students carrying a partial course load, there was no difference between students reporting poor sleep quality ($M=2.49$, $SD=0.94$, $n=81$) and those reporting good quality of sleep ($M=2.39$, $SD=0.97$, $n=77$; $t_{156}=-0.66$, ns). This effect remained unchanged when age and sex were entered as covariates.

We next examined whether sleep quality would interact with course load to predict our second academic measure, GPA. Thus, we conducted another 2 (good vs poor sleep quality) \times 2 (partial vs full course load) analysis of variance, this time with GPA as the dependent measure. The expected interaction effect did not reach conventional levels of significance ($F_{1,368}=3.61$, $p=.06$). However, when age and sex were entered as covariates, the interaction effect was significant ($F_{1,358}=4.40$, $p<.04$). Accordingly, the remaining

results reported for this analysis on GPA reflect the inclusion of age and sex as covariates. Inspection of the means contributing to the interaction effect showed that, for students carrying a full course load, GPA was lower among those having poor sleep quality ($M = 2.64$, $SD = 0.61$, $n = 92$) than among those having a good quality of sleep ($M = 2.86$, $SD = 0.62$, $n = 113$; $t_{203} = 2.52$, $p < .02$; two-tailed testwise $\alpha = .05/2 = .025$), whereas for students carrying a partial course load, there was no difference among students having poor sleep quality ($M = 2.59$, $SD = 0.83$, $n = 82$) and those having good quality of sleep ($M = 2.47$, $SD = 0.83$, $n = 77$; $t_{157} = 0.87$, ns). In the prediction of GPA, a main effect for course load also emerged ($F_{1,358} = 8.47$, $p < .01$) such that students carrying a full course load had higher GPAs ($M = 2.77$, $SD = 0.63$, $n = 205$) than those carrying a partial course load ($M = 2.53$, $SD = 0.82$, $n = 159$).

Finally, we examined whether sleep propensity as assessed with the Epworth Sleepiness Scale would interact with course load to predict our two measures of academic performance, such that a high sleep propensity would predict lower grades only among students carrying a full course load. To this end, we performed two additional analyses of variance parallel to those described above, i.e., with introductory psychology grades and then GPA as dependent measures after dividing the sample using a median split on total scores on the Epworth Sleepiness Scale ($Mdn = 9.00$). Unlike the effects that emerged for sleep quality scores, sleep propensity did not interact with course load to predict either introductory psychology grades or GPAs.

DISCUSSION

The current study explored the association between measures of sleep characteristics and academic performance using standardized measures of sleep propensity and sleep quality and officially recorded GPAs and course grades in introductory psychology. Internal consistency of the measures was acceptable. Our sample yielded somewhat higher overall scores than others have found among nondisordered samples for the Epworth Sleepiness Scale (Johns, 1994) and the Pittsburgh Sleep Quality Index (Carpenter & Andykowski, 1998; Pilcher, Schoeling, & Prosansky, 2000). Scores on the two measures correlated significantly but weakly, consistent with earlier research (Pilcher, *et al.*, 2000). The sleep characteristics yielded by open-ended items on the Pittsburgh Sleep Quality Index identified bedtimes, rising times, sleep durations, and sleep latencies similar to those previously reported for college student samples (Pilcher, *et al.*, 2000; Buboltz, *et al.*, 2001; Hicks, *et al.*, 2001a).

Sleep Quality, Sleep Propensity, and Academic Performance

We predicted that total scores on measures of sleep propensity and sleep quality would correlate with GPA and introductory psychology grades. No such associations arose. This lack of association among our overall sam-

ple is not without precedent: Gray and Watson (2002) also reported no association between scores on the Pittsburgh Sleep Quality Index and GPA. It may be that the sleep measures employed in this research are insensitive to associations between sleep quality or propensity and academic functioning. In addition, adverse consequences of poor sleep quality or high sleep propensity on academic performance may be more diffuse, subtle, or gradual than the effects of sleep deprivation on laboratory measures of cognitive functioning, such as reaction time and logical reasoning. Moreover, while our predictions were based on the premise that poor sleep quality or high sleep propensity impairs academic functioning, some high functioning students may sacrifice sleep, and thereby experience poor sleep quality and/or high sleep propensity, in order to study longer. Indeed, higher GPAs have been shown to be associated with *earlier* getting up times (Trockel, *et al.*, 2000; Gray & Watson, 2002). Gray and Watson interpreted this relationship in light of additional evidence that higher GPAs were related to personality variables such as conscientiousness, stating that "early risers tend to be more disciplined, achievement-oriented individuals than evening types" (p. 200). It is possible that such individuals are attempting to maximize their hours of academic productivity by limiting their sleep. Finally, the lack of associations between sleep propensity, sleep quality, and academic performance for our overall sample may also reflect the use of GPA and introductory psychology course grades as dependent measures as opposed to a single examination performance.

Full and Partial Course Loads

When we separated students into those carrying a full course load and those carrying a partial course load, we found that poor sleep quality was associated with relatively low academic performance only among students carrying a full course load. These results suggest that, among our sample, course load moderated the association between academic performance and sleep quality. Perhaps for students with a full course load there is more likely to be an association between sleep quality and performance because the cognitive and psychological demands of such a course load are high. The moderating influence of course load on the association between sleep quality and academic performance may also explain why others (*i.e.*, Gray & Watson, 2002) have found no association between these variables.

These findings suggest the possibility that additional workload-related factors may moderate the relation between sleep quality and academic performance. For example, students who carry a course load comprised largely of required as opposed to elective courses or those whose majors are more demanding may show an association between sleep quality and academic performance that does not emerge among those with course loads or majors

that are less demanding. Similarly, students who work a relatively large number of hours per week in addition to studying may reveal an association between poor sleep quality and academic performance that does not emerge among students working fewer hours.

In contrast to our findings for sleep quality, we showed that sleep propensity continued not to be associated with academic performance among students with a full course load, suggesting that sleep quality may be more sensitive than daytime sleepiness as an indicator of sleep difficulties among student samples. This, in turn, may reflect that sleepiness can occur for many reasons in addition to disrupted sleep, such as recent physical exertion or lack of stimulation, whereas poor sleep quality is a more direct measure of sleep disturbance.

Limitations and Future Directions

Our correlational design permits no inferences of a causal nature concerning the association between sleep quality and academic performance. Another limitation is that students were aware that the study concerned relations between sleep quality, sleep propensity, and academic performance. Their expectations concerning such relations may have affected our findings. Further studies could take lengths to reduce such effects, e.g., by requesting access to students' grades only after they have completed sleep measures. We further recommend that research employing standardized measures of sleep such as the Epworth Sleepiness Scale or Pittsburgh Sleep Quality Index include a measure of socially desirable responding, such as the Paulhus Deception Scales (Paulhus, 1999), to assess the extent to which response biases may encourage participants to portray their sleep habits in a particular light, e.g., college students desiring to be seen as needing little sleep. Moreover, no research to date has studied the association between academic performance and sleep using a behavioral measure of sleep status, such as the Multiple Sleep Latency Test (Carskadon & Dement, 1987). It may be useful to examine such a relationship, given the nonsignificant associations between self-report measures of sleep and grades found among the overall sample in the current research and given that self-report and behavioral measures seem to assess different aspects of sleep-related functioning, e.g., Chervin, Aldrich, Pickett, & Guilleminault, 1997; Chervin & Aldrich, 1999; Johns, 2000).

The current study is the first to demonstrate that students who carry a full course load may be most likely to show associations between poor sleep quality and poor academic performance. If this finding is replicated, it may point to additional research concerning the relevance of overall demands on functioning to the relationship between sleep quality and academic performance.

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