Perseverative cognition : the impact of worry on health

Verkuil, B.

Worry and Somatic Health

Chapter 4

Effects of momentary assessed stressful events and worry episodes on somatic health complaints

Bart Verkuil, Jos F. Brosschot, Esther E. Meerman, & Julian F. Thayer

Manuscript under review

Abstract

Somatic health complaints are extremely common and are responsible for a large part of human suffering and health care costs. It has been recognized that psychosocial stress can affect somatic health. Yet, according to the "perseverative cognition hypothesis", stressful events can only affect somatic health when people keep on worrying about them. Worry would prolong stress-related physiological activity that can ultimately lead to health problems. In this ambulatory study we tested whether stressful events and worry predict daily somatic complaints, and whether worry mediates the effects of stressful events. In addition, it was tested whether these effects were independent from negative affect. Using electronic diaries, sixty-nine teachers (age 21 - 60) from Dutch primary and secondary schools reported daily stressful events, worry episodes, negative affect and somatic complaints for a period of six days. Results showed that worry intensity predicted the number of somatic complaints and mediated the effect of stressful events on somatic complaints. Furthermore, these results were independent from biobehavioral variables and daily negative affect. These findings support the perseverative cognition hypothesis proposing that the negative somatic health effects of stressful events are largely due to the worry, that is, to the prolonged cognitive representation of stressors.

Introduction

Somatic health complaints are extremely common. A survey among more than 1 million people in the US revealed that 40% to 55% were subject to headaches, 33% to 46% fatigue, and 15% sore throat at the point in time that they were being examined (Hammond, 1964). In a study in the Nordic European countries (Eriksen, Svendsrod, Ursin, & Ursin, 1998) 75% of the respondents reported one or more subjective health complaints. A recent investigation in a general Dutch population (older than 25 yr) found that low back pain, shoulder pain and neck pain occurred in respectively 26.9%, 20.9% and 20.6% of the subjects (Picavet & Schouten, 2003). Between 33 and 42% of those with complaints consulted their general practitioner about their pain. In addition, most of these complaints concern vague symptoms without a clear medical diagnosis (Kroenke & Mangelsdorff, 1989). A survey in seven outpatient clinics in London, across a variety of specialties, showed that 52% of the patients fulfilled criteria for medically unexplained symptoms. In some specialties, it was the most common diagnosis (Nimnuan, Hotopf, & Wessely, 2001). In addition, the costs for the investigations are frequently high, taking into account the medical actions involved, which come on top of sick leave compensations and the loss of productivity (Eriksen & Ihlebaek, 2002). This short analysis makes clear that it is important to investigate which processes underlie the reporting of somatic complaints.

It has been recognized for a long time that psychosocial stress can affect somatic health. The perception of a stressful event triggers the physiological stress response and when this response is prolonged for too long it can become detrimental for ones somatic health (Mcewen, 1998; Brosschot & Thayer, 1998; Linden, Earle, Gerin, & Christenfeld, 1997; Schwartz et al., 2003; Pieper & Brosschot, 2005). One important feature of stressful events is that they not only trigger the physiological stress response, but also trigger perseverative thoughts about these events. In recent years, this perseverative thinking, such as worrying about upcoming stressful events, has been put forward as the central pathological mechanism mediating between the perception of stressful situations and poor somatic health, including somatic complaints (Brosschot, Pieper, & Thayer, 2005; Brosschot, Gerin, & Thayer, 2006; Watkins, 2008). According to this “perseverative cognition hypothesis” (Brosschot et al., 2006), worrying about stressors prolongs the total amount of time that these stressors adversely affect physiological functioning. Several studies provide evidence for this idea, in the laboratory (see Brosschot et al., 2006, and more recent: Gerin, Davidson, Christenfeld, Goyal, & Schwartz, 2006; Key, Campbell, Bacon, & Gerin, 2008; Zoccola, Dickerson, & Zaldivar, 2008) but also in daily life. With respect to the latter, worry mediated the effect of stressful events on cardiac activity during waking as well as sleeping at night (Brosschot, van Dijk, & Thayer, 2007). Other ambulatory studies have shown that worry about *stressful events at work* is related to heightened

cortisol levels (Schlotz, Hellhammer, Schulz, & Stone, 2004) and with heightened heart rate in a sample of teachers (Pieper, Brosschot, van der Leeden, & Thayer, 2007). In addition, people who keep on worrying about their work after the workday has passed, have difficulties 'unwinding' and suffer from more emotional and somatoform symptoms (Geurts & Sonnentag, 2006; Sonnentag, Binnewies, & Mojza, 2008) than those who do not. Moreover, prospective studies have provided evidence that the tendency to worry about things and the inability to 'unwind' or disengage after work is associated with cardiovascular morbidity (van Amelsvoort, Kant, Bultmann, & Swaen, 2003) and even mortality (Kivimaki et al., 2006).

Furthermore, the perseverative cognition hypothesis predicts that worry – through these prolonged physiological responses - leads to somatic complaints, and mediates the effects of stressful events on these complaints. There is some evidence that stressful events have such an influence on somatic complaints. Cross-sectional studies have shown that worry is associated with several somatic health complaints, especially with (neck) pain (Freeston et al., 1996; Thomsen et al., 2004). Also, Emmons and King (1988) found that individuals who spend a large amount of time ruminating about their conflicting life goals show higher levels of somatic complaints. More recently, in a prospective study, Brosschot and Van der Doef (2006) found in a sample of adolescents that a simple worry intervention was helpful in reducing worry during six consecutive days. This reduction in worry in turn, predicted a decrease in the number of subjective health complaint assessed before and after the six days of the worry intervention. Their study is the first to show that worry was prospectively and therefore perhaps causally related to the number of somatic complaints. The present study was set up to extend the findings from Brosschot and Van der Doef's (2006) study and more precisely test the perseverative cognition hypothesis. Firstly, the effects of (daily) stressful events on somatic complaints were not taken into account in that study. Secondly, only worry episodes were assessed using daily assessments whereas all other variables (including somatic complaints and negative affect) were measured retrospectively. Concerning the first issue, it could still be possible that the worry episodes were an indirect indication of the experience of stressful events. Indeed several studies have shown that stressful events are associated with somatic complaints (see e.g. Joksimovic, Starke, Knesebeck, & Siegrist, 2002; Godin & Kittel, 2004; Lepore, Miles, & Levy, 1997) and the perseverative cognition hypothesis predicts that worry about these events might have mediated their effects. To test this, in the present study we tried to replicate the finding that worry was prospectively related to somatic complaints, while also taking the number of stressful events into account. Concerning the second issue, Brosschot and Van der Doef (2006) only measured the number of somatic complaints before and after a period of six days, during which the worry intervention took place, and asked participants to report on the number of complaints

experienced "during the last three days". This latter retrospective way of measuring complaints could have introduced a so called 'retrospective bias'. Houtveen and Oei (2007) recently showed that the total number of somatic complaints experienced during a week is higher when this is assessed at the end of the week, compared to when these complaints are assessed each single day during a week, suggesting that participants use different memory retrieval strategies for these two kinds of assessments. Thus, by using a retrospective method some participants – especially those who worried a lot during the week - might have overestimated their complaints in the Brosschot and Van der Doef study. We therefore used a daily measurement of somatic complaints in the present study.

Stressful events not only result in worrisome thoughts about these events, but are also accompanied by negative affect. Recent evidence suggests that negative affect is prolonged beyond the presence of actual stressors by worry (Watkins, 2008). Negative affect has also been shown to increase the reporting of somatic symptoms, either by enhancing adverse physiological responding to, for example, infections (Cohen et al., 1995) or by biasing attention towards (threatening) misinterpretations of harmless bodily sensations (Petrie, Moss-Morris, Grey, & Shaw, 2004; Rief & Broadbent, 2007). It is plausible that the effects of worry on somatic complaints are in their turn mediated by negative affect – being an indication of prolonged physiological arousal or prolonged attention towards bodily sensations. Yet, not all studies have found independent effects of negative affect on health-related variables. For example, recent studies by us indicated that negative affect has no or only minor effects on cardiac activity (Pieper et al., 2007; Verkuil, Brosschot, Borkovec, & Thayer, 2009). On the other hand, Thomson et al. (2004) found that negative affect mediated the effect of rumination on poor somatic health in elderly people. However, this finding was restricted to the cross-sectional part of their study and was not apparent in the prospective part. Taken together, it is not yet clear what the role of negative affect is in explaining somatic health complaints, and the effect of stress and worry on them. We therefore examined, in the present study, the role of negative affect by including a daily measurement of negative affectivity.

In short, the present study tested whether (1a) stressful events predict the number of somatic complaints and whether (1b) worry episodes predict the number of and (1c) whether worry mediates the effects of stressful events on the number of somatic complaints. Finally, (2a), we tested whether worry predicts negative affect and (2b) whether the effects of worry on somatic complaints are mediated by negative affect. Importantly, and different from previous studies, all variables were assessed using electronic diaries, either per day or per time block of several hours.

Method

Participants

The managers of fifteen primary schools and seven secondary schools were contacted and were asked whether they gave permission to the researchers to contact their teachers for the purpose of this study. In addition, 57 teachers were contacted individually. The research assistants who helped carrying out this study (undergraduate students in psychology) were familiar with many of these teachers, which were from their former schools. All teachers received written information about the study and were asked to respond in case they were willing to participate. In total, 102 teachers responded. In the end, 30 of these teachers could not participate in the study, due to sickness or logistic difficulties, resulting in a final sample of 72 participants. All participants gave written informed consent before participating.

Instruments

Electronic diary

Daily reports on the variables of interest were collected using electronic diaries. Participants were handed a Palm-top computer (either a Palm Tungsten E2 or a Palm M100). The usage of the Palmtop was explained by one of the research assistants. For six consecutive days participants were prompted five times a day (from 8.00 until 21.30). The prompts were separated by randomly varying time periods, each lasting at least 2¾ hours, but maximally 3¾ hours. Daily assessments were gathered via Pendragon Forms 5.0 software and prompts were signaled with alarms programmed in Diary Alarms 1.0.

Daily assessments

Subjective health complaints

At every last assessment of the day, the Subjective Health Complaints questionnaire (SHC) was administered (Eriksen, Ihlebaek, & Ursin, 1999). This questionnaire consists of 29-items measuring the presence and severity of health complaints in five different areas of complaints: musculoskeletal pain; pseudo-neurological; gastrointestinal problems; allergic problems; and flu. The SHC is a reliable, easy, and systematic way to score subjective health complaints as they are experienced by the general population (Eriksen et al., 1999). The items ‘anxious’ and ‘depressed’ were removed before the analyses. Due to a programming error, the item ‘migraine’ was not included in the palmtop version of the questionnaire, yet unpublished data by us show that this complaint is very seldom. The

item ‘headache’ however, was retained. The total number of the remaining twenty-six SHCs was used as our outcome measure.

Worry episodes

The experience of worry episodes was assessed at each prompt. Participants were provided with a definition of worry based upon Borkovec et al. (1983). This definition was also printed on the case of the PDA. As the Dutch word for worry (‘piekeren’) also refers to ‘thinking hard’, we referred to worry as rumination (‘rumineren’; see also, Pieper et al. 2007) while providing the following description: “*rumination involves repeatedly and constantly thinking about negative events or situations in the past, present or future. The thoughts are often accompanied by negative tension”.* At every prompt, participants had to indicate whether they had been worrying, and if this was the case, then they were asked to indicate for how long (less than 5 minutes; 5 to 30 minutes; 30 – 60 minutes; more than 60 minutes). Subsequently, they were asked to indicate the total intensity of the worry episode(s) by dragging a slider on a scale ranging from ‘slightly intense’ to ‘very intense’ (end points ranging from 0-10). Finally, there were asked to indicate whether the worrying concerned private or work related issues. The latter aspects (intensity and content) were also new compared to the Brosschot and Van der Doef study.

Stressful events

Stressful events were also assessed at each prompt. Participants were provided with a definition of stressful events, based upon the definition described in the Daily Hassles Scale (APL, see below): ‘*Stressful events are minor and major events that have made you feel tense, irritated, angry, sad, disappointed or negative in any other way*’. Participants were asked to indicate the number of stressful events that had experienced (‘0’, ‘1’, ‘2’, ‘3’, ‘4’, ‘5 or more’) since the last prompt. In case they had experienced one or more stressful events, they were asked to indicate whether the event concerned private or work related issues.

Negative affect

At every last assessment of the day, negative affect was measured with the negative affect subscale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Example items are ‘distressed’, ‘scared’ and ‘irritable’. The scale point are: 1 ‘very slightly or not at all’, 2 ‘a little’, 3 ‘moderately’, 4 ‘quite a bit’ and 5 ‘very much’. Participants were asked to report on the amount of negative affect experienced during the preceding day.

Biobehavioral variables

To be able to control for the effects of biobehavioral variables on somatic complaints, participants were asked at the last assessment of the day to report the number alcoholic beverages, the number of cups of coffee and the number of cigarettes smoked ('0', '1-2', '3-4', '4 or more'), the amount of physical effort (five point scale ranging from 'none' to 'very much'). In addition, to control for the effects of bad sleep on somatic complaints, each morning at the first assessment, participants were asked to report on the sleep quality during the previous night. Sleep quality was measured on a VAS-scale, with score of 0 represented a 'very bad' sleep-quality and a score of 10 a 'very good' sleep-quality.

Baseline questionnaires

Somatic complaints

The number of somatic complaints experienced during the three days before the start of the experiment was assessed with the paper and pencil version of the SHC described above. In order to control for the effects of SHC during the previous day, including the mean number of complaints during the three days before the start of the experiment, a new time lagged variable was created ("Previous SHC").

Trait-worry

The Penn State Worry Questionnaire (PSWQ) was used to measure the level of (pathological) trait-worry. The PSWQ has proven to be a reliable and valid measure (Meyer, Miller, Metzger, & Borkovec, 1990; Verkuil, Brosschot, & Thayer, 2007b). Examples of items are "I am always worrying about something" and "Once I start worrying, I can't stop." The items are scored on a 5-point Likert scale, with a score of 1 representing "Not at all typical" (for me) and a score of 5 representing "Very typical" (for me).

Daily hassles

Stressful events during the past two months were measured with the Daily Problems Checklist (Vingerhoets, Jeninga, & Menges, 1989)). The DPC is based on the Daily Hassle Scale by Lazurus and colleagues(Kanner, Coyne, Schaefer, & Lazarus, 1981) and has been previously used in stress research in teachers (see e.g. Brosschot et al., 1994). Items include "One of your family members had health problems" and "You had a conflict with your partner". Participants were asked to indicate whether they had experienced such an event, and to what extent they were annoyed by these events

(five points scale ranging from 'not at all' to 'very much'). The total sum on this questionnaire was used as our measure of experienced stress at baseline.

Trait negative affect

Participants filled in the PANAS, described above, but here the trait version, concerning their mood in general.

Statistical analyses

Multilevel or hierarchical regression analyses were used to analyze the associations between the variables of interest (Singer & Willett, 2003). Multilevel analysis is especially suitable to analyze repeated measures data because it accounts for the dependencies of the different measurements (level 1) that are nested within individuals (level 2). Another advantage is that multilevel analysis allows for models to be estimated on all available data from each individual and can handle unbalanced datasets that contain irregularly spaced measurement intervals. Missing values on the questionnaires were imputed using the algorithm provided by Van Ginkel & Van der Ark (2005). Multilevel hierarchical regression analyses were performed with SPSS version 14.0.

To test whether worry mediated the effects of stressful events on somatic complaints, and possibly negative affect on turn mediated these effects, a mediation analysis was conducted in line with the guidelines provided by Baron and Kenny (1986).

Results

Descriptive statistics

Of the initial 72 participants, three participants did not complete the study. The final sample consisted of 69 Dutch secondary school teachers, of which 44 were female and 24 male. Age ranged from 21 to 60 years, with an average of 38.88 years (SD = 12.89). Baseline descriptive statistics are shown in Table 1.

Concerning the daily assessments of somatic complaints, fatigue was the most reported somatic complaint, which is in line with previous studies on the prevalence of SHCs (Eriksen et al., 1999); in 59.9% of all daily reports participants complained about fatigue (including missed reports). Other frequently reported complaints were low back pain (27.3%), flatulence / "wind" (25.6%), sleeping difficulties (25.4%) and cold / flu (23.7%).

The mean number of stressful events per day was 2.60 (SD = 1.91), whereas the mean number of worry episodes per day was 1.49 (SD = 1.24), which is slightly higher than previously observed in comparable studies (e.g. 1.58 and 1.06 respectively, by Pieper et al., 2007). The total

duration of the worry episodes per day was 37 minutes (SD = 48.56), which is in line with previous studies in non-clinical samples (Verkuil et al., 2007b). The mean intensity score per worry episode was 4.67 out of 10 (SD = 2.57).

Table 1. *Descriptive statistics at baseline.*

	%	M	SD
Gender	64.7% female		
Education	79.4% HBO		
	20.6% MBO		
Age		38.88	12.89
SHC		4.66	3.71
PANAS		16.30	4.66
DHC		33.55	23.17
PSWQ		42.94	11.40

Note. SHC = Subjective Health Complaints; PANAS = Positive Affect Negative Affect Schedule; DHC = Daily Hassles Checklist; PSWQ = Penn State Worry Questionnaire.

Preliminary analyses

To assess whether multilevel analysis would be appropriate to analyze the effects of stressful events and worry episodes on somatic complaints, we first estimated the intra-class correlation in a baseline model with a random intercept and with SHC as the dependent variable, but without any predictors. The results showed that the intraclass correlation was .59, showing that 59% of the variance was due to individual differences between participants, thereby providing evidence for a 2-level hierarchical structure of the data. In addition, since the somatic complaints were measured repeatedly within subjects, we tested whether the error terms of the model would be correlated. Residual error covariance was modeled using the first-order auto-regressive covariance matrix, which showed that the estimated auto-correlation (ρ) was .22 (p = .017). With respect to the model predicting daily negative affect, a baseline random intercept model without predictors showed that the intra-class correlation was .46, that 46% of the variance was due to individual differences between participants. Because residual error covariance using the first-order auto-regressive covariance matrix did not yield stable models, the diagonal covariance matrix was used.

Effects of stressful events and worry episodes on daily somatic complaints

First we examined whether stressful events were associated with the number of SHC, while controlling for SHC the previous day. The effect of stressful events on SHC was significant (B = .191, p < .0001, 95% CI: .087 - .294). When stressful work and private events were entered separately into the model, the results showed that work related stressors had a larger effect on somatic complaints (B = .366, $p < .01$, 95% CI: .114 - .617) than private stressors (B = .290, $p < .05$, 95% CI: .052 - .527).

Next, we examined the effects of the worry variables, (frequency, duration and intensity) on the number of SHC. The correlations between these variables were high (rs > .87). In a first step, SHC was regressed on worry frequency and worry duration (the variables used in the study by Brosschot & van der Doef [2006]), while controlling for the number of somatic complaints during the previous day. Worry frequency significantly predicted the number of somatic complaints (B = .451, $p < .01$, 95% CI: .152 - .749), and worry duration did this marginally (B = .008, $p = .082$, 95% CI: -.001 - .019). When worry intensity was entered into the model, only worry intensity predicted the number of SHC (B = .094, $p < .01$, 95% CI: .028 - .160), whereas the effects of worry frequency (B = .137, $p = .460$) and worry duration (B = .000, $p = .954$) were not significant anymore.

Mediating effects of worry episodes between stressful events and somatic complaints

To test whether the effect of stressful events on SHC was mediated by worry intensity, worry intensity was regressed on the number of stressful events. The number of stressful events was significantly related to worry intensity (B = 1.165, $p < .0001$, 95% CI: .863 - 1.467). In a subsequent model, stressful events and worry intensity were both added as predictors of SHC. When controlling for the effect of worry intensity, the effect of stressful events on SHC was reduced and became non-significant (B = .053, $p = .337$, 95% CI: -.055 - .161), whereas the effect of worry intensity was still significant (B = .106, $p < .0001$, 95% CI: .071 - .140), suggesting full mediation. Sobel's z-score of this mediated effect was 4.82 showing that the mediation effect was significant ($p < .0001$; Baron & Kenny, 1986).

In a final model we tested whether worry intensity was related to SHC while controlling for biobehavioral variables (age, gender, education level, smoking, alcohol use, sleep quality, baseline traits and daily hassles during the last two months) and SHC during the previous day. The results are presented in Table 2. In the final model, SHC was predicted by worry intensity, time (days) and daily hassles.

Table 2. *Estimates of fixed effects predicting the number of somatic complaints with and without negative affect (baseline and daily measurements)*

	B	SE	*t*	*p*	B	SE	*t*	*p*
Intercept	4.67	0.38	12.18	.00	4.68	0.36	12.97	.00
Stressful events	-0.03	0.06	-0.43	.67	-0.05	0.06	-0.78	.44
Worry intensity	0.11	0.02	5.99	.00	0.10	0.02	4.88	.00
Age	0.00	0.02	0.05	.96	0.00	0.02	-0.01	.99
Gender	0.63	0.59	1.07	.29	0.48	0.55	0.87	.39
Education	-0.68	0.67	-1.02	.32	-0.57	0.61	-0.92	.36
Caffeine	0.04	0.10	0.41	.68	0.05	0.10	0.52	.60
Smoking	0.10	0.06	1.77	.08	0.16	0.06	2.47	.01
Alcohol	0.10	0.10	0.96	.34	0.05	0.10	0.49	.62
Physical effort	-0.10	0.12	-0.85	.40	-0.10	0.12	-0.83	.41
PSWQ	-0.04	0.03	-1.58	.12	-0.04	0.03	-1.54	.13
DHC	0.03	0.01	2.24	.03	0.02	0.01	1.78	.08
Previous SHC	0.03	0.05	0.64	.52	0.06	0.05	1.11	.27
Sleep quality previous night	-0.07	0.15	-0.47	.64	-0.18	0.15	-1.17	.24
Time	-0.26	0.08	-3.43	.00	-0.23	0.08	-3.10	.00
Baseline negative affect					-0.05	0.07	-0.71	.48
Daily Negative affect					0.14	0.04	3.37	.00
Deviance (-2 log likelihood)	1138.435				1103.456			

Note. PSWQ = Penn State Worry Questionnaire; DHC = Daily Hassles Checklist; SHC = Subjective Health Complaints.

Effects of stressful events and worry episodes on negative affect

First, negative affect was regressed on the number of stressful events, while controlling for negative affect during the previous day. Stressful events significantly predicted negative affect (B = 0.520, $p < .0001$, 95% CI: 0.334 - 0.706). Stressful events related to work were a slightly better predictor of negative affect (B = 0.934, $p < .0001$, 95% CI: 0.516 - 1.353) than stressful private events (B = 0.698, $p < .0001$, 95% CI: 0.308 - 1.089). Next, negative affect was regressed on worry frequency and worry duration. Only worry duration predicted negative affect (B = 0.022, $p < .05$, 95% CI: 0.005 - 0.038), whereas worry frequency did not (B = 0.382, $p = .144$). When worry intensity was entered into the model, only worry intensity predicted negative affect (B = .144, $p < .05$, 95% CI: 0.033 - 0.254), whereas the effects of worry frequency (B = -.065, $p = .839$) and worry duration (B = .010, $p = .308$) were not significant anymore. When controlling for the effect of negative affect during the previous day and worry intensity, the effect of stressful events on negative affect was still significant (B = .323,

p < .01, 95% CI: 0.127 - .519), as was the effect of worry intensity (B = .131, *p* < .0001, 95% CI: .077 - .184).

In the final model, negative affect was regressed on stressful events, worry intensity, the biobehavioral variables, negative affect at baseline and negative affect during the previous day (see Table 3). Negative affect was significantly predicted by negative affect at baseline (B = 0.154, *p* = .098, 95% CI: -0.030 - 0.338), worry intensity (B = 0.128, *p* < .0001, 95% CI: 0.069 - 0.187) and, yet marginally, by age (B = 0.057, *p* = .067, 95% CI: -0.064 - 0.366), but not any more by stressful events.

Table 3. *Estimates of fixed effects predicting daily negative affect.*

	B	SE	*t*	*p*
Intercept	13.50	0.54	25.07	.00
Worry intensity	0.13	0.03	4.29	.00
Stressful events	0.15	0.11	1.38	.17
Age	0.06	0.03	1.90	.07
Gender	0.84	0.74	1.13	.27
Education	-0.28	0.85	-0.34	.74
Caffeine	-0.22	0.15	-1.48	.14
Smoking	-0.06	0.09	-0.67	.51
Alcohol	0.09	0.15	0.59	.56
Physical effort	-0.06	0.18	-0.31	.75
PSWQ	0.01	0.04	0.31	.76
DHC	0.02	0.02	0.81	.42
Negative Affect previous day	0.07	0.06	1.05	.30
Sleep quality previous night	-0.05	0.23	-0.20	.84
Time	-0.08	0.12	-0.66	.51
Baseline negative affect	0.15	0.09	1.71	.10

Note. PSWQ = Penn State Worry Questionnaire; DHC = Daily Hassles Checklist.

Mediating effects of negative affect between worry and somatic complaints

To examine whether baseline negative affect and daily negative affect could add to the model predicting the number of SHC, and whether daily negative affect mediated the effect of worry intensity on SHC, these variables were added as predictors in the model discussed above. In this final model, SHC was independently predicted by daily negative affect (B = 0.118, *p* = .010, 95% CI: 0.029 - 0.208), smoking (B = 0.145, *p* = .025, 95% CI: 0.018 - 0.272), and worry intensity (B = 0.095, *p* < .0001,

95% CI: 0.051 - 0.140). A trend towards significance was still apparent for daily hassles at baseline. As the effect of worry intensity on SHC was not reduced by adding daily negative affect to the model, the hypothesis that negative affect mediates the effect of worry on SHC could not be confirmed. Another possible role of negative affect might be that it interacts with worry and thereby enhances the effects of worry on somatic complaints. However, exploratory analysis showed that the interaction between worry intensity and daily negative affect on SHC was not significant.

Effects on specific complaints

To examine whether worry intensity was associated with the occurrence of specific somatic complaints, multilevel random intercept logistic regression models were fit (using MLwiN software) on the specific complaints. Results showed that worry intensity was significantly associated with the occurrence of 13 of the 26 complaints. These complaints were: neck pain, stomach pains, fatigue, sleeping difficulties, pain in arms, headache, asthma, flatulence / 'wind', chest pains, vertigo, pain in shoulders, stomach discomfort and cold / flu.

Discussion

In this study the effects of stressful events and worry on somatic complaints were examined. In line with previous work, the present study demonstrated that worry was prospectively associated with somatic health (Brosschot & Van Der Doef, 2006; Thomsen et al., 2004). Importantly, this study adds to previous studies the finding that worry mediates the effects of stressful events on somatic health complaints. These effects of worry were independent of negative affect and biobehavioral variables. Moreover we used a more precise measure of worry, that did not contain the connotation of 'thinking hard' of the Dutch word for worry ('piekeren'). Furthermore, health complaints were measured on a daily basis instead of retrospectively as in Brosschot & Van Der Doef (2006). This study therefore provide further evidence for the perseverative cognition hypothesis which states that worry is the crucial link between stressful events and somatic health (Brosschot et al., 2006). The effects of worry were visible on a range of different single complaints, suggesting that there is not one specific biological system involved, but that the effect is the results of a general physiological stress response. This study focused on a group of teachers, workers who are considered to be highly vulnerable for developing work stress related psychological and somatic complaints. As Brosschot & Van der Doef (2006) have found that a relatively simple worry intervention is helpful in reducing worry and somatic complaints in adolescents, a next step might be to test the effectiveness of such a worry intervention in a vulnerable group like this one. Reducing the harmful effects of prolonged stress responses such as worry might be an important addition to existing (preventive) stress

management interventions that are aimed at reducing the immediate effects of stressful events, for example assertiveness training. If proven to be effective, this is expected to have large implications not only for the wellbeing of workers, but, as a consequence, also on the economical costs associated with somatic health complaints.

One reason that worry had stronger effects than stressful events might not have to do with the fact that worry mediated their effects, but with the much larger scope of worry. Worry is always about stressors and by measuring the effects of worry episodes we aggregated the effects of one or many more stressful events at once, including many events outside the time window of this study. Moreover, worries are mostly about very significant personal events, in the (regretted) past as well as in the (feared) future, and these cognitive representations of stressful events are always highly personally relevant. In contrast, by measuring stressful events – that are time-locked - only effects of single stressful events at a time are measured, pertaining only to the here and now. Moreover, stressful events might not necessarily reflect highly personally relevant events, and therefore not lead to any somatic complaints, or, for that matter, worrying.

Furthermore, in line with previous studies, stressful events and worry intensity independently predicted the level of daily negative affect (Watkins, 2008). However, daily negative affect did not mediate or moderate the relation between worry intensity and somatic complaints. Yet, both worry intensity and negative affect were independently associated with the number of somatic complaints. Although worry and negative affect are both signs of prolonged effects of stressful events, the present results suggest that they are associated with the reporting of somatic complaints via separate routes. Worry has been shown to be closely associated with prolonged stress-related physiological activity in daily life and might lead to somatic complaints via such a route. The physiological effects of negative affect, independent of worry and stressors, are less clear (e.g. Pieper et al., 2007). Negative affect might lead to complaints by biasing information processing towards the detection of bodily sensations and interpreting these sensations as threatening or harmful (Petrie et al., 2004; Rief & Broadbent, 2007). This suggestion has to be examined in future studies. What is more, we have previously shown that one specific form of worrying, that is, worrying about ones health, is also associated with enhanced memory for health related information and that this was associated with heightened levels of somatic complaints (Verkuil, Brosschot, & Thayer, 2007a), suggesting that worry itself can lead to somatic complaints via different routes. Future studies should therefore distinguish between more general worries about stressful external events and worry about internal bodily sensations.

Interestingly, of the measures used to capture worry in daily life, worry intensity was most strongly associated with somatic complaints and explained the effects of worry frequency and worry

duration on somatic complaints and negative affect. Although worry frequency, duration and intensity were highly correlated (*r*s > .85), we expected that worry duration would be associated with the number of somatic complaints, which was also found by Brosschot and Van der Doef (2006). Unexpectedly, worry duration was not only related to complaints more weakly than worry intensity, but also than worry frequency, compared to the Brosschot and Van Der Doef study. One explanation may be that in this latter study, total worry duration was estimated by participants at the end of the day, whereas in this study worry duration was measured at random intervals during the day by asking participants to choose from several answer options on their PDA. As the duration of very intense worry episodes might be better recalled at the end of the day, compared to mild worry episodes that possibly occur relatively automatically, the worry duration measure by Brosschot & Van der Doef (2006) might have been more a measure of worry intensity, than a precise measure of worry duration. Yet, this speculative suggestion has to be addressed in future studies on how to best capture worry in daily life.

There are several limitations to this ambulatory study. Although it is prospective, its correlational nature precludes the definite conclusion that worry actually causes somatic complaints. Yet, the intervention study by Brosschot and Van der Doef (2006) has already provided beginning evidence that this is likely the case. Secondly, in this study we measured somatic complaints but did not assess objective illness and absence from work. Thus, it still seems important to investigate what factors predict why people eventually decide to actually not attend work. Thirdly, we only focused on worry in this study, whereas the perseverative cognition hypothesis pertains to a broader range of cognitive representations of stressors, such as negative intrusive thoughts and ruminative thoughts. In addition, as a large part of cognitive processing occurs without conscious awareness, it is likely that stress-related perseverative thoughts occur unconsciously too. It might underlie the effects of negative affect in this study, since it is likely that some form of stress-related cognition must have prolonged negative affect. Unconscious perseveration, such as hypervigilance for threat, cannot be measured using explicit measures such as verbal reports, but warrants the use of implicit measures such as the Implicit Association Test (IAT) or the dot probe task (Mathews & MacLeod, 1994). Future studies could benefit from including portable instruments to measure these types of perseverative cognition. On a related note, previous studies have shown that daytime stressors and worries have prolonged effects during sleep (Hall et al., 2004; Brosschot et al., 2007). This seems to suggest that a part of (unconscious) perseverative cognition takes place during sleeping. This, reduced recovery from stress during sleep might create a vicious cycle in which worry influences recovery during sleep which in turn amplifies the level of experienced stress and worries the next day. Although there were no substantial effects of reduced sleep quality, this might not be very relevant, since these

physiological effects during sleep seem also not dependent on sleep quality (Hall et al., 2004; Brosschot et al., 2007). Thus, it is still possible that an even greater portion of somatic complaints can be explained by perseverative cognition that lingers on, together with its physiological effects, during sleep. As still little is known about the role of sleep in the link between stress – worry and somatic complaints, while sleep is clearly the largest natural restorative period in normal human life, it seems extremely worthwhile to search for ways to investigate the role of perseverative cognition during sleep in future studies.

In sum, in this study evidence was provided that stressful events as well as worry are prospectively associated with somatic complaints and that this effect is mediated by worry intensity. Furthermore, worry intensity was associated with somatic complaints, independently from negative affect. Future studies testing the effectiveness of worry interventions in people at risk for the development of severe somatic complaints are clearly warranted.