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Influence of Apologies and Trait Hostility on Recovery from Anger

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While there is growing evidence that quick recovery from stress is health-protective, relatively little is known about what factors affect recovery rates. We tested whether recovery from anger can be diffused with apologies. 184 participants performed a stress task involving verbal harassment and apologies. Participants were randomly assigned to one of four conditions: non-harassed control, good apology, pseudo-apology, or no apology. Measures of blood pressure and heart rate were taken at baseline, task and recovery periods. Participants scoring high in trait hostility displayed faster systolic blood pressure recovery when they received a genuine apology, but recovered more slowly when they received a pseudo-apology or no apology. Apologies did not influence subjective anger ratings. It was concluded that apologies may accelerate cardiovascular anger recovery among those with hostile personality predispositions.

KEY WORDS: cardiovascular recovery; apology; hostility; blood pressure; heart rate.

Psychological research examining the relationship between stress and cardiovascular disease has focused on how individual personality characteristics interact with stressors such that some people develop illness while others do not. A disposition toward exaggerated stress reactivity may contribute to disease development (Treiber *et al.*, 2003) and the rate of recovery from such stress responses is particularly critical for understanding the pathway from acute stress to disease (Anderson *et al.*, 2005; Linden *et al.*, 1997; Schwartz *et al.*, 2003). The current study examines how a critical individual difference, namely hostility, and a systematic attempt to accelerate recovery via apologies affect cardiovascular functioning following interpersonal conflict.

Reactivity and Recovery

There is promising evidence that slow physiological recovery from psychologically based stress reactivity may be critical for subsequent disease development (Linden *et al.*, 1997) but there is very limited knowledge about strategies that can be systematically used to facilitate or accelerate recovery. One such documented strategy is simple distraction, thought to be effective by preventing hostile rumination (Glynn *et al.*, 2002; Schwartz *et al.*, 2003). For the current study, we sought to investigate for the first time whether apologies offered by the 'offending party' can effectively diffuse anger thereby facilitating cardiovascular recovery. Common wisdom, of course, tells us that apologies are useful and needed but this insight has little research backing to date.

It is not difficult to place the potential role of apologies into existing stress-disease pathway models. Stress reactivity has traditionally been viewed within the context of the *fight or flight model* proposed by Cannon (1929), expanded later by Selye (1976) to include three phases: (1) activation, (2) resistance and (3) exhaustion. Within Selye's model, whenever an organism encounters a perceived threatening stimulus, physiological changes occur within that organism (activation) in order to better its ability to fight or flee from the threat (resistance).

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Activation and resistance to threat maintained beyond the organism's available resources results in exhaustion. It has been proposed that physiological activation beyond the resistance phase (i.e., failure to recover) contributes to disease processes (Linden *et al.*, 1997).

Anger and hostility predispositions may play critical mediating or moderating roles in defining an at-risk status. It has been found that those scoring high in hostility show exaggerated systolic blood pressure stress reactivity (Diamond *et al.*, 1984; McCann and Matthews, 1988), and meta-analysis has further supported that such hyperreactivity in at-risk individuals is most likely to arise if tasks indeed provoke anger (Suls and Wan, 1993). Some have found that one subtype of hostility, namely cynical hostility, is related to hyperreactivity (Christensen and Smith, 1993; Powch and Houston, 1996). Furthermore, all interpersonal stress is given a particularly important role because it is the type of stressor associated with the slowest recoveries (DeLongis *et al.*, 1988; Linden *et al.*, 1998).

In addition to work relating components of hostility to acute cardiovascular reactivity, some recent attention has turned towards examination of rate of recovery following a laboratory stressor. It has been theorized that negative emotions such as anger induce greater physiological arousal within an organism than do positive emotions and that once aroused, organisms minimize that arousal via homeostatic mechanisms (Taylor, 1991). In the physiological sense, effective coping with an acute stressor is generally characterized by quick recovery from stress-related arousal. Slower recovery rates, however, were observed among high hostile individuals (Ganster *et al.*, 1991), and Type A's (Palmero *et al.*, 1993). In a meta-analytic review, Hocking-Schuler and O'Brien (1997) conclude that individuals at high risk for hypertension show delayed recovery from laboratory stressors. A naturally arising question then is what affects recovery rates, and the purpose of this study is to show, for the first time, the effects of apologies offered by an 'offender' to the person who was angered.

Remorse and Apologies

Some clarification of terminology around the apology construct is needed. Landman (1993), in a comparison of remorse with regret, defines remorse as, "gnawing distress arising from a sense of guilt for past wrongs (as injuries done to others)," (pp. 51). Remorse is a narrow, more focused cousin of regret. In particular, remorse applies to one's own past, voluntary, overt, and morally or legally wrong acts, or failures to act.

When individuals commit some offense or error for which they feel remorse, a common strategy is to offer an apology. It has been found that receiving an apology can reduce self-reported aggression and improve the impression of the apologizer (Ohbuchi *et al.*, 1989). In a study comparing an apology following destructive criticism with other remedial strategies, it was found that an apology was the most effective (Baron, 1990). In a study of children who had witnessed a transgression by an actor, children rated the actor most favorably if he had a good reputation, gave an apology, and appeared remorseful (Darby and Schlenker, 1989). Similar results have been found with university undergraduates (Kleinke *et al.*, 1992; Robinson *et al.*, 1994; Taylor and Kleinke, 1992).

Although apologies generally have been demonstrated to be effective in reducing anger, there is no standard in the literature by which apologies are judged. Specific components of apologies have been proposed (e.g., Holmes, 1990), however, there is little consistency across studies as to what constitutes a genuine apology. The system we used in previous research (Anderson and Prkachin, 1998) includes six verbal components, the first being an explicit expression of remorse (e.g., "I'm sorry."). The second is a *specific* statement of why one feels remorse (e.g., "I'm sorry *for stepping on your toe*," as opposed to, "I'm sorry for *what happened*.") and being sorry for the right thing (e.g., "I'm sorry *I called you a liar*," as opposed to, "I'm sorry *you feel that way*."). Next, one must accept responsibility for his or her actions (e.g., "It's my fault."). A genuine apology also includes a truthful explanation for the offensive behavior without trying to excuse the offence and shirk responsibility (e.g., "I'm sorry. *I wasn't looking where I was going*," vs. "I'm sorry I bumped into you *but I had to answer my cell phone quickly*."). The fifth component is a promise of forbearance. This is a statement to say that the offensive behavior is not reflective of the offender's true character, therefore the victim can trust the behavior will not recur (e.g., "I'll be more careful in the future."). Finally, a genuine apology is accompanied by an offer of restitution (e.g., "I'll pay to have it cleaned.").

These components may not be the only factors making up a genuine apology. Aside from what is actually said, non-verbal factors such as facial expression, body posture and tone of voice speak to the sincerity of the apologizer. Indeed, previous research conducted by the principal author suggests that non-verbal factors are essential in perception of apology sincerity (Anderson and Prkachin, 1998). For the current study, apology scripts were pilot tested for their apparent sincerity (see method section for details). Finally, we posit that *sincere* apologies are more likely to be accepted by others and may facilitate forgiveness which in turn is the intended objective of an apology (Darby and Schlenker, 1989). Hence, the purpose of the current study was to investigate the effects of different types of apologies on cardiovascular recovery from anger provocation.

Hypotheses

The study procedure is partly a replication of Earle *et al.* (1999), who examined effects of verbal harassment on cardiovascular reactivity and recovery. In that study, participants performed a mental arithmetic task and those in the experimental group were verbally harassed while those in the non-harassed group completed the arithmetic task without disruption. It was found that harassed participants showed greater reactivity than non-harassed participants and that men showed delayed recovery to baseline levels, while women tended to show overcompensation in cardiovascular recovery.

The unique feature of the current study is its examination of apology strategies in relation to cardiovascular recovery. We used the same harassing procedure as Earle *et al.* (1999), namely harassment, while completing an arithmetic task. As a validity check, we also included a non-harassed group to evaluate the efficacy of the harassment in eliciting emotional and physiological reactivity. Following the arithmetic task, harassed participants were divided into three groups: those who received a good apology, those who received a fake apology, termed a pseudo-apology, and those who received no apology. We hypothesized that participants would show differential recovery depending upon the apology condition to which they were assigned. Further, participants in this study were assessed for level of hostility (high, medium or low). We hypothesized that participants scoring high in hostility would show attenuated return to baseline compared to less hostile participants.

Given the premise that an effectively delivered apology reduces anger in its audience, it follows that receipt of an apology might influence cardiovascular recovery by reducing anger. We are exploring a possible interaction of apology quality and hostility because this personality characteristic might reasonably be expected to influence one's interpretation of the sincerity of an apology and therefore moderate its influence.

METHOD

Participants

184 (92 male, 92 female) psychology undergraduate students participated in the study in exchange for course credit. Although there were no specific hypotheses related to gender, effort was made to recruit equal number of male and female participants, to increase generalizability. Participants' age ranged between 15 and 41, with a mean age of 19.9 years. Sample ethnicity was as follows: 48% Asian, 42% European/Caucasian, 4% Indo-Canadian, 6% others.

Experimental Design

Participants were randomly assigned to one of 4 conditions: non-harassed control ($n = 42$), good apology ($n = 46$), pseudo-apology ($n = 50$), and no apology ($n = 46$). Participants were further categorized into low, medium and high hostility groups, according to their tercile scores on the Cook-Medley hostility questionnaire; one third of participants scored less than or equal to 10 on the Cook-Medley hostility questionnaire and were categorized as the low hostility group. Another third of participants scored between 11 and 14 and were categorized as the medium hostility group. The remaining third scored over 14 and were categorized as the high hostility group. Thus, *n*'s by hostility group categorization were randomly distributed across conditions as follows: non-harassed control (low = 22, medium = 12, high = 8), good apology (low = 13, medium = 16, high = 17), pseudo-apology (low = 9, medium = 24, high = 17), and no apology (low = 18, medium = 14, high = 14).

Materials/Instruments

Cook-Medley Hostility Questionnaire

The Cook-Medley hostility questionnaire is a 50-item measure of trait hostility derived from items on the original MMPI (Cook and Medley, 1954). It has good test-retest reliability ($r = .84$ over four years; Shekelle and Ostfeld, 1983) and internal consistency (Cronbach's alpha $= .82$; Smith and Frohm, 1985). High scores on an abbreviated, 27-item version of the Cook-Medley hostility questionnaire have been linked to poor cardiac outcome (Barefoot *et al.*, 1989; Smith and Pope, 1990). It is this 27-item version of the Cook-Medley hostility questionnaire that was used in the current study.

Emotion Rating Scales

A visual analogue emotion rating scale form was developed for this study as a manipulation check to quickly assess emotional state. The form consists of six 7.5 cm horizontal lines, one for each of six basic emotions (happiness, anger, sadness, disgust, surprise and fear). To the immediate left of each line is one anchor "None at all," and to the immediate right of each line is the other anchor "Most I've ever felt." Participants complete the form by placing a vertical line or tick mark along the line to indicate to what extent they are experiencing each emotion (i.e., a mark on the left end of the line indicates relatively little emotion and a mark on the right end indicates relatively intense emotion). These scales were scored by measuring the distance, in centimeters, from the left end of the line, such that larger raw scores represent more intense emotion.

Harassment Scripts

We used harassment scripts identical to those used in Earle *et al.* (1999), because these scripts have demonstrated efficacy in provoking anger. Complete text is provided in the Appendix.

Apology Scripts

In a pilot study conducted for the current research, nine participants read and listened to the delivery of eight different apology scripts, created by the investigator each with a different number or combination of the apology components listed above. Participants were asked to rate the perceived sincerity of each apology on a 9-point scale for which $1 =$ *Not at all sincere* and $9 =$ *Extremely sincere*. It was found that by varying the number and combination of components included in an apology script one could reliably manipulate the perceived sincerity of the apology. For the present study, the apology that received the highest mean rating ($M = 8.75$, $SD = 1.28$) formed the good apology script and the apology with the lowest mean rating ($M = 2.5$, $SD = 1.51$) formed the pseudo-apology script (see Appendix).

Cardiovascular Instruments

Systolic blood pressure, diastolic blood pressure and heart rate were measured using a Dinamap 845 automated blood pressure monitor (Critikon Corporation, Tampa, Fl). A standard occlusion cuff was placed on the participant's non-dominant arm (to allow participants to complete emotion rating scale forms without influencing blood pressure and heart rate recording), and participants were instructed not to move their arms when the cuff was inflated.

Procedure

Pre-Experiment Visit

One day prior to their participation in the laboratory portion of the study, participants came to the lab to obtain a battery of questionnaires and sign a consent form. Participants were given a tour of the lab and had their blood pressure taken using the same equipment used the following day. This visit was expected to reduce the novelty of the lab environment and assist with habituation, to reduce the influence of novelty on cardiovascular functioning. Participants were informed via written instructions that they were to refrain from consuming alcohol and caffeine, smoking, and exercising vigorously, all for 12 h prior to participation in the study, and to eat a light meal at least 1 h prior to their visit, in order to limit the influence of uncontrolled variables on the observed physiological indices.

Baseline Period

The experiment began by having participants sit alone in the testing room with the blood pressure

monitor attached. Participants were asked to sit quietly for a 12-min baseline period. Blood pressure and heart rate readings were taken at Time 0, and minutes 2, 10, and 12. At the end of minute 12, participants were asked to complete an emotion rating scale form. Following this, the experimenter entered the testing room to provide more detailed task instructions. Participants were told that the purpose of the study was to assess their physiological reaction to a challenging cognitive task. They were not told they would be harassed. Participants were instructed that when told to start, they were to perform serial subtractions of 7, starting at 9000 (i.e., "9000, 8993, 8986, 8979 . . ." etc.), out loud and as fast as possible for several minutes until instructed to stop. They were informed that a lab technician had arrived and would be telling them when to start and stop.

Task Period

At the beginning of the task period, participants were instructed by the technician to begin counting. Five blood pressure and heart rate readings were taken at 3-min intervals over the 13-min task period (i.e., minutes 0, 3, 6, 9 and 12). Each reading took approximately 1 min to complete. A task length of 13 minutes is unusual but was chosen here because salivary cortisol samples were being collected, at the end of the task period, for a separate study, reported elsewhere (Habra *et al.*, 2003). For participants in the harassment condition, the technician provided three scripted, harassing comments at 3-min intervals (minutes 5, 8 and 11), with the intent of producing mild feelings of anger in participants. Participants in the non-harassed control condition performed the arithmetic task without interruption. At the end of the task period, participants were told to stop counting and to complete a second emotion rating scale form. All instructions were provided via an intercom.

Recovery Period

The recovery period began immediately after the participant stopped counting and lasted for 10 min. Participants in the good apology and pseudo-apology conditions received a scripted apology from the technician within the first 2 min of the recovery period. To enhance the apparent sincerity (or insincerity) of the apologies, technicians were coached to alter their tone of voice, facial expression and posture in order to impart feelings of empathy and remorse (for the good apology) or of uncaring condescension (for the pseudo-apology). Those in the no apology and non-harassed conditions were left to spend the recovery period in silence. Blood pressure and heart rate readings were taken at minute 5 and minute 10 of the recovery period. Participants were told to complete a final emotion rating scale form at the end of the recovery period.

RESULTS

Data Analytical Strategy for Manipulation Checks

Reactivity and recovery analyses were conducted separately, because of the very different hypotheses being tested during different portions of the study. Looking at reactivity (i.e., baseline to task changes), the questions addressed manipulation checks: (1) was the task anger-provoking?, (2) did participants respond to the task with increases in blood pressure and heart rate?, and (3) were those increases in blood pressure and heart rate, as well as intensity of subjective anger, of a larger magnitude in the harassed group than in the non-harassed group? For between-group analyses, baseline values were entered as covariates to control for individual differences in initial levels which might otherwise obscure between-group differences in response to the task. Multivariate analyses were chosen for those involving subjective emotion ratings because for these the dependent variables were highly intercorrelated. Univariate analyses were chosen for those involving the cardiovascular measures because systolic blood pressure, diastolic blood pressure and heart rate change is generally poorly intercorrelated. For all analyses, the two-tailed alpha level was set to .05. In addition to reporting *p*-values, measures of effect size (Cohen's *d*, Partial Eta squared) are provided.

Emotion Rating Scales Reactivity

Table I displays participants' mean emotion ratings following the baseline and task periods, as well as raw change scores, broken down by harassment condition. To determine whether participants' subjective emotion ratings changed from baseline to task for each group, raw change scores were entered into a series of one-sample *t*-tests. As can be seen from the

Table I. Emotion Rating Scales Means, Adjusted Means and Raw Change Scores by Harassment

		Task			
	Baseline	Unadjusted	Adjusted	BL to Task Raw Δ	*d*
Happy					
Non-harassed				−0.6**	0.66
M	2.8	2.2	2.3		
SD	1.6				
Range	5.5	5.7			
Harassed				−1.4**	0.83
M	3.1	1.6	1.6		
SD	1.7	1.6			
Range	6.3	5.8			
Anger					
Non-harassed				0.3	
M	0.5	0.7	0.8		
SD	0.7	0.9			
Range	3.4	4.0			
Harassed				1.6**	0.85
M	0.5	2.1	2.1		
SD	0.9	2.0			
Range	6.1	7.5			
Fear					
Non-harassed				0.1	
M	0.9	0.8	0.7		
SD	0.9	1.2			
Range	3.4	4.6			
Harassed				0.8**	0.46
M	0.7	1.5	1.5		
SD	1.0	1.8			
Range	4.9	7.4			
Sad					
Non-harassed				0.2	
M	0.7	0.8	0.8		
SD	0.9	1.0			
Range	3.7	3.6			
Harassed				0.7**	0.38
M	0.7	1.4	1.4		
SD	1.2	1.8			
Range	5.2	7.5			
Disgust					
Non-harassed				0.7*	0.47
M	0.5	1.1	1.2		
SD	0.9	1.5			
Range	3.9	5.5			
Harassed				0.9**	0.47
M	0.9	1.8	1.8		
SD	1.4	2.0			
Range	6.8	7.5			
Surprise					
Non-harassed				0.7*	0.51
M	1.0	1.7	1.7		
SD	1.6	1.5			
Range	5.7	5.5			
Harassed				1.1**	0.59
M	1.1	2.2	2.2		
SD	1.4	2.0			
Range	7.5	7.5			

Note. Positive values in raw change columns reflect increases in emotion intensity; negative values reflect decreases. Values with asterisks indicate statistically significant change from baseline to task.
*$p < .01$, **$p < .001$.

table, for the non-harassed group, happiness ratings decreased significantly, while ratings of surprise and disgust increased significantly. Changes in subjective anger, fear and sadness were all non-significant.

For the harassed group, happiness ratings decreased significantly, while all other negative/neutral valence emotions increased significantly. Of note, anger ratings increased significantly more than surprise ratings (the second-highest mean following anger), $t(138) = 2.98$, $p = .003$, $d = 0.30$, indicating that, for this group, anger was the single most intensely felt emotion resulting from harassment.

To determine whether participants' subjective emotion ratings were of different intensities between harassed and non-harassed groups, mean task ratings for each emotion category were entered as dependent variables into a multivariate analysis of covariance with Harassment (Harassed, Non-harassed) as the between-groups factor and baseline ratings entered as covariates. The overall test was significant, Wilks' Lambda = .88, $F(6, 168) = 3.86$, $p = .001$, $\eta_P^2 = .12$. Examination of between-subjects effects revealed that harassment resulted in a larger magnitude decrease in happiness, $F(1, 173) = 9.45$, $p = .002$, $\eta_P^2 = .05$, and larger magnitude increases in anger, $F(1, 173) = 19.86$, $p < .001$, $\eta_P^2 = .10$, fear, $F(1, 173) = 8.74$, $p = .004$, $\eta_P^2 = .05$, sadness, $F(1, 173) = 5.06$, $p = .026$, $\eta_P^2 = .03$, and disgust, $F(1, 173) = 4.29$, $p = .04$, $\eta_P^2 = .02$. Table I also contains task means adjusted by covariate analysis as well as effect sizes.

Blood Pressure & Heart Rate Reactivity

Table II displays mean baseline and task values for systolic blood pressure, diastolic blood pressure and heart rate along with raw change scores and effect sizes, broken down by harassment. Raw change scores were entered into a series of one-sample *t*-tests. As can be seen from the table, for both the non-harassed and harassed groups, systolic blood pressure, diastolic blood pressure, and heart rate increased significantly in response to the task. To determine whether those in the harassed group showed greater magnitude responses in systolic blood pressure, diastolic blood pressure and heart rate than the non-harassed group, mean task values for systolic blood pressure, diastolic blood pressure and heart rate were entered as dependent variables into separate univariate analyses of covariance, with Harassment (Harassed, Non-harassed) as the between-groups factor and baseline values entered as covariates. Harassed participants showed greater magnitude increases in systolic blood pressure, $F(1, 169) = 7.39$, $p = .007$, $\eta_P^2 = .04$, in diastolic blood pressure, $F(1, 168) = 10.86$, $p = .001$, $\eta_P^2 = .06$, and in heart rate, $F(1, 175) = 11.67$, $p = .001$, $\eta_P^2 = .06$, indicating that the harassment manipulation was effective in producing additional anger and additional cardiovascular reactivity. Table II also displays task means adjusted by analysis of covariance.

Analytical Strategy for the Primary Research Questions

Only the three harassed groups were included in the recovery analyses. Data for the non-harassed group were excluded because the only purpose of this group had been to serve as a manipulation check for the harassment manipulation. Including this group in the recovery analyses would unnecessarily complicate the design of the analyses and any results would be difficult to interpret because, as noted above and consistent with our prediction, this group was significantly less emotionally and physiologically aroused than were the harassed groups. The questions to be addressed by the analyses of the recovery data are in fact the primary focus of the current study: (1) what is the influence of receipt of an apology on cardiovascular and subjective anger recovery following anger provocation?, (2) what is the influence of hostility on subjective/cardiovascular recovery?, and (3) do apologies and hostility interact to influence recovery? Analogous to the reactivity section, for between-group analyses, task values were entered as covariates to control for differences in response to the task which might otherwise obscure between-group differences at recovery. For all analyses, the two-tailed alpha level was set to .05. Post-hoc comparisons were performed using Tukey's Honestly Significant Difference. In addition to reporting *p*-values, measures of effect size (Partial Eta squared) have been provided.

Emotion Rating Scales Recovery

To determine the influence of apologies and hostility on subjective emotion, mean emotion rating scales recovery ratings for each emotion category were entered as dependent variables into a 3 (Condition: good apology, pseudo-apology, no apology) ×

Table II. Systolic Blood Pressure, Diastolic Blood Pressure & Heart Rate Means, Adjusted Means and Raw Change Scores by Harassment

		Task			
Condition	Baseline	Unadjusted	Adjusted	BL to Task Raw Change	*d*
Systolic Blood Pressure					
Non-harassed				12.5*	1.42
M	112.7	125.1	124.3		
SD	9.6	14.2			
Harassed				17.0*	1.84
M	111.5	128.5	128.8		
SD	8.2	11.9			
Diastolic Blood Pressure					
Non-harassed				11.2*	1.61
M	65.4	76.7	76.0		
SD	8.3	11.1			
Harassed				14.9*	2.58
M	64.4	79.2	79.6		
SD	6.5	7.5			
Heart Rate					
Non-harassed		83.5		13.9*	1.11
M	69.11	14.8	82.0		
SD	10.7				
Harassed				21.8*	1.74
M	67.6	89.3	89.7		
SD	10.8	16.2			

Note. Positive values in raw change columns reflect increases in emotion intensity; negative values reflect decreases. Values with asterisks indicate statistically significant change from baseline to task.
*$p < .001$.

3 (Hostility: high, medium, low) multivariate analysis of covariance with task ratings entered as covariates. All results were non-significant, indicating that neither apologies nor hostility, alone or in combination, affected participants' self-reported emotion experience following the 10-min recovery period.

Blood Pressure and Heart Rate Recovery

To examine the influence of apologies and hostility on cardiovascular recovery from harassment, three 2 (Time: recovery 1, recovery 2) × 3 (Condition: good apology, pseudo-apology, no apology) × 3 (Hostility: high, medium, low) between-within analyses of covariance were performed for systolic blood pressure, diastolic blood pressure and heart rate, with task values entered as covariates. These analyses yielded a significant Condition × Hostility interaction for systolic blood pressure, $F(4, 123) = 4.44$, $p = .002$, $\eta_P^2 = .13$, displayed in Fig. 1. Post hoc comparisons revealed that 5 min into the recovery period, within the high hostility group, those who received no apology had higher systolic blood pressure values than those who received a pseudo-apology ($p < .01$), who in turn had higher values than those who received the good apology ($p < .05$). At the end of the recovery period, those in the high hostility group who received no apology continued to show higher systolic blood pressure values than either those who received a good apology or pseudo-apology ($p < .01$), who did not differ from each other. The analysis of diastolic blood pressure was non-significant, as was the analysis of heart rate. Table III displays group means adjusted for analysis of covariance.

Relationship Between Subjective Anger and Systolic Blood Pressure Recovery

To determine the relationship, if any, between participants' amount of subjective anger recovery and their cardiovascular recovery, Pearson *r* correlations were computed between subjective anger change scores and their systolic blood pressure change scores (both scores represent change occurring between the end of the task period and end of the recovery period). Correlations were computed both for the harassed groups overall and separately

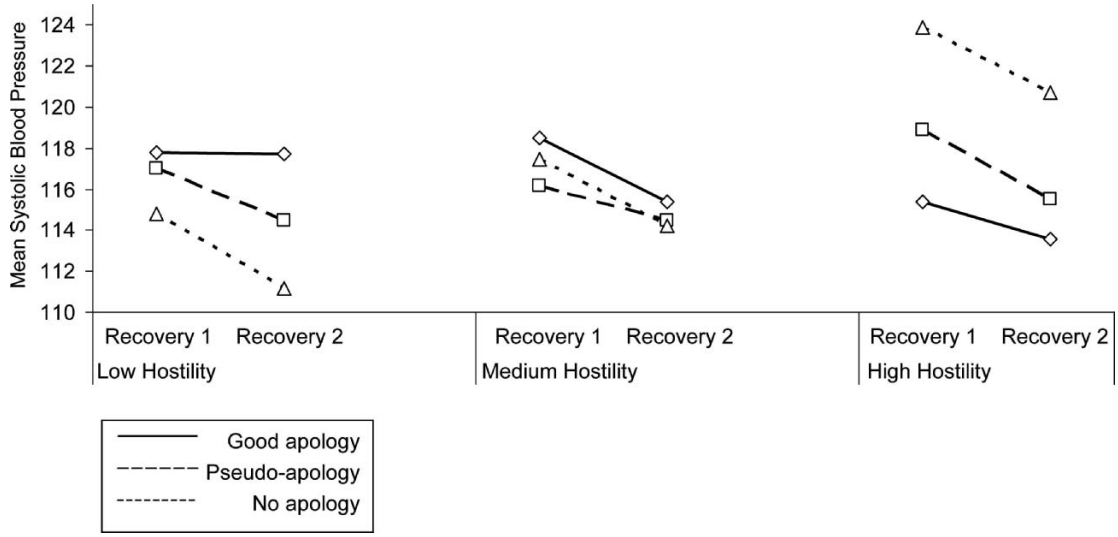

Fig. 1. Analysis of covariance-adjusted systolic blood pressure recovery over time and across apology condition, broken down by hostility.

broken down by apology condition and by hostility level. There was no association between subjective anger recovery and systolic blood pressure recovery, consistent with the findings that subjective emotion was not related to either hostility or apology condition. Of note, findings were null using both raw change scores and those using values adjusted by the analyses of covariance reported above.

DISCUSSION

In this study, participants underwent a mild anger induction involving verbal harassment that resulted in increased subjective anger as well as increased blood pressure and heart rate, compared to a non-harassed control group. Regarding the main hypothesis about the effect of apologies, the key finding was an interaction such that participants scoring high in trait hostility showed attenuated systolic blood pressure recovery, particularly if they received no apology following anger induction; and this is consistent with previous studies demonstrating that high hostility results in slow recovery. However, if offered a genuine apology, this group showed relatively quick systolic blood pressure recovery.

These results may be explained with reference to recent findings relating to hostile rumination. The

Table III. Systolic Blood Pressure Unadjusted Means by Hostility and Apology Condition and Means Adjusted by Analysis of Covariance

		Recovery 1		Recovery 2	
	Task	Unadjusted	Adjusted	Unadjusted	Adjusted
Systolic Blood Pressure					
Low hostility					
Good apology	125.0	115.5	117.8	115.5	117.7
Pseudo apology	126. 9	115.9	117.0	113.6	114.5
No apology	129.8	115.7	114.8	112.0	111.2
Medium hostility					
Good apology	127.1	117.5	118.5	114.5	115.4
Pseudo apology	132.8	119.1	116.2	116.6	114.5
No apology	126.9	116.5	117.5	113.2	114.2
High hostility					
Good apology	127.0	114.4	115.4	112.7	113.6
Pseudo apology	127.3	118.1	118.9	114.7	115.5
No apology	129.9	124.2	123.9	121.6	120.7

propensity to ruminate about past events is known to overlap with trait hostility, and hostile rumination has been shown to maintain arousal following anger (Hogan and Linden, 2004; Schwartz *et al.*, 2000). If hostile rumination accounts for the maintained systolic blood pressure arousal among high hostiles who received no apology, it follows that the receipt of a genuine apology may have allowed hostile individuals to stop ruminating. Although the current study was not designed to directly assess rumination, such a hypothesis finds research support in the area of forgiveness, a topic of surging interest. Apology and forgiveness have been conceptually linked (Lazare, 2004) and there is growing evidence to suggest that the act of forgiving another person (e.g., letting go of a grudge), or the propensity to forgive after being wronged, is positively related to both cardiovascular recovery following a stressful recall task (Lawler *et al.*, 2003) and to relational and clinical health outcomes (Enright and North, 1998; Toussaint *et al.*, 2001).

An important limitation of the current study is that specific measures to assess forgiveness as a situational variable or trait construct were not included in the design. Inclusion of such measures in the future would not only allow one to directly examine the influence of forgiveness on subjective and physiological anger recovery, but also explore the commonalities apparent in high trait hostility and low trait forgiveness.

The failure to find any relationship between the independent variables of apology condition and hostility and the dependent variables of subjective report of emotion, or any association between subjective emotion recovery and systolic blood pressure recovery, was unexpected. One interpretation of this finding is that subjective emotion is truly unrelated to personality, to social interactions such as apology, or to cardiovascular functioning. This interpretation would be contrary to decades of research. However, looking at the anger ratings for example, the mean difference from baseline in response to the task, while statistically significant, was very small. Thus, the rating scales used in this study may not have been sufficiently sensitive to accurately reflect the intensity of subjective emotion change between and within groups. This problem arises because the use of self-report emotion ratings assumes that participants are both willing and able to accurately report their current emotional state. This assumption may not be tenable, particularly when the emotion in question, anger for example, is generally the subject of social constraint. Further, because recovery emotion ratings occurred 10 min following cessation of the task and at least 8 min following the apology, it remains an open question as to participant's subjective emotion state during that intervening time period during which one might hypothesize the effect of an apology to be most potent. Additionally, the assignment of participants into apology condition without regard to their level of hostility resulted in hostility not being represented evenly across conditions, which represents a threat to internal validity. Note the resulting uneven cell sizes. Finally, the small magnitude changes in subjective anger may be due to the fact that our task was designed to provoke only mild anger given that ethical review boards do not permit powerful anger provocation paradigms. We do not know if the relationship between these variables would be stronger in situations involving more intense anger provocation as one might see in everyday life. Thus, further study involving different anger provocation manipulations and more careful monitoring of participants' emotional state is required prior to dismissing the influence of apologies or hostility on subjective emotional state.

In sum, we showed for the first time, that carefully crafted types of apologies can have distinct influences on physiological recovery following anger provocation and we are thereby suggesting that a physiological explanation exists for the constructive role of apologies in interpersonal situations. Unfortunately, these effects appear not to be equally applicable for all angered individuals but produce the clearest and most intriguing findings for those with hostility predispositions. We encourage future researchers to continue studying the health benefits of apologies and to pay attention to population subgroups with particularly volatile or cynical interpersonal styles.

APPENDIX

1. Harassment Scripts

   Script #1: "Look [participant name], you're always subtracting *way too slow*. You've got to do it *much faster*. Continue where you stopped."
   Script #2: "[participant name], you're *still too slow and also inaccurate*. This *can't* be your best. Now try it again from where you left off."

Script #3: "You're obviously *not good enough* at doing this, *now try harder*. Keep going!"

2. Apology Scripts

Good Apology: "Listen [participant name], I'm really sorry for being so rude to you a few minutes ago. If I upset you while you were counting that's totally my fault. I was speaking to you that way on purpose as part of the experiment. I'm usually more courteous and professional. But I do feel bad about this. I'm sorry."

Pseudo-apology: "You seemed a little agitated there. Well, I'm sorry if you got upset during the task, but it's important for you to go really fast, or the experiment isn't going to work."

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