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# Positive behaviors during marital conflict: Influences on stress hormones

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ABSTRACT

To examine the independent and interactive contribution of positive and negative behaviors during marital conflict to changes in adrenocorticotropic hormone (ACTH) and cortisol, behavioral and endocrine data were collected from 90 newlywed couples during a 30-minute conflict task. Positive and negative behaviors were coded by the Marital Interaction Coding System. High levels of husbands' positive behavior and high couple negativity were related to steeper ACTH and cortisol declines in wives. Low levels of wives' positive behavior and high couple negativity were related to flatter declines in wives' cortisol. Supportiveness during highly negative interactions contributed to steeper ACTH and cortisol declines in wives, suggesting that constructively engaging in discussions promotes adaptive physiological responses to interpersonal conflict.

KEY WORDS: cortisol • marital conflict • stress • support

Positive and negative aspects of social relationships independently predict health and well-being (Reis & Gable, 2003; Rook, 1998; Uchino, Holt-Lunstad, Uno, & Flinders, 2001). Conceptualizing social relationship processes along functionally independent positive and negative dimensions is critical because interactions between positive and negative qualities may

Work on this article was supported by grants P01 AG16321, P50 DE13749, MO1-RR-00034, Ohio State University Comprehensive Cancer Center Core Grant CA16058, and an NSF Graduate Research Fellowship to the first author. All correspondence concerning this article should be addressed to Theodore Robles, Dept. of Psychology, Ohio State University, Columbus, OH 43210, USA [e-mail: robles.8@osu.edu].

*Journal of Social and Personal Relationships* 
(www.sagepublications.com), Vol. 23(2): 305–325. DOI: 10.1177/0265407506062482

be central to how we perceive social relationships, and may explain the effects of social relationships on well-being (Fincham & Linfield, 1997; Uchino et al., 2001). For instance, older adults with a high number of social ties rated as both highly positive and highly negative (described as ambivalent social ties), reported more interpersonal stress and depressive symptoms compared to older adults with a high number of social ties rated as highly positive and low negative (Uchino et al., 2001).

In addition to improving our understanding of relationship processes, conceptualizing social relationships along functionally independent positive and negative dimensions may improve our understanding of social influences on physiology and health. In the same study of older adults, Uchino and colleagues found that reporting high numbers of ambivalent social ties predicted increased sympathetic reactivity during stress (Uchino et al., 2001). In a separate study, healthy individuals underwent a 3-day ambulatory blood pressure assessment with blood pressure readings taken 5 minutes into each social interaction, and rated the quality of the interaction partner on separate positive and negative dimensions (Holt-Lunstad, Uchino, Smith, Olson-Cerny, & Nealey-Moore, 2003). Interactions with high-positive/high-negative social ties were related to larger increases in ambulatory systolic blood pressure compared to interactions with social ties evaluated as high positive/high negative, low positive/high negative, and low positive/low positive. Holt-Lunstad and colleagues speculated that interacting with someone rated as highly positive and highly negative might contribute to elevated sympathetic nervous system reactivity because while the positive attributes of the person make them approachable, the negative attributes make the interaction itself more unpredictable and thus require more attention and vigilance. Taken together, these studies suggest that using conceptualizations of independent positive and negative dimensions of social relationships adds to our theories and understanding of social relationships and physiology.

Marriage researchers also recommend examining independent positive and negative aspects of marital functioning in both marital interaction (Heyman, 2001) and marriage and health research (Kiecolt-Glaser & Newton, 2001). Global evaluations of marital quality have separate positive and negative dimensions, and their interactions have implications for behaviors during interpersonal discussions. Wives with high-positive and high-negative attitudes toward their husbands reported higher ratios of negative to positive behaviors during discussions in the preceding week compared to wives with low-positive and low-negative attitudes toward their husbands (Fincham & Linfield, 1997). Despite the call for examining positive and negative aspects of relationship functioning, and the fact that marriage is a key source of support and conflict for most adults (Burman & Margolin, 1992; Pasch, Bradbury, & Sullivan, 1997), most marriage research to date, including marriage and physiology research, has solely focused on marital conflict.

Marital conflict is common; the modal frequency of overt disagreements among couples is once or twice a month (McGonagle, Kessler, & Schilling, 1992). An inability to effectively manage conflict contributes to marital distress and increased psychological distress and depressive symptoms (Beach, Fincham, & Katz, 1998; Fincham & Beach, 1999). Moreover, marital conflict is also related to poor physical health, including increased symptoms, morbidity, and mortality (Kiecolt-Glaser & Newton, 2001). The relationship between aversive or negative marital conflicts and negative outcomes has sparked volumes of research concentrating on spousal interactions and negative behaviors, including criticism, disagreement, and defensiveness (Heyman, 2001).

Increasing evidence suggests that the quality of marital conflict discussions contributes to health outcomes through changes in physiology, including cardiovascular, endocrine, and immune functioning (Robles & Kiecolt-Glaser, 2003). Newlywed couples exhibiting higher levels of hostile and negative behavior during conflict showed elevated levels of adrenocorticotropic hormone (ACTH), which stimulates cortisol production (Malarkey, Kiecolt-Glaser, Pearl, & Glaser, 1994). Similar effects were found in a sample of older couples: Negative behaviors and negative escalation were related to flatter cortisol and ACTH slopes, and accounted for significant variance in cortisol and ACTH slopes (Kiecolt-Glaser et al., 1997).

Marital conflict discussions elicit both positive and negative behaviors, though marital research has primarily focused on the latter. The frequency of positive and supportive behaviors in spousal interactions, including those during marital conflict, may partially explain the psychological and physical health benefits derived from marriage. These behaviors include expressions of *understanding*, such as agreement or assents; *compliments*, such as approval or positive mind reading; and *validation*, such as accepting responsibility for actions and paraphrasing (Heyman, Weiss, & Eddy, 1995). Positive behaviors during conflict discussions differentiate distressed from nondistressed couples (e.g., Birchler, Weiss, & Vincent, 1975; Carstensen, Gottman, & Levenson, 1995; Fichten & Wright, 1983), and are moderately correlated with marital satisfaction (Karney & Bradbury, 1995). Moreover, positive behaviors may also account for overall satisfaction with problem-solving discussions, even though they may not have a major effect on actual problem resolution (Koren, Carlton, & Shaw, 1980). Given the frequency of marital conflict, positive behaviors during these discussions may play an important role in influencing marital satisfaction and physical health. Indeed, more recent research has focused on interactions that elicit supportive behaviors to determine how social support contributes to marital satisfaction (e.g., Cutrona & Suhr, 1994; Pasch & Bradbury, 1998).

Unlike negative behaviors, positive behaviors during marital conflict have shown less consistent relationships with physiological measures in previous work. For instance, supportive behaviors did not predict change in blood pressure during conflict (Ewart, Taylor, Kraemer, & Agras, 1991). However, studies typically focus on negative behaviors to the exclusion of positive behaviors, or focused on their independent, but not interactive contributions. Based on the framework described earlier, we suggest that considering functionally independent positive and negative aspects of relationships, and their interactions, may be more informative to marriage and physiology research. Moreover, although previous work on social relationships and physiology focused on interactive contributions of positive and negative evaluations of social relationships, work to date has not considered the interactive contributions of positive and negative behaviors on physiology.

This study examined the independent and interactive contributions of positive and negative behavior during marital conflict on changes in two key stress hormones, ACTH and the glucocorticoid hormone cortisol. Both hormones are central components of the hypothalamic-pituitary-adrenal (HPA) axis, which is involved in physiological responses to stress. Importantly, chronic HPA axis activation and reactivity may mediate the deleterious effects of chronic stress on health (McEwen, 1998). In addition to chronic HPA axis activation, disruptions in the normal circadian rhythm of HPA axis hormones may also have health implications. Both cortisol and ACTH have a normal circadian rhythm, peaking shortly after awakening, and declining over the course of the day (Stone et al., 2001). Steeper declines are more frequently observed in samples of community individuals compared to flat declines (Smyth et al., 1997; Stone et al., 2001), suggesting that flat declines in cortisol may represent dysregulation of the HPA axis. Studies in breast cancer patients suggest that flatter cortisol slopes are related to increased fatigue (Bower et al., 2005) and subsequent mortality from the disease (Sephton, Sapolsky, Kraemer, & Spiegel, 2000). In our study, conflict discussions occurred at approximately 8:30 am, which captured part of diurnal decline.

We used multilevel modeling to examine individual differences in patterns of change in stress hormones during a conflict discussion, and to predict individual differences in hormone change as a function of positive and negative behaviors observed during the discussion. This allows us to test whether the conceptual framework of independent positive and negative dimensions of behavior applies to HPA axis functioning. Extant research on positive behaviors and physiology suggests that positive behaviors do not have significant effects (e.g., Ewart et al., 1991); therefore, our hypotheses are based on the supposition that the effects of negative behaviors on the HPA axis would be larger than the effects of positive behaviors. Because changes in cortisol and ACTH in our study were influenced by the normal circadian decline, our hypotheses are discussed in terms of steeper vs. flatter hormone declines. Steeper declines reflect smaller HPA axis responses and a more normal circadian decline, while flatter declines reflect higher HPA axis responses and an abnormal circadian decline.

We expected that discussions characterized by low-positive/high-negative behaviors would be the most aversive conflict discussions, provoking elevated responses and flatter declines in ACTH and cortisol. For discussions with high-positive/high-negative behaviors, we predicted that the physiological benefits of positive aspects of relationships would not counteract physiological activation associated with negative aspects, similar to previous work (Holt-Lunstad et al., 2003; Uchino et al., 2001). Consequently, spouses in these discussions should show steeper declines in ACTH and cortisol relative to discussions with low-positive/high-negative behaviors, but flatter declines compared to discussions with high-positive/low-negative behavior. We also expected that discussions characterized by high-positive/low-negative behavior or low-positive/low-negative behavior would provoke smaller ACTH and cortisol responses during conflict. Finally, we predicted that couples showing high-positive/low-negative behavior would show steeper declines in ACTH and cortisol compared to couples exhibiting low-positive/high-negative and high-positive/high-negative behaviors.

## Methods

### Participants

Endocrine and behavioral data were collected from 90 newlywed couples during a 24-hour admission to the Ohio State University Clinical Research Center (CRC; Kiecolt-Glaser et al., 1993; Malarkey et al., 1994). A three-stage recruitment and screening process excluded participants with any current or past mental or physical health problems (see Kiecolt-Glaser et al., 1993). Characteristics of the final sample at intake were as follows: The average age of wives and husbands was 25.2 (*SEM* = 0.32) and 26.2 (*SEM* = 0.32), respectively, with a range of 20–37. 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 US$43,464 (*SEM* = 1764.44). The majority of the couples were white (95%). Couples dated an average of 36.58 months (*SEM* = 2.60) before marriage, and 55 couples (61.1%) lived together before marriage. An average of 10.44 months (*SEM* = 0.15; range = 6–14) elapsed between their marriage and their first CRC admission.

### Procedure

Couples were asked not to drink or eat anything after midnight, and all appointments were scheduled during the luteal phase of wives' menstrual cycle to control for influences of menstrual phase on hormone levels. All couples were served the same meals and remained together in the same CRC room for 24 hours. After the 7:00 am admission to the CRC, a heparin well was inserted in each participant's arm so blood could be drawn regularly across the 24-hour stay with minimized additional discomfort. After the 1.5-hour adaptation period after insertion of the heparin well, participants were positioned in chairs facing each other in front of a curtain. For frequent, unobtrusive endocrine sampling during the interaction tasks, a long polyethylene tube was attached to the heparin well, so nurses could draw blood samples at set intervals, out of the participants' sight. The polyethylene tube was easily accessible to two nurses who sat behind the curtain. Two technicians were also seated behind the curtain during the interviews, monitoring and adjusting two remote-controlled cameras during the videotaping.

Couples completed several questionnaires and then sat quietly for 10 minutes, after which baseline blood samples were drawn. At the end of the 10-minute baseline period, a psychology graduate student or postdoctoral fellow conducted a brief 10–20-minute interview to help identify the best topics for the problem discussion. On the basis of this interview and their ratings from the Relationship Problem Inventory (Knox, 1971), 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 minutes. At the end of the interview, and immediately before the 30-minute problem-solving task, the second blood sample was drawn; the third and fourth samples were drawn 15 minutes after conflict began, and again at the end of the 30-minute problem-solving task. The fifth blood sample was drawn at the end of a 15-minute recovery period following the end of the problem-solving discussion. Couples were videotaped during the discussion.

### Behavioral measures

The Marital Interaction Coding System (MICS-IV; Heyman et al., 1995; Weiss & Tolman, 1990) provided data on problem-solving behaviors during the 30-minute marital conflict-resolution task. The Oregon Marital Studies Program (OMSP), under the direction of Robert L. Weiss, coded the videotapes. The MICS, designed to describe couples' behaviors as they attempt to resolve a relationship issue, is one of the most widely used marital behavioral coding systems and reliably discriminates distressed and nondistressed couples. In accordance with OMSP coding conventions, each coder maintained code-by-code agreement with a master coder of at least 70% on a random sample of 20% of the tapes. Tapes were recoded when agreement fell below this criterion.

In this study, the MICS codes of interest were those that assessed negative and positive behaviors. To capture these dimensions in composite indices, we conducted separate factor analyses of MICS code frequencies for the positive and negative codes. Factor analyses of the positive codes indicated that three factors emerged with eigenvalues greater than 1, similar or identical to the dimensions previously described (Weiss & Summers, 1983): A problem-solving/proposed-change cluster (negative solution, problem description, compromise, and positive solution), a positive-behavior or supportive cluster (agree, approve, accept responsibility, assent, and positive mind reading), and a humor cluster (humor, compliance, and smile/laugh). Factor analyses of the negative codes did not yield a clear factor solution for negative codes, although two clusters emerged that were consistent with the dimensions used by other investigators (Ewart et al., 1991; Weiss & Summers, 1983); the first cluster included 'active' negative behaviors (criticize, disagree, deny responsibility, excuse, interrupt, negative mind reading, noncompliance, put down, turn off, disapprove, and dysphoric affect). Another dimension tapped avoidance or withdrawal behaviors (not tracking, withdrawal, off-topic, and disengage). Several codes were excluded, either because they did not clearly fit either the positive or negative dimensions based on face validity (talk, question, paraphrase, and command), their nonoccurrence was related to experimental constraints (positive physical contact), or they overlapped with other codes (attention and not tracking are correlated, $r = -.98$, $p < .001$).

As shown in Table 1, negative behaviors were strongly correlated between husbands and wives. Thus, we summed negative behaviors for each couple (termed couple negative behavior). Table 1 also shows that the correlation between positive and negative behaviors, both within and between spouses, was not significantly different from zero, indicating that positive and negative

**TABLE 1**
**Mean (*SD*) and correlations between MICS-coded behavioral data for wives and husbands**

| Spouse and behavior | *M* (*SD*) | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 1. Wives' negative behavior | 69.14 (45.52) | – | | | |
| 2. Husbands' negative behavior | 60.60 (40.77) | .74** | – | | |
| 3. Wives' positive behavior | 70.48 (34.47) | –.12 | –.16 | – | |
| 4. Husbands' positive behavior | 68.77 (29.50) | .02 | –.05 | .40** | – |

**$p < .01$.

behaviors were independent of each other during marital conflict. Couples' negative behavior was not significantly correlated with wives' positive behavior ($r = -.15$, *ns*) or husbands' positive behavior ($r = -.01$, *ns*).

## Endocrine measures

ACTH levels were determined by an immunoradiometric assay using materials supplied by Nichols Institute (Capstrano, CA). The sensitivity of this assay was 1 pg/ml, which was adequate for detection of basal levels. The intra- and interassay coefficients of variation for this assay were less than 10%. Plasma cortisol was assayed using a fluorescent polarization technique (TDX; Abbott Laboratories, Chicago, IL). The assay has a sensitivity of 0.5 μg/100 ml and an intra- and interassay coefficient of variation of less than 10%. All of the serum samples from each couple for ACTH and cortisol were run in the same assay to diminish interassay variability. Values for ACTH and cortisol were not log-transformed because the distributions were not markedly skewed.

## Statistical analyses

We used multilevel modeling to assess individual differences in rates of ACTH and cortisol change for each individual. In our study, ACTH and cortisol were modeled as functions of time before, during, and after the conflict discussion. In multilevel models, the intercept (initial value) and slope (rate of change over time) of the outcome variable can be expressed as fixed, with identical values for each individual; or random, with different values between individuals.

Models with random intercepts and slopes generate estimates of the mean and variance for both parameters and their covariation. Additional variables can then be used as predictors of both intercepts and slopes. Significance tests can be performed on the predictors to determine whether their inclusion in the model results in reduction of unexplained variance. We modeled change in ACTH and cortisol levels during conflict with a two-group (husbands and wives) multilevel model with measurement occasion as the Level 1 unit and individuals as the Level 2 unit. The blood sample timepoint (0–4) was the Level 1 predictor of change in ACTH and cortisol levels. Change in hormone levels was modeled as a linear and quadratic function of time, which allowed for capturing stress-related reactivity and recovery for ACTH. Cortisol exhibits a circadian rhythm, at its highest levels in the morning, and decreasing over the course of the day. Therefore, modeling linear and quadratic change captures both the normal circadian decline and stress-related reactivity in cortisol.

Additional Level 2 predictors, behaviors during the conflict discussion, were used to explain variance in initial levels and the rate of change in hormones during the conflict discussion. Behavioral data were collected 15 minutes after the initial baseline blood sample. Although using behaviors to predict initial hormone levels is inconsistent with the sequence of events during the discussion, doing so provides important information on the relationship between initial hormone levels and behaviors during conflict. Therefore, the following independent variables were included in the analyses: Wives' positive behaviors; husbands' positive behaviors; negative behaviors summed across both spouses; the interaction between wives' positive behaviors and couple negative behaviors; and the interaction between husbands' positive behaviors and couple negative behaviors as Level 2 predictors of initial hormone levels and rates of change. All behavior variables were centered around the mean prior to multilevel analyses.

Multilevel analyses were conducted using LISREL 8.53 software. We first determined if intercepts and slopes should be specified as fixed or random; we found that models with random intercepts and slopes offered significantly better fit compared to other models. In addition, we found that models of linear and quadratic change offered a better fit compared to a model of linear and change. Models were computed simultaneously for wives and husbands, which allowed for multivariate and univariate tests of differences in intercepts, and linear and quadratic slopes between wives and husbands (Kurdek, 2003). Unstandardized parameter estimates are presented with standard errors in parentheses. Effect sizes were computed by obtaining the square root of the quantity $t^2/(df + t^2)$ using the $t$-values and $df$ from each parameter estimate.

Relationships between conflict behaviors and endocrine hormones may reflect the influence of other variables, including demographic variables, marital satisfaction, health-related behaviors, and genetic vulnerability. To assess this possibility, we included models with these variables as additional Level 2 predictors of intercepts and slopes. Demographic variables included age, level of education, and income. Marital satisfaction was assessed using the Marital Adjustment Test (MAT) during the initial telephone screening interview. The MAT is widely used in marital research because of its reliability and validity in discriminating satisfied and dissatisfied couples (Locke & Wallace, 1959). Lower scores indicate lower marital satisfaction. Health behaviors assessed in this study included alcohol intake, body mass index, caffeine intake, use of birth control pills, and weekly hours of vigorous physical exercise. Moreover, individuals with a parental history of hypertension exhibit increased cortisol responses to psychological stressors (Fredrikson, Tuomisto, & Bergman-Losman, 1991); therefore, we included this variable in these analyses. Any variables significantly related to endocrine intercepts or slopes were included in the statistical analyses.

## Results

### Individual differences in initial hormone levels and rates of change

A model with intercepts, linear slopes, and quadratic slopes specified as random provided the best fit over a saturated model compared to models where either intercepts or slopes were fixed (ACTH *RMSEA* point estimate = 0.04, 95% *CI*: 0.03–0.06; cortisol *RMSEA* point estimate = 0.06, 95% *CI*: 0.05–0.07). Parameter estimates for ACTH and cortisol are shown in Table 2. There were sufficient

**TABLE 2**
**Level 1 parameter estimates for ACTH and cortisol**

| | ACTH | | Cortisol | |
|---|---|---|---|---|
| **Parameter** | **Wives** | **Husbands** | **Wives** | **Husbands** |
| Intercept | 10.24[a] | 16.86[a] | 18.92[b] | 12.20[b] |
| | (1.25) | (1.15) | (0.88) | (0.47) |
| Linear slope | 1.04[c] | 0.006[c] | –1.17 | –1.05 |
| | (0.84) | (0.71) | (0.51) | (0.38) |
| Quadratic slope | –0.26[c] | –0.24[c] | 0.07[c] | 0.07[c] |
| | (0.21) | (0.16) | (0.12) | (0.09) |
| Intercept variance | 103.21 | 80.65 | 68.56 | 18.65 |
| | (19.45) | (16.71) | (10.59) | (2.98) |
| Linear slope variance | 27.42 | 6.64[c] | 19.17 | 11.02 |
| | (8.83) | (7.21) | (3.50) | (1.97) |
| Quadratic slope variance | 1.69 | 0.02[c] | 0.99 | 0.63 |
| | (0.54) | (0.37) | (0.18) | (0.11) |
| Intercept/linear slope correlation | –.31[c] | –.34[c] | –.09[c] | –.49 |
| Intercept/quadratic slope correlation | –.05[c] | .03[c] | –.09[c] | .35 |
| Linear slope/quadratic slope correlation | –.68 | –.95 | –.96 | –.97 |
| Within-subjects variance | 15.99 | 23.85 | 2.60 | 1.39 |
| Intercept reliability | .90 | .83 | .96 | .90 |
| Linear slope reliability | .66 | .28 | .78 | .67 |
| Quadratic slope reliability | .67 | .18 | .75 | .67 |

*Note*. The model was specified with intercepts and slopes as random parameters, with occasion of measurement as a Level 1 predictor of slopes. All parameters are unstandardized coefficients and are statistically significant, $p < .05$, unless otherwise specified. Values in parentheses are standard errors.
[a] ACTH: Significant difference between wives and husbands, $\chi^2(1) = 15.19, p < .001$.
[b] Cortisol: Significant difference between wives and husbands, $\chi^2(1) = 44.60, p < .001$.
[c] Not significant.

individual differences in baseline ACTH and cortisol levels (intercepts) to justify including Level 2 predictors of initial hormone levels. For instance, using wives' ACTH as an example, all wives in the sample had baseline ACTH levels that significantly varied around an average level of 10.24 pg/ml.

On average, ACTH did not show significant linear or quadratic change over time for wives or husbands. At the same time, wives showed significant individual differences in linear and quadratic slopes. In other words, although the average wife did not show significant change in ACTH, there was sufficient variability in linear and quadratic change over time between wives to justify including Level 2 predictors of hormone change. Husbands did not show significant individual differences in linear and quadratic ACTH slopes.

Cortisol, on average, showed a significant linear decrease over time, but no significant quadratic change for wives and husbands. There was also sufficient variability in linear and quadratic change over time between participants to justify Level 2 predictors of hormone change. For instance, all wives in the sample showed change in cortisol that significantly varied around –1.17 ng/ml per unit of linear time, and significantly varied around 0.07 ng/ml per unit of quadratic time.

Several other parameters described in Table 2 are also worth noting. Wives' mean initial levels of ACTH were significantly lower than husbands' levels, and wives' mean initial levels of cortisol were significantly higher than husbands' levels. Both linear and quadratic slopes for ACTH and cortisol were not significantly different between wives and husbands. Initial levels of hormones were not significantly correlated with linear change over time, with one exception – husbands' cortisol, where high levels of baseline cortisol were related to larger decreases in cortisol over time. Initial levels of hormones were not significantly correlated with quadratic change over time, again with the same exception for husbands' cortisol, such that higher initial levels of husbands' cortisol were related to larger quadratic increases in cortisol. Larger linear decreases in hormones were related to larger quadratic increases in hormones. Finally, initial hormone levels showed high reliability coefficients (ranging from .83 to .96); linear change in hormones showed high reliability coefficients (ranging from .66 to .78), with the exception of husbands' ACTH (reliability coefficient of .28); and quadratic change showed high reliability for cortisol and wives' ACTH, and low reliability for husbands' cortisol.

## Health behaviors as predictors of initial hormone levels and rates of change

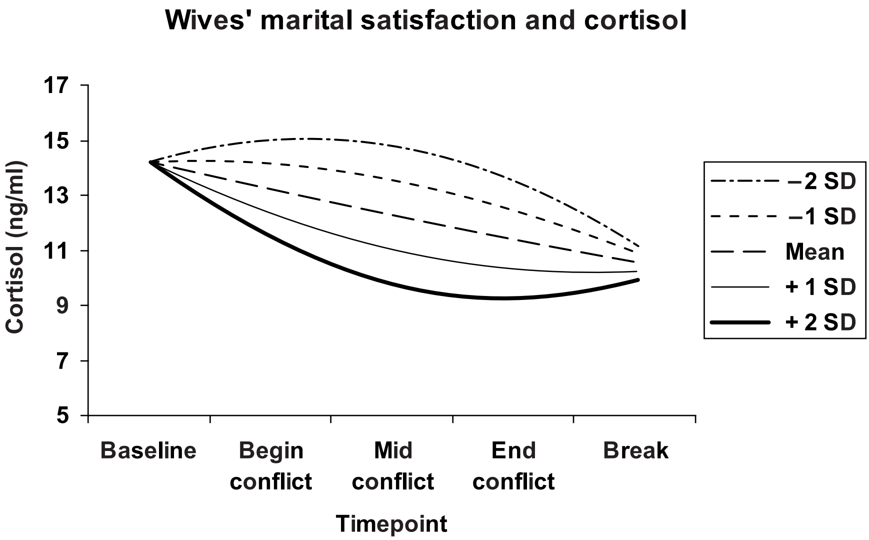
For wives, use of birth control pills was related to initial levels of ACTH, $\beta = -7.43$ (2.89), $p < .05$. Self-rated caffeine intake per week was related to linear change in ACTH over time, $\beta = 1.42$ (0.63), $p < .05$. Including these health behaviors in a single model accounted for 9% of the variance in initial levels of ACTH, and 9% of the variance in linear ACTH slope. ACTH intercepts, linear, and quadratic slopes were not related to any other demographic, marital satisfaction, or health behavior variables. Initial levels of wives' cortisol were related to family history of high blood pressure, $\beta = -4.88$ (2.01), $p < .05$, and use of birth control pills, $\beta = 6.38$ (2.17), $p < .001$. Wives' marital satisfaction as assessed by the MAT was related to linear change in cortisol, $\beta = -0.08$ (0.03), $p < .05$, and quadratic change in cortisol, $\beta = 0.01$ (0.008), $p < .01$. Including these variables in a single model accounted for 12% of the variance in initial levels, 12% of the variance in linear change, and 13% of the variance in quadratic change in cortisol. Figure 1 shows the relationship between marital satisfaction and cortisol change, indicating that lower wives' marital satisfaction was related to flatter linear slopes and larger quadratic increases in cortisol, while higher marital satisfaction was related to steeper linear slopes and larger quadratic decreases in cortisol. In other words, higher marital satisfaction was related to larger diurnal declines and smaller stress-related increases in cortisol. Husbands' marital satisfaction was not significantly related to initial levels or rates of change in wives' cortisol.

For husbands, no demographic or health behavior variables were used to predict ACTH slopes because husbands did not show significant individual differences in ACTH slopes. No demographic, marital satisfaction, or health behavior variables were significantly related to initial levels or rate of change in husbands' cortisol.

## Behavioral predictors of changes in ACTH and cortisol

These models specified intercepts and slopes of hormone levels as random parameters. Demographic or health behavior variables significantly related to hormone intercepts or slopes were included in these models.

**FIGURE 1**
**Modeled change in wives' cortisol during the conflict discussion, as a function of wives' marital satisfaction.**




*Note*. Each line represents change for wives reporting marital satisfaction at –2, –1, +1, and +2 *SD* relative to the mean ($M$ = 129.71, $SD$ = 13.81).

**ACTH.** Models were not estimated for husbands because there was no significant variance in rates of change over time. Parameter estimates for wives are shown in Table 3. This model showed good fit over the saturated model, *RMSEA* point estimate = 0.03, 95% *CI*: 0.00–0.06, and improved fit over a model with no Level 2 predictors, $\chi^2(32) = 77.85$, $p = .00001$. For wives, conflict behaviors were significantly related to initial levels of ACTH and linear change in ACTH over time. Higher wives' baseline ACTH was related to elevated couple negative behavior, shown in Figure 2A. Moreover, a significant husbands' positive behavior by couple negative behavior interaction indicated that baseline ACTH was four times as high prior to highly negative discussions in wives whose husbands showed high levels of positive behavior during conflict compared to less negative discussions. Wives' positive behavior was not significantly related to ACTH intercepts or slopes.

Couple negative behavior significantly predicted linear change in ACTH, also qualified by a significant husbands' positive × couple negative behavior interaction. To interpret this interaction, we computed simple linear slopes based on the parameters in Table 3 using combinations of ±1 *SD* relative to the mean for husbands' positive behavior and couple negative behavior, as shown in Table 4. The linear slope estimates indicated that elevated husbands' positive behavior and elevated couple negative behavior were related to larger decreases in wives' ACTH during conflict. By contrast, elevated husbands' positive behavior and lower couple negative behavior were related to larger increases in wives' ACTH. Couple negative behavior also predicted quadratic

**TABLE 3**
**Level 1 and Level 2 parameter estimates for wives' ACTH**

| Model component | Parameter estimate | Standard error | Effect size |
|---|---|---|---|
| Intercept | 13.11*** | 1.94 | .61 |
| Birth control pill use (1 = use) | –4.05 | 2.12 | .07 |
| Wives' positive behavior | 0.03 | 0.03 | .04 |
| Husbands' positive behavior | –0.008 | 0.04 | .009 |
| Couple negative behavior | 0.04** | 0.01 | .12 |
| Wives' positive × couple negative | –0.0006 | 0.0004 | .06 |
| Husbands' positive × couple negative | 0.002*** | 0.0005 | .19 |
| Intercept variance | 57.77*** | 12.10 | – |
| Linear slope | 0.09 | 0.76 | .01 |
| Caffeine intake | 1.21*** | 0.29 | .16 |
| Wives' positive behavior | –0.02 | 0.02 | .04 |
| Husbands' positive behavior | –0.01 | 0.03 | .02 |
| Couple negative behavior | –0.02* | 0.009 | .08 |
| Wives' positive × couple negative | –0.0001 | 0.0003 | .01 |
| Husbands' positive × couple negative | –0.001*** | 0.0003 | .15 |
| Linear slope variance | 12.66 | 6.51 | – |
| Quadratic slope | –0.25 | 0.2 | .14 |
| Wives' positive behavior | 0.0007 | 0.006 | .004 |
| Husbands' positive behavior | 0.004 | 0.007 | .02 |
| Couple negative behavior | 0.006* | 0.003 | .09 |
| Wives' positive × couple negative | 0.00006 | 0.0008 | .03 |
| Husbands' positive × couple negative | 0.00017 | 0.0001 | .06 |
| Quadratic slope variance | 1.24** | 0.47 | – |
| Within-subjects variance | 16.24*** | 2.10 | |

*Note*. The model was specified with intercepts and slopes as random parameters, with occasion of measurement as a Level 1 predictor of slopes. All parameters are unstandardized coefficients. $N = 82$. For wives, the correlation between intercepts and linear slopes: $r = -.03$, *ns*; between intercepts and quadratic slopes: $r = -.35, p = .14$; between linear and quadratic slopes: $r = -.59, p = .08$.
$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

change in ACTH, with higher couple negative behavior associated with quadratic increases in wives' ACTH over time, and lower couple negative behavior associated with quadratic decreases in wives' ACTH over time.

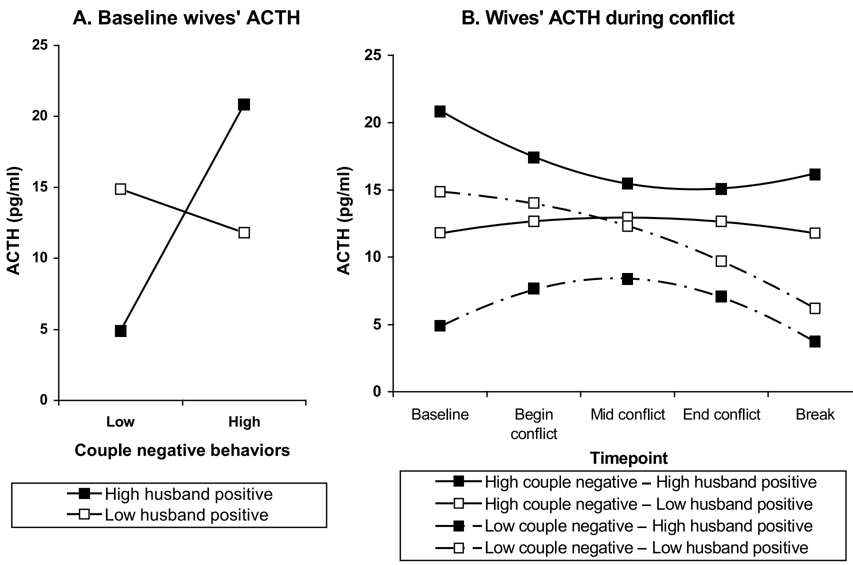
Based on the effect size estimates, the strongest behavioral influences on wives' ACTH were couples' negative behaviors (intercept = .12, linear slope = .08, quadratic slope = .09) and the husbands' positive × couple negative interaction (intercept = .19, linear slope = .08). Combining the behavioral predictors of initial levels and rates of change yields the graph in Figure 2B, which illustrates the overall pattern of ACTH results. Wives whose husbands showed elevated positive behaviors during more negative discussions had the highest ACTH levels overall, which declined during the first 15 minutes of conflict and

**TABLE 4**
**Linear slopes for wives' ACTH based on behavioral predictors**

| | | Couple negative behavior | |
|---|---|---|---|
| **Behavioral predictor** | | **–1 *SD*** | **+1 *SD*** |
| Husbands' positive behavior | –1 *SD* | –0.38 | 1.15 |
| | +1 *SD* | 3.78 | –4.19 |

*Note*. Slopes were computed by combining the following parameter estimates in Table 3: Linear slope, husbands' positive behavior, couple negative behavior, and husbands' positive × couple negative behavior.

**FIGURE 2**
**Modeled change in wives' ACTH during the conflict discussion.**




*Note*. Figure 2A depicts baseline wives' ACTH as a function of couple negative behaviors (± 1 *SD* relative to the mean) and husbands' positive behaviors (± 1 *SD* relative to the mean). Wives with highly positive husbands showed baseline ACTH levels four times as high prior to highly negative discussions compared to less negative discussions.
Figure 2B depicts change in wives' ACTH during the conflict discussion as a function of couple negative behaviors (± 1 *SD* relative to the mean) and husbands' positive behaviors (± 1 *SD* relative to the mean).

increased during the last 30 minutes. By contrast, wives whose husbands showed highly positive behaviors during less negative discussions had the lowest ACTH levels overall, which increased during the first 15 minutes of conflict and decreased over the last 30 minutes. One explanation for these results is that high initial hormone levels often predict larger decreases over time. However, the correlation between intercepts and linear slopes was

–.03. Therefore, a more plausible explanation is that high levels of ACTH contributed to more negative behaviors in general; the rate of change in ACTH was more determined by husbands' positive behaviors, suggesting strong behavioral influences on wives' ACTH.

**Cortisol.** Behaviors during conflict were not significantly related to changes in cortisol for husbands (data not shown). For wives, a model including conflict behaviors showed good fit over the saturated model, *RMSEA* point estimate = 0.06, 95% *CI*: 0.04–0.07, and better fit over a model with no Level 2 predictors, $\chi^2(19) = 94.66$, $p = .00$. As shown in Table 5, the interaction among wives'

**TABLE 5**
**Level 1 and Level 2 parameter estimates for wives' cortisol**

| Model component | Parameter estimate | Standard error | Effect size |
|---|---|---|---|
| Intercept | 13.85*** | 1.57 | .70 |
| Birth control pill use (1 = use) | 6.34*** | 1.61 | .14 |
| Family history of high blood pressure | –0.31 | 0.62 | .02 |
| Wives' positive behavior | 0.01 | 0.03 | .02 |
| Husbands' positive behavior | –0.006 | 0.03 | .007 |
| Couple negative behavior | 0.02 | 0.01 | .06 |
| Wives' positive × couple negative | 0.00004 | 0.0004 | .004 |
| Husbands' positive × couple negative | 0.0004 | 0.0004 | .03 |
| Intercept variance | 60.10*** | 9.38 | |
| Linear slope | –1.26** | 0.48 | .28 |
| Wives' marital satisfaction | –0.08* | 0.03 | .08 |
| Wives' positive behavior | 0.003 | 0.02 | .008 |
| Husbands' positive behavior | –0.0007 | 0.02 | .001 |
| Couple negative behavior | –0.004 | 0.006 | .02 |
| Wives' positive × couple negative | –0.0005* | 0.0002 | .09 |
| Husbands' positive × couple negative | 0.00002 | 0.0002 | .003 |
| Linear slope variance | 15.30*** | 2.92 | |
| Quadratic slope | 0.07 | 0.11 | .07 |
| Wives' marital satisfaction | 0.02* | 0.03 | .08 |
| Wives' positive behavior | –0.0005 | 0.003 | .004 |
| Husbands' positive behavior | –0.00008 | 0.004 | .0007 |
| Couple negative behavior | 0.0009 | 0.001 | .02 |
| Wives' positive × couple negative | 0.00009 | 0.04 | .07 |
| Husbands' positive × couple negative | 0.00001 | 0.00005 | .004 |
| Quadratic slope variance | 0.79*** | 0.15 | |
| Within-subjects variance | 2.59*** | 0.30 | |

*Note*. The model was specified with intercepts and slopes as random parameters, with occasion of measurement as a Level 1 predictor of slopes. All parameters are unstandardized coefficients. $N = 90$. The correlation between intercepts and linear slopes: $r = -.11$, *ns*; between intercepts and quadratic slopes: $r = -.12$, *ns*; between linear and quadratic slopes: $r = -.95$, $p < .001$.
$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$.

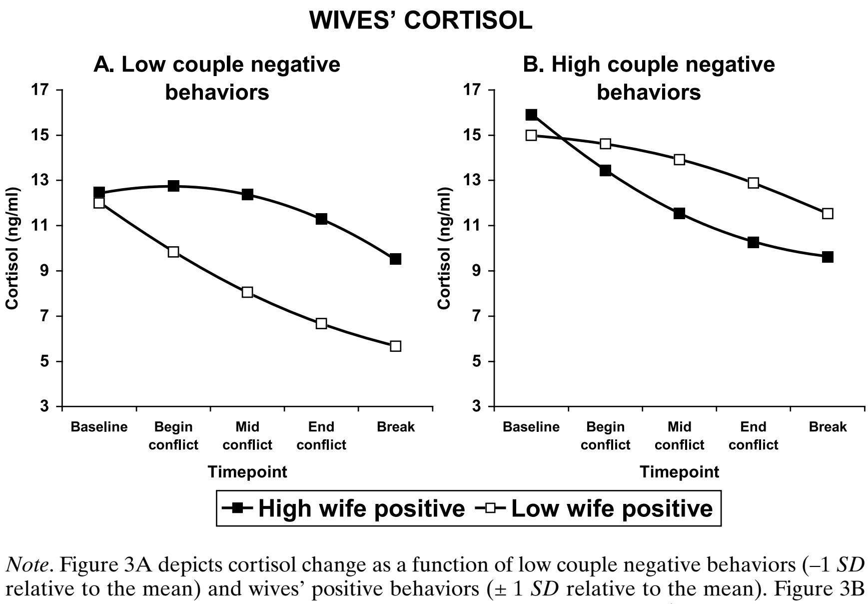
positive behavior and couples' negative behavior significantly predicted linear change in cortisol, accounting for an additional 9% of the variance in wives' linear change. To interpret this interaction, we computed simple linear slopes based on the parameters in Table 5 using combinations of ±1 *SD* relative to the mean for wives' positive behavior and couple negative behavior, as shown in Table 6. In addition, combining the behavioral predictors of intercepts, linear, and quadratic slopes yields the graph in Figure 3. In couples displaying high levels of negative behavior, as wives' positive behaviors increased, wives' cortisol showed a steeper decline. In contrast, in couples displaying low levels of negative behavior, as wives' positive behaviors increased, wives' cortisol

**TABLE 6**
**Linear slopes for wives' cortisol based on behavioral predictors**

| | | Couple negative behavior | |
|---|---|---|---|
| **Behavioral predictor** | | **–1 *SD*** | **+1 *SD*** |
| Wives' positive behavior | –1 *SD* | –2.43 | –0.29 |
| | +1 *SD* | 0.55 | –2.87 |

*Note*. Slopes were computed by combining the following parameter estimates in Table 3: Linear slope, wives' positive behavior, couple negative behavior, and wives' positive × couple negative behavior.

**FIGURE 3**
**Modeled change in wives' cortisol during the conflict discussion.**




*Note*. Figure 3A depicts cortisol change as a function of low couple negative behaviors (–1 *SD* relative to the mean) and wives' positive behaviors (± 1 *SD* relative to the mean). Figure 3B depicts cortisol change as a function of high couple negative behaviors (–1 *SD* relative to the mean) and wives' positive behaviors (± 1 *SD* relative to the mean).

showed a flatter decline. While the high couple-negative/high wife-positive and low couple-negative/low wife-positive patterns show steep declines in cortisol, the high couple-negative/low wife-positive, and low couple-negative/high wife-positive patterns are very similar.

## Discussion

We found that the relationship between positive behaviors and HPA axis hormones depended on the degree of negativity during conflict, with significant influences on ACTH and cortisol responses even after controlling for health behaviors and marital satisfaction. Consistent with our hypotheses, discussions with low-positive/high-negative behaviors predicted flatter hormone slopes, and discussions with low-positive/low-negative behaviors predicted steeper hormone slopes. Surprisingly, discussions characterized by high-positive/low-negative behaviors predicted increases in wives' ACTH and flat cortisol slopes, contrary to our hypotheses. Moreover, high-positive/low-negative behaviors were related to larger increases in wives' ACTH and flatter wives' cortisol slopes compared to high-positive/high-negative behaviors, which were actually related to steep declines, also contrary to our hypotheses.

In addition to these results for hormone change, high levels of wives' ACTH at baseline were related to elevated couple negative behaviors. Based on the temporal order of events, high baseline ACTH predicted later negative behaviors. Increased ACTH levels during stress may reflect perceived threat of social evaluation, consistent with recent conceptualizations by Dickerson and Kemeny (2004), who speculated that stressful situations characterized by high threat of social evaluation provoke more significant HPA axis activation than other laboratory stressors. Although elevated ACTH levels were observed at the resting baseline, these baseline data were collected while couples were seated across from one another in anticipation of the discussion task. Anticipatory anxiety during baseline may have contributed to increased perceived social-evaluative threat, which subsequently contributed to increased negative behavior during conflict. Furthermore, increased negative behavior during conflict predicted larger ACTH responses (quadratic slopes) during conflict.

High levels of wives' ACTH at baseline were also associated with higher husbands' positive behaviors during discussions with high couple-negative behavior. In turn, the combination of high husbands-positive and high couple-negative behavior was related to large linear declines in wives' ACTH. Baseline levels of wives' ACTH were not significantly related to linear slopes. Therefore, the large linear decline in wives' ACTH associated with highly negative behaviors and high husbands-positive behavior probably reflects the efficacy of husbands' positive behaviors in reducing wives' perceived social evaluative threat, rather than the influence of high baseline levels of ACTH.

The theory that HPA axis activation is related to social-evaluative threat also makes sense of our surprising cortisol findings, in which high-positive/low-negative behaviors were related to flatter cortisol slopes in wives compared to high-positive/high-negative behaviors. Therefore, wives who demonstrated high-positive behaviors in the context of a low-negative discussion experienced increased social-evaluative threat. Increased threat may stem from a combination of the situational context and dispositional characteristics of the spouses' relationship. The situational context included the discussion task and the novel environmental surroundings: The hospital room, the presence of research assistants and nurses behind a curtain, and the video cameras. Novel surroundings are particularly relevant because cortisol levels are elevated during novel conditions (Kirschbaum & Hellhammer, 1994). In terms of dispositional characteristics of the relationship, high levels of positive behavior reflect relationship satisfaction (Karney & Bradbury, 1995), and based on the marital satisfaction scores in our sample, 97% of the spouses were highly satisfied with their relationships.

How might the situational context and dispositional characteristics of the spouses' relationship lead to elevated perceived social-evaluative threat? Individuals become more distressed in situations that are incongruent with dispositional characteristics. For instance, persons high on trait agreeableness were more distressed during interpersonal conflicts compared to persons scoring low on trait agreeableness (Suls, Martin, & David, 1998). Extending this reasoning to marital relations, some spouses may experience greater distress in situations that are incongruent with characteristics of the relationship. Thus, individuals in satisfied relationships placed into a novel situation that is incongruent with a satisfied relationship – conflict – may experience greater social threat.

Consistent with this perspective, married couples who showed predominantly positive behavior during a problem-solving discussion showed increases in cortisol (Fehm-Wolfsdorf, Groth, Kaiser, & Hahlweg, 1999). In contrast, couples who displayed predominantly negative behavior in their study showed decreases in cortisol, leading the authors to speculate that satisfied couples experienced distress during the discussion, which may be due to heightened social-evaluative threat similar to our study. In contrast, wives who exhibited low positive behavior in highly negative discussions may have experienced elevated social threat due to heightened hostility during conflict in addition to the novel aspects of the situation.

Cortisol change was also related to wives' marital satisfaction, with higher satisfaction predicting larger linear declines in cortisol. Our results replicate findings from another lab in which wives who reported greater overall relationship quality had steeper circadian declines in cortisol throughout the day (Adam & Gunnar, 2001). Therefore, both marital satisfaction and behaviors during conflict likely influenced HPA axis activation and circadian decreases in cortisol. Psychosocial influences on circadian rhythms may have important health implications. Some researchers suggest that HPA axis dysregulation, as measured by flat cortisol slopes, is one pathway through which psychosocial factors mediate cancer progression (Sephton et al., 2000; Sephton & Spiegel, 2003).

Behaviors were significantly related to wives' hormone levels but not husbands', consistent with evidence suggesting that wives may be more attuned to the emotional quality of marital interactions and show larger physiological responses during marital interactions compared to husbands (Kiecolt-Glaser & Newton, 2001). Moreover, other work suggests that women show more HPA axis activation to stressors with an interpersonal component: social rejection (Stroud, Salovey, & Epel, 2002). In general, the gender differences in hormone levels observed in this study are consistent with other research on ACTH (e.g., Roelfsema et al., 1993) and cortisol (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999).

There are several limitations worth noting in this study. As indicated previously, the conflict discussions occurred around 8:30 am, during the normal cortisol decline. Effect sizes for stress-related increases in cortisol are smaller in the morning compared to the afternoon (Dickerson & Kemeny, 2004). Although conducting discussions around this time may have thus limited our ability to detect stress-related increases in cortisol for the average participant, we did observe significant individual differences in cortisol change. Moreover, conducting discussions in the early morning as opposed to the evening may have limited ecological validity relative to when conflicts may actually occur at home. Finally, the plasma cortisol measures in this study reflect both biologically active and biologically inactive cortisol. In contrast, salivary cortisol measures, which reflect biologically active cortisol, are generally more preferable to plasma cortisol in biobehavioral studies (Kirschbaum & Hellhammer, 1994).

The first studies that demonstrated the utility of measuring functionally independent positive and negative aspects of social relationships focused on the individual's perceptions of social network ties (Fincham & Linfield, 1997; Holt-Lunstad et al., 2003; Uchino et al., 2001). The influence of positive and negative dimensions of social relationships on physiology probably depends on the interpersonal process of interest. On the one hand, interacting with a friend or partner rated as highly positive and highly negative contributes to heightened physiological reactivity (Holt-Lunstad et al., 2003). On the other hand, expressing positive behaviors in the midst of a hostile discussion may have physiological benefits.

Other work suggests that focusing on positive interactions, such as social support interactions (Pasch & Bradbury, 1998) or sharing positive events (Gable, Reis, Impett, & Asher, 2004) may provide additional information on relationship functioning than an exclusive focus on conflict alone. In the context of the larger repertoire of behaviors observed across many types of interactions, the positive behaviors observed during conflict in this study may be more appropriately classified as constructive engagement, which includes the ability to receive and respond constructively to a spouse's expressions of negative affect (Markman, 1991). Therefore, our findings suggest that the absence of constructive engagement disrupts normal physiological regulation during stressful interpersonal interactions.

This study offers preliminary evidence of a relationship between positive and supportive behaviors during marital conflict and regulation of the HPA axis. Moreover, our findings demonstrate that physiological pathways may mediate the beneficial effects of support provided in married relationships. Over time, positive and negative aspects of relationship functioning and their influence on physiological function may have implications for relationship health and physical health (Robles & Kiecolt-Glaser, 2003). Indeed, the health consequences of healthy relationship functioning are compelling: In two longitudinal studies, increased ratings of relationship quality were related to lower atherosclerotic burden (Gallo et al., 2003) and lower left ventricular mass (Baker et al., 2000) after several years, suggesting that the support provided by relationships impacts health through direct influence on physiological pathways.

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