

Effects of Stress on Sleep: The Moderating Role of Coping Style

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The aim of this prospective quasi-experimental study was to assess the role of coping style as a factor moderating the relationship between stress and sleep. Sleep of 36 students was assessed by means of actigraphy and daily logs during low-stress and high-stress periods. The high-stress period was the week that the students were evaluated for acceptance to graduate programs in clinical psychology. The low-stress period was a regular academic week. The students' ways of coping were assessed during the baseline low-stress period using the COPE inventory. Data analysis revealed that a high emotion-focused coping score was significantly predictive of reduction in sleep time from the low- to the high-stress period. These results suggest that coping style is a key factor in assessing the relationship between stress and sleep.

Key words: sleep, stress, actigraphy, coping

Research on the effects of stress on sleep has yielded confusing and inconsistent results. Many studies have associated stress with sleep difficulties in infants, children, and adults (Cartwright & Wood, 1991; Healey et al., 1981; Lavie, 2001; Lundh & Broman, 2000; Pillar, Malhotra, & Lavie, 2000; Ross, Ball, Sullivan, & Caroff, 1989; Sadeh, 1996; Van Reeth et al., 2000; Waters, Adams, Binks, & Varnado, 1993). These sleep problems included difficulty falling asleep, fragmented sleep, and recurrent and frequent nightmares. A few studies have also shown that induced stress can increase arousal and delay sleep onset (Gross & Borkovec, 1982; Van Egeren, Haynes, Franzen, & Hamilton, 1983). However, other studies have failed to detect these disruptions or have documented more resilient sleep in association with stressful conditions or posttraumatic stress disorder (Dagan, Zinger, & Lavie, 1997; Lavie, Carmeli, Mevorach, & Liberman, 1991; Pillar et al., 2000).

Stress theories offer some rationale for these seemingly inconsistent findings. Analysis of the relevant sleep and stress literature (Sadeh, 1996; Sadeh & Gruber, 2002) has led to the identification of two distinct modes of relevant response of the sleep-wake system: (a) the "turn on" response of the "alarm phase" (Selye, 1983), which is compatible with hypervigilance and incompatible with sleep, and (b) the "shut off" response of the stage of exhaustion (Selye, 1983), which leads to reduced activity, preservation of energy, and is compatible with extended sleep. The shut off response is also compatible with the conservation-withdrawal hypothesis (Engel & Schmale, 1972), which suggests that under conditions of severe and uncontrollable stress the organism tends to withdraw from activity and preserve energy until the circumstances change.

These two response modes or biobehavioral systems appear to relate to key factors or principal ways of coping in the coping literature (Folkman & Lazarus, 1980; Skinner, Edge, Altman, & Sherwood, 2003). The conceptualization of ways of coping relies on three different aims for the individual's behavioral and cognitive efforts: (a) problem-focused coping (PFC) focuses on managing or altering the problem causing the distress, (b) emotion-focused coping (EFC) is aimed at regulating emotional responses to the problem, and (c) disengagement (DE) is aimed at disengaging from the threatening stimuli and related thoughts and emotions.

Analysis of the sleep and stress literature (Sadeh, 1996; Sadeh & Gruber, 2002) suggests that a coping style that favors dissociation and disengagement would be more likely to lead to "escape to sleep." Increased sleep is likely to reduce exposure to the stressor and the associated adverse feelings and cognitions. Thus, sleep in itself has a role in regulating the exposure to stress and its effects. However, sleep is incompatible with emotional coping, and sleep itself represents loss of control. Therefore, high EFC is more likely to increase alertness and thus produce physiological arousal (Selye, 1983) and disrupt or reduce sleep.

The individual's coping style has rarely been addressed in sleep and stress studies. The first study that has explored this issue was a retrospective study of sleep and coping style conducted with college students (Hicks, Marical, & Conti, 1991). In this study, the authors examined the coping style with the Ways of Coping assessment questionnaire (Folkman & Lazarus, 1980). Their findings indicated that short sleepers used more EFC than long sleepers. Recently, Morin, Rodrigue, and Ivers (2003) reported that, in comparison with controls, insomnia patients relied more on emotion-oriented coping strategies and perceived their lives as more stressful. Taken together, these studies supported the idea that EFC is associated with compromised sleep.

Our quasi-experimental study was based on exposure to a highly stressful period in the lives of young undergraduate psychology students who apply for graduate programs in clinical psychology. These are highly competitive programs with a 1:10 acceptance ratio. The most intense period is the week in which the students are being interviewed and assessed for the program. Many of them consider this a critical period in their career that would determine

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their ability to pursue their most desirable career track. Previous observations and subjective reports indicated that the students indeed consider this period as one of the most stressful periods of their lives (see also Keinan & Sivan, 2001).

In the present study, we assessed the role of the individual's coping style in moderating the link between stress and sleep. However, unlike previous studies, our study included a quasi-experimental design and objective sleep measures. On the basis of our theoretical perspective and previous findings (Hicks et al., 1991; Morin et al., 2003), we hypothesized that (a) the sleep of individuals with high EFC would be shortened and/or become more disrupted during the high-stress period than during the low-stress period and (b) the sleep of individuals with high DE would be extended and/or less disrupted during the high-stress period than during the low-stress period. No specific hypothesis was made with regard to PFC. However, because PFC plays a major role in the conceptualization of coping and adjustment (Folkman & Lazarus, 1980; Skinner et al., 2003), we have decided to include this measure in our study to evaluate its contribution.

Method

Participants

Thirty-six undergraduate students (28 women and 8 men) majoring in psychology participated in the study. Their ages ranged between 22 and 32 years ($M = 24.75$, $SD = 2.17$), and they were all healthy and medication free. These students were chosen because they all applied to graduate programs in clinical psychology, they agreed to participate in the study on a voluntary basis, and they all signed informed consent forms. Twelve students declined participation because of overload or technical reasons.

Measures

Assessment of ways of coping. Each participant completed the COPE inventory (Carver, Scheier, & Weintraub, 1989) during the low-stress week. The COPE inventory is based on the model and earlier questionnaires developed by Folkman and Lazarus (1980, 1985). This questionnaire consists of 52 items that describe different behaviors and mental activities associated with coping with stress. The participants were asked to rate the level of their own use of each behavior described in each item (e.g., "I learn to live with it" "I think hard about what steps to take" "I let my feelings out"). In the present study, we used three global factors: PFC, EFC, and DE. Acceptable Cronbach's alpha reliability coefficients were reported by the authors (Carver et al., 1989), and in the present study, coefficients of .82, .80, and .59 were obtained for PFC, EFC, and DE, respectively.

Assessment of sleep: Actigraphy. Each participant was monitored with an actigraph (AMA-32, Ambulatory Monitoring Inc., Ardsley, NY) for 5 consecutive nights in each monitoring week (low-stress and high-stress weeks). Participants were asked to attach the actigraph to their nondominant wrist when they went to bed and to remove it after waking up in the morning. The actigraphs were initialized to collect data in Mode 18, with 1-min data-collection intervals. Actigraphic raw data were translated into sleep measures using the Actigraphic Scoring Analysis program for an IBM-compatible PC (Sadeh, Sharkey, & Carskadon, 1994). These sleep-wake measures have been validated against polysomnography with agreement rates for sleep-wake identification higher than 90% (Sadeh et al., 1994).

Actigraphic sleep measures included the following: (a) sleep onset time (the first minute after reported bedtime that was identified as sleep by the Actigraphic Scoring Analysis program sleep-wake algorithm, which was followed by at least 15 min of uninterrupted sleep); (b) sleep period (from sleep onset time to morning awakening); (c) true sleep time (sleep time excluding all periods of wakefulness); (d) sleep percentage (percentage of

true sleep time from total sleep period); (e) night wakings (number of wakings that lasted 5 min or longer and that were preceded and followed by at least 15 min of uninterrupted sleep); (f) morning rise time (the first minute of the first episode of wakefulness following the last episode of sleep).

Assessment of sleep and stress: Daily logs. In addition to the objective sleep measures, daily logs were used to obtain subjective information from the participants. The subjective information was used for assessing a subjective perception of sleep quality and a self-reported stress level. The daily logs included the following scales: (a) Morning Stress Level, a 9-point scale ranging from 1 (*not stressed at all*) to 9 (*very stressed*); (b) Evening Stress Level, identical to the previous scale; (c) Perceived Sleep Quality, a 3-point scale ranging from 1 (*very poor sleep*) to 3 (*very good sleep*); and (d) Difficulty Falling Asleep, a 3-point scale ranging from 1 (*very easy*) to 3 (*very difficult*). We collected multiple stress ratings (morning and evening each day) to increase the reliability of the measure.

Procedures

The study was reviewed and approved by the Ethics Committee of the Department of Psychology at Tel Aviv University. Three to 4 months prior to the scheduled admission evaluation process, the students were contacted and asked to participate in the study. The students were recruited by a peer research assistant who administered all of the procedures and reassured them that their identity would remain anonymous and they would not be linked in any way to the information collected in the study. All data were handled with the study's participant number, and the identity of the participants remained sealed. The participants were informed that the general aim of the study was to explore the relationship between sleep and stress. During a low-stress regular academic week, 2–3 months before the admission evaluation period, each participant completed the COPE inventory to assess ways of coping. For a period of 5 days, the participants were asked to wear an actigraph and complete daily logs assessing their perceived sleep and stress. During the high-stress period, the participants repeated the sleep and stress assessment using actigraphy and daily logs. A research assistant contacted the participants during the study to verify compliance with the procedures. The students received charts illustrating their sleep patterns following the completion of the study.

Results

Our data analyses included the following: (a) analysis of changes in subjective perception of stress from low-stress to high-stress monitoring period; (b) analysis of changes in sleep patterns between these two periods, considering the ways of coping as moderating factors; and (c) analysis of additional links among the sleep and stress variables.

Changes in Perceived Stress Level

To check if the applicants' evaluation week was perceived as more stressful than the regular week, we calculated the stress scores for each individual for each period (low and high stress). The participants completed ratings of stress level twice each day (in the morning when awakening and in the evening before bedtime), and we used two statistics, the averaged and maximum ratings, to characterize each period for each individual. The maximum ratings were used to capture the highest stress levels associated with specific events (such as the day of interview). The results indicate that stress levels during the interview week were significantly higher in comparison with the baseline week on three of the four measures. Morning maximum stress level during the high-stress week ($M = 6.31$, $SD = 1.47$) was significantly higher in comparison with the low-stress week ($M = 4.89$, $SD = 1.82$),

$F(1, 35) = 20.9, p < .0001$, and similar differences were found for the averaged morning stress level ($M = 3.92, SD = 1.23$ vs. $M = 3.43, SD = 1.36$, respectively), $F(1, 35) = 6.5, p < .05$, and the maximum evening stress level ($M = 6.17, SD = 1.70$ vs. $M = 5.17, SD = 1.59$, respectively), $F(1, 35) = 9.6, p < .005$. No significant effect was found for the averaged evening level.

Changes in Sleep Patterns

To test the relationship between stress and sleep and the moderating role of coping style, we used a repeated-measure analysis of variance based on the general linear model (GLM) analysis (SAS, 1990), with gender and age as control variables and EFC, PFC, and DE as three linear independent measures. All of the predictors and control variables were simultaneously entered into the model. The sleep measures on each testing period (low and high stress) were used as the dependent measures, with period as the independent repeating measure (with two levels for low- and high-stress measurement periods).

The test of our hypotheses regarding the moderating role of coping lies in the interactions between the period and the coping scale scores. As shown in Table 1, significant Period \times EFC interaction effects were found for sleep period and true sleep time. These interactions indicate that high EFC scores were associated with reduction in sleep period in true sleep time (high-stress period in comparison with low-stress period). The Period \times DE interaction was marginal and failed significance test with Bonferroni correction.

Significant main effects were found only for PFC for the sleep measures. High PFC scores were associated with longer sleep period and true sleep time (on both study periods). None of the main period effects were significant.

We retested the results of this model using a model of planned comparisons for our specific hypothesis regarding EFC and DE and obtained the same results. For an additional illustration of our findings, we divided the participants into two groups based on their EFC scores (high EFC for those above the median score and low EFC for those below the median score). Participants with low EFC score increased their true sleep time by 33 min (from the low- to the high-stress period), whereas true sleep time of participants with high EFC scores decreased by 23 min, respectively.

The subjective reports also yielded a significant Period \times EFC interaction effect for the perceived sleep quality ratings of the

participants, $F(1, 32) = 9.95, p < .005$. Individuals with high EFC reported decreased perceived sleep quality during the high-stress period in comparison with the low-stress period, whereas the opposite was true for those with low EFC. Furthermore, a significant correlation was found between the change in perceived sleep quality (from the low-stress to the high-stress period) and the change in level of stress between these periods, $r = .45, p < .01$. Increase in stress level was associated with significant decrease in perceived sleep quality.

Discussion

This study is, to the best of our knowledge, the first to assess, in a prospective manner, how individual coping styles moderate the response of the sleep-wake system to significant stress. The naturalistic design of the study enabled documenting sleep using objective measures in the regular sleep environment and subjective stress response using daily subjective ratings. However, the limitations of our study should also be emphasized. Our study relied on measuring stress and sleep during one low-stress period (regular school week) and one high-stress period (screening week), and some order effects cannot be ruled out. Although attempts were made to contact the participants to ensure completion of the daily reports, the compliance with the protocol of the daily reports could not be determined. In addition, the use of multivariate analysis and a number of different measures with a relatively small sample is also a limitation that should be noted, as it might have compromised the reliability of the findings. The significant increase in the stress level documented by the subjective daily stress ratings indicated that the period of evaluation for the clinical psychology graduate program was indeed a stressful period in comparison with the low-stress week that preceded it by 2–3 months.

In line with our hypotheses, changes in sleep were significantly moderated by the individual's coping style. Individuals with high EFC shortened their sleep, whereas those with low EFC extended their sleep during the high-stress period. Furthermore, individuals with low EFC improved their perceived sleep quality during the high-stress period, whereas the opposite was true for those with high EFC. These results support earlier findings linking shortened sleep and insomnia with high EFC (Hicks et al., 1991; Morin et al., 2003). Thus, shortened sleep may reflect ineffective coping. This result is consistent with other findings suggesting that EFC is

Table 1
Multivariate Analysis Based on GLM Analysis: *F* Values and Significance of Effects (With Bonferroni Correction for Multiple Comparisons)

Analysis for sleep measure	Age	Gender	EFC	PFC	DE	Period \times EFC	Period \times PFC	Period \times DE
Sleep onset time	0.03	0.16	0.85	0.24	0.07	1.04	0.69	0.29
Morning rise time	1.01	0.08	0.03	2.49	0.11	6.15	0.48	0.65
True sleep time	2.34	6.66	5.09	17.20**	0.03	15.70**	0.08	4.72
Sleep period	1.36	1.37	2.09	10.40*	0.00	15.00**	0.01	2.19
Sleep percentage	0.26	7.67	1.86	1.73	0.05	1.49	0.42	2.12
Night wakings	0.35	8.10	3.16	2.34	0.00	1.14	0.18	0.54

Note. For all effects, $dfs = 1, 30$. Effects not included in the table were all nonsignificant in all of the analyses. GLM = general linear model; EFC = emotion-focused coping; PFC = problem-focused coping; DE = disengagement coping; period = low-high stress period.

* $p < .05$. ** $p < .005$.

ineffective in stressful situations in which the individual has some level of control (Martelli, Auerbach, Alexander, & Mercuri, 1987).

Our hypothesis that the disengagement coping style would be associated with extended sleep during stress received little support in our study. The Period \times DE interaction was only marginally significant and failed to reach significance after the Bonferroni correction. Therefore, the role of DE in moderating the relationships between stress and sleep could not be determined from our research and should be further explored.

Our findings indicate that, on the basis of actigraphic measures, changes in sleep patterns from the low-stress to the high-stress period were mainly manifested in measures related to sleep period and not in sleep fragmentation measures. It is not clear whether sleep quality was not affected by the stress or our actigraphic measures were not sensitive enough. An interesting significant finding that emerged from our results is the positive association between PFC and the sleep quantity measures (sleep period and true sleep time). A high PFC score was associated with more sleep regardless of the specific period (vis-à-vis stress level). We failed to find any similar finding in the literature and address it as a preliminary finding that requires replication.

In conclusion, our study is the first prospective study that has documented distinct patterns of change in sleep period in response to stress, using objective sleep measures. Our results, emphasizing the role of coping style as a moderating factor, may explain some of the conflicting, or lack of, findings in previous studies (Pillar et al., 2000; Sadeh, 1996; Van Reeth et al., 2000). If coping style had not been considered as a moderating factor in our study, the significant changes in sleep would have been lost, because individuals responded in a variety of ways, according to their coping style.

The biobehavioral mechanisms underlying the role of emotion-focused coping in moderating the relationships between sleep and stress should be further explored. The relationships between coping and anxiety may offer some insight. In a prospective study on coping and anxiety in college students, Zeidner (1994) reported that high EFC predicted increased anxiety during the high-stress period (college examinations) and concluded that EFC is associated with poor adaptation to this specific stress. Furthermore, increased reported anxiety and arousal level have been linked to insomnia and high EFC (Morin et al., 2003). Thus, the underlying mechanism might be that individuals with high EFC tend to react to stressful situations with elevated anxiety, which leads to an increased arousal level that is associated with compromised sleep.

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