mality that either worsened with stress or the extent of wall motion abnormality increased.

Angiographic findings are summarized in Table I. In 4 patients who had not undergone coronary artery bypass surgery, the native vessels showed severe 1-vessel or multivessel proximal coronary artery disease. In the 3 patients who had undergone bypass surgery, there was either total occlusion or severe narrowing of the grafted vessel supplying the area coinciding with the electrocardiogram ST elevation.

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The significance of ST-segment elevation in exercise testing is extensively reported. However, ST-segment elevation during high-dose dobutamine (50 μg/kg/min) and atropine (up to a total dose of 2.0 mg) is less well reported. No mention is made specifically about the incidence of ST-segment elevation–induced arrhythmias in the patient population studied or the use of it as an end point for test termination in any of the large reported studies.

Our results are consistent with the few prior observations seen in the dobutamine atropine stress echocardiographic studies: significant arrhythmias with dobutamine atropine stress echocardiography is unusual, although most of the older studies used lower doses (30 to 40 μg/kg/min) of dobutamine. In addition, angiographic data are not available in all studies.

The prevalence of ST-segment elevation in our series was 6%. Chahine et al[7] reported on 840 veterans and found a 4% prevalence of exercise-induced ST elevation. No patient had a prior myocardial infarction, and he measured ST elevation in leads V_5 and V_6 with the criteria for abnormal elevation being 1 mm of ST elevation. Bruce and Fisher[8] examined 1,136 patients with coronary artery disease but no prior myocardial infarction in a community practice setting and found a 5% prevalence, when the criteria for abnormality was any elevation over baseline. Follow-up of these patients revealed an annual incidence of coronary artery disease events of 8.2%/year compared with 4.1%/year in patients who had ST depression during exercise and persisting in recovery.

Our findings show that similar to exercise testing, ST-segment elevation during dobutamine stress indicates localizing transmural myocardial ischemia when the baseline electrocardiogram has no diagnostic Q waves.

In the present series, ST elevation during dobutamine stress was not associated with serious ventricular arrhythmias despite the fact that dobutamine infusion itself is arrhythmogenic at higher doses.[1]

In conclusion, our experience suggests that ST-segment elevation during dobutamine stress has significance similar to that during exercise stress testing. There appears to be no increased risk of arrhythmogenicity, even with the addition of atropine.

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Blood Pressure Responses to Mental Stress in Emotionally Defensive Patients With Stable Coronary Artery Disease

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Blood pressure (BP) surges, evoked by physical and mental activation, appear to serve as triggers of sudden cardiac death, myocardial infarction, and other cardiac events.[1–4] Mental stressors are known to elicit sudden, large increases in BP, coronary constriction, and total peripheral resistance in healthy and clinical cardiovascular populations.[5–7] Furthermore, large BP responses to mental stress predict subsequent adverse cardiovascular events among coronary patients.[8–10] One validated psychological measure that has been correlated with exaggerated BP surges to mental stress is the Marlowe-Crowne Scale of emotional defensiveness (ED), defined as the stable tendency to deny socially undesirable characteristics of oneself.[11–13] High scorers on this scale endorse items that strongly suggest con-

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TABLE I Clinical Characteristics of Study Patients

Age (yr)	61.5 ± 1.1
Men/Women	42/3
Body mass index (kg/m^2)	27.4 ± 0.5
Clinic blood pressure (mm Hg)	127.8/78.0 ± 2.3/1.4
Clinic heart rate (beats/min)	60.8 ± 1.5
Left ventricular ejection fraction (%)	61.1 ± 1.9
History of myocardial infarction (%)	47.9

cealment of negative emotions and personal vulnerability.[11] Several investigations have reported positive associations between defensiveness and BP responses to stress*.[12–14] One large-scale meta-analysis, relating BP to various personality measures, found strongest and most consistent effects for associations between defensiveness and BP elevation.[15] No reports, however, have specifically focused on BP reactions of patients with coronary artery disease (CAD). Because sequelae of large BP surges may endanger patients with CAD, we studied ED and cardiovascular stress responses among CAD patients.

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Forty-eight patients with documented CAD (by means of coronary arteriography [22 patients] or typical angina and positive exercise stress tests [26 patients]) were studied. Exclusion criteria were congestive heart failure, malignant ventricular regurgitation, rheumatic heart disease, significant aortic stenosis or aortic valvular insufficiency, mitral valve disease, ejection fraction <30%, age >75 years, diabetes, body mass index >35 kg/m^2, absence of normal sinus rhythm, >2 previous myocardial infarcts, and daily use of class 1 and 3 antiarrhythmic agents or digitalis. Clinical characteristics of the patients are presented in Table I. All patients were maintained on their normal medication schedule during the study to provide results representative of responses of normally managed patients with CAD. There were no significant relations between ED scores and number or type of prescribed medications.

Experimental conditions were presented in the morning to seated patients in the following order: (1) a 10-minute resting baseline (baseline 1), (2) a 10-minute computerized mathematic task in which patients keyed answers to addition equations that automatically adjusted to performance level, (3) a 10-minute pretask resting baseline (baseline 2), and (4) a 7-minute standard public-speaking task in which patients prepared (4 minutes) and presented (3 minutes) a speech about an emotionally evocative situation before a video camera.[7] An experimenter was present for each task, and patients were told that their performance would be evaluated.

The Marlowe-Crowne Scale was administered after the experimental protocol. This scale includes 33 statements that are either self-descriptions generally considered desirable but untrue of almost everyone (e.g., ''I never resent being asked to return a favor.''), or are self-descriptions generally considered undesirable but true of almost everyone (e.g., ''At times I have really insisted in having my own way.''). Answer categories are true or false. Additional examples of items are provided in Table II.

TABLE II Sample Items from the Marlowe-Crowne Scale

I never hesitate to go out of my way to help someone in trouble.*
I don't find it particularly difficult to get along with loud-mouth, obnoxious people.*
I'm always willing to admit it when I make a mistake.*
I am sometimes irritated by people who ask favors of me.†
On a few occasions, I have given up on doing something because I thought too little of my ability.†
I sometimes try to get even, rather than forgive and forget.†

*A response of ''true'' yields at positive score for these items.
†A response of ''false'' yields a positive score for these items.

The electrocardiogram and Finapres beat-to-beat finger BP were continuously recorded. Finapres BP has been reported to be highly correlated with intra-arterial measures.[16,17] Digitized data were stored on computer. Sampling frequencies were 400 Hz for the electrocardiogram and 200 Hz for BP. Physiologic signals were analyzed off-line by computer using customized programs. Suspect cardiac intervals were reviewed using the original electrocardiogram signal as means of verification. Ectopic or other abnormal beats were deleted from the RR interval series and replaced by linearly interpolated values. Mean values per condition were calculated for heart rate, systolic and diastolic BP, and rate-pressure product (systolic BP × heart rate). Additionally, cardiac output and systemic total peripheral resistance change were determined by the previously validated pulse-contour analysis (BEATFAST, TNO-BMI, Amsterdam, The Netherlands)†.[18,23] Analyses of variance was performed to examine stress responses (mathematic and speech presentation) from immediately preceding baseline levels for all physiologic variables. Correlational and multiple regression analyses were used to assess associations between ED and physiologic parameters.

ED was not related to clinical variables either by correlational analyses or by comparisons of clinical variables on the basis of upper and lower tertiles of ED (left ventricular ejection fraction, body mass index, arrhythmic activity, history of myocardial infarction, amount of exercise ST-segment depression, extent of coronary occlusion, and smoking).

Mean stress responses of cardiovascular measures are presented in Table III. All measures increased from baseline to either mental stressor ($p \leq 0.001$, most ≤ 0.00001). Additionally, the speech stressor

*Previous investigations sometimes examined personality typologies using combinations of ED and either anxiety or hostility, as well as exploring independent effects of ED alone.[12–14,22] This report focuses specifically on ED.

† The pulse contour method estimates cardiac output from the finger arterial pressure waveform. The pulsatile systolic area of the waveform is integrated, and age-related correction factors adjust for characteristic impedance and arterial compliance. Total peripheral resistance is determined from cardiac output and mean BP.

TABLE III Mean Cardiovascular Baseline-to-Task Reactions for Math and Speech Stress

Measure	Mathematic Reactions (math − baseline 1)	Speech Reactions (speech − baseline 2)
Heart rate (beats/min)	6.6 ± 0.8	11.9 ± 1.1
Cardiac output (L/m)	0.4 ± 0.1	0.4 ± 0.1
Systolic pressure (mm Hg)	33.0 ± 2.3	43.5 ± 2.9
Diastolic pressure (mm Hg)	14.9 ± 1.3	20.5 ± 1.8
Pulse pressure (mm Hg)	18.0 ± 1.4	22.9 ± 2.5
Rate-pressure product (beats/min × mm Hg) × 10^3	3.0 ± 0.2	4.7 ± 0.3
Total peripheral resistance (U)	0.2 ± 0.1	0.3 ± 0.0

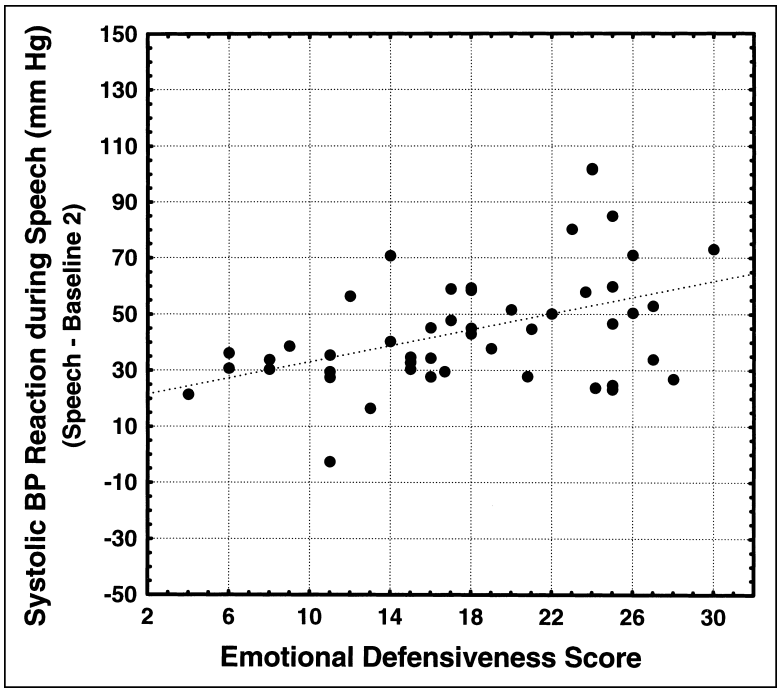

FIGURE 1. Scatter plot and line of identity for the association between emotional defensiveness, as assessed by the Marlowe-Crowne Scale, and systolic BP reactions to speech stress, r = 0.45.

elicited greater reactions for each parameter ($p \leq 0.003$), with the exception of cardiac output which did not differ between tasks.

ED was positively correlated with baseline 1 systolic BP and age of patients (both r = 0.30 to 0.35, $p < 0.05$); relations between systolic BP and ED were examined by adjusting for age and baseline levels. Controlling for these variables, ED remained similarly related to systolic reactions during mathematics (simple r = 0.46, partial r = 0.47; $p < 0.001$). Before and after adjusting for baseline pressure and age, ED was also related to systolic responses to the speech stressor. Figure 1 presents the scatter plot of the 2 variables.

ED was similarly correlated with stress reactions of diastolic BP, pulse pressure, rate-pressure product, and total peripheral resistance for each type of stress: r (mathematic) = 0.49, 0.28, 0.31, and 0.46, respectively (p = 0.0006 to 0.06); r (speech) = 0.45, 0.45, 0.32, 0.43, and 0.31 (p = 0.001 to 0.04). These correlation coefficients also remained of very similar magnitude and significance levels after adjusting for age and baseline levels for each physiologic variable.

Pressor responses from one task to the other were only modestly correlated (e.g. r = 0.25 and 0.32 for systolic and diastolic BP, respectively; p = 0.09 and 0.03). This suggests that ED was associated with a general tendency to respond to differing types of mental stress with exaggerated pressor reactions. To evaluate ED in relation to consistent BP reactions across tasks, we compared highest and lowest BP reactors defined by systolic and diastolic responses to both tasks above versus below median values (n = 12 vs 12). Results revealed large differences between groups in ED scores (see Figure 2): High reactors to both tasks demonstrated dramatically elevated ED scores compared with those with consistently low reactions to both tasks ($p < 0.00008$).

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These results indicate robust relations between ED and BP responses to stress in stable, mainly male patients with CAD. Because elevated ED was associated with increased total peripheral resistance from rest to both stress tasks, our findings point to a link between ED and stress-induced systemic vasoconstriction. A lack of association between ED and cardiac output provides further support that vasomotor responses were responsible for greater BP reactions in patients with high ED.

Recent evidence indicates that laboratory stress responses predict cardiac events among stable CAD patients.[19] Although such studies have confined themselves to specific markers of myocardial ischemia in predicting risk, stress-induced ischemia has repeatedly been associated with elevated BP responses.[7,20,21] The findings of our study point to one mechanism by which personality traits may moderate important cardiovascular responses in CAD. In our investigation, patients characterized by denial of negative feelings, an exaggerated need for approval, and a tendency to represent themselves in an unrealistically favorable light were more prone than others to manifest large vasomotor reactions to mental stress. The associations between ED and pressor reactions generalized across 2 different kinds of stress task, each with specific demands and varying

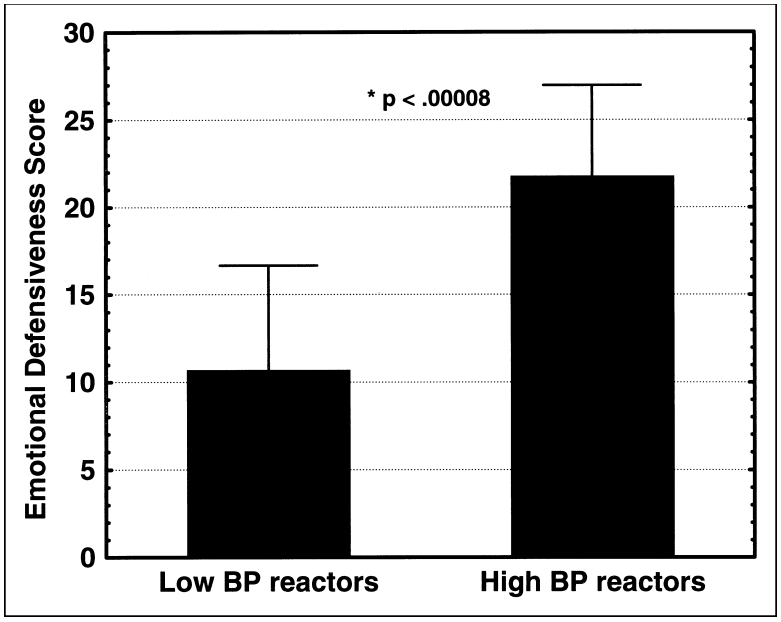

FIGURE 2. Mean emotional defensiveness (± SD) for low and high BP reactors to both tasks (n = 12 for each group). Classification of BP reactions were determined on the basis of systolic and diastolic responses to both mathematic and speech stressors. High reactors were equal to or more than median responses for both systolic and diastolic pressures for both tasks; low reactors were below median levels of all responses. Mean systolic/diastolic responses for low-reactor group = 23.0/9.5 mm Hg for mathematics and 27.3/13.7 mm Hg for speech; means for high-reactor group = 48.5/25.4 mm Hg for mathematics and 56.4/29.0 mm Hg for speech.

hemodynamic consequences. Consistent with earlier investigations among healthy subjects, defensive persons may be threatened in varying stressful circumstances by the risk of the experimenter's negative evaluation of their performance.[11] Because these extreme reactions to social situations are likely to generalize to many real-life situations, defensive coronary patients may frequently manifest exaggerated surges of BP and elevated vascular resistance during the course of everyday life.

In summary, among medicated patients with CAD, ED was substantially and consistently related to the magnitude of pressor and vasomotor reactions to 2 types of psychological stress.

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