International Journal of Psychophysiology 94 (2014) 427–436

Contents lists available at ScienceDirect

International Journal of Psychophysiology

journal homepage: www.elsevier.com/locate/ijpsycho

Alterations in attention capture to auditory emotional stimuli in job burnout: An event-related potential study

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ARTICLE INFO

Article history:
Received 14 April 2014
Received in revised form 29 October 2014
Accepted 2 November 2014
Available online 7 November 2014

Keywords:
Job burnout
Attention
Event-related potential (ERP)
Mismatch negativity (MMN)
P3a
Emotion

ABSTRACT

Job burnout is a significant cause of work absenteeism. Evidence from behavioral studies and patient reports suggests that job burnout is associated with impairments of attention and decreased working capacity, and it has overlapping elements with depression, anxiety and sleep disturbances. Here, we examined the electrophysiological correlates of automatic sound change detection and involuntary attention allocation in job burnout using scalp recordings of event-related potentials (ERP). Volunteers with job burnout symptoms but without severe depression and anxiety disorders and their non-burnout controls were presented with natural speech sound stimuli (standard and nine deviants), as well as three rarely occurring speech sounds with strong emotional prosody. All stimuli elicited mismatch negativity (MMN) responses that were comparable in both groups. The groups differed with respect to the P3a, an ERP component reflecting involuntary shift of attention: job burnout group showed a shorter P3a latency in response to the emotionally negative stimulus, and a longer latency in response to the positive stimulus. Results indicate that in job burnout, automatic speech sound discrimination is intact, but there is an attention capture tendency that is faster for negative, and slower to positive information compared to that of controls.

1. Introduction

In recent years, job burnout has become a significant cause of decreased working capacity of workers in both developing and industrialized countries. More than 25% of working people have been observed to have symptoms of job burnout, in 2% estimated as severe (Ahola et al., 2006). The term 'job burnout' refers to a multidimensional, psychological condition with persistent work-related negative state of mind. It is characterized primarily by symptoms of exhaustion, accompanied by experienced distress as well as decreased effectiveness and motivation. Further, employees develop cynicism to distance themselves from the exhausting demands they encounter in their work. Job burnout develops gradually over time as a consequence of a prolonged stress situation at work (Schaufeli and Enzmann, 1998; Maslach et al., 2001). In their three-dimensional job burnout model of exhaustion, cynicism and reduced professional efficacy, Maslach et al. (2001) place the individual stress experience within the social context of the work-place, and the person's conception of both self and others is included.

In working life, demands on various cognitive functions such as those of attention and working memory are present on a daily basis. Attention can easily be captured by unexpected acoustic or visual changes thereby disrupting task performance. People with job burnout often report having difficulties concentrating and remembering information (Maslach et al., 2001; Österberg et al., 2009). Researchers have suggested that job burnout is associated with impairments of attention (Sandström et al., 2005), reduced processing speed (Österberg et al., 2009), and reduced working memory updating (Oosterholt et al., 2012), but the findings are still at least partly controversial (van Luijtelaar et al., 2010; Castaneda et al., 2011), and non-specific to job burnout. However, neurophysiological studies on this topic are scarce.

Scalp recordings of event-related potentials (ERPs) provide a means to evaluate the effects of job burnout on the time course of automatic processing and attention allocation. ERP recordings are widely used to study a variety of brain functions both in healthy people and in different clinical subgroups such as neurological patients (e.g., Polich and Squire, 1993), patients with depression (MacQueen et al., 2000; McNeely et al., 2008), schizophrenia (e.g., Weir et al., 1998; Alain et al., 2002), autism spectrum disorders (O'Connor et al., 2007), and attention deficit hyperactivity disorder (ADHD; Barry et al., 2003).

The N1 wave of the auditory ERPs peaks at 50–150 ms from stimulus onset, and its amplitude is dependent on the acoustical properties as

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http://dx.doi.org/10.1016/j.ijpsycho.2014.11.001
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well as the number of successive repetitions of the stimulus within the sound sequence. Traditionally, N1 has been interpreted as a marker of early perceptual auditory processing in primary and associative auditory cortices (for a review, see Näätänen and Picton, 1987). The mismatch negativity (MMN) is a negative component that peaks at about 100–250 ms after deviance onset over fronto-central scalp areas (Näätänen et al., 1978; Näätänen, 1992; Näätänen and Winkler, 1999; for more recent reviews, see Picton et al., 2000; Näätänen et al., 2007). It is elicited by oddball stimuli in a sequence of repeating standard stimuli. According to the memory-trace theory, the MMN reflects a neural mismatch between the incoming stimulus and representations of those presented previously in the sequence (Näätänen, 1992). More recent theories view the MMN as an end result of a process aiming at predicting the future auditory stream on the basis of the previously heard sounds (Näätänen et al., 2011). The MMN is strongly correlated with the behavioral discrimination accuracy, depending upon the ability to perceive the difference between the standard and deviant stimuli and to maintain a memory of the presented stimulus characteristics (Pakarinen et al., 2009). The MMN can be elicited in the absence of attention (Näätänen et al., 1978; Alho, 1992; Näätänen, 1992), and therefore it is thought to represent a relatively automatic change detection process. Thus, the MMN provides a powerful tool with which to evaluate automatic change detection in a variety of clinical groups, e.g., stroke patients (Alain et al., 1998; Ilvonen et al., 2003), major depression (Kähkönen et al., 2007), schizophrenia (for a review, see Michie, 2001), dyslexia (Kujala et al., 2006), as well as in fetuses (Huotilainen et al., 2005), infants (Cheour-Luhtanen et al., 1996), and in aging (e.g., Alain and Woods, 1999).

Typically, the MMN has been recorded using the oddball paradigm (Näätänen et al., 1978), where infrequent (probability $P = 10$–20%) deviant tones are scattered within a stream of continually repeated standard ($P = 80$–90%) tones. However, the oddball paradigm is time-consuming, thereby diminishing its usability in clinical settings. Recently, new multi-feature MMN paradigms have been developed to shorten the recording time. They have enabled an unprecedentedly fast parametric evaluation of the central auditory processing of sound changes in simple tones (Näätänen et al., 2004; Pakarinen et al., 2010), musical sounds (Vuust et al., 2011) as well as in speech sounds (Pakarinen et al., 2009). Most typically the standard tone is alternated with several different types of deviants, each differing from the standard in one respect only, though MMN responses have also been recorded even without the standard stimulus (Pakarinen et al., 2010).

Thönnesen et al. (2010) used the traditional oddball as well as the optimum MMN paradigms to investigate the processing of emotional prosody, i.e., nonverbal vocal expression of emotions. The stimuli were bisyllabic pseudowords varying in their emotional utterances (happy, angry, sad, and neutral). The authors showed that the MMN can be elicited by changes in emotional prosody independent of particular acoustic features. They suggested that processing of cognitive feature extraction and automatic emotion evaluation might overlap enabling rapid shifts of attention to socially important cues.

If a deviant stimulus is sufficiently different from the standard one, the MMN is followed by a P3a wave, a positive response peaking approximately 250–400 ms following deviant onset (Escera et al., 1998), but also shorter P3a peak latencies have been reported when complex environmental sound stimuli are used (Alho et al., 1998). While the MMN has been proposed to play a role in the initiation of the possible attentional switch towards task-irrelevant acoustic changes (Näätänen, 1992), the P3a provides an index of the involuntary capture of attention to acoustic novelty and change (Escera et al., 1998; for a review, see Polich, 2007). There is evidence from magnetoelectrography (MEG), functional neuroimaging (fMRI), ERP, as well as from studies with patients with focal brain lesions suggesting that a wide-spread neural network brings about the automatic attention switching behavior. For instance, bilateral temporo-parietal and frontal association regions, lateral prefrontal cortex, and the left auditory cortex in the auditory modality have been suggested as main regions of the P3a generation, the maximal being reached over the central and frontal scalp regions (Knight et al., 1989; Escera et al., 1998; Schröger et al., 2000; Yago et al., 2003; for reviews, see e.g., Soltani and Knight, 2000; Friedman et al., 2001; Polich, 2007). Several researchers have shown that novel environmental sounds that are irrelevant to the task at hand elicit a P3a, reflecting cerebral activity involved in involuntary orientation of attention towards novelty in the acoustic surrounding (Escera et al., 1998; Friedman et al., 2001; Gaeta et al., 2003; Cycowicz and Friedman, 2004; Escera and Corral, 2007). Such an attention capture may have consequences for behavior. For instance, when participants are working on a visual task, infrequent novel task-irrelevant auditory stimuli generate a P3a and disrupt performance at the visual task (Escera et al., 1998; Escera and Corral, 2007). If such disruptions of the original task are frequent, it is burdening for the participant and may feel like a loss of cognitive capacity.

Emotional stimuli often elicit stronger and faster attention capture than neutral stimuli (Öhman et al., 2001; Campanella et al., 2002; Richards and Blanchette, 2004), especially for negative stimuli, such as those of threatening, fear inducing stimuli (Öhman et al., 2001), and angry faces (Esteves et al., 1994). Delplanque et al. (2005) showed that unpredictable visual stimuli, both highly emotional and neutral, elicited a clear P3a response, indicating reorientation of attention towards those stimuli. Combining the emotional context of visual stimuli with unexpected auditory events, Domínguez-Borràs et al. (2008) demonstrated that novel sounds yielded a stronger behavioral disruption on the participants' performance in a visual task when responding to negative pictures compared to neutral ones. The P3a was, accordingly, enhanced in amplitude in the negative context. These results suggest that mechanisms of involuntary attention are influenced by processing emotionally salient stimuli.

Pakarinen et al. (2014) developed a variant of the multi-feature MMN paradigm with bisyllabic pseudoword speech sound stimuli where the probabilities of the standard and the nine deviant stimuli were identical. In addition to that, three rarely occurring variants of the standard sound stimulus with strong emotional prosody – happy, angry, and sad – were included in the sequence in order to achieve an attention-catching effect, similar to novel sounds. The authors showed an MMN that was evoked by all the deviants and the emotional speech sound stimuli. In addition to the MMN, the emotional stimuli generated a P3a which peaked earlier for the happy than for the angry and sad stimuli, compatible with the physical properties of the stimuli in the paradigm.

2. Methods

The present study was a part of the "Job Burnout and Cognition" research project carried out at the Finnish Institute of Occupational Health (FIOH) in collaboration with the Occupational Health Centre of the city of Helsinki. Here, we investigated whether sound detection and automatic auditory change-detection processing, as reflected by the N1 and MMN, are affected by job burnout. Furthermore, we assessed the possible attentional alterations in people with mild to severe symptoms of job burnout, where the P3a was used as an index of involuntary attention switch to speech sound stimuli containing strong emotional prosody. As a method, we used a passive multi-feature pseudoword MMN paradigm containing emotional rarely occurring pseudowords reported in greater detail in Pakarinen et al. (2014).

2.1. Participants

The participants ($N = 67$) were working people: experiencing symptoms of job burnout ($N = 41$, mean age 48.2 years, 4 men), and their non-burnout controls ($N = 26$, mean age 45.9 years, 3 men). The groups were matched on age, gender, education, and working experience, the age range being 27–62 years. The participants were city