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Hostility and anger in: Cardiovascular reactivity and recovery to mental arithmetic stress ☆

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ABSTRACT

Background: Hostility and anger have been attributed as psychosocial risk factors for coronary heart disease. Heightened cardiovascular reactivity (CVR), and poor recovery, to provocative stressors are thought to hasten this risk.
Purpose: To examine the relationship between hostility and anger inhibition (AI), and the moderating situational influences of harassment and evaluation, in predicting CVR and recovery to mental arithmetic (MA) stress using a multiple regression approach.
Methods: 48 male undergraduate students engaged in the following 3 minute tasks during recording of the electrocardiogram, impedance cardiography, and blood pressure: baseline, MA, and evaluation. Hostility and AI were assessed with the Cook-Medley Hostility Scale and the Speilberger Anger In subscale, respectively.
Results: An interaction between hostility and AI showed high diastolic blood pressure reactivity to the MA task among hostile anger inhibitors. Harassment did not modify this effect. However, harasser evaluation predicted prolonged systolic blood pressure (SBP) responding among men scoring high in AI, and facilitated SBP recovery among those scoring low on AI.
Conclusions: The findings highlight the interactive influences of AI and hostility in predicting CVR to stress and underscore the importance of recovery assessments in understanding the potentially pathogenic associations of these constructs.

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Dispositional hostility and anger have been attributed as psychosocial risk factors for coronary heart disease (CHD) (e.g., Everson-Rose and Lewis, 2005; Miller et al., 1996; Sirois and Burg, 2003). Hostile people are prone to cynical attitudes and a mistrust of others, which may give rise to the frequent experience of anger and various associated behaviors. Situations requiring anger inhibition may be more prevalent in the daily life experiences of hostile individuals than encounters permitting anger expression (Brosschot and Thayer, 1998). Moreover, the tendency to suppress anger has been linked to more pronounced carotid arterial stiffness and intima-medial thickness, sub-clinical indices of CHD, compared to individuals rating high on anger expression (Anderson et al., 2006b). Some evidence suggests that hostile persons who inhibit their anger expression are more likely to develop significant coronary atherosclerosis than hostile individuals who express their anger (e.g., Atchison and Condon, 1993; Dembroski et al., 1985; Matthews et al., 1998).

Hostile individuals have been found to display pronounced cardiovascular reactivity (CVR) to stressors involving interpersonal provocation or harassment relative to their non-hostile counterparts (e.g., Davis et al., 2000; Suarez et al., 1998; Suls and Wan, 1993). Insofar as these stress responses are frequent and large in magnitude, they are thought to contribute to pathogenic processes linked to CHD risk (e.g., Kop, 1999). However, some reports indicate that hostile individuals may not display significant CVR to stressors involving harassment or anger recall, but rather show prolonged CV responses to such stressors that are reflected in poor recovery to baseline following stressor completion (e.g., Anderson et al., 2005; Neumann et al., 2004), whereas other reports have found hostile individuals to display both pronounced CVR *and* poor recovery from stressors involving anger elicitation (e.g., Fredrickson et al., 2000).

These findings are in accord with the prolonged activation-perseverative cognition hypothesis, by which the tendency to worry or ruminate may prolong stress responding, and in so doing serve as a final common pathway by which stress exerts deleterious effects on bodily systems and health (Brosschot et al., 2006). In fact, worry and rumination have been linked to a variety of negative CV characteristics such as delayed blood pressure (BP) recovery to stress (Gerin et al., 2006; Glynn et al., 2002), and elevated heart rate (HR) and reduced HR variability (Brosschot et al., 2007; Hofmann et al., 2005; Knepp and

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Friedman, 2008; Pieper et al., 2007; Thayer et al., 1996) Moreover, longitudinal data indicate that high trait worry may confer increased CHD risk in men (Kubzansky et al., 1997). Anger suppression may act similarly to worry by maintaining awareness of negative cognitions.

Tendencies toward anger inhibition, as assessed via the defensiveness construct by use of the Marlowe-Crowne Social Desirability Scale (MC; Crowne and Marlowe, 1964), have been associated with elevated CVR to mental arithmetic (MA) stress when combined with high levels of hostility (Jorgenson et al., 1995; Larson and Langer, 1997). However, inconsistencies have persisted in the defensive hostility literature, whereby defensively hostile individuals have displayed CVR to stressors similar in magnitude to individuals rating low on these constructs (Mente and Helmers, 1999; Shapiro et al., 1995; Vella and Friedman, 2007). Another study found hostile individuals to display significant systolic blood pressure (SBP) reactivity to an interpersonally provoking debate task, but non-significant interactions between hostility and defensiveness in predicting CVR (Powch and Houston, 1996). One potential explanation for these discrepancies concerns the notion that the MC scale assesses behaviors unrelated to the suppression of angry feelings. A more direct measure of anger inhibition may be preferred and can be achieved with the anger-in (AI) subscale from the Spielberger Anger Expression Scale (Spielberger et al., 1985).

Evidence suggests that hostility may interact with AI scores to predict elevations in sympathetic β-adrenergic influences on the heart, as evidenced by decreases in impedance cardiography derived pre-ejection period (PEP) and decreased inter-beat intervals (IBI), in response to MA stress (Burns et al., 1992). However, individuals rating low on both of these scales also displayed significant reductions in PEP to the MA task, which could be due to the absence of interpersonal provocation in the stressor (e.g., Suls and Wan, 1993).

In addition to the potentially critical moderating influence of harassment in the relationship between hostility and CV responses to stress, assessments of the ability to evaluate the source of anger provocation may provide insight into another situational influence that modifies the recovery process. The inability to express anger following provocation among hostile individuals may attenuate CV recovery compared to those rating low on hostility, a tendency that may be accompanied by low cardiac vagal activity (Brosschot and Thayer, 1998). A 'matching hypothesis' has been proposed to explain findings in which use of one's preferred mode of anger management style facilitates CV recovery from stress (Engebretson et al., 1989). The idea behind this hypothesis concerns a 'person–environment' fit, such that individuals rating high on AI may show facilitated BP recovery when instructed to write a positive evaluation of an experimenter following harassment-induced stress, but poor recovery when told to write a negative evaluation of the experimenter after stressor completion.

The concept of a general 'person–environment' fit theory has a longstanding history in social psychology (e.g, Lewin, 1951), with qualities reflected in the transactional model of stress (Lazarus and Folkman, 1984). Support for such matching hypotheses of person–environment fit has been reported with respect to interactions between measures of interpersonal style and situational characteristics in predicting cardiovascular responses to stress (e.g., Davis and Matthews, 1996; Smith and Ruiz, 2007). However, a previous attempt to replicate the matching hypothesis concerning anger management style found no support for this 'person–environment' fit (Lai and Linden, 1992). A plausible explanation for this null finding is the need to directly consider the role of hostility in this relationship. A test of the matching hypothesis might reveal hostile individuals scoring low on AI to benefit from the influence of provocateur evaluation on CV recovery, whereas hostile individuals scoring high on AI display a prolonged activation that persists after evaluation of a provocateur. The combination of hostility with anger inhibition on a person or situation level (i.e., AI or the inability to evaluate the source of provocation following harassment), may be linked to enduring hostile cognitions reflected in a delayed return of cardiac vagal activity and slow CV recovery (Brosschot and Thayer, 1998).

The present study examines the interaction between hostility and AI on CV responses to MA stress with or without harassment, in addition to the influence of experimenter evaluation on CV recovery. The combination of hostility and AI may be associated with stressor-induced CVR, poor CV recovery from stress, and potentially stress-related CHD. Men generally have shown greater CV reactivity to lab and field stressors relative to women (e.g., Guyll and Contrada, 1998; Stoney, 1992). To control for gender, only male subjects were included in the present study. Hostile men rating high in AI were expected to show the most CVR to harassment- induced MA stress, in addition to poor CV recovery. In accord with the matching hypothesis, hostile men rating low on AI were expected to show enhanced CV recovery when given the opportunity to evaluate their provocateur, whereas experimenter evaluation was predicted to be associated with weak CV recovery among individuals rating high on both hostility and AI. This study adds to the literature by testing the interaction between hostility and AI in predicting the CVR to stress with harassment, in addition to assessing the influence of evaluation on CV recovery.

1. Method

1.1. Participants

Forty eight healthy male undergraduate psychology students (M = 19.38, SD = 1.67 years; range: 18–27 years) at Virginia Polytechnic Institute & State University (Virginia Tech) were recruited from on-line advertisements posted on their Psychology Department Experiment Management System. This study received approval from the institutional review board at Virginia Tech. The sample consisted of individuals of Caucasian (85.4%), Asian American (10.4%), and African American (4.2%) ethnicities and roughly approximated the Virginia Tech population base rates. Participants were selected on the basis of information obtained from a health questionnaire. Exclusionary criteria included a positive smoking status and/or use of medications that may alter CV activity. Participants were instructed to abstain from caffeine for 12 h and alcohol for 24 h prior to the study and received extra credit in a psychology course for their participation. Sample characteristics are displayed in Table 1.

1.2. Apparatus

The Cook-Medley Hostility Scale (CMHS; Cook and Medley, 1954) was used to assess dispositional hostility in the current study and consists of 50 true-false items from the Minnesota Multi-phasic Personality Inventory (Hathaway and McKinley, 1943). In combined

Table 1
Sample characteristics and cardiovascular responses to mental arithmetic stress.

Characteristic	M	SD	
Age (years)	19.38	1.67	
Body mass index (kg/m^2)	23.77	3.33	
% Non-Caucasian ethnicity			14.6
Caffeine intake (8 oz drinks/day)	1.33	1.4	
Alcohol intake (drinks/week)	6.83	8.36	
Cook-Medley Hostility Scale	22.02	7.64	
Spielberger Anger-In Scale	16.33	4.40	

	Baseline		Task	
Cardiovascular measure	M	SD	M	SD
Heart rate (bpm)	69.35	10.5	86.67	12.99**
Systolic blood pressure (mm Hg)	119.81	10.79	135.32	13.66**
Diastolic blood pressure (mm Hg)	68.48	8.86	79.72	11.06**
Pre-ejection period (ms)	121.02	16.2	111.64	19.84**
Log high frequency (ms^2 Hz^{-1})	13.78	.926	13.2	.98**
LF/HF ratio (normalized units)	2.11	1.65	2.74	1.63†

Note. $N = 48$; † $p < .06$; ** $p < .001$.

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