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Delayed psychophysiological recovery after self-concept-inconsistent negative performance feedback ☆

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ABSTRACT

The identification of individual differences variables and environmental conditions that may be associated with poor psychophysiological recovery from stress or may serve as protective factors may be relevant in the context of physical and psychological health maintenance. In the present study, heart rate recovery from a mental arithmetic task was examined after participants received bogus performance-related feedback that could be consistent or inconsistent with their specific self-concept about their mental arithmetic skills. That way, the participants' beliefs about their own performance in the task were experimentally manipulated. Recovery of heart rate was examined in two time windows: (1) shortly after the participants had completed the task and had received positive or negative performance feedback and (2) 10 min after the task. In order to evaluate the dynamic of changes in more detail, speed of recovery (linear slope of the continuous beat-to-beat data) was analysed in addition to the degree of recovery (average heart rate decline during the five-minute observation periods). The results indicate that negative performance-related feedback may prolong psychophysiological responses to stressful conditions, in particular when the feedback is inconsistent with the domain-specific self-concept. In conjunction with other evidence these results support the assumption that positive emotional states in the context of stressful events may contribute to poor post-stress recovery. Overall, the findings are supportive of the "perseverative cognition hypothesis" according to which psychophysiological recovery may be delayed through continued cognitive representation of a negative experience.

1. Introduction

Compared to studies on psychophysiological reactivity to a stressor, only a small number of studies have explicitly addressed the issue of recovery (Chida and Hamer, 2008; Linden et al., 1997; Pieper and Brosschot, 2005). Psychophysiological recovery is defined as the rate and/or degree to which a response approaches prestress levels following a stressful experience (Haynes et al., 1991). Adaptive responses to acute stress are characterised as a distinct initial reaction and efficient recovery after stressor termination. Prolonged responses are thought to indicate inflexibility, hindering proper adaptation to changing environmental demands (e.g., Friedman and Thayer, 1998; McEwen, 1998). The efficiency of cardiovascular recovery seems to be relevant to the development of cardiovascular disease.

The view that the duration of the cardiovascular response may be associated with disease risk complements the more traditional reactivity hypothesis (Krantz and Manuck, 1984) positing that heightened stress responses (i.e., the magnitude of responses) may promote the development of cardiovascular disease (Gerin et al., 2000). The empirical evidence supporting the original reactivity hypothesis has not been entirely persuasive (Schwartz et al., 2003). But although the literature on recovery is still limited compared with that on cardiovascular reactivity, a recent meta-analysis confirmed that delayed heart rate and blood pressure recovery from stress are associated prospectively with increased cardiovascular disease risk (Chida and Steptoe, 2010). Several prospective studies indicated that even cardiovascular recovery from acute tasks over the course of several minutes can predict cardiovascular health years later. For instance, delayed heart rate recovery after a mental arithmetic task was associated with higher carotid atherosclerosis two years later (Heponiemi et al., 2007). In studies in which both recovery and reactivity were examined, recovery prospectively predicted cardiovascular health independently of the initial reactivity, and the predictive power of delayed recovery exceeded that of the magnitude of the stress response (Borghi et al., 1986; Steptoe and Marmot, 2005;

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Steptoe et al., 2006; Stewart et al., 2006). Impaired recovery may be more important than the magnitude of the response because the heightened cardiovascular activity during prolonged periods of recovery persists longer and, thus, the cumulative load may exceed that caused by the reactivity spikes of acute stress responses (Brosschot et al., 2006, 2010; Pieper and Brosschot, 2005; Schwartz et al., 2003).

Prolonged cardiovascular responses after a stressful experience may occur as a result of cognitive or emotional processes that sustain arousal such as rumination, or mentally dwelling on the experience, which was labelled "perseverative cognition" by Brosschot et al. (2006). It has been proposed that the disposition to prolonged psychophysiological activation due to rumination may be an important mediator of the close relationship between psychiatric illness and cardiovascular disease (Larsen and Christenfeld, 2009). Related to this, it has been suggested that impaired recovery rather than heightened cardiovascular reactivity may partially explain the increased prospective disease risk in depressed individuals (Salomon et al., 2009).

Evidence of this kind has motivated researchers to investigate individual differences variables and environmental conditions that may be associated with poor psychophysiological recovery or may serve as protective factors. Although responses to acute stress in the laboratory are not of clinical importance in themselves, they may nevertheless be of relevance in this context. They may index the way that individuals respond to ordinary psychological demands in daily life, and accumulation of maladaptive responses may eventually have pathophysiological significance (Chida and Hamer, 2008).

The present study was primarily motivated by the unexpected finding of a previous study on a factor that has been suggested to protect against slow or prolonged recovery from stress (Ong et al., 2006; Tugade and Fredrickson, 2004), that is, positive affect (Papousek et al., 2010). In that study, first-year psychology students were exposed to an examination situation in which they had to answer a difficult statistics question while they were videotaped. High levels of trait positive affect were associated with more complete post-stress recovery of cardiac activation. But the expected additional beneficial effect of state positive affect during anticipation of the challenge was not observed. Instead, those who approached the challenge with high levels of positive affect had poor post-stress recovery (measured 8 min after the stressful event). Thus, the findings suggested that positive emotional states in the immediate context of stressful events may have adverse effects, at least under certain circumstances. In view of the design of this study, in which the questions that had to be answered were very difficult for all participants, perseverative cognition in initially more positively motivated participants, caused by discrepancies to expectations, seemed to be the most likely explanation for this finding. There is evidence from several studies that psychophysiological responses to stressors may be prolonged by continued negative thoughts about the stressor or "extended engagement" after the stressor has terminated (Brosschot et al., 2006; Brosschot and Thayer, 2003; Haynes et al., 1991; Key et al., 2008; Pieper et al., 2010; Radstaak et al., 2011). A preliminary hint to this interpretation was provided by a positive correlation between state positive affect during anticipation of the challenge and the subject-specific self-concept of the participants. Thus, those who had approached the task confidently and positively motivated and hence in a positive mood may later have ruminated about their unexpected poor performance. However, this hypothesis could not be reliably evaluated with the available data. No information was available on to which extent the participants believed they were successfully accomplishing the task, and the measure of self-concept was obtained several weeks before the experiment.

Consequently, in the present study psychophysiological recovery from a mental arithmetic task was examined after the participants received (bogus) performance-related feedback that could be consistent or inconsistent with their specific self-concept. That way, the participants' beliefs about their own performance in the task were experimentally manipulated. If there is something to the tentative interpretation in Papousek et al.'s (2010) study, psychophysiological recovery should be delayed in participants exposed to self-concept-inconsistent negative feedback.

Like positive affect, positive self-views are also widely believed to be beneficial for psychological and physiological functioning and health. But to date there has only been little research on physiological concomitants of positive self-views which might evaluate, explain or specify this assumption, and even less so on those of more specific manifestations such as academic self-concepts. A few studies have been concerned with the effects of global self-esteem on stress reactivity showing that lower levels of trait self-esteem or experimentally induced self-esteem were associated with higher cardiac activation and stress reactivity (Hughes, 2003; Martens et al., 2010; O'Donnell et al., 2008; Rector and Roger, 1997). As well as generally, recovery is under-investigated in this field. O'Donnell et al. (2008) found no correlation between global self-esteem and heart rate recovery after a mental stress task. Only a few studies were concerned with psychophysiological effects of performance feedback in combination with pre-existing levels of self-esteem. In one study heart rates were higher after negative than after positive performance feedback; low global self-esteem exacerbated the impact of negative feedback, but only that on blood pressure reactivity (Hughes, 2007). Another study showed greater physiological responses in a subsequent task indicative of passive coping when participants received negative performance feedback and had low self-esteem or high self-esteem that was unstable (Seery et al., 2004). To our knowledge, psychophysiological recovery after self-concept-consistent or inconsistent performance feedback has not been investigated yet.

Self-esteem and self-concepts both belong to the broader category of self-views (Swann et al., 2007), but specific self-concepts conceptually differ from global self-esteem in so far as self-esteem refers to the way people generally feel about themselves, their personal worth or adequacy, whereas self-concepts refer to the way people appraise their particular abilities, talents, and attributes (Brown, 1998; Brown et al., 2001). Self-esteem can be regarded as the "global construct of the apex of the hierarchy" (Marsh and Martin, 2011, p. 61) while self-concept refers to specific components within this model, for instance, academic self-concept in specific domains. Self-concept has a descriptive and an evaluative component. Individuals form their self-concept in interaction with environmental feedback on an external (how are my skills compared to those of other people) and an internal frame of reference (how are my skills in a subject compared to my skills in other subjects; Marsh, 1992; Marsh and Martin, 2011). Several studies confirm the strong relationship between academic self-concept and achievement (Marsh, 1992; Marsh et al., 1999; Marsh and Martin, 2011). The investigation of more specific self-views such as academic self-concepts that are directly relevant to the domain under investigation (instead of global self-esteem) has been advocated to enhance predictive validity in experimental studies (Swann et al., 2007). Therefore, in the present study, in which false feedback about the performance in a mental arithmetic task was given, the impact of the participants' self-concept about their mental arithmetic skills was examined.

Heart rate and blood pressure recovery (return to baseline) was examined after the participants had completed a stressful mental arithmetic task and had received either positive or negative bogus feedback about their performance. A second measurement was made 10 min after the task. We assessed psychophysiological recovery several minutes after termination of the stress situation, because individual differences in recovery from an emotion-provoking stressor may only become apparent after the initial swift downslope that can typically be observed after completing a cognitive task (Goswami et al., 2010). Considerable individual differences in cardiovascular recovery can be well expected until 10 min after termination of the stress