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Shifting of attentional set is inadequate in severe burnout: Evidence from an event-related potential study

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ABSTRACT

Individuals with prolonged occupational stress often report difficulties in concentration. Work tasks often require the ability to switch back and forth between different contexts. Here, we studied the association between job burnout and task switching by recording event-related potentials (ERPs) time-locked to stimulus onset during a task with simultaneous cue-target presentation and unpredictable switches in the task. Participants were currently working people with severe, mild, or no burnout symptoms. In all groups, task performance was substantially slower immediately after task switch than during task repetition. However, the error rates were higher in the severe burnout group than in the mild burnout and control groups. Electrophysiological data revealed an increased parietal P3 response for the switch trials relative to repetition trials. Notably, the response was smaller in amplitude in the severe burnout group than in the other groups. The results suggest that severe burnout is associated with inadequate processing when rapid shifting of attention between tasks is required resulting in less accurate performance.

1. Introduction

Individuals who experience prolonged work-related stress often report decreased sense of efficacy in performing their daily work, as well as difficulties in information processing and concentration. Indeed, cognitive weariness is typical of job burnout (Melamed et al., 1999, 2006) which develops gradually as a result of prolonged exposure to emotional and interpersonal stressors at work. It is commonly characterized by emotional exhaustion, cynicism toward work, and decreased professional efficacy (Maslach et al., 2001; Schaufeli and Enzmann, 1998).

Several behavioral studies have indicated that chronic occupational stress is associated with impairments in cognitive functioning, especially executive functions, attentional control, and working memory (Deligkaris et al., 2014; Eskildsen et al., 2015; Jonsdottir et al., 2013; Van Der Linden et al., 2005; Oosterholt et al., 2012; Sandström et al., 2005; van Dam et al., 2011; Österberg et al., 2009). Such impairments are apparent especially in severe burnout. When the symptoms are relatively mild, however, performance can be sustained at an equally good level as that of others (Castaneda et al., 2011; Oosterholt et al., 2014; Sokka et al., 2016). Also brain imaging studies suggest burnout-related alterations, for example, in emotion- and stress-processing limbic networks as reflected by reductions in the gray matter volume (Blix et al., 2013; Savic, 2013) and altered functional connectivity (Golkar et al., 2014; Jovanovic et al., 2011), or dysfunctions of frontoparietal mechanisms involved in cognitive control processes of voluntary and involuntary attention (Liston, McEwen, & Casey, 2009; van Luijtelaar, Verbraak, van den Bunt, Keijsers, & Arns, 2010), even in participants with relatively mild burnout symptoms (Sokka et al., 2014, 2016). However, the mechanisms behind the association between burnout and cognitive deficits are yet not well understood due to heterogeneity and scarcity of the research literature (for a review, Deligkaris et al., 2014).

In working life, it is common to encounter frequently changing assignments and sudden, unprepared tasks requiring immediate redistribution of focus and cognitive resources. In the present study, we explored the association between burnout symptom severity and shifting between task sets, which is frequently regarded as one of the key executive functions in the literature (Miyake et al., 2000). We used scalp recordings of event-related brain potentials (ERPs) extracted from continuous electroencephalogram (EEG) to measure attention allocation and set shifting with a task switching paradigm in which we embedded random switches and used simultaneous cue-target presentation.

Task switching paradigms require rapid shifting between simple task sets, and they are commonly used to investigate goal-directed

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control of attention (for a review, see Monsell, 2003), and its neural mechanisms (e.g., Corbetta and Shulman, 2002). Switching from one task to another typically results in substantially slower and, often, more error-prone performance in the switch trials than in the repetition trials, a phenomenon called the switch cost (Meiran, 1996; Monsell, 2003; Rogers and Monsell, 1995). Furthermore, performance immediately after a switch in the task is decreased to a greater extent, as shown by increased switch cost, following sleep deprivation (Heuer et al., 2004), and in certain clinical conditions affecting frontal functions, such as severe burnout (van Dam et al., 2011; van Dam et al., 2012), depression (Meiran et al., 2011), and prefrontal cortical lesions (Barceló and Knight, 2002).

A popular variant of the paradigm is the task-cueing paradigm consisting of a random sequence of switch and repeat trials with the currently valid task indicated by a cue. The time interval between the cue and the target affects the switch cost: the shorter the interval, the larger the switch cost (Logan and Bundesen, 2003, 2004; Meiran, 1996). Furthermore, when the cue and target are presented simultaneously, for example, when the location of the stimulus indicates the task to be completed on a given trial, both the cue and the possible switch need to be encoded in parallel with target stimulus processing which may be disrupted resulting in a further increase in switch cost (Logan and Bundesen, 2003; Nicholson et al., 2005).

ERPs are neural responses that are time-locked to specific events of interest, such as allocation of attention to a stimulus. ERP recordings provide a means to study the cortical basis of fast sensory and cognitive processes, and they are widely applied both in basic research, and in studies with different clinical subgroups such as patients with depression (McNeely et al., 2008), insomnia and/or excessive sleepiness (Gumenyuk et al., 2015), chronic fatigue syndrome (Polich et al., 1995), or a brain lesion (Knight, 1984; Polich and Squire, 1993). Especially, the P3 response of the ERP has been widely studied in clinical subgroups as it is thought to reflect attention and memory processes engaged during stimulus processing (Polich and Herbst, 2000; Polich, 2007; Soltani and Knight, 2000). The P3 is a large positive response elicited by voluntary detection of task-relevant stimuli, generated by a network of cortical regions, and peaking approximately 300–500 ms after stimulus onset over parietal scalp sites (e.g., Knight, 1997; Soltani and Knight, 2000). The P3 amplitude has been shown to decrease in association with high stress (Shackman et al., 2011), increased sleepiness following sleep deprivation (Colrain and Campbell, 2007; Polich and Kok, 1995), depression (Cavanagh and Geisler, 2006), and severe burnout (van Luijtelaar, Verbraak, van den Bunt, Keijsers, & Arns, 2010). In addition, our recent study showed reduced working-memory related visual P3b amplitudes over posterior scalp and increased P3b amplitudes over frontal areas even with relatively mild burnout symptoms (Sokka et al., 2016). Additional recruitment of anterior regions to compensate the decrement in posterior activity might be required in order to sustain a similar performance level than that of the controls. Together these findings suggest disturbed processing of task-relevant information in these conditions.

Neural processes related to task switching can be studied separately, for example, in relation to the cue, target, or motor response. ERP responses time-locked to the onset of the cue typically show a larger posterior positivity for switch trials than repetition trials as indicated by enhanced cue-related centro-parietal P3-like responses (Barceló et al., 2002; Gajewski and Falkenstein, 2011; Karayanidis et al., 2010; Kieffaber and Hetrick, 2005; Kieffaber et al., 2007; Kopp and Lange, 2013; Lange et al., 2015; Nicholson et al., 2006; Nicholson et al., 2005; Tarantino et al., 2016), and a fronto-central task-novelty P3 response (Barcelo et al., 2006; Barceló et al., 2002; Periáñez and Barceló, 2009). Recently, Berti (2016) applied a memory updating task in which either the same or another memory items were compared with the preceding trials, resulting in switch and repetition trials. Both trial types elicited a large bi-phasic P3-like response which was more pronounced for the switch than the repetition trials. By contrast, P3-like responses time-locked to the target stimulus have typically been shown to be more pronounced for repetition trials than for switch trials (Barceló et al., 2000; Gajewski and Falkenstein, 2011; Goffaux et al., 2006; Hsieh and Liu, 2008; Kieffaber and Hetrick, 2005; Tarantino et al., 2016). However, when the interval between the cue and the target is short, or when the cue and the target are simultaneously presented, there is a substantial temporal overlap between cue-related and target-related processes as indicated by coinciding switch-related positive deflections in the ERP waveforms (Nicholson et al., 2005). Furthermore, ERPs related to the response to the preceding trial are characterized by a parietally maximal negativity between the response and the onset of the subsequent stimulus, reaching its maximal around 400 ms post-response (Karayanidis et al., 2003). When the response-stimulus interval is short (e.g., 150 ms) so that there is only little time to prepare for the upcoming stimulus, Karayanidis et al. (2003) observed that the negativity began prior to stimulus onset, and continued after stimulus onset, thereby overlapping with ERP responses associated with subsequent stimulus processing. In sum, several studies applying a wide variety of stimulus and task manipulations indicate that switch-related ERP responses consist of many underlying components, and that various control processes are recruited during task switching, including context monitoring and updating, rapid reconfiguration, and task set preparation and execution (for a review, see Karayanidis et al., 2010).

In the present study, we explored the association between burnout and shifting between tasks in groups of currently working individuals with severe, mild, or no burnout symptoms. To this end, we recorded performance and stimulus-locked ERPs in a task switching paradigm in which switches between task sets occurred randomly, the cue and the target were presented simultaneously, and the response-stimulus interval was short. Previous research on cognitive and brain functions suggests burnout-related impairments in cognitive performance and alterations in control of attention. Therefore, we expected to observe impaired performance at least when burnout symptoms are severe. In addition, based on previous findings on ERPs related to task switching, we expected that switch trials elicit greater P3-like activation than repetitive trials due to the nature of the present experimental paradigm in which the location of the stimulus signaled the task to be completed on a given trial. Therefore, cue-related and target-related processes cannot be separated in the present study. We also expected that burnout-related alterations in electrophysiological activity related to attentional set shifting might be observed as reflected by the P3.

2. Materials and methods

2.1. Participants

The participants in the present study were the same as those reported in Sokka et al. (2014) except for three participants who did not complete the present task switching paradigm, resulting in a total of 64 participants. They reported having normal or corrected-to-normal vision, and no hearing deficits. The participants were employees of the city of Helsinki or customers of the Occupational Health Centre of the city of Helsinki. They were recruited through advertisements informing about the present research project in which association between burnout symptoms and cognitive functions was explored by means of brain research and neuropsychological methods. The advertisements were displayed at the local occupational health care station, as well as on the intranet sites of the aforementioned organizations. Four participants with mild burnout symptoms, and four participants with severe burnout symptoms were referred to the study by a physician, psychologist, or nurse during appointments at the local occupational health care station. The rest of the burnout participants and all control participants entered the study after noticing the advertisement. The recruitment process reported here is the same as that reported in Sokka et al. (2014, 2016). The participants were first interviewed by telephone to ensure that the potentially experienced symptoms of burnout were