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Burnout and the fine-tuning of cognitive resources

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Abstract

We examined the performance in a Constant Foreperiod (CFP) task in two samples screened for either high or low scores on the core burnout dimension emotional exhaustion. In line with our expectations, participants scoring high on emotional exhaustion exhibited a specific deficit with respect to maintaining a high level of response readiness at longer foreperiods. This demonstration of a modulation of CFP performance by burnout adds to the growing body of evidence suggesting that exhaustion is related to deficits in basic cognitive mechanisms underlying the fine-tuning of cognitive resources according to task demands.

Introduction

Western media is increasingly concerned with the prevalence of *burnout* in the working population. Headlines such as 'Stressed staff head for burnout' and 'Executive burnout costing millions' have appeared in recent news outlets in the UK and Australia, respectively, and articles titled 'Do you have job burnout?' have appeared in diverse sources including the CNN website and Men's Health magazine. A key reason for the media concern regarding burnout is the assumption that people who are burned out will perform more poorly at work. Yet we still know relatively little about how burnout affects performance, in particular, whether people with high versus low burnout symptoms suffer decrements related to specific cognitive functions. The aim of the present paper is to investigate the fine-tuning of cognitive resources as a possible cognitive function affected by burnout.

Emotional exhaustion and Performance

Burnout is a state of psychological strain that is characterized by feelings of being emotionally fatigued (*emotional exhaustion*), distanced from other people (*depersonalization*), and less competent and successful than usual (*reduced personal accomplishment*) as a result of one's work (Maslach, Schaufeli, & Leiter, 2001). Estimates of the population prevalence of burnout vary depending on the method of diagnosis, but even using stringent criteria prevalence appears relatively high. For example, a recent study in Belgium reported a prevalence of just under 1% of the working population, based on diagnoses during health examinations carried out by occupational physicians (Mairiaux et al., 2012). Rates of self-diagnosed burnout within susceptible occupations are striking; 46% of physicians in the USA self-report at least one symptom of serious burnout (Shanafelt et al., 2012), while rates among medical residents may be as high as 75% (Ripp et al., 2011). Early accounts of burnout held that those suffering burnout inevitably have poorer job performance, despite little empirical evidence (Wright & Bonnet, 1997). However, links between self-reported burnout and job performance have since been reported in a variety of

studies (e.g., Babakus, Yavas, & Ashill, 2009; Feuerhahn et al., in press; Halbesleben & Wheeler, 2011; Rudman & Gustavsson, 2012; Taris, 2006).

Past research strongly suggests that emotional exhaustion constitutes the core dimension of burnout experience and differentiates between burnout and other related symptoms, such as depression (Maslach et al., 2001; Toker & Biron, 2012). This suggestion is rooted in the empirical finding that the exhaustion component exerts lagged effects on depersonalization as well as personal accomplishment (but not vice versa) and therefore, initializes developing burnout (Diestel & Schmidt, 2010; Taris, Le Blanc, Schaufeli, & Schreurs, 2005). Thus, in our study, we focus on emotional exhaustion. Specific decrements appear to be apparent with respect to cognitive performance during executive control tasks. Executive control refers to a set of functions that require voluntary regulation of perceptual or motor processes as a means of dealing with changing demands (e.g., sustained attention or vigilance; Manly et al., 1999; Norman & Shallice, 1986). Exhaustion is particularly likely to affect executive control by virtue of being dependent on cognitive resources that have been shown to be depleted more readily among those with burnout (Diestel & Schmidt, 2011). Indeed, during a series of executive control tasks, van der Linden et al. (2005) documented that the performance of burnout sufferers was poorer than non-sufferers. In particular, burnout sufferers committed more errors in the Sustained Attention to Response Test (SART) and performed more variable in the Bourdon-Wiersma Sustained Attention Test. These observations suggest that burnout might lead to difficulties in situations in which there exists a conflict between upholding a high readiness to respond and a requirement to withhold responding in some cases.

In recent studies, van Dam and colleagues have further demonstrated that the relatively poor performance of people with burnout in such tasks cannot be improved with motivational incentives or priming (Van Dam et al., 2011, 2012), suggesting cognitive impairments on a rather basic level and an inability to overcome these by voluntary effort.

Furthermore, Oosterholt et al. (2012) recently presented evidence that exhaustion-related cognitive impairments were unaffected by cognitive behavioral therapy although this therapy significantly improved patients' self-reported cognitive performance, which also suggests exhaustion-related impairments on a rather basic, mechanistic level. Beyond these behavioral indications of cognitive deficits associated with burnout, van Luijteaar et al. (2010) reported some preliminary evidence regarding EEG-related changes in burnout patients (reduced amplitude of the P300, lower alpha peak frequency, reduced beta power) that also suggest difficulties regarding the fine-tuning of cognitive operations associated with burnout.

The Present Research

Taken together, the sparse but relatively consistent evidence suggests that exhaustion may specifically impair people's ability to fine-tune resources during cognitive tasks. An experimental paradigm tailored to assess the fine-tuning of elementary processes of response readiness over extended periods of time, under conditions that require a frequent withholding of responses, would therefore enable detection of burnout-related cognitive changes in a more sensitive manner than in previous research. In the present study, we devised a variant of the Constant Foreperiod (CFP) Task that combines a fine-grained measurement of response readiness in a way intended to be especially sensitive to the specific deficits seemingly associated with exhaustion.

The CFP task induces variations in readiness to respond by variations of the foreperiod that separates an alerting signal (most often a tone) from the presentation of an imperative stimulus (most often visually presented). The foreperiod is constant across a block of trials in order to avoid a multitude of other processes involved when varying the foreperiod in an unpredictable fashion (cf. Los & van den Heuvel, 2001). Usually, two basic findings can be obtained by this procedure (cf. Los & Schut, 2008). The first is a decrease of reaction time (RT) as the foreperiod is increased from a very short duration to durations in the range of about 300 – 400 ms, thought to reflect a basic alerting mechanism. The second effect is an

increase of RT as the foreperiod exceeds an 'optimal' value of about 400 +/- 150 ms, which reflects the increasing difficulty of maintaining a maximum of response readiness over extended periods of time (cf. Gottsdanker, 1975). We argue that whereas the first, rather automatic alerting effect should be insensitive to burnout-related changes, the second effect is likely to be sensitive to exhaustion.

We modeled our experimental procedure according to experiments of Los and Schut (2008, Exp. 1 & 2), with two important changes. In order to enhance the supposed sensitivity to burnout-related cognitive changes in the fine-tuning of response readiness over extended periods of time, we included a large number of nogo-trials in our experimental procedure. This procedure allowed us to capture the requirement of withholding responses while at the same time maintaining a high level of response readiness, which was one of the core features of the study of van der Linden et al. (2005). In addition to including a large number of nogo-trials, we studied the full range of foreperiods of interest within a single experiment, with the aim of obtaining a U-shaped function of RT by foreperiod, as it was reported by Müller-Gethmann, Ulrich, and Rinkenauer (2003). Los and Schut (2008), in contrast, obtained the rising and trailing edges across two experiments with different ranges of the foreperiod.

Method

Participants

We recruited our participants from a German university and from the German working population through announcements, individual contacts, and contacts of undergraduate students. A final sample consisted of 32 students and 18 employees from different occupational contexts. The proportion of female participants in the final sample was 64 % and mean age was 30.2 (SD = 10.27; 20-60). All participants had normal or corrected-to-normal vision and no auditory deficiency. Because t-Tests did not reveal any differences between the student and the employee sample in exhaustion (ps > .14), we merged both groups into one sample. Past research on longitudinal effects of academic demands on psychosomatic

complaints, emotional distress and anxiety has repeatedly demonstrated that students are also at the risk of suffering from symptoms similar to exhaustion, especially under conditions of high academic stress (such as examinations; Oaten & Cheng, 2005, 2007). We therefore argue that exhaustion levels in our sample may reflect true symptoms, which result from adverse effects of high demands. In order to capture an effect of emotional exhaustion strong enough to be able to detect relatively subtle changes in elementary cognitive functions, we contrasted the highest and lowest quartiles regarding this variable but also ran correlational analyses including the whole sample.

Procedure

The experimental session started with participants filling out the German version of the Maslach Burnout Inventory (MBI; Büssing & Perrar, 1992). Afterwards, participants performed 72 blocks of 24 trials each of the constant foreperiod task. Each trial consisted of the presentation of an auditory warning signal (50 ms, 1,000 Hz) that was followed by the presentation of a square or a diamond (4 x 4 cm) at the center of a 17" monitor. Viewing distance was not restricted but amounted to approximately 60 cm. Participants were asked to respond only to the squares (8 out of 24 stimuli), whereas they were to withhold their response in case of a diamond (16 out of 24 stimuli). Responses consisted of pressing the 'b'-key on a standard QWERTZ-keyboard. The inter-trial interval ranged between 1,000 and 1,500 ms in an unpredictable manner.

During each block of trials, the foreperiod, that is, the stimulus onset asynchrony that separated the auditory warning signal from the visual stimulus, was kept constant at either 50, 150, 250, 400, 550, or 750 ms. The order of foreperiods across blocks of trials was determined by means of a 6 x 6 Latin Square, with the sequence of conditions being repeated once to yield a total of 72 blocks of trials. The key indicator from the task was participants' response times (RTs) at the different foreperiods. It should be noted that error rates, both in terms of

omissions and false alarms, were quite low (1.75 %) and did not vary as a function of any of the experimental factors.

Measures

The burnout dimension of *emotional exhaustion* was measured by Büssing and Perrar's (1992) German translation of the Maslach Burnout Inventory (Maslach & Jackson, 1986; Maslach et al., 2001). Emotional exhaustion (nine items) refers to feelings of being overextended and drained by work demands (e.g., "I feel emotionally drained from my work"). All items are scored on a 6-point intensity rating scale (1 = *not at all*, 6 = *very strong*). Internal consistencies was $\alpha = .85$.

Results

As can be seen in Table 1, both groups (1st and 4th quartile) did not differ with respect to the percentage of women and mean age. In contrast, as expected, mean values of emotional exhaustion were significantly smaller for participants of the first quartile.

The first six blocks of trials (one per foreperiod) were considered as practice and excluded from the analyses. In addition, the last six blocks were also excluded because performance became quite unstable during these blocks, probably due to fatigue. Individual mean RTs were analyzed by two analyses of variance (ANOVA) as a function of the within-subjects factors foreperiod (6) and half of the experiment (blocks 7 – 36 vs. 37 – 66) and the between-subjects factor emotional exhaustion (1st vs. 4th quartile). Greenhouse-Geisser corrections were employed when appropriate.

- Figure 1 and Table 1 about here -

The ANOVA including the between-subjects factor emotional exhaustion yielded a significant main effect of Foreperiod, $F(5, 100) = 20.33$, $p < .001$, $\eta_p^2 = 50$. As can be seen from Figure 1, we were able to observe both the rising and trailing edges of the U-shaped RT function within a single experiment.

Most important, we obtained an interaction of Foreperiod and emotional exhaustion, $F(5, 100) = 2.82$, $p < .05$, $\eta_p^2 = 12$. This interaction was due to the observation that participants scoring high on emotional exhaustion were not able to modulate their performance as a function of foreperiod duration to the same degree as participants scoring low on emotional exhaustion. Duncan post-hoc tests revealed that irrespective of emotional exhaustion, both groups significantly ($p < .05$) decreased their RT across the first three foreperiods (FP1 > FP2 > FP3). However, whereas the group scoring low on emotional exhaustion maintained their level of performance across the two middle foreperiods (FP4 = FP5) and showed only a marginally significant ($p < .09$) increase of RT with the longest foreperiod, participants scoring high on emotional exhaustion had significantly larger RT already with a foreperiod of 550 ms (FP4 < FP5 = FP6, see Figure 1). This suggests that people with high emotional exhaustion have a relatively low ability to optimally recruit processing resources in a time-based fashion.

In an additional analysis, we tested the correlation between foreperiod effects and emotional exhaustion using the data of all participants. In a first step, mean individual exhaustion scores were correlated with the difference of RTs corresponding to the shortest two foreperiods and the two foreperiods with medium length, thus creating a measure of the falling part of the U-shaped RT function. No significant correlation could be obverved (-.08, $p > .56$). In a second step, the difference of RTs corresponding to the longest two foreperiods and the two foreperiods with medium length were correlated with emotional exhaustion to compare for differences in the rising edge of the function. Here, a positive correlation of .29 ($p < .05$) was visible, indicating a greater difference between medium and long foreperiods (and, therefore, a steeper rising of RTs when a foreperiods are prolonged) for participants with high scored of emotional exhaustion.

Discussion

The present study aimed to investigate burnout-related cognitive deficits by employing a variant of the CFP Task. The CFP Task was designed to analyze a U-shaped function of RT dependent on the duration of the foreperiod. Based on earlier reports suggesting burnout-related deficits in terms of a decrement of sustained attention under conditions in which there is a conflict between maintaining a high level of response readiness and the requirement to frequently withhold responding (van der Linden et al., 2005), we expected a compromised ability to maintain a high level of response readiness with participants scoring high on the core dimensions of burnout. Our findings supported this expectation in the case of emotional exhaustion, which is considered as the core dimension of burnout by many researchers (Maslach et al., 2001), as we observed a steeper rising edge of the RT function among participants with high, but not low, emotional exhaustion.

The present study adds to the evidence suggesting that burnout is associated with a deficit in terms of executive functions that promote the ability to focus on relevant aspects of the environment and maintain a high level of task readiness. This assumption is in line with Müller-Gethmann and colleagues (2003) who combined the CFP paradigm with measuring the lateralized readiness potential and concluded that temporal preparation mainly (which was impaired in participants with high emotional exhaustion in the present study) influences premotor processes like feature extraction and stimulus identification.

A study sharing some theoretical and methodological similarities with the present study was conducted by Langner, Steinborn, Chatterjee, Sturm, and Willmes (2010) who explored the effect of mental fatigue on performance using a variable-foreperiod setting. They observed a decrease in general RT level with increasing amount of mental fatigue (operationalized as the time on task), but no interaction of mental fatigue and foreperiod length. The authors therefore conclude that mental fatigue does not affect temporal preparation. In contrast, our specific pattern of results suggests that deficits in cognitive functioning become not only apparent when sustained attention over a relatively long period

of time comes into play, but also when the task requires a fine-tuned phasic adjustment of processing resources. While this result seems at odds with the results of Langner and colleagues, one has to notice that there are several methodological differences between the two studies. Apart from different self-reported measures (emotional exhaustion vs. mental fatigue), an important diference between the study of Langner et al. employed a variable foreperiod paradigm, which can be expected to capture different processes than the constant foreperiod design used in our study. . Therefore, while emerging differences between our results and that of Langner et al. (2010) can be explained by methodological differences, both studies correspond regarding the assumption of simple RT designs as a useful measure of symptoms of personal depletion.

Our version of the CFP task required participants to mobilize processing resources in a temporary fine-tuned manner in anticipation of the onset of the imperative stimulus, and this was additionally compromised by the frequent presentation of nogo trials. Of course, the latter factor may also have resulted in motivational consequences because the need to frequently inhibit responding can be expected to induce some kind of annoyance. However, we consider it as unlikely that the performance decrements in the group scoring high on emotional exhaustion were mainly due to motivational factors because the two groups of participants did not differ in conditions with the shortest foreperiod which can be considered as being unaffected by a short-term adjustment of processing resources but should still be sensitive to differences in the general level of task engagement. In support of this contention, van Dam et al. (2011) found that motivational incentives and feedback do not enhance the performance in executive tasks for those with high burnout experience.

Our findings are also consistent with the theoretical notion that burnout symptoms reflect chronic impairments of limited cognitive resources supporting executive functioning (Hofman et al., 2012; Osterholt et al., 2012). That is, persons with high burnout are less able to activate cognitive resources for executive functioning, because of deficits in

psychophysiological mechanisms that restore cognitive resources and enable efficient cognitive operations (see also van Luijteaar et al., 2010). In particular, recent studies strongly suggest that burnout symptoms result from prolonged and sustained activation of the human stress response system, which is commonly referred to as allostatic load (McEwen, 2000). Allostatic load indicates dysregulation of the hypothalamic-pituitary-adrenal axis (HPA-axis) that mediates stress response mechanisms, such as blood glucose supply, heart rate, and blood pressure. These mechanisms are highly relevant for executive functioning; thus dysregulation of the HPA-axis may cause inefficiencies in restoring as well as supplying processes of cognitive operations (Segerström & Solberg Nes, 2007). The steeper rising edge of the RT function of those with high emotional exhaustion is considered to be a manifestation of allostatic load.

From a perspective of action regulation theory (ART, Frese & Zapf, 1994; Hacker & Richter, 1990), the CFP-paradigm provides conceptual insights into specific impairments of task performance and thus reveals regulatory deficits that explain lower job performance of those suffering from burnout (Taris, 2006). According to ART, goal-directed behavior at work involves execution monitoring that aims, for example, at resolving conflicts between inhibiting inadequate responses and response readiness in cases of goal deviations from prior defined action plans. For instance, air-traffic controllers are frequently faced with high demands on execution monitoring over longer time periods. In nursing or medical occupations, employees are also often required to sustain their attention and to maintain response readiness. Because of impairments in executive functioning, high emotional exhaustion indicates that, under condition of high demands on execution monitoring, goal-directed behaviour might not be successfully performed, thus increasing the likelihood of errors. Therefore, our results point to a potential mechanism that explains the negative relationship between burnout and task performance in a wide range of occupational contexts.

Future research should provide insights into underlying relationships between psychophysiological processes, such as heart rate variability or blood pressure, and burnout-related cognitive deficits, in order to clarify the role of allostatic load in developing burnout. Furthermore, such empirical evidence would also contribute to identifying biomarkers of burnout and to establish burnout as a severe symptom that differs from other related disorders and can cause chronic impairments of psychological functioning (Danhof-Pont, Veen, & Zitman, 2011).

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Table 1.

Characteristics of the high and low burnout subgroups.

	Emotional Exhaustion	
	Low (1st quartile)	*High (4th quartile)*
n	12	10
Percentage of women	83 %	70 %
Age	28.5 (8.1)	27.1 (7.9)
Emotional exhaustion**	1.47 (0.16)	3.53 (0.40)

Note. For age, exhaustion and personal accomplishment, mean values are given, with standard deviations in parentheses. Different group sizes result from ties on participant's emotional exhaustion scores.
** $p < .01$.

Figure caption

Fig. 1: Mean RT as a function of Foreperiod and Emotional Exhaustion. Error bars represent SEs of the mean.

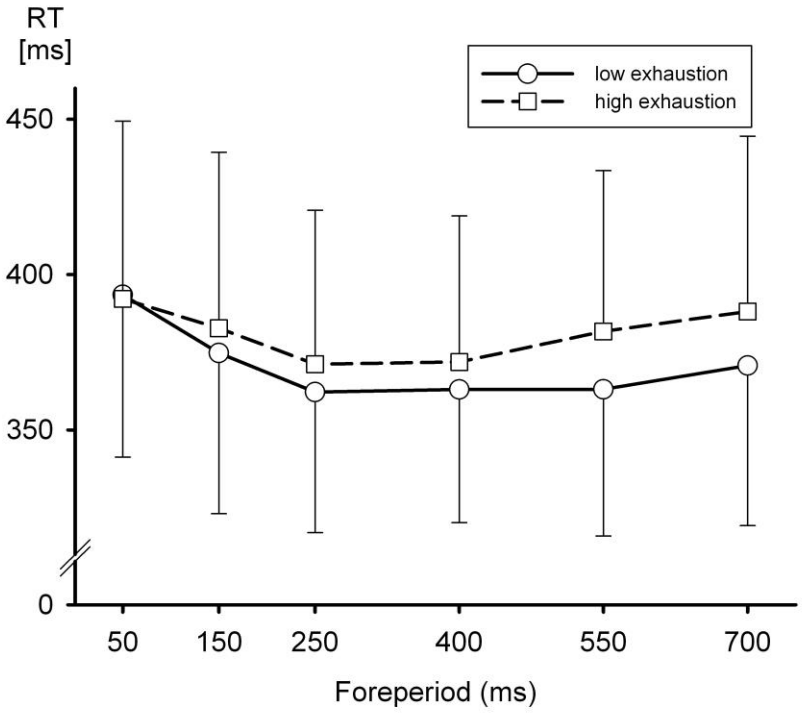

Figure 1