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The Eight Hour Sleep Challenge During Final Exams Week

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Abstract

Many students and educators know that sleep is important to learning, yet there exists a gap between their knowledge and behavior. For example, fewer than 10% of students sleep 8 hr before final exams. In the context of two undergraduate courses on sleep ($N = 34$), students could earn extra credit if they averaged ≥8.0 hr of sleep during final exams week. Sleep/wake patterns were monitored objectively using actigraphy. The 24 students who opted in to the challenge averaged 8.5 hr of sleep ($n = 17$ succeeded). Short sleep (≤6.9 hr) occurred on only 11% of nights, significantly less than early-semester baseline (51%) and comparison group (65%) data. On the final exam, students who slept ≥8.0 hr performed better than students who opted out or slept ≤7.9 hr, even after controlling for prefinal grades. The 8-hr sleep challenge provides proof of principle that many students can maintain optimal sleep while studying, without sacrificing test performance.

Keywords

sleep education, final examinations, examination stress, incentive, motivation, actigraphy, intention–behavior gap, behavior change, implementation gap

Poor sleep has been labeled a "global health epidemic" (Stranges, Tigbe, Gómez-Olivé, Thorogood, & Kandala, 2012). Professional sleep societies recommend that adults sleep 7–9 hr each night and that teenagers sleep 8–10 hr each night (e.g., Hirshkowitz et al., 2015). However, many high school and college students regularly sleep less than the recommended minimum (Bryant, & Gómez, 2015; Taylor & Bramoweth, 2010). For example, when 1,125 university students completed the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), 60% of the college students were classified as poor-quality sleepers (Lund, Reider, Whiting, & Prichard, 2010).

Poor sleep is particularly common when students are studying for exams (Ahrberg, Dresler, Niedermaier, Steiger, & Genzel, 2012). The combination of cramming for tests, increased stress, bright light exposure, and excessive caffeine/stimulant use leads to variable sleep durations and "all-nighters" (Thacher, 2008). During final exams week, students self-report less nighttime sleep (but slightly more daytime napping) than during less stressful periods of the semester (e.g., Pilcher, Ginter, & Sadowsky, 1997; Zunhammer, Eichhammer, & Busch, 2014). Few studies have objectively monitored sleep during final exams week by using wristband actigraphy (accelerometer-based technology, i.e., similar to, but more accurate than, commercial devices such as Fitbit; Meltzer, Hiruma, Avis, Montgomery-Downs, & Valentin, 2015). Actigraphy monitoring is necessary because individuals tend to self-report sleeping longer than they actually did; for example, individuals will self-report total time in bed without subtracting time to fall asleep and time awake in the middle of the night (King, Daunis, Tami, & Scullin, 2017). Actigraphy monitoring during finals week revealed that students in secondary school ($M_{\text{Age}} = 17.63$) averaged 6.38 hr of sleep and students in college ($M_{\text{Age}} = 20.57$) averaged 6.36 hr of sleep (Astill, Verhoeven, Vijzelaar, & van Someren, 2013; King et al., 2017). Almost no students (0–7%) maintained the 8-hr optimal sleep duration (Walker, 2017). Therefore, some researchers refer to final exam periods as a model setting for studying insomnia (Zunhammer et al., 2014).

Restricting sleep has broad implications for health and performance (Kryger, Roth, & Dement, 2017). Shortened sleep increases susceptibility to the common cold, risk of automobile accidents, and incidence of depression (Bryant & Gómez, 2015). Furthermore, when students restrict sleep, they have difficulty sustaining attention and do not efficiently encode or retain/consolidate memories (Rasch & Born, 2013). Mild sleep restriction is cumulative: Reducing sleep by 1 hr/night for 1 week impairs cognitive performance to a similar level as one night of total sleep deprivation (Banks & Dinges, 2007). Such laboratory findings may translate to academic outcomes. Earlier class start times are associated with poorer

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course performance (e.g., Carrell, Maghakian, & West, 2011) and self-reported short- and poor-quality sleep are correlated with lower academic achievement (e.g., Curcio, Ferrara, & De Gennaro, 2006).

In addition to treating students who have clinical sleep disorders (e.g., cognitive–behavioral therapy for insomnia, positive airway pressure, medications), an increasingly common approach in high school and university settings is to educate students about the detrimental effects of sleep loss (e.g., Gruber, 2017; Levenson et al., 2016; Wing et al., 2015). Sleep education programs are generally successful at increasing students' *knowledge* of sleep. They do not, however, always change student's sleep *behaviors* (e.g., total sleep time; for review, see Blunden & Rigney, 2015). Consider, for example, Wing et al.'s randomized controlled trial in 14 secondary schools that consisted of 3,713 students. The sleep education program was extensive in including seminars, small workshops, brochures, a website, and competitions to create the best sleep awareness slogan. Sleep education activities involved the students, teachers, and parents. Wing et al. reported that despite improving students' sleep knowledge, the students reported no change in bedtime or waketime and *less* total sleep time 1 month later. Thus, educating students about sleep is insufficient to motivate them to change their behaviors (as predicted by theories of intentions and behavior and referred to by various names including the "knowledge–behavior gap," "intention–behavior gap," "implementation gap," and "quality chasm"; Ajzen, 1985; Gallasch & Gradisar, 2007; Parthasarathy et al., 2016; Silverman, Jarvis, Jessel, & Lopez, 2016). The current work considers a motivational solution: If given the opportunity to earn extra credit, would college students sleep 8 hr/night during finals week?

Table 1. Ten Tips for How Students Can Improve Sleep Duration and Quality.

1. Only use the bed for sleep rather than for studying or entertainment (to associate the bed with sleeping rather than with alertness; Bootzin, Epstein, & Wood, 1991)
2. Go to bed and wake up at the same time everyday, even on weekends (variability in sleep timing alters circadian rhythms; Phillips et al., 2017)
3. Avoid electronics near bedtime (blue light suppresses melatonin production and REM sleep; Chang, Aeschbach, Duffy, & Czeisler, 2015)
4. Avoid caffeine and other stimulants at least 6 hr before bedtime (caffeine use delays sleep and can decrease slow wave sleep; Drake, Roehrs, Shambroom, & Roth, 2013)
5. Maximize fiber and minimize saturated fats at dinner (high fat/low fiber dinners may decrease slow wave sleep; St-Onge, Roberts, Shechter, & Choudhury, 2016)
6. If you cannot fall asleep in 10-20 min, then get up and leave the room. Only try again when you feel sleepy (avoids associating the bed with not being able to sleep; Bootzin et al., 1991)
7. Avoid long daytime naps (long naps can make falling asleep at night more difficult; Bootzin et al., 1991)
8. Engage in aerobic exercise in the morning or afternoon (moderate intensity aerobic exercise improves sleep quality; Kline et al., 2011)
9. If you are ruminating at bedtime, then write out your to-do list or worries (writing decreases sleep onset latency; Scullin, Krueger, Ballard, Pruett, & Bliwise, 2018)
10. Prioritize sleep and manage time better during the day, for example, by staying on campus after class to complete homework (if incentivized, students can sleep 8 hr, even before final exams; Studies 1 and 2)

Study 1

Students were offered an extra point incentive for averaging $\geq$8.0 hr of sleep, with "the catch" of a points penalty disincentive for averaging $\leq$6.9 hr of sleep. Students' sleep durations during finals week were compared with recently published data from the same university (King et al., 2017). In the comparison data set, we used actigraphy to monitor undergraduate students' sleep but did not provide any incentives to change their sleep habits.

Method

Participants

Eighteen students (78% female) enrolled in an upper-level course on sleep in fall 2016. The course was cross-listed for psychology and neuroscience majors. Similar to Lund, Reider, Whiting, and Prichard's (2010) study of over 1,000 college students, the fall 2016 class was composed of generally poor sleepers, as demonstrated by their poor global scores on the Pittsburgh Sleep Quality Index at the beginning of the semester ($M = 6.72$, standard deviation [SD] $= 2.44$; Buysse et al., 1989; note that higher scores represent worse sleep quality). One reason the enrolled students' sleep was poor was their consistently short sleep durations: The group reported an average of 6.49 hr of sleep ($SD = 0.83$) over the preceding month (approximately 30 min less than the mean duration observed in Lund et al.'s, 2010, study).

Course Content

The class met on Mondays and Wednesdays for 75 min for lecture and journal article discussion on major topics in sleep research and sleep medicine. Topics included the history of sleep research, sleep across cultures, sleep in nonhuman animals, sleep measurement, circadian rhythms, neurobiology of sleep/wake regulation, sleep changes across the life span, the psychological and biological impact of sleep deprivation, sleep-related memory consolidation, sleep disturbances in psychiatric and neurological disorders, theories of dreaming, and sleep disorders. Empirically guided recommendations for improving sleep were interweaved throughout the course, including the 10 sleep tips listed in Table 1. Class discussions also included how students might manage time better during the day to allow for more time to sleep at night.

Table 2. Study 1: Actigraphy-Defined Sleep/Wake Patterns in Students Taking the 8-hr Sleep Challenge During Final Exams Week.

	Total Sleep Time (hours)	Bedtime	Wake Time	Sleep Efficiency (%)	WASO (Minutes)
Student 1	8.60	11:28 p.m.	10:21 a.m.	78.99	48.40
Student 2	9.02	10:57 p.m.	10:16 a.m.	81.60	31.80
Student 3	8.48	10:28 p.m.	8:31 a.m.	84.53	34.83
Student 4	10.46[a]	10:32 p.m.	10:49 a.m.	88.13	58.75
Student 5	8.68	12:00 a.m.	9:31 a.m.	91.21	17.50
Student 6	9.50	7:39 p.m.	7:10 a.m.	85.63	35.60
Student 7	8.93	12:19 a.m.	10:10 a.m.	90.69	30.75
Student 8	9.72	11:22 p.m.	10:13 a.m.	90.37	32.85
Average	9.17	10:50 p.m.	9:37 a.m.	86.39	36.31

Note. WASO is amount of wake time after sleep onset. Sleep efficiency is percentage of time in bed in which person is actually asleep.
[a]Elevated mean was due to one outlier day (after removal, $M = 9.38$).

Instructions for the 8-hr Challenge

Following the final day of class, students were issued the following extra credit opportunity via e-mail:

> If you accept the challenge, you will wear an actigraphy monitor from this Wednesday (office hours) until the Monday exam. If the actigraphy data show that you averaged 8 hours of nighttime sleep (excluding daytime naps) without any nights of less than 7 hours of sleep, then you will win 8 extra points on your final exam. But there's a catch. If the actigraphy data show that you averaged fewer than 7 hours then you will lose 6 points on your final exam. Averaging between 7 and 8 hours will have no impact on your grade. Consider the risks and rewards, and if you decide to accept the challenge email me to reserve an actiwatch.

The reward for 8 hr of sleep was introduced to motivate positive sleep behaviors (cf. Ajzen, 1985). The penalty for short sleep was introduced to discourage "yo-yo" sleeping, or cycles of short—rebound—short sleep, which are detrimental to circadian rhythms, immune function, and cognitive functioning (King et al., 2017; Okun et al., 2011; Phillips et al., 2017). The extra credit opportunity was worth 1.2% of the overall grade, which approximates the definition of an extra credit "microincentive" (e.g., Sundstrom, Hardin, & Shaffer, 2016).

Eight students opted in to the challenge, which lasted five nights (Wednesday–Monday). The students wore the Actiwatch Spectrum Plus actigraphy device (Phillips Respironics—Actiwatch 2). Data were collected in 15-s epochs and we instituted a medium threshold sensitivity for sleep/wake detection (i.e., similar to our comparison data set in which sleep duration was not incentivized; King et al., 2017).

Comparison Group

Sleep in the 8-hr challenge students was compared to data from undergraduate students who were previously monitored via actigraphy at the same university (King et al., 2017). The comparison group was composed of females (61% upper classmen) in the interior design program. Sixteen of these students were monitored during their finals period (the 12 additional students who were monitored during other points of the semester were not included in the current article). In the comparison group, sleep was not incentivized (i.e., no extra credit was offered for sleeping 8 hr/night).

Statistical Analyses

We used t tests and χ^2 tests to compare total sleep duration in the 8-hr challenge students to the comparison group from King et al., 2017. α was set to .05. Cohen's d and φ were reported as effect size estimates.

Results and Brief Discussion

Mean Sleep Duration

When previously monitoring students' sleep during finals week (without providing incentives to maintain optimal sleep patterns), we observed that only 6% of students slept an average of 8 hr/night (King et al., 2017). If such poor sleep habits are not modifiable during finals week, then we would predict only one student to successfully complete the 8-hr sleep challenge. In contrast, all students taking the challenge showed a mean sleep duration greater than 8.0 hr (see Table 2), a significantly greater proportion than in the nonincentivized comparison group (King et al., 2017), $\chi^2(1) = 16.20$, $p < .001$, $\varphi = .91$ (Yates' correction). The incentive to sleep was so effective that the 8-hr sleep challenge group averaged 9.17 hr/night ($SD = 0.68$), 95% confidence interval (CI) = [8.53, 9.82], which was significantly longer than the 6.36 hr/night ($SD = 0.95$), 95% CI [5.90, 6.81] observed in the nonincentivized comparison group (King et al., 2017), $t(22) = 7.42$, $p < .001$, $d = 3.21$, 95% CI [1.93, 4.46].

Variability in Sleep Durations

One possibility was that students maintained excellent *average* sleep durations by restricting sleep (e.g., 5 hr) and then rebounding on sleep (e.g., 11 hr). Such internight sleep variability would counteract the purpose of the 8-hr sleep challenge by impairing health and performance (King et al., 2017; Okun et al., 2011; Phillips et al., 2017). Therefore, we analyzed how many nights students slept fewer than 7.0 hr, which is the minimum number of hours of sleep recommended for adults (e.g., Hirshkowitz et al., 2015). In the nonincentivized comparison group, all participants showed at least one night of short sleep, and short sleep accounted for 65.0% of total nights (King et al., 2017). In the 8-hr sleep challenge group, only one participant showed short sleep, and on only one night (2.5% of total nights), $\chi^2(1) = 45.20$, $p < .001$, $\varphi = .56$. Thus, an extra credit incentive greatly reduced nights of short sleep, at least in students willing to take the 8-hr challenge.

Study 2

The goal of Study 2 was to conceptually replicate Study 1's finding while addressing two shortcomings. First, in Study 1, sleep durations were compared to a group of different students thereby introducing the design weaknesses inherent to cross-sectional studies. In Study 2, students wore actigraphy for 5 days/nights at the beginning of the semester to serve as a baseline for the 8-hr sleep challenge during finals week. Because sleep quantity/quality tends to decline across the semester, the baseline data collection is probably a conservative estimate of how poorly each student would normally sleep during finals week (e.g., Hawkins & Shaw, 1992).

Second, the original 8-hr sleep challenge (Study 1) included a points penalty for averaging $\leq$6.9 hr of sleep, which likely discouraged some students from attempting the challenge. In Study 2, the points penalty was dropped, and a smaller incentive was included for students who improved on their baseline sleep duration by $\geq$20 min or sleep efficiency by $\geq$3%. The goal was to maximize the number of students to opt in to the challenge, providing incentives even for students who may not need 8 hr of sleep (e.g., DEC2 mutation; He et al., 2009).

Method

Participants

Sixteen students (81% female) enrolled in the fall 2017 upper-level sleep course for psychology and neuroscience majors. The course content was similar to that reported in Study 1. In the second week of the semester, students completed the Pittsburgh Sleep Quality Index (Buysse et al., 1989), and their scores showed that they were generally poor sleepers (M = 5.97, SD = 2.07). Despite receiving 3 months of education in the importance of sleep, as well as education on how to improve one's sleep (e.g., Table 1), the number of sleep difficulties reported on the Pittsburgh Sleep Quality Index was not significantly reduced by the 14th week of the semester, M = 5.31, SD = 2.05; $t(15) = 1.29$, $p = .22$, $d = 0.32$.

Baseline Sleep Data Collection

In Weeks 2 and 3 of the semester, students maintained a daily sleep diary (Carney et al., 2012) and wore wristband actigraphy from Wednesday to Monday. They used the sleep diary to complete a writing assignment and they were instructed that the actigraphy data would be used at a later point in the semester (no additional specifics were provided, but their group-averaged sleep data were used to construct questions for Tests 1 and 2, such as explaining why there is a difference between subjective and objective sleep durations).

Instructions for the 8-hr Challenge

At the end of the semester, the students were issued the following extra credit opportunity via e-mail:

> We are nearing the end of the semester and I challenge you to put into practice what you have learned about sleeping better. If you accept, you will wear an actigraphy monitor during final exam week (from Monday, December 4 to Saturday, December 9). If the actigraphy data show that you averaged 8 hours of nighttime sleep (excluding daytime naps) without any nights of less than 7 hours of sleep, then you will win 8 extra points on your final exam. There's no catch. As a smaller incentive, if you do not average 8 hours of sleep/night, but still improve on your early-semester average sleep duration by 20 minutes—or improve on your early-semester sleep efficiency by 3%—then you will win 2 extra points on your final exam.

The scheduling of the 8-hr challenge was constrained by alterations in the final exam scheduling for fall 2017: The sleep course's final exam was on the first day of exams (Thursday) and several students finished all their exams by Saturday. Therefore, the 8-hr sleep challenge in fall 2017 included the nights before two "study" days in which there were no final exams scheduled (Tuesday, Wednesday) and the nights before three final exam days (Thursday, Friday, and Saturday).

Statistical Analyses

Actigraphy data were collected and analyzed in the same manner as in Study 1. During baseline sleep data collection, there was a battery error in some participants ($n = 5$) that caused only four nights to be recorded. Data were recorded for all nights during the finals-week 8-hr sleep challenge. For paired t tests, Cohen's d effect sizes were computed using the original SDs rather than the t-test value.

Results and Discussion

Percentage of Students to Opt In to the Sleep Challenge

In Study 1, only 44% of students (8 of 18) opted in to the sleep challenge, perhaps because the sleep challenge specified a penalty for poor sleep (averaging <7 hr/night). In Study 2, the points penalty was dropped, and a smaller incentive was introduced for students who improved on their baseline sleep duration. Relative to Study 1, the change in incentives/penalties appeared to encourage more students to opt in to the 8-hr sleep challenge (100%; 16 of 16 students), $\chi^2(1) = 10.06$, $p = .002$, $\varphi = .61$ (Yates's correction).

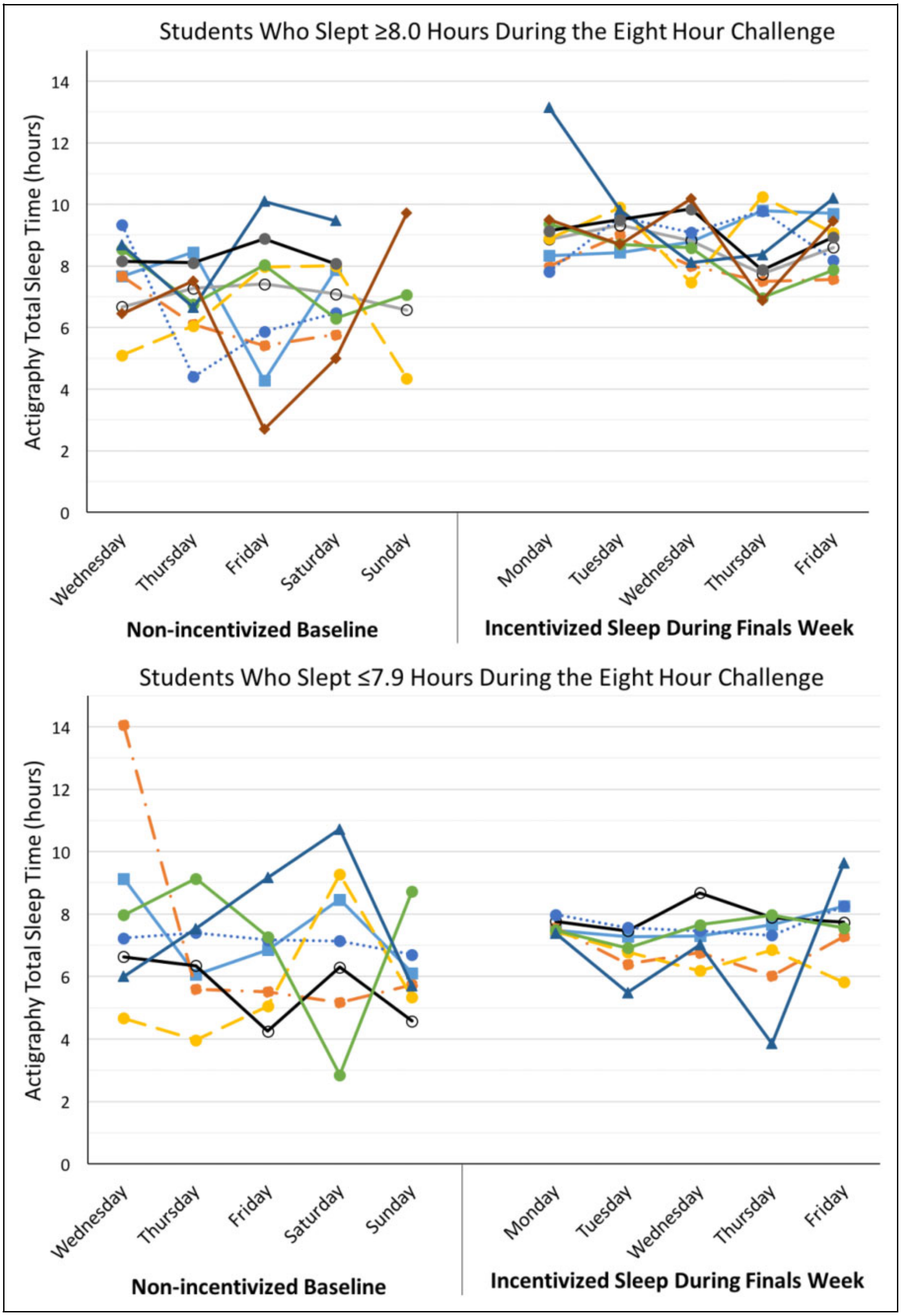

Figure 1. Study 2 sleep durations across nonincentivized baseline days and incentivized (8-hr challenge) finals week days. Graphs display students who averaged ≥8.0 hr (top) and ≤7.9 hr (bottom) during finals week. Missing data on Sunday reflect battery failures ($n = 5$).

Mean Sleep Duration

Figure 1 displays sleep durations across all days and students. At the beginning of the semester (baseline), the class averaged 6.98 hr of sleep ($SD = 0.86$), 95% CI [6.52, 7.44]. During the finals-week 8-hr sleep challenge, the class significantly improved their average sleep durations to 8.17 hr ($SD = 0.98$), 95% CI [7.65, 8.70], $t(15) = 4.25$, $p < .001$, $d = 1.29$, 95% CI [0.40, 2.15]. Sleep durations were similar on nights preceding “study” days ($M = 8.34$, $SD = 1.26$) and final exam days, $M = 8.06$, $SD = 0.92$; $t(15) = 1.32$, $p = .21$, $d = 0.25$.

Finals-week sleep durations were modestly, and not significantly, associated with baseline sleep durations, $r(14) = .27$,

p = .32, or with Pittsburgh Sleep Quality Index scores from Week 2, $r(14) = -.01$, p = .98, and Week 14, $r(14) = -.23$, p = .40. Furthermore, on an individual level, 87.5% of students (14 of 16) improved on their baseline sleep duration, with four students improving by over 2 hr/night. Thus, regardless of students' baseline sleep quantity/quality, the extra credit incentive encouraged longer sleep durations.

Variability in Sleep Durations

Consistent with Study 1, we analyzed how many nights students slept fewer than 7.0 hr, which is the minimum number of hours of sleep recommended for adults (Hirshkowitz et al., 2015). When students were not incentivized to sleep well (baseline), short sleep occurred every other night (50.7% of total nights). Figure 1 illustrates that the frequency of short sleep nights was significantly reduced when students completed the 8-hr sleep challenge during final exams week (15% of total nights), $\chi^2(1) = 22.54$, $p < .001$, $\varphi = .38$. During the nonincentivized baseline, nearly every student had at least one short sleep night (94%), but during the 8-hr sleep challenge, only some students showed one or more short sleep nights (38%), $\chi^2(1) = 11.22$, $p < .001$, $\varphi = .59$. In other words, sleep durations were not only longer, but more consistent.

Sleep Efficiency

Some individuals may show relatively normal sleep durations but may be burdened by low sleep efficiency (i.e., percentage of time in bed in which the individual is actually asleep). There was not a significant difference in sleep efficiency between the baseline week ($M = 84.40$, $SD = 5.38$) and the final-exams 8-hr sleep challenge week, $M = 84.16$, $SD = 6.00$; $t(15) = 0.13$, p = .90, $d = 0.04$. Thus, students can improve their sleep durations during finals week without sacrificing sleep efficiency.

Study 3

Many students perceive that sleeping more during finals week could negatively affect final exam performance (Lund et al., 2010). The logic here is that increasing time for sleep will decrease the total number of hours available for studying. Alternatively, time can be better managed during the day, and better sleep may increase next day work productivity/efficiency (Budnick & Barber, 2015). Furthermore, in laboratory experiments, sleep restriction causes poorer vigilance and decreased retention/consolidation of word lists (including vocabulary; Banks & Dinges, 2007; Rasch & Born, 2013). Because sleep deprivation strongly affects the prefrontal cortex (e.g., Scullin, 2017), poor sleep can also impair higher order reasoning and creative thinking abilities (e.g., Gao, Terlizzese, & Scullin, 2018). Therefore, one might predict poorer sleep during finals week to relate to poorer performance on the essay- and short-answer-based tests used in Studies 1 and 2. Nevertheless, it is empirically unknown whether sleeping 8 or more hours during finals week helps, hinders, or has no impact on final exam performance.

Method

Participants

The students were those from Studies 1 and 2 ($N = 34$). Students who successfully averaged $\geq$8.0 hr of sleep ($n = 17$, 82.4% female) were compared to students who opted out of the sleep challenge or who averaged $\leq$7.9 hr of sleep ($n = 17$, 76.5% female).

Class Assignments

In Study 1, student grades were determined by writing assignments, class participation, an outreach project, a midterm exam, and a final exam. In Study 2, student grades also incorporated weekly quizzes and two tests (rather than only a midterm exam). In each course, the final exam was cumulative, lasted 90–120 min, and constituted 15% of the course's grade. In Study 1, the final exam contained nine essay questions, whereas in Study 2, the final exam contained 50 short-answer questions. The tests were graded according to a rubric and masked to student identity.

Statistical Analyses

Final exam and prefinal grades were transformed to z-scores for each course separately. To compare final exam performance across individuals who succeeded in the 8-hr sleep challenge versus those who did not (opted out, slept $\leq$7.9 hr), we conducted t tests and analyses of covariance, the latter controlling for prefinal exam performance and gender. Covarying prefinal exam scores helps to reduce the impact of selection biases and covarying gender minimizes concerns over gender differences in sleep (Gao et al., 2018; Smarr, 2015).

Results and Discussion

Prefinal Exam Grades

Figure 2 shows that prefinal exam z-scores were nominally higher in students who averaged $\geq$8.0 hr of sleep during finals week ($M = 0.31$, $SD = 1.03$) than in students who opted out of the challenge or averaged $\leq$7.9 of sleep during finals week ($M = -0.31$, $SD = 0.85$), $t(32) = 1.93$, p = .06, $d = 0.66$, 95% CI [−.03, 1.35].

Final Exam Grades

Final exam performance is presented in Figure 2, without the extra credit points from completing the challenge. Students who succeeded in the 8-hr sleep challenge ($M = 0.50$, $SD = 0.82$) significantly outperformed the students who did not succeed/opted out ($M = -0.50$, $SD = 0.90$), $t(32) = 3.37$, p = .002, $d = 1.16$, 95% CI [0.42, 1.88]. Importantly, the group difference remained significant after controlling for prefinal

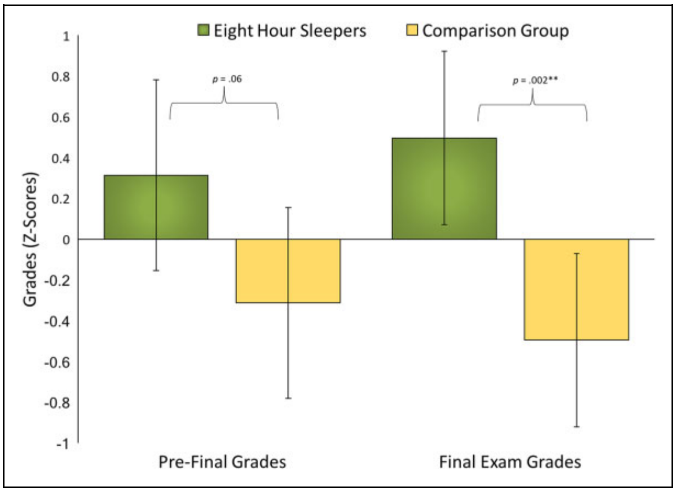

Figure 2. Prefinal and final exam performance across students who successfully completed the 8-hr challenge (i.e., averaged ≥8.0 hr during finals week) relative to a comparison group (i.e., students who opted out or averaged ≤7.9 hr of sleep). Error bars reflect 95% confidence intervals.

exam *z*-scores, $F(1, 31) = 6.62$, $p = .02$, $\eta_p^2 = .18$ (the corrected *z*-score group difference was 0.65 *SD*s). Furthermore, when controlling for both prefinal exam *z*-scores and gender (Smarr, 2015), the students who succeeded in the 8-hr sleep challenge still showed significantly higher final exam scores than students who did not succeed/opted out, $F(1, 30) = 7.62$, $p = .01$, $\eta_p^2 = .20$. Thus, averaging 8 hr of sleep during final exams week may help—not hinder—final exam performance.

General Discussion

Student sleep habits are (nearly) universally poor while studying for final exams (Astill et al., 2013; Zunhammer et al., 2014). Therefore, it is encouraging that 71% of students who opted in to the 8-hr sleep challenge were able to average 8 hr of sleep, which is considered to be an optimal duration for college students (Walker, 2017). Surprisingly, in the quest to sleep 8 hr/night, several students averaged more than 9 hr/night. Averaging 9 hr of sleep may reflect recovery sleep (e.g., from weeks of sleep restriction) or that some college students intrinsically need more than 8 hr per night. Importantly, during the 8-hr sleep challenge, the minimum sleep duration rarely dropped below the 7-hr recommended minimum (10.8% of nights across studies). Collectively, these positive results are salient in light of the modest outcomes of intervention studies that educate students on the consequences of sleep deprivation without incentivizing behavioral change (Blunden & Rigney, 2015; Silverman et al., 2016). The current work highlights that an extra credit incentive may be necessary to close the intention–behavior gap for healthy sleep in students (Gallasch & Gradisar, 2007).

A secondary question was whether maintaining 8 hr of sleep while studying for final exams would be positively or negatively associated with final exam performance. Many students perceive that they must sacrifice sleep to study more, even though "cramming" is recognized to be a poor study strategy (Hartwig & Dunlosky, 2012). By contrast, laboratory studies have shown that sleep restriction impairs higher order cognitive functioning, sustained attention, and memory consolidation (Banks & Dinges, 2007; King et al., 2017; Rasch & Born, 2013). In the present work, students who slept ≥8.0 hr during finals week outperformed students who did not succeed/opted out by 1 *SD* (0.65 *SD*s after correcting for prefinal grades). In practical terms, succeeding on the 8-hr sleep challenge was associated with the equivalent of a 4.9 (corrected) to 7.6 (uncorrected) point boost on the final exam. Although selection biases likely impact these estimates, it is worth noting that one student who had a D+ grade before the final exam, but slept ≥8 hr during finals week, remarked that it was the "first time my brain worked while taking an exam."

There are limitations to the current work. First, we did not collect sleep data in the 10 students who opted out of the 8-hr sleep challenge but assumed that they averaged fewer than 8 hr of sleep/night (Astill et al., 2013; King et al., 2017). Second, even though sleeping more than 9 hr/night is appropriate in adolescents (Hirshkowitz et al., 2015), extending sleep too long is associated with negative outcomes (evidenced primarily by correlational studies in older adults, for review, see Kryger et al., 2017). Third, the sample size was small because these were upper-level courses and actigraphy devices are expensive. It is reassuring, however, that the major findings replicated across Studies 1 and 2 and that the effect sizes were large relative to baseline sleep durations and a comparison data set (King et al., 2017). Future studies might increase their sample size by using commercial accelerometer devices (e.g., Fitbit) that are approximately ⅒th the expense of actigraphy devices, but instructors should be aware that such devices are less accurate at discriminating sleep/wake state; for example, the Fitbit Ultra overestimates sleep by 41 min in "normal" mode and underestimates sleep by 105 min in "sensitive" mode (Meltzer et al., 2015).

Conclusions and Future Directions

The crux of the 8-hr sleep challenge was to motivate students to work efficiently during the day so as to sleep better at night, thereby promoting better work efficiency the following day (Budnick & Barber, 2015). The results of the 8-hr sleep challenge provide proof of principle that students can sleep 8 hr/night during the final exam period, or at least avoid nights of short sleep (<7 hr). Furthermore, students can sleep well without sacrificing final exam performance (potentially even improving final exam performance).

There are at least two important directions for future research on increasing sleep in students. First, several studies have documented that final examinations result in altered functioning of immune, cardiovascular, endocrine, pulmonary, and metabolic systems (Liu et al., 2002; Loft et al., 2007; Marucha, Kiecolt-Glaser, & Favagehi, 1998; Scrimshaw, Habicht, Piché, Cholakos, & Arroyave, 1966). Poor sleep is known to impair functioning of each of these systems (Kryger et al., 2017), raising the empirical question of whether improving sleep during finals week will broadly improve health outcomes. Second, teachers and researchers need to determine what preexisting knowledge and social support is required for students to change their sleep behaviors (e.g., education on sleep and time management, support by peers, parents, and communities; Blunden & Rigney, 2015). Doing so will inform at what age the 8-hr sleep challenge incentive can be effective. By training students in their first year of college, if not earlier, that they can sleep well during finals week without sacrificing performance, we may help to resolve the "global sleep epidemic" that plagues students in America and abroad.

Author's Note

This article is dedicated to the memory of Dr. Charles L. Brewer, a legendary teacher. He served as the Editor of Teaching of Psychology from 1985 to 1996, and he inspired thousands of students across five decades of teaching (Furman University Tribute: https://youtu.be/o7WusIhoits).

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