Original Article

Day-to-day relations between stress and sleep and the mediating role of perseverative cognition

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ABSTRACT

Objective: The goals of this longitudinal diary-based study were to shed light on the day-level relationship between stress and subsequent sleep, and to examine whether perseverative cognition is a mediating factor in this relation.
Methods: A total of 44 Dutch PhD students were followed during a two-month period, from one month before their public thesis defense (ie, a stressful life event), until one month thereafter. Participants completed short evening and morning questionnaires on eight occasions (in anticipation of and following the defense), including questions about day-level stress, sleep quality, and perseverative cognition. Objective sleep parameters were collected with the SenseWear Pro Armband.
Results: Multilevel analysis was used to analyze daily observations nested within individuals. Analyses revealed that day-level stress was not directly related to subsequent subjective sleep indicators or to subsequent objective sleep indicators. Day-level stress was significantly associated with day-level perseverative cognition, and daily variations in perseverative cognition were significantly related to several day-level objective sleep parameters (sleep efficiency, marginally to number of awakenings, and wake after sleep onset), and to several day-level subjective sleep parameters (sleep quality, number of awakenings, wake after sleep onset). Finally, mediation analyses using path analysis suggested that, on the day level, perseverative cognition functions as a mediator between stress and several sleep parameters, namely, subjective sleep quality, objective sleep efficiency, and subjective wake after sleep onset.
Conclusion: Perseverative cognition is a promising explanatory mechanism linking day-level stress to subjective and objective measures of sleep.

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1. Introduction

It has been reported that one-third of people suffer from poor sleep and roughly 10% meet the criteria for insomnia [1,2]. Sleep quality (the experience of sleep in terms of sleep continuity) and sleep quantity (duration of sleep) are both important aspects of sleep [3,4]. Low sleep quality is characterized by difficulties initiating sleep (long sleep onset latency) and difficulties maintaining sleep (high number of awakenings, long duration of awakenings).

Sleep quality and sleep quantity can be assessed objectively, but subjective measures of sleep indicators have also been widely used to assess sleep [5]. Subjective and objective measures of sleep do not always concur [5,6], and it has been suggested that this is due to the fact that both methods measure different underlying processes. However, both provide valuable insights into sleep patterns [5,7,8]. By assessing both objective and subjective sleep parameters, a complete overview of sleep is achieved, which improves the validity of results [9].

Previous research has shown that subjective as well as objective indicators of poor sleep are related to poor health [10–15]. As such, it is important to know the causes of poor objective and subjective sleep [16]. Several reviews have provided evidence for a cross-sectional and longitudinal relationship between (work-related) stress and objective and subjective sleep parameters. A review of all cross-sectional studies, for example, found that stress is related to shortened sleep and sleep fragmentation [16]. Moreover, a recent review of longitudinal and intervention research has shown that job demands are negatively related and job control is positively related to sleep quality [17].

It has been suggested that perseverative cognition (PC) [18,19] is a key mediator in the relationship between stress and poor sleep. PC is defined as "repeated or chronic activation of the cognitive representation of one or more psychological stressors" [19, p. 114] and is related to both stress and sleep complaints [9,18]. It appears that perseverative cognitions about stressors or stressful situations

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prolong physiological activation that occurs in response to stressors and hinder sleep itself and physiological restoration (recovery) during sleep [3].

Longitudinal studies (with time lags of one year or longer) suggest that PC may mediate the relationship between stress and sleep [9,20]. However, longitudinal research has focused mostly on between-person differences in PC, and only in a few studies have within-person fluctuations been considered [21]. As such, these longitudinal studies with long time lags do not take into account that stress, sleep, and PC show day-level fluctuations within an individual and may co-vary accordingly [22].

We set out to investigate whether within-person variations in stress are related to within-person fluctuations in objective and subjective sleep. Second, this study examined whether day-level PC functions as a mediator in this relationship. To provide an answer to these research questions and to ensure a high-stress sample with high within-person variation in stress, PC, and sleep, we chose to study PhD students awaiting and following their PhD dissertation defense. The PhD dissertation defense, which is public in the Netherlands, has previously been described as a strong and well-defined real-life stressor [23], and consequently we expect naturally occurring, daily fluctuations in stress. We predict that daily stress is adversely associated with subsequent day-level objective sleep parameters (hypothesis 1) and with day-level subjective sleep parameters (hypothesis 2). Moreover, we hypothesized that day-level PC mediates day-to-day relationships between stress on the one hand and objective sleep parameters (hypothesis 3) and subjective sleep parameters (hypothesis 4) on the other.

2. Method

2.1. Procedure and design

In this study, we followed a group of PhD students before and after a predictable, stressful event: the PhD dissertation defense. In the Netherlands, the dissertation defense is a one-hour public oral examination in front of an audience and several expert professors who act as opponents. During the first 10 minutes of the dissertation defense, the PhD student gives a presentation introducing his or her PhD thesis. In the remaining 50 minutes, he or she has to answer critical questions, both unknown and usually unexpected, from the professors. The dissertation defense is a situation of low control and has a high social evaluative component, demanding peak performance. Therefore, the defense is commonly experienced as being fairly stressful [23].

For each participant, data collection for this study took place during a time span of eight weeks, starting four weeks before the dissertation defense and ending four weeks after. Four measurements occurred before the dissertation defense [four weeks (Pre 1), one week (Pre 2), three days (Pre 3), one day (Pre 4) before the dissertation defense], and four measurements were done after the dissertation defense [one day (Post 1), three days (Post 2), one week (Post 3), and four weeks (Post 4)]. Before taking part in the study, participants were given detailed information about the research procedure and provided informed consent.

At Pre 1, respondents were asked to fill in a general questionnaire regarding demographic information, psychosocial work characteristics (ie, average job demands and job control), general stress, and overall sleep quality. On all eight day-level measurement occasions, respondents received a short digital questionnaire via e-mail at 7 PM and another questionnaire the following morning (7 AM). Participants were asked to fill in the evening questionnaire at bedtime and the morning questionnaire shortly after awaking. In the evening questionnaire, momentary feelings of stress were measured. In the morning questionnaire, parameters of subjective sleep of the previous night were assessed, as well as bedtime PC. Bedtime PC was measured in the morning to avoid interference with subsequent sleep. During the night in between both diaries (discussed later here), objective sleep was measured with an actigraph. Respondents could choose to receive reminders for completing the diaries in the form of text messages. Text messages were sent as requested by respondents: in the evening, morning, or on both occasions. Fig. 1 provides a visualization of the design and an overview of measurement occasions.

Two lottery prizes were raffled among respondents to promote participation and to reduce missing data. Winners could choose between an iPad mini and a holiday park gift card matching the value of the iPad mini (ie, €389). Respondents who filled in all diaries had a higher chance of winning than respondents with missing data. The present study was approved by the Ethics Committee of the Faculty of Social Sciences of the university involved, and written informed consent was obtained from all participants.

2.2. Participants

Once a month between July 2013 and March 2015, all PhD students affiliated with a university in the Netherlands and awaiting their dissertation defense within two months were invited to participate (ie, 10 – 40 PhD students each month). In total, 356 PhD students were contacted via e-mail. However, many of these were
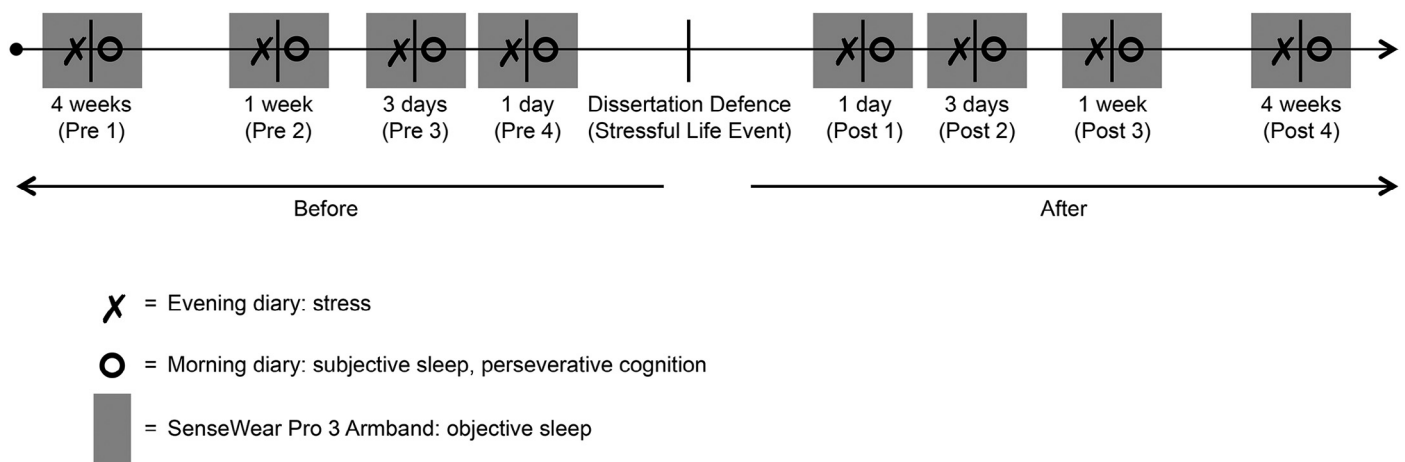

Fig. 1. Visualization of study design and overview of measurement occasions.