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Appraisal predicts hemodynamic reactivity in a naturalistic stressor

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ABSTRACT

Prior research has shown that appraisals are predictive of hemodynamic reaction patterns. The current study examined the relationship between appraisal and hemodynamic responding in a real-life stressful situation. Twenty-four men aged 19–28 wore a blood pressure monitor while presenting a paper in a class.
Participant's appraisal self-reports were obtained prior to the stressor. Multilevel regression models were used to analyze the relationships between appraisal and myocardial responding (as measured by cardiac output) and vascular resistance (as measured by TPR).
Pre-stressor appraisals were significantly associated with CO, both during the stressor ($Z = 2.03$ $p < .05$) as well as during the 30-minute anticipation period preceding the stressor ($Z = 2.43$ $p < .01$). In line with the predictions, relatively challenged participants showed higher CO. Pre-stressor appraisals significantly predicted TPR during anticipation ($Z = 2.70$ $p < .01$) but these associations failed to reach significance during the stressor ($Z = 1.82$, n.s.). As was predicted, during anticipation, increased threat was associated with increased TPR. Thus, during the anticipation period prior to the stressor, increased challenge was associated with decreased vascular resistance and increased myocardial reactivity. Further, increased threat was associated with increased vascular resistance and decreased myocardial reactivity. During the stressor increases in challenge were associated with further increases in myocardial responding but relationships between appraisal and vascular resistance were not significant.
The current study shows that the relationship between appraisal and hemodynamic reactivity seen in laboratory studies are also present during naturally occurring stress. Our findings suggest that threat appraisals to naturalistic stressors contribute to an, arguably unhealthy, vascular reaction pattern.
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1. Introduction

It is widely held that the cardiovascular response to psychological stress is a risk factor for cardiovascular disease, the reactivity hypothesis (Krantz & Manuck, 1984). Cardiovascular reactivity is usually assessed by measuring the CV response to laboratory stressors. The assumption underlying the use of laboratory stressors is that the responses seen in the laboratory are typical of those that occur in everyday life such that individuals who show a large response to laboratory stressors also show larger or more frequent responses in everyday life. While rarely made explicit it is also assumed that the processes underpinning cardiovascular reactivity are similar in laboratory and field settings. There has been extensive research on the generalisation of the CV reactivity from laboratory to field and while results are mixed (Kamarck & Lovallo, 2003; Linden et al., 2003, Schwartz et al., 2003) there is some evidence of generalisation to both specific naturalistic stressors and self reported stress in everyday life (Johnston et al., 2008). However there have been few attempts to determine if the psychophysiological processes determining CV reactivity to naturalistic stressors are the same as those established by laboratory studies.

Blood pressure reactivity is determined by two hemodynamic parameters; the output of the heart (Cardiac Output [CO]) and vascular resistance (Total Peripheral Resistance [TPR]) (Berne & Levy, 1997; Guyton & Hall, 2000). Hemodynamic response patterns differ among individuals and these characteristics appear to be relatively stable. Thus, individuals may be labelled as myocardial, vascular or mixed responders (Kasprowicz et al., 1990; Sherwood & Turner, 1995). A vascular reaction pattern may contribute to structural adaptations of the heart and the vasculature. Short-term vascular responsiveness may promote vascular hypertrophy due to recurring stimulation of vascular muscle (Sherwood & Turner, 1995). Furthermore, stress-induced vascular responsiveness has been shown to

Abbreviations: ANOVA, analysis of variance; CO, cardiac output; CV, cardiovascular; CVR, cardiovascular reactivity; DBP, diastolic blood pressure; MBP, mean blood pressure; OLS, ordinary least squares; SBP, systolic blood pressure; SV, stroke volume; TPR, total peripheral resistance.

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predict left ventricular hypertrophy (Sherwood & Turner, 1995). Steptoe and Marmot (Steptoe & Marmot, 2005) found that vascular responsiveness was predictive of increased BP 3 years later. Ottaviani et al. (Ottaviani et al., 2007) recently found evidence suggesting a link between a vascular recovery pattern and inflammatory cardiovascular risk factors.

Hemodynamic reactivity patterns are affected by a person's reaction to a stressor, which is in turn related to the perception or appraisal of the stressor. Differential hemodynamic response patterns are elicited in reaction to active and passive coping. Active coping with a stressful situation is associated with a myocardial response (Obrist, 1981). In contrast, passive coping is associated with a vascular response pattern (Sherwood et al., 1986; Brownley et al., 2000).

More recently, Tomaka and colleagues (Tomaka et al., 1993; Tomaka et al., 1997) showed that appraisals are predictive of hemodynamic reaction patterns. Challenge and threat appraisal were predictive of myocardial and vascular reactivity, respectively. The concepts of challenge and threat appraisal stem from the work of Lazarus and Folkman (Lazarus, 1966; Lazarus & Folkman, 1984). Blascovich and Tomaka (1996) operationalise appraisal as the outcome of a comparison of perceived situational demands and perceived resources. Challenge appraisals result when resources are perceived to be sufficient or nearly sufficient in comparison to perceived demands. A threat appraisal is made when perceived resources are considered insufficient to meet the demands (Blascovich and Mendes, 2000). Correlational studies provided evidence suggesting that during active coping tasks, challenged individuals showed a myocardial response whereas threatened individuals showed a vascular response (Tomaka et al., 1993; Heffner et al., 2002, Quigley et al., 2002). In addition, experimental manipulations of stressor appraisal provided further evidence for the hypothesised links between appraisal and hemodynamic responding. In these studies, challenge and threat appraisals were manipulated by using challenging or threatening task instructions or situational characteristics (Tomaka et al., 1997; Blascovich et al., 1999; Blascovich et al., 2001; Mendes et al., 2002; Weisbuch-Remington et al., 2005).

Research on hemodynamic reaction patterns in relation to appraisal has been carried out in the laboratory, using a limited range of mental stress tests. Relatively recently, non-invasive ambulatory equipment has been developed that allows the study of hemodynamic reaction patterns in everyday life situations. Nevertheless, to date, we are not aware of any research that has been carried out on the hemodynamic response to everyday life stress and relating this to appraisal.

The current aim is to test whether the relationships between appraisal and hemodynamic responding observed in the laboratory are found in everyday life stressful situations. It is examined whether the appraisal-related hemodynamic differences can be found, even in the face of uncontrollable nuisance variables that are characteristic of naturalistic settings.

In the current study, participants' hemodynamic reactivity was measured before, during and after performance of a speech, a task used successfully to study the generalisation of the magnitude of CV responses from laboratory to field (Johnston et al., 2008). Giving a speech is an active coping task that can be characterised as a motivated performance situation that is goal-relevant (i.e. having real or imagined consequences). Public speaking is a task that has a social-evaluative component, and self-presentation concerns make such a task highly goal-relevant. Accordingly, it may be argued that task involvement will be uniformly high for all participants. These characteristics make the current stressor suitable to test the hypothesized relationships between appraisal and hemodynamic reactivity.

It is hypothesised that, during the stressor, challenged participants will show a myocardial response, whereas threatened participants are hypothesised to show a vascular response.

Anticipation of the stressor is more difficult to characterise, as it may involve both active and passive components. It may be argued that that the anticipation phase is a (relatively) passive stressor since active coping with the stressor (public speaking) is impossible before the start of this stressor. At the same time, stressor anticipation may involve active coping such as rehearsal of the talk.

Finally, it is hypothesised that, during recovery, cardiovascular arousal levels will return to baseline levels. In the current conceptual framework no predictions are specified for the relationship between appraisal and changes in hemodynamic parameters.

2. Methods

2.1. Participants

Participants were twenty-six males. Gender appears to moderate the relationship between physiology, appraisal and behaviour (Quigley et al., 2002). To avoid this complication in a study with a small sample the current study did not include female participants. Participant recruitment took place via the distribution of e-mails and posters in the University of Aberdeen. Cardiovascular data in two participants was lost due to equipment failure. The final sample of participants therefore numbered twenty-four. For this final sample, participants' ages ranged 19–28 (mean age: 23.5; SD: 2.5). Participants' BMI ranged from 17.4 to 34.7 (mean BMI: 23.7; SD: 4.4). Two participants had a BMI higher than 30. Participants were non-smokers, and they were asked to avoid drinking coffee during the day of testing. None of the participants used medication. Three participants reported use of alcohol in the past 24 h, but the highest number of alcohol units reported was no more than 2. The study was granted approval by the University of Aberdeen, School of Psychology Ethics Committee. Each participant gave informed consent and received 12 GBP.

2.2. Self-report measures

2.2.1. Appraisal

Challenge and threat appraisal was conceptualised as the outcome of a comparison between perceived demands and perceived resources. If a participant perceives the situation as a threat then perceived demands outweigh resources. If the participant perceives the situation as a challenge then perceived resources outweigh perceived demands. In order to measure situational appraisal, demand and resource ratings were combined into a ratio, by dividing demands by resources. An appraisal ratio larger than 1 indicates 'threat' whereas an appraisal ratio smaller than 1 indicates 'challenge' (Tomaka et al., 1993; Blascovich & Tomaka, 1996; Tomaka et al., 1997).

Following Tomaka et al, (Tomaka et al., 1993; Tomaka et al., 1997) in the current study, ratings on single-item measures of perceptions of demands and perceptions of resources were combined into a ratio. Ratings were given on a 7-point Likert scale. In the current study, perceived demands were measured using the item 'How demanding do you think the presentation will be?' Perceived resources were measured using the item 'How able are you to cope with this presentation'.

In order to assess whether the presentation was stressful (manipulation check), participants' self-reports were obtained using the item 'How stressful do you expect the presentation to be'.

2.3. Equipment

2.3.1. Portapres

Continuous, non-invasive finger arterial pressure was recorded with a Portapres Model-2 at a sampling rate of 100 Hz. Portapres is the portable version of Finapres. Portapres consists of a belt, which holds a pump, a memory card, as well as a hydrostatic pressure measurement device, which records the position of the hand. The vertical distance

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