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Defensive Hostility: Relationship to Multiple Markers of Cardiac Ischemia in Patients With Coronary Disease

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Three studies assessed whether the combined traits of hostility and defensiveness identify a group of hostile individuals with functionally severe coronary artery disease (CAD). CAD patients completed the Cook-Medley Hostility Inventory (Ho) and the Marlowe-Crowne Social Desirability Scale (MC). Patients were classified into 4 groups: defensive hostile (DH: high Ho, high MC), low hostile (LH: low Ho, low MC), high hostile (HH: high Ho, low MC), and defensive (Def: low Ho, high MC). DH in comparison to HH, LH, and Def CAD patients demonstrate the greatest perfusion defects as measured by exercise thallium scintigraphy; DH patients exhibit the most frequent ischemic episodes during ambulatory electrocardiographic monitoring; and in a laboratory study, DH patients exhibit the most severe mental stress-induced ischemia assessed by echocardiography. Thus, the combination of high hostility and high defensiveness are associated with more functionally severe CAD and may predispose CAD patients to a more adverse prognosis.

Key words: hostility, defensiveness, ischemia, coronary artery disease

Previous research suggests that the psychological trait of hostility may be a risk factor for the development of coronary artery disease (CAD) in initially healthy populations (Barefoot, Dahlstrom, & Williams, 1983; Matthews, Glass, Rosenman, & Bortner, 1977). In addition, in patients with established coronary disease, hostility appears to predict recurrent cardiac events such as myocardial infarction or cardiac death (Koskenvuo et al., 1988; Powell & Thoresen, 1985) and severity of myocardial ischemia (Burg, Jain, Soufer, Kerns, & Zaret, 1993; Helmers, Krantz et al., 1993). However, several studies have failed to observe significant associations between hostility and CAD morbidity and mortality (Hearn, Murray, & Luepker, 1989; Leon, Finn, & Bailey, 1987; McCranie, Watkins, Brandsma, & Sisson, 1986). Methodological limitations may explain some inconsistencies in relationships between hostility and CAD (see Helmers, Posluszny, & Krantz, 1993; Smith, 1992). For example, in McCranie et al.'s (1986) study, the Cook-Medley Hostility Inventory (Ho) was administered during an admission interview for medical school, a time when observed hostility scores may have been biased. In addition, a subset of the Ho items, the Composite Hostility (Chost) score, has been found to be a better predictor of mortality (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989), of myocardial ischemia (Helmers, Krantz et al., 1993), and of cardiovascular responses compared with the total hostility score (Suarez & Williams, 1989). The Chost score consists of three content-derived subscales entitled Hostile Affect, Cynicism, and Aggres-

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sive Responding (Barefoot et al., 1989). Thus, evidence suggests that the Chost score may be more sensitive to detecting associations between hostility and coronary disease than the full-scale score.

Another explanation for the lack of consistent associations between cynical hostility and coronary disease is that only a subset of cynical–hostile individuals may be at increased risk for CAD. Patients who lack an awareness of or deny emotional feelings have been suggested to be at risk of poor prognosis (Kneip et al., 1993; Parsons, Fulgenzi, & Edelberg, 1969; Weinberger, Schwartz, & Davidson, 1979). In this regard, the psychodynamic literature suggests that repressed hostility, the unconscious denial of hostility, predisposes to cardiovascular disorder (Menninger & Menninger, 1936), and repression is commonly observed among coronary disease patients (see Jenkins, 1971). Based on this research, we hypothesized that a measure of repressed hostility incorporating the Ho would identify CAD patients with the most severe disease. In the first of three studies, we operationalized repressed hostility on the basis of a model used by Weinberger et al. (1979) to assess repression of anxiety. Specifically, the combination of cynical hostility (measured by the Ho) and defensiveness (measured by the Marlowe–Crowne Social Desirability Scale, MC) are used to create four groups of patients: low hostile (LH: low Ho, low MC), defensive (Def: low Ho, High MC), high hostile (HH: high Ho, low MC), and defensive hostile (DH: high Ho, high MC). Defensiveness is defined as the tendency to deny socially undesirable characteristics of oneself (Crowne & Marlowe, 1964), and the MC Scale contains items related to conscious and unconscious deception of self and others (Paulhus, 1984). It was expected that repressed hostile individuals, characterized by low Ho and high MC scores (named Def), would demonstrate the most severe ischemia in comparison to other individuals.

The present report consists of three studies examining the relationship between the combined traits of hostility and defensiveness to measures of myocardial ischemia in patients with coronary disease. Myocardial ischemia, a functional measure of CAD severity, is defined as an inadequate imbalance between myocardial oxygen supply and demand. Extent and severity of ischemia are important markers of the clinical activity of CAD and a predictor of CAD morbidity and mortality (Ladenheim et al., 1986).

Study 1 consists of a further analysis of data from a prior study, in which a significant association between hostility and myocardial ischemia was demonstrated among women and middle-aged men (Helmers, Krantz et al., 1993). Unexpectedly, hostility was not related to myocardial ischemia in the total sample of men in this data set. Therefore, in Study 1, we assessed whether repressed hostile patients (low Ho and high MC, Def group) would demonstrate the strongest positive associations with myocardial ischemia in this sample. In Studies 2 and 3, we examined ambulant ischemia during daily life and mental stress-induced ischemia during a laboratory session in relation to hostility and defensiveness.

Study 1

Method

Patient population. A detailed description of this sample and methods of data collection have been published elsewhere (Helmers, Krantz et al., 1993). Briefly, patients were recruited consecutively from individuals referred for clinical evaluation of CAD through thallium stress testing at Cedars–Sinai Medical Center in Los Angeles. Seventy-eight patients (61 men and 17 women) with either documented CAD (myocardial infarct, angiographic evidence of CAD) and/or a high probability of CAD as indicated by a Bayesian probability of CAD greater than 80% postexercise treadmill testing (Diamond & Forrester, 1979; Diamond, Forrester, & Hirsch, 1980) comprised the study sample. All patients were instructed to withhold beta-blocking medication for 48 hr, calcium channel blockers for 24 hr, and long-acting nitrates for 6 hr before testing. The mean age for the 61 male patients was 63.0 ± 9.0 years, and for the 17 female patients the mean age was 64.1 ± 9.9 years.

Questionnaires. Participants completed the Cook–Medley Hostility Inventory (Ho; Cook & Medley, 1954) and the Marlowe–Crowne Social Desirability Scale (MC; Crowne & Marlowe, 1964). The Ho contains 50 true–false items with test–retest reliability of .84 over 4 years (Barefoot et al., 1983). Chost score was computed according to Barefoot et al.'s (1989) criteria.

The MC Scale contains 33 true–false items, with test–retest reliability of .86 or greater over a 1-month period and a Cronbach's alpha of .70 or greater (Crino, Svoboda, Rubenfeld, & White, 1983; Crowne & Marlowe, 1964). Examples of items are "I am always courteous, even to people who are disagreeable," "I have never intensely disliked someone," and "I sometimes think when people have a misfortune they only got what they deserved." Thus, the questionnaire contains items that reflect socially desirable behaviors or cognitions. Studies have demonstrated that individuals with high scores in comparison to low scores are more likely to change their attitudes in response to social pressures, to cheat following a poor score on a test, and to express less aggression (Crowne & Marlowe, 1964; Millham, 1974). Therefore, it is believed that individuals with high MC scores are defensive because they may report inaccurately on other questionnaires and are concerned with a positive self-representation (Crowne & Marlowe, 1964; Paulhus, 1984; Weinberger et al., 1979). Defensiveness as measured by the MC appears to be a stable individual difference that is characterized by the conscious and unconscious tendency not to report socially undesirable aspects of oneself (Crowne & Marlowe, 1964; McCrae & Costa, 1983; Paulhus, 1984).

Thallium exercise scintigraphy. A maximal symptom-limited exercise treadmill test was performed using a standard Bruce protocol. At near-maximal exercise, 3–4 mCi of thallium-201 was injected with tomographic imaging protocol performed using the Cedars–Sinai Medical Center protocol (Kiat et al., 1988; Maddahi et al., 1989). Tomographic imaging was repeated 4 hr later to determine if exercise-induced defects had reversed; reversible defects reflected transient ischemia. Late (24–48 hr) redistribution tomographic imaging was performed if a stress defect was persistent at 4 hr. Poststress and 24-hr thallium-201 myocardial tomograms were divided into 20 segments for each patient. A 4-point scoring system was used to assess each segment, with 0 = *normal*, 1 = *mild*, 2 = *moderate*, and 3 = *severe* decrease in regional thallium-201 uptake. An initial poststress perfusion defect was considered present when a myocardial segment had an initial poststress score greater than or equal to 2. Stress defects with a score less than or equal to 1 at 24-hr redistribution imaging were deemed "reversible." A thallium test result was considered ischemic if

Table 1
Exercise and Demographic Data for Study 1: Patients Who Underwent Thallium Exercise Scintigraphy

Measure	Low hostile	Defensive	High hostile	Defensive hostile
Exercise test				
Peak HR	140.6 ± 18.8	138.0 ± 17.8	143.8 ± 15.5	140.6 ± 19.0
Peak SBP	180.0 ± 20.0	185.6 ± 27.0	179.1 ± 32.2	169.9 ± 32.3
Peak DBP	83.1 ± 10.1	82.6 ± 11.3	82.9 ± 11.4	87.4 ± 15.4
Maximum ST depression	2.3 ± 0.8	2.6 ± 0.9	2.2 ± 1.0	2.5 ± 1.1
Duration (min)	5.5 ± 2.1	5.5 ± 2.7	5.1 ± 2.6	4.0 ± 2.7
Prior MI				
Yes	9	6	8	8
No	10	12	13	12
High blood pressure				
Yes	9	9	8	12
No	9	8	10	7
High cholesterol				
Yes	12	9	11	5
No	7	9	7	11
Smoking				
Yes	1	2	2	1
No	18	16	19	19
Family history				
Yes	4	6	10	10
No	13	12	10	10

Note. Categories for high blood pressure, high cholesterol, and family history have missing data. HR = heart rate; SBP = systolic blood pressure; DBP = diastolic blood pressure; MI = myocardial infarct.

2 or more of the 20 myocardial segments showed evidence of reversibility. To assess the extent of inducible ischemia, we calculated the number of reversible thallium segments (NRTS) among the 20 myocardial segments that were analyzed per patient. NRTS provides an index of the extent of CAD (Prigent et al., 1985).

Statistical analyses. The NRTS was analyzed by a two-step model of multiple regression analysis. The first step entered gender, Chost, and MC. The second step entered the Chost × MC interaction, and the increment in variance was evaluated for significance. Categorical variables of the standard risk factors were analyzed by chi-square analyses for the four groups (LH, Def, HH, and DH).

Results and Discussion

Evaluation of standard risk factors, exercise variables, and gender. To evaluate potentially confounding factors, the combination of Chost and Defensiveness and standard risk factors were analyzed by chi-square analyses. The four groups (LH, Def, HH, and DH) were defined by median splits on Chost and MC scores. Because men reported marginally greater Chost scores than women, $F(1, 76) = 3.2, p < .08$, Chost scores greater than or equal to 11 in men and 9 in women were used to define the high Chost groups, and a score lower than 11 and 9 comprised the low Chost group in men and women, respectively. An MC score greater than or equal to 19 was classified as high Defensiveness and less than 19 as low Defensiveness in both men and women. No significant between-groups differences were demonstrated for the presence or absence of hypertension, high cholesterol, smoking, and family history of CAD. Table 1 provides the frequency of the standard risk factors for each of the four groups. There were no significant group differences for the presence or absence of a prior myocardial infarction. Men were on average 63.0 ± 9.0 years of age, and women were 64.1 ± 9.9 years. For men, the mean scores plus or minus standard deviations for the questionnaires were Ho: 17.2 ± 5.9; Chost: 11.6 ± 4.0; and MC: 18.0 ± 5.5. Mean scores (plus or minus standard deviations) for women were Ho: 14.6 ± 8.7; Chost: 9.5 ± 5.5; and MC: 19.0 ± 4.1.

Exercise test physiologic parameters may also potentially confound the association between thallium defects and the combination of Defensiveness and Chost. Multiple regression analyses in which gender, Chost, MC, and the Chost × MC interaction were conducted. Results revealed a significant negative association between Chost and duration of exercise, $F(1, 65) = 1.9, p < .03$. There were no significant interactions between Chost and MC for peak heart rate, systolic blood pressure, diastolic blood pressure, maximum ST depression during exercise, and duration (in minutes) of exercise. Gender significantly predicted 6.9% of the variance in NRTS, $F(1, 76) = 5.7, p < .05$, and men exhibited a greater magnitude of thallium defects in comparison to women.

Exercise thallium ischemia. We used a two-step regression model to evaluate whether repression of hostility was related to thallium exercise ischemia. The first step simultaneously entered gender, Chost, and MC. The second step evaluated whether the Chost × MC interaction added significant variance to the first step (see Table 2). The combination of gender, Chost, and MC predicted 13.3% of NRTS's variance, $F(3, 74) = 3.8, p < .02$. The Chost × MC interaction significantly added 7.3% variance, $F(1, 73) = 6.7, p = .012$.[1] Inspection of the means derived from median splits on both Chost and MC revealed that DH patients in comparison to Def, LH, and HH

[1] Results using full-scale hostility scores were similar to Chost in all analyses but were associated with smaller increments of variance. For example, the Full-Scale Ho × MC interaction marginally added 4.3% variance, $F(1, 73) = 3.8, p < .06$, to the first step in the regression model for thallium exercise ischemia.

Table 2
Increments in Variance Obtained for Independent Variables in Exercise Thallium Ischemia (Study 1) and Ambulatory ECG (Study 2)

	No. of reversible thallium segments (3.68 ± 3.1)		Total minutes of ischemia/24 hr (24.6 ± 25.7)		Frequency of ischemic episodes/24 hr (2.6 ± 2.3)		Maximum ST depression (2.3 ± 0.8)	
Men and women	R^2	*p*	R^2	*p*	R^2	*p*	R^2	*p*
Gender	.070	.02	.013	*ns*	.042	*ns*	.077	.09
Composite hostility	.055	.04	.121	.03	.093	.06	.072	.09
Defensiveness	.008	*ns*	.022	*ns*	.013	*ns*	.010	*ns*
Chost × MC	.073	.01	.105	.04	.108	.04	.001	*ns*
Total R^2	.162	.01	.262	.03	.256	.04	.159	*ns*

Note. Numbers in parentheses are means plus or minus standard deviations. ECG = electrocardiogram; Chost = Composite Hostility score; MC = Marlowe–Crowne Social Desirability Scale.

patients exhibited the most severe thallium exercise ischemia (see Figure 1).

In our prior study (Helmers, Krantz et al., 1993), when all men were analyzed, Chost did not predict significant variance in thallium exercise ischemia. In the present reanalyses of the total male sample (N = 61), the main effects for Chost and MC also do not predict significant variance in NRTS. However, the Chost × MC interaction marginally added 5.7% of the variance in NRTS, $F(1, 56) = 3.8, p < .06$. Inspection of the means (Figure 2) indicated that the DH male CAD patients in comparison to LH, HH, and Def male CAD patients exhibited the greatest exercise thallium ischemia. There were too few women to allow for a reanalysis of the data for women only.

Discussion

Results of this study reveal that DH CAD patients demonstrated the greatest magnitude of thallium perfusion defects when compared with the three other groups. These results were contrary to initial expectations of the greatest disease in repressed hostile patients and were demonstrated in the total sample, including both men and women and in the subsample of men only. Furthermore, these results were found despite a negative association between Chost and exercise duration. This negative association strengthens the findings that DH CAD patients demonstrate the most severe ischemia despite a shorter duration of exercise.

Data from Study 1 suggest that defensive hostility, the combination of high scores on both the Ho and the MC Scale, is associated with more functionally severe disease in CAD patients. Study 2 sought to replicate this finding by using a measure of cardiac ischemia during daily life.

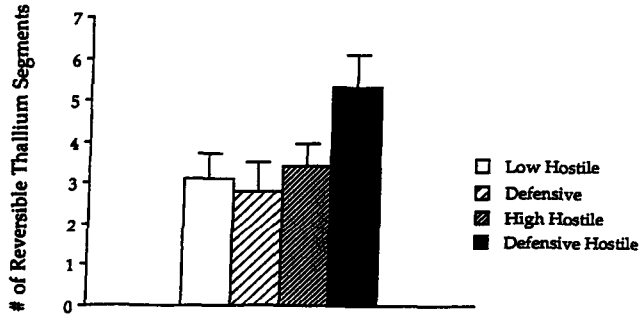

Figure 1. Relationship of defensive hostility and extent of thallium exercise ischemia in 79 coronary artery disease patients in Study 1.

Study 2

Method

Patient population. Patients included in this study (31 men and 8 women) had either documented CAD (myocardial infarct, angiographic evidence of CAD) and/or a high probability of CAD according to criteria used in Study 1. Patients were recruited from two sources. Thirty-three patients were derived from the exercise thallium study (see above) and 6 from other sources at Cedars–Sinai Medical Center. Participants completed the Ho and the MC Scale (see *Questionnaires* section above). The mean age for men was 62.7 ± 8.6 years, and for women was 67.7 ± 8.9 years. In men, the mean scores for Ho, Chost, and MC were 16.6 ± 8.9, 11.2 ± 4.2, and 18.0 ± 4.7, respectively. In women, the mean scores were 14.1 ± 9.7, 9.6 ± 5.5, and 20.6 ± 5.5 for Ho, Chost, and MC, respectively.

Ambulatory electrocardiogram (Holter) monitoring. Patients included in this sample displayed evidence of daily life ischemia during ambulatory electrocardiogram (ECG) monitoring. All patients were instructed to withhold beta-blocking medication for 48 hr, calcium channel-blocking agents for 24 hr, and long-acting nitrates for 6 hr before testing. Twenty-three patients underwent 24 hr and 16 patients underwent 48 hr of ECG monitoring. A Cardiodata AM recorder (frequency response of 0.05–100 Hz) was used, calibrated at 1 mv = 10 mm. Two sets of bipolar leads were attached to the exploring electrodes attached to V_5 and a modified inferior position.

Calibrated 24-hr tapes were visually analyzed by an experienced

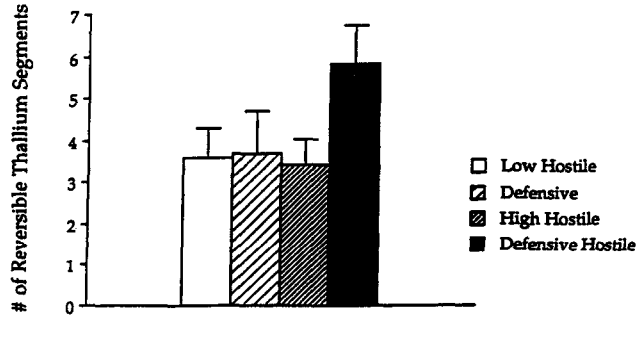

Figure 2. Relationship of defensive hostility and extent of thallium exercise ischemia in 62 male coronary artery disease patients in Study 1.

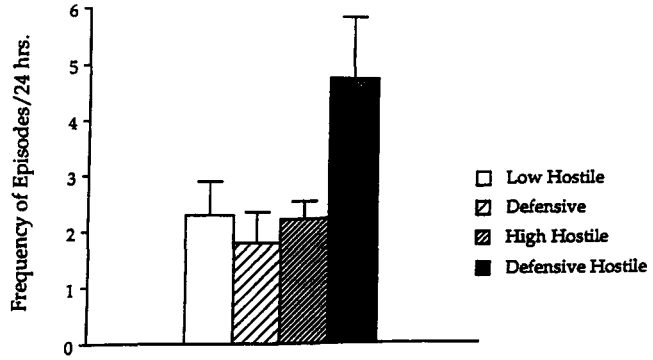

Figure 3. Relationship of defensive hostility and frequency of ischemic episodes per 24 hr of ambulatory electrocardiogram monitoring in 39 coronary artery disease patients included in Study 2.

technician at 60 times real time using a Cardiodata MK4 computer. An ambulatory ECG response was considered ischemic if horizontal or downsloping ST segment depression greater than or equal to 1 mm or upsloping ST depression greater than or equal to 1.5 mm occurred, measured at 0.08 s after the J point and persisting for at least 60 s. Separation of one episode from the next required that the ECG return to baseline for at least 3 min after the previous episode. Holter data for each ischemic episode was read blindly by two physicians (Jacob Klein and Alan Rozanski), with disagreements settled by consensus. For each episode, the magnitude and duration of ST segment depression was assessed.

Statistical analyses. Three dependent variables for ambulant ischemia were assessed: total minutes of ischemia corrected for duration of monitoring, frequency of ischemic episodes corrected for duration of monitoring, and maximum ST depression (in millimeters) obtained during the monitoring period. These dependent variables were analyzed by three separate multiple regression analyses in which gender, Chost, and MC were added simultaneously as the first step. The second step evaluated whether the Chost × MC interaction added significant variance to the first step of the model.

Results and Discussion

The combination of gender, Chost, and MC predicted 15.7% of the variance in total minutes of ischemia, $F(3, 35) = 2.29$, $p = .11$, 14.8% of the variance for frequency of ischemic episodes, $F(3, 35) = 2.0, p = .13$, and 15.8% of maximum ST depression's variance, $F(3, 35) = 2.2, p = .11$. The Chost × MC interaction significantly added 10.5% of the variance to total minutes of ischemia, $F(1, 34) = 4.8, p < .05$, and added 10.8% to the variance of frequency of ischemic episodes, $F(1, 34) = 5.0, p < .05$. The Chost × MC interaction did not add significant variance to maximum ST depression, $F(1, 34) = 0.04, p = .82$.

Similar to results of Study 1, inspection of the means derived from median splits on Chost and MC revealed that DH patients in comparison to LH, HH, and Def patients demonstrated the most frequent and longest duration of ischemic episodes (see Figures 3 and 4, respectively). Once again, DH CAD patients exhibited the greatest ischemia, as measured by total minutes of ischemia and frequency of ischemic episodes, *in comparison to LH, Def, and HH CAD patients.*

Study 3

Previous laboratory studies have demonstrated that mental stressors can induce myocardial ischemia in CAD patients (Giubbini et al., 1991; Rozanski et al., 1988; Specchia et al., 1991). Recently, Burg et al. (1993) observed that hostile patients were those most likely to exhibit mental stress-induced ischemia. In Study 3, we evaluated male CAD patients who participated in a laboratory study of triggers of mental stress-induced ischemia. Based on the results found in Studies 1 and 2, we predict that DH men demonstrate the most severe myocardial ischemia in response to standardized psychological stress tasks.

Method

Patient population. Thirty men (58.0 ± 8.9 years of age) with CAD defined according to criteria used in Studies 1 and 2 were recruited for a laboratory study on stress and myocardial ischemia at the Cardiology Division of the University of Maryland at Baltimore. Before the lab session, CAD patients were tapered off of anti-ischemic medications while under a physician's supervision: beta blockers were withheld for 48 hr before testing, calcium channel blockers for 24 hr, and any long-acting nitrates the day of testing. Mean scores for Ho, Chost, and MC were as follows: 21.0 ± 7.0, 13.2 ± 4.4, and 16.7 ± 5.9, respectively.

Procedures. After informed consent was obtained, patients were positioned in a semireclining position and a 12-lead ECG was attached. The measurement of myocardial ischemia was performed by echocardiography. Echocardiography permits instantaneous real-time assessment of transient wall motion abnormalities, a sensitive marker of myocardial ischemia, during mental stress. Measures of left ventricular wall motion at rest and during stress were obtained through echocardiographic monitoring during baseline and mental stressors (see *Echocardiography* section below). Testing for all patients began at 12 noon. An initial resting baseline of 30 min was obtained, during which the patients was asked to rest quietly. During the last 5 min of baseline, a resting echocardiograph was obtained. Between the two mental stressors, there was a second rest phase lasting 30 min. At the end of the testing session, patients were debriefed and sent home with a battery of questionnaires to complete, including the Ho and the MC Scale.

Mental stressors. Two mental stressors, a math and a speech task, were administered in randomized order. The mental arithmetic task consisted of serial subtraction of 7s from 4-digit numbers, while the

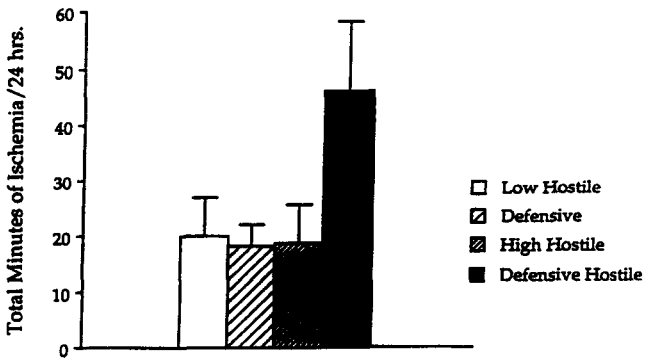

Figure 4. Relationship of defensive hostility and total minutes of ischemia during 24 hr of ambulatory electrocardiogram monitoring in 39 coronary artery disease patients included in Study 2.

experimenter harrassed the patient by telling him or her to speed up and to be more accurate. In the public speaking task, the patient was instructed to speak in front of several experimenters about personal faults or habits that they disliked about themselves (Rozanski et al., 1988). This task was intended to be personally relevant and emotionally arousing. Each task lasted for 5 min, and echocardiographic images were obtained at 30 s, 2 min 15 s, and 4 min 15 s into each task.

Echocardiography. Regional wall motion, a sensitive measure of the severity of ischemia, was assessed through two-dimensional echocardiography recorded at rest and during each stressor. Studies were performed with a commercially available phased-array ultrasonograph (Hewlett Packard 77020C). Care was taken to ensure orthogonal images of the heart as available from parasternal and apical echocardiographic windows. Images were digitized off-line using a commercial image analysis system (Microsonics Datavue II). Each of 16 segments that were potentially suitable for evaluation was scored blindly by an experienced observer (John S. Gottdiener). A score of 1 was assigned for normal motion, 2 for hypokinesis (defined as less than 5 mm inward endocardial excursion), 3 for akinesis, and 4 for dyskinesis. The segment scores were summed and divided by the number of evaluable segments to obtain a mean wall motion score for each intervention. The presence of new wall motion abnormality was determined by worsened wall motion in two or more segments. The reliability for evaluation of regional wall motion was previously established, with coefficients of correlation for intraobserver and interobserver variability of .81 and .84, respectively. A change in wall motion greater than .14 (the 95% confidence interval for interrater reliability) was considered a significant change in wall motion score.

Statistical analyses. Data were analyzed by 2 × 2 × 2 repeated measures analyses of variance (ANOVA) with high–low Chost and high–low MC as between-subjects variables. The repeated measures were wall motion change scores (stressor minus baseline wall motion score) for math and speech. The median scores for Chost and Defensiveness were used to classify patients into the four groups. Patients with Chost scores greater than or equal to 14 comprised the high Chost group and less than 14 were classified as low Chost. High Defensiveness was defined as an MC score greater than or equal to 17 and low as less than 17.

Results

Results revealed no significant task and order of task effects for the repeated measures ANOVA evaluating wall motion change scores during math and speech, suggesting that both tasks were equally stressful in inducing wall motion abnormalities in CAD patients. A significant Chost × MC interaction occurred, $F(1, 26) = 6.7$, $p < .02$, revealing that DH in comparison to LH, HH, and Def CAD patients demonstrated the greatest change in wall motion scores during math and speech, though Duncan post hoc comparisons were not significant. No significant main effects were demonstrated for Chost and Defensiveness. Figure 5 presents mean wall motion scores for the four groups during baseline and stressors. Similar to results of Studies 1 and 2, DH in comparison to HH, Def, and LH patients exhibited the greatest change in wall motion scores, especially during speech.

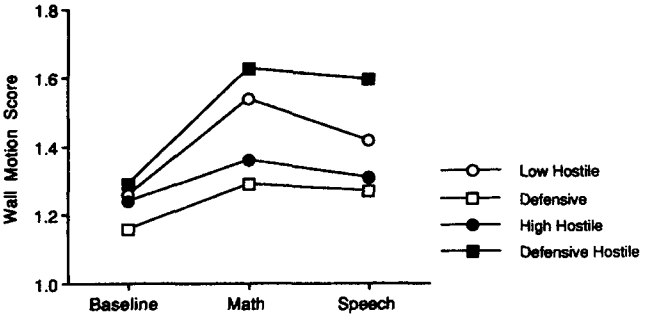

Figure 5. Left ventricular wall motion scores during baseline and mental stressors in 30 male coronary artery disease patients included in Study 3.

General Discussion

In three studies, several different methodologies were used to evaluate the relationship between the combined traits of hostility and defensiveness to myocardial ischemia in patients with established CAD. In two independent samples, DH patients, compared with LH, HH, and Def coronary patients exhibited the most functionally severe CAD. Specifically, in Study 1, the association between defensive hostility and myocardial ischemia was observed in a study on thallium perfusion defects during exercise testing. In an overlapping patient population in Study 2, DH patients exhibited the greatest duration and most frequent episodes of ambulant ischemia during daily life activities. These findings were further replicated in Study 3, a controlled laboratory study, during which DH male CAD patients exhibited the most severe ischemia in response to two mental stressors.

Previous research has shown that hostility is predictive of the development of CAD in initially healthy populations (Barefoot et al., 1989; Matthews et al., 1977) and of recurrent cardiac events in patients with established CAD (Koskenvuo et al., 1988; Powell & Thoresen, 1985). Similarly, prior studies demonstrated positive relationships between hostility and myocardial ischemia in coronary patients (Burg et al., 1993; Helmers, Krantz et al., 1993). In the Helmers et al. study, the hostility–ischemia relationship was significant in women and middle-aged men (below 60 years of age), but no significant relationship was demonstrated between hostility and ischemia among the whole group of male CAD patients. The present analyses clarify these previous results by demonstrating that in the total sample of CAD patients, as well as in all male CAD patients, the Chost × MC interaction significantly adds to the variance obtained for the main effects of CHost and MC in predicting myocardial ischemia. Thus, the unique interaction between Composite Hostility and Defensiveness identifies a subgroup of hostile patients, DH, who demonstrates greater associations with ischemia than LH, HH, and Def patients.

The present results are similar to those obtained in recent studies examining cardiovascular reactivity in healthy male populations (Helmers & Krantz, 1994; Jamner, Shapiro, Goldstein, & Hug, 1991). Jamner and colleagues (1991) evaluated 33 healthy male paramedics in a field study using ambulatory blood pressures. Results revealed that DH paramedics demonstrated greater heart rate responses than LH, HH, and Def paramedics, under certain conditions of stress. In a laboratory study, DH men in comparison to other men exhibited the greatest systolic and diastolic blood pressures during baseline and two mental stressors (Helmers & Krantz, 1994). Thus, DH men appear to exhibit greater cardiovascular responses in

comparison to other men in both a field and a laboratory study. Research has demonstrated that greater cardiovascular responses to stress are associated with more severe ischemia (Krantz et al., 1991). Thus, it is possible that the severe myocardial ischemia exhibited by DH coronary patients may be mediated through greater cardiovascular responses to stress.

Contrary to our original thinking, repressed hostility, as operationalized by low Chost and high MC scores, did not exhibit an association with myocardial ischemia. The repressed hostile (or Def) patients demonstrated ischemic responses similar to LH and HH patients. McCrae and Costa (1983) suggested that it is those individuals who are "highly conscientious, well-adjusted, and cooperative" who would score high on the MC Scale, and similarly Def individuals with low Chost and high MC scores may reflect well-adjusted, calm, and friendly individuals rather than repressors of hostility.

The question remains as to the psychological meaning of defensive hostility and how it may be linked to severity of disease in CAD patients. The DH individual is one who endorses socially desirable ways of behaving, which suggests a need to be viewed in a positive manner by others. In addition, their high hostility scores suggest a cynical and distrusting view of the world (Barefoot et al., 1989; Williams et al., 1980). These two views may be in opposition to one another and may result in greater ambivalence of emotions and experience of conflict, as anger and hostility are generally not viewed as a socially acceptable way of responding (Helmers, 1993; Jamner et al., 1991). In contrast, the HH individual also views the world in a cynical and hostile manner but is not restricted by the need to behave in a socially desirable manner. This may suggest that the suppression of negative emotion may be detrimental to the health of coronary patients. Some support for the latter suggestion was demonstrated in a recent study on the psychosocial correlates of defensive hostility (Helmers, 1993). DH men, when compared with Def, LH, and HH men, reported greater suppression of anger and possibly greater ambivalence over emotional expression. Furthermore, in a study on patients referred for diagnostic coronary angiography, HH patients who reported the greatest suppression of anger evidenced the greatest number of obstructed vessels (Dembroski, MacDougall, Williams, Haney, & Blumenthal, 1985), though results are not always consistent (MacDougall, Dembroski, Dimsdale, & Hackett, 1985). Thus, myocardial ischemia may be associated with the suppression of emotions, such as anger and anxiety, in DH individuals.

The present results may provide an explanation for previous nonsignificant associations between hostility and CAD development (Hearn et al., 1989; Leon et al., 1987; McCranie et al., 1986). It may be that a small subset of hostile participants, who also score high on defensiveness, are vulnerable to the development of coronary disease. Thus, it is possible that no main effects for hostility may be found, but significant interactions between hostility and defensiveness may identify a group of men prone to the development of coronary disease. This would be similar to our current findings with men in Study 1, in that there were no main effects for hostility, but there were significant Hostility × Defensiveness interactions for exercise *thallium ischemia. Nevertheless, factors that are associated* with triggers of ischemia in patients with known CAD may be different from factors that are associated with development of CAD. A prospective study is needed on defensive hostility and the development of CAD.

In summary, the Chost × Def interaction is significantly associated with myocardial ischemia. DH patients exhibited more severe ischemia as measured by echocardiographic wall motion scores during a laboratory study, reversible thallium myocardial perfusion defects during a standard exercise treadmill test, and total minutes of ischemia and frequency of ischemic episodes during activities of daily life. These results were also demonstrated in the subsample of male CAD patients in that DH men in comparison to other men evidenced greater ischemia. Because myocardial ischemia is a potent predictor of outcome in patients with CAD, any information that improves prognostic efficacy will be important clinically. Thus, our results may be of potential importance in the risk assessment of coronary disease patients, but a prospective study is needed to determine this possibility.

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