Stress and Health

Stress and Health **25**: 323–331 (2009)
Published online in Wiley InterScience (www.interscience.wiley.com). **DOI:** 10.1002/smi.1279
Received 27 April 2009; Accepted 21 July 2009

Burnout versus work engagement in their effects on 24-hour ambulatory monitored cardiac autonomic function

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Summary

Burnout has been associated with increased risk of cardiovascular disease. This relationship may be mediated by a stress-related disruption in cardiac autonomic activity. The aim of the present study was to assess cardiac autonomic activity (sympathetic and parasympathetic) during a working day in burned out managers. Thirty burned out, 29 healthy control and 29 engaged managers (a psychologically contrasting group) were identified using the Maslach Burnout Inventory-General Survey (MBI-GS) and the Utrecht Work Engagement Scale (UWES). Twenty-four-hour ambulatory measurements were carried out during a regular workday and the subsequent night. Pre-ejection period (PEP) and respiratory sinus arrhythmia (RSA) were used as measures of cardiac sympathetic and parasympathetic activity, respectively. Contrary to expectations, the burned out, engaged and control groups did not differ in cardiac sympathetic and cardiac parasympathetic activity, or heart rate. Thus, burnout does not seem to be associated with an unfavourable cardiac autonomic profile. Copyright © 2009 John Wiley & Sons, Ltd.

Key Words

burnout; heart rate; pre-ejection-period (PEP); respiratory sinus arrhythmia (RSA); work engagement

Burnout is a work-related syndrome primarily caused by chronic high job demands, poor job resources and insufficient recovery (Halbesleben & Buckley, 2004; Maslach, Schaufeli, & Leiter, 2001). Its characteristics are emotional exhaustion, cynicism and reduced professional efficacy (Maslach et al., 2001). Burnout is associated with self-reported ill health (Soderfeldt, Soderfeldt, Ohlson, Theorell, & Jones, 2000) and there is evidence for burnout, and the related concept of vital exhaustion, to be risk factors for cardiovascular disease (CVD) (Melamed, Shirom, Toker, Berliner, & Shapira, 2006). An elevated CVD risk to be associated with burnout would not be that improbable, considering the accumulated evidence that chronic work stress about doubles the risk of CVD (Belkic, Landsbergis, Schnall, & Baker, 2004) and burnout by definition is a work stress-related syndrome. Assuming a role of burnout as a CVD risk factor, the question rises

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what the mediating (stress) physiological mechanisms may be.

Melamed et al. (2006) suggest possible mediating roles of the metabolic syndrome, dysregulation of the hypothalamic–pituitary–adrenal axis, immunological factors and fibrinolysis. Underexposed in this review is the potential mediating role of the autonomic (sympathetic and parasympathetic) nervous system. Sympathetic arousal is at the core of the stress response, and a sustained over-activity is supposed to play a role as a mediator between stress and CVD because of its influence on, for example, the initiation and progression of atherosclerosis, blood coagulation and cardiac electrical stability. The other branch of the autonomic nervous system, the parasympathetic (vagal) system, is supposed to have cardioprotective properties; thus, vagal under-activity may also play a role as a mediator between stress and CVD. Indeed, low vagal control has shown to be an independent prognostic factor for cardiac disease, and cardiac- and all-caused mortality (Dekker et al., 2000). The plausibility of finding low vagal control in burned out persons is strengthened by the findings of reduced vagal control in depression, anxiety (disorders) and other negative mental health conditions (Rottenberg, 2007; Watkins, Grossman, Krishnan, & Sherwood, 1998), all psychological conditions correlated with burnout (Schaufeli & Enzmann, 1998). Yet, another reason to expect deviations in cardiac autonomic control in burnout is that several studies have observed differences in sympathetic and/or vagal cardiac control by way of ambulatory recordings in groups differing in levels of work stress (Collins, Karasek, & Costas, 2005; Hanson, Godaert, Maas, & Meijman, 2001; Vrijkotte, van Doornen, & de Geus, 2000, 2004).

To date, only two studies investigated cardiovascular functioning in burnout (De Vente, Olff, Van Amsterdam, Kamphuis, & Emmelkamp, 2003; Zanstra, Schellekens, Schaap, & Kooistra, 2006). De Vente et al. (2003) observed a higher heart rate (HR) both at rest and during a stress test, as compared with a group of healthy controls. Zanstra et al. (2006) measured burnout and controls on a simulated workday while measuring HR and high-frequency HR variability (HF-HRV) as an index of vagal control. They observed no group differences in resting HR and HF-HRV. Both studies, however, took place in a laboratory setting, and it thus remains to be seen whether the obtained results can be generalized to the real world. The aim of the current ambulatory study is to examine HR, and sympathetic and vagal influences on the heart of burned out employees, during work and non-work activities in a daily life setting.

It is obvious to use 'normal' employees as a control group. In an effort to increase the power to detect possible physiological disturbances in the burned out subjects, we decided to include an additional control group with opposite work-related well-being: highly work-engaged employees. Work engagement is defined as a positive, fulfilling state of mind characterized by *vigour, dedication* and *absorption* (Schaufeli, Salanova, Gonzalez-Roma, & Bakker, 2002). In contrast to burnout, work engagement is (positively) associated with job resources and is related to positive mental and psychosomatic health (for a review, see Schaufeli & Salanova, 1997). The expectation of a potentially increased vagal control in work-engaged persons is necessarily indirect because not investigated before. In a recent review on positive affect (PA), a construct related to work engagement, it was concluded that PA might be associated with relatively elevated parasympathetic cardiac control (Pressman & Cohen, 2005). Furthermore, Steptoe and Wardle (2005) reported that greater happiness was associated with lower ambulatory HR during a working day. On the basis of this indirect evidence, we might expect work engagement to be related to a healthy cardiac profile as manifested in stronger cardiac vagal control as compared with the burnout subjects.

In short, the aim of the current ambulatory study is to examine cardiac autonomic (sympathetic and parasympathetic) activity in a daily life setting in two opposite poles of work-related well-being: burned out and engaged employees. Both groups will be compared with a normal control group.

Method

Participants

In total, 88 male managers participated in this study. These managers were selected from a larger sample of managers (n = 338) employed at a Dutch telecommunications company. An extensive periodic employee health and well-being survey was carried out in this company by an Occupational Health Service. The survey was sent

DOI: 10.1002/smi

to the home addresses of 450 managers of which 338 returned the completed survey (response rate = 75%). Managers were assigned to the burned out group when their individual score on the burnout questionnaire [Maslach Burnout Inventory—General Survey (MBI—GS)] met the following validated inclusion criteria (e.g. Brenninkmeijer & Van Yperen, 2003): exhaustion $\geq$ 2.2 and either cynicism $\geq$ 2.0 or personal accomplishment $\leq$ 3.66. These criteria were based on validated cut-off points from the test manual (Schaufeli & Van Dierendonck, 2000) that have been established using a group of 100 employees with ICD-10 work-related neurasthenia (see Schaufeli, Bakker, Schaap, Kladler, & Hoogduin, 2001). These cut-off points had been confirmed in other independent studies with burned out patients (e.g. Brenninkmeijer & Van Yperen, 2003; Roelofs, Verbraak, Keijsers, de Bruin, & Schmidt, 2005). Thirty managers fulfilled the burnout inclusion criteria.

In contrast to burnout, a statistical cut-off point for work engagement was used: managers who scored higher than 4.67 (i.e. mean sum of all 17 items) on the engagement questionnaire [(Utrecht Work Engagement Scale (UWES)] were assigned to the engaged group (n = 29). This cut-off score corresponds with the 75th percentile of the score distribution of the UWES in the Dutch normative sample of over 9,000 persons (M = 9,679) (Schaufeli & Bakker, 2003).

The control group (n = 29) was composed of managers with an individual score according to the following inclusion criteria: (1) burnout questionnaire (MBI—GS) exhaustion $\leq$ 1.5, cynicism $\leq$ 1.0 and personal accomplishment > 3.66; and (2) engagement questionnaire (UWES) mean score $\leq$ 4.67. Managers were excluded if they had any CVD, a body mass index (BMI) > 30, or if they used alcohol or drugs excessively. All the participants signed an informed consent. The university ethics committee approved the study. The participants did not receive any monetary reward for participation but were freely offered a general medical health check.

Procedure

The managers underwent ambulatory monitoring on one full workday and the subsequent night. They were visited at their workplace between 8 a.m. and 11 a.m. After the general instructions, the recording electrodes were attached and connected to the Vrije Universiteit Ambulatory Monitoring System (VU-AMS, see succeeding sections). The managers continued working and followed their normal working routines as well as their daily routines at home. They were instructed to keep a diary of their activities and to write down the time, their activity, their body posture and their location every half an hour during daytime. The managers wore the device the entire day and night up until awakening the next morning. They removed the device by themselves after waking up, and it was returned to the researcher later on.

Psychological measures

Burnout was measured with the Dutch version (Schaufeli & Van Dierendonck, 2000) of the MBI—GS (Schaufeli, Leiter, Maslach, & Jackson, 1996). The Dutch MBI—GS consists of 15 items and taps three subscales, namely *exhaustion* (five items, e.g. 'I feel mentally exhausted because of my work'; α = 0.93), *cynicism* (four items, e.g. 'I doubt the significance of my work'; α = 0.85) and *professional efficacy* (six items, e.g. 'I can effectively solve the problems that arise in my work'; α = 0.83), which are scored on a seven-point scale ranging from 0 (*never*) to 6 (*every day*).

Work Engagement was measured with the UWES (Schaufeli & Bakker, 2003; Schaufeli et al., 2002). The UWES includes 17 items that are indicative of three dimensions, namely *vigour* (six items, e.g. 'At work, I feel full of energy'; α = 0.88), *dedication* (five items, e.g. 'I am enthusiastic about my job'; α = 0.94) and *absorption* (six items, e.g. 'When I am working, I forget everything else around me'; α = 0.74), which are scored on a seven-point scale ranging from 0 (*never*) to 6 (*every day*).

Ambulatory physiological measures

The ambulatory electrocardiogram (ECG) and impedance cardiogram (ICG) were measured continuously from a six-Ag/AgCl electrode configuration using the VU-AMS (version 4.3, TD-FPP, Vrije Universiteit, Amsterdam, The Netherlands; www.psy.vu.nl/vu-ams). The average motility over 30-second periods was additionally monitored and stored by this device throughout the recording time and used as a proxy for gross body movement. Details on the recording methodology

DOI: 10.1002/smi

and reliability, and validity of the VU-AMS can be found in de Geus, Willemsen, Klaver, and van Doornen (1995), de Geus and van Doornen (1996), Riese et al. (2003), and Willemsen, de Geus, Klaver, van Doornen and Carroll (1996).

An interactive graphical program (AMSGRA) was used to display the recorded heart period time series, together with the motility signal, and information on the type of activity and (changes in) posture from the diary. This made it possible to accurately specify the exact start and termination of changes in type of activity and posture that the managers reported in the diary. The entire data file was hereby divided into segments coded for: posture (supine, sitting, standing, walking), activity (e.g. meeting, computer work, watching television) and location (e.g. work, home, on the road). Sub-segments containing too many artefacts were rejected. The minimum duration of the originally coded segments was 5 min; maximum duration was 1 h. Since cardiac measures are largely influenced by posture and movement (Houtveen, Groot, & de Geus, 2005), we decided to analyse only segments in which managers were seated or in supine position. Three final segment conditions were selected for further analysis: sitting at work, sitting in leisure time and supine during sleep. This distinction is consistent with the approach taken by Vrijkotte et al. (2000, 2004).

Cardiac autonomic measures were defined for each of the selected segment conditions (i.e. sitting-work, sitting-leisure, sleep). Data preparation is described in detail elsewhere (see Houtveen & van Doornen, 2007; Houtveen & Molenaar, 2001). In short, artefact pre-processing was performed first. Next, segment-specific mean interbeat interval (IBI) values were computed as a measure of HR. Next, discrete wavelet transformation was performed to compute the HF power (the variance in the 0.125–0.5 Hz window) as measure of respiratory sinus arrhythmia (RSA), reflecting changes in cardiac parasympathetic (vagal) control (Berntson et al., 1997). The HF power values were 10log transformed to obtain normal distributions. Pre-ejection period (PEP) was manually scored using the VU-AMS interactive software (AMSIMP), which graphically displays the large-scale ensemble averaged ICG signal (i.e. averaged per segment). PEP was used as a measure of cardiac sympathetic control (Sherwood, Fahrenberg, Kelsey, Lovallo, & van Doornen, 1990). PEP reflects the time interval between the onset of the electromechanical systole (Q-wave onset) in the ECG and the onset of left ventricular ejection at the opening of the aortic valves (B-point) in the ICG. The B-points were manually determined for each ensemble averaged (selected) segment, and the PEP values were determined by summing a fixed Q-to-R interval of 48 ms to the R–B interval time.

Statistical analyses

Multivariate analysis of variance (MANOVA) and χ^2 tests were used to test whether the three groups differed with respect to demographics, psychological measures, total duration of the selected segments and hours spent on different activities. Repeated measure univariate ANOVA tests were used to test if the burned out, engaged and control group differed in IBI, HF power and PEP with the within factor *Condition* (3) and the between factor *Group* (3).

Results

Demographics and psychological measures

The mean scores of demographics and psychological measures are displayed in Table I. The three groups did not differ from each other with respect to smoking behaviour and BMI. As obvious, the groups differed strongly from each other with regard to all psychological measures, multivariate $F(12, 160) = 22.23$, $p < 0.001$. Bonferroni post-hoc tests showed that the burned out group scored significantly higher on exhaustion and cynicism than the two other groups and lower on professional efficacy ($p < 0.001$), vigour ($p < 0.001$) and dedication ($p < 0.001$). The engaged group scored significantly higher on all work engagement scales than the two other groups ($p < 0.001$ for both).

Physiological registration periods

No significant group differences were found in registration duration and the total duration of the selected segments. The mean duration of the VU-AMS registrations was 21:23 ± 1:53 in the burned out group, 21:18 ± 1:31 in the engaged group and 21:13 ± 1:38 in the control group. The mean total duration of the selected segments in these groups were 18:46 ± 2:24, 18:56 ± 2:46 and

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Table I. Mean and standard deviation (SD) for the burned out, engaged and control groups on demographic variables and psychological measures.

	Burned out (n = 30) Mean (SD)	Engaged (n = 29) Mean (SD)	Control (n = 29) Mean (SD)	Test value
Demographics				
Age (years)	43.8 (7.60)	43.8 (8.26)	42.4 (8.22)	F = 0.22, ns
Organizational tenure (years)	18.5 (10.48)	18.5 (12.22)	20.1 (12.52)	F = 0.16, ns
Current function (years)	2.1 (1.46)	1.8 (1.25)	1.4 (0.91)	F = 2.48, ns
Marital status (% married)	96.7	89.3	72.4	χ^2 = 8.51, ns
Educational level, secondary (%)	46.7	32.1	53.6	χ^2 = 2.72, ns
Educational level, college (%)	53.3	67.9	46.4	
BMI (kg/m^2)	25.7 (3.36)	25.2 (2.12)	26.1 (3.37)	F = 0.63, ns
Smokers (%)	30.0	14.8	14.3	χ^2 = 2.90, ns
Burnout (MBI—GS)†				
Exhaustion	3.0^a (0.69)	0.84^b (0.72)	0.91^b (0.95)	F = 71.66
Cynicism	2.5^a (0.87)	0.38^b (0.46)	0.53^b (0.46)	F = 107.02
Professional efficacy	3.5^a (0.74)	4.9^b (0.54)	4.5^b (0.57)	F = 43.18
Work Engagement (UWES)				
Vigour	3.4^a (0.70)	5.2^b (0.38)	4.4^c (0.63)	F = 70.11
Dedication	3.2^a (0.80)	5.5^b (0.39)	4.7^c (0.69)	F = 91.09
Absorption	3.4^a (0.69)	4.7^b (0.36)	3.5^a (0.62)	F = 44.48

Note: Means with unequal superscripts (a, b, c) differ significantly from each other at the $p < 0.001$ level.
† Burnout and work engagement are measured on seven-point scales ranging from 0 (*never*) to 6 (*every day*).
ns: not significant; BMI: body mass index; (MBI—GS): Maslach Burnout Inventory—General Survey; UWES: Utrecht Work Engagement Scale.

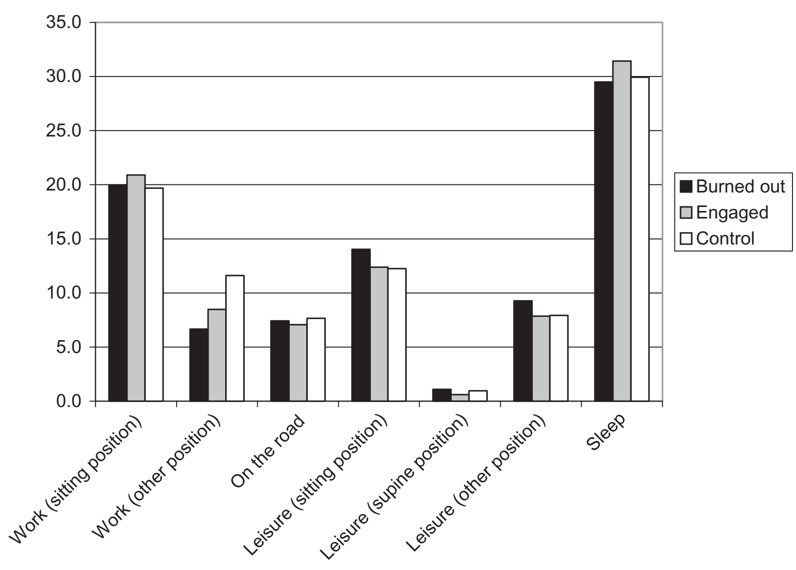

Figure 1. Percentage of time spent in different postures during the measurement day for the burned out, engaged and control group.

19:07 ± 2:45, respectively. Furthermore, a comparison of the time (h) spent in different postures showed that the three groups did not differ in the duration of postures during the different periods (Figure 1).

IBI, HF Power and PEP

The mean scores of the three groups on IBI, HF power and PEP during the conditions (sitting-work, sitting-leisure, sleep) are presented

DOI: 10.1002/smi

Table II. Mean and standard deviation (SD) for the burned out, engaged and control groups on IBI, HF power and PEP.

	Burned out (n = 30) Mean (SD)	Engaged (n = 29) Mean (SD)	Control (n = 29) Mean (SD)
IBI (ms)			
Sitting at work	838.78 (99.78)	820.20 (110.21)	841.09 (112.43)
Sitting in leisure time	871.45 (113.22)	837.06 (106.58)	863.43 (126.70)
Sleep	1,028.65 (97.11)	1,022.84 (171.01)	1,041.95 (146.76)
HF power (^{10}log ms^2)			
Sitting at work	2.39 (0.39)	2.41 (0.42)	2.43 (0.33)
Sitting in leisure time	2.31 (0.41)	2.32 (0.46)	2.34 (0.37)
Sleep	2.49 (0.45)	2.56 (0.51)	2.61 (0.38)
PEP (ms)			
Sitting at work	83.33 (9.76)	84.32 (8.27)	83.76 (10.30)
Sitting in leisure time	83.49 (9.18)	84.74 (8.83)	83.24 (10.33)
Sleep	84.32 (9.77)	85.94 (8.94)	84.75 (10.58)

IBI: inter-beat interval; HF: high frequency; PEP: pre-ejection period.

in Table II. The repeated measure analysis for IBI showed a significant main effect for condition, $F(2, 79) = 210.00$, $p < 0.001$, indicating that IBI was different for the different situations across groups. Post-hoc tests showed that IBI during sleep was larger than IBI during the day ($p < 0.001$), whereas IBI sitting in leisure time was larger than IBI sitting at work ($p < 0.001$). The main group effect for IBI was not significant, $F(2, 80) = 0.33$, $p = 0.72$, indicating that the three groups did not differ in IBI across conditions. No significant condition × group interaction was found either, indicating that condition-specific group differences were absent as well.

The results for HF power and PEP, our measures for cardiac parasympathetic and sympathetic control, respectively, more or less resemble the results for HR. With regard to HF power, a significant main effect was found for condition, $F(2, 79) = 30.30$, $p < 0.001$. Post-hoc tests showed that HF power during sleep was larger than HF power during the day ($p < 0.001$), whereas HF power sitting in leisure time was larger than HF power sitting at work ($p < 0.001$). Notice that the order sitting in leisure versus sitting at work is different compared with IBI. The main group effect for HF power and the condition × group interaction were not significant.

For PEP, a significant main effect for condition was also found, $F\ (2, 79) = 5.89$, $p < 0.005$. Post-hoc tests showed that PEP during sleep was longer (indicating smaller sympathetic drive) than PEP during the day ($p < 0.005$), whereas PEP sitting at work did not differ from PEP sitting in leisure time ($p = 0.93$). Again, the main group effect and the condition × group interaction were not significant.

Discussion

The central aim of the present study was to examine cardiac autonomic activity in a daily life setting in burned out and work-engaged employees. The results showed that these two opposite poles of work-related well-being neither differed from each other, nor from a 'normal' control group with regard to HR, cardiac sympathetic and cardiac parasympathetic activity, and neither in basal levels during sleep nor in reaction to the work setting. So, we could not replicate the laboratory study observing a higher basal HR in burned out individuals (De Vente et al., 2003). In contrast to earlier suggestions (Steptoe & Wardle, 2005), a positive affective state such as work engagement could also not be linked to a lower HR or a favourable sympathovagal balance.

As far as burnout overlaps with the concept of vital exhaustion (Shirom, Melamed, Toker, Berliner, & Shapira, 2005), our negative findings with respect to parasympathetic activity are in line with a laboratory study that observed no difference in resting-state HF-HRV between middle-aged male workers scoring extreme high or low on vital exhaustion (Watanabe et al., 2002).

DOI: 10.1002/smi

Assuming that the burned out subjects will experience their work situation as more stressful and overcommitment to work is associated with vital exhaustion (Preckel, von Känel, Kudielka, & Fischer, 2005), we can also compare our results with those studies that have assessed the effects of job stress on ambulatory-measured HR and cardiac autonomic balance. Riese, van Doornen, Houtman and de Geus (2004), observed no effects of work stress on HR and HRV as a measure of vagal tone either. This study, however, included young, healthy, female nurses. Vrijkotte et al. (2000), also measuring middle-aged males similar to the present study, found no effect of overcommitment on HR and vagal tone. Hanson et al. (2001) did not find an association between HRV and work stress (measured by effort, reward, effort-reward imbalance and demands) either. On the other hand there are some positive findings as well. In the large-scale Whitehall study, those civil servants experiencing low job control showed lower HRV (Hemingway et al., 2005). In the aforementioned study of Vrijkotte et al. (2000), individuals with a high effort–reward imbalance showed a lower 24-hour vagal tone and a higher HR, and overcommitted employees showed a shorter PEP, reflecting higher sympathetic activity (Vrijkotte et al., 2004). In this study, however, another index of work stress (i.e. effort–reward imbalance) was not related to stronger sympathetic activity.

It thus seems that some specific aspects (operationalizations) of work stress may have an effect on HR or cardiac autonomic balance, whereas other aspects have not. Because burnout is the result of a complex interaction between all of these aspects of work stress and individual vulnerability, it is hard to predict what to expect with respect to the cardiac correlates of burnout. It remains surprising, however, that although several studies have shown an effect of (varying aspects of) work stress on cardiac autonomic functioning, no effects were found for burned out managers. This is remarkable because burned out employees succumbed under the influence of chronic work stress and are thus more extreme in this respect than the participants in the aforementioned ambulatory studies. On the other hand, it may be a simplification to compare the more or less acute effects of daily work stress on cardiac parameters with the effects of burnout, which is a chronic state of exhaustion that results from long lasting work stress.

Limitations

A limitation of our study may be that the participants were all managers, working in the same company and thus constituted a relatively homogenous sample, thereby restricting variance. Nevertheless, we observed considerable variance in the burnout and engagement scores and thus were able to select a sufficiently large group fulfilling the established criteria for burnout and work engagement. Another potential limitation of our study is the '*healthy worker effect*'. Although our burned out managers had burnout scores similar to individuals who receive psychotherapeutic treatment for their complaints (Schaufeli & Van Dierendonck, 2000), they were all still working. This implies that more severely burned out managers (who were on sick leave or had left their job altogether) were not included. However, after having visited the Occupational Health Service, one-third of the managers in the burned out group were, on advice of the occupational health physician, sent home for several weeks to recover. This implies that rather severe burnout cases were also included in our sample. Moreover, the inclusion of a psychologically contrasting group (Gonzáles-Roma, Schaufeli, Bakker & Lloret, 2006), the engaged managers, has increased the power to find deviating physiological values for the burnouts.

The concept of burnout was operationalized as a combination of scores on three subscales. With respect to burnout, doubts have been expressed on the relevance of a burnout total score (Maslach, Leiter, & Schaufeli, 2008). With respect to a possible association of burnout with (reduced) vagal activity, probably the exhaustion component is the most relevant (as outlined in the introduction) considering its association with an energetic/physiological dimension. The distance to physiology seems more remote for the social–cognitive burnout facets of cynicism and personal accomplishment. Despite the fact that the groups in the present study differ considerably in exhaustion scores, the potential effect of exhaustion on vagal control is diluted by selecting the groups on the basis of a combined selection criterion. Future studies specifically focusing on the exhaustion component may have a higher sensitivity to detect effects on vagal control. The same limitation applies to our definition of engagement as a sum score of three subscales. Maybe a focus on the vigour component in future studies searching for physiological correlates of engagement is more promising.

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An absence of group differences may be due to an incomplete correction for confounding variables. One can imagine burned out persons to be more depressed, to use anti-depressants or to have a lower physical fitness. All of these factors, however, would favour the chance of finding differences in autonomic control between the burned out group and the other groups.

A final limitation may be that we measured only one work day, thereby limiting the reliability of the physiological recordings in the sense of representativeness of this particular day. An argument in favour of our one-day approach, however, is the high test–retest reliability of ambulatory HR, PEP and RSA recordings: between two work days around 0.90 (Vrijkotte et al., 2004). Also, the long-term stability of 24-hour recordings is rather good ($r > 0.66$) and comparable to stability as assessed under standardized laboratory conditions (Burleson, Poehlman, Hawkley, Ernst, Berntson, 2003).

Our results suggest that burned out managers have a normal cardiac autonomic profile. This does not rule out, however, that studying the dynamics of autonomic control may show deviances. We measured baseline functioning in sitting positions at work, at home and during sleep. We did not measure the responsivity to stressful events or periods. The study by De Vente et al. (2003) showed that physiological reactivity to a stressful task, presented three times during the day, differed between burnouts and controls, although the base levels of the groups did not differ. Specifically, these results pointed to a less responsive vagal system to demanding conditions in the burnouts. Maybe future studies should focus more on the effects of burnout (exhaustion) on disability to mobilize the system to adapt to stressful environmental conditions, which has been suggested to be associated with risk for cardiac disease (Martin, Magid, & Myers, 1987).

References

Belkic, K.L., Landsbergis, P.A., Schnall, P.L., & Baker, D. (2004). Is job strain a major source of cardiovascular risk? *Scandinavian Journal of Work, Environment & Health*, *30*, 85–128.

Berntson, G.G., Bigger, J.T. Jr, Eckberg, D.L., Grossman, P., Kaufmann, P.G., Malik, M., Haikady, N.N., Porges, S.W., Saul, J.P., Stone, P.H., & van der Molen, M.W. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology*, *34*, 623–648.

Brenninkmeijer, V., & Van Yperen, N. (2003). How to conduct research on burnout: Advantages and disadvantages of an unidimensional approach to burnout. *Occupational and Environmental Medicine*, *60*(Suppl. 1), 16–21.

Burleson, M.H., Poehlman, K.M., Hawkley, L.C., Ernst, J.M, & Berntson, G.G. (2003) Neuroendocrine and cardiovascular reactivity to stress in mid-aged and older women: Long-term temporal consistency of individual differences. *Psychophysiology*, 40, 358–369.

Collins, S.M., Karasek, R.A., & Costas, K. (2005). Job strain and autonomic indices of cardiovascular risk. *American Journal of Industrial Medicine*, *48*, 182–193.

Dekker, J.M., Crow, R.S., Folsom, A.R., Hannan, P.J., Liao, D., Swenne, C.A., & Schouten, E.G. (2000). Low heart rate variability in a 2-min rhythm strip predicts risk of coronary heart disease and mortality from several causes: The ARIC study. *Circulation*, *102*, 1239–1244.

De Vente, W., Olff, M., Van Amsterdam, J.G.C., Kamphuis, J.H., & Emmelkamp, P.M.G. (2003). Physiological differences between burnout patients and healthy controls: Blood pressure, heart rate, and cortisol responses. *Occupational and Environmental Medicine*, *60*, 54–61.

de Geus, E.J.C., & van Doornen, L.J.P. (1996). Ambulatory assessment of parasympathic/sympathic balance by impedance cardiography. In J. Fahrenberg, & M. Myrtek (Eds), *Ambulatory assessment; Computer-assisted psychological and psychophysiological methods in monitoring and field studies* (pp. 141–163). Göttingen, Germany: Hogrefe & Huber Publishers.

de Geus, E.J.C., Willemsen, G.H.M., Klaver, C.H.A.M., & van Doornen, L.J.P. (1995). Ambulatory measurement of respiratory sinus arrhythmia and respiration rate. *Biological Psychology*, *41*, 205–227.

Gonzáles-Roma, V., Schaufeli, W.B., Bakker, A., & Lloret, S. (2006). Burnout and engagement: independent factors or opposite poles? *Journal of Vocational Behavior*, 68, 165–174.

Halbesleben, J.R.B., & Buckley, M.R. (2004). Burnout in organizational life. *Journal of Management*, *30*, 859–879.

Hanson, E.K.S., Godaert, G.L.R., Maas, C.J.M., & Meijman, T.F. (2001). Vagal cardiac control throughout the day: The relative importance of effort–reward imbalance and within-day measurements of mood, demand and satisfaction. *Biological Psychology*, *56*, 23–44.

Hemingway, H., Shipley, M., Brunner, E., Britton, Malik, M., & Marmot, M. (2005). Does autonomic function link social position to coronary risk? The Whitehall II Study. *Circulation*, 111, 3071–3077.

Houtveen, J.H., & van Doornen, L.J.P. (2007). Medically unexplained symptoms and between-group differences in 24-hr ambulatory recording of stress physiology. *Biological Psychology*, *76*, 239–249.

Houtveen, J.H., & Molenaar, P.C.M. (2001). Comparison between the Fourier and Wavelet methods of spectral analysis applied to stationary and non-stationary heart period data. *Psychophysiology*, *38*, 729–735.

Houtveen, J.H., Groot, P.F.C., & de Geus, E.J.C. (2005). Effects of variation in posture and respiration on RSA and pre-ejection period. *Psychophysiology*, *42*, 713–719.

Martin, G.J., Magid, N.M., & Myers, G. (1987). Heart rate variability and sudden death secondary to coronary artery disease during ambulatory electrocardiographic monitoring. *American Journal of Cardiology*, 60, 86–89.

Maslach, C., Leiter, M.P., & Schaufeli, W.B. (2008). Measuring burnout. In C.L. Cooper, & S. Cartwright (Eds), *The Oxford handbook of organizational well-being* (pp. 86–108). Oxford: Oxford University Press.

Maslach, C., Schaufeli, W.B., & Leiter, M.P. (2001). Job burnout. *Annual Review of Psychology*, *52*, 397–422.

DOI: 10.1002/smi

Melamed, S., Shirom, A., Toker, S., Berliner, S., & Shapira, I. (2006). Burnout and risk of cardiovascular disease: Evidence, possible causal paths, and promising research directions. *Psychological Bulletin*, *132*, 327–353.

Preckel, D., von Känel, R., Kudielka, B.M., & Fischer, J.E. (2005). Overcommitment to work is associated with vital exhaustion. *International Archives of Occupational and Environmental Health*, *78*, 117–122.

Pressman, S.D., & Cohen, S. (2005). Does positive affect influence health? *Psychological Bulletin*, *131*, 925–971.

Riese, H., van Doornen, L.J.P., Houtman, I.L.D., & de Geus, E.J.C. (2004). Job strain in relation to ambulatory blood pressure, heart rate, and heart rate variability among female nurses. *Scandinavian Journal of Work, Environment & Health*, *30*, 477–485.

Riese, H., Groot, P.F.C., Van den Berg, M., Kupper, N.H.M., Magnée, E.H.B., Rohaan, E.J., Vrijkotte, T.G.M., & de Geus, E.J.C. (2003). Large-scale ensemble averaging of ambulatory impedance cardiograms. *Behavior Research Methods, Instruments, & Computers*, *35*, 467–477.

Roelofs, J, Verbraak, M., Keijsers, G.P.J., de Bruin, M.B.N., & Schmidt, A.J.M. (2005), Psychometric properties of a Dutch version of the Maslach Burnout Inventory—General Survey in individuals with and without burnout. *Stress and Health*, *21*, 17–25.

Rottenberg, J. (2007). Cardiac vagal control in depression: A critical analysis. *Biological Psychology*, *74*, 200–211.

Schaufeli, W.B., & Bakker, A.B. (2003). *Utrechtse Bevlogenheidschaal. Voorlopige Handleiding [The Utrecht Work Engagement Scale. Manual]*. Utrecht, The Netherlands: Department of Social & Organizational Psychology.

Schaufeli, W.B., & Enzmann, D. (1998). *The burnout companion to research and practice: A critical analysis*. London: Taylor & Francis.

Schaufeli, W.B., & Salanova, M. (2007). Work engagement: An emerging psychological concept and its implications for organizations. In S.W. Gilliland, D.D. Steiner, & D.P. Skarlicki (Eds), *Research in social issues in management (Volume 5): Managing social and ethical issues in organizations* (pp. 135–177). Greenwich, CT: Information Age Publishers.

Schaufeli, W.B., & Van Dierendonck, D. (2000). *Handleiding van de Utrechtse Burnout Schaal (UBOS) [Manual Utrecht Burnout Scale]*. Lisse, The Netherlands: Swets & Zeitlinger.

Schaufeli, W.B., Leiter, M.P., Maslach, C., & Jackson, S.E. (1996). Maslach Burnout Inventory—General Survey. In C. Maslach, S.E. Jackson, & M.P. Leiter (Eds), *The Maslach Burnout Inventory: Test manual* (3rd edn., pp. 22–26). Palo Alto, CA: Consulting Psychologists Press.

Schaufeli, W.B., Salanova, M., Gonzalez-Roma, V., & Bakker, A.B. (2002). The measurement of engagement and burnout: A two sample confirmatory analytic approach. *Journal of Happiness Studies*, *3*, 71–92.

Schaufeli, W.B., Bakker, A., Schaap, C., Kladler, A., & Hoogduin, C.A.L. (2001). On the clinical validity of the Maslach Burnout Inventory and the Burnout Measure. *Psychology and Health*, *16*, 565–582.

Sherwood, A., Fahrenberg, J., Kelsey, R.M., Lovallo, W.R., & van Doornen, L.J.P. Methodological guidelines for impedance cardiography. *Psychophysiology*, 1990, 27, 1–23.

Shirom, A., Melamed, S., Toker, S., Berliner, S., & Shapira, I. (2005). Burnout and health review: Current knowledge and future research directions In: G.P. Hodgkinson, & J.K. Ford (Eds), *International review of industrial and organizational psychology* (Vol. 20, pp. 269–309). Chichester, UK: Wiley.

Soderfeldt, M., Soderfeldt, B., Ohlson, C.G., Theorell, T., & Jones, I. (2000). The impact of sense of coherence and high-demand/low-control job environment on self-reported health, burnout, and psychophysiological stress indicators. *Work and Stress*, *14*, 1–15.

Steptoe, A., & Wardle, J. (2005). Positive affect and biological function in everyday life. *Neurobiology of Aging*, *26S*, S108–S112.

Vrijkotte, T.G.M., van Doornen, L.J.P., & de Geus, E.J.C. (2000). Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability. *Hypertension*, *35*, 880–886.

Vrijkotte, T.G.M., van Doornen, L.J.P., & de Geus, E.J.C. (2004). Overcommitment to work is associated with changes in cardiac sympathetic regulation. *Psychosomatic Medicine*, *66*, 656–663.

Watanabe, T., Sugiyama, Y., Sumi, Y., Watanabe, M., Takeuchi, K., Kobayashi, F. & Kono, K. (2002). Effects of vital exhaustion in cardiac autonomic nervous functions assessed by heart rate variability at rest in middle-aged workers . *International Journal of Behavioral Medicine*, *9*, 68–75.

Watkins, L.L., Grossman, P., Krishnan, R., & Sherwood, A. (1998). Anxiety and vagal control of heart rate. *Psychosomatic Medicine*, *60*, 498–502.

Willemsen, G.H.M., de Geus, E.J.C., Klaver, C.H.A.M., van Doornen, L.J.P., & Carroll, D. (1996). Ambulatory monitoring of the impedance cardiogram. *Psychophysiology*, *33*, 184–193.

Zanstra, Y.J., Schellekens, J.M.H., Schaap, C., & Kooistra, L. (2006). Vagal and sympathetic activity in burnouts during a mentally demanding workday. *Psychosomatic Medicine*, *68*, 583–590.

DOI: 10.1002/smi