Gender and Communal Trait Differences in the Relations Among Social Behaviour, Affect Arousal, and Cardiac Autonomic Control

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To examine the relation between social behaviour and vagal activity, the communal behaviour of healthy college men ($N = 33$) and women ($N = 33$) was manipulated while monitoring heart rate (HR) and respiratory sinus arrhythmia (RSA). The subjects were classified as low or high on communal trait. Communal behaviour was manipulated by having the subjects behave in an agreeable or quarrelsome manner in scripted role-plays. HR, RSA and self-report arousal were obtained during or immediately following baseline, experimental and relaxation periods. 2 (Gender) × 2 (Communal Trait; low/high) × 2 (Condition; agreeable/quarrelsome) ANCOVAs were performed. Men had lower RSA values when behaving in a quarrelsome fashion than agreeable and lower RSA values than women in the quarrelsome condition. In the latter condition, low communal men reported more arousal than other groups. Strong but opposite associations between RSA and affect arousal were observed in low communal men and woman. Men, especially more quarrelsome (less communal) men exhibited weaker vagal control during arousing social situations.

KEY WORDS: RSA; cardiovascular reactivity; affect arousal; communion; gender differences.

INTRODUCTION

Coronary artery disease (CAD) is the leading cause of death in men and women in industrial societies (Scheit, 1996; Shepherd, 1998). However, the onset of CAD in women usually occurs 10–20 years later than in men. While cardio-protection by estrogen is believed to play a role in this sex/age differential, other mechanisms may also be involved. Sex-related differences in hostility and/or in cardiovascular reactivity (CVR) to interpersonal stress may be two such determinants of sex-related differences in CAD among younger individuals. Examination of these differences could provide insights into the possible behavioural and biological mechanisms involved in the incidence and pathophysiology of CAD in men and women.

Hostility and Coronary Artery Disease

Evidence accumulated over the past decades suggest a role for hostility (Barefoot *et al.*, 1983, 1994; Haynes *et al.*, 1980; Helmers *et al.*, 1993; Matthews, 1982; Shekelle *et al.*, 1983; Smith, 1992; Williams, 1987; Williams *et al.*, 1989) in the incidence of CAD. For example, a recent prospective study of Danish men and women found that hostility was associated

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with an increased risk of a myocardial infarction (MI) and early mortality at 27 years follow-up, even when controlling for potential risk factors (Barefoot *et al.*, 1995). Hostility was also found to be an independent risk factor for CAD and all-cause mortality in a meta-analytic review of this area (Miller *et al.*, 1996).

The results of several studies suggest gender differences in the experience or expression of hostility. For example, Engebretson and Matthews (1992) reported higher ratings on potential for hostility (propensity to become angry and irritable in various situations) as well as higher hostile style ratings (e.g., more argumentative, condescending, and uncooperative, in tone or language) during a structured interview (SI) in middle-aged men compared to women. Barefoot *et al.* (1991) similarly reported more cynical hostile attitudes towards others in men compared to women. Interestingly, in the Engebretson and Matthews study (1992), hostile style in men was associated with the tendency to be competitive, hard-driving and time-pressured. Women with more hostile styles, on the other hand, tended to withhold expressing their anger. The authors concluded that expressive hostility, as measured via SI Hostile Style, may serve a different function in men and women. Such differences in hostility may play a role in observed sex differences in CAD risk.

Cardiovascular Reactivity and Hostility

The mechanisms relating hostility to CAD remain to be determined, though one potential mechanism may implicate altered cardiac autonomic control (Krantz and Manuck, 1984; Sloan *et al.*, 1999, 2001). Hostility (measured either as trait or behaviour) has been associated with exaggerated CVR to psychological challenge in numerous studies (Engebretson *et al.*, 1989; Gallo *et al.*, 2000; Guyll and Contrada, 1998; Matthews, 1982; Matthews and Haynes, 1986; Smith, 1992; Smith and Gallo, 1999; Suls and Wan, 1993; Weidner *et al.*, 1989; Williams *et al.*, 1982). Importantly, greater CVR to stress also increases the risk of atherosclerosis and CAD in humans and animals (Kamarck *et al.*, 1997; Krantz and Manuck, 1984; Manuck *et al.*, 1987; Williams *et al.*, 1993).

However, not all stress is equivalent, and inconsistent results in the literature regarding hostility and CVR do exist, particularly when using non-social tasks (Diamond *et al.*, 1984; Durel *et al.*, 1989; Engebretson *et al.*, 1989; Hardy and Smith, 1988;

Mills *et al.*, 1989; Smith and Allred, 1989; Smith and Houston, 1987; Suarez and Williams, 1989; Suls and Wan, 1993; Suls *et al.*, 1995). These may be explained, in part, by differences among studies in the actual aversiveness of the stressors to which subjects were exposed. More predominant effects of hostility on CVR to social tasks compared to non-social tasks may result from the fact that personality traits such as hostility are closely tied to social processes and thus require interpersonal tasks to fully express themselves (Everson *et al.*, 1995; Smith and Brown, 1991; Smith and Gallo, 1999; Suarez *et al.*, 1993; Suls and Wan 1993).

Other factors such as whether participants were allowed to use their preferred interpersonal style may also be important. In a study with male undergraduate students, Engebretson *et al.* (1989) manipulated both the aversiveness (via harassment) of a task and the subsequent mode of anger expression. Men who tended to express their anger outwardly demonstrated exaggerated CVR only when harassed. Expressing their anger (e.g., writing a negative evaluation of the harassing confederate) decreased their reactivity. While the aforementioned study examined anger expression, a concept that is distinct from trait hostility, results may nonetheless extend to hostile individuals. Research on the behavioural concordance model of affect by Moskowitz *et al.* (Côté and Moskowitz, 1998; Moskowitz and Côté, 1995) suggests that behaving in a quarrelsome fashion for quarrelsome/hostile individuals (in whom a concordance exists between interpersonal traits and behaviour) is associated with more pleasant affect than is experienced in similar situations by individuals with friendlier predispositions (in whom quarrelsome behaviour is discordant with their interpersonal trait). To the extent that there exists a concordance between behavioural, affective and physiological response dimensions, one might also expect hostile persons to respond to stress with reduced CVR in situations that permits them to respond in a hostile manner.

Gender Differences in Response to Stressors

Until recently, most research was performed principally with men. Some research suggests greater CVR to stress in men compared to women, particularly when using non-social tasks (e.g., motor or arithmetic tasks) and measures of blood pressure (BP; Earle *et al.*, 1999; Lawler *et al.*, 1993; Matthews and Stoney, 1988; Matthews *et al.*, 1991;

Rossy and Thayer, 1998; Stoney *et al.*, 1987). Others have reported no differences in CVR among men and women (Durel *et al.*, 1989; Girdler *et al.*, 1990; Smith and Brown, 1991; Uchino *et al.*, 1999; Weidner *et al.*, 1989). According to Girdler *et al.* (1990), gender differences in cardiovascular responses may depend on whether the stressors employed call on the particular coping skills of women or are of personal importance to them. Within the laboratory context, interpersonal tasks (e.g., interpersonal speech task) are particularly potent for producing increased CVR in women (Girdler *et al.*, 1990; Lawler *et al.*, 1993) and men (Everson *et al.*, 1995; Smith and Brown, 1991; Smith and Gallo, 1999).

Smith *et al.* (Brown and Smith, 1992; Gallo *et al.*, 2000; Smith and Brown, 1991; Smith *et al.*, 1996, 1998) have based their evaluation of social stimuli and interpersonal responses on the interpersonal circumplex (Wiggins, 1979). The interpersonal circumplex perceives interpersonal processes as located within the conceptual space defined by two axes—friendliness vs. quarrelsomeness/hostility (communion domain), and dominance vs. submissiveness (agency domain). Concerned by possible gender differences in the importance assigned to these interpersonal domains (i.e., agency vs. communion), Smith *et al.* (1998) experimentally manipulated agentic and communal concerns during a marital interaction. Wives responded to communal concerns (disagreement with their husband) with increased CVR whereas husbands reacted with increased CVR to the achievement challenge that engaged agentic concerns.

Overall, past research tends to indicate that the relation between CVR and hostility may be moderated by gender, by task characteristics, by personality characteristics and by the match between task and characteristics of the individual as reflected in gender or more specific personality characteristics.

Assessment of Cardiovascular Reactivity to Stress

Previous research have placed emphasis on measures of CVR such as heart rate (HR) and BP. However, recent advances have permitted quantification of heart rate variability (HRV) into bands that reflect different autonomic influences on HR. The high-frequency (HF) band (0.14–0.40 Hz) is used as an index of cardiac vagal or parasympathetic control (Akselrod *et al.*, 1985; Appel *et al.*, 1989; Pomeranz *et al.*, 1985; Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996), and as a result of its association with respiration, is typically referred to as respiratory sinus arrhythmia (RSA). In light of findings that reduced HRV is associated with CAD incidence, morbidity and mortality (Bigger *et al.*, 1993; Farrell *et al.*, 1991; Kleiger *et al.*, 1987; Liao *et al.*, 1997; Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996; Tsuji *et al.*, 1996), consideration of RSA may prove particularly informative.

Summary of Essentials Points and Predictions

Research suggests hostility is associated with greater CVR, particularly to social tasks. However, some findings suggest the importance of examining the congruence of the tasks with the characteristics of the participants engaged in them. In the present study, we experimentally manipulated whether the participants behaved in their habitual mode (aggressively for more quarrelsome individuals; in a friendly, non-aggressive manner for individuals characterized as agreeable) or not, and then examined how this match or mismatch affected CVR to an interpersonal stressor. As with Smith and associates (Brown and Smith, 1992; Gallo *et al.*, 2000; Smith and Brown, 1991; Smith *et al.*, 1996, 1998), our evaluation of interpersonal style was also based on the interpersonal circumplex (Wiggins, 1979), though our focus was on the communal domain. The current study sought to explore sex differences in the relations among communal traits, and behavioural, affective and autonomic responses to interpersonal stress. More specifically, we tested the following hypotheses. First, individuals who had high scores on the trait of quarrelsomeness and low scores on the trait of agreeableness (low communal individuals) would exhibit greater HR and less parasympathetic cardiac control (lower RSA) during the interpersonal stressors compared to individuals high in communal traits. However, this general response may be moderated by the consistency of the task demand with their interpersonal traits. As such, the second hypothesis was that individuals would show greater reactivity in situations that required them to act in a manner inconsistent with their interpersonal traits. An additional purpose of this study was to examine whether behavioural and physiological arousal were in synchrony with each other, and whether sex and communal trait impacted on the extent of synchrony.

METHODS

Participants

Sixty-six healthy undergraduate men ($N = 33$) and women ($N = 33$) were recruited. Complete data for physiological measures were obtained for 29 men and 30 women. Loss of data was due principally to problems with our equipment. Participants averaged 21 years of age (SE = 0.35, range = 18–32 years), were predominantly white, and 77% spoke English as a first language.

The study was approved by the McGill University Research Ethics Board, and subjects were paid $10 for their participation in the study.

Measures and Apparatus

Interpersonal Style

The Revised-Interpersonal Adjective Scales (IAS-R; Wiggins, 1995; Wiggins *et al.*, 1988): a 64-item questionnaire that provides interpersonal trait measures of Cold-heartedness (*interpersonal hostility and quarrelsomeness*) and Agreeableness, as well as other traits (e.g., dominance, submissiveness). Subjects are presented with a list of adjectives and are asked to rate the extent to which each item describes them on an 8-point Likert scale (*"extremely inaccurate"* to *"extremely accurate"*). Sample items for the Cold-heartedness scale include *"uncharitable"* and *"cruel."* *"Accommodating"* and *"kind"* are examples of adjectives constituting the Agreeableness scale. Scores for each scale are obtained by averaging responses from their constituent items. Alpha-coefficients for the various scales range from 0.75–0.85. For the purposes of the present study, focus was placed on the communal axis of the interpersonal circumplex. The meta-construct of communal trait was obtained by subtracting the score for the Cold-heartedness scale from the score from the Agreeableness scale. A higher communal trait value indicates a more friendly, less quarrelsome disposition.

Affect

Affect Grid is a 1-item measure that reliably assesses both valence and intensity of affect (Russel *et al.*, 1989). The participant is presented with a 9×9 rectangular grid of squares and is asked to indicate the extent to which he/she is feeling pleasure–displeasure on the horizontal dimension of the grid, and the extent of arousal–sleepiness on the vertical dimension of the grid. The reliability and validity of the measure has been demonstrated in a series of studies (Russel *et al.*, 1989). The affect grid has previously been used to assess mood in a daily sampling study occurring over a 2-month period (McFarlane *et al.*, 1988) and in a 1-month cross-over event-contingent recording study examining the effects of tryptophan (Moskowitz *et al.*, 2001). The affect grid is a particularly useful tool when the time needed to make an assessment of affect is minimized as in the present study when multiple forms were required, one after each relaxation induction and after each condition.

Anger was measured using a 7-point rating scale ranging from (Scheit, 1996) *not at all* to (Matthews, 1982) *very much*. Subjects responded to the question "How much did you feel the following emotion?"

Physiological Variables

HR and RSA Measures were obtained using a reusable electrode band placed around the thorax. The electrocardiogram (ECG) was recorded on-line using a Polar Vantage NV HR monitor and Polar Precision software. This data was then analyzed using a Porges Vagal Tone Monitor, which quantifies HRV within a bandwidth of 0.12–0.40 Hz, encompassing adult respiratory frequencies. The analysis is based upon heart period values measured to the nearest millisecond. Errors in the marking of R waves were corrected interactively.

Procedure

Participants responded to ads requesting subjects for participation in a study on supervisory feedback. During the initial telephone call, an overview of the study was given and an appointment was made. Subjects were requested to abstain from caffeine or nicotine use, as well as from strenuous exercise for at least 4 h prior to testing. They were also asked to refrain from alcohol or other drug use during the 24-h period preceding the experiment.

In the laboratory, subjects were tested by research assistants of the same sex. The procedure was explained and informed consent was obtained, after which the electrode band was placed around the subject's thorax for measurement of the ECG. Participants were instructed to remain quiet

throughout the procedures with the exception of the experimental conditions. Subjects proceeded to complete various questionnaires (demographic, medical history, IAS-R) and rested quietly for 15 min. A 3-min baseline ECG was recorded at the end of this adaptation period. All subjects were then guided through a 5-min progressive muscle relaxation procedure to ensure a calm neutral state. The ECG was recorded during relaxation and an affect grid completed immediately afterwards. Subjects were subsequently handed 1 of 2 role-play scenarios. Each task involved a preparation phase during which subjects read the script to themselves followed by the role-play. The role-plays required participants to imagine that they were personnel supervisors providing feedback to an employee whose performance had been mediocre. In one condition, the script provided feedback using many agreeable behaviours. For example, "I can see that you tried hard... You have made good progress... We just have to work on the parts of the task that you did not perform so well on." In the other condition, the script provided feedback using an equal number of quarrelsome behaviours. For example, "This task has to be completed, and you are not going to get it done unless you do a better job... I think that a high-school freshman could do better than this... I am not impressed with your performance." The behaviours incorporated into the scripts were adapted from event-contingent recording forms developed by Moskowitz (1994). Subjects delivered the script, which they were asked to enact as effectively as they could, to the research assistant who served as the supervisee to whom they provided the feedback. The ECG was recorded during the role-play, and subjects completed the affect-grid and the affect ratings after delivering the script. This procedure (relaxation, preparation, and role-play) was repeated for the second script. The order of presentation of the conditions was counterbalanced across subjects and role-plays were videotaped.

Data Reduction and Analysis

Cardiac parameters were calculated for sequential 30 s epochs, and then averaged over each period (baseline, two relaxation periods, two experimental conditions). For the purposes of statistical analyses, RSA was log transformed to correct for skewness.

Communal trait measures were also log transformed. Given continued departure from the normal distribution, analyses were performed on a dichotomized communal score. Communal trait was divided into low and high based on a median split within gender ($M_{men} = 3.44$, $M_{women} = 4.56$).

Three-way Sex (male/female) × Communal Trait (low/high) × Condition (agreeable/ quarrelsome script) repeated measures ANCOVAs were performed to test differences in HR, RSA, affect arousal, affect valence and anger.

To examine the association between autonomic and behavioural reactivity to the conditions, two multiple regression analyses were conducted with change scores in affective arousal (quarrelsome—agreeable condition) as the dependent variable. The independent variables were sex, change in RSA (quarrelsome—agreeable condition), and the interaction between sex and change in RSA. Separate analyses were performed for low communal and high communal individuals. The analyses were repeated for anger.

All analyses controlled for relevant covariates, defined as variables correlating at least at $r = 0.20$ with the dependent variable under analysis. Potential covariates included: order of presentation, age, body mass index, baseline HR, baseline RSA, affect and arousal ratings during relaxation, as well as other IAS-R trait measures. If days since onset of last menses and oral contraceptive use was associated at $r \geq 0.20$ with any dependent variable in women, correction for these variables was first performed by regression in the women's data. The adjusted values were then included along with the men's data.

For the multiple regression analyses, correction for covariates was accomplished by first regressing change in affect arousal and change on RSA on the relevant covariates for all subjects, and then analyzing the residuals.

The criterion for statistical significance was $p < .05$. Correction for multiple tests was not performed given the restricted sample size.

RESULTS

Demographic and Other Measures Obtained at Baseline and Relaxation

"Low" communal individuals obtained higher scores on the Cold-heartedness scale (2.6 vs. 1.7; $F(1, 58) = 86.86$, $p = 0.000$) and lower scores on the Agreeableness scale (5.7 vs. 6.6; $F(1, 61) = 29.02$, $p = 0.000$) compared to "high"communal individuals. No group differences emerged for trait measures of dominance and submissiveness (Table I).

Table I. Baseline and Experimental Characteristics for Men and Women as a Function Communal Trait

	Men		Women	
	Low communal (Mean ± SE)	High communal (Mean ± SE)	Low communal (Mean ± SE)	High communal (Mean ± SE)
Age (years)	20.6 ± 0.700	22.9 ± 0.639	20.3 ± 0.678	21.4 ± 0.678
BMI (kg/m^2)	22.6 ± 0.582	22.2 ± 0.531	21.1 ± 0.564	20.6 ± 0.564
Days since onset of last menses	na	na	15.5 ± 2.744	9.2 ± 2.313
Oral contraceptive use	na	na	31%	25%
Heart rate				
Baseline	76.0 ± 2.690	75.6 ± 2.372	77.2 ± 2.598	80.8 ± 2.516
Relaxation	76.1 ± 2.336	73.7 ± 2.060	73.4 ± 2.185	73.9 ± 2.257
Agreeable condition	83.2 ± 2.296	84.7 ± 1.968	80.6 ± 2.075	83.2 ± 2.047
Quarrelsome condition	84.1 ± 2.390	86.0 ± 2.048	82.6 ± 2.159	82.7 ± 2.131
Respiratory sinus arrhythmia (log units)				
Baseline	0.82 ± 0.015	0.83 ± 0.014	0.83 ± 0.015	0.82 ± 0.015
Relaxation	0.83 ± 0.014	0.84 ± 0.014	0.83 ± 0.014	0.83 ± 0.014
Agreeable condition	0.81 ± 0.015	0.82 ± 0.013	0.82 ± 0.013	0.79 ± 0.014
Quarrelsome condition	0.76 ± 0.017	0.79 ± 0.014	0.82 ± 0.015	0.80 ± 0.015
Arousal				
Relaxation	3.0 ± 0.300	2.3 ± 0.263	2.3 ± 0.271	2.4 ± 0.280
Agreeable condition	7.0 ± 0.400	5.9 ± 0.325	6.8 ± 0.324	6.1 ± 0.355
Quarrelsome condition	7.7 ± 0.438	5.7 ± 0.355	6.7 ± 0.355	6.6 ± 0.393
Affect valence				
Relaxation	7.2 ± 0.316	7.4 ± 0.276	7.3 ± 0.285	7.7 ± 0.294
Agreeable condition	.3 ± 0.570	6.4 ± 0.476	5.7 ± 0.482	5.4 ± 0.512
Quarrelsome condition	3.3 ± 0.593	4.5 ± 0.495	3.2 ± 0.502	3.4 ± 0.533
Anger				
Relaxation	1.2 ± 0.074	1.2 ± 0.068	1.1 ± 0.072	1.0 ± 0.072
Agreeable condition	1.3 ± 0.207	1.5 ± 0.196	1.3 ± 0.200	1.5 ± 0.200
Quarrelsome condition	2.5 ± 0.385	2.4 ± 0.364	2.3 ± 0.371	2.2 ± 0.371
N	12	17	15	15

Note. BMI: body mass index.

"Low" and "high" communal women did not differ significantly on oral contraceptive use or stage of menstrual cycle. Men had a slightly greater body mass index than women (22 vs. 21; $F(1, 61) = 7.45$, $p = 0.008$). There were no sex differences with respect to age, though more communal individuals were slightly older than those who were less communal (22 vs. 20 years of age; $F(1, 61) = 6.42$, $p = 0.014$).

Men and women with low or high communal traits showed no significant differences in regards to HR and RSA obtained during baseline or relaxation, nor with respect to affect valence and arousal measures obtained immediately following relaxation. Men did report slightly more anger compared to women (1.2 vs. 1.0; $F(1, 61) = 4.59$, $p = 0.036$).

Efficacy of Role Play as a Stress Protocol

Physiological and affective measures were analyzed using 2 (Period: baseline vs. role-play) × 2 (Sex: men vs. women) × 2 (Communal trait: low vs. high) ANCOVAs to test the hypothesis that the role-plays would be effective in increasing HR, decreasing RSA, increasing affect arousal, and decreasing affect valence compared to baseline. It was also hypothesized that less communal individuals would show greater reactivity to interpersonal stress compared to more communal individuals. Values obtained during both role-plays were averaged to produce mean role-play physiological and affective measures.

Compared to baseline, subjects exhibited significant changes in HR ($77.0 ± 1.230$ vs. $83.2 ± 1.348$; $F(1, 56) = 4.85$, $p = 0.032$) and in RSA ($0.82 ± 0.008$ vs. $0.80 ± 0.007$; $F(1, 54) = 9.21$, $p = 0.004$) during the role-play trials. No effect of gender or communal trait emerged.

With respect to measures of affective arousal, there were main effects for Condition ($F(1, 52) = 4.92$, $p = 0.031$) and for Communal Trait ($F(1, 52) = 6.99$, $p = 0.011$). Participants felt more aroused during role-play conditions compared to baseline

$(6.6 \pm 0.139$ vs. $2.5 \pm 0.141)$. The interaction between gender and communal trait was also significant $(F(1, 52) = 6.45, p = 0.014)$, indicating that men low in communal trait were significantly more affectively aroused than all other groups.

Engaging in the role-plays led to significant decreases in affect valence (Condition main effect; $F(1, 54) = 5.26$, $p = 0.026$) in all participants except for high communal men (3-way interaction; $F(1, 54) = 4.06, p = 0.049$).

Manipulation of Communal Behaviour

For each physiological and affective measure, 2 (Gender: male/female) × 2 (Communal trait: low/high) × 2 (Condition: agreeable/quarrelsome script) repeated measures ANCOVAs were performed to test the hypothesis that individuals would show greater physiological and behavioural reactivity in situations that required them to act in a manner inconsistent with their interpersonal traits. More specifically, men and women who had high scores on communal traits were expected to show greater reactivity to the quarrelsome script, while less communal individuals would show greater reactivity during the agreeable script (Table I).

Heart Rate

The covariates included baseline HR, age and order. A significant main effect of Condition emerged $(F(1, 53) = 5.57, p = 0.022)$, suggesting increased reactivity during the quarrelsome $(84 \pm 1.068 \text{ bpm})$ relative to the agreeable condition $(83 \pm 1.026 \text{ bpm})$.

Respiratory Sinus Arrhythmia

The covariates included baseline HR, baseline RSA, anger following relaxation, and order. The ANCOVA produced a significant condition main effect $(F(1, 51) = 9.82, p = 0.003)$. The Gender × Condition interaction was also significant $(F(1, 51) = 9.90, p = 0.003$; see Fig. 1) and indicated a significant reduction in RSA in the quarrelsome relative to the agreeable condition in men $(F(1, 25) = 8.45, p = 0.008)$. Men also exhibited significantly lower RSA values during the quarrelsome condition compared to women $(F(1, 55) = 5.11, p = 0.028)$.
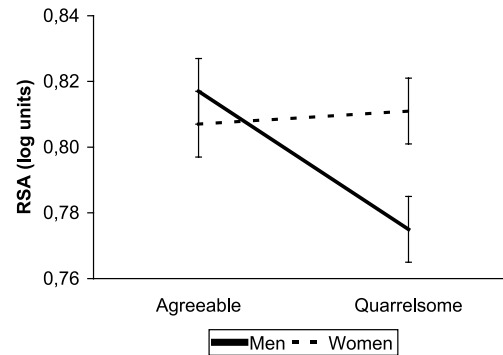

Fig. 1. Mean (±SE) RSA as a function of role-play condition and gender.

Arousal

Covariates included order, age, BMI, relaxation anger and relaxation arousal. Days since onset of last menses was used to adjust women's scores. Analyses of arousal revealed a significant Communal Trait main effect $(F(1, 51) = 9.29, p = 0.004)$, a significant Sex × Communal Trait interaction $(F(1, 51) = 4.05, p = 0.049)$, as well as a significant 3-way interaction between Sex, Communal Trait and Condition $(F(1, 51) = 4.08, p = 0.049)$. When behaving in a quarrelsome manner, less Communal (high quarrelsome) men reported being significantly more affectively aroused than the other three groups $(p < 0.030)$. When behaving in an agreeable way, less communal men were significantly more aroused than high communal men $(F(1, 23) = 5.66, p = 0.026)$, but not compared to women. (See Fig. 2).

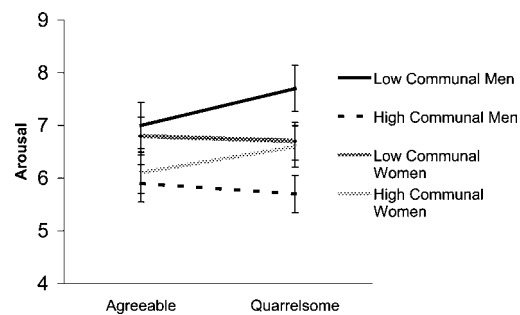### Affect Valence

There were no significant results.

Fig. 2. Mean (±SE) affect arousal as a function of role-play condition. gender and communal trait.

Anger

Covariates included order, age and relaxation anger, and scores were adjusted for days since onset of last menses for women. A significant main effect for Condition ($F(1, 58) = 10.37$, $p = 0.002$) revealed higher anger scores during the quarrelsome condition relative to the agreeable condition (2.4 vs. 1.4).

Association Between Affective
and Autonomic Arousal

The multiple regression analyses examining change in arousal as a function of gender and change in RSA were significant only for the less Communal (high quarrelsome) individuals ($F(3, 24) = 5.05$, $p = 0.007$; adjusted $r^2 = 0.31$). This analysis demonstrated the unique contributions of change in RSA ($\beta = -1.64$, $t = -3.24$, $p = 0.003$) as well as the 2-way interaction of Sex × change in RSA ($\beta = 1.55$, $t = 3.09$, $p = 0.005$). Follow-up correlational analyses revealed that for men low in Communal (high quarrelsome) trait, decreases in RSA were associated with *increases* in behavioural arousal ($r = -0.54$, $p = 0.058$, $N = 13$), while for low communal women, decreases in RSA during the quarrelsome condition were associated with *decreases* in behavioural arousal ($r = 0.58$, $p = 0.023$, $N = 15$).

Multiple regression analyses with change in anger as dependent variable were non-significant.

Similar results were obtained when cold-heartedness was employed rather than the meta-construct of communal trait. A tri-partite split in Communal trait did not alter the findings obtained with a median split.

DISCUSSION

Men and women varying in communal traits engaged in two role-play tasks that required them to adopt either quarrelsome or agreeable behaviours towards a confederate. Both sexes were similarly reactive to the interpersonal tasks, as indicated by significant changes in HR, RSA, affect valence and arousal during the role-plays (combined) compared to baseline. This is consistent with results of previous studies that have used interpersonal tasks (Lawler *et al.*, 1993; Girdler *et al.*, 1990). Sloan *et al.* (2001) have also reported decreased HF-HRV (analogous to RSA in our study) in *both* men and women using other types of stressors.

However, when our analyses focused on group differences as a function of the behavioural manipulation condition, a different picture emerged, with significant gender differences in RSA appearing in the quarrelsome, but not the agreeable condition. More specifically, when behaving in a quarrelsome manner, men exhibited significantly lower RSA values (suggestive of greater vagal withdrawal) compared to women and compared to themselves when behaving agreeably. Earle *et al.* (1999) have previously reported greater BP and cortisol responses in men relative to women exposed to harassment during psychological challenge. Our results and that of Smith and associates (Brown and Smith, 1992; Smith *et al.*, 1996) demonstrate that heightened reactivity among men also occurs in interpersonal tasks when the participant is the one doing the "harassing," that is, engaging in quarrelsome behaviour.

Given Smith *et al.* (1998) previous finding that women were reactive to manipulation of communal concerns (disagreement with their husband), we might have expected women to exhibit reduced RSA during the quarrelsome condition relative to the agreeable condition. Yet, women were equally reactive to both conditions. It is unlikely that the current results can be explained by failure of the experimental condition to elicit changes in affect and physiological activity, as adopting quarrelsome behaviours producing similar increases in HR and anger in both men and women relative to the agreeable condition. While other methodological differences were present, two important differences between our study and the study of Smith *et al.* (1998), were the significance of the relation with the other and the response of the other. Our subjects did not receive feedback (aggressive or otherwise) from the research assistant, whereas in the Smith study, women actively interacted with their spouse and their reactivity was significantly associated with the degree of hostility they perceived in their spouse. Our results may indicate that women are less reactive to their own behaviour than to the behaviour of others, particularly significant others (as in Smith *et al.*, 1998) that imply criticism or possible rejection. The importance of significant others' behaviour for women is supported by separate research suggesting that women are particularly sensitive to the beneficial influence of social support on cardiovascular activity (Lepore, 1995; Linden *et al.*, 1993).

Alternatively, Engebretson and Matthews (1992) have suggested that higher levels of hostility (state or trait) may be required before they impact

on cardiovascular activity in women. The women in our study had higher communal scores than the men; at least as low or lower scores than observed in men may be necessary to observe effects of hostility on RSA in women. Engebretson and Matthews (1992) further proposed that hostility or anger may serve a different function in women, and hence be differentially linked to physiological arousal. Our findings that changes in affective arousal and RSA were positively associated with each other in less communal women while in less communal men, they were negatively associated supports the idea of a differential function of hostile behaviour in men and women. The present results suggest that cardiac autonomic control may be less easily disturbed by women's own quarrelsome behaviour, at least in a context devoid of feedback from others, and this may be one mechanism by which women, at least younger women, may be protected from heart disease. Our sample was young. It would be of interest to compare the present findings to findings from an older sample. Perhaps with hormonal changes subsequent to menopause, a time when risk for CAD begins to increase in women (Grodstein *et al.*, 1996; Grodstein *et al.*, 1997; Peterson, 1998; The writing group for the PEPI, 1995), men and women would show greater similarities in cardiovascular control in response to engaging in more hostile/quarrelsome behaviour.

Surprisingly, no support was found for the hypothesis that less communal individuals, regardless of gender, would be more physiologically reactive than more communal individuals or that a mismatch between interpersonal style and behaviour would be associated with greater autonomic reactivity. Several investigators have found evidence for heightened CVR in individuals with elevated trait hostility (Gallo *et al.*, 2000; Powch and Houston, 1996; Sloan *et al.*, 2001; Suarez *et al.*, 1993; Weidner *et al.*, 1989), particularly in men (Engebretson and Matthews, 1992; Lawler *et al.*, 1993; Sloan *et al.*, 1994; Smith and Gallo, 1999). Yet, lack of an association between communal trait and RSA activity in the current study is consistent with some mixed or null findings in the literature regarding hostility and CVR (Diamond *et al.*, 1984; Engebretson *et al.*, 1989; Hardy and Smith, 1988; Smith and Allred, 1989; Smith and Houston, 1987; Suarez and Williams, 1989; Suls and Wan, 1993; Suls *et al.*, 1995). Differences in results may reflect differences in the constructs of hostility used, as well as differences in the physiological indices (BP *vs.* HR and RSA).

However, results involving men suggest the importance of interpersonal style. Interpersonal predisposition interacted with gender and task characteristics for ratings of affect arousal. Less communal, more quarrelsome men reported considerably more behavioural arousal than the more communal men when behaving agreeably as well as more arousal during the quarrelsome feedback condition relative to the other groups. Moreover, all men exhibited greater reductions in RSA during the quarrelsome role-play. Thus, less communal men exhibited *both* physiological and behavioural arousal when behaving in a quarrelsome fashion. Furthermore, results suggested behavioural and physiological synchrony (decreases in RSA during the quarrelsome condition compared to agreeable condition were strongly associated with increases in affect arousal) in less communal men. Suarez and Williams (1989) had reported a similar correlation in a study of hostility and CVR in male undergraduates.

Interestingly, increased arousal in less communal men was not associated with similar changes in affect valence (i.e., they did not experience more unpleasant feelings) during the quarrelsome relative to the agreeable condition. This is consistent with findings by Moskowitz *et al.* (Côté and Moskowitz, 1998; Moskowitz and Côté, 1995) suggesting that quarrelsome individuals may actually enjoy their quarrelsome behaviour. Unfortunately, though they may obtain some momentary pleasure from quarrelsome behaviour, less communal men may become agitated in ways that may be to their detriment.

To the extent that individuals low in communal traits may more frequently interact with their environment in ways that create interpersonal conflict and perhaps more arousal, as proposed by the transactional model (Smith, 1992, 1994), one might expect that greater synchrony between physiological and behavioural arousal may place them at greater risk for heart disease. This would be consistent with previous findings that lower cardiac vagal control is related to hostility in young individuals (<40 years of age) but only during daytime hours, that is, when interpersonal conflicts tend to occur (Sloan *et al.*, 1994).

Reduced vagal tone and strong arousal may have serious implications for CAD. Reduced HRV is associated with CAD incidence, morbidity and mortality (Bigger *et al.*, 1993; Farrell *et al.*, 1991; Kleiger *et al.*, 1987, Liao *et al.*, 1997; Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology,

1996; Tsuji *et al.*, 1996). Further, mental stress and trait hostility have been shown to be potent triggers of myocardial ischemia in the laboratory and during daily life in both men and women with CAD (Merz *et al.*, 1993). In a retrospective case crossover study of 1623 patients who suffered a MI (Mittleman *et al.*, 1995), Mittleman *et al.*, found that acute episodes of anger were associated with a transient doubling of the baseline risk of the onset of MI in the subsequent 2 h. While HPV measures were not obtained in the Mittleman *et al.* study, it is possible that reduced vagal tone may have been one mechanism relating anger to subsequent MI. Indeed, blunted cardiac-vagal modulation of HRV has been observed among men and women who perceived more stress during the preceding week, an effect that was independent of age, gender, trait anxiety, and cardiorespiratory fitness level (Dishman *et al.*, 2000).

Limitations

Several limitations inherent in this study merit mention. Respiratory frequency was not measured. This was deemed adequate given findings that within respiratory rates of 4–20 breaths per minute, the RSA values obtained using our method are quite reliable. Nonetheless, it cannot be excluded that a reduction in RSA resulted, at least in part, from changes in respiration rather than solely from a reduction in vagal activity. Greater affective arousal in men during the quarrelsome task may have led to increased respiration rate. However, Dishman *et al.* (2000) reported that respiration rates were not related to perceived stress or to their indices of HRV. Similarly, while psychological challenge increased respiration rates in Sloan *et al.* (2001) study, no gender differences were observed in this respect. Thus, it is unlikely that our findings of gender differences in RSA during the quarrelsome condition were attributable to differences in respiration rates.

Inclusion of other parameters of autonomic activity may have proved informative with respect to our gender differences. Indeed, Ramaekers *et al.* (1998) reported significantly higher LF-HRV and LF/HF (suggestive of higher sympathetic activity) in men compared to women younger than 40–50 years of age. However, the physiological significance of lower frequency oscillations is less clear than that of HF-HRV (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996).

The main tasks in the current study involved speaking, an activity associated with increased cardiovascular activity relative to baseline (e.g., Girdler *et al.*, 1990). However, given that HR and RSA measures obtained during the quarrelsome condition were compared to those obtained during the agreeable condition, and both conditions required speaking for a similar length of time, findings could not be attributed simply to the act of speaking.

Smoking status and fitness level were not ascertained. However, research indicates that better health habits are associated with higher RSA (Ramaekers *et al.* 1998). While smoking appears particularly relevant to LF-HRV (Ramaekers *et al.*, 1998), even mild differences in level of exercise (Molgaard *et al.*, 1994; Ramaekers *et al.*, 1998) or aerobic capacity (Rossy and Thayer, 1998) can affect HR and HRV (low and HF domains). If body mass index is taken as an indication of fitness, we might suspect men were less fit than women in our study. However, controlling for BMI did not alter our results. It is worth noting that our participants had a much lower BMI compared to subjects in Dishman *et al.* (2000) study on *physically* fit men and women (21.5 vs. 24 g/m^2), suggesting good health habits in our group. Further, we would expect the influences of smoking or fitness level to appear during the quarrelsome as well as the agreeable condition, baseline or relaxation phases. Since this was not the case, it is unlikely that differences in smoking status or fitness could explain our results.

Research suggests that it takes time to recover from harassing interpersonal situations, and that individuals who characteristically express their anger outwardly exhibit elevated HR and BP well into recovery. Continued elevations in BP during recovery have been reported in men who were harassed compared to those who were not (Engebretson *et al.*, 1989) and in more hostile women (Gallo *et al.*, 2000). It is conceivable that support for greater CVR in less communal individuals could have been observed during the recovery period had it been included. While the omission of these measures in our study is not a limitation per se, it would appear as a promising avenue for future studies.

CONCLUSION

In the present study, men exhibited enhanced RSA reactivity when behaving in a quarrelsome manner compared to women. To the extent that

stress-related cardiovascular responses play a role in the etiology of heart disease, sex-related differences in reactivity to interpersonal stress may be one determinant of sex-related differences in CAD morbidity among younger individuals. Weaker vagal control during arousing social situations in men, particularly less agreeable, more quarrelsome men may further contribute to their higher CAD risk.

Considering that the effect sizes for hostility are "equal to or greater in magnitude to those reported for the traditional risk factors for CAD" (e.g., smoking, BP; Miller *et al.*, 1996), continued research is clearly indicated.

ACKNOWLEDGMENTS

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