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Hostility, emotional expression, and hemodynamic responses to laboratory stressors: Reactivity attenuating effects of a tendency to express emotion interpersonally

Keith A. Kline [a,*], Erin M. Fekete [b], Cary M. Sears [c]

[a] *Department of Psychology and Philosophy, Virginia Military Institute, 403 Carroll Hall, Lexington, VA 24450, USA*
[b] *Department of Psychology, University of Miami, USA*
[c] *Department of Psychology, Cleveland State University, USA*

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Abstract

The present study examined the interactive effects of hostility and a predisposition towards emotional expression or suppression in interpersonal situations. We also attempted to partially replicate findings from a recent investigation which provided evidence of lower myocardial and greater vascular responses in high-hostile relative to low-hostile individuals. Undergraduate students ($n=99$) participated in a protocol consisting of rest periods, speech preparation and presentation, a social-evaluative mental arithmetic task, and a stress interview. After classifying participants into high/low hostility by high/low interpersonal emotional expression groups using median-splits, high-hostile individuals showed lower HR and SBP responses to speech preparation and reported greater threat appraisal and negative affect than low-hostile participants. High-hostile interpersonal expressors and male interpersonal expressors displayed lower DBP and TPR reactivity, respectively, than high-hostile or male suppressors. High-hostile expressors also reported lower levels of positive affect than high-hostile suppressors, and expressors reported lower threat appraisals than suppressors, irrespective of hostility. Findings are discussed in terms of an absence of conflict or ambivalence over interpersonal emotional expression for high-hostile expressors and are suggestive of potential health benefits of expressing emotion interpersonally for at-risk groups.

Keywords: Cardiovascular reactivity; Hemodynamic; Hostility; Emotional expression; Interpersonal

1. Introduction

A considerable body of evidence supports an association between cynical hostility [assessed by the Cook-Medley Hostility Scale (Ho; Cook and Medley, 1954)] and an increased risk of coronary heart disease (CHD) (for reviews, see Miller et al., 1996; Smith, 1992). Cynical hostility, defined as "a set of negative attitudes, beliefs, and appraisals concerning others… [including]…a belief that others are generally unworthy and not to be trusted" (Smith, 1992, p. 139), has been described as an *interpersonal* risk factor (e.g., Smith and Gerin, 1998). In reviewing the relevant literature, Timothy Smith (1992) found support for the idea that "…[hostile] individuals…experience a more taxing interpersonal environment" (p. 145). According to Smith (1992), the "transactional model" of the hostility–health relationship assumes that hostile people are likely to appraise the behavior of others as indicative of "hostile intent" (p. 145) and "…to elicit and exacerbate conflict in their daily lives" (p. 145). Consistent with this view, recent research has found that individuals with high hostility appraised videotapes depicting ambiguous social interactions more negatively (Vranceanu et al., 2006). The idea that such interpersonal cynicism and hypersensitivity connotes risk is supported by evidence that stress-induced cardiovascular reactivity, a putative mechanism for the hostility-CHD link, is reliably associated with hostility in the laboratory only when social/interpersonal stressors are examined (for reviews, see Smith, 1992; Suls and Wan, 1993).

* Corresponding author. Tel.: +1 540 464 7464; fax: +1 540 464 7648.
E-mail address: klineka@vmi.edu (K.A. Kline).

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Given their difficulty trusting others, the prospect of expressing emotions interpersonally might be especially daunting for some hostile individuals. Consistent with this notion, Christensen and Smith (1993) found an association between hostility and heightened blood pressure reactivity among men who were asked to disclose personal details to a stranger. However, while situational self-disclosure undoubtedly involves some degree of interpersonal emotional expression, participants' dispositional tendencies toward expressing versus suppressing their emotions interpersonally were not examined. This attribute could be particularly important in terms of disease relevance as it has been observed that hypertensive patients are characterized by internal conflict between the experience of hostility or anger and a desire to avoid expressing emotion to others (Alexander, 1939). Indeed, it is becoming increasingly evident that chronic emotional suppression carries risk for illness in its own right, whereas expression promotes well-being (e.g., for reviews, see Pennebaker, 1989, 1997; Scheier and Bridges, 1995). Thus, cynical hostility, along with a tendency to suppress emotion in interpersonal situations, in conjunction with life experiences that require the contrary, might be a particularly toxic combination. Conversely, the capacity to express emotion interpersonally might serve to buffer or ameliorate the potentially harmful effects of hostility.

Most research examining relationships between cardiovascular reactivity and emotional expression, alone or in conjunction with the experience of hostility, has focused on the expression of specific negative emotions, most notably, anger (for review, see Siegman, 1993). Although findings have been mixed (e.g., Bongard et al., 1998; Burns, 1995; Vögele et al., 1997), several investigations have found trait anger expression to be related to greater reactivity than suppression, but this relationship consistently emerges only when laboratory conditions are designed to intentionally induce anger (e.g., Siegman, 1993). Furthermore, in addition to emphasizing a single negative emotion, these studies often define anger expression using measures such as Spielberger's (1991) Anger-In and Anger-Out scales, which include items (e.g., "I do things like slam doors") that do not seem to tap *interpersonal* expression. Investigations not restricted to the study of anger have tended to examine situation-specific expression of primarily negative emotions (Mendes et al., 2003), rather than the dispositional tendency to express positive and negative emotions in general.

Individuals differ markedly in the extent to which their blood pressure responses to one or more stressors are driven primarily by increases in cardiac output (CO), total peripheral resistance (TPR), or both (Manuck et al., 1993) and these hemodynamic response patterns, known as myocardial, vascular, and mixed responses, respectively, may have differential pathophysiological implications (Obrist, 1981; Saab and Schneiderman, 1993). While longitudinal data are still needed, there is increasing evidence suggesting that vascular responses (Goldberg et al., 1996; Kapuku et al., 1999; Sherwood et al., 1999; Treiber et al., 1993) may be more maladaptive than myocardial responses (Heponiemi et al., 2007). Despite the apparent meaningfulness of interindividual variability in hemodynamic profiles, surprisingly few studies have attempted to relate hostility (with or without anger expression/suppression) to CO or TPR reactivity. While Bongard et al. (1998) did not find evidence of such relationships, high-hostile anger expressors tended to show the least overall blood pressure reactivity, while low-hostile anger expressors tended to be most reactive. In a more recent investigation by Davis et al. (2000), high-hostile participants exhibited less heart rate (HR), systolic blood pressure (SBP), and CO reactivity and greater diastolic blood pressure (DBP) and TPR responses than their low-hostile counterparts.

Associations of psychosocial traits like hostility with cardiovascular responses may be due, in part, to stressor-related appraisals, emotions, and/or behaviors habitually experienced by people with the trait in question. In terms of appraisals, perhaps the best candidates in this regard are challenge and threat appraisals, which have been shown to precede myocardial and vascular/mixed responses to laboratory stressors, respectively (Tomaka et al., 1993, 1997). While data are remarkably lacking in this regard, it seems reasonable to predict that high-hostile individuals might be predisposed to appraise social/interpersonal stressors as more threatening than their low-hostile counterparts. This would seem to be particularly true of hostile people who are uncomfortable with expressing their emotions to others. For example, although Mendes et al. (2003; Study 2) conceptualized challenge and threat as situational emotional expression and suppression (to same-sex research assistants), respectively, as opposed to defining them in terms of appraisals, they observed cardiovascular sequelae commonly associated with the latter.

The present study was intended to partially replicate the findings of Davis et al. (2000) by examining hemodynamic responses to subtle social stressors as a function of hostility. We also sought to extend the existing literature by exploring the interactive effects of hostility and an index of interpersonal expressive style on hemodynamic responsivity, appraisals, and state affect.

2. Method

2.1. Participants

Participants were 60 female and 39 male normotensive undergraduate students from a large, urban, state university, ranging in age from 17 to 48 years (M=21.9 yr). The sample consisted of 61 Caucasians, 23 African-Americans, and 15 individuals of other ethnicities. Students earned partial credit toward an undergraduate psychology course.

2.2. Procedure

Prior to the stress-reactivity session, participants were asked to refrain from caffeine, alcohol, and nicotine intake and strenuous exercise for 3 h before the appointment. Participants on cardioactive medications were asked to abstain; otherwise, they were either rescheduled for a later date at which they were medication-free or excluded from the study.

Upon arrival at the laboratory, participants' compliance with restrictions was verified and they filled out a preliminary set of questionnaires, including an informed consent form and a demographic and medical history information sheet. Casual blood pressure was then determined via mercury sphygmomanometer (three readings at 2 min intervals, following 5 min of rest) and height and weight were assessed. Exclusion criteria consisted of (a) personal history of hypertension, diabetes, heart attack, heart disease, or other chronic physical diseases, (b) casual blood pressure >140 mm Hg/90 mm Hg (i.e., average of last 2 readings), and/or (c) pregnancy.

Following skin treatment with alcohol and a mild abrasive pad, surface electrodes were applied, for the purpose of recording the electrocardiogram and impedance cardiogram. A pair of electrodes was positioned bilaterally at the root of the neck, with a second pair applied 5 cm above the first pair. An additional pair of electrodes was then placed bilaterally on the sides of the thorax, at the level of the xiphoid process and on the midaxillary line, with a final pair applied 5 cm below them. The student was then instrumented with a Dinamap automated blood pressure cuff on his or her right arm. Once seated, the participant received final instructions prior to the beginning of the protocol.

The protocol included an initial 10-min rest period, three tasks separated by 10-minute rest periods, and a final 10-min rest period. Task order was randomized and participants were matched with same-sex experimenters. Appraisals of each stressor were assessed following task-instructions but prior to task-administration. Speech appraisals were measured prior to the preparation period. Baseline levels of state affect were assessed immediately following the initial rest period and measures of state affect experienced during the tasks were obtained after the recovery period following each task. Following the final rest period, the electrodes and blood pressure cuff were removed. Participants also completed a packet of self-report trait measures as part of the experimental procedure. At the conclusion of the session, students were debriefed before departing the laboratory.

2.3. Tasks

The present study utilized subtle social challenges (e.g., Davis et al., 2000) as opposed to tasks involving explicit provocation or harassment. The former have recently been suggested to better approximate the types of social stressors experienced during the course of daily living by hostile and nonhostile people alike (Davis et al., 2000; Raikkonen et al., 1999).

2.3.1. Speech task

The evaluated speaking task (Saab et al., 1989) is a commonly used stressor that entails participants preparing (3 min) and presenting (3 min) a speech, with the understanding that the speech will be videotaped and then evaluated at a later date.

2.3.2. Social-evaluative mental arithmetic

In order to add a social-evaluative component to a standard mental arithmetic task, instructions for the evaluated speaking task were adapted for a 3-min task that required the participant to perform serial mental subtractions by "7s" from a starting number (i.e., 1250), providing his or her responses verbally to an experimenter. The participant was aware that his or her performance would be videotaped and later evaluated for poise, speed, and accuracy.

2.3.3. Stress interview

This study also utilized an adaptation of the 8-min version of the Social Competence Interview (SCI; Ewart and Kolodner, 1991), in which the participant was asked to engage in dialogue with an experimenter about a stressful problem in his or her life that he or she was willing to discuss. Because our primary concern was standardization of task-administration, the adaptation of the SCI used in this study required experimenters to adhere to rigid guidelines with regard to questioning of participants and time-limits for specific portions of the interview.

2.4. Self-report measures

2.4.1. Trait-hostility and state affect

Dispositional hostility and state affect were assessed via the Ho and the Positive and Negative Affect Schedules (PANAS; Watson et al., 1988), respectively. Both are widely used measures with well-established psychometric properties (Barefoot et al., 1989; Cook and Medley, 1954; Watson et al., 1988).

2.4.2. Cognitive appraisals

Subscales developed by Tomaka et al. (1999) were used to assess appraisals of perceived demand (3 items) and perceived ability to cope with the upcoming task (3 items). Participants rated items on a 9-point scale from 1 ("Strongly Disagree," "Not At All," or "Definitely No") to 9 ("Strongly Agree," "Extremely," or "Definitely Yes"). Both sets of items were found by Tomaka et al. (1999) to be high in internal consistency ($\alpha_{\text{demand}}=.82$; $\alpha_{\text{coping ability}}=.93$). Threat and challenge appraisals were operationalized in terms of appraisal ratios of scores on the demand subscale to scores on the coping ability subscale (Tomaka et al., 1993, 1999). High ratios of demand to coping ability reflect overall threat appraisal, whereas low ratios are indicative of overall challenge appraisal.

2.4.3. Interpersonal emotional expression

The participant's tendency to express or suppress emotions interpersonally was assessed via the Expression of Intimacy subscale (EEQ-INT) of the Emotional Expessiveness Questionnaire (EEQ; King and Emmons, 1990). The EEQ-INT consists of the following 5 items: (1) "I often tell people that I love them."; (2) "Whenever people do nice things for me, I feel 'put on the spot' and have trouble expressing my gratitude." (reverse-scored); (3) "When I really like someone they know it."; (4) "I apologize when I have done something wrong."; (5) "If a friend surprised me with a gift, I wouldn't know how to react." (reverse-scored). These items are rated by respondents on a Likert-type scale ranging from 1 ("Strongly Disagree") to 7 ("Strongly Agree") and, according to King and Emmons (1990), measure the expression of emotions pertaining to "relational concerns" (p. 867). King and Emmons observed modest internal consistency for the EEQ-INT ($\alpha=.63$; Cronbach's α for the entire EEQ was .78). While no construct validity data are available specifically for the EEQ-INT, the EEQ correlated positively with peer ratings of expressiveness and self-report measures of emotional expression in a family context and emotional intensity (King and Emmons, 1990).

2.5. Physiological recording

A Critikon Dinamap (PRO 100) monitor was used to assess SBP, DBP, and mean arterial pressure (MAP) and a BioZ Portable (CardioDynamics, San Diego, CA) was used to record basal thoracic impedance (Z_o), the rate of change in impedance (dZ/dt), and the ECG. Impedance and ECG data were recorded beat-by-beat and averaged over every 8 acceptable heartbeats, in order to derive HR, CO (L/min), and TPR [peripheral resistance units; TPR = (MAP/CO) / 16.67].

The BioZ utilizes innovations in hardware and software, including digital signal processing and use of the ZMARC (impedance-modulating aortic compliance) equation, which have resulted in enhanced reliability and validity of measurements (for reviews, see De Maria and Raisinghani, 2000; Van De Water et al., 2003). In clinical settings, intrasession correlations between CO or cardiac index (i.e., CO adjusted for body mass index) values obtained via the BioZ have ranged from .96 to .98 (De Maria and Raisinghani, 2000; Van De Water et al., 2003), while intersession correlations, over one-week intervals, have varied from .86 to .90 (De Maria and Raisinghani, 2000). Furthermore, in terms of correlations with CO measurements obtained via thermodilution, CO values derived from stroke volumes (SV) computed using the BioZ's ZMARC equation (r = .81) compared favorably to CO values calculated using previously developed SV equations (e.g., the Kubicek equation) (rs = .56–.69) (Van De Water et al., 2003).

2.6. Physiological data sampling schedule

During rest periods, blood pressure readings were initiated at 1 min, 3 min, 5 min, 7 min, and 9 min into the period. During mental arithmetic, as well as both speech preparation and presentation, samples were obtained immediately and at 1 min and 2 min into the period. For the interview, readings were obtained immediately and at 2 min, 4 min, and 7 min into the period.

2.7. Data reduction

Total peripheral resistance was computed by matching blood pressure readings with CO values derived from impedance samples occurring closest in time. Heart rate, SBP, DBP, CO, and TPR data were reduced by computing averages for pretask baselines, mental arithmetic, speech preparation, speech presentation, and the stress interview. For pretask baseline periods, data were averaged over the last two samples, while task means were averaged over the three or four samples obtained during the task. Reactivity was operationalized in terms of delta (Δ) change scores (mean task level − mean pretask level).

2.8. Hostility × interpersonal emotional expression group classification

Participants were divided into high/low hostility by high/low interpersonal emotional expression groups (i.e., high = expressors; low = suppressors) based on median-splits performed on sample distributions of Ho and EEQ-INT scores. The resulting groups consisted of low-hostile suppressors (n = 17), low-hostile expressors (n = 33), high-hostile suppressors (n = 30), and high-hostile expressors (n = 19).

2.9. Methods of data analysis

A mixed design was utilized to investigate hostility by interpersonal emotional expression group differences in appraisals, state affect, and cardiovascular reactivity. Due to differences in the gender composition and age of hostility and expression groups (see next section), respectively, gender was included as a control variable and age served as the covariate in all primary and follow-up analyses. Interactions of hostility and/or expression group with gender or task were followed up by examining group differences at each level of gender or task.

Reactivity data were examined using a series of 2 (Gender) × 2 (Hostility Group) × 2 (Interpersonal Expression Group) × 4 (Task: speech preparation, speech presentation, math, interview) analyses of covariance (ANCOVAs). Appraisal data were examined with 2 (Gender) × 2 (Hostility Group) × 2 (Interpersonal Expression Group) × 3 (Task: speech, math, interview) ANCOVAs, while state affect data were analyzed using 2 (Gender) × 2 (Hostility Group) × 2 (Interpersonal Expression Group) × 4 (Period: baseline, speech, math, interview) ANCOVAs.

For within-subject analyses, the Huynh–Feldt ε correction was used in instances where the sphericity assumption had been violated. Differences in reported degrees of freedom reflect missing data. Finally, main analyses were conducted at the .05 level and all follow-up analyses were conducted at the .01 level.

3. Results

3.1. Demographic and baseline characteristics

Demographic and baseline characteristics of high/low hostility by high/low interpersonal emotional expression groups are shown in Table 1. Chi-square tests of independence conducted to examine potential hostility by expression group differences in gender composition, χ^2 (3, N=99) = 5.26, p > .10, and smoking status, χ^2 (3, N=97) = 3.36, p > .10, as well as ethnic composition and parental history of hypertension, χ^2s (6, N=99) < 4.23, ps > .10, yielded no group differences. Due to small cell sizes in some of the above analyses and the possibility of hostility or emotional expression group differences irrespective of the other variable, chi-square analyses were also performed separately for high/low hostility groups and high/low emotional expression groups. These analyses yielded a trend toward a difference in the gender composition of hostility groups that was nearly significant, χ^2 (1, N=99) = 3.73, p = .053, with the low-hostile group being composed of a greater

Table 1
Demographic and baseline characteristics of high/low hostility × high/low interpersonal emotional expression groups

Variable	Low HOST–Low EX	Low HOST–High EX	High HOST–Low EX	High HOST–High EX
Gender				
Men	41%	24%	47%	53%
Women	59%	76%	53%	47%
Ethnicity				
African-American	12%	33%	20%	21%
Caucasian	70%	55%	60%	68%
Other	18%	12%	20%	11%
PH				
Positive	53%	58%	53%	53%
Negative	18%	24%	20%	31%
Uncertain	29%	18%	27%	16%
Smoking status				
Smokers	24%	15%	14%	33%
Nonsmokers	76%	85%	86%	67%
Age (yr)	20.1 (4.7)	24.8(8.4)	20.3 (3.5)	21.1 (3.4)
Height (in)	66.1 (4.5)	65.4 (4.0)	66.3 (3.4)	67.1 (4.1)
Weight (lb)	151.1(50.9)	162.0 (40.7)	158.3 (28.6)	160.9 (43.0)
BMI (kg/m^2)	23.9 (6.0)	26.5(6.0)	25.2 (3.6)	25.0 (5.5)
BSA (m^2)	1.76(.31)	1.81(.24)	1.81(.19)	1.83 (.26)
CASSBP [a] (mm Hg)	113 (13.0)	114 (8.7)	114 (7.3)	112 (10.1)
CASDBP [a] (mm Hg)	69 (8.8)	70 (9.0)	71 (9.6)	72 (8.3)
SBP [b] (mm Hg)	108.4(13.4)	108.7(9.1)	110.7 (8.7)	109.7 (11.6)
DBP [b] (mm Hg)	61.6(7.4)	61.0 (7.4)	61.3 (6.1)	62.9 (6.9)
HR [b] (bpm)	74.2(10.0)	72.7(10.5)	74.9(11.7)	73.0(8.7)
CO [b] (L/min)	5.4(1.18)	5.7(1.03)	5.9(1.09)	5.9 (1.19)
TPR [b] (pru)	.89(.21)	.83 (.15)	.85(.16)	.84 (.17)

Values for age, height, weight, BMI, BSA, CASSBP, CASDBP, SBP, DBP, HR, CO, and TPR are unadjusted means (SD). HOST—hostility; EX—interpersonal emotional expression; PH—parental history of hypertension; BMI—body mass index; BSA—body surface area; CASSBP—casual SBP; CASDBP—casual DBP; SBP—systolic blood pressure; DBP—diastolic blood pressure; HR—heart rate; CO—cardiac output; TPR—total peripheral resistance.
[a] Casual blood pressure assessed via mercury sphygmomanometer.
[b] Initial resting levels of physiological variables.

percentage of women and a smaller percentage of men than the high-hostile group. Gender was included as a control variable in all remaining analyses.

A 2 (Hostility Group) × 2 (Interpersonal Expression Group) × 2 (Gender) ANOVA revealed a significant main effect of expression group for age, with interpersonal expressors being older than suppressors, $F(7,91) = 6.64$, $p = .012$. Age was included as a covariate in all remaining analyses.

A series of 2 (Hostility Group) × 2 (Interpersonal Expression Group) × 2 (Gender) ANCOVAs performed on the remaining variables in Table 1 yielded no significant main effects or interactions involving hostility or emotional expression group, $Fs(8, 90) < 1.58$, $ps > .10$.[1] While no group differences were observed for BMI, it should be noted that 30% of the participants were overweight (25 < BMI < 29.9) and 16% were obese (BMI > 30) (National Heart, Lung, and Blood Institute, 2006).

3.2. Hostility × interpersonal emotional expression group differences in reactivity

The mixed ANCOVA for CO revealed no main effects of hostility or emotional expression group or interactions among hostility group, expression group (see Table 2), and/or gender, $Fs(1,90) < 3.05$, $ps > .10$. There were also no interactions involving hostility and/or expression group with task, $Fs(3,270) < 1.45$, $ps > .10$.

Analyses for both HR, $F(1,90) = 5.06$, $p < .05$, and SBP, $F(1,88) = 4.46$, $p < .05$, yielded significant main effects of hostility group that were qualified by significant Hostility Group × Task interactions [for HR: $F(3,270) = 2.86$, $p < .05$; for SBP: $F(3,264) = 2.78$, $p < .05$]. Follow-up analyses for speech preparation yielded significant main effects of hostility group for both HR ($M_{\text{High-Hostile}} = 4.3$, SD = 5.4; $M_{\text{Low-Hostile}} = 8.9$, SD = 8.0), $F(1,90) = 9.59$, $p < .01$, and SBP ($M_{\text{High-Hostile}} = 8.3$, SD = 6.3; $M_{\text{Low-Hostile}} = 11.0$, SD = 8.9), $F(1,93) = 8.74$, $p < .01$, with high-hostile individuals exhibiting less reactivity than low-hostile individuals.

Inspection of means suggested that high-hostile expressors were the least responsive group in terms of SBP, DBP, and TPR responses (see Table 2). While Hostility Group × Interpersonal Expression Group interactions were observed for both SBP, $F(1,88) = 4.08$, $p < .05$, and DBP, $F(1,88) = 5.01$, $p < .05$, follow-up analyses revealed only a significant main effect of expression group for high-hostile individuals, for DBP, $F(1,43) = 12.86$, $p = .001$, with high-hostile expressors being less reactive across all tasks than high-hostile suppressors (see Fig. 1).

Although no Hostility Group × Interpersonal Expression Group interaction emerged for TPR, $F(1,89) = 1.37$, $p > .10$, the mixed ANCOVA did result in a main effect of interpersonal expression group, $F(1,89) = 5.24$, $p < .05$, qualified by an Interpersonal Expression Group × Gender interaction, $F(1,89) = 4.56$, $p < .05$, as well as a Hostility Group × Gender interaction, $F(1,89) = 6.64$, $p = .012$. Follow-up analyses showed that male expressors exhibited lower TPR responses than male suppressors, $F(1,35) = 9.80$, $p < .01$ (see Fig. 2). No significant hostility

Table 2
Changes from pretask baseline to task, averaged across stressors, for high/low hostility × high/low interpersonal emotional expression groups

Variable	Low HOST–Low EX	Low HOST–High EX	High HOST–Low EX	High HOST–High EX
SBP (mm Hg)	13.7 (8.1)	14.6 (8.0)	14.3 (6.8)	10.3 (6.5)
DBP (mm Hg)	9.0 (5.2)	8.9 (5.1)	9.5 (3.6)	5.3(3.9)
HR (bpm)	10.0 (6.0)	10.1(6.1)	6.8 (4.6)	7.3 (5.0)
CO (L/min)	.45 (.42)	.62 (.50)	.41 (.33)	.46(.42)
TPR (pru)	.06 (.06)	.04 (.05)	.06 (.05)	.02(.06)

Values for SBP, DBP, HR, CO, and TPR are unadjusted means (SD). HOST—hostility; EX—interpersonal emotional expression; SBP—systolic blood pressure; DBP—diastolic blood pressure; HR—heart rate; CO—cardiac output; TPR—total peripheral resistance.

[1] Despite the absence of hostility by expression group differences in BMI, given the high percentages of overweight and obese participants in this sample and potential effects of BMI on cardiovascular measures, we repeated the analyses of cardiovascular baseline and reactivity data using BMI as an additional covariate. The results of these analyses did not differ appreciably from those presented here.

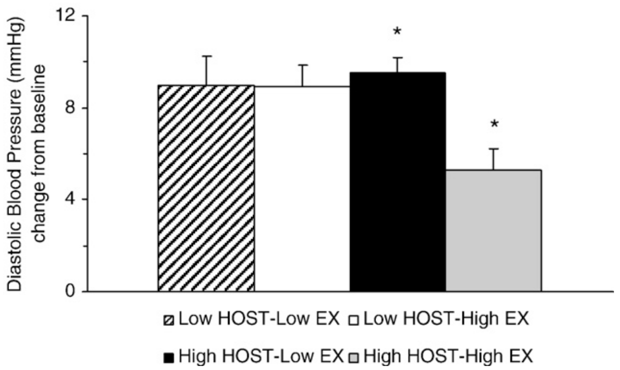

Fig. 1. Mean (±SEM) diastolic blood pressure reactivity change scores, averaged across tasks, for hostility by interpersonal emotional expression groups. Values are unadjusted means. HOST: hostility; EX: interpersonal emotional expression. Significant differences (*$p<.01$) are indicated.

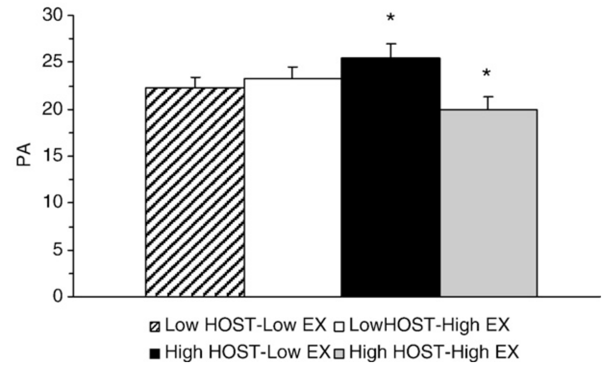

Fig. 3. Mean (±SEM) positive affect (PA) levels, averaged across baseline and tasks, for hostility by interpersonal emotional expression groups. Values are unadjusted means. HOST: hostility; EX: interpersonal emotional expression. Significant differences (*$p<.01$) are indicated.

group differences were observed for men, $F(1,35)=3.11$, $p>.05$, or women, $F(1,35)=1.45$, $p>.10$.

3.3. Hostility × interpersonal emotional expression group differences in cognitive appraisals

Mixed ANCOVAs performed on cognitive appraisal ratios yielded significant main effects of both hostility group, $F(1,90)=5.00$, $p=.016$, and expression group, $F(1,90)=4.26$, $p<.05$. Relative to their low-hostile counterparts ($M=.60$, SD=.26), high-hostile individuals ($M=.72$, SD=.28) reported greater overall threat (and lower overall challenge) appraisals of all tasks. Conversely, emotional expressors ($M=.61$, SD=.27) reported lower overall threat (and greater challenge) appraisals than suppressors ($M=.72$, SD=.28).

3.4. Hostility × interpersonal emotional expression group differences in state affect

Results for negative state affect showed only a hostility group main effect, $F(1,90)=4.28$, $p<.05$. Specifically, high-hostile individuals reported higher negative affect than low-hostile participants at baseline and maintained this elevated negative emotion across the tasks ($M_{\text{High-Hostile}}=18.3$, SD=4.83; $M_{\text{Low-Hostile}}=16.1$, SD=3.71).

Results for positive affect revealed a Hostility Group × Interpersonal Expression Group interaction, $F(1,90)=7.79$, $p<.01$. Follow-up analyses indicated that high-hostile expressors reported lower levels of positive affect at baseline and during the tasks than high-hostile suppressors, $F(1,44)=8.79$, $p<.01$ (see Fig. 3).

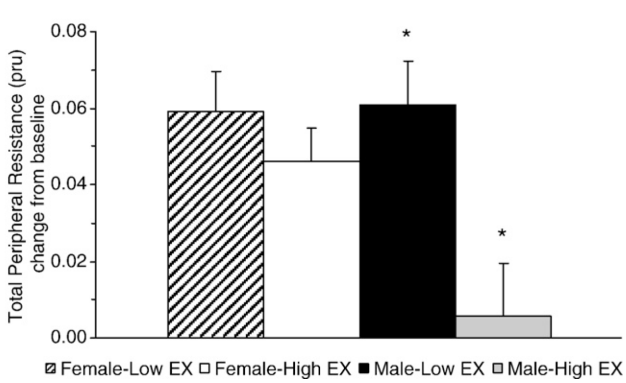

Fig. 2. Mean (±SEM) total peripheral resistance reactivity change scores, averaged across tasks, for gender by interpersonal emotional expression groups. Values are unadjusted means. EX: interpersonal emotional expression. Significant differences (*$p<.01$) are indicated.

4. Discussion

This investigation partially replicated the findings of Davis et al. (2000), who compared high and low hostility groups on hemodynamic responses to subtle social stressors. Consistent with Davis et al.'s work, our high-hostile participants displayed lower HR and SBP responses, albeit for speech preparation only. In contrast to Davis et al.'s findings, in the present study, high hostility was not associated with significantly lower CO or greater DBP or TPR responses.

A unique contribution of this study is the demonstration of interactive effects of hostility and a proclivity to express positive and negative emotion interpersonally on cardiovascular reactivity. Specifically, high-hostile interpersonal expressors exhibited reduced DBP reactivity across all tasks relative to high-hostile interpersonal suppressors. This finding is generally consistent with those of Bongard et al. (1998) who found that high-hostile anger expressors showed lower blood pressure responses than other hostility by anger-expression groups. Furthermore, interpersonal emotional expression significantly interacted with gender in a like manner, with male interpersonal expressors displaying decreased TPR responses across stressors relative to male interpersonal suppressors. This finding is somewhat consistent with those of Mendes et al. (2003), who observed decreases in TPR among men and women engaged in situation-specific emotional expression to same-sex research assistants.

In providing evidence of high-hostile individuals appraising stressors as more threatening and less positively challenging than low-hostile individuals, this study has helped to fill a surprising gap in the literature. Furthermore, to our knowledge, the present investigation is the first to provide evidence of differences in threat and challenge appraisals as a function of *trait*-emotional expression/suppression (interpersonal or otherwise). Participants scoring high in interpersonal emotional expression reported greater challenge and lower threat appraisals of all tasks than individuals prone to suppression of emotion in interpersonal situations.

Not surprisingly, high-hostile individuals scored higher in negative affect across the session than their low-hostile counterparts. In addition, high-hostile interpersonal expressors reported lower positive affect than high-hostile suppressors. While measures of task-engagement or effort were not obtained, the higher threat appraisals and negative affect experienced by high-hostile participants may have led to decreased effort or engagement, which would, in turn, explain their lower HR and SBP responses (e.g., Obrist, 1981) to speech preparation.

Considered together, the reduced DBP responses of high-hostile interpersonal expressors and reduced TPR responses of male interpersonal expressors suggest possible attenuating effects of a tendency to express emotion interpersonally on reactivity, and vascular responses, in particular. Consistent with gender stereotypes, there is evidence that men are less likely to express emotion than women (see Kring and Gordon, 1998, for review). Thus, the common denominator that makes comfort with emotional expression in interpersonal encounters salient to hostile individuals and men may be that the capacity for such expression is commonly lacking in these groups. Based on the present findings, we speculate a possible buffering or cathartic effect of a propensity to express emotion interpersonally for subgroups of hostile individuals and men.

Although the DBP and TPR findings from this study were not accompanied by corresponding interactions of hostility or gender with interpersonal expression for appraisals or state affect, a tendency to express emotion in interpersonal situations was associated with a less threatening view of the tasks. Our reactivity findings suggest that this characteristic may be most beneficial to high-hostile and male interpersonal expressors.

At first glance, the relatively low levels of positive state affect reported by high-hostile interpersonal expressors might seem incongruent with their dampened reactivity. However, a potential explanation becomes apparent if one first considers that hostile individuals, on average, might be expected to have "personality baselines" (Gunnells, 2007) distinguished by high negative and low positive affect levels, similar to those reported at baseline in this study by the high-hostile group and the high-hostile interpersonal expressors, respectively.

Although one might suppose that hostile individuals would be more likely to *experience* heightened negative and diminished positive affect, it is not necessarily the case that they would, uniformly, be more likely to *express* this socially undesirable profile, even via self-report. For instance, while often not differing significantly from the other groups in this sample, high-hostile interpersonal *suppressors* paradoxically reported the highest levels of both negative (M=18.7 versus Ms=17.6, 16.7, and 15.7 for high-hostile expressors, low-hostile suppressors, and low-hostile expressors, respectively) and positive (see Fig. 3) affect. Low scores on the emotional expression measure used here appear to be more reflective of conscious suppression than unconscious or semi-conscious repression (Paulhus, 1984). Thus, the high-hostile interpersonal emotional *suppressors* in this study might be best construed as similar to the individuals described by Jamner et al. (1991) and Shapiro et al. (1993) who scored high on measures of defensiveness and hostility/anger. Echoing Alexander's (1939) observations in hypertensives, Jamner et al. (1991) postulated that defensive-hostile individuals may feel "...conflicted or ambivalent about inhibiting expressions of anger and hostility." (p. 403). These participants showed heightened cardiovascular responses to real-life, highly interpersonal situations (Jamner et al., 1991; Shapiro et al., 1993). The fact that our high-hostile interpersonal suppressors did not always show a correspondingly higher level of reactivity than other groups may reflect the relatively subtle social challenges employed in this study.

We speculate that the tendency for our high-hostile interpersonal emotional suppressors to display higher levels of both negative and positive affect than the other hostility by expression groups may reflect conflict or ambivalence over the expression of emotion. A logical extension is that our finding of high-hostile interpersonal *expressors* exhibiting the lowest levels of positive affect may represent the absence of such conflict or ambivalence. Future investigations should include measures of defensiveness/social desirability in order to clarify the psychosocial profiles of hostility by interpersonal expression groups. Nevertheless, the possibility that the liberating effects of being comfortable enough with interpersonal expression to not report the most socially desirable response (e.g., higher positive affect) might be beneficial to hostile individuals is suggested by the manner in which the pattern of group differences in positive affect (see Fig. 3) paralleled the patterns of group differences in DBP reactivity (see Fig. 1).

A limitation of the present study is that post-task cardiovascular recovery data were not examined. While studying recovery may be particularly important in hostility investigations involving anger provocation (e.g., Anderson et al., 2005, 2006; Fredrickson et al., 2000; Neumann et al., 2004), our reactivity findings suggest investigation of recovery as a function of hostility, interpersonal expressive style, and gender as a worthwhile topic for future research.

There is evidence of both stability and change in personality, in general (Caspi et al., 2005), and hostility, in particular (Siegler et al., 2003), with aging. Consequently, more studies are needed to sort out the likelihood of traits such as those examined here enduring across the lifespan as well as predictors of stability versus instability. Additional work relating hemodynamic response patterns to disease endpoints is also desirable. Nevertheless, in light of increasing evidence of negative health implications of vascular responses (e.g., Kapuku et al., 1999) and support for relatively long-term stability of reactivity (e.g., Sherwood et al., 1997), as well as the risk associated with being hostile (for reviews see Miller et al., 1996; Smith, 1992) or male (e.g., National Heart, Lung, and Blood Institute, 2004), our findings suggest potential protective effects of a tendency to express emotion interpersonally for certain at-risk groups.

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