Anger, Harassment, and Cardiovascular Reactivity Among Chinese and Indian Men in Singapore

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Objective: This experiment examined psychological and cardiovascular responses to experimental harassment among Chinese and Indian men in Singapore who differed in levels of dispositional anger. **Methods:** Eighty-four Chinese and Indian men participated in a laboratory experiment on cardiovascular reactivity in which mood was rated and heart rate and blood pressure were measured during computer tasks in which they were either harassed or allowed to complete the tasks without interruption. **Results:** Comparison of systolic reactivity to harassment and nonharassment indicated, as expected, that reactivity was greater after harassment. Furthermore, a significant race by dispositional anger by harassment effect was obtained for systolic reactivity that indicated different patterns of reactivity for Chinese and Indian participants. In the absence of harassment, Chinese participants showed low systolic reactivity regardless of their level of dispositional anger, whereas systolic reactivity increased as a function of dispositional anger when they were harassed. For Indians, however, systolic reactivity was a positive function of dispositional anger both when they were harassed and not harassed. **Conclusions:** These results suggest stronger cardiovascular reactivity to stress among Indian than among Chinese men. This seems to be particularly true for Indians high in dispositional anger. **Key words:** anger, cardiovascular reactivity, stress, Chinese, Indians, Singapore.

CHD = coronary heart disease; CVR = cardiovascular reactivity; DA = dispositional anger; ECG = electrocardiogram; STAXI = State-Trait Anger Expression Inventory.

INTRODUCTION

Over the last few decades, evidence has accumulated on the possible role of anger and hostility in the development of CHD. A number of studies have demonstrated that high levels of anger or hostility are predictive of both CHD and all-cause mortality over periods of up to 28 years (1–3). In addition, a recent meta-analysis of studies showed that this relationship remains significant when other risk factors are statistically controlled (4). Although not all studies have found this relationship, current evidence indicates that it is a stable one and that the association of anger/hostility with CHD is at least as strong as the relationships between CHD and more traditional risk factors, such as smoking and high cholesterol (4, 5).

Currently, there are several hypotheses for this observed relationship between anger/hostility and CHD. These models are not mutually exclusive but do suggest different mechanisms by which anger/hostility may lead to CHD (5). Probably the most widely researched model is the psychophysiological reactivity model. This model hypothesizes that hostility contributes to the development of CHD, and possibly other diseases, through its association with heightened levels of cardiovascular and neuroendocrine responses to stress on the part of highly hostile individuals. Highly hostile individuals are hypothesized to show greater increases in heart rate, blood pressure, and secretion of stress-related hormones when faced with certain types of stressors. Individuals high in hostility are expected to experience anger more frequently and intensely, and this greater experience of anger is believed to produce greater physiological reactivity, which is hypothesized to, in turn, facilitate the development of coronary artery disease and eventually CHD. In addition, increases in stress-related hormones, particularly cortisol, are thought to impair immune functioning, which then puts the person at greater risk for other diseases (5, 6).

Evidence of greater levels of CVR in highly hostile individuals has been obtained in a number of studies, although not all. There is little evidence of heightened reactivity in highly hostile individuals as a general response across different tasks. However, heightened reactivity has been found for highly hostile individuals when they are put into situations that can be construed as involving social threat (5). For example, higher levels of reactivity in highly hostile individuals has been found when research participants are harassed, involved in a social interaction task involving a high level of self-disclosure, or engaged in debate. Greater physiological reactivity has, in turn, been associated with later development of CHD (7).

Although there is growing evidence of the relationship between anger/hostility and CHD, the cross-cultural validity of this relationship is unknown. To date, the evidence supporting this relationship comes primarily from studies in Western countries, predominantly the United States. In addition, most studies have been of whites (cf, Refs. 8 through 10), although several have examined reactivity among African

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Americans (cf, Ref. 11). To the best of our knowledge, there are no studies examining this relationship in Asia or with Asian populations. Although it would seem plausible that the relationships of anger/hostility to reactivity and CHD would be stable across cultures, this cannot be assumed. Emotions are very much a product of culture, and even though research has demonstrated certain cross-cultural universals concerning emotions and their recognition (12, 13), there is also evidence of substantial variation in the experience and expression of various emotions (14). For example, Japanese and Chinese persons seem to experience certain negative emotions, including anger, less intensely and for shorter periods than do people from other cultural groups, such as white Americans (15, 16). Such differences in the experience of anger make it clear that cross-cultural validity of the relationships between anger/hostility and both reactivity and CHD need to be empirically established before they can be generalized beyond the populations in which they were tested.

Singapore provides a particularly interesting locale for testing the relationships among anger/hostility, reactivity, and CHD because it has three major ethnic groups that differ culturally and in their rates of CHD. Research on CHD death rates in Singapore has indicated that Indian Singaporeans die of ischemic heart disease at much higher rates than do Chinese or Malay Singaporeans. For example, Hughes et al. (17) found that among men aged 30 to 69 years, the CHD death rates for Indians were 3.8 times those for Chinese and 1.9 times those for Malays. The differential in death rates was particularly high for young men (age 30–39 years), with the rates for Indians being 12.5 times those for Chinese and 4.4 times those for Malays. Similar patterns were observed for women, but the differences were not as marked. Among women aged 30 to 69 years, the ratio was 3.4 between Indians and Chinese and 1.6 between Indians and Malays. For women aged 30 to 39 years, the ratio was 6.8 between Indians and both Chinese and Malays. This pattern of high CHD rates among Indians has also been found in other countries, such as the United Kingdom (18), South Africa (19), and Trinidad (20).

Although studies of the role of traditional risk factors in these differences have been conducted, these differences have remained unexplained (cf, Ref. 21). Also, to the best of our knowledge, no studies have examined the potential role of psychosocial risk factors in the differential rates of CHD. One study has suggested that Indians may have higher levels of hostility than Chinese or Malays (22), but this result may have been biased by use of an unrepresentative sample and unvalidated instruments and has yet to be replicated. The study reported here is part of a research program aimed at examining ethnic differences in anger/hostility and relating these differences to cardiovascular responses to stress. This study is an initial investigation of the extent to which DA is related to cardiovascular responses among Chinese and Indian Singaporeans. As such, we examined the cardiovascular responses of Indian and Chinese men, who differed in DA, to a series of computerized laboratory tasks. In line with the finding that differences between individuals with high and low levels of hostility can be expected only under conditions of social challenge, participants were harassed during some tasks but allowed to finish others without interruption. If the relationship between anger/hostility and CVR is cross-culturally valid, we would expect to find that higher levels of anger are related to greater levels of CVR under conditions of harassment but not in the absence of harassment. If anger/hostility plays a role in the higher CHD death rate among Indians, we would expect this pattern to be stronger among Indians than among Chinese.

METHODS

Participants

Eighty-four male students at tertiary educational institutions in Singapore took part in this study. Forty-seven participants were Chinese, and 37 were Indian. Participants ranged in age from 17 to 32 years (mean = 22.7 years). Participants were screened before participation to exclude those with a history of heart disease or hypertension and were paid $12 (Singaporean; equivalent to $7.25 US) for their participation. Characteristics of this sample and baseline values of dependent variables are given in Table 1.

Design

This study used a 2 × 2 mixed design (Chinese vs. Indian and harassed vs. nonharassed) with race as a between-subjects factor and

TABLE 1. Participant Age, STAXI Scores, and Baseline Values by Ethnicity

Variable	Chinese	Indian	Total Group
Age (years)	22.21	23.50	22.68
STAXI score			
Trait anger	21.30	23.08	22.08
Trait anger/angry reaction[a]	9.81	11.03	10.35
Trait anger/angry temperament	7.91	8.18	8.03
Anger out	16.26	15.27	15.82
Anger in	17.83	19.19	18.43
Anger control	22.53	23.61	23.00
Anger expression	27.41	26.85	27.17
Baseline systolic blood pressure[a]	123.93	118.31	121.45
Baseline diastolic blood pressure	76.71	75.16	76.02
Baseline heart rate	74.83	77.51	76.01
Baseline anger index	2.30	1.86	2.05

[a] Means were significantly different between ethnic groups at $p < .05$.

harassment as a within-subjects factor. In addition, DA was measured for each participant and entered into the design as a continuous variable using repeated-measures regression with interactions (23). All participants performed four different tasks, two while being harassed and two without harassment. The tasks performed under harassment and the order of harassment was varied between participants. To control for possible order effects due to either task or harassment order, four different Greco-Latin squares were used with a total of 16 combinations. To the extent possible, an equal number of Chinese and Indian participants were randomly assigned to each order.

Procedure

Laboratory Arrangement. The experiment was conducted in a psychophysiology laboratory with the participant seated before a computer monitor in a soundproof room. A one-way mirror was located behind the participant, allowing the experimenter to observe the participant and to watch the monitor to control the experimental tasks from an adjacent room. To help the participant relax before the experiment and during baseline periods, nature posters were hung on the walls in front and to the side of the participant, and soft nature sounds were piped in through two loudspeakers located behind the participant.

Tasks. During the experiment, participants performed four computerized tasks from a set of tasks developed for studies of CVR (24). The tasks used included a target shooting task, a scanning task, a Stroop color-word task, and a mental arithmetic task. The tasks differed in their cognitive requirements, and the difficulty of the tasks was standardized across participants (level of accuracy, 60%). To standardize the difficulty of the tasks, the participant's skill was assessed at the beginning of each task, and difficulty was adjusted accordingly. In the target shooting task, participants were required to shoot a target moving across the top of the screen using a cannon barrel displayed in the lower part of the screen. Difficulty was varied by adjusting the speed at which the target moved across the screen. The scanning task was a memory task in which a series of circular icons appeared for about 1 second each in four positions across the top of the screen. Participants were instructed to observe and remember the order of the positions in which the icons appeared and then, after a 3-second delay, to reproduce the order. Difficulty was adjusted by varying the number of icons presented in each trial. For the Stroop color-word task, one of four color words (red, yellow, blue, or green) appeared randomly in the center of the screen in one of the four colors named. Simultaneously, all four words appeared at the bottom of the screen, randomly assigned to the different colors. Participants were required to select the word from the list at the bottom of the screen that named the color of the word in the center of the screen and to do so before they were given the correct answer. Difficulty was varied by manipulating the time before the answer was given. Finally, the mental arithmetic task presented various arithmetic problems on the screen, each of which was followed by a proposed answer. The participant was asked to indicate whether the proposed answer was correct and to do so before they were given the correct answer. As with the Stroop task, difficulty was altered by varying the amount of time before the answer. With the exception of the mental arithmetic task, each task was preceded by a practice period. Each task lasted approximately 4 minutes, 10 seconds. In addition, a baseline task that required participants to simply watch the appearance of colored squares on the monitor and remember the number of times a particular color appeared was included. This task was designed to keep the participant occupied with minimal cognitive involvement so that baseline physiological readings could be obtained. The baseline task, which lasted approximately 10 minutes, was presented at the beginning of the experiment, between each task, and after the final task.

Harassment Manipulation. To test the effects of harassment on levels of anger and CVR, participants performed the tasks under conditions involving either harassment or no harassment. For two of the four tasks, participants were subjected to verbal harassment through tape-recorded statements, ostensibly coming from a research technician, played over the loudspeakers. Two statements were used for each harassed task and were played 45 seconds and 2 minutes, 45 seconds into each task. The two pairs of statements were 1) "You're not trying hard enough. You need to put in more effort!" and "Your performance is inadequate. You need to do better." and 2) "You're still making too many mistakes. Concentrate, please!" and "You're not very good at this, are you?" All statements were made by a man, ostensibly an experimental assistant. The person on the tape was Chinese, but every attempt was made to keep his accent as neutral as possible. For each statement, a stern, emphatic tone of voice was used. For tasks in the nonharassment condition, the participant was allowed to complete the task without commentary.

Measures. The trait anger/angry reaction subscale of the STAXI (25, 26) was used to measure differences in DA. The STAXI was chosen because it has been shown to be the most valid and reliable among a series of anger/hostility measures tested in Singapore (27). Although the Cook-Medley Hostility Scale (28) has been commonly used in studies of hostility and CHD and has been shown to have an acceptable level of reliability in Singaporeans, the STAXI was used because of concerns about the validity of Cook-Medley hostility scores for Singaporeans. Attempts in our laboratory to replicate findings such as those by Barefoot et al. (2) concerning the underlying structure of Cook-Medley hostility items have been unsuccessful, leading us to question whether the scale measures the same underlying construct in Singaporeans as it does in North Americans. In contrast, examination of the structure of the STAXI yielded results similar to those reported in other studies (cf, Ref. 25). In addition, the STAXI also measures different aspects of the experience and the expression of anger. The trait anger/angry reaction subscale was used because it specifically targets the customary responses that a person has to anger-provoking situations. Theoretical formulations of the role of hostility in CHD have consistently identified this as the key construct in relating anger/hostility to CVR and CHD (cf, Refs. 5 and 29). The STAXI was completed by participants on arrival in the laboratory and before the beginning of experimental procedures.

Measures of changes in feelings of anger during the experiment were obtained from mood questionnaires filled out by participants before and after each task. Participants were asked to indicate their current mood by rating 10 mood statements on a scale from 1 (strongly disagree) to 10 (strongly agree). Each statement began with the stem "I feel." The 10 mood adjectives or phrases were "anxious," "angry," "tensed," "that I am able to concentrate," "irritated," "motivated," "happy," "upset," "frustrated," and "that I am able to control the situation." For the analyses reported here, the key items were angry, irritated, upset, and frustrated. In addition, a summary anger scale was computed as the average of scores for these four items.

Physiological Measures. Blood pressure readings were taken using an IBS model SD-700A automated blood pressure monitor. A standard occluding cuff with an internal sensor for detecting Korotkoff sounds was attached to the upper portion of the participant's nondominant arm, with the sensor placed over the brachial artery. Readings were initiated by the experimenter every 2 minutes beginning 45 seconds into each experimental segment by pressing a foot pedal in the control room. Each reading took 40 to 50 seconds to complete. Four readings were taken during each baseline period,

and two readings were taken during each task. Heart rate for each segment was obtained from a continuous ECG using lead 2 and recorded digitally using a Biopac MP100 physiological recording system.

Experimental Sequence. Participants arrived individually for the experimental sessions and were immediately taken to the room where the experiment was conducted. At that time, they were given a brief description of the experiment and asked to sign an informed consent form. The experiment was described as one concerned with the physiological effects of playing computer games under different conditions, some of which might be unpleasant. The physiological measures were then described, and then electrodes for electrocardiographic measurements were attached and the blood pressure cuff was placed on the participant's nondominant arm. After a test reading with the blood pressure monitor, the order of baseline and experimental tasks was explained, and the participant was shown the questionnaires to be completed during the experiment and given instructions about when they were to be completed. Instructions for the baseline and experimental tasks were given on the computer monitor at the beginning of each segment.

The experiment proper began with a 10-minute baseline period, during which the participant was instructed to watch the computer monitor and remember the number of times a square of a given color was shown. During this time, recorded sounds of waves on the shore were played softly through the speaker behind the participant. At the end of the baseline period, participants were asked to rate their current mood on the mood questionnaire. This was followed by the first task. Instructions were given on the monitor, followed by practice trials for all tasks except the mental arithmetic task and then the experimental trials. At the end of this task, participants again rated their mood. The experiment then continued in the same manner with the alternation of baseline and experimental tasks, after which participants rated their current mood. After the fourth task, a final baseline period completed the experiment proper. After the final baseline period, the blood pressure cuff and ECG electrodes were removed, and the participant was asked to complete a final postexperiment questionnaire about his reactions to the experiment and "technician." Participants were asked to rate the extent to which they felt they did well on the experimental tasks and found the experiment to be challenging, difficult, frustrating, boring, and enjoyable and to rate the technician on the extent to which they perceived him to be hostile, friendly, aggressive, agreeable, and rude. All ratings were made on a nine-point scale, with 1 labeled "not at all" and 9 labeled "extremely." After completing the questionnaire, the participant was interviewed to ascertain any suspicions about the experimental procedures and then debriefed. The entire experiment lasted approximately 90 minutes.

Data Reduction and Analysis

Baseline scores for both systolic and diastolic blood pressure were obtained by averaging the final two readings from each baseline period and then averaging across the five baseline averages to obtain an overall baseline value. The final two readings were used to maximize the likelihood that the participants' blood pressure had stabilized at the resting level after the immediately preceding task. An overall baseline value, as opposed to the baseline value obtained before each task, was used for comparison of all tasks, because previous research (30) has shown that an overall baseline value tends to be more stable and a better point of comparison. Overall baseline values for heart rate were obtained by computing the heart rate during the last 5 minutes of each baseline period from the continuous ECG and then averaging across the five baseline values. For blood pressure readings, task scores were obtained by averaging the two readings obtained during each task and then calculating averages for each participant across harassed and nonharassed tasks. Heart rate was computed for each task using the continuous ECG across the entire task and then computing means for harassed and nonharassed tasks. CVR was computed as residualized change scores by regressing the after-task averages for harassed and nonharassed tasks against baseline scores and then taking the nonstandardized residuals as representing the extent to which the blood pressure and heart rate scores for each type of task deviate from what would be expected solely on the basis of baseline values. This procedure, described by Manuck et al. (31), produces change scores that are uncontaminated by differences in baseline values. Because the mean of these residuals is zero by definition, the actual amount of change from baseline to after the task is reduced by the overall mean difference between the baseline and task measurements. To facilitate interpretation of means obtained and to provide a more direct comparison to studies measuring CVR as an arithmetic change from baseline to task, the means are reported with the overall mean difference between baseline and task values added to the residuals. The same procedure was used to compute the baseline, task, and CVR scores for mood scales. To obtain a more stable rating of changes in anger, the four scales associated with anger (angry, frustrated, upset, and irritated) were averaged to obtain an overall anger score. Correlations among the scales for baseline measures and change scores indicated that the measures were closely related to each other. For baseline measures, the interitem correlations ranged from 0.55 to 0.85, whereas for change scores, correlations ranged from 0.53 to 0.74 ($p < .001$ for all correlations). Coefficient α was 0.88 for the combined baseline scales and 0.87 for both changes under harassment and changes without harassment.

Preliminary analyses of ratings of the technician indicated that the five rating scales were highly correlated, with r values ranging in absolute value from 0.49 to 0.80. Furthermore, principal components analysis indicated that all scales loaded onto a single factor, accounting for 66% of the variance. In light of this finding, a summary scale of negative feelings about the technician was constructed by averaging across the five scales after reversing the scales of friendly and agreeable. Coefficient α for this scale was 0.87.

Hypotheses about reactivity were tested using repeated-measures multiple regression with interaction effects by means of the PROC GLM procedure of SAS software (32). In these analyses, race was a categorical variable; DA, a continuous variable; and harassment, a within-subjects variable.

RESULTS

Psychological Responses to Harassment

Key results from this study are shown in Table 2. Our first analyses addressed the question of partici-

TABLE 2. Summary of Reactivity Analyses

Measure	$F(1,80)$	p	R^2
Anger reactivity			
Race	4.38	<.05	0.052
Harassment	4.30	<.05	0.051
Systolic reactivity			
Harassment	5.41	<.05	0.063
Race by DA by harassment	4.78	<.05	0.056
Heart rate reactivity			
DA	5.06	<.05	0.060

pants' psychological responses to harassment. Analysis of residualized change scores for the overall anger index computed from the mood scales of angry, frustrated, upset, and irritated indicated two statistically significant effects. As expected, changes in anger were greater when participants were harassed (mean = 1.20) than when they were not (mean = 0.94, $F(1,80) = 4.30$, $p < .05$, $R^2 = 0.051$). In addition, a significant main effect for race showed that, on average, Indians showed greater anger reactivity (mean = 1.43) than did Chinese (mean = 0.79, $F(1,80) = 4.38$, $p < .05$, $R^2 = 0.052$).

Analyses of the other six mood items indicated only one significant effect. A significant interaction was obtained between race and DA for motivation ($F(1,80) = 4.64$, $p < .05$, $R^2 = 0.055$): higher levels of DA were associated with increases in motivation for Indians ($\beta = 1.15$) but with decreased motivation in Chinese ($\beta = -0.68$).

Cardiovascular Responses to Harassment

The primary analyses of interest concerned the effects of harassment on CVR. Analysis of the data for changes in diastolic blood pressure indicated no statistically significant effects. Two statistically significant effects were obtained for changes in systolic blood pressure. First, a significant main effect was obtained for harassment ($F(1,80) = 5.41$, $p < .05$, $R^2 = 0.063$). Examination of the means indicated that, on average, participants showed greater increases in systolic blood pressure when they were harassed (mean = 9.30) than when they were not (mean = 7.76). Second, a race by DA by harassment effect ($F(1,80) = 4.78$, $p < .05$, $R^2 = 0.056$) was obtained, indicating that the relationship of DA and harassment to systolic reactivity differed by ethnic group. The pattern of this effect, shown in Figure 1, indicated that when Chinese participants were not harassed, there was little difference in systolic reactivity as a function of DA; however, when they were harassed, Chinese participants higher in DA showed greater reactivity. For Indian participants, a positive relationship was obtained between DA and systolic reactivity in both conditions. In addition, for heart rate reactivity, a significant effect was obtained for DA ($F(1,80) = 5.06$, $p < .05$, $R^2 = 0.06$) such that higher levels of DA were associated with greater reactivity ($\beta = 0.23$).

Relationship Between CVR and Self-Reported Changes in Anger

To examine the extent to which CVR during harassment was accompanied by self-reported changes in feelings of anger, changes in the summary anger index were correlated with CVR. In line with previous work indicating that such correlations can be expected to differ for individuals with high and low levels of anger (10), correlations were computed separately by level of DA. For this analysis, participants were classified as low or high in DA on the basis of a median split. As expected, systolic CVR was significantly and positively correlated with anger reactivity for high-DA participants ($r(38) = 0.36$, $p < .05$[1]) but not for low-DA participants ($r(46) = 0.003$, p = NS). Separate examination of Indian and Chinese participants indicated that both groups showed the same pattern. For high-DA participants, the correlations were $r(21) = 0.41$, $p < .05$ and $r(17) = 0.39$, $p < .07$ for Indians and Chinese, respectively; the corresponding correlations for low-DA participants were $r(16) = -0.18$, p = NS and $r(30) = 0.13$, p = NS, respectively. For heart rate reactivity, the correlations between changes in the composite anger index and heart rate reactivity showed the same pattern, with the correlation significant for high-DA participants ($r(38) = 0.41$, $p < .01$) but not for low-DA participants ($r(46) = 0.07$, p = NS). This pattern was not obtained, however, for diastolic reactivity, for which the correlations were −0.04 and 0.07 for high- and low-DA participants, respectively.

To examine the extent to which the statistically significant pattern of systolic reactivity was mediated by changes in anger, regression analyses with interactions relating systolic reactivity to race, DA, and anger reactivity were performed. Because the degree of anger reactivity obviously depends on harassment, separate analyses were performed for the harassment and nonharassment conditions. In line with results obtained

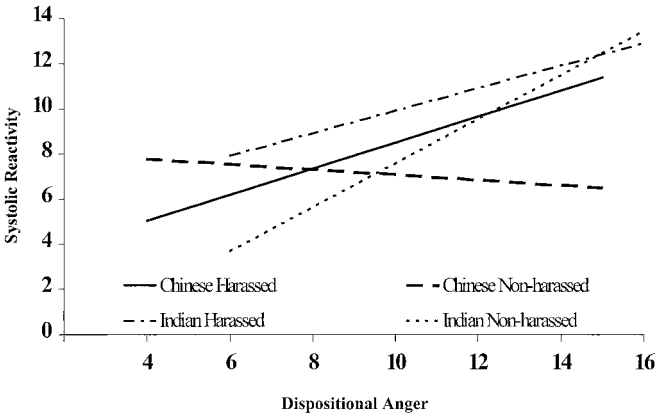

Fig. 1. Systolic reactivity as a function of race, dispositional anger, and harassment.

[1] One-tailed tests of significance were used because the direction of the correlations was predicted.

by Suarez and Williams (10), we expected the DA by anger reactivity effect to be significant. Results of the analyses confirmed this prediction, with significant effects obtained for both conditions (harassment: $F(1,76) = 6.62$, $p < .05$, $R^2 = 0.080$; nonharassment: $F(1,76) = 17.61$, $p < .0001$, $R^2 = 0.188$). The regression lines for these effects are shown in Figures 2 and 3. In both cases, individuals high in DA showed greater systolic reactivity when they also showed higher levels of anger reactivity during the task, whereas individuals low in DA tended to show less systolic reactivity in conjunction with higher levels of anger reactivity. Under harassment, this pattern was found irrespective of race, as indicated by the nonsignificant race by DA by anger reactivity effect ($F(1,76) < 1$, p NS). When participants were not harassed, however, this effect was significant ($F(1,76) = 6.56$, $p < .05$, $R^2 = 0.080$). The pattern for this effect is shown in Figure 4. As shown in this figure, systolic reactivity for Chinese participants showed little difference between those high and low in DA regardless of anger reactivity. In contrast, high-DA Indians showed greater systolic reactivity in conjunction with higher anger reactivity, but those lower in DA showed the opposite pattern.

Reactions to the Experiment and Technician

To determine whether there were systematic differences in the way in which Chinese and Indian participants responded to the experiment and technician, regression analyses using race and DA and their interaction as independent variables were performed on scales used to rate the experiment and technician. Statistically significant effects were found for only two variables. When asked to rate how enjoyable the experiment was, Indian participants rated the experiment as more enjoyable (mean = 6.82) than did Chinese participants (mean = 5.69, $F(1,72) = 8.95$, $p < .01$, $R^2 = 0.111$).

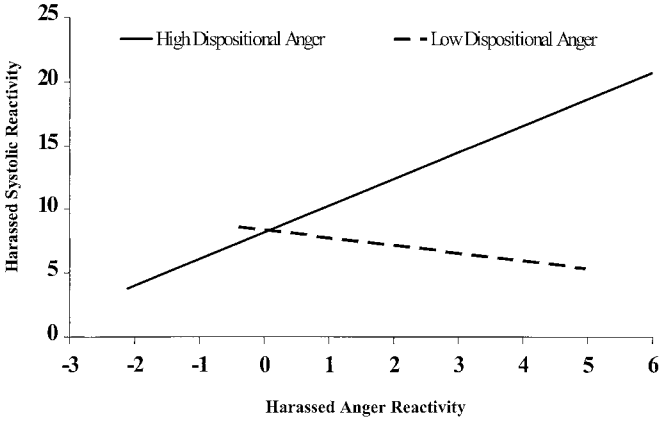

Fig. 2. Systolic reactivity under harassment as a function of dispositional and anger reactivity.

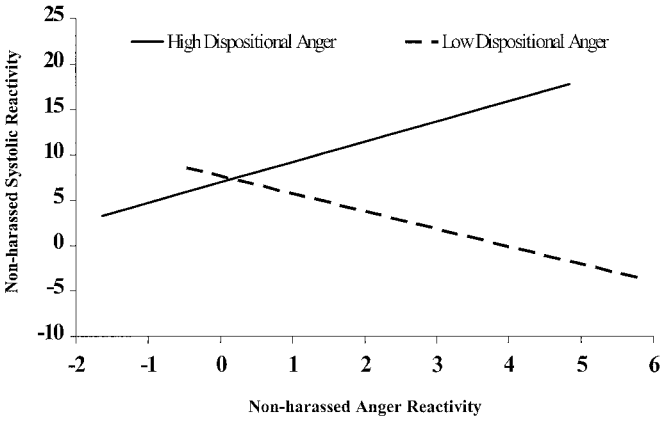

Fig. 3. Systolic reactivity under nonharassment as a function of dispositional anger and anger reactivity.

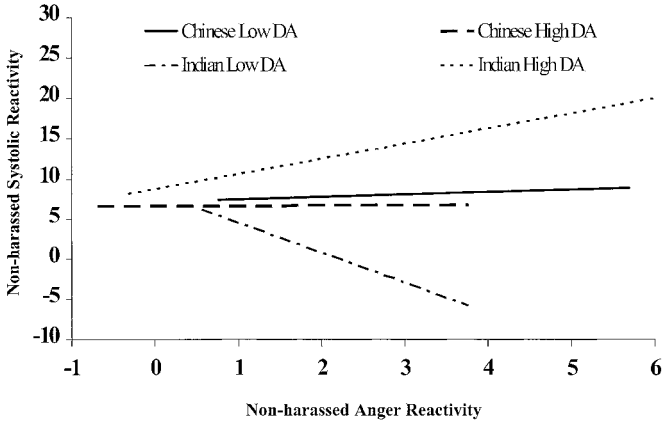

Fig. 4. Systolic reactivity under nonharassment as a function of dispositional anger, anger reactivity, and race.

Responses to the technician were assessed through examination of the composite scores for negative emotional reactions to the technician. Analysis of these scores revealed a significant race by DA effect ($F(1,79) = 10.85$, $p < .01$, $R^2 = 0.120$). Examination of this effect indicated that, whereas for Indians higher levels of DA were associated with more negative ratings of the technician ($\beta = 1.71$), for Chinese higher levels of DA were associated with less negative ratings of the technician ($\beta = -1.33$).

DISCUSSION

The results of this study replicate previous findings demonstrating higher reactivity to harassment for individuals high in DA and point out differences between Chinese and Indian Singaporeans in physiological responses to stress. Analysis of blood pressure

responses indicated that in Chinese participants, DA was positively related to systolic reactivity when they were harassed; however, when they were not harassed, this relationship was not found. In comparison, reactivity in Indian participants was a positive function of DA scores regardless of harassment. Despite the fact that a similar pattern was not found for self-reported changes in anger, evidence from the correlations between anger changes and systolic reactivity as well as analyses of systolic reactivity as a function of DA and anger reactivity indicate that anger plays a mediating role in the systolic reactivity for high-DA participants of both races.

The pattern of results for systolic reactivity is intriguing. For Chinese participants, the results are similar to those found in other studies of the relationship of hostility to CVR. Several studies have demonstrated that individuals high in anger or hostility show higher levels of CVR to socially challenging tasks, such as harassment, but that their CVR to nonsocial tasks is no different than that of persons low in anger or hostility (5, 8, 10). Previous results were obtained in North American populations, and, to the best of our knowledge, this is the first study to demonstrate this effect in an Asian population. The fact that this pattern also occurs among Chinese Singaporeans indicates that it has at least some degree of cross-cultural validity. This is particularly important given the known cultural differences in the experience and expression of emotion discussed earlier.

Even more interesting, however, is the pattern of results obtained among Indians, which indicates some of the limits of this cross-cultural validity. In Indians, higher levels of DA were associated with greater systolic reactivity regardless of harassment. When harassed, Indians showed a pattern directly parallel to that of Chinese participants in this study and to that of North Americans in previous studies. However, in contrast to the results in Chinese as well as other groups in previous studies, the relationship between DA and reactivity was, if anything, stronger when Indian participants were not harassed. Also, it is interesting to note that for low-DA Indian participants, reactivity was noticeably higher for harassed than for nonharassed tasks, whereas for Indians high in DA, systolic response to harassed and nonharassed tasks was nearly identical. Furthermore, the difference between harassed and nonharassed tasks for low-DA Indians was about the same as that for high-DA Chinese. Evidence from both correlations between changes in anger and systolic reactivity and analyses examining the join effects of DA and anger reactivity indicate that the relationship of DA to CVR is mediated by greater changes in anger among high-DA participants. For CVR under harassment, this effect was independent of race, indicating that anger, not race, is the critical variable. When no harassment was present, an interaction with race was obtained, indicating that high-DA Indians showed greater reactivity when the task produced greater increases in anger, whereas the opposite was true for low-DA Indians. In contrast, no relationship was found for Chinese participants regardless of DA.

Clearly this is a pattern that needs to be replicated and explored further before firm conclusions can be drawn. However, such a pattern suggests a generally greater reactivity among Indians and is consistent with the higher level of death due to CHD among Indians noted earlier. If, in fact, higher levels of CVR are predictive of heart disease (cf, Ref. 7), then the facts that 1) high-DA Indians showed high systolic reactivity to both harassed and nonharassed tasks and 2) low-DA Indians showed higher reactivity to harassed than nonharassed tasks (a finding generally found only for individuals high in anger or hostility) would put Indians at higher risk than Chinese.

Before such a conclusion can be drawn, however, a number of questions must be addressed. First, the pattern of findings obtained in our study must be replicated, preferably with a variety of social stressors and with other samples of participants. We found a statistically significant race by DA by harassment effect for systolic reactivity, but the actual changes in blood pressure were relatively modest compared with those found in previous studies. The greatest changes shown in Figure 1 were in the range of 12 to 13 mm Hg, compared with changes of 16 to 18 mm Hg obtained in other studies (8, 10). Also, no effects were obtained for diastolic blood pressure. For heart rate, a sole significant effect was obtained for DA, indicating that heart rate increases were unrelated to either race or harassment. One likely explanation for this pattern of results is that, for practical and ethical reasons, the harassment used in this experiment was relatively mild. Had a stronger harassment been used, the results would most likely have been stronger. Work is currently under way in our laboratory to replicate these findings with tasks producing greater CVR and to investigate cardiovascular responses to naturally occurring stressors using an ambulatory methodology.

Second, it is important to replicate this finding in other populations. The participants in this research were all students in tertiary educational institutions and cannot be considered to be in any way representative of Indian and Chinese Singaporeans. Before it can be concluded that Indians are, in fact, more reactive to social stressors, this finding must be replicated in other groups. Along these lines, we are currently

examining these relationships in police officers, in whom anger-provoking situations can be expected to be relatively prevalent, and other groups to establish the generality of the findings.

Third, the findings obtained in this study are limited because the role of the technician delivering the harassment was played by only one person, who was Chinese. This raises the possibility that the effects obtained for Indians may be due to the fact that the person delivering the harassment was of a different race. Efforts were made to have the harassment statements delivered with as neutral an accent as possible, but participants may have been able to discern the race of the technician. Indians are a minority in Singapore, making up only 7% of the population, whereas Chinese make up approximately 76% of the population. It might be argued that Indians showed greater reactivity because they particularly resented being harassed by a Chinese person. However, if Indians discerned the race of the technician and found harassment by a Chinese to be particularly aversive as compared with Chinese participants, it would seem reasonable that this would be reflected in their ratings of the experiment and the technician. As noted above, however, Indians rated the experiment as more enjoyable than did the Chinese, contradicting the argument that Indians found the experiment more aversive. Also, no main effect was found for race in ratings of the technician. It is true that high-DA Indians rated the technician more negatively than did those lower in DA. However, this is to be expected, because individuals higher in anger or hostility are more likely to see negative traits in others (5). Interestingly, low-DA Chinese rated the technician less favorably than did those higher in DA, a difference that seems counterintuitive and for which we have no explanation. However, this pattern of results does not support the argument that higher reactivity for Indians was due to any greater aversiveness of the harassment situation for them.

Finally, it should be kept in mind that this study operationalized DA through use of the STAXI trait anger/angry reaction subscale. As noted above, this scale was chosen because it measures the extent to which a person tends to become angry in response to provocation, which has been identified as the key construct relating anger/hostility to CVR (5, 29). The use of this scale raises the possibility that the results obtained here are not directly comparable to those of studies that used other measures, such as the more commonly used Cook-Medley Hostility Scale. As such, these results must be replicated using other measures of anger and hostility. Work is currently under way to address this issue through the use of additional measures, including the Interpersonal Hostility Assessment Technique (33), a promising technique for assessing hostility based on the Structured Interview for Type A.

Together, the results of this study provide provocative but still preliminary evidence on ethnic differences in cardiovascular responses to stress among Chinese and Indian Singaporeans. These differences seem to be consistent with the higher CHD death rate among Indians. However, before such a conclusion can be drawn, these results must be replicated using other tasks and population samples and further explored through additional research.

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