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RESEARCH REPORT

Lost Sleep and Cyberloafing: Evidence From the Laboratory and a Daylight Saving Time Quasi-Experiment

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The Internet is a powerful tool that has changed the way people work. However, the ubiquity of the Internet has led to a new workplace threat to productivity—cyberloafing. Building on the ego depletion model of self-regulation, we examine how lost and low-quality sleep influence employee cyberloafing behaviors and how individual differences in conscientiousness moderate these effects. We also demonstrate that the shift to Daylight Saving Time (DST) results in a dramatic increase in cyberloafing behavior at the national level. We first tested the DST–cyberloafing relation through a national quasi-experiment, then directly tested the relation between sleep and cyberloafing in a closely controlled laboratory setting. We discuss the implications of our findings for theory, practice, and future research.

Keywords: cyberloafing, sleep, Daylight Saving Time (DST), self-regulation, conscientiousness

Cyberloafing is a specific form of loafing behavior in which employees spend work hours and company internet access to check personal e-mails or visit websites not related to their work (V. K. G. Lim, 2002). Many forms of loafing—such as taking long lunches, socializing with coworkers, or making personal phone calls—are easily identified as such (“Getting the Goods on Time Thieves,” 1983), but the nature of Internet usage makes cyberloafing much more difficult for coworkers to discern by observation. Workers can now maintain the guise of being hard at work in the real world, while travelling through cyberspace visiting non-work-related websites for personal interests and purposes. Unlike other

forms of loafing, cyberloafing does not require one to be physically absent from the office for long periods of time and, thus, is not as visible as other loafing behaviors. In fact, employees can spend substantial amounts of time engaged in personal pursuits without even leaving their desks. Not surprisingly, the costs of such behavior can have a significant impact on an organization. For instance, a study of employee web surfing in the United Kingdom pegged the cost to employers at some \$600 million dollars annually (Taylor, 2007).

Given the ease of engaging in this productivity-draining endeavor, cyberloafing can be viewed as a workplace temptation that requires employees to exercise self-regulation in order to stay on task. Viewed within this lens, the ego depletion model of self-regulation (Muraven & Baumeister, 2000) posits that the availability of self-regulatory resources should affect the likelihood of individuals to engage in cyberloafing. In particular, given that sleep is thought to restore self-regulatory resources (Parrott, Garnham, Wesnes, & Pincock, 1996), failing to get a good night’s sleep may render individuals more likely to cyberloaf. Moreover, an ego depletion framework suggests that those with higher typical or trait levels of self-regulatory resources (i.e., highly conscientiousness individuals) should demonstrate a weaker relation between lack of sleep and cyberloafing (Costa & McCrae, 1992).

In the present study we sought to test these predictions in two ways. First, using the shift to Daylight Saving Time (DST) as a proxy for sleep loss, we conducted a quasi-experiment by utilizing archival data on the aggregate Internet search behaviors of people in over 200 of the largest metropolitan areas in the United States. Specifically, we tested how the shift to DST leads to increased cyberloafing immediately after the change, later returning to normal levels after the sleep-depriving effects of the shift to DST have

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subsided. The second study more directly tested the influence of sleep on cyberloafing in a closely controlled laboratory setting and also examined conscientiousness as a moderator of this relation. In the sections below, we present theory and research on the ego depletion model of self-regulation, demonstrating how lost and low-quality sleep and the shift to DST are likely to affect cyberloafing behaviors. We then present and test hypotheses relating sleep with cyberloafing through two diverse studies. Finally, we discuss the implications of our findings for theory, practice, and future research.

Hypothesis Development

Ego Depletion Model of Self-Regulation

The ego depletion model of self-regulation posits that all acts of self-regulation draw upon a common pool of resources (Baumeister, Muraven, & Tice, 2000). This pool of resources is limited yet renewable and has been likened to a muscle: engaging in self-control causes short-term depletion of self-regulatory resources, much as exercising a muscle would result in short-term depletion of physical strength. Hence, after engaging in episodes of self-regulation or when concurrently engaging in multiple tasks that require self-regulation, the self-regulatory resource is drained, resulting in a state of diminished regulatory ability, or ego depletion (Muraven & Baumeister, 2000).

Meta-analytic evidence has indicated that support for this model can be observed across many different populations and many different paradigms (Hagger, Wood, Stiff, & Chatzisarantis, 2010). In sum, these studies indicate that, compared with those who are not required to exert self-control in an initial task, those who exert higher levels of self-control in one task are much more likely to demonstrate poorer self-control in a subsequent task (Baumeister, 1999). These failures of self-control can result in the inability to engage in desired behaviors, ranging from failing to suppress a triumphant smile or making a snide remark, to failing to be attentive at a boring meeting (Baumeister & Vohs, 2003). Similarly, a state of ego depletion makes it difficult to avoid engaging in impulsive or counterproductive behaviors that are ultimately not beneficial to the individual (Marcus & Schuler, 2004). In the present context, this suggests that a state of self-regulatory depletion may result in individuals engaging in cyberloafing behaviors. Cyberloafing represents a classic problem for self-regulation: the temptation to engage in pleasurable yet counterproductive behaviors that provide an immediate benefit but long-term cost to the individual. As such, individuals should be able to resist the temptation to engage in cyberloafing to the extent that an individual's self-regulatory resources have not been exhausted.

Sleep and Self-Regulation Failure

Because the activities that require the exertion of self-regulation are ubiquitous (Baumeister, 2003), it is inevitable that these resources will become depleted over time. Hence, it is useful to understand how self-regulatory resources can be replenished. In this respect, researchers have noted that "diets are broken most often and impulsive crimes are most frequently committed late in the evening, when people are tired," suggesting that sleep helps restore the self-regulatory resources that are depleted over the

course of a typical day (Baumeister et al., 2000, p. 131). Moreover, sleep physiology researchers have shown that sleep quantity and sleep quality exert independent effects on relevant outcomes, suggesting that both characteristics of sleep are likely to influence the extent to which self-regulatory resources can be replenished (Hursh et al., 2004).

Ghumman and Barnes (in press) explicitly argued that self-regulatory resources are recovered during sleep, finding that people are less able to suppress prejudices when low on sleep. In a more direct test of the recovery of self-regulatory resources during sleep, Parrott et al. (1996) asked a group of smokers to refrain from smoking and later engage in a distinct task that also required self-control. Consistent with self-regulatory research in other settings, compared with smokers not required to refrain from smoking, the smokers who were required to do so did worse on a subsequent vigilance task. Importantly, however, after these individuals were allowed to sleep, they actually showed higher levels of self-control on the subsequent task. These findings are consistent with the notions that sleep has restorative effects on one's self-regulatory resources and that a lack of sleep is associated with a smaller pool of regulatory resources (Barnes, Schaubroeck, Huth, & Ghumman, 2011; Christian & Ellis, 2011). A meta-analysis by J. Lim and Dinges (2010) summarized related research, finding that sleep plays a role in self-control, showing that lapses in simple attention are strongly related to sleep deprivation.

In addition to this behavior-based evidence, neurological research suggests the restorative effect of sleep on self-regulatory resources. The prefrontal cortex, which has proven critical for executive functioning and self-control (Kaplan & Berman, 2010; Nilsson et al., 2005), is quite vulnerable to a lack of sleep (Harrison & Horne, 2000), as indicated by a dramatic drop in cerebral metabolic rate in the prefrontal cortex during sleep deprivation (Schnyer, Zeithamova, & Williams, 2009). This suggests that an individual deprived of sleep will be less able to restore his or her self-regulatory resources, thereby leaving the prefrontal cortex less capable of performing its executive functions. The result is that sleep-deprived individuals are more likely to make impulsive decisions, similar to those they might make immediately after having been depleted by a situation demanding self-control (Baumeister, 1998), because they have not had sufficient rest to restore their regulatory resources.

In short, ego depletion research suggests that decisions throughout the day contribute to ego depletion, resulting in the need to replenish these resources, and thus "the opportunity to rest and recover seems crucial to the success of self-control" (Baumeister et al., 2000, p. 143). Therefore, it stands to reason that those who obtain inadequate or low-quality sleep are less likely to replenish their self-regulatory resources, making self-regulatory failure more likely among sleepy individuals (Baumeister, Heatherton, & Tice, 1994).

Switch to DST, Sleep, and Cyberloafing

Having discussed the contextual factors (e.g., inadequate and low-quality sleep) that might deplete self-regulatory resources, we now take a step back to examine societal influences that might affect sleep patterns. First, we note that humans follow a circadian rhythm, meaning that their activities follow a general pattern—eating, working, sleeping—across a 24-hr period. These circadian

rhythms generally match the 24-hr period dictated by clock time (Ancona & Chong, 1996). However, when a nation shifts to DST, the synchronization between circadian rhythms and clock time is disrupted, making it likely that individuals will experience reduced and disrupted sleep (Kantermann, Juda, Merrow, & Roenneberg, 2007). This disruption arises because many social interactions, including one's work shift, are dictated by clock time and must be completed at the corresponding time, even though the individual's endogenous circadian cycle might suggest that it is only time to wake up for the day. Indeed, sleep physiology research indicates that circadian rhythms are extremely resilient to exogenous influences (Czeisler et al., 1999), suggesting that individuals cannot immediately adjust following the shift to DST. In other words, this research would suggest that switching to DST should lead individuals to get less sleep because their bodies are not ready to sleep for the night, yet their work shift will begin at the mandated hour, regardless of the amount of sleep the employees have obtained.

In a direct test of the connection between the shift to DST and subsequent sleep, Barnes and Wagner (2009) found that on the *Monday* following the shift to DST, working Americans report having slept 40 min less the previous night than on comparison days. Thus, the effect of the time change spills over into the typical work week because humans are entrained to a 24-hr clock cycle (Czeisler et al., 1999), and changing the length of that cycle (i.e., shifting your watch by 1 hr) does not affect the circadian rhythm system that largely regulates sleep (Borbély & Achermann, 1999). Given the connection between lost or low-quality sleep and self-regulation, we expect the shift to DST, a proxy for sleep loss, to lead to reduced levels of self-regulatory ability immediately following the time change, owing to the decreased time available for sleep and replenishment of regulatory resources. This suggests that individuals should be less able to self-regulate their behavior, including refraining from cyberloafing. In other words, the depletion of self-regulatory resources following the switch to DST should result in higher levels of cyberloafing immediately following the switch compared with similar workdays.

Hypothesis 1: Following the switch to DST employees will cyberloaf more than on comparison work days.

Hypothesis 2: Employee time spent sleeping will be negatively related to subsequent time spent cyberloafing at work.

Hypothesis 3: Employee interrupted sleep will be positively related to subsequent time spent cyberloafing at work.

Individual Differences in Self-Regulation

As discussed above, we expect that the situational influence of reduced or low-quality sleep will lead to increased cyberloafing by rendering employees less able to self-regulate. Yet scholars have remarked that there are "substantial individual differences in the basic capacity for self-control" (Muraven & Baumeister, 2000, p. 248). That is, research shows that people differ in their ability to focus or regulate their behavior (Baumeister & Heatherton, 1996; Muraven, Baumeister, & Tice, 1999), and thus researchers have proposed individual differences in the ability to self-regulate. One individual difference implicated in self-regulatory processes is conscientiousness.

Conscientiousness represents an overarching personality trait indicated by facets such as self-discipline, deliberation, competence, order, dutifulness, and achievement striving (Costa & McCrae, 1992). Conscientiousness and its facets play important roles in self-regulatory processes (McCrae & Löckenhoff, 2010). For example, effective self-regulation involves setting, persisting toward, and ultimately achieving difficult goals (Bandura, 1997; Carver & Scheier, 1982); highly conscientious individuals have been shown to set more difficult goals (presumably reflecting achievement striving; Judge & Ilies, 2002), to be less likely to procrastinate when pursuing goals (presumably reflecting self-discipline and dutifulness; Steel, 2007), and to be more likely to employ time management and other effort regulation techniques (presumably representing self-discipline, deliberation, and order; Bidjerano & Dai, 2007).

Given its primary role in directing superior self-regulatory processes, conscientiousness has been suggested to ultimately represent an individual difference in the extent to which individuals possess self-regulatory resources (Tangney, Baumeister, & Boone, 2004). As McCrae and Löckenhoff (2010) noted, highly conscientious individuals routinely employ different self-control techniques (including ignoring distracting thoughts, maintaining orderly lifestyles, and adhering to schedules) that conserve regulatory resources that otherwise would be consumed by distractions and decisions. Consequently, this frees up regulatory resources for highly conscientious individuals to allocate to other life domains. Empirically, conscientiousness shows convergent validity with other measures of self-regulatory resources or abilities, with measures of conscientiousness or its facets loading on or correlating significantly with multiple distinct measures of self-regulatory resources (see McCrae & Löckenhoff, 2010).

As conscientiousness represents an individual difference in the extent to which one self-regulates, it stands to reason that if self-regulation impairment is at the heart of the relation between sleep and cyberloafing, individuals who possess greater abilities to self-regulate—that is, highly conscientious individuals—should be less affected by lost or interrupted sleep. As such, we expect that highly conscientious individuals will demonstrate a lower tendency to cyberloaf following interrupted or decreased sleep, compared with individuals lower in conscientiousness.

Hypothesis 4: Employees low in conscientiousness will demonstrate a stronger negative relation between sleep quantity and cyberloafing compared with those high in conscientiousness.

Hypothesis 5: Employees low in conscientiousness will demonstrate a stronger positive relation between interrupted sleep and cyberloafing compared with those high in conscientiousness.

Study 1

Method

Sample and procedure. Google.com specializes in Internet search activity; the company maintains a log of these searches, and data aggregated to the metropolitan level are available for public download (Google Insights for Search, 2010). Users can examine

search trends over various periods for specific metropolitan areas, with daily search data available when examining search volume over a period of 3 months or less. Google categorizes the search terms used in these searches, and these categories include descriptive titles such as “Entertainment.” Search terms included in the entertainment category include *YouTube*, *videos*, *music*, *ESPN*, and *Facebook*.

Because the intent of our study is to better understand antecedents of cyberloafing, we utilized the Entertainment category under the assumption that Facebook, YouTube, and ESPN are “non-job related Web sites” (V. K. G. Lim, 2002, p. 677), meaning that time spent on these websites constitutes cyberloafing. In order to illustrate how cyberloafing relates to DST—a proxy for lost sleep—we obtained the search volumes for the Monday following the switch to DST, and the Mondays immediately preceding and following this day for the years 2004 to 2009, consistent with other studies examining the impact of the shift to DST on various criteria (Coren, 1996; Holland & Hinze, 2000). This database was drawn from a larger set of data summarizing daily search volume conducted from February until the end of April for these same years for 203 metropolitan areas in the United States. Given that our data set was based upon 3 specific days in each of 203 metropolitan areas each year for 6 years, we had a potential for 3,654 total measurement points. For reasons unknown to us, data at the day level were not available for a small number of cases and, thus, our final sample size was 3,492 measurement points.

Measures.

Monday after DST. We created a dichotomous variable indicating whether the search activity occurred on the Monday immediately following the switch to DST. Each metropolitan area generally had one third of its cases marked as DST = “1.” However, two states do not participate in DST (Arizona and Hawaii) and, thus, all cases for these states were marked as DST = “0” on this variable (Indiana adopted DST in 2006 and was marked accordingly).

Cyberloafing. The relative percentage of Internet searches conducted in the Entertainment category on a given day represented cyberloafing. The data available from the Google database have all been “normalized,” meaning that the value for each day represents the search volume relative to all search volume over the time period downloaded for that particular metropolitan area (in our case, the 3 months from February through April). In this sense, all data in the sample effectively controlled for differences in metropolitan areas.

Metropolitan population. Population differences across U.S. metropolitan areas are nontrivial, thus we obtained population estimates from the 2000 U.S. census for use as a weighting variable in our analyses, allowing for a more accurate estimate of cyberloafing by the general population.

Analyses. Because data were nested within metropolitan areas, the cases were not independent. We therefore conducted our analyses within a hierarchical linear modeling (HLM) framework. The data were structured as a quasi-experiment, in which the Monday before DST provides a baseline level of cyberloafing, the shift to DST serves as the experimental manipulation, and the second Monday after DST serves as another reference day that should reflect a return to the baseline level of cyberloafing. Research indicates that during DST months, when there is extra evening light, people engage in more shopping and other activities

away from home and work (Downing, 2005). Likewise, with warmer spring weather people are more likely to spend time outdoors. Both of these points suggest that there is likely to be a linear trend in cyberloafing behaviors from February through April.¹ Therefore, we controlled for this linear trend when testing for differences in cyberloafing on the Monday before DST and the second Monday after DST. We then compared cyberloafing levels on the Monday immediately following the shift to DST to cyberloafing on the Monday before the shift to DST; finally, we compared cyberloafing levels on the Monday immediately following the shift to DST to cyberloafing levels the second Monday after the shift to DST, obtaining an estimate of national cyberloafing behavior in each of these comparisons by weighting cases by the population of the respective metropolitan areas.

Results

Initial examination of the data via HLM indicates a significant correlation between search volume and the Monday after DST ($r = .13, p < .01$), providing initial support for Hypothesis 1. The levels of cyberloafing on the comparison Mondays (i.e., the Monday before the shift to DST and the second Monday after the shift to DST) do not significantly differ from one another ($B = 0.97, ns$), after accounting for the linear trend, thus providing a baseline and return to baseline against which our focal day of interest can be compared. On the Monday following the switch to DST, Google users searched for over 3.1% more entertainment-related websites compared with the preceding Monday ($B = 3.11, \Delta R^2 = .01, p < .01$) and over 6.4% more compared with the subsequent Monday ($B = 6.41, \Delta R^2 = .03, p < .01$), relative to all searches conducted during the period (see Table 1). These results support Hypothesis 1.

The evidence from Study 1 indicates that DST leads to cyberloafing behaviors, yet one limitation of the study is that we cannot be certain that the searches were conducted in the workplace. However, research done on the distribution of Internet usage behavior at different hours and in different locations indicates that 60% of entertainment website traffic occurs in the workplace (Online Publishers Association, 2003), meaning that employees spend considerable work time cyberloafing. Furthermore, none of the Mondays in our study fell on a national holiday, meaning that Internet usage on these days probably occurred in the same locations as on other Mondays. On the basis of these findings, we

¹ Our data demonstrate a pattern consistent with this argument. Search behavior from February through April shows decreasing levels of cyberloafing as the year advances: from 1 February until the DST change cyberloafing is higher (2.9%; Time 1) than during the full week immediately following the shift to DST (0.6%; Time 2), and from 1 week after the shift to DST until the end of April (−0.2%; Time 3). In short, these findings demonstrate that people cyberloaf more during standard time as opposed to during DST, possibly because there is more sunlight during evening hours. Accordingly, we controlled for this trend when testing for differences in cyberloafing on the comparison Mondays (i.e., we coded responses as belonging to Time 1, 2, or 3). We also checked whether including this control influenced our primary analyses (see Table 1) and found that the results were not substantively different. Thus, we report our primary analyses without the time trend in order to make the results easier to interpret.

Table 1
Relative Level of Google Searches Conducted in
“Entertainment” Category on Monday Following Switch to
Daylight Saving Time (DST; Study 1)

	vs. Monday before DST		vs. second Monday after DST	
	<i>B</i>	<i>t</i> value	<i>B</i>	<i>t</i> value
Intercept	-6.73	-19.82*	-10.02	-21.58*
Hypothesis test				
Monday after DST	3.11	6.89*	6.41	12.74*
Δ Pseudo R^2		.01*		.03*

Note. Level 1 (day) $N = 3,492$; Level 2 (metro) $N = 203$. Unstandardized regression coefficients represent the percentage change in search volume on the day of interest, as compared with each respective referent day (Monday before DST and second Monday after DST); variables were weighted by population size of the respective metro area in order to provide an estimate of the search behavior of the entire U.S. population.

* $p < .01$.

assert that cyberloafing at work does occur and that the shift to DST is a plausible explanation for the increase in cyberloafing evident in our data.

Having provided support for the effect of DST on cyberloafing at the metropolitan level, we more directly tested the connection between sleep and cyberloafing through a closely controlled laboratory study examining various components of sleep, both quality and quantity, and individual differences that should moderate the hypothesized relations.

Study 2

Method

Sample and procedures. Ninety-six undergraduate students at a large public university participated in this study. Participants were enrolled in a management course and took part in the study for course credit. Forty-three percent of participants were men, and the average age was 22 years. The study consisted of two parts: Demographic and personality variables were collected at Time 1; 2 weeks later (Time 2) participants attended a lab study. One day before the study, each participant collected an Actigraph electronic sleep monitor (described below), which he or she wore the entire night prior to the lab session. On the day of the study, participants returned their monitors to a research assistant and then proceeded to the lab. Once in the lab, each of the 10 to 12 participants in each session was seated in a private cubicle with a computer and headphones.

At the start of the session, participants were briefed that they would be required to watch a 42-min video-recorded lecture on their computer monitor. They were told that the professor giving the lecture had applied for a job opening at the university. The researchers asked participants to provide feedback on the professor’s teaching effectiveness and rate his suitability for hire by the university. Participants were told to pay careful attention to the lecture because their feedback would play an important role in determining the professor’s suitability for hire. Unknown to the participants, each computer contained monitoring software that

recorded the amount of time each participant spent visiting websites rather than watching the video lecture. Following the lecture and completion of the survey, participants were debriefed and excused.

Measures.

Sleep duration and interrupted sleep. The Actigraph sleep monitor provided information on sleep duration and interruptions. The monitor measured how many minutes the participant was asleep during the night and the duration of sleep interruptions throughout the night. Several validation studies have confirmed the accuracy of Actigraph-measured sleep (e.g., de Souza et al., 2003; Jean-Louis et al., 1996; Sadeh, Sharkey, & Carskadon, 1994) for clinical and research use.

Cyberloafing. Monitoring software captured the amount of time participants spent on websites while the video lecture was being presented. The lab task required participants to focus on watching and critiquing the video, thus the number of minutes spent visiting websites instead of performing the task was classified as cyberloafing.

Conscientiousness. We measured conscientiousness using a 9-item scale (Benet-Martínez & John, 1998). A sample item is “I see myself as someone who makes plans and follows through with them” (*strongly disagree* = 1 to *strongly agree* = 5; $\alpha = .81$).

Controls. We included age, sex, and years completed at university as controls, given past research connecting them to time spent working (Rones, Ilg, & Gardner, 1997). We also controlled for a measure of lecture interestingness, rated by participants following the lecture (*1 = not interesting at all* to *5 = very interesting*), as this could be associated with intrinsic motivation for the task. The mean score for this item was 2.01, suggesting that participants found the video lecture rather boring. Previous studies have linked task boredom with cyberloafing (Prasad, Lim, & Chen, 2010), suggesting that this task presented a situation in which participants were required to effectively self-regulate.

Analyses. We centered independent variables before computing interaction terms and analyzed data via hierarchical ordinary least squares regression. Model 1 includes the control variables age, sex, years of study, and interestingness of the lecture. In Model 2 we added centered measures of sleep, interrupted sleep, and conscientiousness. Finally, in Model 3 we added the interaction between sleep and conscientiousness and between interrupted sleep and conscientiousness.

Results

Table 2 presents intercorrelations among independent, control, and dependent variables. The correlation table provides initial support for our hypotheses, as the objective measure of cyberloafing obtained during the lab session was related to both the amount of sleep obtained the prior night ($r = -.39, p < .01$) and the amount of interrupted sleep from the prior night ($r = .59, p < .01$). Results (see Table 3) indicate that the addition of sleep quantity ($B = -.05, p < .01$) and amount of interrupted sleep the previous night ($B = .14, p < .01$) explained a large amount of the variance in cyberloafing during the lab task ($\Delta R^2 = .50, p < .01$), providing support for Hypothesis 2 and Hypothesis 3, which state that time sleeping will be negatively related and interrupted sleep will be positively related to time spent cyberloafing, respectively.

Table 2
Correlations Among Study Variables (Study 2)

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
1. Age	21.66	1.64							
2. Sex	1.55	.50	-.51*						
3. Years of study	2.16	1.06	.73*	-.11					
4. Interestingness of lecture	2.01	.95	.04	-.04	.03				
5. Sleep	292.11	83.95	.08	-.07	.00	.05			
6. Interrupted sleep	72.63	39.44	.03	-.19	.01	.14	.06		
7. Conscientiousness	3.29	.55	.16	-.14	.14	.05	-.01	.01	
8. Cyberloafing	5.74	8.91	-.13	.01	-.03	.10	-.39*	.59*	-.02

Note. $N = 96$ university students. Sex coded as 1 = male, 2 = female. Education variable indicates the number of years of university education that the student has completed. Sleep and interrupted sleep are measured in minutes and were obtained during the night prior to the lab task.

* $p < .01$.

Hypothesis 4 stated that the relation between time sleeping and time cyberloafing will be more strongly negative for individuals low in conscientiousness, compared with those high in conscientiousness. Similarly, Hypothesis 5 stated that those low in conscientiousness are likely to have a stronger positive relation between interrupted sleep and cyberloafing than those high in conscientiousness. Model 3 tested these interaction effects and showed that the interaction between sleep quantity and conscientiousness does not significantly predict cyberloafing ($B = -.02$, ns), failing to provide support for Hypothesis 4. However, the interaction between interrupted sleep and conscientiousness was significant ($B = -.11$, $p < .01$), explaining an additional 7% of the variance in cyberloafing during the lab task ($\Delta R^2 = .07$, $p < .01$). A plot of the simple slopes (Aiken & West, 1991) indicates that conscientious participants experienced a positive relation between interrupted sleep and cyberloafing ($B = .08$, $p < .01$), and those low in conscientiousness were more than twice as affected by interrupted sleep ($B = .20$, $p < .01$), as shown in Figure 1. These findings provide support for Hypothesis 5.

From a practical perspective, these results suggest that for every minute the participant slept the night before the lab session, the participant engaged in .05 fewer minutes cyberloafing (or 3 fewer minutes cyberloafing per hour spent sleeping). For every minute of interrupted sleep the prior night, participants engaged in .14 minutes more cyberloafing (or 8.4 more minutes cyberloafing per hour of interrupted sleep) during the task. Given that the task was 42 minutes long, an hour of disturbed sleep would on average result in cyberloafing during 20% of the assigned task, and every hour of lost sleep would result in cyberloafing during an additional 7% of the task.

General Discussion

This article presents results of two studies that examine the impact of sleep loss and DST—a proxy for sleep loss—on cyberloafing. The quasi-experiment in Study 1 indicated that non-work-related Internet searches had considerably higher search volume on the Monday immediately following DST than on the comparison

Table 3
Time Spent Cyberloafing as a Function of Sleep and Interrupted Sleep the Previous Night (Study 2)

Predictor	Model 1		Model 2		Model 3	
	<i>B</i>	β	<i>B</i>	β	<i>B</i>	β
Intercept	48.31		21.34		28.84	
Controls						
Age	-2.04	-.37	-.85	-.16	-1.16	-.21
Sex	-2.84	-.16	.40	.02	.29	.02
Years of study	1.85	.22	.63	.08	.60	.07
Interestingness of lecture	1.03	.11	.47	.05	.20	.02
Sleep previous night			-.05	-.42*	-.04	-.37*
Interrupted sleep previous night			.14	.62*	.14	.61*
Conscientiousness			-.30	-.02	-.92	-.06
Conscientiousness \times Sleep					-.02	-.11
Conscientiousness \times Interrupted Sleep					-.11	-.25*
R^2		.05		.55		.62
ΔR^2		.05		.50*		.07*

Note. Unstandardized regression coefficients represent minutes change in cyberloafing for every unit increase in predictor.

* $p < .01$.

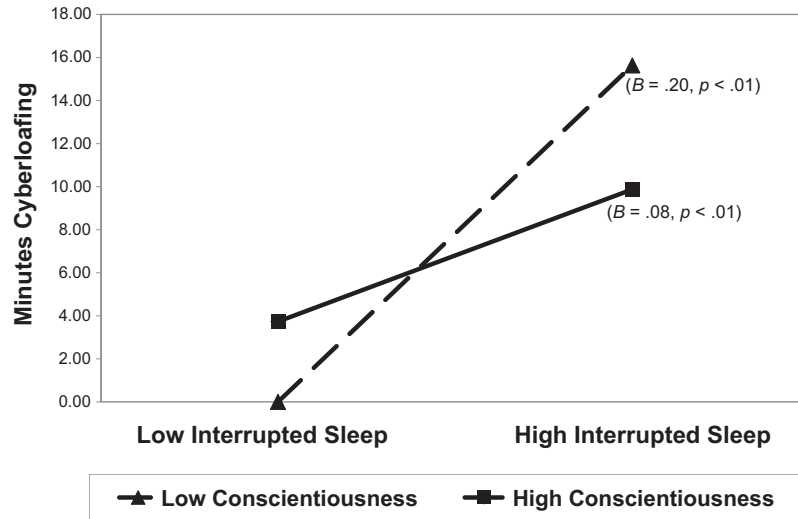


Figure 1. Time cyberloafing during laboratory task as a function of interrupted sleep and conscientiousness.

Mondays, suggesting that the shift to DST leads people to cyberloaf more than on comparison work days. Study 2, conducted in the laboratory, directly tested the connection between objectively measured sleep and cyberloafing. Findings indicate that half of participants' cyberloafing can be predicted by the sleep quality and quantity experienced the prior evening. Study 2 also showed that highly conscientious individuals were less likely to cyberloaf in response to low quality sleep than those low in conscientiousness, suggesting that sleep loss and the change to DST should be less problematic for conscientious workers.

To our knowledge, these are the first studies directly connecting sleep and the DST shift to cyberloafing. Given that one third of the nations around the world participate in some form of DST, our study has global implications that are particularly salient for a workforce increasingly performing knowledge-based work. We thus encourage policy makers and managers to consider the cost of employee sleep loss when making decisions for their nations and organizations.

Implications and Future Research

Our findings also hold implications for research and theory on self-regulation. This area has generally examined self-regulation as an individual phenomenon, influenced by personal decisions or physiological processes (Gailliot et al., 2007; Hagger et al., 2010). However, our findings extend the ego depletion model to include situations in which individuals' ability to self-regulate is not driven by proximal individual decisions or behaviors, but by an external factor over which they have no control: DST. Theoretically, this extension is important because it opens the door to different applications of the theory to the workplace. For instance, given that the practice of DST has a strong influence on employee self-regulation and cyberloafing, it may be worth considering other practices that might influence workers and their self-regulation. For instance, research suggests that travel across multiple time zones can also disrupt sleep patterns (e.g., Monk, Buysee, Billy, & DeGrazia, 2004) and, thus, could also be expected to influence self-regulatory processes. Similarly, shiftwork research (e.g.,

Czeisler, Moore-Ede, & Coleman, 1982) highlights another environmental factor that is likely to affect employee self-regulation.

Practical implications of this article point to an overlooked cost of lost sleep and DST—an increase in employee cyberloafing. Global productivity losses from a spike in employee cyberloafing are potentially staggering. More generally, when employees are low on sleep, they will engage in more workplace cyberloafing. In the push for high productivity, managers and organizations may cut into the sleep of employees by requiring longer work hours. This may promote vicious cycles of lost sleep, resulting in less time spent working, which could result in more frantic pushes for extended work time. Managers may find that by avoiding infringement on employee sleep, they will get more productivity out of their employees (Barnes, 2011).

Given the many ways to erode self-control (Hagger et al., 2010), employees are likely to be enticed to cyberloaf by many different types of websites (V. K. G. Lim & Teo, 2005). Perhaps one way to minimize the temptation to cyberloaf is to restrict access to certain websites—such as YouTube.com—while on company computers. Another option could be to arrange computer screens at angles where managers and other employees could observe cyberloafing, in order to enable supervisor or peer monitoring. Providing designated break times in which employees could cyberloaf would be another means of channeling cyberloafing to noncritical time periods.

Despite our arguments and evidence that self-regulatory depletion is the mechanism connecting sleep loss to cyberloafing, other mechanisms may also play a role. For instance, sleep influences negative mood and job satisfaction (e.g., Pilcher & Huffcutt, 1996; Scott & Judge, 2006), suggesting that sleepy employees may also cyberloaf because they lack intrinsic motivation. Also, given the association of sleep with mood and job satisfaction, our findings should also encourage researchers to test connections among DST, sleep, and outcomes such as unethical behavior (cf. Mead, Baumeister, Gino, Schweitzer, & Ariely, 2009), harassment, or employee conflict. We encourage researchers to further explicate mechanisms connecting sleep

loss and DST to cyberloafing behaviors and to expand the criterion domain in future studies.

In conclusion, we note that one of the principal motivations for implementing DST was to reduce energy consumption, but research findings on this point are mixed (Aries & Newsham, 2008). What is not mixed is the mounting evidence that sleepy employees do not a productive office make. Thus, we encourage policy makers to revisit the costs and benefits of implementing DST, and we encourage managers to consider how they can facilitate greater employee self-regulation by ensuring that employees get good sleep.

References

- Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage.
- Ancona, D. G., & Chong, C. L. (1996). Entrainment: Pace, cycle, and rhythm in organizational behavior. *Research in Organizational Behavior, 18*, 251–284.
- Aries, M. B. C., & Newsham, G. R. (2008). Effect of daylight saving time on lighting energy use: A literature review. *Energy Policy, 36*, 1858–1866. doi:10.1016/j.enpol.2007.05.021
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.
- Barnes, C. M. (2011). “I’ll sleep when I’m dead”: Managing those too busy to sleep. *Organizational Dynamics, 40*, 18–26. doi:10.1016/j.orgdyn.2010.10.001
- Barnes, C. M., Schaubroeck, J., Huth, M., & Ghumman, S. (2011). Lack of sleep and unethical conduct. *Organizational Behavior and Human Decision Processes, 115*, 169–180. doi:10.1016/j.obhdp.2011.01.009
- Barnes, C. M., & Wagner, D. T. (2009). Changing to daylight saving time cuts into sleep and increases workplace injuries. *Journal of Applied Psychology, 94*, 1305–1317. doi:10.1037/a0015320
- Baumeister, R. F. (1998). The self. In D. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *Handbook of social psychology* (4th ed., pp. 680–740). Boston, MA: McGraw-Hill.
- Baumeister, R. F. (1999). *The self in social psychology*. New York, NY: Psychology Press.
- Baumeister, R. F. (2003). Ego depletion and self-regulation failure: A resource model of self-control. *Alcoholism: Clinical and Experimental Research, 27*, 281–284. doi:10.1097/01.ALC.0000060879.61384.A4
- Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological Inquiry, 7*, 1–15. doi:10.1207/s15327965pli0701_1
- Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1994). *Losing control: How and why people fail at self-regulation*. San Diego, CA: Academic Press.
- Baumeister, R. F., Muraven, M., & Tice, D. M. (2000). Ego depletion: A resource model of volition, self-regulation, and controlled processing. *Social Cognition, 18*, 130–150. doi:10.1521/soco.2000.18.2.130
- Baumeister, R. F., & Vohs, K. D. (2003). Self-regulation and the executive function of the self. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of self and identity* (pp. 197–217). New York, NY: Guilford Press.
- Benet-Martínez, V., & John, O. P. (1998). Los cinco grandes across cultures and ethnic groups: Multitrait–multimethod analyses of the Big Five in Spanish and English. *Journal of Personality and Social Psychology, 75*, 729–750. doi:10.1037/0022-3514.75.3.729
- Bidjerano, T., & Dai, D. Y. (2007). The relationship between the big-five model of personality and self-regulated learning strategies. *Learning and Individual Differences, 17*, 69–81. doi:10.1016/j.lindif.2007.02.001
- Borbély, A. A., & Achermann, P. (1999). Sleep homeostasis and models of sleep regulation. *Journal of Biological Rhythms, 14*, 557–568.
- Carver, C. S., & Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality-social, clinical, and health psychology. *Psychological Bulletin, 92*, 111–135. doi:10.1037/0033-2909.92.1.111
- Christian, M. S., & Ellis, A. P. J. (2011). Examining the effects of sleep deprivation on workplace deviance: A self-regulatory perspective. *Academy of Management Journal, 54*, 913–934. doi:10.5465/amj.2010.0179
- Coren, S. (1996). Daylight savings time and traffic accidents. *New England Journal of Medicine, 334*, 924–925. doi:10.1056/NEJM19960403341416
- Costa, P. T., & McCrae, R. M. (1992). *Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI)*. Odessa, FL: Psychological Assessment Resources.
- Czeisler, C. A., Duffy, J. F., Shanahan, T. L., Brown, E. N., Mitchell, J. F., Rimmer, D. W., . . . Kronauer, R. E. (1999, June). Stability, precision, and near-24-hour period of the human circadian pacemaker. *Science, 284*, 2177–2181. doi:10.1126/science.284.5423.2177
- Czeisler, C. A., Moore-Ede, M. C., & Coleman, R. M. (1982, July). Rotating shift work schedules that disrupt sleep are improved by applying circadian principles. *Science, 217*, 460–463. doi:10.1126/science.7089576
- de Souza, L., Benedito-Silva, A. A., Pires, M. L. N., Poyares, D., Tufik, S., & Calil, H. M. (2003). Further validation of actigraphy for sleep studies. *Sleep, 26*, 81–85.
- Downing, M. (2005). *Spring forward: The annual madness of daylight saving time*. Berkeley, CA: Counterpoint.
- Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., . . . Schmeichel, B. J. (2007). Self-control relies on glucose as a limited energy source: Willpower is more than a metaphor. *Journal of Personality and Social Psychology, 92*, 325–336. doi:10.1037/0022-3514.92.2.325
- Getting the goods on time thieves. (1983, March 22). *ABA Banking Journal*, p. 22.
- Ghumman, S., & Barnes, C. M. (in press). Sleep and prejudice: A resource recovery approach. *Journal of Experimental Social Psychology*.
- Google insights for search. Retrieved February 2010 to May 2010, from <http://www.google.com/insights/search/#>
- Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin, 136*, 495–525. doi:10.1037/a0019486
- Harrison, Y., & Horne, J. A. (2000). The impact of sleep deprivation on decision making: A review. *Journal of Experimental Psychology: Applied, 6*, 236–249. doi:10.1037/1076-898X.6.3.236
- Holland, N., & Hinze, J. (2000). Daylight savings time changes and construction accidents. *Journal of Construction Engineering and Management, 126*, 404–406. doi:10.1061/(ASCE)0733-9364(2000)126:5(404)
- Hursh, S. R., Redmond, D. P., Johnson, M. L., Thorne, D. R., Belenky, G., Balkin, T. J., . . . Eddy, D. C. (2004). Fatigue models for applied research in warfighting. *Aviation, Space, and Environmental Medicine, 75*, A44–A53.
- Jean-Louis, G., vonGizycki, H., Zizi, F., Fookson, J., Spielman, A., Nunes, J., . . . Taub, H. (1996). Determination of sleep and wakefulness with the actigraph data analysis software (ADAS). *Sleep, 19*, 739–743.
- Judge, T. A., & Ilies, R. (2002). Relationship of personality to performance motivation: A meta-analytic review. *Journal of Applied Psychology, 87*, 797–807. doi:10.1037/0021-9010.87.4.797
- Kantermann, T., Juda, M., Merrow, M., & Roenneberg, T. (2007). The human circadian clock’s seasonal adjustment is disrupted by daylight saving time. *Current Biology, 17*, 1996–2000. doi:10.1016/j.cub.2007.10.025
- Kaplan, S., & Berman, M. G. (2010). Directed attention as a common resource for executive functioning and self-regulation. *Perspectives on Psychological Science, 5*, 43–57. doi:10.1177/1745691609356784
- Lim, J., & Dinges, D. F. (2010). A meta-analysis of the impact of short-term sleep deprivation on cognitive variables. *Psychological Bulletin, 136*, 375–389. doi:10.1037/a0018883
- Lim, V. K. G. (2002). The IT way of loafing on the job: Cyberloafing,

- neutralizing and organizational justice. *Journal of Organizational Behavior*, 23, 675–694. doi:10.1002/job.161
- Lim, V. K. G., & Teo, T. S. H. (2005). Prevalence, perceived seriousness, justification and regulation of cyberloafing in Singapore: An exploratory study. *Information & Management*, 42, 1081–1093. doi:10.1016/j.im.2004.12.002
- Marcus, B., & Schuler, H. (2004). Antecedents of counterproductive behavior at work: A general perspective. *Journal of Applied Psychology*, 89, 647–660. doi:10.1037/0021-9010.89.4.647
- McCrae, R. R., & Löckenhoff, C. E. (2010). Self-regulation and the five-factor model of personality traits. In R. H. Hoyle (Ed.), *Handbook of personality and self-regulation* (pp. 145–168). Malden, MA: Blackwell Publishing. doi:10.1002/9781444318111.ch7
- Mead, N. L., Baumeister, R. F., Gino, F., Schweitzer, M. E., & Ariely, D. (2009). Too tired to tell the truth: Self-control resource depletion and dishonesty. *Journal of Experimental Social Psychology*, 45, 594–597. doi:10.1016/j.jesp.2009.02.004
- Monk, T. H., Buysse, D. J., Billy, B. D., & DeGrazia, J. M. (2004). Using nine 2-h delays to achieve a 6-h advance disrupts sleep, alertness, and circadian rhythm. *Aviation, Space, & Environmental Medicine*, 75, 1049–1057.
- Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin*, 126, 247–259. doi:10.1037/0033-2909.126.2.247
- Muraven, M., Baumeister, R. F., & Tice, D. M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *The Journal of Social Psychology*, 139, 446–457. doi:10.1080/00224549909598404
- Nilsson, J. P., Soderstrom, M., Karlsson, A. U., Lekander, M., Akerstedt, T., Lindroth, N. E., & Axelsson, J. (2005). Less effective executive functioning after one night's sleep deprivation. *Journal of Sleep Research*, 14, 1–6. doi:10.1111/j.1365-2869.2005.00442.x
- Online Publishers Association. (2003). The existence and characteristics of dayparts on the Internet. *The OPA White Papers*, 1(3), 1–19.
- Parrott, A. C., Garnham, N. J., Wesnes, K., & Pincock, C. (1996). Cigarette smoking and abstinence: Comparative effects upon cognitive task performance and mood state over 24 hours. *Human Psychopharmacology: Clinical & Experimental*, 11, 391–400. doi:10.1002/(SICI)1099-1077(199609)11:5<391::AID-HUP780>3.0.CO;2-Z
- Pilcher, J. J., & Huffcutt, A. I. (1996). Effects of sleep deprivation on performance: A meta-analysis. *Sleep*, 19, 318–326.
- Prasad, S., Lim, V. K.G., & Chen, D. J. Q. (2010, July). Self-regulation, individual characteristics and cyberloafing. *Proceedings of the 14th Pacific Asia Conference on Information Systems (PACIS)*, pp. 1641–1648, Taipei, Taiwan.
- Rones, P. L., Ilg, R. E., & Gardner, J. M. (1997, April). Trends in hours of work since the mid-1970s. *Monthly Labor Review*, 120, 3–14. Retrieved from <http://stats.bls.gov/opub/mlr/1997/04/art1full.pdf>
- Sadeh, A., Sharkey, K. M., & Carskadon, M. A. (1994). Activity-based sleep-wake identification: An empirical test of methodological issues. *Sleep*, 17, 201–207.
- Schnyer, D. M., Zeithamova, D., & Williams, V. (2009). Decision-making under conditions of sleep deprivation: Cognitive and neural consequences. *Military Psychology*, 21(Suppl. 1), S36–S45. doi:10.1080/08995600802554607
- Scott, B. A., & Judge, T. A. (2006). Insomnia, emotions, and job satisfaction: A multilevel study. *Journal of Management*, 32, 622–645. doi:10.1177/0149206306289762
- Steel, P. (2007). The nature of procrastination. *Psychological Bulletin*, 133, 65–94. doi:10.1037/0033-2909.133.1.65
- Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality*, 72, 271–324. doi:10.1111/j.0022-3506.2004.00263.x
- Taylor, A. (2007, January 4). Gambling at work “costs employers £300M a year.” *Financial Times*.

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