

Marital Conflict and Endocrine Function: Are Men Really More Physiologically Affected Than Women?

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This study assessed marital conflict behavior and endocrine function in 90 newlywed couples. Blood samples acquired hourly from 8:00 a.m. through 10:00 p.m. were combined to provide composite daytime values for 3 stress hormones-epinephrine (EPI), norepinephrine (NEPI), and cortisol and 3 related hormones (ACTH, growth hormone, and prolactin). These pooled data provided a window on endocrine function in couples for whom the day included a conflict. For wives, higher probabilities of husband's withdrawal in response to wife's negative behavior were associated with higher NEPI and cortisol levels. In addition, higher frequencies of positive behaviors were associated with lower EPI and higher prolactin levels among wives. Husbands' endocrine data were not associated with behavioral data. These findings are discussed in the context of gender models of marital conflict.

There is growing evidence that personal relationships have significant consequences for physiological functioning. Data from large, well-controlled epidemiological studies suggest that social isolation constitutes a major risk factor for morbidity and mortality, with statistical effect sizes comparable with those of such well-established health risk factors as smoking, blood pressure, blood lipids, obesity, and physical activity (House, Landis, & Umberson, 1988). The endocrine system serves as one important gateway between personal relationships and health; stress can provoke the release of pituitary and adrenal hormones that have multiple effects, including alterations in cardiovascular and immune function (Ader, Felten, & Cohen, 1991; Fredrikson, Tuomisto, & Bergman-Losman, 1991; Smith & Christensen, 1992).

Social stressors can substantially elevate epinephrine (EPI), norepinephrine (NEPI), and cortisol (Dimsdale, Young,

Moore, & Strauss, 1987; Oleshansky & Meyerhoff, 1992). As part of our larger study on the physiological consequences of marital discord, we examined the relationship between marital conflict and short-term, or "phasic," endocrine changes in 90 newlywed couples (Malarkey, Kiecolt-Glaser, Pearl, & Glaser, 1994). These endocrine samples, collected immediately before, during, and 15 min after conflict, provided a window on short-term reactivity: Five of the six hormones that we assayed changed during the 30-min problem discussion, and negative behavior was associated with larger and more persistent alterations. We found increased levels of two of the three stress hormones (EPI and NEPI), but no significant behavioral associations with cortisol; in addition, we found changes in three related hormones associated with negative behavior, including increased levels of ACTH and growth hormone (GH) and decreased levels of prolactin (PRL). Moreover, differences between high and low negative behavior groups tended to be relatively larger for women than for men, particularly for EPI.

The majority of psychoendocrine studies have focused on the three classic stress hormones, EPI, NEPI, and cortisol, and most have addressed acute responses to discrete novel or stressful events (Kuhn, 1989). However, chronic stimulation of cortisol and catecholamine secretion at lower levels has been more clearly linked to cardiovascular pathology (see review in Kuhn, 1989) and immune function (Ader et al., 1991; Baum, Cohen, & Hall, 1993). The ability to "unwind" after stressful encounters (i.e., to return quickly to one's neuroendocrine baseline) influences the total burden that stressors place on an individual (Frankenhaeuser, 1986). Stressors that are resistant to behavioral coping, particularly those perceived as unpredictable and uncontrollable, may continue to be associated with elevated stress hormones even after repeated exposure (Baum et al., 1993). Accordingly, the present investigation used pooled blood samples acquired hourly from 8:00 AM through 10:00 p.m. to provide composite daytime values for the three stress hormones, as well as three related hormones; the pooled samples reflect an integrated value across the day, providing

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a stronger basis for health-related inferences. These composite data provided a window on endocrine function in couples for whom the day included a conflict.

In addition, we used our daytime endocrine data for exploration of gender-related behavioral correlates. Women are more likely to complain, criticize, or demand change during marital conflict, whereas men are more likely to avoid or withdraw; this gender disparity is one of the most reliable behavioral differences in the marital literature, particularly among distressed couples (Weiss & Heyman, 1990). Called the "wife demand-husband withdraw" or the "negative-withdraw" interaction sequence, it appears to be particularly destructive, linked both cross-sectionally and prospectively to marital discord (Christensen, 1987; Heavey, Lane, & Christensen, 1993).

The gender differences in the negative-withdraw pattern have been explained in several ways. Christensen (1987) has argued that differences in the need for intimacy reflect, in part, divergent socialization experiences; in general, women want more closeness, whereas men seek more autonomy. Thus, wives demand and complain as a way of seeking intimacy, and husbands withdraw to maintain greater autonomy. Several studies have supported this conceptualization (Christensen, 1987; Christensen & Shenk, 1991).

The conflict structure hypothesis relates gender differences in the negative-withdraw pattern to power differences in the structure of conflict (Heavey et al., 1993). For example, Jacobson (1983) has argued that traditional marital relationships provide greater benefits to men than women. Because men have less interest in changing the status quo, they are more likely to withdraw when confronted with their wives' requests for change. Data from two recent studies (Christensen & Heavey, 1990; Heavey et al., 1993) support this hypothesis.

The escape-conditioning model (Gottman & Levenson, 1988) further suggests that men experience greater physiological arousal during marital conflict than women and that men are slower to return to baseline after conflict; because of men's (hypothesized) greater and more prolonged "diffuse physiological arousal," men are more likely to avoid or withdraw from conflict than women. Because physiological arousal is unpleasant, men's withdrawal is a protective mechanism (Gottman & Levenson, 1988). This hypothesis has been widely discussed within the marital literature (e.g., Bradbury & Fincham, 1992; Heavey et al., 1993; Markman & Kraft, 1989; Weiss & Heyman, 1990).

However, several recent studies have explicitly compared gender differences in physiological arousal; contrary to the pervasive view in the literature, wives appear to experience greater and more persistent physiological change associated with marital conflict than their husbands (Ewart, Taylor, Kraemer, & Agras, 1991; Kiecolt-Glaser et al., 1993; Malarkey et al., 1994). Moreover, wives' physiological changes have been more closely linked to conflict behavior and marital adjustment than husbands' responses (Ewart et al., 1991; Jacobson et al., 1994; Kiecolt-Glaser et al., 1993; Morell & Apple, 1990). In addition, longitudinal data from one study suggested that wives' physiological responses to conflict may have greater predictive power than husbands' responses: Comparisons of couples at high or low risk for marital dissolution showed that high-risk wives had faster heart rates and greater peripheral vasoconstriction during conflict than low-risk wives, whereas high- and low-risk hus-

bands did not differ (Gottman & Levenson, 1992). In contrast to these studies, Notarius and Johnson (1982) suggested that there was a trend toward greater physiological change in men than in women in response to marital conflict; however, gender differences on their sole physiological measure, skin potential response, did not reach significance in their sample of six couples.¹

In related work with these newlywed couples, wives showed greater immune change than husbands during the 24 hr they spent on a hospital research unit, and women's immune changes were more closely related to frequency of negative behaviors during conflict than men's (Kiecolt-Glaser et al., 1993). We expected a similar pattern in our pooled daytime endocrine data, because interpersonal stressors can alter both endocrine and immune function; furthermore, endocrinological alterations provide one avenue for immune modulation (Ader et al., 1991).

Moreover, the present investigation uses sequential analysis data to provide further information on couples' interactional processes beyond simple frequencies or base rates (Weiss & Heyman, 1990). In addition to the negative-withdraw sequence, we were interested in negative reciprocity, one of the "signatures" of marital distress (Notarius, Benson, Sloane, Vanzetti, & Hornyak, 1989); distressed wives are more likely than distressed husbands to respond in kind to negative messages (Margolin, Burman, & John, 1989; Notarius et al., 1989). Thus, the present study assessed daytime, or "tonic," levels of six hormones and related these data to two key conflict sequences: wife negative-husband withdraw (Christensen, 1987) and negative reciprocity. We expected higher frequencies of negative behaviors and a greater propensity for negative reciprocity to be associated with higher daytime levels of the three stress hormones, and we expected that wife negative-husband withdraw would be associated with higher daytime levels of the stress hormones for women. In contrast, the escape-conditioning model (Gottman & Levenson, 1988) would predict that men would show greater and more prolonged diffuse physiological arousal related to conflict than women would.

Method

Participant Selection

Immunological, endocrinological, autonomic, behavioral, and self-report data were collected from 90 newlywed couples during a 24-hr

¹At least four other studies have examined physiological responses during marital conflict. In three reports, the researchers did not compare the magnitude of wives' and husbands' physiological changes during conflict or assess relationships between behavior during conflict and physiological data (Levenson et al., 1994; Levenson & Gottman, 1983, 1985). In other work, Brown and Smith (1992) assessed the cardiovascular consequences of interpersonal control in couples who were given an incentive to influence the spouse. Both spouses were given the incentive, but each was led to believe that he or she alone had been given the incentive. Husbands showed greater elevations in systolic blood pressure than wives under these conditions, and these elevations were correlated with husbands' hostile and controlling behavior. However, the topic for the influence task was unrelated to the couples' personal issues, and thus differed from the marital conflict studies that are our focus. In addition, data from studies investigating the conflict structure hypothesis have demonstrated that differences in the spouse who is requesting the change alter the conflict structure (Heavey et al., 1993).

admission to the Ohio State Clinical Research Center (CRC), a hospital research unit. The intensive three-stage process used for screening and recruitment, described elsewhere (Kiecolt-Glaser et al., 1993; Malarkey et al., 1994), excluded participants with any current or past mental or physical health problems. For our final sample, the average ages of wives and husbands were 25.21 ($SD = 3.01$) and 26.13 ($SD = 3.05$), respectively (range, 20 to 37). Couples were well educated: 6.1 % were high school graduates, 23.3% had some college training, 53.3% were college graduates, and 17.2% had additional postgraduate training. The average couple's combined income was \$43,464 ($SD = 16,739$). Most of the couples were Caucasian (95%). Couples dated an average of 36.58 months ($SD = 25.32$) before marriage, and 55 couples (61.11%) lived together before marriage. An average of 10.44 months (range, 6 to 14) elapsed between their marriage and their CRC admission.

CRC Admission

After the 7:00 a.m. admission to the CRC, a heparin well was inserted in each participant's arm so that we could draw blood regularly across the 24-hr stay and minimize additional discomfort. After the 1.5-hr adaptation period after insertion of the heparin well, participants were positioned in chairs facing each other in front of a curtain. The couples completed several questionnaires and then sat quietly for 10 min.

At the end of the baseline period, a 10- to 20-min interview helped us to identify the best topics for the problem discussion. On the basis of this interview and their ratings on a list of common marital problems, couples were asked to discuss and try to resolve two or three marital issues that the interviewer judged to be the most conflict producing while the research team remained out of sight for 30 min. After a 30min break following the conflict discussion, the couples responded to questions about the history of their relationship, generally a pleasant interview that lasted 30 to 45 min. The couples had no further experimental tasks and were left alone except for the hourly blood draws until 5:00 p.m. that afternoon when we assessed cardiovascular reactivity during 2-min mental arithmetic serial subtraction tasks (see Kiecolt-Glaser et al., 1993, for details).

Endocrine Data

In addition to individual blood samples drawn during interviews, additional blood samples acquired hourly from 8:00 a.m. through 10:00 p.m. were pooled to provide composite daytime values for each of the six hormones; assay methods have been described previously (Malarkey et al., 1994). Although individual analyses of these 15 hourly samples would have provided interesting data on changes throughout the day, the costs would have been prohibitive. Moreover, these pooled samples provide desirable information on tonic levels of stress hormones, augmenting our previous data on phasic or acute changes: Chronic stimulation of stress hormones at lower levels has been more clearly linked to pathology (Ader et al., 1991; Kuhn, 1989).

Cortisol facilitates the vasoconstrictive effects of catecholamines; accordingly, the combination of catecholamine and cortisol responses is important for pathogenesis in cardiovascular disease (Fredrikson et al., 1991). Furthermore, both the catecholamines and cortisol are associated with immunological down-regulation (Ader et al., 1991). In contrast to the three major stress hormones, much less is known about the psychosocial mediation of ACTH, PRL, and GH (Baum & Grunberg, 1995). However, PRL and GH do not appear to be as stress responsive as the catecholamines and cortisol (Brown, Seggie, Chambers, & Ettigi, 1978; Delahunt & Mellso, 1987; Rose, 1984); this is not surprising because stress-related responses among these hormones are frequently dissociated, and there is no single mechanism of endocrine change (Delahunt & Mellso, 1987; Rose, 1984). ACTH serves as one stimulus for cortisol secretion, and, like cortisol, down-regulates immune function (Breier et al., 1987); in contrast, PRL and GH have immunoenhancing effects (Gala, 1991).

Marital Interaction Coding System (MICS)

The Marital Interaction Coding System-IV (MICS; Weiss & Summers, 1983) provided data on problem solving behaviors during the 30min marital conflict task. The videotapes were coded by the Oregon Marital Studies Program (OMSP) under the direction of Robert L. Weiss. The MICS, the most widely used marital behavioral coding system, is designed to describe couples' behaviors as they attempt to resolve a relationship issue (Weiss & Heyman, 1990). For a detailed discussion of MICS reliability procedures and data see Weiss and Tolman (1990) and Heyman, Weiss, and Eddy (in press).

We used the results of factor analyses as well as conventional groupings to help determine the final clustering of MICS codes (for details, see Kiecolt-Glaser et al., 1993; Malarkey et al., 1994). We grouped the 15 negative behavior codes into two clusters, consistent with dimensions used by other investigators (Ewart et al., 1991; Jacob & Krahn, 1987; Weiss & Summers, 1983); the first cluster included 11 "active" negative behaviors (i.e., criticizing, disagreeing, denying responsibility, excusing, interrupting, negative mind reading, noncompliance, putting down, turning off, disapproving, and dysphoric affect). Our second negative dimension included four avoidance or withdrawal behaviors (e.g., not tracking, withdrawal, being off-topic, and disengaging; Weiss & Tolman, 1990). For simplicity, discussions of negative behaviors will refer only to the 11 active negative behaviors, not the 4 withdrawal behaviors.

Positive behaviors were subdivided into a positive behavior or validation-facilitation cluster (agreeing, approving, accepting responsibility, assenting, and positive mind reading), a problem-solving-propose change cluster (negative solution, problem description, compromise, and positive solution), and a humor cluster (humor, compliance, and smile-laugh). For the analyses in this article that included positive behavior, we used the frequency of behaviors from the validation-facilitation cluster, because they corresponded to the groupings used for positive behaviors in related studies (Ewart et al., 1991; Weiss & Summers, 1983).

Psychological Assessment

The Marital Adjustment Test (MAT; Locke & Wallace, 1959), used to assess marital adjustment, was administered during the initial telephone screening interview. The mean for our final sample of 180 participants was 128.28 ($SD = 14.60$), consistent with the higher scores reported in other studies of engaged or newlywed couples (Storaasli & Markman, 1990).

The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) includes two 10-item mood scales. The two scales, largely uncorrelated, show good convergent and discriminant validity when related to state mood scales and other variables (Watson et al., 1988). Coefficient alpha for positive items was .87, and the mean was 29.98 ($SD = 5.87$); alpha for negative items was .78, with a mean of 13.54 ($SD = 3.66$).

The Cook-Medley Hostility scale provided a measure of trait hostility (Cook & Medley, 1954). Hostile individuals show a vulnerable social profile, including greater familial conflict as well as fewer and less satisfactory social supports (Smith & Christensen, 1992). Our sample's mean was 15.23 ($SD = 6.79$), with a Kuder-Richardson of .81. Pope and Smith (1991) found that men with high levels of hostility ($M = 28.1$) had twice the increase in cortisol excretion during daytime hours as men with low levels of hostility ($M = 12.5$).

The Marlowe-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) was included because high scorers characteristically avoid conflict, even when provoked, and show greater autonomic arousal when asked to behave assertively (Kiecolt-Glaser & Greenberg, 1983). High scorers tend to describe themselves in unrealistically positive ways on self-report measures (Crowne & Marlowe, 1960). The Kuder-Richardson was .77. The mean was 17.40 ($SD = 5.25$).

The Profile of Mood States (POMS; McNair et al., 1981), one of

the best self-report measures for assessing transient affective states, was administered before and after interviews. The POMS has excellent norms and, psychometrically, is very strong in terms of both reliability and validity. We were interested in the hostility, anxiety, depression, and total POMS scales.

Sequential Analyses

Bakeman's (1983) lag sequential analysis program, ELAG, was used to assess behavioral sequences across the 30-min conflict task. In such analyses, the base rate, or unconditional probability, of a target behavior is compared with its conditional probability (i.e., the probability of the target behavior given the occurrence of a particular criterion behavior). This difference is then divided by an estimate of the standard error of the difference, thereby expressing the relationship between the conditional and unconditional probabilities as a z statistic. Positive z statistics indicate that the criterion behavior increases the likelihood of the target behavior (i.e., a facilitative effect), whereas negative z statistics indicate that the criterion behavior decreases the likelihood of the target behavior (i.e., an inhibitory effect). We used Lag 1 data (the immediate response of one spouse to the other) for our analyses; the z score data always reflect alternating patterns of wife-husband or husband-wife behavior.

Results

Regression Analyses

On the first step of our regression analyses, we entered the couple's (sum of husband and wife) frequency of negative behaviors, the variable of primary interest in our previous reports (Kiecolt-Glaser et al., 1993; Malarkey et al., 1994); by entering these data initially, we controlled for the possibility that any other relationships were simply a function of negativity during the session. The frequency of each spouse's positive (validation-facilitation) behaviors was entered on the second step to examine the contribution of more positive aspects of conflict resolution to daytime hormone levels. Weiss and Heyman (1990) suggest that women show a positivity bias (i.e., women interpret a lack of negative affect as positivity), whereas men's negativity bias leads them to interpret an absence of positive affect as hostility (Gaelick, Bodenhausen, & Wyer, 1985; Noller & Fitzpatrick, 1990). Thus, entering each spouse's positive behaviors separately allowed us to examine both spouses' contributions. Spouses' negative behavior frequencies, $r(89) = .74, p < .001$, and positive behavior frequencies, $r(89) = .40, p < .01$, were both significantly correlated; however, the former relationship is significantly larger than the latter, $z = 4.93, p < .001$. We entered the two z scores for negative reciprocity (husband negative-wife negative, wife negative-husband negative) on the third step, and the z score for wife negative-husband withdraw on the fourth and final step. Regressions were conducted separately for husbands and wives. An alpha level of .05 was used for all statistical tests.

Low base rates may bias z statistics; following work by Heyman et al. (in press), we excluded 28 couples from the regression analyses because the husband showed withdrawal behavior fewer than five times.² (All subjects showed a minimum of six negative behaviors.) Technical problems with serial blood draws, storage of endocrine samples, or endocrine assays led to missing data in several additional cases. We excluded cortisol data from one woman who fell more than 4 SD s above the wom-

en's mean. The worst case for missing endocrine data left us a sample of 52 women and 56 men for ACTH.

Four of the six behaviors of interest had negative behavior as a component; to assess possible problems with multicollinearity, correlations were computed among these variables. Neither the correlation between the couple's frequency of negative behavior and wife negative-husband withdraw, $r(61) = .10$, nor the correlation between wife's negative reciprocity and couple's frequency of negative behavior, $r(61) = .01$, was significant, and these two z scores were not reliably related, $r(61) = -.04$. Husband's negative reciprocity was correlated with the couple's negative behavior, $r(61) = .30, p < .05$, as well as with wife's negative reciprocity, $r(61) = .35, p < .01$. These data did not suggest that multicollinearity was a problem.

For women, the three classic stress-responsive hormones produced significant squared multiple correlations: Higher probabilities of husband's withdrawal in response to wife's negative behavior were associated with higher NEPI and cortisol levels (Table I). In addition, wives who showed higher frequencies of positive (validation-facilitation) behaviors had lower EPI levels. For men, none of these three models approached significance.

Among the related hormones, only PRL produced a significant regression model, and this was true only for women, not for men (Table 2). Increased levels of PRL were associated with lower frequencies of negative behaviors, replicating the pattern previously observed during conflict (Malarkey et al., 1994). Husbands' positive behaviors made the largest contribution, accounting for 18% of the variance. Although the simple correlations of PRL with wives' positive behaviors and negative-withdraw were small, both of these independent variables made significant contributions in the regression model when other independent variables were partialled out. This appears to be a case of suppression (Cohen & Cohen, 1983), wherein an independent variable may exhibit a stronger effect in a multiple regression model than reflected by its simple correlation with the dependent variable. Interpretation of the biological relevance of these PRL data is unclear; in contrast to the other hormones we studied, PRL and GH have immunoenhancing effects, and the direction of change for PRL during stress may be variables (Delahunt & Mellso, 1987).

To obtain a global assessment of gender differences, we used LISREL 7 (Jöreskog & Sörbom, 1989) to test the hypothesis that the regression weights for predicting a given hormone measure were the same for husbands and wives. This was done by using the multisample option in LISREL 7 and imposing equality constraints on the regression weights across groups. For the standardized model, the hypothesis of no gender differences was rejected when cortisol was the dependent variable, $\chi^2(6, N = 180) = 13.61, p < .05$, and a nearly significant difference was found for PRL, $\chi^2(6, N = 180) = 11.48, p < .075$. When we conducted the same tests, comparing raw score regression models, significant gender differences were found for models

² When we included z scores for all couples in which husbands showed any withdrawal behaviors, we found the same pattern of results, with significant effects for women for EPI, NEPI, and cortisol, and no significant regression models for men. The sole exception was PRL, which did not produce a significant regression model for women when the full sample was included.

Table 1
Wives' and Husbands' Daytime Stress Hormones and Behavior During Marital Conflict

Hormone and behaviors	Wives				Husbands			
	<i>r</i>	β	R^2	<i>t</i>	<i>r</i>	β	R^2	<i>t</i>
EPI^a								
Step 1. Couple's negative behaviors	.07	0.06	0.00	0.45	-.14	-0.16	0.02	-1.10
Step 2. Wife's positive behaviors	-.36	-0.47		-3.32**	-.17	-0.24		-1.58
Husband's positive behaviors	-.01	0.11	0.14	0.78	-.03	0.06	0.06	0.41
Step 3. Husband negative-wife negative	-.18	-0.22		-1.74	-.12	-0.16		-1.11
Wife negative-husband negative	-.02	-0.13	0.22	-0.89	-.05	-0.03	0.08	-0.21
Step 4. Wife negative-husband withdraw	-.17	-0.14	0.24	-1.11	-.09	-0.05	0.09	-0.39
NEPI^b								
Step 1. Couple's negative behavior	.14	0.08	0.02	0.66	.05	0.08	0.00	0.56
Step 2. Wife's positive behaviors	.26	0.22		1.61	.22	0.18		1.22
Husband's positive behaviors	.09	0.04	0.10	0.33	-.05	-0.04	0.05	-0.30
Step 3. Husband negative-wife negative	-.31	-0.29		-2.32*	-.20	-0.14		-0.97
Wife negative-husband negative	-.05	0.13	0.17	0.91	-.16	-0.07	0.08	-0.47
Step 4. Wife negative-husband withdraw	.38	0.35	0.29	2.88**	.11	0.08	0.09	0.08
Cortisol^c								
Step 1. Couple's negative behaviors	.09	0.00	0.01	-0.01	-.11	-0.03	0.01	-0.20
Step 2. Wife's positive behaviors	-.01	-0.11		-0.80	-.09	-0.09		-0.66
Husband's positive behaviors	.05	0.14	0.01	1.01	-.14	-0.13	0.03	-0.88
Step 3. Husband negative-wife negative	-.12	-0.13		-1.02	.20	0.27		2.03*
Wife negative-husband negative	.02	0.07	0.03	0.48	-.13	-0.26	0.12	-1.76
Step 4. Wife negative-husband withdraw	.45	0.47	0.24	3.81***	.05	0.06	0.12	0.44

Note. EPI = epinephrine; NEPI = norepinephrine.

^a Full model: For wives, $F(6, 51) = 2.66, p < .05$; for husbands, $F(6, 53) = 0.83, ns$. ^b Full model: For wives, $F(6, 52) = 3.50, p < .01$; for husbands, $F(6, 53) = 0.86, ns$. ^c Full model: For wives, $F(6, 53) = 2.73, p < .05$; for husbands, $F(6, 55) = 1.24, ns$.

* $p < .05$ for R^2 change. ** $p < .01$ for R^2 change. *** $p < .001$ for R^2 change.

predicting both cortisol, $\chi^2(6, N = 180) = 15.99, p < .01$, and PRL, $\chi^2(6, N = 180) = 20.30, p < .002$.

Finally, to supplement the sequential analysis data, we computed correlations between the frequency of withdrawal behaviors and endocrine levels as a further assessment of one of the tenets of the escape-conditioning model. Husbands' withdrawal did not correlate significantly with any of their daytime hormone levels. Wives who showed greater withdrawal or avoidance had higher EPI levels, $r(88) = .25, p < .05$, but no other significant relationships.

Genetic Vulnerability, Health-Related Behaviors, Affect, and Personality

We conducted further analyses to assess the possibility that our behavior-endocrine relationships might simply reflect the contribution of other variables (e.g., health-related behaviors, genetic vulnerability, marital adjustment, positive or negative affect on entry to the CRC, or personality). Correlations between health behaviors (e.g., alcohol intake, body mass, and weekly hours of vigorous physical exercise) and daytime endocrine values were significant in only two cases: customary alcohol intake (number of drinks per week) was inversely related to wives' NEPI values, $r(83) = -.26, p < .05$, compared with $r(84) = -.09$ in men; and positively related to GH in men, $r(88) = .24, p < .01$, compared with $r(88) = .11$ among women. Controlling for alcohol intake by entering it on the first step of the regressions before behavioral data did not alter previous relationships between behavior and NEPI or GH.

Because individuals with a parental history of hypertension

show exaggerated EPI, NEPI, and cortisol responses to psychological stressors (Fredrikson et al., 1991), we used data from participants' medical history forms to assess the possibility that differences across these hormones might reflect underlying genetic differences. The presence or absence of a history of parental hypertension was not related to husbands' or wives' daytime EPI, NEPI, or cortisol levels, all $F_s < 1$.

We computed correlations between hormone data and positive and negative affect at entry into the CRC, MAT scores, social desirability, and hostility as measured by the Cook-Medley Hostility scale. These correlations were nonsignificant for women; only one correlation was significant for men, a negative relationship between hostility and PRL, $r(84) = -.32, p < .01$. Levenson et al. (1994) found that affect ratings that were made while a couple watched the videotape of their conflict session several days later were correlated with husbands' (but not with wives') autonomic responses during conflict. We computed correlations between affect as measured by the POMS (using the anxiety, depression, hostility, and total POMS scales) that our participants had completed immediately after conflict and their endocrine data. We found no significant correlations between self-rated affect immediately after conflict and the daytime endocrine levels for either spouse. Thus, neither marital satisfaction nor affect nor personality measures showed reliable relationships with daytime endocrine data.

Discussion

The present study found significant relationships between conflict behavior and endocrine function for women for the

Table 2
Wives' and Husbands' Behavior During Marital Conflict and Daytime ACTH, Growth Hormone, and Prolactin

Hormone and behaviors	Wives				Husbands			
	<i>r</i>	β	<i>R</i> ²	<i>t</i>	<i>r</i>	β	<i>R</i> ²	<i>t</i>
ACTH^a								
Step 1. Couple's negative behaviors	.23	0.20	0.04	1.25	.09	0.14	0.00	0.95
Step 2. Wife's positive behaviors	-.13	-0.14		-0.84	-.14	0.06		0.36
Husband's positive behaviors	-.04	-0.02	0.05	-0.12	-.26	-0.31	0.09	-2.08*
Step 3. Husband negative-wife negative	-.01	0.01		0.03	.22	0.20		1.42
Wife negative-husband negative	-.01	-0.07	0.06	-0.38	.19	0.05	0.13	0.30
Step 4. Wife negative-husband withdraw	.07	0.07	0.06	0.47	-.12	-0.17	0.16	-1.22
Growth hormone^b								
Step 1. Couple's negative behaviors	.13	0.06	0.02	0.43	-.11	-0.13	0.01	-0.95
Step 2. Wife's positive behaviors	-.31	-0.39		-2.76**	.17	0.17		1.20
Husband's positive behaviors	.02	0.17	0.12	1.23	.15	0.11	0.05	0.76
Step 3. Husband negative-wife negative	-.04	-0.10		-0.78	.26	0.28		2.08*
Wife negative-husband negative	.11	0.02	0.13	0.12	.01	0.03	0.13	0.20
Step 4. Wife negative-husband withdraw	.13	0.17	0.16	1.34	.00	0.02	0.13	0.13
Prolactin^c								
Step 1. Couple's negative behaviors	-.16	-0.35	0.03	-2.99**	-.23	-0.32	0.05	-2.29*
Step 2. Wife's positive behaviors	-.03	-0.25		-2.05*	-.02	0.03		0.18
Husband's positive behaviors	.40	0.60	0.26	4.95***	-.07	0.00	0.06	0.07
Step 3. Husband negative-wife negative	-.07	-0.16		-1.41	.00	-0.07		-0.51
Wife negative-husband negative	.05	0.22	0.31	1.79	.12	0.25	0.10	1.65
Step 4. Wife negative-husband withdraw	.14	0.25	0.37	2.23*	.04	0.07	0.11	0.57

^a Full model: For wives, $F(6, 45) = 0.82$, *ns*; for husbands, $F(6, 49) = 1.54$, *ns*. ^b Full model: For wives, $F(6, 54) = 1.74$, *ns*; for husbands, $F(6, 55) = 1.40$, *ns*. ^c Full model: For wives, $F(6, 54) = 5.19$, $p < .001$; for husbands, $F(6, 55) = 1.09$, *ns*.

* $p < .05$ for R^2 change. ** $p < .01$ for R^2 change. *** $p < .001$ for R^2 change.

three stress-responsive hormones, EPI, NEPI, and cortisol, and one of the related hormones, PRL. Women whose husbands were more likely to withdraw after the wife's negative behaviors were more likely to show elevated cortisol, NEPI, and PRL levels. As noted earlier, the wife negative-husband withdraw interaction sequence appears to be a particularly destructive marital pattern, strongly associated with marital discord (Heavey et al., 1993); recent prospective work has linked the interactional pattern with longitudinal declines in wives' (but not husbands') marital satisfaction (Heavey et al., 1993).

In other physiological data from this study, relationships between physiological change and negative behaviors have been significantly stronger for women than for men, and women's physiological changes following marital conflict show greater persistence than men's (Kiecolt-Glaser et al., 1993; Malarkey et al., 1994). The full regression models for EPI, NEPI, cortisol, and PRL were significant for wives and not for husbands; tests of the regression weights showed significant differences between men and women in the relationship of conflict behavior to cortisol and PRL. In fact, these data are contrary to the central premise for the escape conditioning model, that men will show greater and more prolonged diffuse physiological arousal related to conflict than women.

Indeed, "confinement," or forced exposure to a stressor can exacerbate stress-related hormone changes in susceptible individuals. In research with parents of children who were dying of leukemia, those parents who relied on avoidance or denial had high levels of urinary cortisol metabolites when they were forced to spend the day talking with their child whom they had been avoiding, or on days when they had an interview with a psychiatrist (Wolff, Hofer, & Mason, 1964). On the basis of

the escape conditioning model, a similar response might be expected from men forced to spend the day with their wives in the close proximity of a hospital room after a marital disagreement. On the contrary, women showed significantly greater immunological change than men during their 24-hr confinement (Kiecolt-Glaser et al., 1993), and women's (but not men's) daytime endocrine data showed significant relationships to behavior.

It could be argued that our data are not representative because we studied couples in the early stages of marriage who were generally quite happy or that our unusually stringent mental and physical health exclusion criteria produced a nonrepresentative sample. However, in data from a sample of hypertensive patients whose average age was 57, wives showed larger blood pressure increases during marital conflict than husbands, and women's blood pressure changes were specifically related to both hostile behaviors and marital quality; in contrast, only speech rate predicted men's blood pressure increases (Ewart et al., 1991). The fact that wives displayed larger blood pressure changes than husbands in data from Ewart et al. (1991) as well as greater increments in EPI in response to conflict in our data (Malarkey et al., 1994) is particularly interesting because men typically show larger blood pressure and urinary EPI increases in response to acute stressors than women, although the gender relevance of a stressor may modulate responsivity (Stoney, Davis, & Matthews, 1987).

Moreover, consistent both with our findings and with data from Ewart et al. (1991), Morell and Apple (1990) found that negative affect accounted for 20% of the variance in women's systolic blood pressure during a 10-min marital conflict discussion, and 53% of the variance in self-reported marital distress.

Although Morrell and Apple (1990) did not collect cardiovascular data from husbands, negative affect and marital distress were unrelated for men. Differences in cardiovascular arousal during conflict discriminated wives (but not husbands) in physically violent marriages from distressed but nonviolent marriages (Jacobson et al., 1994). Finally, as noted earlier, longitudinal data suggest that wives' physiological responses to conflict may have greater predictive power for assessing risk for marital dissolution than husbands' data in couples married for an average of 5 years (Gottman & Levenson, 1992). Thus, the endocrinological and immunological data from this study are compatible with physiological data from studies of longer-term marriages in which couples were not selected on such stringent health criteria.

Levenson et al. (1994) reported that affect self-ratings made while a couple watched the videotape of their conflict session several days earlier were correlated with husbands' (but not wives') autonomic responses recorded previously during conflict. As they noted, a number of laboratory studies have shown that men show greater accuracy than women at detecting physiological signals when situational cues are experimentally controlled, similar to their data (see Pennebaker & Roberts, 1992, for a review). However, in naturalistic settings that provide multiple cues (including data from several large field studies), women and men show equal accuracy at detection of blood pressure, heart rate, or blood glucose (Pennebaker & Roberts, 1992), in contrast to laboratory studies such as that of Levenson et al. (1994).

The escape conditioning model emphasizes event-related data, and our daytime endocrine data span 15 hr, so our study may not provide an optimal test of the model. However, a more parsimonious explanation for women's greater physiological responsiveness during conflict (based on convergent data from different laboratories, reviewed earlier) may be related to the fact that women show greater sensitivity to negative marital interactions than men (Floyd & Markman, 1983; Noller & Fitzpatrick, 1990; Notarius et al., 1989). Wives demonstrate more detailed and vivid memories of marital disagreements than their husbands (Ross & Holmberg, 1990). Wives also report that they reminisce more frequently about important relationship events and spend more time thinking about their marital relationships than their husbands (Burnett, 1987; Ross & Holmberg, 1990). Because memories of stressful experiences can themselves continue to evoke stress-related physiological changes (e.g., Baum et al., 1993), women's stronger and more enduring memories may help sustain their physiological arousal. Indeed, increased sympathetic nervous system activity has been reliably associated with intrusive thoughts about past stressors in both clinical and nonclinical samples; importantly, NEPI is elevated as well (Baum et al., 1993; Southwick et al., 1993). Perhaps the unresolved conflicts that follow wife negative-husband withdraw interactions may be more likely to fuel wives' continued reminiscence about the disagreements than similarly intense conflicts that were resolved, and unresolved conflicts may be more likely to resurface in subsequent interactions.

Wives' greater sensitivity to marital distress (Floyd & Markman, 1983; Noller & Fitzpatrick, 1990; Notarius et al., 1989) and their associated physiological arousal may be tied to their greater propensity to mend or end their marriages. Wives are

more likely to voice their discontent with their marriages and more likely to do so earlier than their husbands (Hagestad & Smyer, 1982; Harvey, Wells, & Alvarez, 1978). Only one quarter to one third of marital separations are directly prompted by husbands (Kitson, 1982). Although the pervasive gender differences in marital research are compelling, an important direction for future research concerns the extent to which these gender differences may also be linked to behavior of an individual or a couple (Fitzpatrick, 1992) or such dimensions as psychological femininity, rather than simply to gender per se.

As previously reported, negative behavior during conflict was closely linked to acute alterations in serum hormonal levels across five of the six hormones we studied (Malarkey et al., 1994). Might our pooled endocrine samples simply reflect these acute changes during conflict? Both biological and statistical considerations argue strongly against such an interpretation. The pooled endocrine samples represent a summary measure across 15 different time points, from 8 a.m. through 10 p.m. The half-life for the catecholamines is 1 to 2 min, compared with 60 to 90 min for cortisol, 10 min for ACTH, 15 to 20 min for GH, and 8 min for PRL (Baum & Grunberg, 1995; Breier et al., 1987; Rose, 1984): Thus, normal turnover or decay rapidly diminishes any extreme neuroendocrine peaks in the absence of further stimulation. Moreover, cortisol, the sole hormone among the six we sampled that showed no significant relationship to negative behavior in the phasic data collected during the conflict period (Malarkey et al., 1994), has the longest half-life.³ In addition, the conflict discussion and the preparatory interview lasted less than 1 hr; a single point would have to be remarkably high to eclipse the other 14 values, and the average magnitude of change across hormones was clearly not sufficient (Malarkey et al., 1994). Accordingly, these pooled data provide a window on endocrine function in couples for whom the day included a disagreement, not simply a reflection of acute hormone changes during the conflict itself.⁴

Our couples have the high MAT scores characteristic of newlyweds: only three percent of our subjects scored below 100 on the MAT, the traditional cut used to select the distressed couples whose conflict discussions are most reliably marked by negative reciprocity (Margolin et al., 1989; Notarius et al., 1989). The intensity of marital conflict is lower in the early years of marriage, generally increasing over time (Storaasli & Markman, 1990), and couples' arguments in laboratory settings are less negative than those at home (Margolin et al., 1989). The endocrine system's involvement in the pathogenesis of stress-related disease processes is probably mediated through frequent small

³ The couples' problem discussion occurred in the morning when cortisol levels were still close to their normal diurnal peak at 8:00 AM (Baum & Grunberg, 1995).

⁴We did not systematically assess couples' behavior during the remainder of their day; some couples may have resumed discussion of issues raised during the 30-min conflict, and these discussions could have contributed to hormone elevations. However, it seems unlikely that the endocrine data primarily reflect the continuance of conflict; given the brief half-lives of the hormones (particularly NEPI and EPI), and the fact that the pooled samples represent the average of 15 separate time points, maintenance of hormone elevations in the face of normal turnover would have necessitated chronic or sustained conflict, behaviors not reported by nurses when they drew blood hourly, or by the research assistants who interacted with the couples.

daily excursions in hormonal levels after stressful events: Chronic stimulation of cortisol and catecholamine secretion at lower levels has been linked to cardiovascular pathology (Kuhn, 1989) and immunological down-regulation (Ader et al., 1991; Baum et al., 1993; Kiecolt-Glaser, Malarkey, Cacioppo, & Glaser, 1994). The present data may actually underestimate the physiological impact of marital strife (Burman & Margolin, 1992).

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