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The role of affect and rumination in cardiovascular recovery from stress ☆

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ABSTRACT

This study examined the psychological processes that may impede or facilitate cardiovascular recovery. It was hypothesized that cardiovascular recovery would be hampered by negative affect and rumination, and facilitated by positive affect. In an experimental study, stress was elicited by exposing participants ($N = 110$) to a mental arithmetic task with harassment. After the stress task, affective levels were manipulated via a movie scene with negative, neutral, or positive emotional valence, or without an affect manipulation (control condition). During the entire experiment, heart rate and systolic and diastolic blood pressure levels were measured continuously. Results indicated that blood pressure recovery was hampered by the negative affect manipulation and by rumination. However, the positive affect manipulation did not facilitate blood pressure recovery. No effects were found on heart rate recovery. In sum, the findings emphasize the importance of negative affect and rumination in stress recovery.

1. Introduction

It is widely accepted that stress adversely affects individual health. For example, a longitudinal research has demonstrated that exposure to psychosocial risk factors at work is associated with increased physical and psychological health problems among employees over time (Belkic et al., 2004; Chandola et al., 2008; Kivimäki et al., 2006).

Still, the mechanisms that cause such adverse health effects remain poorly understood. This is possibly due to the predominant focus on physiological 'reactivity' to stressors: physiological responses that occur while the stressor is present. Only limited attention has been paid to physiological 'recovery' after exposure to stressors, that is, physiological responses that prolong or (re)occur when the stressor is no longer present (Linden et al., 1997; Schwartz et al., 2003).

Over the last decade, awareness has risen that recovering from stress is an essential part of a healthy life style. Longitudinal studies have yielded evidence that poor recovery is related to serious health threats such as hypertension (Hocking Schuler and O'Brein, 1997), and even cardiovascular death (Kivimäki et al., 2006). Recovery is also a better predictor of long-term increases in blood pressure than mere reactivity to stressors (Steptoe and Marmot, 2005). Therefore, recovery is seen as a vital link between acute physiological responses to job stressors and employee health (Geurts and Sonnentag, 2006).

The crucial role of incomplete recovery from stress can be understood from the perspective of Effort-Recovery (E-R) theory (Meijman and Mulder, 1998). A core assumption of this theory is that dealing with high demands or stressors requires effort which is mobilized by activation of the Sympathetic-Adrenal-Medullary (SAM) system that, amongst others, regulates cardiovascular activity. E-R theory posits that health is not at risk as long as the physiological activation disappears shortly after the stressor had ended—and thus complete recovery occurs—(Meijman and Mulder, 1998). However, when physiological stress responses prolong and sympathetic activation no longer returns to and stabilizes at a pre-stressor level, the total load on the individual exceeds homeostatic capacity. Such a state is referred to as 'allostatic load' (McEwen, 1998), and includes a disturbed sympathetic–parasympathetic balance that is an important factor in the development of later hypertension and cardiovascular disease (Brosschot and Thayer, 1998; Thayer et al., 2010).

The present study focused on cardiovascular recovery after stress exposure. Specifically, we examined the role of affect and rumination in the recovery process.

1.1. The role of affect in stress recovery

Various field diary studies on recovery have provided indirect evidence for the impact of negative and positive affect on the process of stress recovery. For instance, a higher level of negative affect after a work day was associated with higher need for recovery before bedtime (Sonnentag and Zijlstra, 2006). Recently, Van Hooff et al.

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(2011) investigated among university faculty members to what extent subjective parameters of recovery (i.e., fatigue and vigor) at the end of the working day and before bedtime were influenced by positive affect experienced during work and during off-job time. They showed that the experience of pleasure at work and during off-job time had favorable effects on recovery at the end of the working day and before bedtime. Although these studies demonstrate the impact of affective states on subjective recovery, it remains unclear to what extent affective states are related to cardiovascular recovery as well.

Overall, research suggests that negative affect, or feelings of distress, are associated with prolonged stress-related cardiovascular activation, and thus slower cardiovascular recovery (for reviews: Chida and Hamer, 2008; Pieper and Brosschot, 2005). In two real life studies, cardiovascular activity was prolonged between 5 and 45 min after negative emotional episodes, independently of initial response, posture, physical activity, talking, alcohol intake, and other biobehavioral variables (Brosschot and Thayer; 2003; Kamarck et al., 1998). Although these field studies provided evidence for the hampering impact of negative affect on cardiovascular recovery from stress, the role of positive affect in the process of cardiovascular recovery is less clear.

A few laboratory studies with experimentally induced stressors investigated the role of positive affect in stress recovery. A laboratory study in which participants had to answer a difficult statistical question showed that a general positive mood was associated with more complete cardiovascular and subjective post-stress recovery, independent of negative affect. In contrast, a more positive affective state during anticipation of the challenge was related to poorer cardiovascular recovery (Papousek et al., 2010). Another laboratory study on the role of positive and negative affect in stress recovery took a different approach by manipulating affective states after a stressful task (a 60-s speech preparation task). After this stressful task, participants watched 100-s film clips with different emotional valence. Results revealed that a positive affect manipulation facilitated cardiovascular recovery as opposed to a negative affect manipulation (Fredrickson et al., 2000).

The study by Fredrickson et al. (2000) is the only experimental study examining the role of both positive and negative affect in the process of cardiovascular recovery from stress. However, they examined the anticipation of a stressor and did not examine the experience of a real stressor. After the speech preparation task, all participants were 'by chance' selected to watch a video clip and knew that they did not have to actually deliver their speech. In this way the stressor was ended immediately, which may have influenced the recovery process.

The current laboratory study investigated to what extent affective processes hamper or facilitate cardiovascular recovery from a stressful task. After exposure to a stressful event an affective manipulation took place by showing participants a movie with either a negative, neutral, or positive emotional valence, or without an affect manipulation (the control condition). We hypothesized that cardiovascular recovery after stress exposure is slower during the negative affect manipulation (Hypothesis 1), and faster during the positive affect manipulation (Hypothesis 2), than during the neutral affect manipulation.

1.2. The role of rumination in stress recovery

Rumination may be another process responsible for incomplete cardiovascular recovery after stress exposure. All definitions of rumination share the notion of repetitive, intrusive, and negative cognitions about past stressors. Rumination differs from problem-solving in that the repetitive nature of the thoughts is generally non-constructive, strongly negative affect-laden, and not resulting in action that changes the situation (Gerin et al., 2006). The perseverative cognition hypothesis (Brosschot et al., 2006) states that rumination, worry, and related concepts that share the same mechanism of 'repetitive thought' play an important role in the process of incomplete recovery.

Field studies convincingly demonstrate a stress prolonging role for rumination and worry. Field diary studies among employees have shown that negative work-related thoughts during off-job time are associated with insufficient recovery (Sonnentag and Bayer, 2005), and that work-related worry is associated with simultaneous physiological activation (Pieper et al., 2007). Other field studies have shown that worry can mediate the long-term health effects of minor stressors (Verkuil et al., in press) and a major stressor ("9/11"; Holman et al., 2008). Thus, these cognitions may extend the stress response and impede cardiovascular recovery by causing a continued mental representation of the stressor.

Experimental results also suggest a hampering role of worry and rumination for cardiovascular recovery. Glynn et al. (2002) held spontaneous rumination about the stressor accountable for slow blood pressure recovery after exposure to an emotional stressor (i.e., anger provocation) as blood pressure recovery was speeded up among participants who were distracted from the stressor. Later experiments indeed yielded some evidence that spontaneous rumination may prolong physiological activation: high trait ruminators who were not distracted had the poorest blood pressure recovery (Gerin et al., 2006). Research also has shown that rumination among low trait ruminators hampered blood pressure recovery: low trait ruminators who were still ruminating 10 min after the termination of the stressor had the poorest blood pressure recovery (Key et al., 2008).

In summary, research suggests that repetitive thinking about past stressful events may impede cardiovascular recovery from stress. Therefore, our third hypothesis states that slower cardiovascular recovery after stress exposure is associated with higher levels of rumination about the stress task (Hypothesis 3).

1.3. Present research

The present study examined the role of negative affect, positive affect, and rumination in the process of cardiovascular recovery after stress exposure. Participants were exposed to a standard stress task in order to raise blood pressure and heart rate levels and to induce negative affect and rumination. After stress exposure, affect was manipulated by showing participants a movie with a negative, neutral, or positive emotional valence (in addition to a control condition). To examine the hypotheses, we analyzed cardiovascular indicators after stress exposure as a function of the affect manipulation (Hypotheses 1 and 2) and of rumination (Hypothesis 3).

2. Method

2.1. Participants

Participants were 110 undergraduates (14 males, 96 females; *M* age = 21.1 years, *SD* = 3.5 years). Participants were randomly assigned to the four conditions. There was no significant association between gender and condition, $\chi^2(3) = 1.22$, $p = .75$. All participants were Caucasian. Individuals with hypertension were excluded from participation. Reliable cardiovascular data was obtained from 103 participants. Participants received course credit or a small monetary compensation (€ 7.50).

2.2. Cardiovascular recording

Systolic blood pressure (SBP), *diastolic blood pressure* (DBP) and *heart rate* (HR) were measured during the entire experiment, using a noninvasive beat-to-beat blood pressure monitor (Finometer®, Finapres Medical Systems BV (FMS), Amsterdam, The Netherlands). The inflatable Finometer blood pressure cuff was placed on the third finger of the nondominant hand. The Finometer computed all cardiovascular variables using Beatscope Easy®. This program integrates