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Ego Depletion Is Not Just Fatigue: Evidence From a Total Sleep Deprivation Experiment

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Abstract

Is the self-regulation failure that comes from prior exertions of self-regulation—the ego-depletion effect—the result of fatigue? A reading of the literature suggests that self-regulatory resource depletion and fatigue might be overlapping constructs, but direct empirical evidence is lacking. The authors put this question to the test by subjecting half of their participants to total sleep deprivation for 24 hours whereas others were rested; they crossed this factor with a self-regulation manipulation in which participants did or did not suppress their emotional reactions to a film. The authors' measure of self-regulation was aggressive responses in a game involving blasting noise at an opponent. Contrary to expectations, there was no effect of sleep deprivation on aggression. In confirmation of the limited-resource model, the authors found that depleted participants were more aggressive than nondepleted participants (irrespective of fatigue condition). Lax self-regulation seems to be from a lack of self-regulatory capacity, not fatigue.

Keywords

self-regulation, self-control, sleep deprivation, fatigue, aggression

A report by the National Sleep Foundation released in March 2010 found that only 4 in 10 Americans say that they get enough sleep most nights (Marcus, 2010). This means that many Americans, and we suspect this is true to some degree around the world, are in some state of being sleep deprived on most days. Does this spell trouble for their ability to exert self-regulation and reach their goals? In other words, does fatigue, a state of being weary from effort or exhaustion (Merriam-Webster, 2010), portend self-regulation failure? The extant literature suggests so.

Another perspective on how people reach their goals contends that people who engage in self-regulation are likely to show poor self-regulation subsequently. This pattern has been said to support a limited-resource model, which posits that self-regulation is governed by a global but depletable supply of energy that is taxed during the self-regulation process (Baumeister, Vohs, & Tice, 2007). Earlier engagements in self-regulation lead to later self-regulation failures, a hangover effect termed *ego depletion* or *self-regulatory resource depletion.* Although depletion effects occur reliably, there is little consensus as to what explains them.

We asked whether being fatigued is tantamount to being depleted of self-regulatory resources using a controlled sleep design because sleep deprivation affects cognitive abilities much more so than physical abilities (Horne, 1985), making it an apt state to compare to the state of ego depletion. We tested fatigue (via sleep deprivation) and self-regulatory resource depletion as potential predictors of later self-regulation. Some of our participants were deprived of sleep for 24 hours, whereas others were not. In combination, some of our participants were instructed to use self-regulation to control their emotions whereas others were not. Then, all participants completed a game that offered opportunities to behave aggressively. Would sleep deprivation condition, self-regulation condition, or their mixture predict participants' aggressive responses?

The Limited-Resource Model of Self-regulation

It is perhaps no surprise that self-regulation is so difficult, as there are myriad reasons why people fail at it. One model depicts self-regulation as governed by a limited stock of energy. This energy is said to be involved in every act of self-regulation, which suggests that it can be taxed easily. Numerous experiments have shown a pattern that supports a limited-resource model: After a person performs an act of

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self-regulation, it is more likely that later self-regulation attempts will be unsuccessful than if the person had not engaged in self-regulation earlier (Hagger, Wood, Stiff, & Chatzisarantis, 2010). The self-regulation resource is renewable but does not appear to replenish itself as readily as it can be diminished.

Initial research on the limited-resource model established that it could predict basic self-regulation findings, such as persistence and cognitive performance (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Muraven, Tice, & Baumeister, 1998). In this work, participants engaged in one form of self-regulation (or not, for participants in comparison conditions), and then all participants' self-regulation ability was tested.

One thread running through this literature is that dormant urges become unleashed after people have earlier engaged in self-regulation. The limited-resource model has been invoked to explain why dieters (but not nondieters) eat more after having resisted the temptation of high-calorie foods or persisted at a challenging task (Vohs & Heatherton, 2000). People spend money impulsively after using their self-regulation resources to infuse emotion into reading an otherwise dry text, and this especially pronounced among those who have trouble restraining their spending urges (Vohs & Faber, 2007). Cigarette smokers give in to their addiction more after having earlier resisted eating brownies, as compared to resisting broccoli (Shmueli & Prochaska, 2009). Alcohol intake also rises on days when people report having tackled highly demanding (vs. less demanding) tasks requiring self-regulation (Muraven, Collins, Shiffman, & Paty, 2005).

The depletion effect has been framed as a fatigue effect. Portraying self-regulation failure as because of sapped energy suggests that the self is tired, just as a person feels tired after strenuous exercise or a long bout of energy expenditure. Initial and continued explanations of the limited-resource model likened the process to tiring and building up a muscle (Baumeister, Vohs & Tice, 2007 ; Baumeister & Heatherton, 1996), which suggests that using one's self-regulation abilities culminates in fatigue.

The fatigue notion could accommodate many of the findings that pertain to the limited-resource model, as a recent meta-analysis noted (Hagger et al., 2010). After people engage in self-regulation, their bodies show evidence of effort by way of diminished heart rate variability (Segerstrom & Solberg Nes, 2007), weak neural errors (Inzlicht & Gutsell, 2007), and drops in glucose (Gailliot et al., 2007). In addition, forces known to counteract depletion, such as cash incentives (Muraven & Slessareva, 2003), reminders of one's core values (Schmeichel & Vohs, 2009), the use of if–then contingencies (Webb & Sheeran, 2002), and—most germane—rest (Tyler & Burns, 2008), could aid self-regulation performance when people are fatigued (for motivational factors that overcome sleep deprivation, see Harrison & Horne, 1998). Recent work has connected sleep patterns to the limited-resource model. Self-reports of sleeping sufficiently (more than 7 hours) combined with consistent nightly sleep, relative to other combinations, were related to perceiving life events as less stressful (Barber, Munz, Bagsby, & Powell, 2009).

Yet other depletion effects do not suggest that fatigue is a crucial variable. When people are depleted of their self-regulatory resources, they experience an elongated perception of time (Vohs & Schmeichel, 2003) and adopt a low-level construal of the world (Schmeichel & Vohs, 2009), which are psychological changes but not fatigue indicators. Humor, which does not immediately pertain to fatigue, aids self-regulation after depletion (Tice, Baumeister, Shmeuli, & Muraven, 2007). Queries of people who have just engaged in a self-regulation task versus those who have not shown equivalent levels of self-perceived tiredness.

On balance, though, theory and data favor the notion that when people are depleted of their self-regulation resources, it results in a state that is akin to fatigue. Nonetheless, no direct evidence has been brought to bear on the issue. The current article reports two experiments, the first regarding lay perceptions of how sleep deprivation would affect self-regulation and the second regarding the effects of experimentally manipulated sleep deprivation and self-regulatory resource availability on subsequent self-regulation. Both experiments centered on aggressiveness, which was chosen because of prior work linking aggressiveness to self-regulatory resource depletion (e.g., DeWall, Baumeister, Gailliot, & Stillman, 2007) and sleep deprivation (Haynes, Bootzin, Smith, Cousins, & Stevens, 2006; Kahn-Greene, Lipizzi, Conrad, Kamimori, & Killgore, 2006).

Self-Regulation and Aggression

Self-regulation is relevant to aggression because behaving aggressively represents a violation of social and personal norms for most people (Zimbardo, 1969). Children as young as 6 years old possess, and can report on, normative beliefs about the (in)appropriateness of aggressiveness (Huesmann & Guerra, 1997). Modern societies codify many aggressive behaviors as wrong via the criminal justice system.

In line with this theorizing, there is a long history of conceptualizing aggression as an unbridled reaction to frustration (e.g., Dollard, Doob, Miller, Mowrer, & Sears, 1939) and more recent empirical work connecting temporary lapses in self-regulation to aggression. Children who lack self-regulation skills are more likely to behave aggressively than those with strong self-regulation skills (Krueger, Caspi, Moffitt, White, & Stouthamer-Loeber, 1996; Murphy & Eisenberg, 1997). Occupational researchers found that workers with low self-regulation exhibit aggression more than do workers with high self-regulation (Latham & Perlow, 1996). In fact, the robust finding that men are more aggressive than women has been said to be an artifact of the difference in self-regulation between genders. Once self-regulation scores are statistically held constant, gender differences in aggression disappear (Burton, Cullen, Evans, Alarid, & Dunaway, 1998).

A landmark theory by Gottfredson and Hirschi (1990) concluded that poor self-regulation is the leading cause of criminality and aggressiveness. Criminologists have used this perspective to develop and successfully implement a scale to

study crime, aggression, and delinquency (Arneklev, Grasmick, Tittle, & Bursik, 1993). Those data show that individuals who lack self-regulation are more likely than others to enact a variety of violent, sadistic behaviors. A longitudinal study of nearly 1,000 people from ages 3 until 21 tested Gottfredson and Hirschi's claims about deficient self-regulation and aggressiveness (Wright, Caspi, Moffitt, & Silva, 1999). The authors found that self-regulation measured in childhood predicted criminality and hostile behaviors decades later, at ages 15 and 21. A prominent personality geneticist (Caspi, 2000) concluded that weak self-regulation is a precursor to antisocial and behavioral deviance.

A group of researchers tested whether the link from low self-regulation to aggression could also be observed in the laboratory, with situationally reduced lax self-regulation. DeWall et al. (2007) systematically altered participants' self-regulatory ability through having participants engage in self-regulation or not and then assessed their aggressive responding. They found that participants who had earlier engaged in self-regulation, compared to participants who had not engaged in self-regulation, blasted more annoying white noise to an opponent and sabotaged another's opportunity to win a coveted position. Similar results were found by Stucke and Baumeister (2006) and Muraven (2008), who measured indirect aggression in the form of unfavorable evaluations of people they disliked. In short, there is strong support for the notion that the temporary weakening of self-regulation through self-regulatory resource depletion heightens aggression.

Self-Regulation and Sleep

The broad question of whether sleep deprivation affects self-regulation is still an open one, a fact that spurred the current research. However, the link between sleep deprivation and decision making, which is relevant to self-regulated behaviors, is better studied. Findings from a controlled experiment of sleep deprivation and risky choices (using gambles) suggested that sleep-deprived people do not self-manage well (Roehrs, Greenwald, & Roth, 2004). Sleep-deprived participants won less money than alert participants because they failed to adjust their bets according to their current capacities. A recent review (Harrison & Horne, 1998) concluded that sleep deprivation impairs higher order decision making. In particular, the decision-making processes that are harmed by sleep deprivation mirror those harmed by self-regulatory resource depletion (Baumeister, Vohs, & Tice, 2007). People who are sleep deprived perseverate on one behavioral pattern when a shift in approaches is necessary, make risky decisions, and exhibit lackluster responses instead of innovation. Hence, the consequences of sleep deprivation and self-regulatory resource depletion effects seem to be consistent, suggesting some link between the two.

Correlational data also link sleep and aggressiveness. A study of Dutch adolescents (Meijer, Habekothe, & Van Den Wittenboer, 2000) found that students' ratings of their quality of sleep were positively related to their reports of how well they control their aggressive urges. Juvenile offenders' sleep reports revealed a correlation between sleep patterns and self-reported aggressiveness (Ireland & Culpin, 2006) in showing that sleep disturbances predicted aggressiveness. Adolescents in substance abuse treatment reported in their diaries that aggressive thoughts preceded sleep problems (Haynes et al., 2006). A study of juvenile offenders also found a connection—albeit in the opposite direction as that just reported—that self-reported sleep disturbances predicted self-reported aggressiveness (Ireland & Culpin, 2006). Averill's (1982) classic book on aggression cites sleep problems as a cause of aggressiveness, as do governmental reports on aggressiveness and crime (Rand, Klaus, & Taylor, 1983).

We located one experiment that systematically varied whether participants were sleep deprived or not and measured aggressive tendencies using a projective test (Kahn-Greene et al., 2006). In this within-subjects experiment, participants gave two written responses of how they imagined they would respond to hypothetical scenarios, one after a full night's sleep and a second after 55 hours of continuous wakefulness. After being deprived of sleep for 2 nights as compared to assessments made rested, participants predicted that they would not accommodate to others to avoid a conflict and would deflect blame away from the self.

Extant data suggested that sleep deprivation seems to heighten aggression. Yet these data are not entirely convincing. Most of the findings are correlational, with the one experimental study we located operationalizing aggressiveness as self-reported predictions of behavior, which does not provide a definitive answer as to whether systematically manipulated differences in sleep would predict actual behavior (C. Anderson, 2009; Baumeister, Vohs, & Funder, 2007).

There is a broader question of lay beliefs about sleep deprivation and aggression. Often a weak link ties how people think they would respond and how they do respond when faced with an event. This divergence can be seen plainly in the work on affective forecasting (Wilson & Gilbert, 2003) and might contribute to Kahn-Greene et al.'s (2006) effects pertaining to hypothetical scenarios.

Hence, the pilot study set aside the question of self-regulatory resource depletion to test whether there is a lay belief that sleep deprivation predicts aggressive responding. We hypothesized that participants would predict that someone who had been deprived of sleep would be more aggressive than someone who was rested. Subsequently, Experiment 1 addressed whether sleep deprivation affects aggression using systematic manipulations within experimental design and measuring actual behavior.

Pilot Study

We conducted a test of lay beliefs to assess if people believe that being sleep deprived is related to aggressive behaviors. In line with Kahn-Greene et al.'s (2006) study, in which sleep-deprived participants read hypothetical scenarios and predicted that they would behave more aggressively, we

predicted that even non-sleep-deprived people would think that a person who was sleep deprived, as opposed to a person who was rested, would be aggressive.

Participants

A total of 34 undergraduates (15 female) participated voluntarily in a one-factor design (sleep-deprived character vs. rested character).

Procedure

Participants in the *sleep deprivation condition* were given a scenario describing a genderless target character who had not slept all night, whereas participants in the *rested condition* were given a similar scenario that described the character as getting a full night's sleep. In both conditions, "J" went into a convenience store early in the morning and got in line to buy a lottery ticket (adapted from Tremblay & Belchevski, 2004). The scenario next read, "It's very busy. J has already been waiting for 10 minutes. Just when it's J's turn, someone else pushes in front of J." Then participants were asked how aggressive (1 = *not at all*, 7 = *very*) they believed J would respond. Last, participants reported how many hours and minutes they had slept the night prior to the experiment and whether they considered themselves sleep deprived (*no* vs. *yes*).

Results and Discussion

Descriptive analyses. Participants reported that they had slept between 5.5 and 14 hours during the night prior to the study. No one claimed to be sleep deprived.

Predictions of aggressive behavior. As expected, participants predicted that the sleep-deprived person ($M = 4.94$, $SD = 1.95$) would react more aggressively than the rested person ($M = 2.35$, $SD = 1.62$), $t(32) = 2.58$, $p < .01$. This confirms our expectation that people hold a lay belief that being deprived of sleep will lead to aggression.

There was a marginally significant correlation between amount of sleep that participants received on the night prior to the study and their ratings of how aggressive the character would be, $r(34) = .33$, $p = .056$. However, when both condition (sleep-deprived character vs. rested character) and amount of sleep participants obtained were entered into an analysis of covariance, only condition contributed to predictions of aggressiveness, $F(1, 31) = 12.77$, $p < .01$; amount of sleep: $F < 1$.

Discussion. In summary, participants who slept less the night prior to the study projected even more aggression onto the target character than did participants who had gotten more sleep. These data corroborate earlier studies in which people predicted that they themselves would behave more aggressively when sleep deprived than when not (Kahn-Greene et al., 2006). Moreover, this study goes beyond earlier work to show that there is a lay belief that being deprived of sleep causes aggressive responding. Regardless of how much sleep they received the night before the experiment, participants who read about a character described as sleep deprived predicted that the character would behave more aggressively in response to a frustrating situation as compared to participants who read about a character described as rested.

That there is a lay theory that sleep deprivation produces aggressiveness seems to explain patterns seen in the literature. The pilot study is mute, however, as to whether people systematically deprived of sleep would show more aggressive behavior than people who had slept. Experiment 1 addressed that matter.

Experiment 1

Our intent was to create an experiment to simultaneously answer three questions. First, is the state of self-regulatory resource depletion akin to being fatigued via sleep deprivation? Second, does a state of sleep deprivation produce aggressive behavior? Third, does the combination of sleep deprivation and self-regulatory resource depletion produce the highest levels of aggression? Given our reviews of the literature and the pilot study, we hypothesized two main effects and an interaction: that participants would be more aggressive after depletion and after sleep deprivation compared to their counterparts and that the confluence of being deprived of sleep and taxed of self-regulatory resources would lead to the highest levels of aggression.

Participants

A total of 58 adults participated (11 female; $M_{age} = 22.1$, $SD = 4.0$). Of these, 21 were public university undergraduates, 14 were West Point cadets, and 23 were U.S. Army enlisted servicepersons. Data from 3 participants (2 rested condition participants and 1 sleep deprived) were excluded for failure to follow the emotion-regulation directions. Results did not differ by participant sample, so we collapsed across this variable. Participants were randomly assigned to condition in a 2 (self-regulatory resource depletion vs. no depletion) × 2 (sleep deprivation vs. rested) between-subjects design.

Procedure

Trials were conducted in the morning. At that time, participants who had been randomly assigned to the rested condition had a full night's sleep when tested. Participants who had been randomly assigned to the deprivation condition had experienced 24 hours of total sleep deprivation. Chaperones monitored sleep deprivation participants at all times while participants engaged in activities of their choosing (e.g., watching videos, walking, reading). No participant in the sleep deprivation condition got even one minute of sleep for the 24 hours prior to the experiment.

Next, participants watched disgusting footage from the movies *Trainspotting* (the toilet bowl scene) and *Monty Python's The Meaning of Life* (the overeating scene), which

prior research has confirmed elicit disgust (Lerner, Small, & Loewenstein, 2004). Participants in the *depletion condition* were instructed to show no facial reactions whatsoever and to neutralize their innermost feelings. These emotion-regulation instructions have been shown to induce a state of self-regulatory resource depletion (e.g., Vohs, Baumeister, & Ciarocco, 2005). Participants in the *no depletion condition* were instructed to act naturally. A video camera in plain sight recorded participants' facial expressions to check that they followed instructions.

Aggression Task

We measured aggression with a 25-trial aggression game. Participants were told that to win a trial they had to press a key faster than their online human opponent (which was a computer in reality). Prior to each trial, participants selected a volume level between 0 and 10 (0 = *no noise*; 10 = *107 dB*) that, if they were to win, would be blasted at their opponent (C. A. Anderson & Bushman, 1997). Participants always won the first trial. This triggered a screen that displayed the noise levels that each player chose. To induce provocation, the opponent's choice of noise level was displayed as one unit higher than the participant set for the opponent. Therefore, participants' volume selection for Trial 2 is considered to be retaliatory since participants thought that their opponent would have been more aggressive than they were. The winner of each trial subsequently was determined at chance. Level of noise chosen to be blasted at the opponent was the measure of aggression.

Results

Manipulation check. Two coders, blind to condition and hypotheses, rated participants' expression intensity while watching the video (1 = *none*, 7 = *very*) to assess whether participants followed the emotion-regulation instructions. The coders' ratings were highly consistent (Cronbach's $\alpha = .92$) so we summed their ratings to create an expressiveness index for each participant. In confirmation of the manipulation, a 2 × 2 analysis of variance (ANOVA) with sleep condition and depletion condition as predictors yielded only an effect of depletion condition on ratings of expressiveness. As expected, participants instructed to neutralize their facial expressions were less expressive than participants instructed to act naturally to the disgusting footage, $M_{\text{depletion}} = 1.82$, $SD = 0.86$; $M_{\text{no depletion}} = 1.05$, $SD = 0.06$; $F(1, 54) = 27.03$, $p < .001$, $\eta^2 = .35$. There was no effect of sleep condition nor an interaction with depletion condition, Fs < 2.25, *ns.*

Aggression. Volume selection for Trial 2 was the primary measure of aggression (DeWall et al., 2007).[1] A 2 (rested vs. sleep deprived) × 2 (no depletion vs. depletion) ANOVA revealed the predicted effect of depletion condition, $F(1, 54) = 7.20$, $p = .01$, $\eta^2 = .12$, in that depleted participants selected higher volume levels than nondepleted participants (Figure 1). However, neither sleep condition nor the interaction of Sleep Deprivation × Depletion Condition was significant, Fs < 1. Volume levels for Trials 2 to 25 (collapsed) echoed these findings. There was a significant main effect of depletion condition, $F(1, 54) = 5.63$, $p = .02$, $\eta^2 = .10$ ($M_{\text{depletion}} = 7.01$, $SD = 2.37$; $M_{\text{no depletion}} = 5.27$, $SD = 2.89$) and again no sleep-deprivation effect nor interaction with depletion condition, Fs < 1.

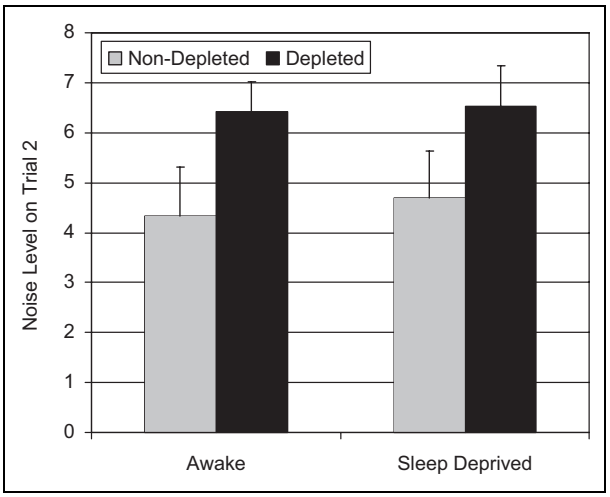

Figure 1. Noise volume selection in Trial 2 as a function of sleep deprivation condition (rested vs. sleep deprived) and depletion condition (depleted vs. nondepleted)

There was a parallel effect on initial noise blast choices (i.e., volume for Trial 1). Initial aggressiveness was higher when participants were depleted, $F(1, 54) = 5.35$, $p < .03$, $\eta^2 = .10$, such that depleted participants selected higher volume levels than nondepleted participants ($M_{\text{depletion}} = 5.35$, $SD = 2.72$; $M_{\text{no-depletion}} = 3.77$, $SD = 2.60$). There was no effect of sleep condition nor its interaction with depletion condition, Fs < 1.6, ps > .20.

Ancillary tests analyzed aggressiveness as a function of whether participants won or lost the previous trial. A mixed ANOVA of 2 (rested vs. sleep deprived) × 2 (no depletion vs. depletion) × 2 (within subjects: won vs. lost) revealed a Depletion Condition × Won/Lost Condition interaction, $F(1, 51) = 8.40$, $p < .01$, $\eta^2 = .14$, and the aforementioned depletion effect remained significant, $F(1, 51) = 5.83$, $p < .02$, $\eta^2 = .10$; other effects, Fs < 1. Figure 2 illustrates the means. Losing led to higher noise blast choices than did winning, $t(53) = 3.17$, $p < .01$, $d = .80$ and $t(53) = 1.68$, $p < .10$, $d = .42$. But the pattern was the same regardless of whether participants won or lost—being depleted of self-regulatory resources predicted aggressive behaviors.

General Discussion

This article reports on an experiment that used a controlled total sleep deprivation paradigm to assess whether a state of self-regulatory resource depletion is akin to the fatigue caused by sleep deprivation and to offer a stringent test of whether

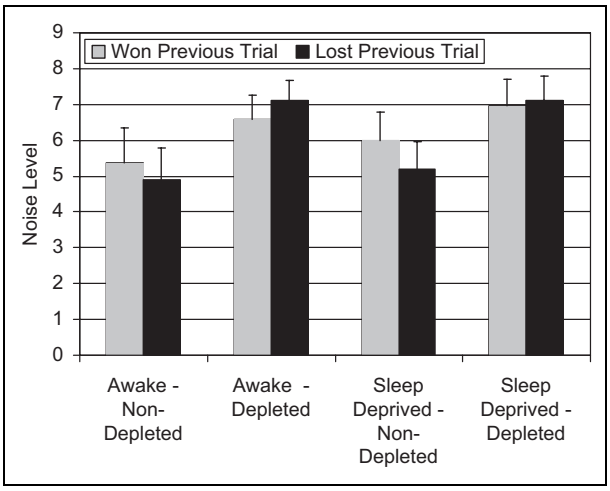

Figure 2. Noise volume section for Trials 2–25 (averaged) as a function of the within-person factor of whether the participant won or lost the previous trial combined with the between-person factors of sleep deprivation condition (rested vs. sleep deprived) and depletion condition (depleted vs. nondepleted)

sleep deprivation causes aggression. This experiment, the first to assess sleep deprivation's effects on the behavioral regulation of aggressiveness, found no effect of sleep deprivation. As expected, though, the findings did support a popular account of self-regulation failure, namely depletion of self-regulatory resources.

These data point to two conclusions. First, self-regulatory resource depletion is not tantamount to fatigue. When people were depleted of their self-regulatory resources, they let loose their urges and behaved aggressively. This is not what happened when people were sleep deprived, which leads to the second conclusion: Despite proposals in the literature and the data from our pilot study, systematically regimented sleep deprivation did not influence aggressive behavior.

Design drawbacks present in prior studies, along with the link from lack of sleep to poor decision making, may offer hints as to why our experiment found effects that diverged from the extent literature. Three of the four studies that found a relationship between sleep problems and aggression employed adolescent populations, and, moreover, two of the three investigated troubled youths (Haynes et al., 2006; Ireland & Culpin, 2006; Meijer et al., 2000). A more serious concern, though, was that these studies relied on self-reports of aggression and self-reports of sleep quality and quantity, which gives rise to myriad alternate accounts for why sleep problems and aggression may co-occur (e.g., emotional problems, trouble at home, response tendencies).

The one experiment (Kahn-Greene et al., 2006) that did make use of total sleep deprivation did not, however, measure aggressive behavior but rather self-reports of anticipated behavior using a projective test. Because participants who are sleep deprived tend not to think at high levels but instead fall back on well-learned response tendencies (Harrison & Horne, 1998), they may have used stored beliefs about how sleep (or lack thereof) would affect aggressive reactions. Indeed, the results of our pilot study support such an interpretation, in that participants believed that a sleep-deprived person would be more aggressive than a rested person. We suspect, therefore, that participants who were sleep deprived in the Kahn-Greene et al. (2006) experiment might have relied on lay beliefs about how they, or anyone else who was sleep deprived, would respond in a given situation. Our experimental data point to the fact that it is worthwhile to test actual behavior because behavior does not always align with intentions or predictions (Baumeister, Vohs, & Funder, 2007). Moreover, these data suggest that when people are sleep deprived and faced with an actual provocation, their behavior is not determined by their sleep state. Rather, it is determined by their self-regulatory resource availability.

There are limitations to the current research. We did not specifically measure whether participants who were kept awake for 24 hours were in fact sleepier than participants who got a full night's rest. We were unable to obtain information on the average amount that our participants typically slept and their sleep deprivation tolerance. Both are possible control variables that might add to the variance predicted above and beyond our experimental treatments. Last, it is possible that the fatigue caused by lack of sleep may not be synonymous with the form of fatigue evoked by self-regulatory resource depletion. Future research might seek to pull apart various forms of fatigue and their relation to self-regulation failure brought on by resource depletion.

We conclude by returning to the robustness of the self-regulatory resource depletion effect. People who were rested and totally deprived of sleep for more than 24 hours responded similarly—and negatively—to being ego depleted. Lax self-regulation seems not to be the result of fatigue but instead exhaustion of the inner energy that modulates unwanted responses.

Authors' Note

The first two authors share lead authorship.

Declaration of Conflicting Interests

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Note

1. At Trial 1, five participants selected the maximum volume of 10, which precluded the computer from selecting a higher volume (as it had been instructed to do). Nevertheless, the pattern of results remains the same regardless of whether these five participants were

removed from or included in the analyses. Analyses in the main text include these participants.

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