Hostile Behavior During Marital Conflict Alters Pituitary and Adrenal Hormones

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We evaluated hormonal changes and problem-solving behaviors in 90 newlywed couples who were admitted to a hospital research unit for 24 hours. The subjects were selected on the basis of stringent mental and physical health criteria, and admissions were scheduled during the follicular phase of the woman's menstrual cycle. For frequent, unobtrusive endocrine sampling during the interaction tasks, a long polyethylene tube was attached to a heparin well, allowing nurses to draw blood samples at set intervals, out of subjects' sight. Five blood samples were obtained before, during, and after a 30-minute structured problem-solving or conflict task. The conflict session was recorded on videotapes that were later scored for problem-solving behaviors using the Marital Interaction Coding System (MICS).

Marital conflict and MICS-coded hostile or negative behavior during conflict was closely linked to changes in serum hormonal levels across five of the six hormones we studied, in spite of the high marital satisfaction of our newlywed couples and the healthy lifestyles demanded by our exclusion criteria. Hostile behavior was associated with decreased levels of prolactin (PRL) and increases in epinephrine (EPI), norepinephrine (NEPI), ACTH, and growth hormone (GH), but not cortisol. These data suggest that the endocrine system may be an important mediator between personal relationships and health.

Key words: psychoendocrinology, hostility, hormones, stress, marriage.

Many disease processes such as asthma, hypertension, peptic ulcer disease, herpes simplex infections, rheumatoid arthritis and Graves disease are induced or aggravated by stressful events (1). Several of these diseases have immunological components involved in their pathogenesis (2). Our laboratory and others have reported immunological alterations after both acute and chronic stressors (3, 4). Stress is also a stimulus for the release of pituitary and adrenal hormones that can influence humoral and cellular immunity (5). Numerous studies have suggested that norepinephrine (NEPI), epinephrine (EPI), ACTH, cortisol, growth hormone (GH), and prolactin (PRL) can influence quantitative and qualitative changes in cellular immunity (6), and a bi-directional feedback system has been described between the endocrine and immune systems (2).

Investigators have found that a variety of stressors can influence the secretion of catecholamines, ACTH, cortisol, GH, and PRL. For example, extreme events such as cardiac arrest, surgery, and ultraendurance exercise produce marked increases in NEPI, EPI, ACTH, cortisol, GH, and PRL (7-9). In addition, more common stressful events- such as - academic examinations, computer games, or mental arithmetic may also initiate changes in these hormones, albeit generally to a lesser extent (10, 11).

Recent research has highlighted the significance of interpersonal stressors for physiological reactivity (12); social stressors such as public speaking (13), an interview about personally important topics (11), or the rigorous, structured interview of a soldier by a panel of senior noncommissioned officers (14, 15) can have potent endocrinological consequences. If the endocrine system is involved in the pathogenesis of stress-related disease processes, it is possible that the mediator of these outcomes is frequent small daily excursions in hormonal levels following stressful events. Thus, chronically abrasive relationships could exact a high physiological tax (12). The opportunity to examine the influence of interpersonal conflict on the endocrine response to stress was provided by a study we have been performing using newlywed couples.

Marital researchers typically ask couples to discuss a topic on which they are known to disagree; differences in behavior during these problem-solving or conflict discussions have been widely studied (16, 17). Across a large number of marital studies, negative or hostile communication strategies during these problem-solving or "conflict" discussions discriminate much better between happy and unhappy

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couples than positive communication indices (17). Negative or hostile communication also predicts divorce in longitudinal studies (16). Moreover, a number of studies have shown a pattern of heightened autonomic arousal associated with marital conflict (18-22).

In a related report from this project (23), we described the relationship between negative or hostile behaviors during a 30-minute discussion of marital problems and downward changes in immune function in our sample of 90 newlywed couples who were admitted to a hospital research unit for 24 hours. In this study we used endocrine data from this same sample of couples to investigate the influence of hostile behavior on endocrine secretion during marital conflict.

METHODS

Subject Selection

Immunological, endocrinological, autonomic, behavioral, and self-report data were collected from 90 newlywed couples during a 24-hour admission to the Ohio State University Clinical Research Center (CRC), a hospital research unit. A three-stage process was used for screening and recruitment.

We initially identified couples through Franklin County Court records for the Columbus metropolitan area. We sent letters to demographically "appropriate" couples (first marriage, ages 20-40, no children) who had obtained marriage licenses 4 to 6 months previously. The first phase of the study was described as a phone survey of newlyweds' health and happiness, and subjects were told that they would be paid $10 per couple for interviews concerning their physical and mental health if they returned an enclosed postcard; 2249 individuals were interviewed of 4758 who received letters, representing a 47% response rate. Eight percent of the couples who returned our original postcards were eventually admitted to the CRC.

We eliminated couples from further consideration if either spouse reported any acute or chronic health problems that might have immunological or endocrinological consequences, if they took any medications except birth control pills, if they drank more than 10 alcoholic drinks per week or used any street drugs, if they smoked, if they used caffeine excessively, or if they were not within 20% of their ideal weight for their height. We explored the reasons for past surgeries or hospitalizations, as well as any psychological/psychiatric treatment. Women were asked about any menstrual problems, because of their endocrinological relevance. Couples who were planning to move or to have children within the next 2 years were excluded, because they might be lost to follow-up.

We also administered the telephone version (24) of the Marital Adjustment Test (1v1AT; 25). The MAT mean for the telephone interview sample was 126.98 (SEM = 0.33); higher MAT scores indicate greater marital satisfaction. Couples were targeted for further screening if they met the above criteria, and if either member of the couple scored 130 or greater or 118 or less on the MAT (in an attempt to maximize the marital satisfaction range among our sample).

During the second set of phone interviews we collected both current and lifetime psychiatric disorder data as well as a detailed medical history; for the latter, the interviewer completed a standard medical history/review of systems form that was later reviewed by the project's research nurse and a physician. Subjects received $15 each for these 30- to 90-minute interviews administered by postdoctoral fellows and advanced clinical psychology graduate students. Comparisons of physical health and depression data collected through telephone or in-person interviews suggest that the two methods produce comparable data (26).

We excluded subjects who had met DSM-III-R criteria for any psychotic diagnosis, any depressive or anxiety disorder other than simple phobia, or substance abuse. These criteria were designed to exclude previously impaired or vulnerable individuals whose psychopathology might produce marital discord (27), as well as associated endocrinological or immunological alterations, e.g., the hypercortisolemia or altered immune function associated with clinical depression (28). We eliminated individuals with any history of major depression or dysthymia, since impairments in marital and other close relationships can persist for 4 years or more after an acute episode (29).

Of the 313 individuals who completed the second set of interviews (14% of the original interview sample of 2249), 58% of these subjects (90 couples) were eventually admitted to the CRC. Aside from our stringent mental and physical health criteria, couples were eliminated if they reported any needle or hospital phobias, if they could not be scheduled for their CRC admission within 14 months of their marriage, or if one spouse could not be reached to complete the interviews. Because all CRC evaluations had to be scheduled during the follicular phase of the woman's menstrual cycle (days 5 to 9), matching couples' schedules with CRC availability was particularly problematic.

The sociodemographic characteristics of our final sample were as follows: the average age of wives and husbands was 25.21 (SEM = 0.32) and 26.13 (SEM = 0.32), respectively, with a range from 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 (SEM = 1764.44). The majority were white (95%). Couples dated an average of 36.58 months (SEM = 2.60) before marriage, and 55 couples (61.11%) lived together before marriage. An average of 10.44 months (SEM = 0.15; range = 6-14) elapsed between their marriage and their CRC admission.

CRC Admission

Subjects were admitted to the Clinical Research Center (CRC) at 7:00 AM, and a heparin well was inserted in each subject's arm. We asked couples not to drink or eat anything after midnight. All CRC evaluations were scheduled during the follicular phase of the woman's menstrual cycle (days 5 to 9).

After the 1 1/2 hour adaptation period after insertion of the heparin well, subjects were positioned in chairs facing each other in front of a curtain. The couples completed several questionnaires, then sat quietly for 10 minutes.

Interviews. At the end of the baseline period a psychology graduate student or postdoctoral fellow conducted a brief interview (10-20 minutes) to help identify the best topics for the problem discussion. Based on this interview and the couples' independent ratings of their disagreements about common relationship issues (e.g., in-laws, finances, leisure time), couples were asked to discuss and try to resolve the two or three marital issues that the interviewer judged to be the most conflict producing.

During the 30-minute problem discussion that followed immediately, the research team remained out of sight behind a curtain.

Blood Sampling Protocol. For frequent, unobtrusive endocrine sampling during the interaction tasks, a long polyethylene tube was attached to the heparin well, allowing nurses to draw blood samples at set intervals, out of subjects' sight. During the marital interaction tasks the couples were seated facing each other in front of a curtain, with the polyethylene tubes easily accessible to two nurses who sat behind the curtain. Two psychology team members were also seated behind the curtain during the interviews, monitoring the videotaping and adjusting the remote-controlled cameras.

Approximately 90 minutes after the heparin well had been inserted, subjects were asked to sit quietly in the chairs used for interviews for 10 minutes, and then the baseline blood samples were drawn (Figure 1). At the end of the 10- to 20-minute interview, and immediately before the 30-minute problem-solving or conflict 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 conflict task. The fifth blood sample was drawn at the end of a 15-minute recovery period after the end of the problem-solving discussion.

Marital Interaction Coding System (MICS)

The Marital Interaction Coding System-IV (MICS; 30) provided data on problem-solving behaviors during the 30-minute marital conflict resolution 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 (31). A number of studies have shown that the MICS discriminates well between happy and unhappy couples, and marital therapy studies show changes in MICS-coded behaviors from pre- to posttreatment (32). After 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.

One study that used generalizability theory as a method for evaluating the dependability of the MICS produced impressive evidence supporting its reliability (33); generalizability and error coefficients computed for samples collected under five different conditions showed that most of the variation in marital interaction samples was a function a differences among couples and cross-situational differences within couples, with no evidence of observer drift, coder biases across couples or occasions, or reactivity from the first to the second sampling occasion. Moreover, distressed couples' negative behaviors showed strong cross-situational consistency, despite discussion topic differences and sampling on two occasions (33).

Unhappy marriages are reliably characterized by negative affect, conflictual communication, and poor listening skills (16, 17, 30-32). For these reasons, the MICS codes of greatest interest were those that assessed hostile or negative behaviors (criticize, disagree, deny responsibility, excuse, interrupt, negative mind reading, noncompliance, put down, turn off, disapprove, and dysphoric affect); for greater detail concerning the rationale for combining codes, see our prior paper (23). As in other studies (18), husbands' and wives' negative or hostile behaviors were significantly correlated, $r = .74$, $p < .001$, so we summed them for each couple, following the convention in other marital research (18); also, we were interested in the couple's negative behavior total because we assumed that one partner's behavior affected the other. We divided the resulting frequencies at the median, 105, to form high and low negative groups for the endocrine analyses, with higher scores on this dimension reflecting higher frequencies of negative or hostile behaviors. Thus, our MICS groups were defined solely on the basis of high or low hostile or negative behavior, not avoidant or positive behaviors.

Psychological Assessment

The Structured Clinical Interview for DSM-III-R, nonpatient version (SCID-NP) is designed to enable a clinically trained interviewer to make rapid and valid DSM-III-R diagnoses for both lifetime and current psychopathology (34). We used the SCID-NP to exclude vulnerable individuals, as described earlier. Interrater reliability for SCID-NP diagnoses, calculated using randomly selected audiotaped interviews for 10% of the sample, had acceptable reliability based on the resulting kappa coefficient of .74.

The Marital Adjustment Test (MAT; 25), used to assess marital satisfaction, was administered 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 (24). Lower scores indicate lower marital satisfaction.

The Profile of Mood States (POMS, 35), one of the best selfreport measures for identifying and assessing transient, fluctuating moods, was administered at baseline before the interviews began and again at the end of the conflict task. The POMS has excellent norms, and psychometrically is very strong in terms of both reliability and validity (35); we were particularly interested in changes on the hostility scale.

Endocrine Assays

The GH, PRL, ACTH, cortisol, and catecholamine assays were performed in our laboratory with methods that have been used for several years. The GH and PRL RIA's have a sensitivity of 1

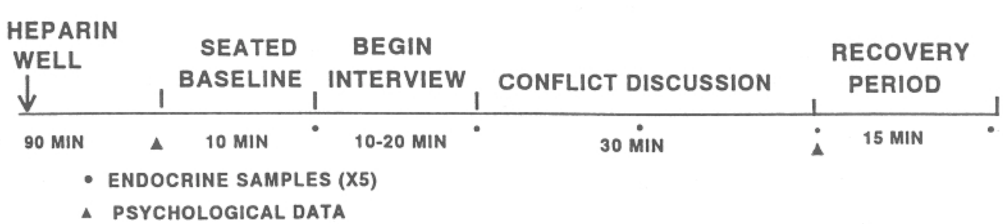

Fig. 1. Time line for insertion of the heparain well and the five blood samples drawn before, during, and after the 30-minute problem-solving or conflict discussion.

ng/ml. The assays have intra- and interassay coefficients of variation of less than 6%. ACTH levels were determined by an IRMA assay using materials supplied by Nichols Institute (Capistrano, 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). This assay has a sensitivity of 0.5 μg/100 ml and an intra- and interassay coefficient of variation of less than 10%. The coefficients of variation of these assays were calculated using at least 1 high and low serum control sample.

The plasma catecholamine concentrations (NEPI and EPI) were determined by HPLC using a Water's system. Alumina was used to extract the catechols from plasma. DHBA is used as the internal standard for calculation of the extraction efficiency. Using this method, we have an extraction efficiency of 60 to 90%. The mobile phase consists of Waters catecholamine eluent. The sensitivity of our HPLC system for epinephrine is 10 pg/ml and for norepinephrine is 20 pg/ml. The assay has an interassay coefficient of variation of 15% for epinephrine and 9% for norepinephrine. All of the serum samples from each couple for ACTH, cortisol, GH, and PRL were run in the same assay to diminish interassay variability.

Data Analyses

Data for EPI, NEPI, ACTH, cortisol, and PRL were analyzed using MANOVAs with change across the five time points serving as a within-subjects variable, whereas gender and high- vs. low-hostile behaviors on the MICS were the between-subjects variables. Gender main effects were analyzed using the difference between spouses at each time point in these hormones (i.e., husband/wife as a within-subjects variable), because the endocrine data for a couple were always assayed simultaneously. The gender main effects did not differ when analyzed as either a within-subjects variable or a between-subjects variable. Finally, the presence or absence of detectable levels of growth hormone (>0.8 ng/ml) were analyzed using log-linear models, because these data were not normally distributed.

RESULTS

Whereas initially we only drew blood for endocrine analyses at the beginning and end of the conflict discussion, we began taking more frequent endocrine samples after we had already collected data from the first 10 couples in this study. Thus, the sample size for the analyses reported below is 160 (80 couples), with lower numbers on occasion due to missing data within a particular assay.

The high- and low-negative MICS groups did not differ on age, education, income, caffeine or alcohol intake, hours of exercise per week, Fs < 1, or history of premarital counseling, $X^2(1)= 1.94$. Because individuals with a parental history of hypertension show exaggerated epinephrine, norepinephrine, and cortisol responses to psychological stressors (36), we used data from subjects' medical history forms to assess the possibility that any differences in catecholamine response in our high- and low-negative MICS subjects might reflect underlying genetic differences. High- and low-negative MICS groups did not differ with respect to either the frequency of parental hypertension, $X^2(1)=0.75$, or cardiovascular disease, $X^2(1)= 1.17$. In addition, our high- and low-hostile subjects did not differ either in baseline blood pressure or in their responses to a standard cardiovascular reactivity assessment conducted later in the day (23).

As described in our prior report of immunological data (23), self-assessed hostility on the POMS showed that the two MICS groups had different subjective responses to conflict. MICS groups did not differ in self-reported hostility at baseline, with means of 44.82 (SEM = 0.67) for low-hostile subjects, compared with 44.79 (SEM = 0.75) for high-hostile subjects. Although both MICS groups reported less hostility after conflict, the decline was greater in low-hostile subjects (M = 39.46, SEM = 0.43) than high-hostile subjects (M = 41.92, SEM = 0.73), producing a significant interaction between groups and time, $F(1,156) = 6.31$, $p <.01$. There were not significant gender effects.

We believe the declines in negative affect over time reflect our couples' initial apprehension about our protocol and the clear stressfulness of our procedures (hospital admission, insertion of a catheter, and awareness that they would be videotaped while discussing a marital problem). Thus, after accomplishment of these major hurdles, subjects' self-rated negative affect declined.

Endocrine Changes During Conflict

We found significant gender differences (all *p*s<01) for all hormones except for NEPI, $F<1$. For example, on the average at baseline, men had 74 ± 15% higher EPI and 158 ± 24% higher ACTH levels than their wives. On the other hand, women had 81 ± 12% higher levels of cortisol and 39 ± 8% higher levels of prolactin than their husbands at baseline. Detectable levels of growth hormone were found in 47% of the women, and 25% of the men at baseline.

Analysis of EPI data (Figure 2) showed a significant change over time, $F(4, 137) = 7.74$, $p < .001$, reflecting the overall downward trend after baseline. These changes, with time, followed a significantly different pattern for the husbands and wives, $F(4,66)= 3.05$, $p < .05$, with the EPI values in the women increasing an average of 14 ± 7% from baseline to the break

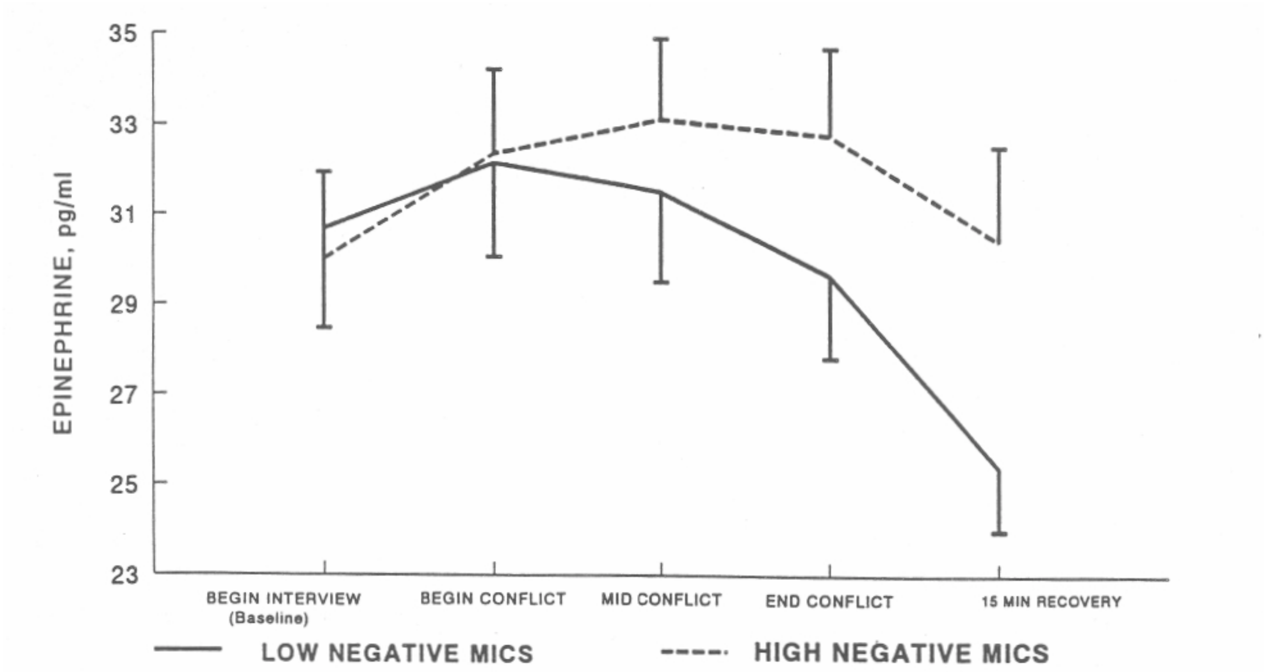

Fig. 2. The mean (± SEM) values at each point in time for the two MICS groups. The responses to the marital conflict session produced significantly ($p < .001$) different epinephrine levels. Differences in epinephrine concentrations were also found between the high and low hostility groups ($p < .05$) as determined by the Marital Interaction Coding System (MICS). Note that the vertical axis does not start at zero in order to better illustrate differences between groups.

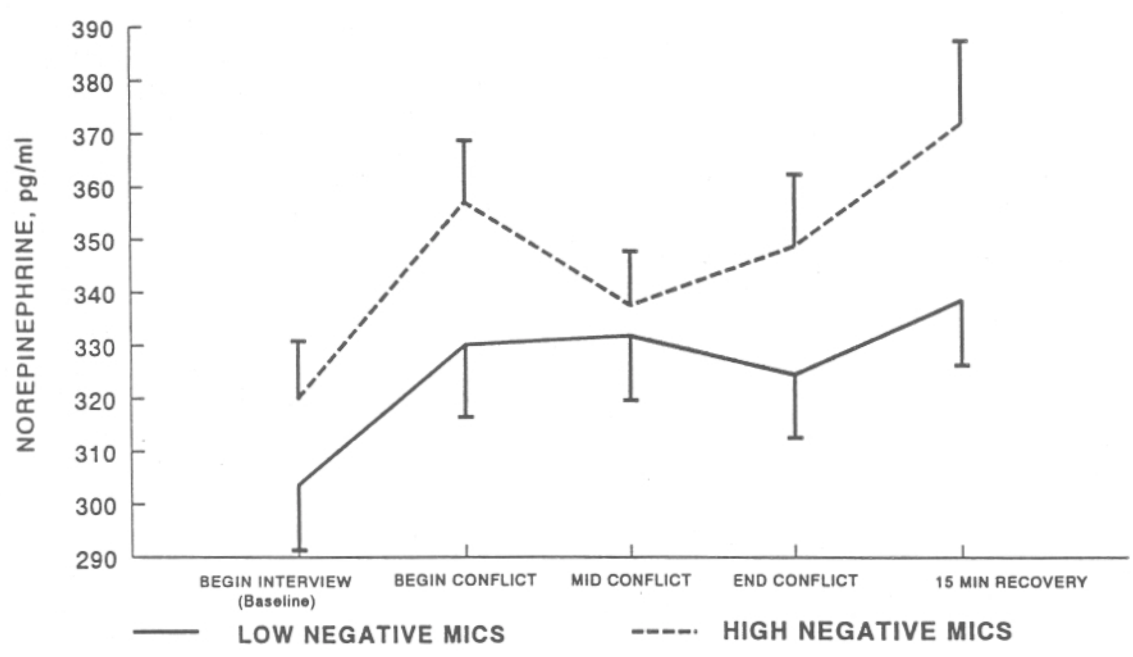

Fig. 3. The significant ($p < .001$) increase in mean (±SEM) NEPI levels produced by the interview and marital conflict discussion was influenced ($p < .05$) by the level of hostility expressed by the couples. Note the persistent elevations in NEPI 30 minute after the completion of the conflict session.

although the EPI levels in the men decreased an average of 5 ± 5%. In addition, there was a significant interaction among MICS group, gender, and change over time, $F(4, 137) = 2.44$, $p < .05$. The high-hostile MICS subjects did not differ from low-hostile MICS subjects at baseline, but EPI decreased in low-hostile MICS subjects over time, whereas EPI in high-hostile negative subjects remained fairly constant. These MICS group differences were relatively larger in women than men.

NEPI data (Figure 3) also showed changes over the five sample points, $F(4, 135) = 16.68$, $p < .001$, as well as a significant differences between the MICS groups in their changes over time, $F(4, 135) = 2.39$, $p < .05$, with the most pronounced differences between MICS groups apparent 15 minutes into the recovery period. No other interactions were significant.

ACTH (Figure 4) also showed a reliable association with hostile MICS behaviors, with significantly higher levels for high-hostile MICS subjects compared with low, $F(1, 109) = 5.53$, $p <.02$. In addition, there was a significant interaction between gender and change over time, $F(4, 47) = 3.80$, $p <.01$, with men showing a gradual decline over the five sample points, whereas the women's data did not show the same downward slope, on the average. No other interactions were significant.

Of the six hormones we assessed, cortisol (Figure 5) showed the weakest relationships with conflict or MICS-coded negative behaviors. Although there was a significant decrease over the five sample points that probably reflects the normal diurnal fall from the early morning peak, $F(4, 138) = 32.74$, $p < .001$, we did not find a significant difference between MICS groups in the pattern of cortisol changes with time.

Prolactin (Figure 6) changed across the five time points, $F(4, 130) = 24.87$, $p < .001$, with peak levels occurring at the beginning of conflict. In fact, despite the expected drop in prolactin values at this time of day, there was a 29 ± 4% increase in prolactin levels from baseline to the beginning of conflict in the high-negative MICS group and a 17 ± 5% increase in the low-negative MICS group. The difference between the MICS groups in the pattern of prolactin changes with time were also significant (4, 130) = 2.50, $p <.05$, with low-negative MICS subjects showing higher PRL levels than high-negative subjects following conflict. No other interactions were noteworthy, Fs < 1.

The high MICS group also had a significantly greater proportion of subjects with detectable levels of growth hormone when compared with the low MICS group, $p <.01$ (Figure 7). No significant differences between the MICS groups were seen in the pattern of growth hormone levels with time.

DISCUSSION

In this investigation we found that marital conflict and hostility during conflict was closely linked to changes in serum hormonal levels across five of the six hormones we studied. Specifically, it seems that hostile behavior during marital conflict was associated with decreased levels of PRL and increased levels of EPI, NEPI, GH, and ACTH. In contrast, the only change noted in cortisol levels was a persistent decline throughout the sampling period that probably reflected normal diurnal influences. Although

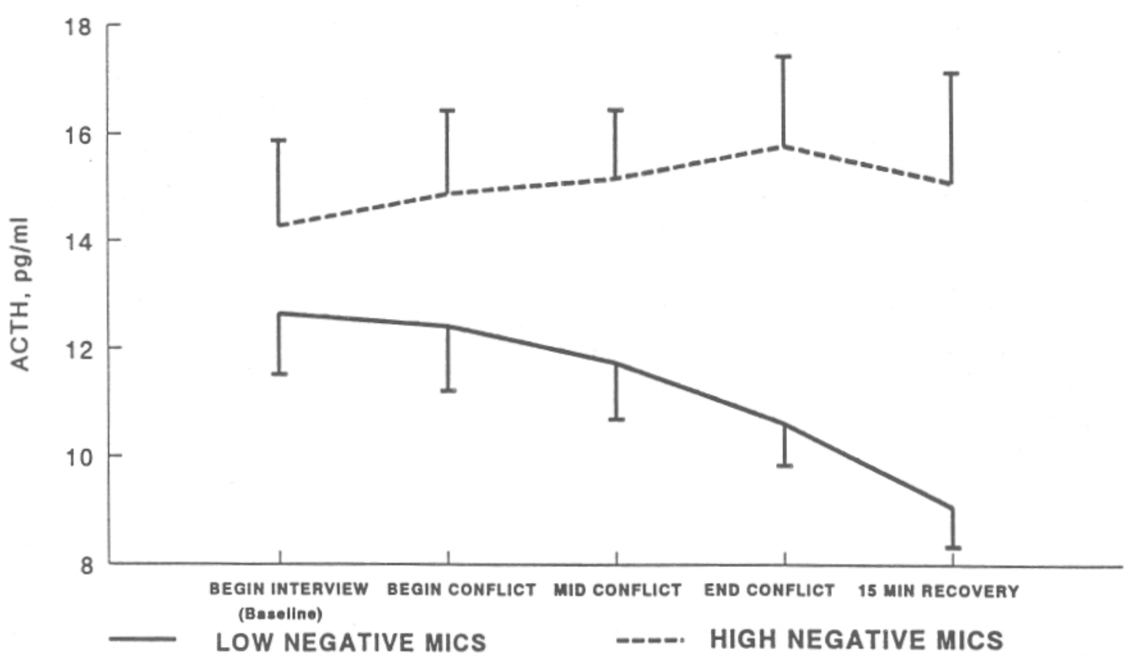

Fig. 4. The marital conflict discussion produced significant ($p <.02$) differences in mean (±SEM) ACTH levels between the high and low hostile couples.

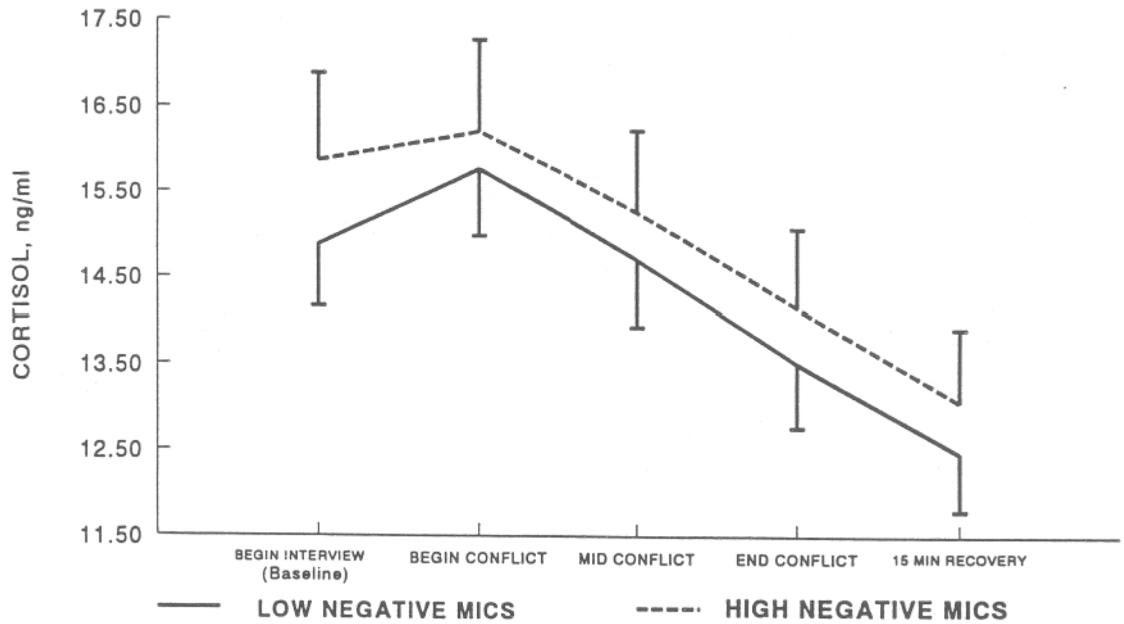

Fig. 5. Plasma cortisol levels were not significantly influenced by conflict or hostile behavior. The significant ($p < .001$) decrease in values over time probably reflected normal diurnal variation.

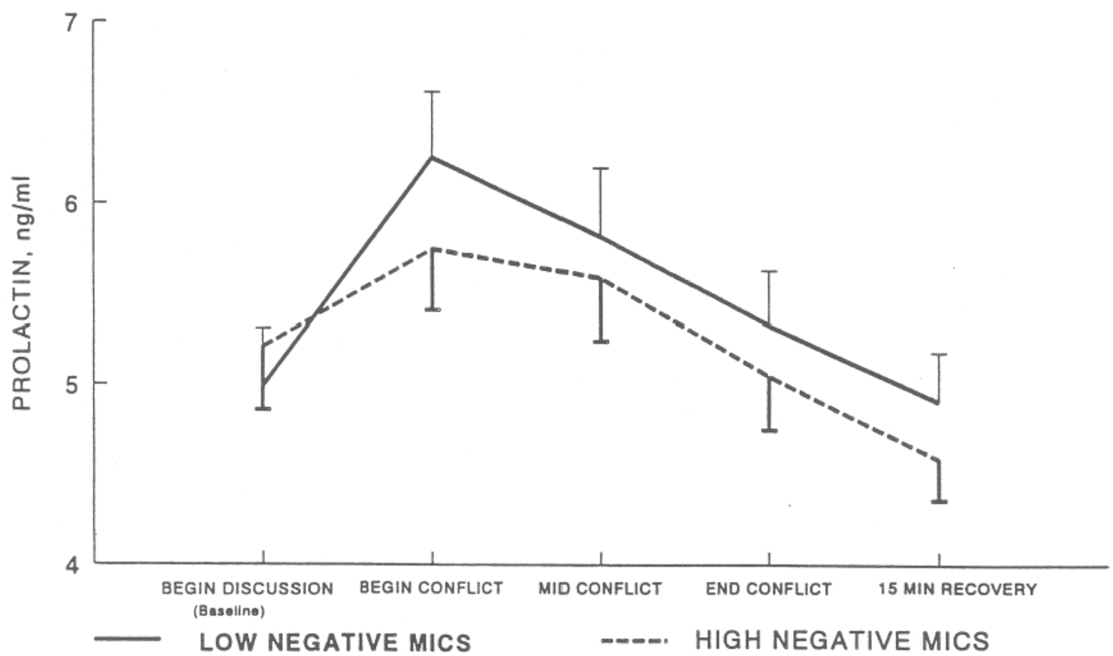

Fig. 6. The initial interaction produced significant ($p < .001$) changes in prolactin levels over the five sample points. Also, low hostility subjects had significantly ($p < .05$) higher prolactin levels than the high hostility group.

ACTH is a stimulus for cortisol secretion, the changes in ACTH levels related to hostile behavior were evidently not of sufficient magnitude to induce significant changes in serum cortisol levels during the study intervals. Perhaps the same stimulus applied later in the day when cortisol levels have declined from their early morning peak might have yielded different results.

The response of catecholamines to conflict varied greatly between men and women depending on the degree of negative behavior exhibited during the conflict. The response of plasma EPI levels before, during, and after the conflict was influenced by gender and behavior. Men had higher baseline EPI levels then women, as well as higher poststress levels, similar to other evidence that men may show

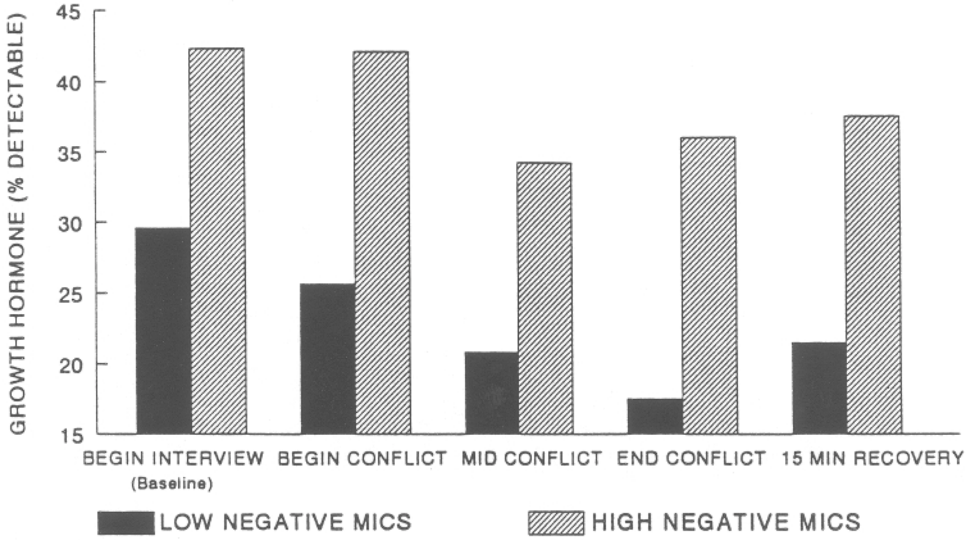

Fig. 7. The figure shows the percent of subjects who had detectable levels of GH at each sample point. The were a greater number of subjects with detectable GH levels in the high hostility group. However, there were no significant changes in GH during or after conflict. Note that many of the samples acquired were below the detection level of the assay.

a larger plasma EPI response to laboratory stressors (37); however, differences between high- and low--hostile groups were relatively greater for women than for men for EPI. The NEPI levels were sensitive to the stress of the initial interview when couples choose the problems to discuss; the conflict task that followed produced no additional increase in NEPI levels. Of interest was the observation that the NEPI levels remained elevated 15 minutes after the conflict. We and others have previously noted a persistence of elevated NEPI levels after ultraendurance stress (9, 38); similarly, Oleshansky and Meyerhoff (15) found that NEPI remained elevated after the termination of a stressful interview. Presumably the prolonged increase in NEPI reflects persistence of sympathetic stimulation after termination of the stressor.

Similar to the NEPI response pattern, prolactin increased after the initial interview, and the actual conflict task produced no additional stimulation. In addition, low hostile behavior individuals had higher PRL levels from the beginning of conflict through the 15-minute recovery period.

In this study we demonstrated that marital conflict and hostile or negative behaviors have significant neuroendocrine consequences. The pattern of the behavior group differences across the various hormones was noteworthy. For example, EPI and NEPI are generally associated with immunological downregulation (39, 40), and these levels were higher in the individuals who showed more hostile behaviors during conflict. The influence of EPI and NEPI on the immune system is partially exerted via stimulation of mononuclear intracellular cAMP levels which inhibit lymphoproliferation (39, 40).

We also noted lower PRL levels in the high hostile behavior group. Because we and others have shown that PRL is immune enhancing (41, 42), the combination of elevated catecholamines and depressed PRL levels could lead to diminished immune function in the group with more hostile behaviors. As noted earlier, we also obtained immunological data from these subjects twice, first on entry to the CRC and then again 24 hours later (23). High-hostile subjects showed greater decrements relative to low-hostile subjects on four functional immunological assays (NK cell lysis, the blastogenic response to two mitogens, and the proliferative response to a monoclonal antibody to the T3 receptor), as well as larger increases in the numbers of total T lymphocytes and helper T lymphocytes. The elevated plasma EPI levels in our high-hostile subjects are one likely candidate for these changes in both lymphocyte numbers and function; injections of physiological levels of EPI and/or brief laboratory stressors produce similar immunological consequences, notably the down-regulation of function concomitant with a transient increase in T lymphocyte numbers (43, 44). High-hostile subjects had higher antibody titers to latent Epstein-Barr virus than low-hostile subjects, consistent with down-regulated immune function. Women were more likely to show negative immunological changes than men.

We also found that the discussion of marital problems also led to larger increases in blood pressure that remained elevated longer in our high-hostile subjects than low-hostile subjects (23). These blood pressure changes seemed to be closely tied to behavior during the conflict discussion: high- and low hostile subjects did not differ either on baseline cardiovascular measures, or in their response to a standard cardiovascular reactivity assessment conducted later in the day. Positive or supportive problem-solving behaviors were not related to either immunological or blood pressure changes. Similarly, Ewart et al. (18) found that a 10-minute marital problem-solving task produced clinically significant increases in blood pressure, with hypertensive patients reaching a mean of 160/100 mm Hg. These blood pressure changes were specifically associated with hostile marital interactions: neither supportive nor neutral behaviors produced significant changes. Parallel data from Morrell and Apple (20) showed that negative affect during a marital conflict discussion accounted for 20% of the variance in women's systolic blood pressure (men's changes were not assessed), and positive affect was unrelated to women's cardiovascular responses. Thus, the pattern of change in our immunological and blood pressure data was consistent with both the endocrine data reported in this paper and results of two other marital interaction studies.

"Trait" hostility, as measured by the Cook-Medley Hostility Scale (45), has been associated with more frequent marital conflict, as well as more hostile behavior during marital conflict (46-49). Neurohormonal changes related to hostility are thought to provide one of the links between trait hostility and risk for coronary heart disease (50). Taken together, data on both trait and state hostility provide support for the idea that chronically abrasive marital relationships could contribute to the heightened sympathetic tone believed to play an early role in hypertension and atherogenesis (18).

A number of different laboratory stressors have been used to study physiological reactivity; however, the generalization of laboratory effects to real life stressors has been a matter of concern (11). Dimsdale et al. (11) showed that talking with subjects about interpersonal aspects of stressful situations in their lives produced much greater elevations in blood pressure than standard mental arithmetic or cold pressor tasks. Moreover, structured interviews were the strongest laboratory predictors of ambulatory blood pressure in two additional studies (51, 52). The discussion of marital problems provides another way to produce physiological changes in the laboratory that have clear relevance to everyday stressors.

We controlled for a variety of health-related behaviors in this investigation including weight, illness, caffeine ingestion, smoking, physical activity, psychological disorders, alcohol intake, medications, and phase of the menstrual cycle. As described in our previous paper, high- and low-hostile groups did not differ at baseline on positive or negative affect, depression, anxiety, social support, or social desirability (23); the absence of any baseline affective differences is particularly important because of evidence that individuals high in neuroticism or negative affectivity may show an enhanced stress response and report more health complaints (53). These design features strengthen the argument that the stress of marital conflict and hostile behaviors contributed to the observed endocrine changes.

What are the physiological and health implications of these hormonal changes? First, the impact of marital conflict on hormonal levels was greater and more persistent in individuals who exhibited more hostile behavior. Moreover, the magnitude of these changes was probably influenced by several factors. Our subjects were quite healthy as a function of our stringent mental and physical health exclusion criteria. These newlywed couples were, on the average, very satisfied with their spouses; only 3% of our subjects actually scored below 100 on the MAT, the traditional cutoff for marital distress (18). The intensity of marital conflict is lower during the early years of marriage, typically increasing over time (54, 55). Couples' fights at home are more negative and last longer than those studied in the laboratory (56). Our couples are much better educated and have higher incomes than the average family in the United States, both factors that have been implicated in moderating responses to stress-ful events (57). Thus, we believe our data are likely to underestimate the physiological impact of marital discord: marital conflict may produce even greater endocrine change in less fit populations.

In summary, we noted that both pituitary and adrenal hormones were influenced by hostile behavior during martial conflict. The health consequences of these exaggerated hormonal responses occurring throughout the day after stressful encounters remain to be determined (57).

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