Journal of Abnormal Psychology
2011, Vol. 120, No. 3, 719–729

0021-843X/11/$12.00 DOI: 10.1037/a0022941

Daily Stress Interacts With Trait Dissociation to Predict Sleep-Related Experiences in Young Adults

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Building on the previously documented effects of stress and dissociation on sleep and dreaming, we examined their interactive role in *general sleep-related experiences* (GSEs; e.g., nightmares, falling dreams, hypnagogic hallucinations; see Watson, 2001). Stress, sleep quality, and GSEs were assessed daily for 14 days among young adults. Baseline assessment included life stress, sleep quality, psychopathology, dissociation, and related dimensions. Multilevel analyses indicated that daily stress brings about GSEs among highly dissociative young adults. Additionally, baseline trait dissociation predicted within-subject elevation in GSEs when daily stress was high. Flawed sleep–wake transitions, previously linked to dissociation and sleep-related experiences, might account for this effect.

Keywords: dreaming, sleep-related experiences, stress, dissociation, sleep quality

Biopsychological processes involved in sleep are intimately related to those involved in psychopathology. Accordingly, when studying one, researchers must take the other into account (Dahl, 1996; Peterson & Benca, 2006). For example, sleep disruptions such as insomnia, fatigue, and nightmares predispose individuals to mood disorders, suicidality, and posttraumatic stress disorder (PTSD; e.g., Cukrowicz et al., 2006; Mellman, David, Bustamante, Torres, & Fins, 2001; Peterson & Benca, 2006; Pigeon & Perlis, 2007; Tanskanen et al., 2001). Despite voluminous literature on the relation between sleep and mood and/or anxiety disorders, little is known about the relation between sleep and dissociation. For example, in a meta-analysis of 177 studies on sleep across several psychopathological syndromes (Benca, Obermeyer, Thisted, & Gillin, 1992), dissociation was absent.

Nevertheless, disruptions to the sleep–wake cycle intensify dissociative symptoms (Giesbrecht, Smeets, Leppink, Jelicic, & Merckelbach, 2007). Additionally, patients diagnosed with dissociative identity disorder have increased rates of nightmare disorder (Agargun, Kara, Ozer, Selvi, Kiran, & Ozer, 2003). Poor sleep quality and nightmares are linked to dissociative experiences following trauma (Agargun, Kara, Ozer, Selvi, Kiran, & Kiran, 2003) and in borderline personality disorder (Semiz, Basoglu, Ebrinc, & Cetin, 2008). Research focusing on the relation between dissociative symptoms and deviant sleep and dream patterns may shed light on some of the specific psychosomatic deficits in dissociation (Giesbrecht, Lynn, Lilienfeld, & Merckelbach, 2008).

The construct of sleep-related experiences (SREs, Watson, 2001) is strongly pertinent to dissociation. SREs are nocturnal altered consciousness experiences such as elevated dream recall, nightmares, falling dreams, and narcoleptic tendencies. Watson and colleagues demonstrated associations between SREs and dissociation and schizotypy (Koffel & Watson, 2009; Watson, 2001). Watson further differentiated between general SREs (GSEs) and lucid dreams (LDs; dreams that include awareness of dreaming). GSEs are related to general psychopathology; in nonclinical samples, they were correlated with negative affect (Fassler, Knox, & Lynn, 2006) and were increased following psychopathological symptoms (Soffer-Dudek & Shahar, 2009). In a psychiatric outpatient sample, they were elevated compared with matched controls (Soffer-Dudek et al., in press). Additionally, within this sample, GSEs were associated with illness intrusiveness (i.e., the extent to which patients felt that their illness disrupts their lives). Despite the association between GSEs and general psychopathology, there is also evidence that while insomnia and fatigue are uniquely related to depression and anxiety, unusual dreaming is a unique characteristic of dissociation and schizotypy (Koffel & Watson, 2009).

Stress impacts both sleep (e.g., insomnia, fatigue) and dreaming. It affects sleep quality and patterns (e.g., Åkerstedt, Kecklund, & Axelsson, 2007; Fortunato & Harsh, 2006; Van Reeth et al., 2000) and is associated with nightmares (e.g., Levin & Nielsen, 2007; Roberts, Lennings, & Heard, 2009; Schredl, 2003; Zadra & Donderi, 2000) and with recurrent dreams (Brown & Donderi, 1986; Zadra, 1996). An increase in minor stressful life events is associated with an increase in GSEs (Soffer-Dudek & Shahar, 2009), and exposure to traumatic stress through the media predicts GSEs (Soffer-Dudek & Shahar, 2010). GSEs are also associated with life stress among psychiatric outpatients (Soffer-Dudek et al., in press).

This article was published Online First March 28, 2011.

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This article is partially based on Nirit Soffer-Dudek's doctoral research, supervised by Golan Shahar.

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Stress also activates dissociation (e.g., Freinkel, Koopman, & Spiegel, 1994; Morgan et al., 2001), although it is not yet clear whether this pertains to state (peritraumatic) dissociation or trait dissociation. While state and trait dissociation are related, the exact nature of their relation is unclear. Because sleep deprivation intensifies dissociative symptoms (Giesbrecht et al., 2007), it is likely that stress, dissociation, sleep and unusual dreaming are closely intertwined.

Unlike GSEs, LDs were related to dissociation in some studies (Soffer-Dudek & Shahar, 2009; Watson, 2001, 2003) but not others (Fassler et al., 2006; Giesbrecht & Merckelbach, 2004, 2006). They were unrelated to stress and psychopathology in Soffer-Dudek and Shahar (2009) and in Soffer-Dudek et al. (in press). In fact, LDs were related to resilience in the face of traumatic stress (Soffer-Dudek, Wertheim, & Shahar, 2011) and have been utilized as a form of therapy in the face of nightmares (Brylowski, 1990; Spoormaker, van den Bout, & Meijer, 2003). Consequently, our focus when exploring the effects of stress and dissociation on unusual dreaming is on GSEs rather than on LDs. Our aim is to bridge two hitherto unrelated lines of inquiry: the original work of Watson and colleagues implicating dissociation in GSEs (Koffel & Watson, 2009; Watson, 2001) and a later one attesting to the role of stress in GSEs (Soffer-Dudek & Shahar, 2009, 2010; Soffer-Dudek et al., in press).

Our first aim was to assess the impact of stress on GSEs while utilizing a rigorous daily diary design. In recent years, it has become generally accepted that two-wave designs are insufficient for measuring change (Singer & Willett, 2003). We conducted 14 daily assessments, which are sufficient to reliably estimate individual differences in dream recall (Schredl & Fulda, 2005b). Measuring dream recall frequency using a daily dream log is more accurate than retrospective estimation (Beaulieu-Prévost & Zadra, 2005). These 14 days were the final 2 weeks of the semester, immediately followed by exams. Thus, we expected overall stress to rise during the study period.

Second, we surmised that dissociation would moderate the effect of stress on GSEs because dissociators exhibit reduced ability for coping with stress (McCaslin et al., 2008; Morgan, Hazlett, Dial-Ward, & Southwick, 2008). Additionally, recent evidence suggests that at least in insomniacs, stress-related arousal persists to affect the brain during sleep (Hall et al., 2007). Such arousal might represent a form of sleep–wake transition "switching errors" (Mahowald & Schenck, 2001), that is, faulty transitions between rapid eye movement (REM), nonrapid eye movement (NREM), and waking, producing mixed states. These mixed states may be more readily experienced by dissociators and explain the relation between dissociation and GSEs (Giesbrecht et al., 2008; Koffel & Watson, 2009; Mahowald & Schenck, 2001).

Third, we tested a stress-diathesis perspective, according to which stress might moderate the effect of dissociation on GSEs. Dissociation is the most prominent trait that has been related to the SREs construct (e.g., Fassler et al., 2006; Giesbrecht & Merckelbach, 2004, 2006; Watson, 2001). Because stress appears to activate dissociation in general (e.g., Freinkel et al., 1994; Morgan et al., 2001), it makes sense that the effect of dissociation on GSEs would be particularly pronounced under high stress.

To summarize, our aims were to

(a) provide a more stringent test of the effect of stress on GSEs; we hypothesized that daily stress will predict GSEs while controlling for sleep patterns, but not vice versa;

(b) test the possibility that this effect is particularly pronounced among dissociative individuals; and

(c) test a stress-diathesis model, according to which stress magnifies the effect of dissociation on GSEs.

We measured three additional constructs relevant to GSEs. We assessed sleep quality because GSEs follow an increase in stress (Soffer-Dudek & Shahar, 2009) and stress adversely influences sleep (Van Reeth et al., 2000). However, in Watson (2003), no association between GSEs and sleep quality or length was found.[1] Notably, we explored both habitual (trait) and daily (state) sleep quality (see Schredl & Reinhard, 2008). We also assessed psychopathological symptoms, which predict GSEs (Soffer-Dudek & Shahar, 2009) and mediate the relationship between media-related traumatic stress and GSEs (Soffer-Dudek & Shahar, 2010). Finally, we assessed transliminality, a hypothesized tendency for psychological material to cross thresholds into or out of consciousness (Thalbourne & Houran, 2000), which predicts SREs (Soffer-Dudek & Shahar, 2009).

Method

Participants and Procedure

This study included two phases. Participants in the *screening phase* were 200 Israeli freshmen psychology students (155 women, age 18–28 years, $M = 23.36$ years, $SD = 1.40$) responding to an e-mail message soliciting participation in a study on "emotion, personality, and sleep." The message stated that should they choose to participate, the research team would approach them again the following month for a follow-up phase. They completed consent forms and anonymous questionnaires including demographic data, sleep quality, SREs, trait dissociation, psychopathological symptoms, transliminality, life stress, depression, and state dissociation (respectively) via e-mail. They were reimbursed with course credit.

One month later, they were asked to respond again for additional course credit. All questionnaires were translated and back translated by native English speakers. One hundred fifty-five people (116 women, age 18–28 years, $M = 23.40$ years, $SD = 1.35$) participated in this second wave. Attrition analyses indicated no difference in study variables between participants assessed at Time 2 and those dropping out. The second wave included only a subset of questionnaires, due to limited resources (see Table 1).

For the *daily diary phase*, 60 participants (43 women, age 21–26 years, $M = 23.54$ years, $SD = 1.16$) were randomly sampled from

[1] Note, however, that both the SREs general score and the dream recall item were correlated with sleep schedule variables. Studies show that elevated dream recall is related to longer sleep duration and vice versa (Pagel & Shocknesse, 2007; Schredl & Fulda, 2005a; Schredl & Reinhard, 2008), due to the likeliness of awakening from a REM period (Schredl & Reinhard, 2008).

Table 1
Questionnaires Administered in Each Assessment Wave of the Study

Measure	Screening phase Time 1	Screening phase Time 2	14-day daily diary phase
ISES	*	*	
NLEQ	*	*	
DES	*	*	
CADSS	*	*	
RTS	*	*	
PSQI	*		
BSI	*		
BDI	*		
Demographic data	*		
Daily SREs			*
Daily sleep			*
DSI			*

Note. ISES = Iowa Sleep Experiences Survey; NLEQ = Negative Life Events Questionnaire; DES = Dissociative Experiences Scale; CADSS = Clinician Administered Dissociative States Scale; RTS = Revised Transliminality Scale; PSQI = Pittsburgh Sleep Quality Index; BSI = Brief Symptom Inventory; BDI = Beck Depression Inventory; SREs = sleep-related experiences; DSI = Daily Stress Inventory.

the larger pool of 155. Before sampling, we excluded (a) those whose Time 2 GSEs score was over 2 standard deviations different from their Time 1 score (four participants) and (b) those who reported having no SREs (one participant). For the remaining 150 participants, we performed random sampling with a random number generator. Thirteen participants declined and were substituted by others. Participants were notified that sampling had been random. Each participant was reimbursed for completing the 14-day study (the sum approximated U.S.$40). This 14-day phase commenced 5 weeks after Wave 2 of the screening phase.

All 60 participants reported SREs, sleep quality, and stressful daily events each day. To enhance validity, SREs and quality were reported in the morning, after awakening, whereas daily stressful events of the passing day were reported before bedtime. These daily reports were e-mailed twice a day to the research team, which ascertained that all participants had adequately responded. Participants failing to respond were reminded via a cellular text message. Retention was outstanding: There was only one case of missing data (the 14th day's stress report of one participant).

Measures

Screening phase.

Iowa Sleep Experiences Survey (ISES; Watson, 2001). The ISES measures various SREs, such as narcoleptic tendencies, vivid dreams, waking dreams, LDs, and nightmares, on a 7 point-Likert scale (1 = *never*, 7 = *several times a week*). It consists of a 15-item GSEs subscale (e.g., "I remember my dreams," "I have recurring dreams") and a three-item LD subscale (e.g., "I am aware that I am dreaming, even as I dream"). Both subscales were reported to have adequate internal consistency. In this study, Cronbach's alpha was .85 and .86 for the GSEs scale and .75 and .85 for the LD scale, for Time 1 and 2 data, respectively. For evidence of the validity of the Hebrew version of the ISES, see Soffer-Dudek and Shahar (2009).

Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI measures sleep quality of the last month. It consists of 19 items, summed up into seven components and a global score. Components include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Authors report acceptable measures of reliability and validity for this measure. Cronbach's alpha for the seven components was a somewhat low .62. The Hebrew version of the PSQI has been validated in Shochat, Tzischinsky, Oksenberg, and Peled (2007).

Dissociative Experiences Scale (DES; Bernstein & Putnam, 1986; Bernstein Carlson & Putnam, 1993). The DES is a widely used self-report scale requiring respondents to estimate what percentage of the time they experience 28 dissociative phenomena on an 11-point scale (0%, 10%, 20%, etc.). The DES measures both nonclinical and clinical dissociation. Factor analyses reported in Bernstein Carlson and Putnam (1993) revealed that some of the DES items produce three subscales: Absorption, Amnesia, and Derealization/Depersonalization. Cronbach's alpha for the DES global score was .92 and .93 for Times 1 and 2, respectively. The Hebrew version of the DES has good psychometric properties (Somer, Dolgin, & Saadon, 2001).

Clinician Administered Dissociative States Scale (CADSS; Bremner et al., 1998). The CADSS measures state dissociation with 19 participant-rated items and an optional eight-item observer-rated component not used in this study. Participants were asked to report to what extent they felt different dissociative sensations "at this time" (0 = *not at all*, 4 = *extremely*). Bremner et al. (1998) reported the CADSS to have good psychometric properties. However, we were concerned about the validity of Item 12, expressing a feeling that completing the questionnaire is taking longer than expected. Because some participants notified us that questionnaire completion was in fact longer than we maintained, we suspected that this item might not have measured a dissociative state but a realistic situation. Thus, we calculated Cronbach's alpha with it (.80, for both Times 1 and 2) and without it (.85, for both Times 1 and 2) and decided to omit it from the CADSS score. These results provide initial support for the reliability of the Hebrew version of the CADSS.

The Revised Transliminality Scale (RTS; Lange, Thalbourne, Houran, & Storm, 2000). This 29-item true–false scale assesses magical ideation, mystical experience, absorption, hyperaesthesia, manic experience, dream interpretation, and fantasy proneness. The RTS total score was calculated with the Rasch-scale (Houran, Thalbourne, & Lange, 2003; Lange et al., 2000). Cronbach's alpha of the 17 items used for calculation was .74 and .77 for Times 1 and 2, respectively. For evidence of the validity of the Hebrew version of the RTS, see Soffer-Dudek and Shahar (2009).

Negative Life Events Questionnaire (NLEQ; Saxe & Abramson, 1987). The NLEQ is a 66-item stressful events measure tailored specifically for college students. Participants were requested to indicate whether they had experienced each item within the past month, on a 5-point Likert scale (1 = *never*, 5 = *all the time*). Items tap academics, work, achievement, parents and family, roommates, friends, and romantic partner. Five items are binary and are not scored. The NLEQ has been found to have adequate reliability and validity (e.g., Saxe & Abramson, 1987), and the Hebrew version was validated in Golan Shahar's lab using an independent sample (information is available upon request). In this study, Cronbach's alpha was .91 at both Times 1 and 2.

Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983). This 53-item scale assesses psychopathological symptoms experienced in the last month, including somatization, obsessive-compulsive symptoms, interpersonal sensitivity, anxiety, depression, hostility, phobic anxiety, paranoid ideation, and psychoticism. Cronbach's alpha for the global BSI score was .95. The Hebrew version of the BSI has been used extensively (e.g., Soffer-Dudek & Shahar, 2009). Gilbar and Ben-Zur (2002) reported norms for an Israeli population.

Beck Depression Inventory (BDI; Beck, Rush, Shaw, & Emery, 1979). This widely used, 21-item depression inventory includes items scored on a 0–3 scale, referring to the past month. It has shown good reliability and validity (Beck, Steer, & Garbin, 1988), and the Hebrew version is extensively used in Israel. Cronbach's alpha was .81.

Daily diary phase.

SREs. Sleep-related experiences were measured with a daily dream diary, which Nirit Soffer-Dudek received from D. Watson (personal communication, August 13, 2008). This measure is a daily questionnaire on various SREs adapted from the ISES (Watson, 2001). It refers to last night's sleep and consists of 14 items in a yes–no format. Items address dream recall, bad dreams and nightmares, flying and falling dreams, LDs, recurring dreams, bizarre dreams, waking dreams, hypnagogic and hypnopompic hallucinations, confusion between dream and reality, sensing a presence, and sleep paralyses. In accordance with the original ISES (Watson, 2001), in which LDs are a separate subscale, we decided to omit the LD item from the global daily score. We did not expect the remaining 13 items of the GSEs measure to reliably converge into acceptable values of Cronbach's alpha. For example, having a bizarre dream is not expected to increase the likelihood of having other SREs on that same night (e.g., a hypnagogic hallucination). Nevertheless, Cronbach's alpha for this measure, calculated separately for each of the 14 days, ranged between .47–.70, with an average of .57.

Sleep data. *Sleep data* was measured with six items (also taken from D. Watson, personal communication, August 13, 2008). They required stating retiring and waking hours, sleep latency in minutes, amount of night awakenings, amount of alcoholic beverages consumed last night, and a subjective rating of sleep quality (1 = *very poor*, 5 = *very good*). Sleep quality was inversely related to number of awakenings in 13 out of 14 days and to latency in 11 out of 14 days. Quality was related to duration in only 6 of the 14 days. Duration had two statistically significant inverse correlations with latency and two statistically significant correlations with number of awakenings, but in a positive direction, meaning that *longer* duration was related to *more* awakenings. This suggests the need to separate duration from a general quality measure (see also Footnote 1).

Thus, we created a sleep quality composite from standardizing and averaging sleep latency, amount of awakenings, and reversed subjective quality. Higher scores indicate poorer sleep quality. Sleep duration and alcohol were treated as separate variables. In addition, we computed a variable stating whether each night was a weekend or a school night.

The Daily Stress Inventory (DSI; Brantley, Waggoner, Jones, & Rappaport, 1987). The DSI assesses daily stressful events with 58 items. Respondents report (a) whether this happened within the past 24 hr and (b) if it did, how stressful it was (1 = *not stressful*, 7 = *caused panic*). Items such as "thought about unfinished work" and "thought about the future" were suitable to capture exam-related stress.

The DSI generates three indices: SUM is the sum of ratings for endorsed items. FREQ is the number of items endorsed, regardless of ratings. AIR, the average item rating, is calculated by dividing SUM by FREQ. It represents stress *intensity* (DiPietro, Novak, Costigan, Atella, & Reusing, 2006). We used the AIR measure as our daily stress variable, as it proved to be the most relevant for predicting GSEs. Results with the other measures are described in a footnote in the results section. Psychometric properties for the DSI are established (Brantley et al., 1987). Cronbach's alpha ranged between .70–.84, with an average of .80. To the best of our knowledge, we are the first to use this measure in Hebrew.

Data analyses. Analyses were conducted in two phases. In the *screening phase*, we examined which variables were related to GSEs and thus should be controlled for subsequently. The longitudinal design of the *daily diary phase* produced a multilevel data structure (Raudenbush & Bryk, 2001; Singer & Willett, 2003). Consequently, hierarchical linear modeling (HLM) was employed. Level-1 data were daily measurements of GSEs, sleep quality, and daily stress, nested within Level-2 variables capturing individual differences in gender, dissociation, transliminality, psychopathology, and baseline levels of stress, SREs, and sleep quality.

We expected daily stress to predict GSEs, while controlling for sleep quality and duration. We also hypothesized that there will be statistically significant cross-level interactions, that is, Level-2 dissociation will interact with Level-1 daily stress to predict daily GSEs. Specifically, we expected an enhanced effect of daily stress on GSEs under elevated levels of baseline trait dissociation and expected that baseline trait dissociation would predict an elevation in GSEs under high daily stress.

Multilevel modeling was implemented through SPSS mixed models (Version 17). We used maximum likelihood estimation to permit model comparison. The covariance structure type was diagonal, assuming that there are no correlations between day-to-day measurements. This assumption was based on our finding that most of the variance of GSE scores was within-subject, and not between-subjects, variance (see below). The variable representing time (values 0–13), and daily measurements of stress and sleep quality were entered into the model as both fixed and random effects. This means that their intercepts and slopes were allowed to vary among individuals. Level-2 variables and their interactions with daily stress were entered as fixed effects. Given that the model included interactions, all continuous variables were standardized.

As suggested in Tabachnick and Fidell (2007), we first computed an "*intercepts only model*," in which no predictors are entered, and time is not specified as a repeated measures variable. Two variance values are generated: a Level-1 value, representing within-subject variance (the extent to which participants vary from their own mean), and a Level-2 value, representing between-subjects variance (the extent to which participants' means vary from the general mean).

Results

Screening Phase

Correlations between measures included in the screening phase (Times 1 and 2) are presented in Table 2. GSEs were significantly correlated with stress ($r = .44–.46$, $p < .001$), as well as with state and trait dissociation ($r = .29–.53$, $p < .001$) and transliminality ($r = .38–.55$, $p < .001$). In addition, GSEs were correlated with general psychopathological symptoms and depression ($r = .44–.50$, $p < .001$), poor sleep quality ($r = .29$, $p < .001$), and gender ($r = .35$, $p < .001$, and $r = .27$, $p < .01$, for Times 1 and 2, respectively). Thus, all of these variables were controlled for in subsequent analyses. The BSI and the BDI were very strongly correlated ($r = .72$, $p < .01$), suggesting that they overlap. We therefore standardized and averaged them to create a composite psychopathology variable.

Next, we examined the distribution of these measures among the 60 participants of the daily diary phase. Only the RTS was normally distributed, according to the Shapiro-Wilk test for normality, as its *p*-level exceeded .05. Thus, all measures besides RTS were transformed. The CADSS was dichotomized, as 60% of participants had the lowest possible score (i.e., answered zero to all items). The ISES, PSQI, DES, NLEQ, and psychopathology composite were log transformed, so as to optimize improvement in skewness and kurtosis values.

Daily Diary Phase

Descriptive statistics for the daily SRE individual items are presented in Table 3. The grand mean of the GSEs global score was 1.68, with a standard deviation of 1.60. Sleep duration had a grand mean of 7.30, with an standard deviation of 1.63, and means and standard deviations for awakenings, latency, and quality were $M = 0.89$, $M = 16.61$, and $M = 3.70$, and $SD = 1.43$, $SD = 20.34$, and $SD = 0.97$, respectively. Daily stress' grand means and standard deviations were $M = 2.42$, $M = 27.48$, and $M = 11.15$, and $SD = 0.86$, $SD = 16.53$, $SD = 5.32$, for AIR, SUM, and FREQ, respectively. In Table 4, we present the intercepts-only model for daily GSEs (Model A). Daily GSEs scores varied mostly within subjects and not between subjects (87% vs. 13%, respectively).

Next, we specified the time variable as a repeated measure and entered all Level-1 variables into the model, namely, time, daily stress, sleep quality and duration, alcohol consumption, and a dichotomous weekend versus weekday variable. This model (Model B, presented in Table 5) evinced a better fit than Model A, $\chi^2(26, N = 60) = 122.54$, $p < .05$. Thus, Level-1 predictors improved the model beyond merely considering variability among individuals. While daily stress was a statistically significant predictor ($b = 0.13$, $SD = 0.06$), $t(451.91) = 1.97$, $p = .05$, time was not. Other significant predictors were sleep quality ($b = 0.31$, $SD = 0.09$), $t(47.90) = 3.64$, $p = .001$, and sleep duration ($b = 0.35$, $SD = 0.06$), $t(65.85) = 6.11$, $p = .000$. Both *worse* sleep quality and *longer* duration predicted an elevation in GSEs.

In a reversed model (-2 log likelihood = 1,284.14, parameters = 28), in which we attempted to predict daily stress by GSEs, time, sleep quality, duration, alcohol, and the weekend variable, only time was statistically significant ($b = 0.07$, $SD = 0.03$), $t(58.32) = 2.25$, $p = .028$. Thus, stress did rise with time (presumably due to the upcoming exam period), but GSEs did not predict the next day's stress.[2]

Next, main effects of Level-2 variables were added (Model C, presented in Table 6): gender, baseline GSEs (from the ISES), baseline stress, baseline sleep quality, psychopathology, trait dissociation, state dissociation, and transliminality. Statistically significant predictors were sleep duration ($b = 0.32$, $SD = 0.06$), $t(54.40) = 5.61$, $p = .000$, sleep quality ($b = 0.30$, $SD = 0.08$), $t(43.84) = 3.56$, $p = .001$, and trait dissociation ($b = 0.31$, $SD = 0.11$), $t(54.78) = 2.69$, $p = .01$. Then, interactions of these Level-2 variables with daily stress were entered (Model D, presented in Table 6). Statistically significant cross-level interactions were trait dissociation by daily stress ($b = 0.16$, $SD = 0.08$), $t(298.20) = 1.95$, $p = .05$, and sleep quality by daily stress ($b = -0.15$, $SD = 0.07$, $t(267.82) = -2.12$, $p = .04$.[3,4]

Probes of statistically significant interactions were performed based on Preacher, Curran, and Bauer (2006). Focusing first on trait dissociation, we found that the effect of daily stress on GSEs was statistically significant among dissociative participants ($b = 0.28$, $SD = 0.14$), $t(312.41) = 2.06$, $p = .04$, for 1 standard deviation above the DES sample mean, but nonsignificant among those low in dissociation ($b = -0.04$, $SD = 0.16$), $t(341.53) = -0.25$, *ns*, for 1 standard deviation below the DES sample mean.

Focusing on baseline sleep quality, we found that the effect of daily stress on GSEs was statistically significant among those who regularly sleep well ($b = 0.27$, $SD = 0.14$), $t(305.91) = 1.95$, $p = .05$, for 1 standard deviation below the PSQI sample mean, but not for those who report habitual low sleep quality ($b = -0.03$, $SD = 0.15$), $t(326.85) = -0.21$, *ns*, for 1 standard deviation above the PSQI sample mean.

To test our stress-diathesis hypothesis, the dissociation by daily stress interaction was probed by focusing on dissociation as the predictor and daily stress as the moderator. While multilevel cross-level interactions usually define the Level-2 variable as the moderator and the Level-1 variable as the focal predictor, there is no such restriction, that is, the conditional effects in the model are symmetrical (Bauer & Curran, 2005). Probes revealed that the effect of dissociation was robustly significant in conditions of high daily stress ($b = 0.54$, $SD = 0.14$), $t(99.93) = 3.90$, $p = .000$, for

[2] To conduct such an analysis, observations were paired differently in time, so that a night's GSEs were paired with the stress of the following day. Given that our first measurement was that of daily stress, in this model, there were 13 observations, not 14 (the first stress measurement and last GSEs measurement were omitted).

[3] In response to an anonymous reviewer's comment, we repeated these analyses with the three DES subscales instead of the DES global score. There was a statistically significant main effect for amnesia. Interactions were nonsignificant, although an interaction between absorption and stress approached statistical significance ($p = .056$). Notably, the transliminality by stress interaction, which was nonsignificant in Model D, became statistically significant in the subscale model.

[4] When performing these analyses with SUM or FREQ instead of AIR as daily stress measures, the effect of stress in Model B became nonsignificant. Model C was unaffected. In Model D, trait dissociation by stress interactions were nonsignificant, but when using FREQ, a state dissociation by stress interaction was statistically significant. Probes showed that among nondissociators, the effect of stress was nonsignificant ($b = -0.17$, $SD = 0.13$), $t(534.54) = -1.30$, *ns*, but it also failed to reach statistical significance in dissociators ($b = 0.17$, $SD = 0.09$), $t(435.67) = 1.91$, $p = .056$.

Table 2
Correlations, Means, and Standard Deviations of Screening Phase Study Variables (Times 1 and 2)

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Gender	—															
2. GSE T1	.35***	—														
3. LD T1	.08	.32***	—													
4. PSQI T1	.13†	.29***	.10	—												
5. DES T1	.16*	.41***	.15*	.23**	—											
6. CADSS T1	.07	.29***	.14*	.23**	.49***	—										
7. RTS T1	.09	.38***	.14*	.18**	.47***	.43***	—									
8. BSI T1	.23**	.50***	.16*	.41***	.55***	.35***	.35***	—								
9. BDI T1	.14*	.44***	.06	.40***	.43***	.37***	.35***	.72***	—							
10. NLEQ T1	.07	.46***	.19**	.29***	.43***	.41***	.29***	.57***	.49***	—						
11. GSE T2	.27**	**.73*****	.35***	.26**	.44***	.47***	.40***	.43***	.40***	.38***	—					
12. LD T2	.11	.25**	**.77*****	.06	.30***	.28***	.25**	.26**	.13	.24**	.43***	—				
13. DES T2	.15†	.39***	.29***	.23**	**.76*****	.58***	.46***	.44***	.40***	.32***	.53***	.43***	—			
14. CADSS T2	.14†	.28***	.15†	.22**	.58***	**.76*****	.41***	.36***	.45***	.31***	.38***	.23**	.67***	—		
15. RTS T2	.10	.40***	.22**	.17*	.47***	.40***	**.79*****	.30***	.33***	.24**	.55***	.30***	.57***	.47***	—	
16. NLEQ T2	.15†	.42***	.26**	.38***	.41***	.48***	.25**	.54***	.50***	**.80*****	.44***	.36***	.49***	.42***	.37***	—
M		2.80	2.55	5.38	11.90	0.13	21.06	0.86	7.17	1.50	2.81	2.48	10.38	0.09	21.02	1.45
SD		0.81	1.22	2.63	9.19	0.24	3.76	0.50	5.70	0.31	0.83	1.25	9.02	0.21	3.80	0.32

Note. Correlations with gender represent point-biserial correlations. Women were coded 1, and men were coded 0. Bold indicates test–retest correlations. Italics indicate statistically significant correlations. GSE = general sleep experiences; LD = lucid dreams; PSQI = Pittsburgh Sleep Quality Index; DES = Dissociative Experiences Scale; CADSS = Clinician Administered Dissociative States Scale; RTS = Revised Transliminality Scale; BSI = Brief Symptom Inventory; BDI = Beck Depression Inventory; NLEQ = Negative Life Events Questionnaire; T1 = Time 1; T2 = Time 2.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

1 standard deviation above the DSI–AIR sample mean, but nonsignificant in conditions of low daily stress ($b = 0.21$, $SD = 0.13$), $t(86.46) = 1.59$, *ns*, for 1 standard deviation below the DSI-AIR sample mean.

Discussion

Using a daily diary design enabling multilevel analyses, we found support for our three hypotheses, namely (a) within-subject daily stress prospectively predicts within-subject GSEs, even when controlling for the robust effects of sleep variables. We established *directionality* of this effect by demonstrating that GSEs were not a statistically significant predictor of the following day's stress; we demonstrated *specificity* of this effect in that (b) the effect of stress on GSEs was present only among dissociative individuals and (c) the effect of baseline trait dissociation on GSEs was present only in the face of daily stress.

Table 3
Descriptive Statistics for Daily SREs

			Individuals experiencing each item at least 1 night					
	Reports		1–2 nights		3–4 nights		≥5 nights	
Item	*n*	%	*n*	%	*n*	%	*n*	%
Remembering a dream	453	53.93	3	5.00	11	18.33	46	76.67
Bizarre dream	246	29.29	16	26.67	10	16.67	27	45.00
Hypnopompic hallucination	186	22.14	17	28.33	11	18.33	19	31.67
Hypnagogic hallucination	137	16.31	24	40.00	7	11.67	11	18.33
Bad dream	136	16.19	19	31.67	18	30.00	8	13.33
Confusion as to dream vs. reality	110	13.10	25	41.67	9	15.00	8	13.33
Sensing a presence	33	3.93	11	18.33	2	3.33	2	3.33
Nightmare	25	2.98	17	28.33	1	1.67	0	0.00
Dream of waking	24	2.86	13	21.67	3	3.33	0	0.00
Recurring dream	22	2.62	13	21.67	1	1.67	0	0.00
Falling dream	15	1.79	14	23.33	0	0.00	0	0.00
Sleep paralysis	13	1.55	6	10.00	0	0.00	1	1.67
Flying dream	0	0.00	0	0.00	0	0.00	0	0.00
Lucid dream	47	5.60	10	16.67	5	8.33	2	3.33

Note. Number of reports are from 840 reports, submitted by 60 participants across 14 nights; percentage of reports are out of 840; and number and percentage of individuals who reported the experience in 1–2, 3–4, and over 4 nights are out of 60 participants. SREs = sleep-related experiences.

Table 4
Covariance Parameters for Model A: The Intercepts-Only Model Predicting GSEs

Parameter	Covariance parameters						
	Level	Estimate	Standard error	Wald *Z*	*p*	Lower b.	Upper b.
Within sub. var.	1	2.23	0.11	19.75	.00	2.02	2.46
Between sub. var.	2	0.32	0.09	3.64	.00	0.19	0.55

Note. Model fit: −2 log likelihood: 3,124.04; parameters = 3. Lower b. = lower bound within a 95% confidence interval; Upper b. = upper bound within a 95% confidence interval; *df* = degrees of freedom. Within sub. var. = within-subject variance; Between sub. var. = between-subject variance.

Additionally, we found a robust main effect of dissociation on GSEs. These findings replicate and extend the cross-sectional association found between dissociation and GSEs (Fassler et al., 2006; Giesbrecht & Merckelbach, 2004, 2006; Soffer-Dudek & Shahar, 2009; Koffel & Watson, 2009; Watson, 2001, 2003) in establishing directionality of this association using a longitudinal daily diary design. Moreover, our findings go beyond this bivariate (albeit directional) association by specifying a condition in which it is manifested (i.e., high stress). This was enabled by integrating two separate lines of research, one focusing on dissociation and GSEs (e.g., Koffel & Watson, 2009; Watson, 2001) and the other on stress and GSEs (Soffer-Dudek & Shahar, 2009, 2010; Soffer-Dudek et al., in press).

The prospective effect of stress on GSEs among dissociators is reminiscent of Blagrove and Fisher's (2009) finding that daily mood predicts nightmares only among participants with "thin boundaries." Yet, while nightmares are linked to negative mental health or emotional distress (e.g., Bernert, Joiner, Cukrowicz, Schmidt, & Krakow, 2005; Levin & Fireman, 2002; Tanskanen et al., 2001; for a review, see Levin & Nielsen, 2007), most GSEs are not usually considered to be a negative phenomenon (e.g., waking dreams, bizarre dreams). Our findings suggest that they follow psychological stress and thus emanate from, or indicate, negative thoughts or emotions.

The impact of stress on GSEs might be explained through the activation of vigilance and hyperarousal. Stress leads to difficulties in falling asleep and maintaining sleep (e.g., Bernert, Merrill, Braithwaite, Van Orden, & Joiner, 2007; Brand, Gerber, Puhse, & Holsboer-Trachsler, 2010; Morin, Rodrigue, & Ivers, 2003), at least partly due to hyperarousal or hypervigilance (Morin et al., 2003). Dahl (1996) suggested that excessive worrying causes arousal, which prevents relaxation, in turn standing in the way of falling asleep. However, it is also possible that such arousal continues to be activated after sleep onset. Insomniacs have been shown to have higher activation in brain regions related to arousal (e.g., the ascending reticular activating system, ARAS) both when awake and when asleep, and whole-brain metabolism was significantly increased during different stages of the sleep–wake cycle (Nofzinger et al., 2004). Following psychological stress, insomniacs also have increased physiological arousal during NREM sleep, as assessed through measures of heart-rate variability (Hall et al., 2007). Arguably, stress causes changes in regulation and activation of brain regions or functions that are involved in hypervigilance in response to threat (such as the amygdala), even within dream states. The most obvious example would be nightmares, characterized by arousal and sensitivity to threat (Levin & Nielsen, 2007) and known to follow stressful events (e.g., Roberts et al., 2009).

Levin and Nielsen (2007) referred to a "cross-state continuity" to describe an effect of stress on both sleep and wakeful states, causing concurrent nightmares and psychopathology. Other unusual dream phenomena could be conceptualized as arousal periods within sleep as well. For instance, elevated dream recall and vivid dreams imply good memory and perception, usually characteristic of waking. Falling dreams constitute another example; they are likely to involve intense motor sensations and arousal. Similarly, problem-solving dreams could be viewed as activation of high-order regulation processes that are usually characteristic of waking, rather than dreaming, states.

It has been suggested that unusual nocturnal experiences represent switching errors between waking and sleeping states (Koffel & Watson, 2009; Mahowald & Schenck, 2001). Elements characterizing a certain state (e.g., REM sleep) occur in a different state (e.g., waking). For instance, hypnagogic hallucinations are conceptualized, in this view, as dreamlike mentation, occurring in the "wrong" time (i.e., during sleep onset instead of during REM sleep). Koffel and Watson (2009) posited that this is a possible

Table 5
Estimates of Fixed Effects for Model B

Parameter	Estimate	Standard error	*df*	*t*	*p*	Lower b.	Upper b.
Intercept	1.71	0.11	141.34	15.41	.00	1.49	1.93
Time	0.00	0.05	790.84	0.02	*ns*	−0.10	0.10
DSI–AIR	0.13	0.06	451.91	1.97	.05	0.00	0.25
Sleep quality	0.31	0.09	47.90	3.64	.00	0.14	0.49
Sleep duration	0.35	0.06	65.85	6.11	.00	0.23	0.46
Weekend	−0.08	0.11	1,267.30	−0.73	*ns*	−0.30	0.14
Alcohol	−0.06	0.06	1,126.11	−1.09	*ns*	−0.17	0.05

Note. Model fit: −2 log likelihood = 3,001.50; Parameters = 29; DSI = Daily Stress Inventory; AIR = average item rating; Lower b. = lower bound within a 95% confidence interval; Upper b. = upper bound within a 95% confidence interval; *df* = degrees of freedom.

Table 6
Model Fit and Estimates of Fixed Effects for Models C and D

Parameter	Estimate	Standard error	*df*	*t*	*p*	Lower b.	Upper b.
			Model C				
Intercept	1.70	0.19	76.18	9.10	.00	1.33	2.07
Time	0.00	0.05	531.96	0.70	*ns*	−0.10	0.11
DSI–AIR	0.10	0.07	433.47	1.48	*ns*	−0.03	0.23
Sleep quality	0.30	0.08	43.84	3.56	.00	0.13	0.47
Sleep duration	0.32	0.06	54.40	5.61	.00	0.21	0.44
Weekend	−0.09	0.11	102.67	−0.81	*ns*	−0.31	0.13
Alcohol	−0.07	0.06	23.53	−1.23	*ns*	−0.19	0.05
Gender	0.00	0.23	57.28	−0.01	*ns*	−0.47	0.47
CADSS	0.01	0.20	57.97	0.06	*ns*	−0.39	0.41
PSQI	−0.02	0.09	56.93	−0.24	*ns*	−0.20	0.16
ISES	0.11	0.11	56.83	1.03	*ns*	−0.11	0.34
NLEQ	0.04	0.10	56.70	0.46	*ns*	−0.15	0.24
DES	0.31	0.11	54.78	2.69	.01	0.08	0.53
Psych.	−0.02	0.12	56.91	−0.21	*ns*	−0.26	0.21
RTS	−0.13	0.10	56.30	−1.36	*ns*	−0.33	0.06
			Model D				
DSI * Gender	−0.01	0.19	400.59	−0.04	*ns*	−0.37	0.36
DSI * CADSS	0.01	0.15	393.76	0.09	*ns*	−0.29	0.31
DSI * PSQI	−0.15	0.07	267.82	−2.12	.04	−0.29	−0.01
DSI * ISES	0.03	0.08	214.89	0.34	*ns*	−0.13	0.19
DSI * NLEQ	0.02	0.08	302.01	0.27	*ns*	−0.13	0.17
DSI * DES	0.16	0.08	298.20	1.95	.05	0.00	0.32
DSI * Psych.	−0.04	0.09	316.02	−0.42	*ns*	−0.20	0.13
DSI * RTS	0.13	0.07	205.48	1.78	*ns*	−0.01	0.27

Note. For Model C, model fit: −2 log likelihood = 2,987.49; parameters = 37. For Model D, model fit: −2 log likelihood = 2,977.02; parameters = 45. In Model D, only interaction terms are shown, though all appropriate variables were entered into the regression analyses (i.e., main effects and interactions). For these analyses, gender was coded as women = 1, men = −1. Gender, CADSS, and weekend were entered as dichotomous variables. PSQI = Pittsburgh Sleep Quality Index; DES = Dissociative Experiences Scale; CADSS = Clinician Administered Dissociative States Scale; RTS = Revised Transliminality Scale; NLEQ = Negative Life Events Questionnaire; DSI = Daily Stress Inventory; AIR = average item rating; Psych. = psychopathology composite measure; Lower b. = lower bound within a 95% confidence interval; Upper b. = upper bound within a 95% confidence interval; *df* = degrees of freedom.

explanation for the relation between SREs and dissociation, the latter being viewed as REM dreamlike intrusions into waking (Giesbrecht et al., 2008) or NREM intrusions into waking (Mahowald & Schenck, 2001). Indeed, NREM mentation is often reported as fragmented (Pivik, 2000) and involving less perception than REM mentation (Hobson, Pace-Schott, & Stickgold, 2000). To the extent that such states of consciousness should occur during wakeful states, they might produce a dissociative experience. Thus, the construal of GSEs as "mixed states," in which arousal and vigilance mechanisms usually involved in waking become more activated in sleep, might account for the effect of stress on GSEs.

This leads to the stress-diathesis effect. In the face of negative emotion, dissociators switch attention faster in a set-switching task (Chiu, Yeh, Huang, Wu, & Chiu, 2009). They also experience a degraded ability for inhibition (Dorahy, McCusker, Loewenstein, Colbert, & Mulholland, 2006). Possibly, stress intensifies dissociators' ability to switch between different mental states. This may explain the hypothesized tendency for sleep–wake switching errors under stressful conditions: Boundaries between mental states may be less rigorously defined in dissociators experiencing stress.

Apparently, the tendency to dissociate mental states (e.g., separating memory from consciousness) is closely linked to the opposite tendency, namely, excessive fluidity between consciousness states (e.g., mixed states). This is also evident in the correlation found between dissociation and transliminality (see Table 2; as well as Soffer-Dudek & Shahar, 2009). Stress might be the trigger propelling individuals to shift from disengagement to fluidity and back. In clinical dissociation, disengagement and detachment enable the individual to ward off unwanted conscious experiences, such as traumatic memories. Future research should explore the role of stress in regulating transitions between detachment and fluidity in pathological dissociation.

Another noteworthy finding is the role of sleep patterns in GSEs. Replicating and extending previous studies on dream recall (Schredl & Fulda, 2005a; Schredl & Reinhard, 2008), we found that longer sleep duration was robustly related to GSEs. Possibly, GSEs are more likely to occur when sleep is longer, simply because there is more time for them to occur. Alternatively, dream recall might be increased following long sleep due to increased likelihood of awakening from REM sleep (Schredl & Reinhard, 2008). GSEs were also strongly related to poor sleep quality. While it is established that stress impairs sleep quality (e.g., Van Reeth et al., 2000), it is possible that GSEs follow a similar pattern, coinciding with impaired sleep following stress. Such a view is consistent with the above speculation, whereby stress leads to GSEs through increased vigilance and provides support for the notion that GSEs are a form of sleep disruptions. Alternatively, impaired sleep might serve as a mediator of the relation between stress and GSEs. Further research is needed to differentiate between these possibilities.

It is noteworthy that GSEs were predicted by both poor sleep quality and long sleep duration, because **short s**leep duration is usually treated as an indicator of poor sleep quality. In Watson (2003), there was no association between SREs and sleep quality. However, in this study, such a relation was robust. The discrepancy might emanate from the complex relations between sleep duration and quality and between duration and dream recall, mentioned above. Perhaps in Watson (2003), the combination of poor sleep quality and short sleep duration into a single score, as manifested in the PSQI, prevented GSEs from correlating with poor quality. In this study, separation of duration from quality enabled their reverse effects to reach statistical significance. Our findings suggest that these variables, albeit related (e.g., poor quality was associated with short duration in over a third of the nights measured), do not always converge into a single dimension.

The finding whereby daily stress predicted daily GSEs only among those who habitually slept well and not among those who reported habitual poor sleep quality is somewhat surprising. This finding might reflect a floor effect. Possibly, stress compromised sleep to a substantial extent only among those who habitually slept well.

Several correlations presented in Table 2 are noteworthy. First, there are statistically significant correlations involving LDs on one hand, and stress and psychopathological symptoms on the other. Similar relations were not found in Soffer-Dudek and Shahar (2009) and in Soffer-Dudek et al. (in press). LDs were also correlated with dissociation. This is compatible with some reports (Soffer-Dudek & Shahar, 2009; Watson, 2001, 2003) but not with others (Fassler et al., 2006; Giesbrecht & Merckelbach*,* 2004, 2006). Theoretically, LDs may be viewed as a mixed state of sleeping and waking. Thus, it should follow dissociation and stress much like GSEs. Research on LDs is inconsistent. It has been related to stress on one hand (e.g., Wolpin, Marston, Randolph, & Clothier, 1992) and to resilience on the other (e.g., Soffer-Dudek et al., 2011; Wolpin et al., 1992). Their similarities and differences with respect to GSEs and their associations with stress and dissociation should be clarified in future research.

Second, while trait and state dissociation were significantly correlated at both Times 1 and 2, as were GSEs and state dissociation, state dissociation did not emerge as a significant predictor of GSEs in the daily diary phase. Possibly, the 9-week time lag between the first wave of the study and the daily diary phase rendered the state measure less relevant. Third, dissociation and transliminality were intercorrelated, as were GSEs and LDs with transliminality, replicating previous findings (e.g., Soffer-Dudek & Shahar, 2009) and extending the relation of transliminality to state, and not just trait, dissociation. Somewhat surprisingly, transliminality did not predict, or interact with stress to predict GSEs. While both dissociation and transliminality are related to unusual cognitive perception, dissociation is more strongly tied to psychopathology (in line with the stronger correlations with psychopathology, presented in Table 2) and is thus perhaps more relevant to stress-diathesis effects.

A somewhat surprising finding emerged when using the DES subscales instead of the global DES score. There was a statistically significant main effect of amnesia on daily GSEs, while the main and interactive effects of absorption did not reach statistical significance. In Watson (2001), GSEs were related to all three DES subscales and were most strongly related to absorption. Absorption tends to be viewed as less pathological than other dissociative symptoms (Giesbrecht & Merckelbach, 2006) and was associated with GSEs in Fassler et al. (2006). Moreover, the significance of amnesia in dissociation has been questioned (Giesbrecht et al., 2008). In contrast, our own finding points to the relevance of amnesia in dissociation and in altered consciousness states and supports the association of GSEs with psychopathology (Soffer-Dudek & Shahar, 2009; Soffer-Dudek et al., in press).

One more noteworthy finding of this study pertains to Cronbach's alphas calculated for the daily GSEs measure, for each of the 14 nights. Although we did not expect items to be interrelated (i.e., having one GSE is not supposed to increase the likelihood of having another on the same night), alphas demonstrated low to moderate consistency between GSE items. It is possible that GSEs are related as a state, and not only a trait, factor. This pattern should be examined in future studies.

Study limitations should be noted. Our focus on a predominantly female student sample restricts generalization to other populations. Moreover, generalizability is tempered as stress varied between assessment waves. Additionally, while daily measurements and logs are more reliable than retrospective reports (Beaulieu-Prévost & Zadra, 2005), study measures were exclusively self-report ones, and this might lead to shared method variance, possibly inflating associations. Also, while an interaction between DSI–FREQ and CADSS followed a similar path to our hypotheses, overall, effects were unique to DSI–AIR. Additionally, high and low levels of dissociation and stress were determined statistically; their correspondence to clinical entities is not clear. Finally, although our findings are consistent with causal inference and in fact establish directionality, such causality is not yet definitive. Other variables underlying the relation between sleep and dissociation were not assessed (e.g., daily mood, attention, memory, and fantasy proneness).

Nevertheless, these limitations should be weighed in the context of the study's strengths. These include a methodologically rigorous daily diary design, enabling a straightforward test of theoretically based, hypothesized interactions between stress and trait dissociation, while taking into consideration a host of intervening variables. The role of dissociation, psychological stress, and possibly arousal during sleep should be further explored in an attempt to decipher different forms of nocturnal consciousness.

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Received June 25, 2010
Revision received January 20, 2011
Accepted January 20, 2011 ■