Sex Differences in Stress Responses: Social Rejection versus Achievement Stress

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Background: *Sex differences in stress responses may be one mechanism underlying gender differences in depression. We hypothesized that men and women would show different adrenocortical responses to different stressors. In particular, we predicted that women would show greater responses to social rejection stressors, whereas men would demonstrate greater responses to achievement stressors.*

Methods: *Following a rest session in which they habituated to the laboratory, 50 healthy volunteers (24 men and 26 women, mean age 19.1, SD = 1.13) were randomly assigned to achievement or rejection stress conditions. The achievement condition involved a mathematical and a verbal challenge; the rejection condition involved two social interaction challenges. Self-reported affect and salivary cortisol were measured throughout each stress session (baseline, stress, and poststress periods).*

Results: *There were no sex differences in mood ratings following the stressors; however, cortisol responses showed the predicted gender by condition by time interaction. Men showed significantly greater cortisol responses to the achievement challenges, but women showed greater cortisol responses to the social rejection challenges.*

Conclusions: *Women appear more physiologically reactive to social rejection challenges, but men react more to achievement challenges. Women's greater reactivity to rejection stress may contribute to the increased rates of affective disorders in women.* Biol Psychiatry 2002;52: 318–327 © *2002 Society of Biological Psychiatry*

Key Words: Sex differences, stress, depression, cortisol, achievement, rejection

Introduction

One of the most consistent findings in the epidemiology of depression is women's greater rates of unipolar depression (Boyd and Weissman 1981; Nolen-Hoeksema 1987, 1990; Weissman and Klerman 1977). Across nations and cultures, women of reproductive age are approximately 2 times as likely to suffer from depressive syndromes and symptoms as men (Nolen-Hoeksema 1987). Although numerous theories to explain sex differences in depression have been proposed, adequate evidence in support of most theories has been lacking.

A large body of evidence has shown links between depression, psychological stress, and alterations in the limbic-hypothalamic-pituitary-adrenal (LHPA) axis. Stressful life events and early adverse experiences, particularly when superimposed on genetic proclivities, have been consistently linked to the onset of depression (Hammen et al 2000; Heim and Nemeroff 1999; Kaufman et al 2000; Kendler et al 1993, 1995; Kessler and Magee 1993; McCauley et al 1997). Similar alterations along the LHPA axis may underlie links between stress and depression. Acutely, perception of stress leads to activation of various central pathways that culminate in the release of corticotropin releasing hormone (CRH) from the paraventricular nucleus of the hypothalamus. The release of CRH triggers a cascade of events resulting in the release of glucocorticoids from the adrenal cortex. Chronically, stress can lead to more permanent alterations along the LHPA axis, including both hypo- and hyperreactivity (Chrousos and Gold 1992; Heim et al 2000). Similarly, depression has been associated with multiple abnormalities along the LHPA axis, including increased basal cortisol levels (Halbreich et al 1985; Rubin et al 1987), nonsuppression in response to dexamethasone (suggesting blunted negative feedback; American Psychiatric Association 1987; Carroll 1982; Carroll et al 1981), blunted adrenocorticotropin hormone (ACTH) response to CRH (Holsboer et al 1987) and increased central CRH drive, as evidenced by elevated CRH in cerebrospinal fluid (Nemeroff et al 1984, 1991), and reduced CRH receptor binding sites in the frontal cortex (Nemeroff et al 1988). Given links between stress, LHPA dysregulation, and depression, we propose that

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sex differences in HPA responses to stress may be one mechanism underlying sex differences in depression.

Preclinical research has shown consistent sex differences in HPA responses. Similar to depressed humans, female rats consistently show greater basal corticosterone levels compared with male rats (Allen-Rowlands et al 1980; Atkinson and Waddell 1997; Chisari et al 1995; Critchlow et al 1963; Griffin and Whitacre 1991; Hiroshige et al 1973; Kitay 1961, 1963). In response to both acute and chronic stressors, female rats also have consistently shown greater increases in both ACTH and corticosterone compared with males (Armario et al 1995; Galea et al 1997; Haleem et al 1988; Handa et al 1994a; Kant et al 1983; Lesniewska et al 1990; Rivier 1999). Finally, recent research has also shown sex differences in central components of the HPA responses to stress, including expression of corticosteroid receptors and dendritic atrophy of the CA3 pyramidal neurons (Galea et al 1997; Karandrea et al 2000).

Although women's greater HPA reactivity in preclinical studies has been posited as relevant to greater rates of depression in women (Haleem et al 1988), the direction of sex differences in human HPA regulation is, if anything, reversed. In response to laboratory challenges including public speaking and mental arithmetic before an audience (Kirschbaum et al 1992, 1999; Kudielka et al 1998) as well as "real-world" examination stress (Frankenhaeuser et al 1978), male subjects have generally shown greater cortisol and ACTH responses compared with female subjects. Male subjects have also shown greater increases in epinephrine, blood pressure, and total peripheral resistance responses to performance tasks such as mirror star tracing, mental arithmetic, and public speaking (Allen et al 1993; Girdler et al 1990; Matthews and Stoney 1988; Stoney et al 1987). In tests of basal HPA functioning, men have shown greater ACTH secretion compared with women, with no gender differences in cortisol secretion (Dorn et al 1996; Horrocks et al 1990; Roelfsema et al 1993). Only in biological challenges to the HPA axis have women shown greater responses than men. Gallucci et al (1993) found that women exhibited greater and more prolonged ACTH responses to an ovine CRH (oCRH) challenge compared with men, with few gender differences in cortisol secretion; however, Dorn et al (1996) found a greater secretion of ACTH in male adolescents compared with their female counterparts following an oCRH challenge.

We hypothesized that most of the stressors in the human HPA stress studies have been achievement or instrumentally oriented (e.g., math problems, academic exams) and thus may have been more salient for male subjects. Instrumental traits tend to be more central to men's self-construal than to women's (e.g., Cross and Madson 1997), which might lead to greater investment in and physiologic responses to achievement-oriented tasks. This might explain the contrast between gender differences in human stress responses and gender differences in depression. In support of this, studies of gender role stress have shown that situations involving interpersonal concerns were perceived as more stressful for female subjects, whereas situations involving intellectual inferiority and performance failures were perceived as more stressful for male subjects (Eisler and Skidmore 1987; Gillespie and Eisler 1992). Furthermore, Taylor et al (2000) proposed that women's stress response may be better characterized by "tend and befriend," involving nurturant activities and the creation of social networks, whereas men's may involve the more traditional "fight or flight" response. Similarly, Cyranowski et al (2000) suggested that greater intensification in affiliative need along with exposure to negative events, particularly those with interpersonal consequences, may be one factor underlying the emergence of gender differences in depression during adolescence.

We propose that sex differences in HPA stress responses may be one mechanism underlying sex differences in depression. In particular, we predicted that women would show greater responses to social rejection stress, but men would demonstrate greater responses to achievement-oriented stress. To test this hypothesis, we examined sex differences in adrenocortical responses to achievement and social rejection stressors in healthy young male and female subjects.

Methods and Materials

Overview

First, a validation study verified the stressors as social rejection and achievement-oriented. For the main experiment, we randomly assigned men and women to the social rejection or the achievement challenge. Following a rest session to eliminate cortisol increases due to novelty, salivary cortisol was measured before, during, and after the stressors in a repeated-measures design.

Participants

Twenty-seven men and 31 women ranging in age from 17 to 23 years participated in the study. Exclusion criteria were based on factors known to influence cortisol reactivity. All participants reported that they were in good physical and mental health (denied psychological and emotional problems and feeling "depressed"), did not use oral or injected prescription medications including birth control, were nonsmokers, and exercised less than 7 hours per week. Participants refrained from food and drink (besides water) for 2 hours before the stress session, from exercise or alcohol for 24 hours before the session, and from caffeine beginning the evening before the stress session. Participants who completed the study during finals week (who showed significantly higher baseline negative affect and greater numbers

of negative life events) and two pilot subjects were excluded from analyses, leaving 24 men and 26 women (mean age 19.1, SD = 1.13; inclusion of pilot subjects did not change patterns or significance of results). Mean score on the Beck Depression Inventory II (Beck et al 1996) was 8.60 (SD = 6.61), below clinical cutoffs for depression. Participants slept an average of 6.52 hours (SD = 1.47) the night before the stress session and 7.12 hours (SD = 2.00) 2 nights before the stress session, with no significant differences in hours of sleep before the stress session by gender or condition (t (48) < .85, p = ns). With menstrual phase approximated using date of last period and typical cycle length, there were no significant differences in numbers of women in follicular and luteal phases by condition (χ^2 (1) = .41, p = ns).

Salivary Cortisol Measures

Salivary cortisol is considered a reliable and valid measure of unbound, or free cortisol levels in plasma (Hellhammer et al 1987; Kirschbaum and Hellhammer 1989). Six saliva samples were taken from each participant over the course of the stress session using the Salivette sampling device (Sarstedt, Rommelsdorf, Germany). Two samples were taken approximately 7 minutes apart at baseline, two during stress (one following each stressor) and two during the poststress period (at 15-min intervals). Cortisol samples were frozen by the General Clinical Research Center at the Yale School of Medicine. Salivettes were centrifuged at 4°C at 3000 rpm for 10 min to remove particulate matter. Two hundred μL samples of the supernatant were then assayed in duplicate by radioimmunoassay (Diagnostic Products Corporation, Los Angeles, CA). The average of the duplicates for each sample was used in the analyses. All samples from each individual subject were tested in the same assay run. The sensitivity of the saliva assay is 0.03 μg/dL. Intra- and interassay coefficients of variation ranged from 6% to 16%.

Psychologic Measures

VISUAL ANALOG SCALES (VASs). Self-reported affect was assessed at five points during the stress session: once at baseline, twice during stress, and twice during the poststress period corresponding to the cortisol time points described above. Based on the results of a principal components analysis of the 20 mood adjectives, we created two affect scales: negative affect (NA) and positive affect (PA). The NA scale included *tense, defeated, stressed, powerless, hopeless, tense, worthless, distressed, anxious, challenged, out of control, depressed, angry, annoyed,* and *sad.* The PA scale included *energetic, happy, relaxed, alert,* and *in control.* Both scales showed good internal consistency (Cronbach's alphas were .94, and .88 for NA and PA, respectively).

Stressors

MATHEMATICAL CHALLENGE (BEN ZEEV 1995). Participants were taught the rules for a challenging, hypothetical numbering system called "New Roman." Participants were then asked to solve 24 extremely challenging addition problems using the new numbering system. Time pressure was imposed, and participants were asked to explain their reasoning into a tape recorder.

VERBAL CHALLENGE. The verbal challenge involved memorizing a 20-line passage from *Paradise Lost* (Milton 1953). Participants were given 10 min to memorize the passage and then were asked to recite the passage into the tape recorder for 3 min.

SOCIAL REJECTION CHALLENGES (STROUD ET AL 2000; TANOFSKY-KRAFF ET AL 2000). These involved two extensively trained undergraduate confederates who gradually excluded and rejected the participant during two interaction segments. Confederates used a variety of verbal and nonverbal techniques to exclude the participant, while connecting well with each other. Exclusion of the participant began slowly and built gradually so as not to appear planned.

Procedure

Procedures were approved by the Yale Institutional Review Board. Informed consent was obtained from all participants. Because we were interested primarily in the effects of specific types of stress on reactivity, all participants completed a separate "rest" session before the experimental manipulation session. The primary purpose of the rest session was to allow participants to habituate physiologically to the laboratory before undergoing the experimental manipulation. With the influence of laboratory novelty attenuated, differences in reactivity could be attributed to the type of stress, the primary independent variable in the study. Each participant completed both a rest and a stress session. All sessions commenced between 3 and 6 PM to control for diurnal changes in cortisol secretion. The rest session lasted approximately 1.5 hours and was identical for all participants. Participants completed a large battery of questionnaires while listening to soft, classical music.

Based on random assignment, participants either completed an achievement or social rejection stress session at least 2 days after the rest session. Both conditions included baseline, stress, and poststress periods. The baseline period lasted approximately 20 min. For the first 10 min, participants read a travel magazine while listening to soft classical music. This was followed by collection of the first VASs and saliva measures, in this sequence. For the next 5 to 7 min, participants completed a short questionnaire packet including items to verify that they had followed pre-experimental instructions. The second saliva sample followed.

In the achievement condition, participants were told that the experimenters were studying the relationship between intelligence and physiologic responses. They were also told that they would be ranked on their ability to complete challenging mathematical and verbal tasks and that their peers had found the tasks to be quite easy. Participants then completed the 30-min mathematical challenge and a 15-min verbal challenge. Each challenge was followed by VASs and a saliva sample.

The social rejection condition involved two same-sex confederates. The participant and confederates were told that the experimenters were interested in how individuals get to know one another and that they would discuss two different topics

while the experimenter videotaped the interactions. Participant and confederates then engaged in the two rejection challenges (weekend activities and college friendships) in which the participant was excluded by the confederates. Each challenge segment lasted 15 min. VASs and saliva samples were then taken after the completion of each interaction segment.

The poststress period was the same for the social rejection and achievement conditions. Participants completed questionnaires while listening to soft, classical music. Saliva, and affect measures were obtained at 15 min following the second stressor and then again 15 min later (or 30 min following the second stressor). Extensive debriefing followed.

Stressor Validation

To confirm the descriptions of the stressors as social rejection versus achievement and the relevance of each stressor to typical young men and women, we randomly assigned an independent sample of young adults (27 male and 44 female subjects) to read vignettes describing the social rejection ($n = 35$) or achievement stressors ($n = 36$). Participants rated the stressors along the following dimensions using 6- and 7-point Likert scales: 1) achievement, 2) social rejection, 3) relevance to typical men and women. As predicted, the achievement condition was perceived as significantly more academic [$F(1,68) = 32.73$; $p < .0001$] and involving significantly more achievement issues, academic concerns, and performance than the rejection condition (Fs = 24.49, 44.91, and 6.52, respectively; ps $< .05$); the rejection condition was perceived as significantly more social [$F(1, 68) = 113.58$, $p < .0001$] and involving significantly more social rejection, social isolation, and social exclusion than the achievement condition [Fs(1, 68) = 16.36, 8.14, and 14.63, respectively; ps $<$ .01]. Finally, the achievement condition rated as more stressful and relevant to male participants than the rejection condition, and the rejection condition as more stressful and relevant to female participants than the achievement condition [Fs(1, 69) = 6.07, and 23.72, respectively; ps $< .05$].

Data Analyses

Because cortisol values were positively skewed at all time points (skewness: 2.8–4.7; kurtosis: 9.9–26.9), logarithmic (base 10) transformations of cortisol values were used for all statistical analyses; however, nontransformed cortisol values are presented in Figure 1. For self-reported affect, we conducted two 2 (gender) $\times$ 2 (condition: achievement, social rejection) $\times$ 3 (time: baseline, challenge 1, challenge 2) repeated measures analyses of variance (ANOVAs) for the NA and PA scales. For cortisol, analyses followed a 2 (gender) $\times$ 2 (condition) $\times$ 4 (time: challenge 1, challenge 2, poststress 1, poststress 2) repeated measures analyses of covariance (ANCOVA) framework with baseline levels as a covariate (Benjamin 1967). Significant effects were followed by directional simple contrasts adjusted for baseline levels. Huynh-Feldt corrections were applied for all repeated measures analyses (Vasey and Thayer 1987).

Results

Baseline Cortisol and Affect Measures by Sex and Stressor Condition

To assess for unexpected baseline differences between conditions as well as baseline sex differences, we conducted a series of 2 (gender) $\times$ 2 (condition) ANOVAs comparing participants on year in college, baseline cortisol, and baseline NA and PA. No significant main effects for condition emerged, indicating that participants were appropriately randomized to experimental conditions. No significant sex differences in grade, or baseline NA, PA, or cortisol emerged.

There were no significant gender by condition interactions at baseline.

Changes in Self-Reported Affect between Baseline and Stressors

Mean ratings from the NA and PA scales for achievement and social rejection conditions and men and women following baseline and the two stressors are presented in Figure 1. We found a significant main effect of time such that participants showed greater NA and lower PA during the stress tasks compared with baseline [overall Fs(2,92) = 37.73 and 26.27, ps $< .0001$ for NA and PA, respectively; for each time point compared with baseline, ps $< .0001$]. Although both conditions produced significant changes in affect from baseline, we found a significant condition by time interaction [Fs(2,92) = 15.12 and 5.35, ps $< .01$ for NA and PA, respectively]. Participants in the achievement condition showed significantly greater increases in NA (ps $< .005$ for both stress time points) and decreases in PA ($p < .01$, first stress time point) between baseline and stress periods compared with participants in the rejection condition. Separate analyses including only the adjective *stressed* showed the same patterns of effects as the NA composite scale. We found no significant main effects or interactions over time for gender for NA, PA, and stress.

The Influences of Gender and Stressor Condition on Cortisol Levels Over Time

As predicted, we found an overall gender by condition by time interaction [$F(3,126) = 3.88$, $p < .05$]. We also found significant gender by time interactions for the achievement condition [$F(3,69) = 3.80$, $p < .05$] and the social rejection condition [$F(3,69) = 3.23$, $p < .05$]. As shown in Figure 2, male subjects showed robust increases in cortisol over time (from a mean baseline of .23 to a mean peak of .52 μg/dL) in response to the achievement stressors, whereas female subjects showed minimal changes in cortisol (.14–.18 μg/dL, baseline to peak).

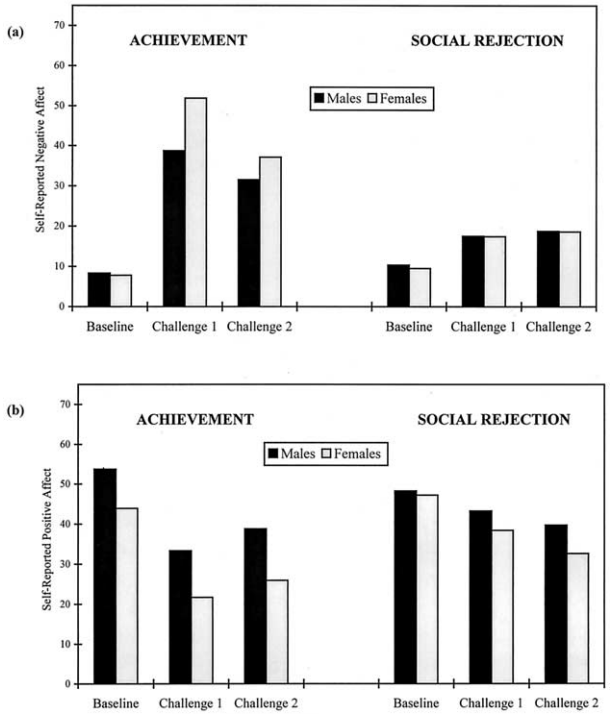

Figure 1. Mean self-reported negative **(A)** and positive **(B)** affect ratings during baseline and postchallenge for achievement and social rejection conditions for male and female subjects. Challenges were a verbal (Challenge 1) and math (Challenge 2) task for the Achievement condition, and two interaction challenges for the Social Rejection condition. Significant main effects for condition ($ps < .01$) emerged after Challenges 1 and 2 for negative affect, and after Challenge 1 for positive affect. Affect values represent mm along a 120-mm visual analog scale.

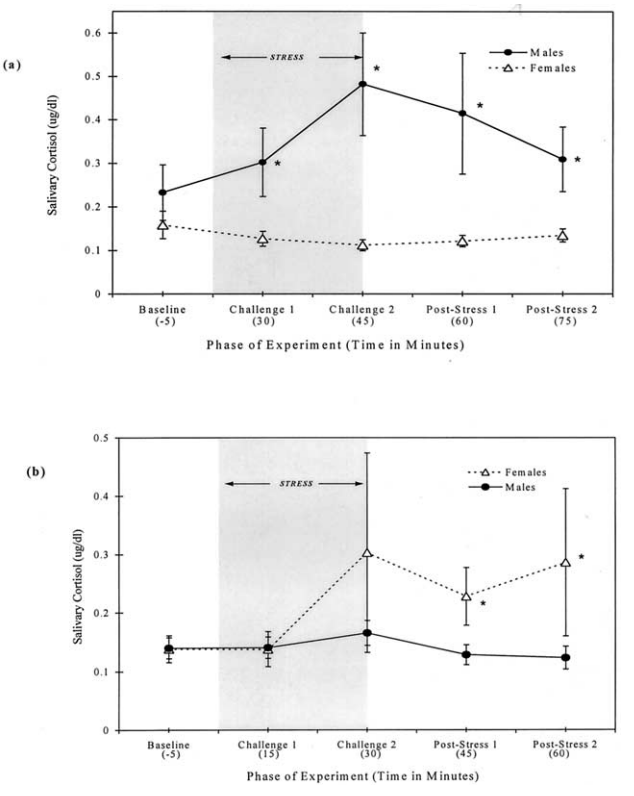

Figure 2. Salivary cortisol levels (means ± SEM) over achievement **(A)** and social rejection **(B)** stress sessions for male and female subjects. Salivary cortisol for 5 time points are shown: mean of two baseline measures before onset of the stress period (Baseline), after the first challenge (Challenge 1, math challenge and interaction challenge), following the second challenge (Challenge 2, verbal challenge and interaction challenge), 15 min following the end of the stress period (Post-Stress 1), and 30 min following the end of the stress period (Post-Stress 2). Duration of the stress period is highlighted in gray. A 20-min lag in cortisol increase following the onset of stress is typical. Differences between men and women are significant at the $p < .05$ level by specific contrasts and are indicated with *. Significance tests are based on the log-transformed cortisol levels controlling for baseline levels.

Male subjects also showed greater variability in cortisol responses compared with female subjects (SEM = .06–.14 μg/dL for male subjects, .01–.03 μg/dL for female subjects) over the achievement session. Significant sex differences in cortisol levels emerged following the mathematical challenge, the verbal challenge, and both poststress measures (all $ps < .05$).

As shown in Figure 2, the opposite pattern emerged for the social rejection stressor. Female subjects showed increases in cortisol (from a mean baseline of .14 to a mean peak of .39 μg/dL) in response to the social rejection stressor, whereas male subjects showed minimal changes in cortisol (.158–.160 μg/dL, baseline to peak). Female subjects also showed greater variability in cortisol responses compared with male subjects (SEM = .02–.17 μg/dL for female subjects, .017–.021 μg/dL for male subjects). Specific sex differences in cortisol levels emerged following the first and second poststress measures ($ps < .05$). Although variability is high at 30 and 60 min in the raw data shown in Figure 2 (representing the influence of one outlier), logarithmic transformations normalized the data at these time points (skewness < .59).

Given differences in the length and intensity of the achievement and social rejection conditions, we conducted analyses with of length of session and change in negative affect during the stressor (stressor intensity) as covariates. Inclusion of either covariate did not alter the significance or patterns of results reported here.

Discussion

This experiment examined sex differences in HPA responses to social rejection and achievement stress in healthy subjects as a preliminary investigation into HPA stress responses as a mechanism underlying gender differences in depression. We tested the hypothesis that male

subjects would show greater adrenocortical responses to an achievement challenge, but that female subjects would show greater responses to the rejection challenge. As predicted, with the effects of laboratory novelty controlled, male subjects showed a significantly greater increase in cortisol in response to math and verbal challenges than female subjects, whereas female subjects demonstrated greater increases in response to social rejection challenges.

Results lend empirical validation to emerging models of sex differences in depression and stress responses (Cyranowski et al 2000; Taylor et al 2000). For example, Cyranowski and colleagues suggested that intensification in affiliative need, along with negative events with interpersonal consequences, may help to explain the emergence of sex differences in depression during adolescence. Our study suggests that women are indeed more physiologically reactive to negative interpersonal events than men. Women's greater reactivity to rejection challenges may also explain their particularly high rates of depression with atypical features (2–3 times those of men), which can be characterized by a long-standing pattern of extreme sensitivity to interpersonal rejection (American Psychiatric Association 1994). Future research might examine whether women's greater physiologic reactivity to negative interpersonal events begins or intensifies during adolescence. Similarly, using an integrative, sociobiological approach, Taylor and colleagues proposed that women's stress response may be better characterized by "tend and befriend," involving nurturant activities and the creation of social networks, whereas men's may involve the more traditional "fight or flight" response (Taylor et al 2000). Our study suggests that women may not only use interpersonal strategies to cope with stress but also may show greater physiologic responses to interpersonal events.

Results also complement studies of sex differences in personality. For example, women's greater interpersonal orientation and men's greater instrumental orientation has emerged as one of the most consistent findings in the literature on sex differences in personality (Bakan 1966; Feingold 1994; Helgeson 1994; Lippa 1995). In a meta-analysis of studies of sex differences in personality, women showed significantly greater tender-mindedness (e.g., nurturance) and extroversion, but men scored higher on measures of assertiveness (Feingold 1994). Similarly, in a model of self-construals, Cross and Madson (1997) suggested that men tend to maintain an independent self-construal, in which self-definition is based on their unique abilities and the distinguishing of self from others (instrumental concerns), whereas women tend to maintain an interdependent self-construal, in which self-definition is based largely on their relationships and pursuit of harmony (interpersonal concerns).

Of note is not only men's greater increases in cortisol in response to the achievement stressor, but women's minimal response to this potent stressor and the lack of variability in their responses. Because the diurnal pattern of cortisol is a downward slope throughout the afternoon, even the relatively flat pattern of cortisol response that women show in reaction to the achievement stressor likely represents an increase over the typical diurnal pattern. In previous studies of sex differences in cortisol responses to achievement stressors (public speaking and mental arithmetic), however, women have shown approximately 125% to 250% increases in cortisol in response to the stress (Kirschbaum et al 1992, 1999). In contrast, women in our study showed increases of approximately 30%. One possibility is that the stressors in our study (witnessed by only one experimenter and an audio tape) may have allowed female subjects to disengage from the tasks, whereas stressors in previous studies (performed in front of three judges with a video camera) may have allowed for less disengagement. Similarly, in the rejection condition, perhaps male subjects withdrew more from the interactions than did female subjects, explaining their minimal response and lack of variability of responses. Lack of variability in female subject's responses to the achievement stressor and male subject's responses to the rejection stressor are likely due to the tendency for variability in cortisol responses to increase in relation to increases in mean cortisol levels (Kirschbaum et al 1992, 1993, 1995).

In contrast to the sex differences found in cortisol responses, we found no significant sex differences in self-reported positive and negative affect between the achievement and social rejection conditions. Women showed slightly greater changes in affect during both stressors, but differences were not significant. These findings are similar to those of Frankenhaeuser et al (1978), in which changes in affect did not mirror physiologic changes: following examination stress, male subjects showed greater physiologic responses, but female subjects showed greater increases in negative affect. That both men and women found the stressors to be similarly stressful suggests that sex differences in physiologic stress responses may not be mediated by affect and perceptions of stress, but may instead reflect more fundamental, biological processes, or perhaps implicit, cognitive processes.

Future research might examine whether sex differences in responses to different types of stress represent the influence of biology, socialization, or some combination of the two. One study of stress responses in newborns suggested that sex differences in adrenocortical responses are present even at birth, highlighted the importance of biology (Davis and Emory 1995). Circulating and prenatal sex hormones also appear to play a critical role in determining gender differences in HPA responses to stress

in preclinical studies (Burgess and Handa 1992; Handa et al 1994b; McCormick et al 1998; Patchev and Almeida 1996; Patchev et al 1995; Rivier 1999; Viau and Meaney 1991, 1996) and a possible role in humans (Kirschbaum et al 1999; but see Abplanalp et al 1977; Marinari et al 1977; Stoney et al 1990). Yet studies of socialization show important influences of parental modeling and encouragement of sex-typed activities. For example, in a recent meta-analysis, Leaper et al (1998) found that when talking to their children, mothers used more affiliative-expressive speech, whereas fathers were more likely to use assertive-instrumental speech. In another meta-analysis, parents were more likely to encourage feminine-stereotyped activities (involving affiliative behaviors) in girls, but masculine activities (emphasizing more assertiveness) in boys (Lytton and Romney 1991; see also Maccoby and Jacklin 1974). Peers and teachers have also been shown to differentially encourage sex-typed behaviors in boys and girls (e.g., Faggot 1984; for a review, see Keenan and Shaw 1997). Future studies might examine the interaction of biological and social influences on responses to instrumental and affiliative stress.

Although these findings are novel and should spur further research in this area, it is important to note that the achievement and rejection stressors differed in duration (45 vs. 30 min, respectively) and intensity (the rejection stressor was perceived as less stressful and resulted in smaller overall increases in cortisol); however, given that we obtained the same pattern of findings and similar effect sizes when length of the experiment or stressor intensity (change in negative affect over the stressor) was controlled, we do not believe that differences in stressor duration or intensity explain our results. Second, although measures of cortisol may give us a window into upstream responses including CRH, ACTH, and central pathways influencing the HPA axis, the use of this peripheral measure represents a limitation of this study. Another limitation of the study is that the achievement condition involved a dimension of social evaluation (performance before an audience, comparison with other subjects) in addition to academic difficulty. Thus, it is difficult to determine which dimension was most relevant to men's increased cortisol responses. Future studies might assess which specific components of both the achievement and social rejection stressors are most important for determining physiologic reactivity. Other limitations include the use of self-report rather than biological verification of menstrual cycle phase, and validation of the stressor categories through an impression from a vignette rather than participation in the stressor. Finally, although this was the first study to examine adrenocortical responses to different types of stressors by sex, it was conducted in healthy adults. Future studies might examine HPA reactivity to achievement and rejection stressors in depressed individuals as well as individuals at risk for depression.

Given links between stress, HPA dysregulation, and depression, we suggest that gender differences in HPA responses to stress may be one mechanism underlying gender differences in depression. In a preliminary test of this hypothesis, we examined HPA responses to achievement and social rejection stress in healthy men and women. As predicted, women showed greater adrenocortical responses to a social rejection stressor, but men showed greater responses to achievement stressors. We suggest that women's greater reactivity to interpersonal rejection stress may render them more vulnerable to depression. Future studies should examine gender differences in HPA responses to stress in adolescents, particularly those at risk for depression, to determine whether responses to different types of stress may mediate the emergence of sex differences in depression.

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