Social Relationships and Physiological Function: The Effects of Recalling Social Relationships on Cardiovascular Reactivity

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ABSTRACT

Background: *The mechanisms by which social relationships exert their influence on mental and physical health outcomes deserve greater attention.* ***Purpose:*** *Although many studies assess the influence of actual social interactions on cardiovascular reactivity, we hypothesized that cognitive and behavioral processes (e.g., recalling and discussing relationships) may be important factors responsible for the health effects of social relationships.* ***Methods:*** *We had men and women recall and speak about specific relationships that differed in their underlying positive and negative substrates.* ***Results:*** *Results revealed that gender moderated the hypothesized pattern of responses, with women showing consistently greater cardiovascular reactivity to the speaking task, particularly when speaking about negative relationships, compared to men.* ***Conclusions:*** *This study is discussed in light of recent research on gender differences in relationship outcomes as well as the potential importance of delineating the cognitive representations and processes that influence reactions to one's social environment.*

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INTRODUCTION

There is a significant amount of research supporting the influence of social relationships on both mental and physical health (1,2). For instance, a lack of social support has been shown to predict cardiovascular morbidity and mortality (3). These associations hold even when statistically controlling for the influence of more traditional risk factors, such as smoking and physical activity (1,2). Little is known, however, about the specific mechanisms underlying the association between social relationships and physical health outcomes.

One mechanism potentially linking social relationships to health outcomes is described by the *reactivity hypothesis* (4,5). Although more research is needed, this hypothesis suggests that exaggerated cardiovascular responses to behavioral and psychosocial stressors over time may contribute to the etiology and/or clinical progression of cardiovascular disease (6–8). It is important to note that laboratory studies have consistently found that enacted social support during acute stress reduces cardiovascular responses compared to no-support conditions (9,10).

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Although evidence suggests the importance of actual supportive interactions on cardiovascular responses, very little research exists on whether general cognitive perceptions of relationships and related behavioral processes (e.g., discussing relationships) may influence cardiovascular outcomes. This is significant because supportive behaviors occur in the context of specific relationships, and such behaviors are encoded and organized in relationship schemas. In fact, individuals recall relationship information in various ways (e.g., self-disclosure, rumination, priming; 11,12). Recalling such information can activate relationship-specific cognitive perceptions with subsequent effects on emotional processes (13,14). For example, this type of relationship recall was part of a broader laboratory task developed by Ewart et al. (15) that was associated with alterations in cardiovascular responses. Thus, the first aim of this study was to investigate whether recalling and talking about particular social relationships as a laboratory task alters mood and cardiovascular function.

Although recalling supportive relationship information may be important in its own right, there is significant variability in the quality of people's relationships that may also be important to consider (16). On the basis of research suggesting the importance of examining both positive (supportive) and negative (upsetting) aspects of relationships (17–19), we have proposed a more comprehensive model for the organization of relationships (16) (see Figure 1). First, the low positivity/low negativity corner of Figure 1, labeled *Indifferent Network Tie*, represents a relationship characterized by relatively low frequency or depth of social interactions. The high positivity/low negativity corner represents a social network member who is primarily a source of positivity or support. Next, the low positivity/high negativity corner represents a network tie that is primarily a source of negativity. Finally, the high positivity/high negativity corner represents what is labeled an ambivalent network tie. We have found that many important relationships are characterized by

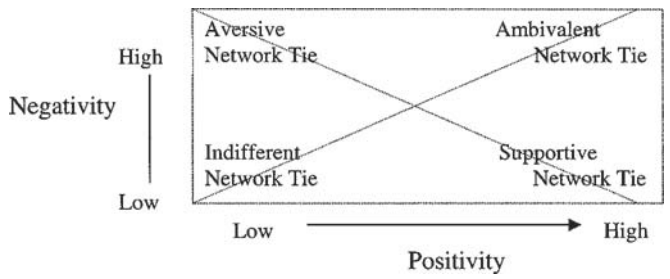

FIGURE 1 Model of social relationships incorporating the positive and negative aspects of social relationships.

strong feelings of both positivity and negativity (16). In fact, the negativity associated with aversive and ambivalent network ties may be associated with poorer health outcomes (e.g., negativity bias; 19). For instance, negativity in close social relationships has been associated with stronger effects on relationship and health-related outcomes than positive aspects of relationships (20). A second aim of this study, therefore, was to examine differences in cardiovascular reactivity during the task as a function of recalling and speaking about relationships that differ according to Figure 1.

In the study of relationships and health, it is also important to consider gender differences (21–23). For example, women may contemplate their close relationships more so than men (21), and women tend to be more responsive to the negative aspects of relationships, such as negative behaviors or conflict (22). Kiecolt-Glaser and Newton (22) reviewed research from the past decade on the pathways between marital relationships and physical health. They found that the negative qualities of marital functioning exert a greater detrimental influence on health outcomes and physiological responses for women than for men. For instance, in laboratory marital conflict studies, women often show greater and more persistent reactivity to negative behaviors compared to men (22). These findings suggest that gender may influence the outcomes associated with the process of recalling social relationships that differ in their affective (especially negative) qualities. Therefore, a third aim of this study was to examine the moderating role of gender on the association between recalling particular relationships and cardiovascular responses.

The theoretical and empirical evidence provides support for exploring the role of recalling and discussing relationships on cardiovascular outcomes as well as a more comprehensive view of positive and negative dimensions of relationships and possible gender differences. Therefore, in this study we predicted that (a) recalling a supportive network tie will lead to a reduced or attenuated response compared to recalling an indifferent network tie, reflecting the beneficial effect of the supportive relationship on the speaking task; (b) recalling an ambivalent or aversive network tie will lead to increased reactivity compared to the supportive and indifferent ties; and (c) the effects of ambivalent and aversive network ties on reactivity will be greater in women compared to men.

METHOD

Participants

Forty-three men and 66 women were recruited and randomized into one of four conditions to perform the recalling and speaking task. Consistent with prior research, self-reported inclusion criteria were used to select healthy participants (24). These criteria included no existing hypertension; no cardiovascular prescription medication use; and no history of chronic disease with a cardiovascular component, such as diabetes. Potential participants were first screened by telephone according to these criteria and then scheduled for an appointment in the laboratory. Characteristics of the sample are presented in Table 1.

TABLE 1
Sample Characteristics

Characteristic	*n*	*%*
Gender		
Male	43	39.4
Female	66	60.6
Race/Ethnicity		
White	76	69.7
African American	3	2.8
Asian/Pacific Islander	14	12.8
Hispanic/Latino	11	10.1
Other	5	4.6
Marital status		
Single, never wed	77	70.6
Married, living with mate	28	25.7
Divorced	4	3.7
Education		
High school graduate	13	11.9
Some college	80	73.4
College graduate	6	5.5
Some graduate/professional school	3	2.8
Completed graduate/professional school	7	6.4
Household income		
≤ $9,999	22	20.4
$10,000–$24,999	36	33.4
$25,000–$49,999	18	16.5
≥ $50,000	32	29.4
Employment status (self)		
Unemployed	20	18.3
Employed	89	81.7

Note. Ages ranged from 17 to 52 years old (M = 24.1 years).

Procedure

When participants arrived, they were given an overview of the procedures and asked to complete a consent form. Participants also completed background health and demographic forms, which were checked to verify eligibility. Next, participants' height and weight were obtained using a standard medical scale from which body mass index (BMI) was calculated.

Participants were prepared for the cardiovascular assessments, which included placing four Mylar bands in the tetrapolar configuration for impedance cardiograph recordings according to published guidelines (25). An occluding cuff was also placed on the upper left arm for blood pressure assessments. Participants were asked to sit comfortably, remaining as still as possible while cardiovascular readings were checked. The experimenter explained that the baseline period would last 12 min, during which resting measures of cardiovascular function were obtained. Impedance cardiograph readings were taken continuously during the last 5 min of the resting period. Measures of systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were obtained at 90-sec intervals during this period. At the conclusion of the baseline, participants completed a measure of state anxiety as

well as the Social Relationships Index (SRI) (16), according to the condition to which they were assigned.

The participants were randomized into one of the four relationship quality conditions: (a) relationships described as generally positive, providing helpful support; (b) relationships described as generally upsetting and a source of negative interactions; (c) ambivalent ties that are a source of positive and negative interactions; and (d) relationships described as indifferent, with low levels of positive and negative interactions. Participants read a description of one of the four types of relationships (based on descriptions from the SRI) and indicated up to five people of the same gender who match the description (gender was held constant; 10). They were then asked to talk about one particular relationship—the one most like the description.

Prior to the 3-min speaking task, participants had a 3-min preparatory period to think about what they would say. The instructions were as follows:

> I would like you to talk about your relationship with _____ (indicate the first name of the person) whom you indicated on the questionnaire. First I would like you to think about _____ and recall as many memories about him/her as you can. When I ask you to describe your relationship with _____, you may talk about: a) how long you have know him/her; b) in what situations you interact with him/her; c) the general feelings you have about him/her; d) what he/she is like in regards to your important life goals that you would like to achieve; e) what he/she is like in day-to-day interactions; or f) any other specific memories you have about him/her. You may talk about him/her in terms of any one or all of these things.

Blood pressure readings were obtained at the start and at 90 sec into the preparatory and speaking periods, and impedance cardiography measures were obtained continuously during the task. With a focus on the speaking task, if a participant stopped talking during this task, he or she was prompted with a question to encourage him or her to talk throughout the entire period. After the task, participants completed another state anxiety measure. At the end of the experiment, participants completed questionnaires regarding social support and relationships.

Assessments

Cardiovascular measures. Cardiovascular response is the main outcome measure assessed in this study. A Dinamap Model 8100 (Critikon Corporation, Tampa, FL) was used to measure SBP, DBP, and MAP. The Dinamap uses the oscillometric method to estimate blood pressure, which was obtained via a properly sized occluding cuff positioned on the upper left arm of the participant according to manufacturer's specifications. Mean heart rate and blood pressure for each period were averaged across minutes to increase their reliability.

We used a Minnesota Impedance Cardiograph Model 304B (Instruments for Medicine, Inc., Old Greenwich, CT) to measure the ECG, basal thoracic impedance (Z_0), and the first derivative of the impedance signal (dZ/dt). Four Mylar bands were placed in the tetrapolar configuration according to published guidelines (25). A 4mA AC current at 100 kHz was passed through the two outer bands, and Z_0 and dZ/dt were recorded from the two inner bands. The ECG, Z_0, and dZ/dt signals were digitized at 500 Hz. Impedance data were averaged within 1-min epochs, and each waveform was verified. If necessary, impedance derived data were edited prior to analysis.

From these signals, we estimated the stroke volume (SV) using the Kubicek equation (25) and calculated the subsequent cardiac output (CO) by multiplying heart rate by SV/1000. Total peripheral resistance (TPR) was measured by resistance units (dynes – second × cm^{-5}) based on MAP and CO (i.e., TPR = MAP / CO × 80). Providing an index of sympathetic control of the heart, the pre-ejection period (PEP) was calculated as the time interval in milliseconds between the Q-point of the ECG and the B-point of the dZ/dt signal. Each of the minute-by-minute impedance-derived measures (heart rate, CO, TPR and PEP) was averaged across minutes within each study epoch (e.g., baseline and speaking task) to increase measurement reliability.

Respiratory sinus arrhythmia (RSA), a noninvasive measure of parasympathetic control of the heart, was calculated based on the digitized interbeat intervals. These were checked and edited for artifacts using the detection algorithm of Bernston et al. (see 25). After linear detrending (25), the heart period time series was band pass filtered from .12 to .40 Hz (25). The power spectrum of the heart period time series was calculated using a Fast Fourier Transform and scaled to $msec^2/Hz$. RSA was calculated as the natural log of the area under the heart period power spectrum within the corner frequencies of the band pass filter (25).

SRI. Individuals completed two versions of the SRI. The SRI is used to identify network members who are primarily sources of support, upsetting interactions, both support and upsetting interactions, or low levels of support and upsetting interactions (see Figure 1). Our prior research has demonstrated the internal consistency and test–retest reliability of this instrument (16). One version of the SRI served to determine whom the participant would talk about (see Procedure section). The second SRI assessment obtained continuous ratings (ranging from 1 [*not at all*] to 6 [*extremely*]) of the person participants spoke about in regard to how positive (helpful) and negative (upsetting) they felt the person was when seeking support from them and during everyday interactions. These ratings were used as a manipulation check on the relationship selection procedure. In this study, the alpha coefficients for the positivity items and negativity items were .79 and .91, respectively.

Impact Message Inventory. Elsewhere (26,27), we argued that concepts and methods of interpersonal psychology (28) are useful in the complex process of modeling social processes in psychophysiological studies. Specifically, well-validated measures based on the interpersonal circumplex can be used to verify the effectiveness of social manipulations in a standard conceptual framework. Toward this end, participants completed the Impact Message Inventory (IMI), a 32-item mea-

sure, in terms of how they felt generally when interacting with the person they had discussed (29). The measure uses a 4-point response scale ranging from 1 (*not at all*) to 4 (*very much so*). The 32 items yield eight octant scale scores and two independent dimensions. The first bipolar dimension describes dominance, ranging from submissive to dominant, and the second dimension describes loving/nurturance, ranging from loving/friendly to hostile (29). Alpha correlation coefficients for five of the octant scales were acceptable, ranging between .65 and .91. Reliability coefficients for hostile/dominant, hostile/submissive, and friendly/dominant were low (.46, .33, and .55, respectively). The IMI was included in the manipulation check to assess whether ratings of dominance and loving/nurturance differed across the four relationship quality conditions, which would support findings from the SRI.

State Anxiety Scale. A short form of the Spielberger State–Trait Anxiety Scale was administered to participants following the resting and speaking periods. The short form contains six items rated on a scale from 1 (*not at all*) to 4 (*very much*) (30). The internal consistencies for this scale have ranged from .78 to .80 (30,31). For this study, the alpha coefficient for this scale at baseline was .72.

Health behavior questionnaire. A health behavior questionnaire provided self-reported information on health-related variables, including average hours per week of exercise and sleep and average amount of caffeine intake and alcohol consumption. In addition, height and weight were measured (using a Health-o-meter® scale; QuickMedical, Snoqualmie, WA) from which BMI was calculated (i.e., using the quetelet index: weight in kilograms/[height in centimeters]^2).

Behavioral ratings. To obtain an objective rating of the discussion content in each relationship condition, narratives from the relationship-speaking task were coded independently. Two coders rated the 3-min speaking task for the frequency of positive and negative references. The number of references for each minute was summed together. Reliability of these ratings across the raters was assessed for a random subsample of 33 narratives. The intraclass correlation coefficients were .94 for positive references and .95 for negative references.

RESULTS

To test the study hypotheses, we conducted 4 (relationship condition) × 2 (gender) analyses of variance (ANOVAs) on participants' self-reports of relationship quality, state anxiety, and behavioral ratings, as well as cardiovascular reactivity measures. Significant effects were followed up with appropriate post hoc tests.

Preliminary Analyses

We first conducted a series of one-way ANOVAs to confirm the equivalency of participants assigned to the different relationship conditions. Results indicated that the participants in the four relationship groups did not differ on the demographic variables of age, ethnicity, marital status, education, income level, and employment status (all ps > .23). We conducted similar analyses to examine baseline equivalency on the resting cardiovascular measures. Again, no significant differences were observed among the four relationship groups (all ps > .48).

Manipulation Checks

We evaluated the relationship quality manipulation to determine whether it effectively led to participants recalling and speaking about a person who exemplified the intended quality (i.e., indifferent, supportive, ambivalent, or aversive). We thus examined the continuous SRI ratings of positivity (helpfulness) and negativity (upsetting). As expected, results indicated ratings of positivity (helpful when seeking support, $F[3, 100] = 29.56$, $p < .001$, and helpful day to day, $F[3, 100] = 21.98$, $p < .001$) and negativity (upsetting when seeking support, $F[3, 100] = 21.30$, $p < .001$, and upsetting day to day, $F[3, 100] = 23.30$, $p < .001$) differed significantly across the relationship conditions. Condition main effects were followed up with Student–Newman–Keuls post hoc tests. These analyses revealed that supportive relationships were rated significantly higher on helpfulness when seeking support and in day-to-day interactions than were ambivalent relationships. Furthermore, ambivalent relationships were rated significantly higher than were aversive relationships on these positivity ratings. For negativity, aversive relationships were rated significantly more upsetting in day-to-day interactions compared to ambivalent relationships and a similar level of negativity as ambivalent relationships were rated when seeking support. Ambivalent and aversive relationships were rated significantly higher on both negativity ratings than supportive relationships (see Table 2). In comparison, indifferent relationships were rated similarly to ambivalent and aversive relationships on ratings of positivity and similarly to supportive relationships on negativity. No other main effects or interactions were significant. Considering the positivity and negativity ratings in conjunction, the relative differences in relationship quality suggest the manipulation was effective.

We found converging evidence for differences in relationship quality across the conditions from the IMI dimensions of dominance and loving/nurturance. Results of the one-way ANOVA revealed a condition main effect for both the dominance, $F(3, 104) = 6.34$, $p = .001$, and loving/nurturance, $F(3, 104) = 24.06$, $p < .001$, scales. Student–Newman–Keuls post hoc tests indicated that relationships characterized as ambivalent or aversive were reported to be significantly more dominant than indifferent and supportive relationships. More distinctive were the results on the loving/nurturance scale. Supportive relationships were characterized as significantly more loving and nurturant compared to other relationships. In addition, indifferent and ambivalent relationships were also characterized as more loving and nurturant than the aversive condition (see Table 3). No other main effects or interactions were significant.

Self-Report and Behavioral Ratings

Having established an effective manipulation, we next evaluated the effects of recalling a particular relationship on behav-

TABLE 2
Means and Standard Deviations of Positivity and Negativity Ratings for Men, Women, and Overall Sample as a Function of Relationship Condition

	Indifferent		*Supportive*		*Ambivalent*		*Aversive*	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Women–Positivity								
Helpful when seeking support	2.81	1.17	5.21	0.71	4.31	1.14	2.33	1.63
Helpful day to day	4.06	1.57	5.32	0.75	3.69	1.49	2.67	1.29
Women–Negativity								
Upsetting when seeking support	1.88	1.26	1.63	0.83	3.75	1.29	4.13	1.41
Upsetting day to day	1.63	1.09	1.42	0.51	3.19	1.42	4.07	1.58
Men–Positivity								
Helpful when seeking support	2.78	0.97	4.78	1.72	3.82	1.40	1.77	1.01
Helpful day to day	4.11	1.27	5.22	0.97	4.36	1.03	2.31	1.32
Men–Negativity								
Upsetting when seeking support	1.33	0.50	2.78	1.92	3.09	1.04	4.23	1.59
Upsetting day to day	1.44	0.53	2.00	1.32	2.64	1.03	4.00	1.73
Overall–Positivity								
Helpful when seeking support	2.80_{c}	1.08	5.07_{a}	1.12	4.11_{b}	1.25	2.07_{c}	1.39
Helpful day to day	4.08_{b}	1.44	5.29_{a}	0.81	3.96_{b}	1.34	2.50_{c}	1.29
Overall–Negativity								
Upsetting when seeking support	1.68_{b}	1.07	2.00_{b}	1.36	3.48_{a}	1.22	4.18_{a}	1.47
Upsetting day to day	1.56_{c}	0.92	1.61_{c}	0.88	2.96_{b}	1.29	4.04_{a}	1.62

Note. For the overall analysis, Student–Newman–Keuls post hoc analysis groups are denoted by the subscripts. Mean ratings of positivity or negativity with different subscripts differ significantly at $p < .05$.

TABLE 3
Means and Standard Deviations of Dominance and Loving/Nurturance Ratings for Men, Women, and Overall Sample Across Relationship Conditions

	Indifferent		*Supportive*		*Ambivalent*		*Aversive*	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Women								
Dominance	–0.06	1.51	–0.50	1.22	0.70	2.06	1.25	2.03
Loving/Nurturance	2.14	2.21	4.63	1.27	1.55	2.71	0.34	2.72
Men								
Dominance	–1.25	1.55	–0.81	1.23	0.47	1.35	0.71	1.69
Loving/Nurturance	2.95	1.39	4.68	1.44	1.82	2.23	–0.91	2.39
Overall								
Dominance	-0.48_{a}	1.50	-0.59_{a}	1.21	0.60_{b}	1.76	1.00_{b}	1.87
Loving/Nurturance	2.43_{b}	1.96	4.64_{c}	1.30	1.66_{b}	2.47	-0.24_{a}	2.60

Note. For the overall analysis, Student–Newman–Keuls post hoc analysis groups are denoted by subscripts. Mean ratings of dominance or loving/nurturance with different subscripts differ significantly at $p < .05$.

ioral and self-report measures. The number of prompts given during the relationship task was used as a behavioral measure of task difficulty. Results revealed no significant main effects or interactions for the number of prompts given during the task ($p = .25$). Next, main effects for relationship condition were observed for the behavioral ratings of the number of positive, $F(3, 87) = 9.77$, $p < .001$, and negative references, $F(3, 87) = 13.62$, $p < .001$. Student–Newman–Keuls post hoc analyses revealed that there was a significantly lower number of positive references made when speaking about aversive relationships compared to the other relationship conditions. Also, these analyses revealed that there was a significantly greater number of negative references made when talking about ambivalent and aversive relationships compared to the supportive relationship condition (see Table 4). There were no significant gender main effects for the behavioral ratings.

We next conducted an analysis of covariance to evaluate the change in state anxiety across the four relationship conditions.

TABLE 4
Mean Numbers and Standard Deviations for Positive and Negative References for Women, Men, and Overall Sample Across Relationship Conditions

	Indifferent		*Supportive*		*Ambivalent*		*Aversive*	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Women								
Positive references	5.08	3.80	5.69	3.03	4.37	2.93	1.61	1.48
Negative references	3.27	4.46	0.34	0.85	4.47	2.86	7.04	5.48
Men								
Positive references	5.80	3.53	5.67	1.17	5.35	3.58	1.68	1.72
Negative references	0.80	0.92	0.08	0.20	4.40	3.36	6.41	4.76
Overall								
Positive references	5.39_a	3.62	5.68_a	2.62	4.76_a	3.17	1.64_b	1.56
Negative references	2.20_c	3.57	0.27_c	0.74	4.44_b	3.00	6.76_a	5.08

Note. For the overall sample, Student–Newman–Keuls post hoc analysis groups are denoted by subscripts. Mean ratings of the number of positive and negative references with different subscripts differ significantly at $p < .05$.

Controlling for baseline state anxiety, a main effect for relationship condition was observed, $F(3, 98) = 16.32$, $p < .001$. Student–Newman–Keuls post hoc analyses revealed that talking about aversive relationships led to significantly greater changes in reported state anxiety than the other three conditions. No other effects were significant.

Cardiovascular Data

The primary objective of the study was to evaluate the effects of recalling and talking about relationships on measures of cardiovascular reactivity. The main dependent measures were SBP, DBP, and heart rate. We followed these analyses with their underlying determinants: PEP, RSA, CO, and TPR. To increase measurement reliability, cardiovascular measures were averaged within each period (32; e.g., baseline, speaking task periods). Change scores were calculated by subtracting the average measurements during the baseline period from those during the speaking task.

We conducted a series of 4 (relationship condition) × 2 (gender) ANOVAs to assess for group differences in reactivity using change scores. Analyses adjusting for both the respective baseline cardiovascular measure and BMI showed results comparable to those reported later for all cardiovascular reactivity analyses. Several gender main effects emerged (see Table 5). Among the cardiovascular measures, women showed greater changes in DBP, $F(1, 100) = 9.08$, $p = .003$; heart rate, $F(1, 93) = 4.01$, $p = .05$; and the parasympathetic substrate of heart rate (RSA), $F(1, 97) = 6.52$, $p = .01$, compared to men. This pattern of results suggests that women in this study were more reactive to the relationship-speaking task compared to men. It is interesting to note that this response pattern is in contrast to

TABLE 5
Mean Change Scores and Standard Deviations for Cardiovascular Measures During Relationship-Speaking Task (Unadjusted Analyses)

	Heart Rate[a]		*RSA*[a]		*PEP*[b]		*SBP*[b]		*DBP*[a]		*TPR*		*CO*	
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Women														
Indifferent	7.69	5.48	–0.36	0.62	–3.31	6.48	11.70	5.55	10.07	5.06	17.87	152.09	0.81	0.96
Supportive	9.98	6.99	–0.62	1.12	–3.52	7.07	14.05	9.84	12.69	6.68	154.54	176.43	0.38	1.60
Ambivalent	12.70	4.47	–0.55	0.61	–7.72	8.29	16.66	7.11	13.03	6.08	78.59	354.18	0.71	0.96
Aversive	12.53	6.02	–0.51	0.93	–8.23	7.51	22.23	10.47	15.59	7.22	77.55	244.87	0.94	0.89
Men														
Indifferent	9.25	8.03	0.30	0.65	–3.51	8.28	11.87	8.73	6.63	5.33	–29.78	182.74	1.07	1.43
Supportive	7.71	4.09	–0.58	0.93	–3.25	5.75	16.20	9.25	10.70	5.38	79.84	127.10	0.64	1.30
Ambivalent	8.60	4.76	–0.08	0.81	–6.62	12.78	16.95	10.00	9.76	5.77	–75.98	547.84	0.67	0.83
Aversive	8.28	3.21	–0.03	0.39	2.36	5.65	11.97	5.55	9.81	5.61	26.42	349.04	0.28	1.02

Note. Analyses adjusting for respective baseline measure and body mass index revealed comparable results. RSA = respiratory sinus arrhythmia; PEP = pre-ejection period; SBP = systolic blood pressure; DBP = diastolic blood pressure; TPR = total peripheral resistance; CO = cardiac output.
[a]Gender main effects ($p < .05$). [b]Condition × Gender interaction ($p < .05$).

other reactivity studies that have showed that men are more reactive to achievement-oriented laboratory tasks compared to women.

No main effects of relationship condition were observed; however, the Relationship Condition × Gender interactions were statistically significant for SBP, $F(3, 100) = 2.98$, $p = .03$, and PEP, $F(3, 93) = 2.74$, $p = .05$ (see Figures 2 and 3). Follow-up analyses of relationship quality differences for each gender showed a significant simple relationship quality main effect for women for SBP, $F(3, 62) = 4.40$, $p = .007$. For this contrast, women showed a higher SBP response when talking about aversive relationships compared to talking about supportive or indifferent relationships. No other simple main effects for relationship quality were significant. More distinctive were the follow-up analyses of gender differences within each relationship condition. These analyses revealed significant simple gender main effects in the aversive relationship condition for SBP, $F(1, 26) = 10.01$, $p = .004$, and PEP, $F(1, 26) = 17.35$, $p < .001$. In these contrasts, women showed a higher SBP response and a greater shortening of PEP, indicating greater sympathetic activation compared to men. No other simple main effects for gender were significant.

Although no Relationship Condition × Gender Interaction effects for heart rate, DBP, RSA, CO, and TPR were statistically significant, we conducted exploratory analyses of potential gender differences within the aversive-relationship condition for these measures. Consistent with the effects detailed previously, the simple main effects for gender on heart rate, $F(1, 26) = 5.19$, $p = .03$, and on DBP, $F(1, 26) = 5.46$, $p = .03$, were significant, with women in the aversive condition showing a greater increase in heart rate and in DBP compared to men.

Finally, we also evaluated the cardiovascular responses during the preparation period, when participants recalled the relationship. Although not significant, results during this period showed gender main effect and Relationship × Gender interaction trends similar to those reported earlier, for the speaking

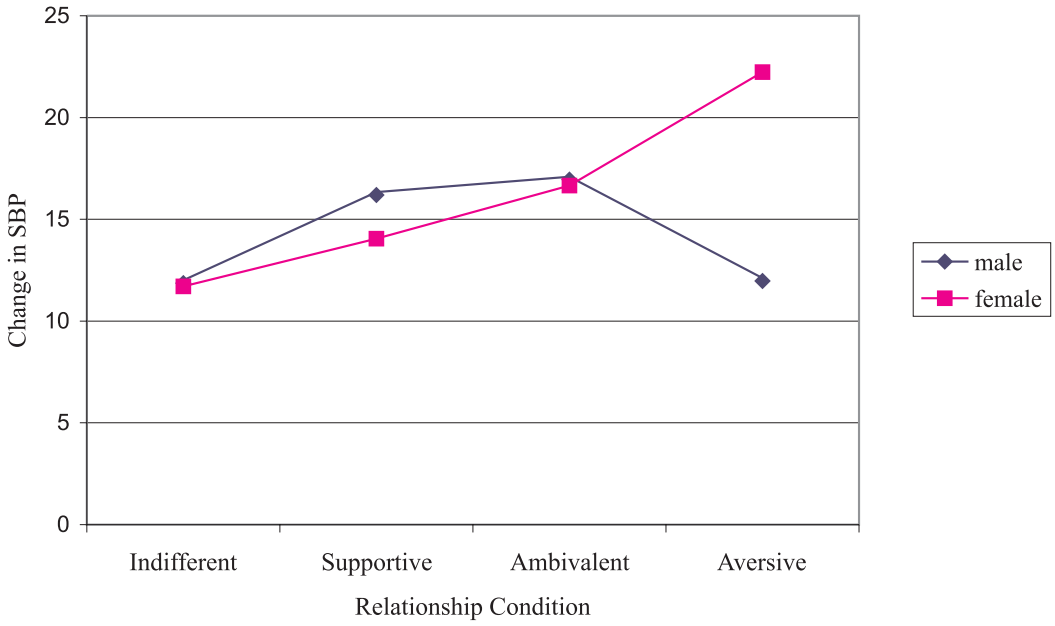

FIGURE 2 Gender × Condition interaction on systolic blood pressure (SBP), $F(3, 100) = 2.98$, $p = .03$.

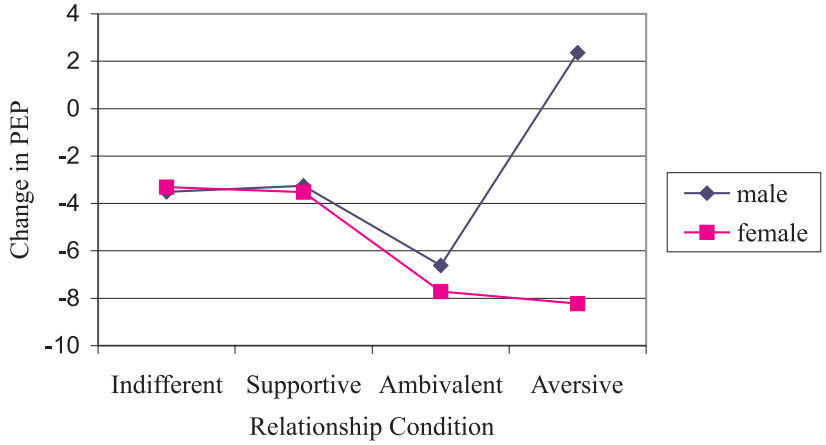

FIGURE 3 Gender × Condition interaction on pre-ejection period (PEP), $F(3, 93) = 2.74$, $p = .05$.

task. These weaker trends are likely due to the limited nature of the manipulation during this period (i.e., simply thinking about the relationship) and the resulting small changes in cardiovascular reactivity.

DISCUSSION

Prior research on social relationships and cardiovascular function has demonstrated a beneficial influence of social support and a detrimental effect of negative social relationships on health (1,33,34). However, considerably less is known about how social relationships that differ in their affective qualities exert these influences on health-related outcomes. In this study we hypothesized and evaluated the effects of one possible mechanism, namely, the cognitive and behavioral processes associated with recalling and speaking about particular relationships on cardiovascular reactivity.

The study's procedure for recalling particular relationships was effective and led to participants speaking about relationships that differed significantly on affective ratings of positivity and negativity from the SRI, ratings of dominance and loving/nurturance from the IMI, and behavioral ratings of the number of positive and negative references. However, the predicted main effect of relationship condition—that speaking about affective relationships that are supportive, ambivalent, or aversive would lead to differences in cardiovascular reactivity compared to speaking about indifferent social relationships—was not supported. There was also no evidence of an attenuated response in the supportive-relationship condition, as reactivity levels were comparable in the indifferent and supportive conditions. It may be possible that recalling supportive relationships reflected a positive but arousing reaction (e.g., greater task engagement), which would increase rather than attenuate cardiovascular responses.

Although the first two hypotheses of our study did not receive support, consistent evidence for gender differences in cardiovascular responses was observed. First, the gender main effects revealed that women showed greater cardiovascular reactivity than men during the task that was more relationship oriented compared to prior standard laboratory tasks (e.g., mental arithmetic), which are more achievement oriented. These findings are consistent with studies suggesting that women may be more responsive to relationship-based tasks than men (35). There were also significant Relationship Condition × Gender effects when women were talking about their aversive relationships. It is important to note that, consistent with Figure 1's depiction of positivity and negativity as separable dimensions, women showed the greatest increases in SBP reactivity and shortening of PEP compared to men when speaking about aversive relationships. Exploratory analyses showed a similar gender difference in the aversive condition for DBP and heart rate. These findings suggest that women were more responsive to the purely negative quality of relationships compared to men, which is consistent with the literature on gender differences in relationships (22,23).

On the basis of our prior research, it was possible that recalling ambivalent relationships would be associated with higher levels of cardiovascular reactivity even compared to aversive ties (16). However, it is important to note that the relative levels of positivity and negativity differed somewhat from the model depicted in Figure 1. An unequivocal test of the effects of ambivalent ties would require that the levels of positivity be similar for supportive and ambivalent relationships and that the levels of negativity should be similar for aversive and ambivalent relationships. However, the mean level of positivity in this study was significantly higher for the supportive- compared to the ambivalent-relationship condition. In addition, the level of negativity was significantly higher in day-to-day interactions for the aversive condition compared to the ambivalent-relationship condition. These differences may be important, as the unequal levels of positivity and negativity across conditions may have weakened our ability to detect associations for ambivalent relationships.

Alternatively, because individuals were free to think about any aspect of the relationship, the lack of findings for ambivalent ties may be due to participants focusing on positive rather than negative qualities of these relationships. If this were correct, we would expect that the behavioral coding would reveal a similar number of positive references for the ambivalent and supportive groups and a significantly lower number of negative references in the ambivalent compared to the aversive group. Consistent with this possibility, analyses revealed that participants in the aversive condition made significantly more negative references than did participants in the ambivalent condition. These data, in combination with the SRI ratings presented earlier, suggest that negative activation associated with ambivalent relationships may have been weaker than that for aversive relationships.

In contrast to the reactivity results, the self-report measures and behavioral ratings of positive and negative references did not demonstrate a gender main effect or a Gender × Condition interaction. These findings potentially suggest the importance of obtaining more specific measures of cognitive processes in future research that may underlie these behavioral and self-report measures (22,36). As Kiecolt-Glaser and Newton (22) discussed, women's greater sensitivity to negative relationship information may result from the structure of their self-representations. For women, these mental representations are more likely to incorporate representations of significant others, and this characteristic leads to greater awareness of the emotional quality of relationships (22). Future research is needed to determine the more precise processes that lead to the recall of relationships that in turn may be health relevant.

This suggestion relates to an important question this study raises in terms of what social–cognitive processes were actually manipulated. This study had participants recall and talk about particular relationships with the notion that this is a cognitive and behavioral process that is associated with important outcomes. The process of speaking about relationships presumably draws on relational information, such as self-representations or schemas for relationships, that is accessible in memory. The activated mental structures may then influence health-relevant car-

diovascular processes. Consistent with this reasoning, Levy and her colleagues have subliminally primed older adults with negative aging stereotypes (e.g., senile, dependent; 37,38). These older participants showed not only declines in memory performance (37) but also increases in autonomic nervous system reactivity (38) compared to those who were primed to positive aging stereotypes (e.g., wise, astute). One conclusion posited by the authors was that the health-relevant effects of these mental structures may be more enduring and important to long-term health because the structures are continually available in memory. In relation to our study, accessing relationship information at a conscious level was found to have potential health-relevant effects in women. Therefore, developing research paradigms that access this relationship information via different methods (e.g., priming relationship schemas at the subliminal level) may be an important future step in assessing the promise of our findings.

There are limitations of this study that should be discussed. The generalizability of these findings needs examination given that this study involved a sample of predominantly White undergraduates. In addition, although preliminary support exists for the reactivity hypothesis, it is not known whether stress-induced cardiovascular responses are definitively linked to long-term physical health (39). We also do not know (a) the more precise social psychological mechanisms underlying these findings or (b) how frequently individuals actually engage in the cognitive and behavioral processes of recalling and discussing these relationships under naturalistic conditions. In the real world, there are a number of factors that might lead to the activation of such mental structures. For instance, rumination can lead to self-disclosure in an effort to cope with the aversive relationship. It is also possible that network members may sense that a problem exists and probe the individual, leading to the recall and/or disclosure of such relationship information. The use of ambulatory protocols that provide detailed information on such interpersonal, cognitive, and behavioral processes, and the links to ambulatory cardiovascular function, may be useful to address these issues. Laboratory paradigms that examine posttask measures, including cardiovascular recovery, may also be able to examine more precise cognitive processes (e.g., rumination) as well as track the associated time course of these effects.

Despite these limitations, our study has several strengths. The observed association between cognitive aspects of relationships and cardiovascular responses is consistent with existing research on social relationships, gender differences, cardiovascular function, and health (1,22,33). In addition, the broad model depicted in Figure 1 proved to be useful for examining the outcomes associated with perceptions of relationships that differ in their positive and negative substrates. It should be highlighted that the model in Figure 1 can be used to categorize either the quality of the relationship (e.g., ambivalent relationships) or specific behaviors (e.g., ambivalent transactions) depending on the goals of a study. Finally, this study's focus on potential cognitive and behavioral aspects of relationships (i.e., thinking about and recalling relationships) that are continually available in memory represents one promising, complementary pathway through which social relationships may affect health.

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