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Harassment, Hostility, and Type A as Determinants of Cardiovascular Reactivity During Competition

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Anger/hostility and Type A behavior have been implicated in elevated cardiovascular reactivity and disease. In the present experiment systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were monitored during conditions of competition alone or in conjunction with goal blocking or harassment. Cardiovascular reactivity was examined as a function of conditions, Type A or B pattern, and various measures of anger/hostility. Harassment elicited significantly elevated SBP and HR changes relative to goal-blocking and control conditions. Type As reliably exceeded Type Bs in magnitude of SBP change during the harassment condition only. However, exploratory analyses correlating anger/hostility measures and cardiovascular reactivity indicated that only subjects scoring high on the Buss-Durkee Hostility Inventory showed significantly elevated SBP reactivity as a function of Type A behavior pattern, rated hostility during the A-B interview, or outward expression of anger assessed by the Framingham Anger-In vs Anger-Out Scale.

KEY WORDS: anger/hostility; Type A; harassment; heart rate; blood pressure.

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INTRODUCTION

Systematic studies (Barefoot *et al.,* 1983; Williams *et al.,* 1980) and clinical observations (Alexander, 1939; Arlow, 1945; Dunbar, 1943) have suggested that anger and hostility may be associated with cardiovascular disorders. Excessive cardiovascular reactivity concomitant with emotional arousal has also been suggested to be pathogenetic in cardiovascular diseases (Williams, 1975). Type A coronary-prone individuals, for example, have been reported to show more cardiovascular reactivity on challenging tasks than Type Bs (Glass *et al.,* 1980). Also hypertensives have been shown to manifest greater blood pressure (BP) increases than normotensives during emotionally engaging tasks (McKegney and Williams, 1967; Weiner *et al.,* 1962). More recently, persons having at least one hypertensive parent, which puts these offspring at increased risk, have been shown to display greater heart rate (HR) and BP reactivity on challenging behavioral tasks than do the offspring of normotensive parents (Falkner *et al.,* 1979; Manuck *et al.,* 1981; Obrist, 1981).

Pronounced cardiovascular reactivity can be elicited by situations that provoke anger and hostility (Ax, 1953; Funkenstein *et al.,* 1954; Schachter, 1957). Social psychological studies have used harassment (Ax, 1953; Schachter, 1957) or harassment plus frustration (Hokanson and Burgess, 1962) to induce anger while monitoring cardiovascular reactivity. In general, aggression studies have often confounded the effects of task frustration (disruption of goal-directed behavior) and harassment (Baker and Schaie, 1969; Green and Berkowitz, 1967; Hokanson and Shetler, 1961). In an attempt to disentangle failure, insult, and goal blocking, Geen (1968) found that blocked subjects and subjects experiencing failure counter-aggressed less than insulted subjects. Subsequently, Carver and Glass (1978) compared task frustration (working on a puzzle not solvable within a time limit) and insult in a study of aggressiveness and Type A behavior (Friedman and Rosenman, 1959). Both conditions elicited more aggressive responses in Type As relative to their aggressiveness in a control condition. Only the insult procedure increased the aggression of Type B subjects. Finally, studies have reported that insult evoked both larger diastolic blood pressure changes (Geen, 1968; Gentry, 1970) and reports of greater anger (Geen *et al.,* 1968) relative to goal-blocking and control conditions.

Type A subjects have been found to respond to situations eliciting competitiveness, time urgency, and aggression with exaggerated cardiovascular reactivity (Dembroski *et al.,* 1977, 1979; Manuck *et al.,* 1978). Isolating specific components of the global pattern A, namely, potential for hostility, impatience, and vigorous vocal stylistics, has been shown to enhance prediction of both reactivity (Dembroski *et al.,* 1978) and coronary heart disease (CHD) (Matthews *et al.,* 1977). Psychometric studies have supported an association between aggressiveness and pattern A (see Chesney *et al.,* 1981; Glass, 1977). Furthermore, epidemiological evidence has linked hostility to both CHD (Shekelle *et al.*, 1983) and essential hypertension (Kahn *et al.*, 1972).

A significant question in regard to Type A as a risk factor is what stimulus conditions elicit enhanced physiological reactivity among As. Glass *et al.* (1980) found that the addition of harassment by a confederate to a competition paradigm evoked larger BP, HR, and catecholamine increases among As than among Bs. Such results suggest that harassment as an anger induction may be uniquely related to increased reactivity among As; however, the effects of blocked goal attainment have not yet been tested in this regard.

The present study had four major objectives. First, the effects of competition alone or in conjunction with either goal blocking or harassment were compared in terms of HR and BP reactivity. Second, the HR and BP reactivities of interview-defined As vs. Bs were compared as a function of experimental condition. The As in the harassment condition were expected to manifest a greater reactivity than Bs (Glass *et al.*, 1980). In the goal-blocking situation, however, it was not clear whether frustration might increase aggressiveness but not cardiovascular reactivity (Geen, 1968) or whether frustration might elicit more reactivity than competition alone, given its potential to elicit aggressiveness. In this context, As might be considered susceptible to goal blocking in view of their habitual goal orientation and need for control (Glass, 1977). The third objective of the study was to examine the role of hostility in the Type A pattern by comparing the reactivity of high- vs low-hostile As. Prior evidence (Dembroski *et al.*, 1979) suggests that high-hostile As may be more reactive to a wider range of stimuli than low-hostile As; however, the reactivity of these subjects to hostility-relevant manipulations (e.g., harassment) remains an important question. The fourth objective was to assess anger and hostility with psychometric instruments and to explore their relationship to cardiovascular reactivity using correlations. Behavioral and self-report indices of hostility were therefore assessed with regard to reactivity in the context of anger provocation.

In the present study the anger-related variables of harassment and goal blocking were manipulated. Expression of anger in a behavioral situation (Type A structured interview) was assessed directly via a component rating (potential for hostility; PH). Self-report of hostility was examined using the Buss-Durkee Hostility Inventory. Preferred mode of expressing anger (inward or outward) was assessed using the Framingham Anger-In vs Anger-Out Scales.

METHOD

Subjects

Subjects were 60 male undergraduates enrolled in introductory psychology courses. Prior to participating in the study, subjects completed the student version of the Jenkins Activity Survey (JAS), form T (Krantz *et al.,* 1974). Those scoring in the upper (Type A) and lower (Type B) thirds of the distribution were eligible for inclusion. Six subjects who completed the experiment were subsequently deleted due to inaudible taped interview (one), equipment failure (two), and suspicion of the confederate (three) and replaced by others from the subject pool.

Procedure

Subjects participated in two separate sessions as follows.

Session 1. In this session, subjects completed a series of questionnaires and received the Type A structured interview (Rosenman *et al.,* 1964).[4] The following measures were computed in order: (a) an information sheet surveying daily habits, recent stress, and family history of cardiovascular disease; (b) the Buss-Durkee Hostility Inventory (Buss and Durkee, 1957), which yields a total hostility score and eight subscale scores; (c) the anger section from the Framingham Psychosocial Survey (Haynes *et al.,* 1978), which consists of seven questions concerning response to anger arousal.[5]

Session 2. Physiological testing was conducted 2 to 5 weeks following the first session. Upon reporting to the laboratory, the subject was escorted to the "game room" and seated in one seat of a two-person module with adjacent seats. He was asked to wait while the experimenter attempted to locate a tardy second subject. Shortly thereafter, the experimenter returned with a confederate, who was introduced as the person whose name had appeared on the sign-up sheet.

The subject and confederate were oriented to general procedures and completed informed consent forms. An assistant was then summoned via intercom to attach HR and BP monitoring equipment to the subject, while the experimenter attached similar but nonfunctional equipment to the confederate. Four minutes of baseline readings were then obtained.

Following the baseline period, the experimenter delivered the instructions for the competitive Super-Pong video game emphasizing with both content and verbal stylistics the need for accuracy, speed, and drive. To enhance the sense of time urgency, a highly visible "game clock" was set to time a 15-min period. Success was defined as winning two games of 21 points each within the time limit.

[4]The interviewer for all subjects was Eric Diamond.

[5]Anger-out and anger-in classifications were determined as follows: total scores on the Framingham anger-in (three items) and anger-out (two items) were adjusted by multiplying anger-out by 1.5. Subjects with anger-out scores higher than anger-in ($N = 20$) were classified as anger-out. Those with higher anger-in scores were classified as anger-in ($N = 30$). Ten subjects with equivalent scores were excluded.

The game period began 30 sec after the instructions and lasted 15 min. The confederate had been pretrained in Super-pong so as to be sufficiently skilled to control game outcome. Subjects were permitted to win the first game and then were defeated in the second game. In most cases, the pace of play was varied in such a way that the time expired during the third game, and therefore neither player won two games. When the time did not expire, the victory of either player occurred close to the time limit, and thus success or failure did not influence overall levels of physiological reactivity.

Subjects were initially assigned to one of three conditions in such a way as to equate the number of JAS-defined As ($N = 10$) and Bs ($N = 10$) in each condition. The three conditions were as follows. (1) *Competition control:* The subject and confederate merely competed for 15 min. (2) *Goal blocking:* A programmed series of distractions was delivered in order to impede the subject in his efforts to successfully compete. Examples of the interventions are interrupting the subject (and confederate) with irrelevant questions, frequently reminding players to remain still, delaying the onset of Games 2 and 3, and accidentally resetting the score in Game 2 to 0–0 (after permitting the subject to attain a four-point lead). The interventions were designed to exclude personal insult and harassment and to minimize the subject's perception of arbitrary unfair treatment. The bulk of the interference was presented during Game 1 and early in Game 2 so as to impact on the subject during success. (3) *Harassment:* The confederate delivered eight derogatory comments to the subject such as "Christ, can't you keep your eye on the ball?" "You're not even trying," and "I sign up for an experiment and they pair me up with a retard." In order to enhance the credibility of his role, the confederate established himself during the pregame period as a rude and contentious individual.

At the end of the game period, subject and confederate were asked to remain seated for 3 min. During this recovery period, each completed a brief postexperimental questionnaire. Following the recovery period, subjects were interviewed for indications of suspicion, the nature of the experiment was explained, and a full debriefing was given.

Physiological Recording

A microphone-monitoring cuff placed over the brachial artery left arm (Sphygmostat 350) was used to measure BP. The electrocardiogram (EEG) was transduced by Bard Biomedical AG/AgCl electrodes placed on the upper chest with right ankle ground, recorded with a Grass Model 7P5A preamplifier, and displayed on a Grass Model 7 polygraph.

Physiological Data Reduction

Three to four BP determinations were made during baseline. The final two readings were averaged to produce each subject's baseline score. Baseline HR was calculated from the 30-sec intervals immediately preceding the final two BP readings, approximating the intervals 30–60 and 120–150 sec prior to the end of baseline. BP readings typically required 25–30 sec.

Blood pressure readings were taken at the onset of Game 1 and every 1.5 min thereafter, for a total of 11 readings during competition. HR was calculated from the 30 sec preceding the BP determinations as above, with the exception of the first reading, where the HR overlapped the BP determination. In order to monitor physiological "recover," BP readings were taken at 1.5 and 3 min postgame, and HR was calculated as above.

Reactivity during the experiment was calculated as follows: the 11 game readings were divided into three blocks by averaging readings 1 to 4 to form Block 1, readings 5 to 7 to form Block 2, and readings 8 to 11 to form Block 3. Three change scores were calculated by subtracting the subject's baseline value from each block value. For certain secondary analyses, reactivity was considered to be the mean of all 11 readings during the game minus the mean baseline value. Finally, the two readings taken during the 3-min recovery period were averaged to form a single index for the recovery period.

Statistical Analysis

Physiological data were subjected to 2 (A–B) $\times$ 3 (Control, Goal-Blocking, Harassment conditions) $\times$ 3 (change scores from baseline to Blocks 1, 2, and 3 during the game) repeated-measures analyses of variance in conjunction with Duncan range posttests. Statistical significance on the Duncan range tests was set at $P < 0.05$. The A–B distinction for all descriptive statistics and tests of statistical inference was based on the structured interview, because prior research has indicated that this measure is superior to the JAS in predicting physiological reactivity (e.g., Dembroski *et al.,* 1978). Subjects were initially categorized by the JAS and entered among groups in a double-blind fashion in order to provide an approximate balance of Type As and Bs subsequently defined by the structured interview after the experiment was completed.

RESULTS

Behavior Pattern Assessment

The taped interviews were independently scored by E.D. (trained by T. Dembroski) and J.S. (trained by Rosenman and associates) using a component rating system described by Dembroski (1978). The system yields (a) a global, four-point behavior pattern classification using criteria employed by Rosenman and associates (Al, fully developed pattern; A2, incompletely developed pattern; x, indeterminate pattern; and B, absence of coronary-prone pattern) and (b) five-point ratings of each of five vocal stylistic dimensions: loud:explosive (LE), rapid:accelerated (RA), response latency (RL), potential for hostility (PH), and verbal competitiveness (VC).

Interrater agreement for the global pattern was 61.4% for the four-point system and 87.7% for the dichotomous classification (A1 and A2 vs x and B). Typing disagreements were resolved with the following formula: A1 + A2 = A2; A2 + x = A2; A2 + B = x; x + B = B. [Three subjects on whom the two raters disagreed by more than one category (i.e., A2 vs B) were rerated independently, yielding final classifications of x, A2, and A1.] In this way, 5 (8%) of the 60 subjects were classified as A1, 31 (57%) as A2, 2 (3%) as x, and 22 (36%) as B. A dichotomous classification (A1 and A2 vs x and B) was used for subsequent analyses.

Interrater reliability for the verbal stylistic ratings was determined by computing the Pearson correlations between the two ratings assigned for each dimension across subjects. This analysis yielded the following reliability values: LE (r = 0.63); RA (r = 0.61); RL (r = 0.62); PH (r = 0.61); and VC (r = 0.69). For subsequent data analyses the two ratings were simply averaged. Finally, intercorrelations between the global typing (four-point scale) and the vocal stylistic components were as follows: Type–LE (r = 0.77); Type–RA (r = 0.79); Type–RL (r = 0.79); Type–PH (r = 0.54); and Type–VC (r = 0.61). The present study utilized a sample of 30 JAS-defined As and 30 JAS-defined Bs. Agreement of the JAS typing with the structured interview assessment was 63%. The JAS correctly classified 61% of the 36 interview-defined As and 67% of the 24 interview-defined Bs. These results are generally consistent with previous research.

Psychophysiological Data

Mean baseline values across all subjects were 118 mm Hg for seated SBP, 70 mm Hg for DBP, and 79 beats/min for HR. An analysis of variance failed to confirm the presence of significant differences in any baseline measure as a function of subsequent experimental condition or A–B behavior pattern.

Experimental Conditions. It is apparent from Table I that the Harassment condition induced larger SBP changes from baseline during the game than either the Control or the Goal-Blocking conditions. In general, SBP increased across blocks in the Harassment condition but not in the other two conditions. There was a tendency for Bs to be more reactive than As in the Control condition, whereas As were more reactive than Bs in the Harassment condition. A 2 (A–B) × 3 (Conditions) × 3 (Trials: change-

Table I. Baseline and Change Values of Systolic Blood Pressure (mm Hg) for Type As and Bs

	Baseline		Block 1		Block 2		Block 3	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Control								
A (N = 10)	117	(9)	10	(7)	9	(10)	11	(8)
B (N = 10)	115	(11)	13	(10)	15	(14)	13	(13)
Both (N = 20)	116	(10)	11	(8)	12	(12)	12	(11)
Goal Blocking								
A (N = 15)	124	(10)	13	(12)	15	(11)	14	(10)
B (N = 5)	111	(18)	12	(6)	17	(8)	13	(6)
Both (N = 20)	121	(13)	13	(10)	16	(10)	13	(9)
Harassment								
A (N = 11)	117	(11)	24	(8)	31	(10)	30	(10)
B (N = 9)	119	(11)	16	(6)	23	(8)	27	(9)
Both (N = 20)	119	(11)	21	(8)	27	(10)	29	(10)

scores) repeated-measures ANOVA conducted on SBP indicated a significant main effect for Conditions [$F(2/54) = 11.92$, $P < 0.001$] and for Trials ($F(2/108) = 13.01$, $P < 0.001$] (reflecting an increase in SBP over trials) and a reliable Trials × Conditions interaction ($F(4/108) = 6.26$, $P < 0.001$]. Post hoc analysis with the Duncan test confirmed that SBP was significantly higher in the Harassment condition relative to the other conditions. The reliable Trials × Conditions interaction confirmed that the progression of SBP elevations over blocks was most pronounced in the Harassment condition.

It may be seen in Table I that the difference in SBP reactivity between As and Bs emerged most strongly during the first third of game competition.[6] In order to test for an interaction of the A–B variable with Conditions, a second repeated-measures ANOVA was performed on raw scores, with baseline and Block 1 values as trials. This interaction approached significance [$F(2/54) = 1.95$, $P = 0.15$]. Since the Goal-Blocking condition provided no meaningful data with regard to the A–B distinction (see Fig. 1), in was deemed appropriate to examine the A–B × Condition interaction in a post hoc analysis with Goal-Blocking subjects removed from consideration. In this case the Trials × Condition × A–B interaction reached significance [$F(1/36) = 4.91$, $P = 0.033$]. Thus, it appears that increased responsiveness of Type As relative to Bs did not occur in the control condi-

[6]All A–B analyses reported are based upon the structured interview. There were no significant differences between JAS-defined As and JAS-defined Bs on any statistical analyses of cardiovascular reactivity.

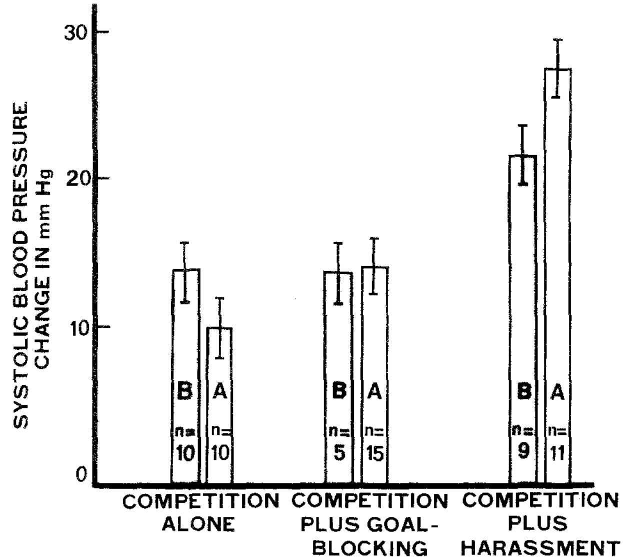

Fig. 1. Change in systolic blood pressure from baseline to competitive game for interview-defined As ($N = 36$) and Bs ($N = 24$) during the three experimental conditions.

tion, whereas the presence of a harassing and derogatory opponent seems to have provoked As to a rather sudden and pronounced elevation in SBP.

Changes in DBP from baseline ($M = 7$ mm Hg) were smaller than SBP changes from baseline ($M = 17$ mm Hg) but generally paralleled the latter changes as a function of conditions and trials. An ANOVA indicated that changes in DBP approached, but failed to reach, statistical significance for Conditions ($F(2/54) = 2.45$, $P < 0.10$] and for Trials [$F(2/108) = 2.80$, $P < 0.07$]. No A–B differences were obtained.

Table II indicates that HR was elevated in the Harassment condition relative to the Goal-Blocking and Control conditions and tended to increase across blocks in the Harassment condition. An analysis of variance revealed reliable main effects for Conditions [$F2/54) = 7.68$, $P < 0.001$] and for Trials [$F(2/108) = 5.80$, $P < 0.004$], as well as a nearly significant Trials × Condition interaction [$F(4/108) = 2.32$, $P < 0.06$] and a significant Trials × A–B interaction [$F(1/108) = 4.65$, $P < 0.01$]. Post hoc analyses (Duncan range test) indicated that HR was significantly elevated in the Harassment condition relative to the Control and Goal-Blocking conditions. The reliable Trials effect indicated the tendency for HR to increase across blocks, while the Trials × Condition interaction tended to suggest that this effect was most pronounced in the Harassment condition. The Trials × Condition interaction tended to suggest that this effect was most pronounced in

Table II. Baseline and Change Values of Heart Rate (beats/min) for Type As and Bs

	Baseline		Block 1		Block 2		Block 3	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Control								
A (N = 10)	73	(13)	10	(13)	9	(12)	11	(11)
B (N = 10)	79	(12)	10	(11)	14	(15)	15	(13)
Both (N = 20)	76	(12)	10	(12)	11	(13)	13	(12)
Goal Blocking								
A (N = 15)	76	(10)	9.2	(11)	7	(10)	8	(10)
B (N = 5)	79	(15)	5.6	(11)	5	(8)	7	(10)
Both (N = 20)	77	(11)	8.3	(10)	6	(9)	8	(12)
Harassment								
A (N = 11)	85	(19.7)	19	(14)	19	(11)	21	(10)
B (N = 9)	80	(11.5)	16	(8)	25	(11)	26	(15)
Both (N = 20)	83	(13.4)	17	(12)	22	(11)	23	(12)

the Harassment condition. The Trials × A–B interaction indicated that Type Bs tended to increase in HR across blocks, whereas As tended to maintain HR levels attained during change from baseline to Block 1.

Potential for Hostility. Subjects with ratings of 3.5 or above on the PH component of the Type A structured interview were arbitrarily designated as high hostile (N = 18); all others were considered low hostile (N = 42). This cutoff point of 3.5 was chosen because it most closely balanced the number of high (N = 16)- vs low (N = 20)-hostile Type As for the purposes of the analyses described in the next paragraph. Of the high-hostile group, only two were interview-defined Bs. A 2 (High vs Low Hostile) × 3 (Condition) × 3 (Trials: change from baseline to Blocks 1, 2, and 3) ANOVA did not reveal any reliable differences between high- and low-PH subjects for SBP, DBP, or HR.

In order to compare high- and low-hostile Type As, interview-defined As were grouped on the basis of PH component ratings (3.5–5.0 = high; 1.0–3.0 = low). Examination of mean changes from baseline to Blocks 1, 2, and 3 of game competition failed to reveal any significant difference between groups for SBP, DBP, and HR. However, significant differences emerged when mean levels of asbsolute SBP and HR were examined. Table III presents mean HR values for baseline and game block periods. For SBP, low-hostile As and the control group had higher values than high-hostile As across game condition but were exceeded by high-hostile As across baseline and the game in the Goal-Blocking and Harassment conditions. A 2 (High-Hostile A vs Low-Hostile A) × 3 (Conditions) × 4 (baseline—Blocks 1, 2, and 3) repeated-measures ANOVA conducted upon mean SBP yielded a near-significant High—Low Hostility × Conditions in-

Table III. Baseline and Absolute Levels of Systolic Blood Pressure (mm Hg) and Heart Rate (beats/min) for Type As with High or Low Stylistic (PH Component) Hostility in Each Competition Condition

	Baseline		Block 1		Block 2		Block 3	
Hostile	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
			Systolic blood pressure					
Control								
High (N = 6)	124	(10)	132	(10)	130	(8)	123	(11)
Low (N = 4)	122	(5)	134	(3)	135	(6)	135	(7)
Goal Blocking								
High (N = 4)	127	(11)	142	(15)	146	(19)	142	(19)
Low (N = 11)	122	(10)	135	(13)	136	(13)	135	(12)
Harassment								
High (N = 6)	121	(8)	145	(8)	152	(6)	151	(12)
Low (N = 5)	112	(14)	136	(15)	143	(16)	142	(15)
			Heart rate					
High (N = 6)	69	(6)	73	(6)	74	(8)	77	(9)
Low (N = 4)	81	(16)	98	(22)	96	(24)	95	(23)
Goal Blocking								
High (N = 4)	72	(13)	83	(18)	79	(15)	76	(14)
Low (N = 11)	78	(8)	86	(12)	84	(11)	88	(13)
Harassment								
High (N = 6)	80	(10)	97	(11)	98	(17)	100	(17)
Low (N = 5)	92	(18)	113	(25)	112	(23)	113	(23)

teraction [$F(2,30) = 2.92$, $P < 0.07$]. In contrast, HR in the low-hostile As exceeded HR in the high-hostile As across baseline and game for all three conditions [$F(1,30) = 6.84$, $P < 0.01$]. Therefore, a divergence between mean HR and mean SBP was noted in the high- versus low-hostile Type A comparison.

Recovery. In order to assess the possible influence of conditions, Type A–B, and other individual difference variables on the course of recovery, repeated-measures ANOVAs were carried out using Block 3 and recovery period values as trials. No effects other than the expected Trials effects were observed in any analysis. In all instances the physiological measures between the end of the game and the end of recovery returned to levels approximating the pregame baseline period.

Personality Variables. Personality variables were first correlated with baseline values of BP and HR. Of greatest importance with regard to baseline values was its relation to scores on the 16 Hypertension Instrument (HI). The relationship between 16 HI scores and basal SBP approached significance [$r = 0.19$, $P = 0.17$]. This was limited to Type As, however, among whom 16 HI scores correlated with both SBP and DBP at baseline ($r = 0.32$ and $r = 0.34$, respectively; $P < 0.03$ in each case).

Table IV. Correlations between Buss-Durkee Hostility Inventory and Systolic Blood Pressure Changes for Type A, High-Hostile, and Anger-Out Subgroups

	Buss-Durkee hostility score		
	N	*r*	*P*
Type A (structured interview)	36	0.30	0.04
High hostile (PH component)	18	0.55	0.01
Framingham anger-out	20	0.55	0.006

A pattern of marginal findings emerged in relating interview components to baseline levels. For the full sample, Loud/Explosive (LE), Rapid/Accelerated (RA), and Response Latency (RL) were all moderately associated with resting SBP (r's = 0.20, 0.17, 0.22; all P's < 0.08), while Verbal Competitiveness was more strongly related to SBP at baseline ($r = 0.26$), $P < 0.02$). Again, these findings primarily reflect the pattern among Type As, for whom the correlations between LE, RA, and VC and SBP at baseline were 0.25, 0.24 (P's < 0.07) and 0.32 ($P = 0.03$), respectively.

In order to study the relationship between anger/hostility and physiological reactivity, scores on the Buss-Durkee Hostility Inventory were correlated with measures of physiological reactivity for subjects classified as Type A, high potential for hostility as determined from the structured interview component analyses, and anger-out as determined from the Framingham scale. Reactivity was assessed in terms of change from baseline to block 1 across conditions. Although the correlations between Buss-Durkee scores and HR changes approached significance for subjects showing an elevated PH component in the structured interview ($r = 0.45$, $p < 0.08$) and was very significant for subjects classified as anger-out on the Framingham scale ($r = 0.55$, $p < 0.006$), the strongest set of correlations occurred for SBP. Table IV indicates that significant positive correlations existed between scores on the Buss-Durkee Hostility Inventory and changes from baseline in SBP for subjects classified as Type A, high-hostile in the component analysis of the interview, and anger-out on the Framingham instrument.

Particularly interesting findings also emerged when subjects were divided at the mean in terms of Buss-Durkee scores. Table V indicates that in terms of SBP changes from baseline, structured interview typing (four-point scale), stylistic hostility (PH component), and anger-out affect reactivity in opposite ways among high- and low-hostile subjects as assessed by self-report (Buss-Durkee). Similarly, Framingham anger-out scores were positively correlated with changes in HR ($r = 0.44$, $P = 0.01$) for those classified as high hostile on the Buss-Durkee inventory, whereas Framingham anger-out scores were

Table V. Correlations Between Personality Measures and Systolic Blood Pressure Changes for High- and Low-Hostile Subjects

	Buss-Durkee Hostility Inventory			
	High hostile (N = 29)		Low hostile (N = 31)	
	r	P	r	P
Type A (structured interview)	0.26	0.09	−0.12	NS
Potential for Hostility (interview)	0.37	0.02	−0.39	0.01
Framingham Anger-Out	0.33	0.04	−0.16	NS
Framingham Anger-In	−0.50	0.003	±0.00	NS

negatively correlated with changes in HR (r = −0.34, P = 0.03) for those classified as low-hostile on the Buss-Durkee self-report measure. This suggests that different factors may be associated with cardiovascular reactivity for high- vs low-hostile individuals as assessed by self-report.

Postexperimental Questionnaire (PEQ)

Subjects indicated their degree of tension, involvement, irritation, success, and anger on 11-point Likert-type scales following game competition. First, in terms of conditions, an analysis of variance indicated that mean scores for the five items failed to differ across conditions. When A–B differences were analyzed via 2 (A–B) × 3 (conditions) ANOVAs, an A–B main effect was found for irritation [$F(1/53) = 4.27$, $P = 0.04$], with As reporting greater irritation than Bs. A significant interaction emerged on tension [$F(2/53) = 4.88$, $P = 0.01$]. Individual post hoc comparisons between cell means indicated that Bs exceeded As in tension in the control condition, whereas As exceeded Bs in the Harassment condition.

Among As (N = 36), PEQ tension correlated with irritation (r = 0.60, P = 0.001), involvement (r = 0.55, P = 0.001), and anger (r = 0.44, P = 0.01); irritation and anger were strongly related (r = 0.86, P = 0.001), as were success and involvement (r = 0.43, P = 0.01). All such intercorrelations were weak and nonsignificant among Bs.

Next PEQ ratings were correlated with physiological reactivity. For the full sample, tension was associated with both SBP and HR change from baseline (r = 0.37 and r = 0.38, respectively; $P < 0.002$ in each case), as was involvement (r = 0.26 and r = 0.27, respectively; P = 0.02 in each case). The relationship for tension was even stronger for As (with SBP, r = 0.41 and P = 0.02; with HR, r = 0.51 and P = 0.001).

Among Bs, while tension was marginally related to SBP change (r = 0.30, P = 0.08), irritation and anger were associated with DBP change (r = 0.41, P = 0.02, and r = 0.47, P = 0.01, respectively).

DISCUSSION

The major findings of the present study were the following: harassment in the context of competition elicited marked elevations in SBP and HR compared to goal blocking during competition or to simple competition alone. Type A subjects showed greater SBP increases than Bs in the Harassment condition, particularly early in the game period, whereas Bs tended toward higher BP reactivity than As in the Competition-Only (Control) condition. Among Type As, high stylistic hostility (PH) was associated with greater absolute SBP than was low stylistic hostility under Goal-Blocking and Harassment conditions, whereas low-hostile As showed greater absolute HR levels relative to high-hostile As across all three conditions. Stylistic hostility, outwardly directed anger, and Type A were associated with physiological reactivity among high-hostile subjects (Buss-Durkee).

The finding that harassment elicited pronounced physiological changes is consistent with the findings of Glass *et al.* (1980) and those of Ax (1953) and Schachter (1957). The magnitude of the changes observed exceeded those reported in many prior studies of the cardiovascular reactivity of Type As and Bs (cf. Dembroski *et al.*, 1978; Manuck *et al.*, 1978), indicating the potency of the harassment-competition manipulation. However, the observed changes were somewhat smaller than those reported by Glass *et al.* (1980) using a similar paradigm. This discrepancy may be attributable to sample differences in terms of (a) age (college students vs adult transit workers) or (b) degree of experience with TV games and/or experimentation (with college students having the greater familiarity).

Type As showed greater SBP changes than Bs in the initial segment of the Harassment condition. Over the course of competition, As tended to level off, while Bs continued to gradually increase in SBP and HR until reaching levels approaching the As. There are at least three possibilities for interpreting this finding. First, As may have reached a ceiling earlier than Bs. However, the physiological levels attained did not approach any real biological ceiling. Second, since the bulk of the harassing comments was delivered during the first half of play, it may be that As are only more reactive than Bs during derogation, whereas Bs may have dwelled on the confederate's comments and manifested a kind of "incubation effect." Third, As' reactivity may have been mitigated by rationalization of hostility (Friedman, 1977). The Type A subject, perceiving arousal (or tension) during the course of competition, may have formed cognitions such as "This is only an experiment; there is no good reason to get upset" and "He (the confederate) is so rude he must not be a real subject." Indeed, postexperimental interviews revealed that some subjects formed such cognitions partway through the harassment induction. Such cognitions might facilitate the subject's ability to focus on the central task of winning the contest.

Goal blocking in the context of competition failed to elicit increased physiological activity relative to competition alone and also failed to differentiate As from Bs. Given that As were indeed more reactive than Bs in the Harassment condition, it may be that interference with goal-directed behavior does not evoke excessive levels of reactivity among As [although it may be sufficient to provoke aggressive responding (cf. Carver and Glass, 1978)]. If this is the case, it suggests that the relationship of hostility in the Type A pattern to CHD (Matthews *et al.,* 1977) may derive from risk conferred by heightened reactivity in situations of interpersonal threat or challenge, even though descriptions of the Type A behavior pattern (Rosenman and Friedman, 1977) suggest that As' potential for hostility would be frequently elicited by a wide range of circumstances analogous to interference with goal-directed behavior (e.g., waiting in lines, traffic, and so on).

In view of the lack of differences in physiological reactivity between (a) the Competition-Only and Goal-Blocking conditions and (b) Type A and Type B subjects in the Goal-Blocking condition, it is reasonable to question whether the Goal-Blocking manipulation actually had an effect. It can be argued, for example, that subjects in this condition, while intermittently impeded and distracted, did not win fewer games than other subjects. Behavioral observations and postexperimental comments suggested that subjects in the Goal-Blocking condition responded to the distractors by concentrating more intensely on the game and thus were not effectively blocked.

In contrast to prior studies (e.g., Dembroski *et al.,* 1979), the potential for hostility component of the Type A structured interview did not strongly predict cardiovascular reactivity. One possible explanation is that the tasks employed were highly challenging; in the study by Dembroski *et al.,* high- and low-hostile As diverged only under low-challenge conditions. Interestingly, although high- and low-hostile As in the present study were similar with regard to change from baseline, sizable differences between these groups in absolute levels of BP and HR were noted. Specifically, high-hostile As manifested higher SBP levels across baseline and game periods than low-hostile As in the Goal-Blocking and Harassment conditions; yet low-hostile As had consistently higher HR levels than high-hostile As in all three conditions. This unexpected pattern suggests that mechanisms mediating reactivity may differ between these groups. Although admittedly speculative, the significantly increased BP in conjunction with reliably lower HR among high-hostile As could reflect a relative increase in total peripheral resistance compared to low-hostile As. Such a speculation would, of course, have to be tested empirically since peripheral resistance was not measured in the present study. The differences in baseline could reflect differences between high- and low-hostile As in the manner in which they approached introduction into the experimental situation.

Modest but significant relationships were found between hostility measures and BP reactivity when relevant subgroups were compared. For example, among Type As, outward expression of anger (Framingham scale) and high self-reported hostility (Buss-Durkee) were related to BP elevations across conditions, and these relationships were even stronger among high-hostile As (PH component rating). A significant finding also emerged when reporters of high vs low hostility (Buss-Durkee) were compared. Among high-hostile subjects (Buss-Durkee), overt anger expression (Framingham anger-out), hypertensive-like qualities (16HI), and Type A behavior (including the PH component) all were associated with increased reactivity. In contrast, among low-hostile subjects, suppressed anger (Framingham anger-in), Type B behavior, and low stylistic/attitudinal (PH) hostility were better associated with reactivity. This divergence may explain the difficulty of some prior studies in detecting correlations among personality scales and reactivity measures (Light *et al.,* 1981).

A theoretical model relevant to these data has been described by Weinberger *et al.* (1979). These investigators posited that low-*anxious* individuals actually comprise two distinct groups, veridically low-anxious persons and "repressors" (described as individuals "preoccupied with mastering their negative emotions and vigorously controlling their behavior"). Repressors, while scoring as low anxious, were *more* physiologically reactive than even *high*-anxious subjects in the experiment of Weinberger *et al.* (1979). Low-*hostile* subjects who report an anger-in coping style may be analogous to repressors, in that they perceive themselves as having emotional self-control. These individuals might be seen as witholding anger for fear of losing this control.

The Type A individual has been characterized by aggressiveness, loud and explosive speech, and other manifestations of expressed anger (Rosenman, 1978). Conversely, essential hypertension has been characterized by passivity and suppressed anger (Diamond, 1982) in case (Alexander, 1939; Saul, 1939) and experimental studies (Kalis *et al.,* 1957). At present there is insufficient evidence to link anger-in or suppressed hostility to essential hypertension, or expressed hostility to CHD, in terms of differences in physiological reactivity. Previous work has linked anger-in to BP and HR increases associated with elevations in epinephrine and anger-out to BP increases and HR decreases associated with elevations of norepinephrine as well as epinephrine (Funkenstein *et al.*, 1954). The present findings suggest that the situation is actually considerably more complex. Thus, for example, divergences in SBP and HR responses were found between high- and low-hostile (PH) Type As during competition with goal blocking or harassment. Also, cardiovascular responses differed for high- and low-hostile (Buss-Durkee) subjects as a function of personality characteristics (Type A vs Type B; anger-in vs anger-out).

In summary, the present study confirms a positive relationship between harassment during competition and pronounced increases in HR and BP (Glass *et al.*, 1980). Previous research has also indicated that elevated potential for hostility and Type A are both associated with increased physiological reactivity (Dembroski *et al.*, 1979). The present study found that these characterisics together with anger-out expressiveness were associated with high physiological reactivity among high-hostile but not low-hostile subjects. Therefore, if cardiovascular reactivity is related to increased coronary risk in Type A individuals, it may well be that such risk is carried only by a particular subset of such persons.

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