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Effects of coping flexibility on cardiovascular reactivity to task difficulty☆

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ABSTRACT

Objective: Coping flexibility refers to an individual's ability to effectively modify his or her coping behavior to better fit the nature of each stressful situation they encounter. More flexible coping is believed to produce more adaptive psychological functioning and physical health.
Methods: We examined the relationship between coping flexibility and cardiovascular reactivity (CVR) to psychological stress. Challenging tasks of two difficulty levels were presented to 24 men and 24 women aged 18 to 24 years. Heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure were measured.
Results: Change scores (from baseline to reactivity) for SBP and HR responses in the difficult task were higher than those in the easy task and were negatively correlated with coping flexibility during the difficult task but not the easy one.
Conclusions: The findings suggest that more flexible coping is associated with reduced CVR to a difficult task.

1. Introduction

Psychological stress excites the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system (SNS) [1–5] and is associated with unhealthy behavioral changes, such as increased alcohol intake or smoking, sedentary lifestyle, poor diet, and changes in sleeping habits [2,5,6]. These physiological [1,5] and behavioral [5] changes influence cardiovascular reactivity (CVR). Evidence that individual differences, such as personality or behavioral traits, moderates the relationship between psychological stress and CVR has long been observed in laboratory settings [7,8]. Among these variables, flexibility—especially coping flexibility—has recently received particular attention [4,8]. Research on individual differences in CVR is of substantial importance to stress physiology [7], because heightened CVR is a known risk factor for cardiovascular (CV) pathology [6,9,10]. In the present study, we examined the relationships between coping flexibility as a trait and CVR to laboratory tasks.

1.1. Coping and cardiovascular reactivity

Coping behavior, which is defined as "constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person [11,p.141]", has received much attention as an individual difference variable that can influence CVR to laboratory-induced stress [11,12]. A meta-analytic study [7] showed that positive personality or behavioral traits including coping were associated with decreased CVR to laboratory stress. For example, higher levels of trait problem-focused coping, which is a type of coping directed towards solving the problem that is causing the distress, were associated with decreased heart rate (HR) and systolic blood pressure (SBP) during a stressful task, but not with diastolic (DBP) [13]. According to transactional theory [11,12], certain coping strategies can reduce perceived stress or negative emotions (e.g., depression and anger) that are evoked by a laboratory task; moreover, these contribute to improving unhealthy behaviors. Such reductions of perceived stress or negative emotions [2,7,14] and improvements of unhealthy behaviors [5], as a result, are associated with decreased CVR to acute stress.

1.2. Coping flexibility and cardiovascular reactivity

Coping flexibility generally refers to an individual's ability to effectively modify their coping behavior to fit the nature of a given stressful situation [15]. For example, the dual-process theory on coping flexibility [15,16] defines it as "the ability to discontinue an ineffective coping

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strategy and produce and implement an alternative coping strategy [15, p.263]." Furthermore, this theory considers it to comprise two processes: evaluation and adaptive coping. Evaluation coping occurs when an individual abandons a coping strategy that produces undesirable outcomes. This coping process requires individuals to employ various strategies, including comprehension of their environment, the monitoring and evaluating of coping outcomes, and the eventual abandonment of ineffective coping strategies [15,16]. This strategy may reduce negative psychological outcomes by preventing the experience of repeated failure, given that the continued use of an ineffective coping strategy is unlikely to improve a stressful situation. Various empirical studies on concepts related to evaluation coping, such as accommodative coping [17], goal adjustment [18], and secondary control [19], have provided preliminary support that evaluation coping has a positive effect on psychological and physical health. Adaptive coping, by contrast, refers to the implementation of alternative coping strategies. If adaptive coping produces unfavorable outcomes, then the cycle of evaluation and adaptive coping is repeated until a favorable outcome is obtained.

Other researchers, who focus on flexibility, have also theorized that coping flexibility might predict protect against negative physical health outcomes, such as CV disease [4,8,20] through its relation to CVR to and acute stress. For example, Rozanski and colleagues [4,20] suggest that greater coping flexibility may protect against CV disease through its buffering effect on chronic stressors and negative emotions such as depression and anger, which are associated with increased CVR to laboratory stress [2,7,14]. In fact, individuals with greater coping flexibility reported lower levels of depressive symptoms [15,21–25] and greater emotion control, including control over anger [26]. Briefly, coping flexibility may be associated with decreased CVR to acute stress through reducing depressive mood and anger that is evoked by the acute stress. Moreover, another researcher on flexibility [8] has suggested that cognitive distancing and cognitive restricting, which refer to an ability to shift thought patterns away from destructive rumination by shifting one's point of view, may be associated with decreased CVR.

To our knowledge, only one study has examined coping flexibility in relation to CVR to laboratory stress. The previous study [27] found that greater coping flexibility was found to be negatively correlated with average change in HR reactivity to controllable and uncontrollable tasks, which were alternated. In this study, only HR measures were used without other physiological measures, and coping flexibility in relation to the tasks rather than as a trait was measured by a self-report scale. Additionally, indirect evidence that greater coping flexibility is associated with decreased CVR also exists. For example, a recent study on personality and physiological reactions [28] found that openness to experience, which is a personality trait associated with creativity, preference for variety, and being flexible in one's thinking, was associated with reduced HR and SBP reactivity to laboratory stress, but not with DBP. Based on this background research, we hypothesized that trait coping flexibility would be associated with decreased CVR to laboratory stress.

1.3. Task difficulty and cardiovascular reactivity

Integrating motivational intensity theory [29] and Obrist's [30] active coping approach, Wright [31,32] proposed a model to better understand CVR in active coping situations (i.e., when an individual can influence the outcomes of an event). According to motivational intensity theory, effort engagement can predict both subjective task difficulty and the importance of a successful task outcome. More specifically, the degree of effort mobilization expended for a task increases with task difficulty when the task is perceived as possible and worthwhile. Obrist's [30] active coping approach predicted that CVR increases in active coping situations through beta-adrenergic innervations of the SNS. Drawing on both approaches, Wright's model predicts that the impact of the SNS on the heart and vasculature responses increases proportionally with task difficulty as long as task success is possible. Over 30 years, evidence supporting this model has accumulated [33]. For example, SBP reactivity to a memory task increases with task difficulty (low, moderate, or high), whereas SBP reactivity to a task where success is impossible is lower than in tasks of low, moderate, and high levels [34].

SBP has been found to respond reliably in research concerning the effects of task difficulty on CVR [31,32]. Although there is also some evidence supporting that task difficulty also influences HR and DBP, the results are inconsistent [34]. SBP is systematically influenced by the SNS via myocardial contractibility, which is determined by beta-adrenergic sympathetic discharge, whereas DBP mainly depends on vascular resistance, which is less systematically affected by sympathetic discharge. In contrast, HR is determined by the activation of both the SNS and parasympathetic nervous system (PNS), and responds to effort mobilization only when the impact of the stressor on the SNS is stronger than that on the PNS [34,35]. Consequently, SBP appears to be the most reliable measure among these CV activity indices, and compared with SBP, HR and DBP should be somewhat and poorly sensitive to sympathetic influence, respectively [31].

1.4. Hypotheses

Regarding task difficulty, individuals are less likely to need to change a coping strategy when they encounter an easy task because succeeding in the task is not difficult. On the other hand, when they encounter a difficult task, individuals may need to change their coping strategy because succeeding in the task is harder. Therefore, in the present study, we hypothesized that greater coping flexibility would be associated with reduced CVR when a difficult task was presented. Additionally, based on the effects of coping flexibility and task difficulty on CVR outlined above, we hypothesized that the correlation coefficient between coping flexibility and CVR would be stronger for the difficult task than for the easy task.

2. Methods

2.1. Participants

The participants were 24 women and 24 men college students (mean age 19.85, $SD = 1.46$, range 18–24 years); all participants were Japanese and healthy. They were selected from a participant pool obtained from introductory psychology classes. We excluded potential participants who smoked tobacco cigarettes or consumed alcoholic beverages excessively because these habits might influence CV activity. Additionally, none of the participants were receiving outpatient treatment or taking any medications when they consented to this experiment.

2.2. Task

Challenging cognitive tasks that involved solving disentanglement puzzles (Cast puzzle; HANAYAMA, Tokyo, Japan) were used in the present study, because a meta-analytic study [9] showed that this cognitive task has been used most frequently as a laboratory stressor in research on CVR, and that only CVR to a cognitive task predicted poor CV outcomes in an analysis by types of stressors. Disentanglement puzzles are widely available for purchase, and nearly all Japanese know that disentanglement puzzles can be solved. The puzzles contained six levels of difficulty, which were determined by the company that manufactured them. The level 1 and 2 puzzles, which were the easiest to solve, were used in the easy condition, and the level 6 puzzles, which were the most difficult to solve, were used in the difficult condition. The presentation order of the two tasks was counter-balanced within the sexes.

Before the experiment, a separate group of 10 college student participants was recruited to verify the task difficulty of the puzzles. Each of these participants was given 20 min to solve the ones selected. All of them could solve the level 1 and 2 puzzles but not the level 6 puzzles in the allocated time. Thus, the level 6 puzzle can be considered more difficult to solve than the level 1 and 2 puzzles.