Trait Hostility and Ambulatory Cardiovascular Activity:
Responses to Social Interaction

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This study examined trait hostility and social interaction in relation to ambulatory cardiovascular activity in 40 male and 39 female undergraduates. Participants wore an ambulatory blood pressure monitor and completed diary entries while engaged in everyday activities. Diary reports indicating that participants had been talking were used to identify cardiovascular readings taken during social interaction. Interaction effects for overall diastolic blood pressure and heart rate levels indicated that hostility was positively associated with these variables in men only. In addition, hostility was associated with higher systolic blood pressure during social interaction, an effect primarily due to data for men. Because physical activity was controlled statistically, it is likely that these effects were mediated by psychological processes. These findings are consistent with the hypothesis that cardiovascular reactivity to social interaction mediates the relationship between hostility and coronary disease, and they may have implications for understanding sex differences in coronary risk.

Key words: hostility, ambulatory cardiovascular monitoring, social interaction, sex differences

Much of the research that has investigated the relationship between personality and coronary heart disease (CHD) has centered around Type A, a behavior pattern consisting of competitive achievement striving, time urgency, and hostility (Rosenman, Swan, & Carmelli, 1988). Although initial evidence indicated a positive relationship between Type A and CHD, subsequent studies began to yield negative results (for a review, see Siegman, 1994a). One possible explanation for the discrepant findings is that only particular facets of the Type A pattern are deleterious to health. Consistent with this hypothesis, research that differentiated among the various behaviors reflected in structured interviews suggests that hostility may be the toxic component of Pattern A (Hecker, Chesney, Black, & Frautschi, 1988; Matthews, Glass, Rosenman, & Bortner, 1977).

These findings have encouraged researchers to investigate the relationship between CHD and other measures of hostility. Research involving the Cook-Medley Hostility scale (Ho; Cook & Medley, 1954) has been a particularly important source of support for such a relationship. This work has linked high Ho scores to coronary risk (Barefoot, Dahlstrom, & Williams, 1983; Dembroski & Williams, 1989; Matthews, 1988) and to all-cause mortality (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989). Although not all studies have yielded positive findings, the weight of the evidence indicates that hostility is a possible CHD risk factor (for reviews, see Helmers, Poslusny, & Krantz, 1994; Miller, Smith, Turner, Guijarro, & Hallet, 1996; Scheier & Bridges, 1995).

Of the several explanatory models that have been proposed to account for the hostility–CHD relationship (Smith, 1992), the psychophysiological reactivity model has received the most attention. The reactivity model hypothesizes that hostile individuals experience anger more often and more intensely than their nonhostile counterparts (Williams, Barefoot, & Shekelle, 1985). This presumably causes them to experience more frequent and more intense activation of the sympathetic-adrenomedullary (SAM) system. It is suspected that SAM activation promotes the development of coronary artery disease and precipitates clinical CHD (Kamarck & Jennings, 1991; Krantz & Manuck, 1984).

Laboratory investigations have provided some support for the reactivity model. Several laboratory studies have shown that Ho scores predict cardiovascular reactivity, especially in response to interpersonal stressors (Christensen & Smith, 1993; Hardy & Smith, 1988; Powch & Houston, 1996;
et al. (1993) study, personal stress (Powch & Houston, 1996). These findings exhibit cardiovascular reactivity to conditions of high inter-

that, like their male counterparts, high

suggested that psychological factors mediate the relationship between hostility, social interaction, and cardiovascular reactivity. It was expected that hostility would be associated with higher ambulatory blood pressure and heart rate (HR) levels, even after controlling for physical activity. In an effort to capture variation in social interaction, we compared cardiovascular levels under conditions in which participants reported that they had been talking, with levels obtained under conditions in which they reported they had not been talking. As a possible marker for interpersonal stress or emotional involvement, we expected that talking would be associated with greater cardiovascular reactivity among hostile participants. Effects for mood were expected to parallel those for cardiovascular activity. Documentation of these relationships would suggest that social features of the natural environment may be important factors in the relationship of hostility to cardiovascular activity, and that psychological processes may mediate this relationship.

Method

Participants

Participants were 40 male and 39 female undergraduates at Rutgers University. The students were recruited from undergraduate classes and professional societies. Each received $10 for participating in the study.

Procedure

Ambulatory monitoring took place on weekdays while classes were in session. To increase the likelihood that participants would be engaged in a variety of activities during ambulatory monitoring, participants were scheduled such that they attended classes or worked or did both on the day of monitoring. Participants wore the monitor during the waking part of 1 day for an average of 11.7 hr. They arrived at the laboratory in the morning and were set up with the monitor. A trained technician assured monitoring accuracy by checking that readings were within ±5 mmHg of those obtained using a stethoscope and mercury sphygmomanometer that took simultaneous measurements from the same arm. The participant was sitting for three of these readings and standing for three. Participants were kept blind to their cardiovascular data during the setup. The Accutracker II (Suntech Medical Instruments, Raleigh, NC) ambulatory blood pressure monitor was used to acquire both baseline and ambulatory readings of SBP, DBP, and HR. The Accutracker II determines blood pressure noninvasively by using the auscultatory method and also measures HR by three electrocardiogram electrodes attached to the chest. Light, Obrist, and Cubeddu (1988) have described the monitor in detail.

The monitor was programmed to take readings of SBP, DBP, and average DBP levels in men, but not in women. This suggests that the relationship between Ho hostility and naturalistic cardiovascular activity may be stronger in men. These sex differences, if confirmed, may have implications for understanding the greater incidence of CHD in men compared with women (Stoney & Engebretson, 1994).

For the foregoing reasons, researchers have begun to investigate the relationship between hostility and cardiovascular activity in the natural environment. To date, however, we are aware of only two studies that have investigated the relationship between Ho scores and ambulatory cardiovascular activity. In a study of male paramedics, Jamner, Shapiro, Goldstein, and Hug (1991) found that high Ho scores predicted greater mean systolic blood pressure (SBP), both while participants were awake and asleep. Additionally, Ho scores interacted with location to predict diastolic blood pressure (DBP). The form of the interaction suggested that locations associated with interpersonal stress produced higher DBP among high Ho paramedics. However, because social interaction was not directly assessed, this provocative finding offers only suggestive support for the hypothesis that, as with laboratory stressors, naturalistic social stressors, in particular, produce cardiovascular hyperreactivity among high hostile individuals (Suls & Wan, 1993). This highlights the need for additional naturalistic research that specifically examines the effects of trait hostility and social interaction on cardiovascular activity. A second naturalistic study, conducted by Linden, Chambers, Maurice, and Lenz (1993), linked Ho scores to ambulatory DBP levels in male undergraduates, but the study did not involve an assessment of social interaction.

Unfortunately, neither of the above studies explicitly controlled for the effects of body position. Changes in position exert comparatively large effects on cardiovascular activity (Gellman et al., 1990; Schwartz, Warren, & Pickering, 1994). Thus, findings obtained in the studies cited above may have reflected differences in physical activity between high and low Ho individuals. Resolution of this issue is necessary to determine whether psychological mechanisms link hostility to naturalistic cardiovascular activity. For this reason, the present study was designed to determine whether hostility is related to ambulatory cardiovascular activity independently of position effects.

Additional research is also required to examine the relationship of Ho scores to ambulatory cardiovascular activity in women, who have generally been underrepresented in such studies. Recent laboratory evidence indicates that, like their male counterparts, high Ho hostility women exhibit cardiovascular reactivity to conditions of high interpersonal stress (Powch & Houston, 1996). These findings need to be extended to the natural environment. The Jamner et al. (1991) study did not include women. And in the Linden et al. (1993) study, Ho scores were positively related to position exert comparatively large effects on cardiovascular activity (Gellman et al., 1990; Schwartz, Warren, & Pickering, 1994). Thus, findings obtained in the studies cited above may have reflected differences in physical activity between high and low Ho individuals. Resolution of this issue is necessary to determine whether psychological mechanisms link hostility to naturalistic cardiovascular activity. For this reason, the present study was designed to determine whether hostility is related to ambulatory cardiovascular activity independently of position effects.

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HR every 20 min on the average. The time between readings varied randomly within the range of 15 to 25 min, thereby reducing participants' ability to anticipate cuff inflation. To minimize participant discomfort, the monitor was set to operate in dynamic inflation mode. Operation in this mode causes the monitor to inflate the arm cuff to 30 mmHg higher than the SBP recorded on the preceding reading. If the dynamic inflation cuff pressure was insufficient to achieve complete arterial occlusion, the monitor took another reading 4 min later, at which time it inflated the cuff to the maximum pressure. The monitor did not display cardiovascular data during the ambulatory period, thus keeping participants blind to their cardiovascular readings.

After each reading, participants completed an entry in the diary we provided. The diary assessed a number of variables, including (a) body position: lying down, sitting, standing, or walking; (b) social interaction: talking; (c) social context: alone, family, friends, peers, significant other, or other(s); and (d) location: work, home, in transit, class, library, or elsewhere. The diary also assessed whether the participant was currently driving or commuting, and had, since the last reading, consumed nicotine, caffeine, a snack, or a meal, or engaged in exercise. Finally, each diary entry included a mood scale consisting of the 10 positive affect and 10 negative affect items from the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) as well as the items angry, sad, anxious, happy, depressed, relaxed, stressed, and pressed for time. Participants returned the monitor to the laboratory the following day, at which time they completed a questionnaire battery that included the Ho scale.

Analysis

Selection of ambulatory readings. Readings were deleted if they violated any of the following criteria: SBP < 50 mmHg or > 200 mmHg, DBP < 30 mmHg or > 140 mmHg, HR < 40 beats per minute (bpm) or > 200 bpm. Additionally, the Accutrack II flags readings with test codes if they are very likely to be erroneous because of factors such as major arm movement, low cuff pressure, or weak Korotokoff sounds. As per the manufacturer's recommendation (Suntech Medical Instruments, 1991), readings that generated test codes were deleted, except where the test code indicated only minor arm movement. The latter data were retained if they satisfied all other criteria.

As the monitor records cardiovascular data, it compares them with a group of preset criteria (e.g., difference between successive SBP readings < 50 mmHg), as detailed in the operating manual (Suntech Medical Instruments, 1991). Violation of a criterion causes the monitor to flag the reading with a quality code and to take another reading 4 min later. A quality code indicates that a reading was markedly dissimilar to the preceding reading. However, it does not necessarily indicate that the reading was erroneous, as does a test code, because cardiovascular activity may actually change significantly from one reading to the next. Therefore, quality code readings were retained unless values deviated from the participant’s overall mean by more than two standard deviations within the participant’s own distribution. This procedure permits the retention of both the quality code reading and its corresponding retry should they both satisfy all other criteria. On the average, each participant provided 33.8 ambulatory readings that met all criteria. This corresponded to retention of 83% of all readings taken during the ambulatory monitoring period.

Cardiovascular variables. Baseline and ambulatory cardiovascular activity was measured by calculating mean values of SBP, DBP, and HR separately for different conditions. For both baseline and ambulatory data, mean values were computed for both the sitting and the standing position. In addition, mean values of ambulatory cardiovascular activity were calculated separately for conditions of both high and low social interaction for the sitting position. The level of social interaction was defined by using participants’ responses to the diary item pertaining to talking.

To ensure reliability of the cardiovascular means, we conducted analyses with data from participants who provided at least three readings for each within-subject condition. Work by Liabre et al. (1988) indicated that three to six ambulatory readings taken within a particular location, such as home or work, are required to provide reliable means. Because we controlled for position, a variable that accounts for more variability in ambulatory cardiovascular activity than does location (Gellman et al., 1990; Schwartz et al., 1994), setting the criterion of the current study at the lower end of this range is justified.

Mood variables. Anger and negative affect were assessed by the ambulatory diary. Anger was measured with the items angry, irritable, and hostile. The latter two items were also included in the Negative Affect scale of the PANAS. At each cardiovascular reading, participants indicated how strongly they currently felt each affect item by using a 7-point Likert scale that ranged from 1 (not at all) to 7 (extremely). For each participant, mean anger and negative affect scores were calculated separately for the conditions of talking and not talking (high and low social interaction).

Hostility. The 50-item Ho scale (Cook & Medley, 1954) was used to measure trait hostility (Cronbach's α = .82). Response options for each item ranged from 1 (strongly disagree) to 6 (strongly agree). We chose not to use the traditional true-or-false response format, because it has been our experience that college students often resist making such dichotomous responses. Other investigators have taken a similar approach. For example Weidner, Friend, Ficarrotto, and Mendell (1989) used a Likert-scale response format and obtained a significant association between Ho scores and both cardiovascular reactivity and anger ratings in response to a performance challenge. In the current study, male–female differences in Ho responses were not significant, although men (M = 3.43, SD = 0.35, Mdn = 3.46) did tend to score somewhat higher than women (M = 3.29, SD = 0.44, Mdn = 3.26), t(77) = 1.54, p < .13. Participants were identified as high or low Ho by median splits. Median splits were performed separately for men and women to reduce the correlation between Sex and Ho, and to keep the cell ns reasonable. This procedure resulted in 21 low Ho men (M = 3.20, SD = 0.28), 19 high Ho men (M = 3.69, SD = 0.21), 20 low Ho women (M = 2.96, SD = 0.30), and 19 high Ho women (M = 3.65, SD = 0.25).

Repeated measures analyses. The cardiovascular data were analyzed with repeated measures analyses of variance (ANOVA)s. The purposes of the analyses were twofold. The first was to test for...
Table 1
Baseline Cardiovascular Activity While Sitting and Standing

<table>
<thead>
<tr>
<th></th>
<th>Participants</th>
<th>SBP</th>
<th></th>
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<th>HR</th>
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<td>Sitting</td>
<td>Standing</td>
<td>Sitting</td>
<td>Standing</td>
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<tr>
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<tr>
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<td>11.3</td>
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<td>109.8</td>
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<td>117.9</td>
<td>62.3</td>
<td>75.8</td>
<td>64.1</td>
<td>72.0</td>
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</tr>
<tr>
<td>SD</td>
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<td>6.5</td>
<td>5.6</td>
<td>9.9</td>
<td>10.6</td>
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<tr>
<td>High Ho (n = 19)</td>
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<tr>
<td>M</td>
<td>109.5</td>
<td>113.9</td>
<td>64.5</td>
<td>77.7</td>
<td>70.1</td>
<td>80.8</td>
<td></td>
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<tr>
<td>SD</td>
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<td>8.8</td>
<td>6.8</td>
<td>9.9</td>
<td>9.7</td>
<td></td>
</tr>
</tbody>
</table>

Note. For systolic blood pressure (SBP): Sex, p < .001; Position, p < .001. For diastolic blood pressure (DBP): Position, p < .001; Sex × Position, p < .001. For heart rate (HR): Sex, p < .002; Position, p < .001. Ho = Cook–Medley Hostility scale.

the between-subject effects of sex and hostility on ambulatory cardiovascular levels. In so doing, effects of body position were controlled because otherwise a positive relationship between hostility and cardiovascular activity could arise if hostile individuals had a tendency to stand and walk more than nonhostile individuals did. Accounting for position effects provides a more direct test of the hypothesis that any between-subjects effects that might be obtained for hostility are due to psychological factors and not differences in physical activity. Accordingly, two sets of analyses were conducted, one for baseline data and one for ambulatory data. In each case, between-subject effects of sex and hostility were examined by using 2 × 2 × 2 (Sex × Hostility × Position) repeated measures ANOVAs, where Position was the repeated measures factor. A participant’s data were included in an analysis if there were at least three valid sitting readings and three valid standing readings. For baseline analyses, data were available for all 79 participants, whereas 63 participants provided sufficient data for analyses of ambulatory readings.

The second purpose of the analyses was to test the reactivity hypothesis, that is, to determine whether hostile persons experience greater cardiovascular reactivity in the natural environment to social interaction as indexed by talking. This question was examined by using 2 × 2 × 2 (Sex × Hostility × Talking) repeated measures ANOVAs, where Talking was the repeated measures factor. To control for position effects, only readings taken in the sitting position were analyzed. Because we required at least three readings in both the talking and not-talking conditions, data for these analyses were available only for 38 participants, with the number of participants in each between-subjects cell ranging from 5 to 15. The effects of talking while in the other physical positions (lying down, standing, walking) were not examined because too few participants (ns ≤ 13) had at least three readings in both the talking and not-talking conditions for any of these positions.

The effects of sex, hostility, and hostilities interaction on anger and negative affect were also examined by using 2 × 2 × 2 (Sex × Hostility × Talking) repeated measures ANOVAs in which Talking was the repeated measures factor. Fifty-six participants had three or more mood scores for each condition and therefore could be included in the analyses.

Results

Descriptive Data

A questionnaire administered along with the Ho was used to obtain information on a number of participant characteristics, including age (M = 20.9, SD = 2.4), body mass index (kilogram/meter²; M = 22.5, SD = 3.3), ethnicity (5 Asian, 4 Black, 67 White, 3 Other), parental hypertensive status (36% positive), and number of physical symptoms reported for the past 6 months (M = 8.0, SD = 4.2). Ambulatory diary responses indicated that 8% of participants smoked and 37% drank coffee.

Analyses were conducted to determine how these variables were related to sex and hostility. As expected, body mass index scores were greater for men than for women (23.5 kg/m² vs. 21.6 kg/m², p < .01). It was also found that men were less likely than women to drink coffee (23% vs. 51%, p < .01). Otherwise, sex and hostility were not related to these variables.

Effects of Sex, Hostility, and Body Position on Baseline Cardiovascular Activity

Baseline cardiovascular results are presented in Table 1. Compared with women, men exhibited greater baseline SBP,
### Table 2
Ambulatory Cardiovascular Activity While Sitting and Standing

<table>
<thead>
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<th>Participants</th>
<th>SBP</th>
<th>DBP</th>
<th>HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Ho (n = 15)</td>
<td>Sitting</td>
<td>Standing</td>
<td>Sitting</td>
</tr>
<tr>
<td>Women</td>
<td>M</td>
<td>112.8</td>
<td>116.7</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>10.8</td>
<td>9.9</td>
</tr>
<tr>
<td>High Ho (n = 16)</td>
<td>M</td>
<td>114.7</td>
<td>117.7</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>8.9</td>
<td>7.7</td>
</tr>
<tr>
<td>Men</td>
<td>Low Ho (n = 20)</td>
<td>M</td>
<td>125.3</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>7.4</td>
<td>8.9</td>
</tr>
<tr>
<td>High Ho (n = 12)</td>
<td>M</td>
<td>125.9</td>
<td>129.7</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>11.3</td>
<td>11.9</td>
</tr>
</tbody>
</table>

Note. For systolic blood pressure (SBP): Sex, p < .001; Position, p < .001. For diastolic blood pressure (DBP): Sex × Ho, p < .05; Position, p < .001. For heart rate (HR): Sex, p < .02; Sex × Ho, p < .05; Position, p < .001. Ho = Cook–Medley Hostility scale.

\[ F(1, 75) = 12.63, p < .001, \text{ effect size (ES)}^4 = 7.6 \text{ mmHg}, \]
and lower baseline HR, \( F(1, 75) = 10.63, p = .002, \text{ ES} = 7.2 \text{ bpm} \). Men and women did not differ with respect to baseline DBP (\( F < 1 \)). Although Hostility was positively related to baseline HR, this relationship was only marginally significant, \( F(1, 75) = 3.61, p < .07, \text{ ES} = 4.2 \text{ bpm} \). No other main effects for Hostility or for its interaction with Sex were obtained (\( p > .10 \)).

Changing body Position from sitting to standing produced increases in baseline SBP, DBP, and HR: \( F(1, 75) = 19.45, p < .001, \text{ ES} = 5.7 \text{ mmHg} \); \( F(1, 75) = 14.78, p < .001, \text{ ES} = 2.9 \text{ mmHg} \); and \( F(1, 75) = 94.08, p < .001, \text{ ES} = 7.3 \text{ bpm} \), respectively. Sex interacted with Position to predict baseline DBP, \( F(1, 75) = 10.97, p < .001, \text{ ES} = 2.0 \text{ mmHg} \). Simple-effects tests revealed that standing DBP was greater than sitting DBP in both men and women (\( p < .001 \)), although men exhibited greater differences in DBP between the two positions. No other interactions of Sex or Hostility or both with Position were found at baseline (\( p > .07 \)).

Effects of Sex, Hostility, and Body Position on Ambulatory Cardiovascular Activity

Results for ambulatory cardiovascular activity are presented in Table 2. Consistent with the findings for baseline data, significant effects for Sex were found for SBP and HR but not for DBP. Specifically, men had greater SBP, \( F(1, 59) = 27.58, p < .001, \text{ ES} = 12.0 \text{ mmHg} \); and lower HR, \( F(1, 59) = 5.85, p < .02, \text{ ES} = 7.3 \text{ bpm} \), than women had. In addition, although no significant main effects emerged for Hostility, Sex and Hostility did interact to predict both DBP, \( F(1, 59) = 3.99, p = .05, \text{ ES} = 2.8 \text{ mmHg} \), and HR, \( F(1, 59) = 4.23, p < .05, \text{ ES} = 5.0 \text{ bpm} \). The interaction for DBP reflects greater average DBP levels for high Ho men compared with low Ho men, a difference of marginal significance (\( p < .15 \)) as determined by simple-effects tests. By contrast, high Ho women had lower DBP levels than their low Ho counterparts, although this difference did not approach significance. A similar pattern was evident for HR in that ambulatory HR for high Ho men was greater than that of low Ho men (\( p < .05 \)), whereas there was little difference between ambulatory HR for high and low Ho women.

In comparison to sitting, the standing position was associated with greater SBP, \( F(1, 59) = 19.45, p < .001, \text{ ES} = 5.7 \text{ mmHg} \); \( F(1, 59) = 14.78, p < .001, \text{ ES} = 2.9 \text{ mmHg} \); and HR, \( F(1, 59) = 94.08, p < .001, \text{ ES} = 7.3 \text{ bpm} \). Body Position did not interact with either Sex or Hostility to predict any measure of ambulatory cardiovascular activity (\( F < 1 \)).

### Effects of Social Interaction on Ambulatory Cardiovascular Activity

As detailed in the Method section, a third set of analyses tested the cardiovascular reactivity hypothesis as it relates to hostility and social interaction. Specifically, repeated measures ANOVAs tested the interaction of the between-subjects factors (Sex and Hostility) with the within-subjects factor of social interaction (Not-Talking, Talking). To focus on psychological factors associated with social interactions, we controlled for physical activity by restricting analyses to readings obtained while participants were sitting. Inclusion of a participant’s data in these analyses required having at least three valid cardiovascular readings under conditions of both sitting–not-talking, and sitting–talking. Thirty-eight participants met this criterion. Because between-subjects

\[ ^4 \text{Effect size estimates are identical to unstandardized regression weights in that they denote the amount of change in the dependent variable predicted by a unit change in the predictor variable. In the current analysis, a unit change in the predictor variable corresponds to the qualitative difference associated with a participant being categorized as a man as opposed to a woman. Thus, other factors being equal, a man's baseline SBP is predicted to be 7.6 mmHg greater than that of a woman. } \]
Table 3
Sitting Ambulatory Cardiovascular Activity While Not Talking and Talking

<table>
<thead>
<tr>
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<td>Not talking</td>
<td>Talking</td>
<td>Not talking</td>
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<td>68.5</td>
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<td>4.1</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>High Ho (n = 5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M 126.8</td>
<td>133.3</td>
<td></td>
<td>69.5</td>
<td>73.7</td>
</tr>
<tr>
<td></td>
<td>SD 10.8</td>
<td>11.6</td>
<td></td>
<td>7.5</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Note. Only within-subject effects are reported. Because too few participants had sufficient readings in the standing position, only sitting readings were analyzed. For systolic blood pressure (SBP): Talking, p < .04; Ho × Talking, p < .03. For diastolic blood pressure (DBP): Talking, p < .002. Ho = Cook–Medley Hostility scale.

Effects were assessed in the larger sample (n = 63) of the previous set of analyses, we do not report between-subject results from the current analyses that include fewer participants.

Table 3 presents mean cardiovascular values under conditions of both talking and not talking. Talking was associated with greater SBP, \( F(1, 34) = 4.98, p < .04, ES = 1.9 \) mmHg, and DBP, \( F(1, 34) = 10.97, p = .002, ES = 2.8 \) mmHg, but not with greater HR (F < 1). In addition, Hostility interacted with Talking to predict SBP, \( F(1, 34) = 5.42, p < .03, ES = 2.0 \) mmHg. Simple-effects tests indicated that Talking was associated with SBP reactivity among high Ho participants (p < .01), but not among low Ho participants. Figure 1 shows the form of this interaction. A similar interaction of Hostility and Talking was also found for HR, although it failed to attain significance, \( F(1, 34) = 3.02, p < .10 \). No Hostility × Talking interaction was evident for DBP (F < 1). Finally, neither the Sex × Talking interaction nor the three-way interaction of Sex × Hostility × Talking predicted ambulatory SBP, DBP, or HR reactivity (p > .10).

Effects of Sex, Hostility, and Social Interaction on Mood

Table 4 presents anger and negative affect data for high and low Ho men and women under both not-talking and talking conditions.

**Anger.** High Ho individuals reported higher levels of anger, \( F(1, 52) = 4.97, p = .03 \). A marginally significant interaction between Sex and Hostility also emerged, \( F(1, 52) = 3.45, p < .07 \). Simple effects indicated that high Ho men reported more anger than their low Ho counterparts (p < .05), whereas anger reports from high and low Ho women were not significantly different. Talking exhibited no effect on anger reports, nor did Sex or Hostility interact with Talking to predict anger.

**Negative affect.** Neither Sex, Hostility, nor their interaction predicted negative affect levels. However, the three-way interaction of Sex, Hostility, and Talking was significant, \( F(1, 52) = 6.62, p < .02 \). This interaction primarily reflects the tendency of high Ho men to report less negative affect while talking than while not talking (p < .01). Low Ho women also reported less negative affect while talking, although the simple effect was of only marginal significance.

![Figure 1](image-url)
(p < .10). Talking and negative affect were unrelated among low Ho men and high Ho women. Otherwise, neither Talking nor its two-way interactions with Sex or Hostility were significantly related to negative affect.

### Discussion

Results of this study indicated that sex interacted with Ho hostility to predict ambulatory cardiovascular activity. Specifically, men with higher Ho scores tended to have greater ambulatory DBP and HR levels than did men with low Ho scores. Women, on the other hand, exhibited no relationship between Ho scores and cardiovascular levels. In addition, high Ho participants exhibited SBP reactivity to social interaction as indexed by talking, whereas no reactivity was found among low Ho individuals. These findings concur with previous psychophysiological research on trait hostility and extend that literature in a number of ways.

Findings of this study are in accord with previous research linking high Ho scores to elevated ambulatory SBP levels in men (Jamner et al., 1991; Linden et al., 1993). They also confirm and extend the observations of Linden et al. (1993) regarding sex differences and the Ho. Linden et al. analyzed data separately for each sex and found Ho scores to be positively related to DBP for men but not for women. We explicitly tested the Sex × Ho Hostility interaction and found it to be significant, reflecting a stronger relationship between Ho hostility and DBP for men than for women. Findings of this study are also consistent with the results reported by Lundberg, Hedman, Melin, and Frankenhausener (1989). Lundberg et al. found that hostility assessed by the structured interview was positively related to ambulatory HR levels in men but not in women, although a direct test of the Sex × Hostility interaction was not reported.

The current study is the first to assess directly the interaction of trait hostility and naturalistic social challenge. Analyses yielded a significant interaction effect, indicating that high Ho individuals, but not low Ho individuals, exhibited greater SBP reactivity to conditions involving social interaction as reflected in diary entries indicating that the participant had been talking. This effect was most pronounced in high Ho men. These findings are consistent with the hypothesis that cardiovascular reactivity to factors associated with social interaction mediates the relationship between trait hostility and CHD. They are also in partial agreement with those of Jamner et al. (1991), in which DBP was greatest among high Ho men in a location presumed to be associated with a high level of interpersonal stress. Likewise, these results partially confirm evidence from laboratory studies indicating that Ho hostility predicts cardiovascular reactivity to interpersonal stressors, although DBP hyperreactivity is most typically reported (Suls & Wan, 1993).

The present study also extends previous research by explicitly controlling for the effects of body position while examining the relationships of sex, Ho hostility, and social interaction to ambulatory cardiovascular activity. Data indicating an association between hostility and cardiovascular activity among men, independent of position, argue against the possibility that previous findings reflect differences in physical activity between high and low Ho men. Rather, these data strengthen the case that psychological factors may be responsible for the greater cardiovascular levels of high Ho men in the natural environment and for the greater cardiovascular reactivity observed among high Ho individuals in response to conditions of social interaction.

The basis for sex differences in the relationship of hostility to naturalistic cardiovascular activity is unclear. Because baseline cardiovascular data did not produce parallel findings, the Sex × Ho effects appear to have been generated in response to participants' usual daily activities. Furthermore, because means and standard deviations for Ho scores did not differ between men and women, the interaction of sex with hostility on naturalistic cardiovascular activity apparently did not result from men being more

### Table 4

<table>
<thead>
<tr>
<th>Participants</th>
<th>Anger</th>
<th>Negative affect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not talking</td>
<td>Talking</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Ho (n = 17)</td>
<td>1.23</td>
<td>1.20</td>
</tr>
<tr>
<td>M</td>
<td>1.23</td>
<td>1.20</td>
</tr>
<tr>
<td>SD</td>
<td>0.19</td>
<td>0.25</td>
</tr>
<tr>
<td>High Ho (n = 16)</td>
<td>1.23</td>
<td>1.24</td>
</tr>
<tr>
<td>M</td>
<td>1.23</td>
<td>1.24</td>
</tr>
<tr>
<td>SD</td>
<td>0.24</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Ho (n = 11)</td>
<td>1.17</td>
<td>1.22</td>
</tr>
<tr>
<td>M</td>
<td>1.17</td>
<td>1.22</td>
</tr>
<tr>
<td>SD</td>
<td>0.16</td>
<td>0.26</td>
</tr>
<tr>
<td>High Ho (n = 12)</td>
<td>1.50</td>
<td>1.43</td>
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<td>M</td>
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<td>1.43</td>
</tr>
<tr>
<td>SD</td>
<td>0.37</td>
<td>0.36</td>
</tr>
</tbody>
</table>

**Note.** For anger: Ho, p = .03. For negative affect: Sex × Ho × Talking, p < .02. Ho = Cook–Medley Hostility scale.
dispositionally hostile. Instead, these findings suggest that a given Ho score may have different ramifications for men and women. The Ho may reflect different psychological attributes in men and women, or it may be that the same attributes relate differently to physiological processes in the two sexes. These possibilities can only be cast in general form at the present time and underscore the need for additional measurement-oriented work in this area (Contrada & Jussim, 1992; Steinberg & Jorgensen, 1996; Stoney & Engebretson, 1994).

The pattern of cardiovascular findings obtained across the different analyses reported in this article raises questions about underlying physiologic mechanisms. Positive relationships between hostility and overall ambulatory DBP and HR levels for men suggest increased sympathetic nervous system activity, as do positive relationships between hostility and SBP reactivity to social interaction. It is also possible that decreased parasympathetic activity played a role in producing these associations, particularly that involving HR. However, it is not clear why DBP and HR effects were obtained in the absence of SBP effects in the data for ambulatory levels, whereas the reverse was true for the social interaction effects. Although it might be possible to speculate about different patterns of autonomic activity underlying overall and talking-related ambulatory readings, this would go beyond the information provided by the available data. However, the positive relationships between hostility and cardiovascular measures obtained in this study do suggest greater sympathetic nervous system activity or lesser parasympathetic nervous system activity, or both, in high Ho participants. Therefore, the findings of this study are generally consistent with hypotheses about the processes whereby hostility contributes to disease.

With regard to mood, high Ho individuals reported higher levels of anger overall than did their low Ho counterparts. These data are consistent with the literature reporting positive associations between hostility and exposure to psychosocial factors likely to produce negative emotionality (Smith, 1992). However, high Ho persons did not report greater anger during social interaction. In fact, sex, hostility, and social interaction interacted such that high Ho men reported more negative affect when not talking and less when they were. These results seem to be at odds with data indicating that hostile persons exhibit greater cardiovascular reactivity while talking with others. However, the processes by which hostility produces cardiovascular effects may not always be associated with negative affect. For example, hostile individuals may prefer to dominate social situations and therefore may engage in a form of active coping when interacting with others. Active coping can increase cardiovascular activity without producing concomitant increases in measures of subjective states such as negative affect (Obrist, 1981). Other possible explanations for the dissociation of cardiovascular and mood measures in this study include psychological processes involved in emotion-focused coping (Newton & Contrada, 1992) and limitations of self-report measures.

Although consistent with theoretical expectations and previous findings, the present results should be viewed with caution. Because the effects of trait hostility and social interaction on cardiovascular activity were obtained from analyses that included only a subset of the original participants, their generalizability may be limited. Moreover, diary entries indicating that the participant had been talking provide an imperfect marker for social interaction. Whereas “talking” strongly suggests that social interaction is taking place, an individual could still be interacting with another person under not-talking conditions. Additionally, body movements associated with talking may have influenced the cardiovascular data. Although the present study used procedures to identify and remove artificial data, the latter point raises the possibility that speech-related motor activity or its physiologic requirements, or both, contributed to the differences between high and low Ho participants. Indeed, the mere act of speaking has been found to produce cardiovascular elevations (e.g., Brown, Szabo, & Seraganian, 1988). However, other researchers have concluded that speech-related cardiovascular effects are due primarily to psychological factors such as evaluation apprehension or emotional involvement and not to the physiological requirements of speech itself (Linden, 1987; Siegman, 1994b). Although a psychological interpretation would seem more plausible given the interaction of talking with personality hostility, the present data do not unequivocally rule out a role for speech-related motor activity.

In summary, the results of this study are consistent with the reactivity model of hostility and coronary disease in suggesting that high Ho individuals show cardiovascular responsiveness to social interactions. This demonstrates the potential utility of categorizing naturalistic situations according to their psychological importance for hostile individuals. The present findings also encourage further examination of talking and other diary indicators of social interaction in research that seeks to link ecological momentary analysis to physiologic measurements taken in ambulatory individuals.

References


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**Call for Nominations**

The Publications and Communications Board has opened nominations for the editorships of *Experimental and Clinical Psychopharmacology, Journal of Experimental Psychology: Human Perception and Performance (JEP:HPP), Journal of Counseling Psychology,* and *Clinician’s Research Digest* for the years 2000–2005. Charles R. Schuster, PhD, Thomas H. Carr, PhD, Clara E. Hill, PhD, and Douglas K. Snyder, PhD, respectively, are the incumbent editors.

Candidates should be members of APA and should be available to start receiving manuscripts in early 1999 to prepare for issues published in 2000. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations are also encouraged.

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