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The Father-Daughter Dance: The Relationship between Father-Daughter Relationship Quality and Daughters' Stress Response

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Abstract

The goal of the study was to determine whether father-daughter relationship quality is related to activity of the hypothalamic-pituitary-adrenal (HPA) axis (salivary cortisol) and autonomic nervous system (salivary alpha-amylase, sAA) in late adolescence-emerging adulthood during peer interactions. In the first study, reported father-daughter relationships characterized by rejection, chaos, and coercion had lower morning cortisol levels and were temperamentally more sensitive to emotional changes. In the second study, young women who reported father-daughter relationships characterized by warmth, autonomy, support, and structure had lower pre-task cortisol levels, and had attenuated cortisol responses to problem discussion with a friend. In contrast, those who reported father-daughter relationships characterized by rejection, chaos, and coercion had higher pre-task cortisol levels, had elevated cortisol in response to problem discussion with a friend, and were more likely to self-disclose about psychosocial stressors. No differences were observed between reported father-daughter relationship quality and sAA levels or task-related reactivity. The findings suggest that father-daughter interactions potentially influence both social cognition and HPA reactivity to developmentally salient stressors in young women.

Keywords

paternal investment; stress; peer relations; friendships

The nature of parental investment is correlated with a suite of characteristics that may influence developmental trajectory and social cognitions (Belsky, Steinberg, & Draper, 1991; Del Guidice, Ellis, & Shirtcliff). Paternal investment in humans is particularly facultative, such that investment by men is highly variable and thus, individual differences in investment are likely to be associated with variability in terms of child outcomes (Geary,

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[1]In the interest of full disclosure, we note that Dr. Granger is founder and president of Salimetrics LLC (State College, PA).

1998; 2000). Indeed, variability in the quality of fathering has been shown to be associated with the timing of developmental milestones (Ellis, McFayden-Ketchum, Dodge, Pettit, & Bates, 1999), emotion regulation (Pellegrini, 1988), and social cognition (Paquette, 2004).

Recent research indicates that father attributes are associated with psychobiological activity in young children. For example, father negativity has been related to cortisol responses to emotional challenge and overall cortisol levels in infancy and toddlerhood (Mills-Koonce, Garrett-Peters, Barnett, Granger, Blair, & Cox, 2011). The present studies examine the association between the quality of father-daughter relationships[2] and daughters' morning stress system activity, baseline stress system activity, and stress response to self-disclosure with a friend. These are some of the first studies, to our knowledge, to examine the specific association between father-daughter relationship quality and psychobiological reactivity and regulation in peer relationships during the late adolescent-emerging adulthood period (see also Flinn, Quinlan, Decker, Turner, & England, 1996).

Fathers' Influence on Developmental Outcomes

A series of studies have demonstrated that the quality of family dynamics are related to the timing of developmental milestones such as menarche, sexuality, adult attachment styles, social cognitions, and reproductive trajectories (Belsky, Houts, & Fearon, 2010). Family dynamics characterized by high stress and conflict and inconsistent or negative parent-child relationships are associated with earlier maturation and reproduction, insecure adult attachments, and limited parental investment. Family dynamics characterized by primarily positive affect and support (e.g., warmer relationships) are associated with the opposite trajectory (Belsky et al., 1991). Fathers are thought to play a unique role in determining the family climate through support of the mother and through parenting behaviors that have developmental consequences for their children (Flinn, 1992; Flinn, 2011; Geary, 2000; Geary & Flinn, 2001).

The father-daughter relationship, in particular, has been the focus of much research. Warmer relationships, characterized by emotional support and consistency, are associated with delayed pubertal maturation (Ellis et al., 1999), monogamy, and heavy maternal investment (MacDonald, 1992). The quality of paternal investment may serve as a cue related to the likely availability of paternal investment in the potential mating pool. Such cues have the potential to impact reproductive strategy where, for example, girls with high investing fathers at home begin dating and initiate sex at a later age (Flinn, 1988). Even time spent with father during childhood is associated with a number of developmental outcomes (Byrd-Craven, Geary, Vigil, & Hoard, 2007).

Despite these consistent findings, no mechanism has been clearly identified that links the quality of paternal investment to the physiological and psychosocial functioning of daughters. Ellis and colleagues (1999) proposed several potential mechanisms that might mediate the relationship between the quality of paternal investment and developmental

[2]It is important to note that the present studies did not collect data on mother-daughter relationship quality, and as such, the effect of father over and above that of mothering was unable to be examined.

outcomes such as heredity, exposure to unrelated males, and increased stress resulting from lack of paternal investment.

The concept of heredity and exposure to unrelated males acting as mediators of parental investment and developmental outcomes has received mixed support with some studies showing relationships to divergent developmental trajectories based on these factors (Ellis & Garber, 2000; Figueredo et al., 2006). Other studies, however, have shown that familial disruption and father absence are key factors in determining pubertal maturation, at least, when controlling for heritability (Tether & Ellis, 2008). These findings suggest that although genetic predisposition accounts for some variability, the quality of paternal investment may tip the balance towards one developmental trajectory or another. We chose to focus on the quality of the father-daughter relationship as one proposed mechanism for influencing developmental trajectories, specifically, the development of the stress response system.

Familial and Father Influence on the Stress Response System

Familial relationships have been shown to be related to the activity of the hypothalamic-pituitary-adrenal (HPA) axis and its primary glucocorticoid product, cortisol. These changes are complex, and likely also involve the hypothalamic-pituitary-gonadal (HPG) axis, in addition to cross-talk between the HPA and HPG axes (Muehlenbein & Flinn, 2011). In natural settings, family conflict and disruptions (e.g., father leaving the residence) are associated with altered diurnal cortisol patterns in children and with withdrawal from peer relationships, demonstrating a relationship beyond the family and later romantic relationships (Flinn, Muehlenbein, & Ponzi, 2009). In laboratory settings, cortisol responses to a parent-child conflict task were associated with internalizing symptoms in both children and adolescents (Gordis, Granger, Susman, & Trickett, 2006). In infancy and toddlerhood, father negativity was associated with stronger cortisol responses to an emotion challenge task and to overall cortisol levels. These effects were evident over and above maternal effects (Mills-Koonce, et al., 2011). The nature of the effects of chronic psychosocial stress, such as family conflict and father absence, on the HPA axis is likely context-specific. For example, exposure to high levels of family conflict resulted in lower cortisol levels in response to a laboratory conflict task in children (Granger, Serbin, Schwartzman, Lehoux, Cooperman, & Ikeda, 1998). Conversely, in naturalistic settings, exposure to family conflict has been associated with elevated cortisol levels for several days (Flinn, 2006). The effects of negative family relationships on the stress response system appear to persist into adulthood (Luecken, Kraft, & Hagan, 2009).

The associations between family climate and stress response systems development extend to both romantic and peer relationships. This suggests that early relationships may provide cues regarding the potential social world children are likely to experience (Belsky et al., 1991; Flinn, 2006). It is possible that father-child interactions moderate reactivity of emotion regulation mechanisms, preparing them for later social interactions. One example includes rough-and-tumble play. Here, the interaction between fathers and their children are thought to momentarily destabilize the stress reactivity systems of children and contribute to their ability to manage such responses in risky situations or novel social interactions (Paquette, 2004). When fathers and their associated tools for shaping emotional responses to stress are

absent or of low-quality, developmental consequences may exist. Girls in father-absent homes are more likely to have internalizing disorders, while boys in father-absent homes are more likely to have externalizing disorders and to be less popular (Parke et al., 2002). This suggests that the nature and quality of father-child interactions could have a long-lasting impact on response to psychosocial stressors.

Indices of Stress System Activity

Cortisol is a glucocorticoid hormone produced within the adrenal cortex. Stimuli that are interpreted as posing a physical or psychological threat, are challenging, and are novel will stimulate the HPA axis to release glucocorticoids (Nesse & Young, 2000) and the release of glucocorticoids in primates primarily takes the form of cortisol (Gunnar, Marvinney, Isenee, & Fisch, 1988). Salivary cortisol has been demonstrated to be a valid and reliable biomarker of activity in the hypothalamic-pituitary-adrenal (HPA) axis and its use is widely accepted and frequently implemented in psychoneuroendocrinology (Dickerson & Kemeny, 2004). Salivary alpha-amylase (sAA) is secreted from the salivary glands in response to sympathetic stimuli and serves as one of several critical protein components in saliva. Alpha-amylase has been used as a marker of activity in the sympathetic-adrenal-medullary system (SAM) or broadly, a marker of autonomic nervous system (ANS) activity in numerous studies (Granger et al., 2007; Rohleder & Nater, 2009).

Cortisol levels are typically low at night and rise in the hours before waking. After awakening, most people show a further rise in cortisol, peaking 20-45 minutes after awaking (Clow, Huckelbridge, Stalder, Evans, & Thorn, 2010; Flinn & England, 1991). The magnitude of the awakening response is related to psychosocial stressors and health in meaningful ways and provides a useful index of HPA function and dysfunction (Chida & Steptoe, 2008). It is complex, however, and not as simple as high or low, making clear predictions regarding the direction of this effect is not entirely straightforward. High morning cortisol levels have been associated with early life adversity (Gonzalez, Jenkins, Steiner & Fleming, 2009), whereas low cortisol awakening response has been related to poor social support (Sjogren, Leanderson & Kristenson, 2006). Low cortisol awakening responses have also been found for children in difficult family environments, particularly after a significant stressor (Flinn, Nepomnaschy, Muehlenbein, & Ponzi, 2011).

The Father-Daughter Relationship and Peer Dynamics

In addition to overall stress system functioning, we were interested in determining how the father-daughter relationship is related to the stress response during active attempts to cope with psychosocial stressors in the context of friendship discussions in late adolescence and emerging adulthood. Girls and women typically utilize their close, same-sex friendships as sources of social support, particularly during times of interpersonal stress (Carbery & Buhrmester, 1998). This primarily takes the form of self-disclosure about difficult social and emotional situations. These friendship interactions have been associated with protection from the negative effects of psychosocial stress, and are often associated with stress hormone reduction and lower frequency of stress-related illnesses and psychopathology (Taylor, 2006). For friendship interactions at the extremes, however, there appear to be

adjustment tradeoffs. Whereas moderate amounts of self-disclosure appear to reduce both physiological and subjective assessments of stress, excessive self-disclosure and focus on negative emotions appears to enhance stress system activity (Byrd-Craven, Geary, Rose, & Ponzi, 2008; Byrd-Craven, Granger, & Auer, 2011).

The Present Study

The study explored whether the quality of father-daughter relationships is related to individual differences in the cortisol awakening response (Clow et al., 2010), and to cortisol reactivity to a dyadic problem discussion between friends (Byrd-Craven et al., 2011; Rose et al., 2005). Based on previous findings, the positive aspects of the father-daughter relationship were expected to be predictive of rising morning cortisol levels, indicating a normally functioning HPA system. Negative aspects of the father-daughter relationship were expected to be predictive of lower morning cortisol levels, indicating disruptions of HPA system functioning.

In study two, both main components of the stress system, the HPA axis and autonomic nervous system (ANS), were assessed due to the interrelatedness of the two systems in response to psychosocial stress. Gordis and Colleagues (2006) demonstrated that the two systems may augment one another and that examining the two subsystems together results in greater predictive value. The quality of the father-daughter relationship was predicted to be related to cortisol and salivary alpha-amylase (sAA) levels such that more warm relationships (e.g., high on warmth, support, and structure) are predicted to be associated with lower pre-task cortisol and sAA levels and more negative (e.g., high on rejection, coersion, and chaos) father-daughter relationships to be associated with higher pre-task cortisol and sAA levels. Second, the quality of the father-daughter relationship was predicted to be associated with stress responses after problem discussion with a friend, with those with warmer relationships showing more muted cortisol and sAA responses and those with more negative relationships showing enhanced cortisol and sAA responses to problem discussion. Next, given that the quality of father-daughter relationships may lower the threshold for responding negatively to relationship issues (Belsky et al., 1991), we predicted that those with more negative relationships would be more likely to discuss psychosocial stressors with a friend.

Methods

Common methods: Determination of salivary analytes

Participants were instructed to avoid potential confounding influences in HPA and ANS responses by restricting the intake of food, caffeine, and nicotine at least one hour prior to saliva collection. One participant was excluded from analysis due to reporting caffeine consumption within 30 minutes of the laboratory task. All participants completed a questionnaire regarding their activities prior to coming to the lab (e.g., sleep, diet, activity level) and a questionnaire regarding their health status. Overall health was rated on a 1-10 scale. Participants were asked if they had any symptoms of an impending illness (e.g., fever, runny nose) and were asked to list any medication they were currently taking. No

participants in this analysis reported using medication (e.g., corticosteroids) or having symptoms of impeding illness that would interfere with the accuracy of the assays.

Saliva was obtained by having participants hold a 1 x 4 CM absorbent swab in their mouths for 1-2 minutes, and following collection, were stored at −20 degrees C. On the day of testing, for sAA, saliva samples were centrifuged at 3000 rpm for 15 minutes to remove mucins. Following Granger and colleagues (2007), samples were assayed for sAA (kinetic reaction) and cortisol (enzyme immunoassay) using commercially available reagents (Salimetrics, State College, PA) without modification to the manufacturers recommended protocols. sAA units are expressed in units of enzymatic activity per mL (U/mL) and cortisol levels are reported in micrograms per deciliter (ug/dL).

Cortisol and sAA scores were positively skewed. In all analyses, we used a natural log transformation for cortisol scores and a square root transformation for sAA scores to normalize the distributions (see Gordis et al., 2006). The sample was examined for outliers (more than three standard deviations above the mean), and none were identified. Six participants in Study 1 and two participants in Study 2 had insufficient saliva volume for analysis. Analyses using saliva assays were from a total of 86 participants in Study 1 and 37 participants in Study 2.

Study 1

Participants

Eighty-eight undergraduate women (M_{age} = 19.9 years, *SD* = 1.84) were recruited from the psychology subject pool at Oklahoma State University and from fliers posted on campus. They received course credit or $25 for their participation.

Procedures

Participants completed the Six Dimensions of Parenting Questionnaire (Skinner, Johnson, & Snyder, 2005) (see Measures). Participants were then given a saliva collection vial, shown how to collect saliva and how to operate the personal digital assistant (PDA) used to answer questions after saliva collection. They were asked to collect saliva within 20-45 minutes after awaking the following morning (see Table 1), and answered questions on the PDA regarding how many hours of sleep they had and whether they had taken any substances that would interfere with cortisol (e.g., caffeine). The PDA served to screen participants indicating confounds to cortisol (e.g., less than 4 hours sleep) but also served as a validity check, as a time stamp was included for saliva collection to assure it was taken at the time indicated by the participant. Participants were given freezer packs to store the samples until they returned to the laboratory, on average 30 hours (+/− 2 hours) later. All participants collected saliva during weekdays (Tuesday, Wednesday or Thursday) to avoid disruptions of sleep associated with weekend days and in order to return the sample to the laboratory within 36 hours.

Measures

The six dimensions of parenting—Skinner and Colleagues (2005) created a motivational model based on the six dimensions of parenting. The questionnaire used for this study was based on their model and modified for this study in order to reflect the relationship of the participant with her father. Instructions were given to participants to answer based on their overall relationship with their father, which included perceptions of the relationship while growing up as well as current relationship. The questionnaire includes six major factors. Warmth (e.g., "My father and I do special things together.") (α= .77), Structure (e.g., "My father's expectations for me are clear.") (α= .66), and Autonomy Support (e.g., "My father expects me to say what I really think.") (α= .73) are the three warm/positive dimensions. Rejection (e.g., "Sometimes I feel like my father thinks I'm difficult to like") (α= .69), Chaos (e.g., "My father changes the rules a lot at home.") (α= . 67), and Coercion (e.g., "I often get into power struggles with my father.") (α= .74) are the three negative dimensions. In order to create parsimonious discussion of questionnaire dimensions and for ease of analysis, Warmth, Structure, and Autonomy Support were combined into a single composite "Perceived Warm Father" variable (α = .84). Rejection, Chaos and Coercion factors were combined into a single composite "Perceived Negative Father" variable (α= .83). Perceived Warm Father and Perceived Negative Father were inversely related, r (86) = −.59, $p < .01$.

Study 2

Participants

Forty undergraduate women (M_{age} = 19.17 years, SD = 1.29) from Oklahoma State University participated in the second study. This consisted of 20 friendship dyads and all dyads indicated they were "best" or "close" friends. Participants were recruited from the psychology subject pool or from fliers posted on campus. They received course credit or $25 for their participation.

Procedure

Two sessions were utilized in order to resolve issues concerning anticipatory HPA and ANS responses that could potentially result from participants being placed in a laboratory setting .The first session served to gain information via questionnaires as well as to allow participants to habituate to the laboratory and research staff. During the first session, participants all gave written consent after being informed about the study. Participants then completed the Six Dimensions of Parenting Questionnaire (modified to reflect their relationship with their father), and a Problem Generation questionnaire (see Measures section). On average, the first session was completed in approximately 60 minutes.

All dyads participated in the second session between noon and 5:00 p.m. The second session began as saliva samples were collected from both friends (see below) and the friends were video recorded in a five-minute warm-up task (planning a menu for a party). After the warm up task, each participant selected one problem from the Problem Generation questionnaire for discussion. Participants were asked to discuss the problem as they normally would and were told that they could discuss either of the friend's problems or both problems. Typical

discussions focused on romantic relationships, peer relationships, and academic concerns. Participants were recorded for 17 minutes. The second laboratory session was completed in approximately 45 minutes on average.

Saliva samples were taken in the laboratory 10 minutes before the task (T = −10), immediately after the task (T = +17) when sAA levels are likely to be at their post-stressor peak, and 15-20 minutes after the task (T = +35), when cortisol levels are likely at their post-stressor peak (see Table 1 for sampling intervals). Sampling intervals were selected to best reflect the activity of HPA and ANS responses to stressors (Gordis et al., 2006). Dyads were separated post-task to prevent further interaction, and instructed to look at home, garden, travel, furniture, or architecture magazines for 15 minutes

Measures

Problem generation and salience questionnaire

The Problem Generation and Salience questionnaire (Rose et al., 2005) was implemented as a tool to assess factors that would influence the post-task cortisol and sAA levels of participants. The questionnaire consisted of participants generating three current problems and writing short descriptions of them.

The six dimensions of parenting questionnaire

Participants completed the Six Dimensions of Parenting, modified to reflect the participant's relationship wither father, as above. As in the first study, in order to create parsimonious discussion of questionnaire dimensions and for ease of analysis, Warmth (α= .73), Structure (α= .69), and Autonomy Support (α= .70) were combined into a single composite "Perceived Warm Father" variable (α = .81). Rejection (α= .76), Chaos (α= .64) and Coercion (α= .72) factors were combined into a single composite "Perceived Negative Father" variable (α= .84). As in the first study, Perceived Warm Father and Perceived Negative Father were inversely correlated r (37) = −.56, $p < .01$.

Results

Study 1

Multiple regression analysis was used to test whether reported quality of the father-daughter relationship was predictive of morning cortisol levels. For each dependent variable, Perceived Warm Father and Perceived Negative Father were run simultaneously as predictors.

The overall model was significant, $R^2 = .07$, F (2, 82) = 3.83, $p < .05$. Higher perceived negative father ratings were associated with lower morning cortisol, β = −.27, $p < .05$. Warm aspects of the father relationship was not a significant predictor of morning cortisol, β =.02, $p = .21$.

Study 2

A series of multiple regression analyses were conducted to determine whether reported father-daughter relationship quality was predictive of pre-task stress responses and stress

responses to problem discussion. For each dependent variable, Perceived Warm Father and Perceived Negative Father were run simultaneously as predictors.

The overall model predicting pre-task cortisol from perceived father-daughter relationship quality was significant, $R^2 = .13$, F (2, 37) = 3.35, $p < .05$. Higher Perceived Negative Father ratings were associated with higher pre-task cortisol, $\beta = .28$, $p < .05$. In contrast, higher ratings of Perceived Warm Father relationship were associated with lower pre-task cortisol levels, $\beta = -.37$, $p < .05$. Neither Perceived Warm Father nor Perceived Negative Father were related to pre-task sAA levels, $R^2 = .03$, F (2,37) = 1.18, $p = .51$, $\beta = -.03$, $\beta = .02$, respectively.

A change score was computed to determine the change from pre-task to post-task by subtracting post-task from pre-task cortisol and sAA scores. First, pre-task to post-task cortisol change score was predicted from quality of father-daughter relationship. The overall model was significant, $R^2 = .15$, F (2,37) = 3.79, $p < .05$. Higher Perceived Negative Father ratings were related to a greater cortisol response to problem discussion with a friend, $\beta = .39$, $p < .05$, whereas the effect of Perceived Warm Father was not, $\beta = .08$, $p = .97$.

Next, pre-task to post-task sAA change score was predicted from quality of father-daughter relationship. The overall model was not significant, $R^2 = .02$, F (2,37) = .45, $p = .64$, nor was the effect of Perceived Negative Father, $\beta = -.19$, $p = .35$, nor Perceived Warm Father was significant, $\beta = -.17$, $p = .56$.

We sought to determine whether the reported quality of the father-daughter relationship was associated with attention to and discussion of psychosocial stressors (e.g., relationship issues) compared to other stressors (e.g., money, academic concerns). Problem content was scored 1 for psychosocial stressors and 0 for non-psychosocial stressors. In order to qualify as either of these categories, the dyad had to discuss one or the other type of stressor for the majority (60% or more) of their total problem discussion time (10 minutes or more of the 17 minute discussion period). All of the dyads fell into one of these two categories (see Table 2). Higher ratings of Perceived Warm Father scores were associated with less frequent discussion of psychosocial stressors, $r(40) = -.27$, $p < .05$, whereas higher ratings of Perceived Negative Father scores were associated with more frequent discussion of psychosocial stressors, $r(40) = .28$, $p < .05$.

Discussion

The association between reported father-daughter relationship quality and the psychobiology of the stress response was investigated in the current studies. Specifically, routine HPA functioning to awakening and HPA and ANS responses within the context of a social discussion task between friends was examined. Although the quality of father-child relationships has been associated with future relationship strategies and life history development (Byrd-Craven et al., 2007; Ellis et al., 1999), the mechanisms underlying how father-child relationships relate to the dynamics of peer relationships and active attempts to cope with stressors had not yet, to our knowledge, been examined. Several aspects of the

findings are particularly noteworthy and are discussed within the general framework of biological sensitivity to context and the biosocial model of the family.

In the first study, negatively perceived aspects of the father-daughter relationship was predictive of morning cortisol levels. This finding is consistent with prior research assessing biomarkers such as age of menarche (Tither & Ellis, 2008). Further, while previous research has demonstrated that morning cortisol is related to a number of psychosocial factors such as early life adversity (Gonzalez et al., 2009), poor social support (Sjogren et al., 2006), and work stress (Schultz, Kirschbaum, Prubner & Hellhammer, 1998), this study is the first, to our knowledge, to demonstrate long term associations between paternal relationship quality and routine functioning of the HPA axis. These results should be interpreted with caution, however, because they are based on a single morning cortisol sample. Recent research emphasizes the use of three samples over the course of the waking period to enable stronger conclusions regarding the amplitude of the awakening response (see Chida & Steptoe, 2009). The first study found that negatively perceived aspects of the father-daughter relationship were associated with reported sensitivity to emotional changes as well as lower inhibitory control. While the causal direction of these findings should be approached with caution, it is clear that coercive, rejecting, and inconsistent paternal behaviors are associated with psychobiological and emotional thresholds.

In the second study, the quality of father-daughter relationships was associated with baseline and stress reactivity. Perceived quality of father-daughter relationships were predictive of baseline cortisol levels in young women. Both father-daughter relationships perceived to be warm and those perceived to be negative were found to predict baseline cortisol levels. Consistent with our hypothesis, warmer father-daughter relationships were associated with lower baseline cortisol levels. By contrast, more negative father-daughter relationships were associated with higher baseline cortisol levels. These findings are consistent with previous research demonstrating that the nature of paternal investment is associated with a set of psychobiological characteristics and developmental trajectories (Belsky et al., 2010; Ellis et al., 1999). Our results cannot rule out alternative explanations, such as heredity or the combined parental influence of both mother and father variables compared to father attributes alone, but they do provide additional evidence that the reported father-daughter relationship is related to psychobiological development into late adolescence and early adulthood. It is also important to note that shared genes and proximate relationship experiences are not mutually exclusive mechanisms. Family research, such as the Ellis & Essex (2007) study on girls' pubertal development, will be needed to disambiguate the relative contributions of shared genes and relationship quality.

We also examined how the quality of reported father-daughter relationships relates to stress response following discussion of a problem with a friend, a procedure that has been shown to increase cortisol response in young women (Byrd-Craven et al., 2011). Consistent with our hypothesis, the quality of the father-daughter relationship predicted stress responses following problem discussion with a friend. Specifically, women with higher negatively perceived father ratings showed an elevated cortisol response to problem discussion with a friend.

These findings are consistent with others linking social evaluative threat, social anxiety, and perceived social contingency to individual differences in cortisol levels and reactivity in adolescence and emerging adulthood (Hellhammer, Wust, & Kadielka, 2009). During the transition from adolescence to young adulthood, a salient developmental challenge is the establishment and maintenance of same-sex friendships, especially for women (Taylor, 2006). This study clearly demonstrates the biosocial relationship between perceived paternal behavior and individual adjustment and adaptation to developmentally salient aspects of their social worlds. The father-daughter relationship is related to the HPA response in anticipation to, or in response to, a core developmentally salient issue, in this case, the development and maintenance of same-sex friendships. Based on these results, later in development, father-daughter relationship quality may be associated with women's cortisol regulation in response to their crying infants, and even later, in response to the caregiver role for their aging parents.

In contrast to our predictions and to the findings with cortisol, sAA was not found to be related to any father-daughter relationship variables prior to or following problem discussion. This finding may be attributed to the fact that the sympathetic nervous system does not appear to be specifically reactive to social stressors, but rather more rapidly reacts to real or perceived threats as arousal in preparation for the “fight or flight response” (Huether, 1998). It may also be that early social dynamics do not impact the reactivity of the autonomic nervous system to the extent that they impact the HPA system. Furthermore, the results of the relationship between sAA and social dynamics are not always consistent across studies. sAA has been found to be related to both positive and negative affect, and thus may not be as much of an indicator of perceived social threat as is HPA activity (Fortunato, Dribin, Granger, &Buss, 2008).

This study also demonstrated that quality of the father-daughter relationship was associated with attention to and discussion of psychosocial stressors (e.g., relationship issues) compared to non-social stressors (e.g., money, academic concerns). Based on previous work suggesting that the quality of father-daughter relationships may prime social cognitions (Belsky et al., 1991), it was predicted that women who reported perceiving more negative paternal relationships would be more likely to discuss psychosocial stressors with a friend than women who reported perceiving more warm relationships. Women whose relationships with their fathers prime their cognitions toward viewing future relationships in terms of an increased probability of social dismissal (i.e., rejection), encountered stressors that are unpredictable (i.e., chaos), and stressors that are uncontrollable (i.e., coercion). Unpredictable and/or uncontrollable interpersonal dynamics are associated with HPA activation (Dickerson & Kemeny, 2004). These women appear more likely to self-disclose by engaging in the extensive dyadic problem discussion of psychosocial stressors than women whose relationships with their fathers instilled an expectation of care and acceptance (i.e., warmth), problems that can be accounted for (i.e., structure), and problems that can be successfully navigated either alone or with help from another (i.e., autonomy-support). These findings are consistent with previous theories regarding the impact of early paternal experience and later social cognitions (Flinn, 2006). Father-daughter relationships appear to provide cues regarding the potential social dynamics likely to be experienced in the future, and individuals appear to adjust their psychobiology accordingly.

Limitations

This study provided novel insights regarding the association between the father-daughter relationship, stress response, and subsequent peer dynamics, but is not without limitations. First, father-daughter relationship ratings by the daughter may not accurately reflect the reality of the relationship, but rather the perception of the relationship by the daughter. However, since perception drives both stress response and social cognition and the stress response, this is not seen as a fundamental flaw of the study. Second, as mentioned above, a single sample was used for the morning cortisol response rather than several samples over the course of the waking period. This could reduce the validity of these findings. Third, the recovery to baseline, an index of the system's ability to regulate the stress response and associated emotions, of each of the stress responsive systems was not assessed. Having this indicator would have added important understanding of the mechanics of the stress system functioning (McEwen, 2000). Further, father-daughter relationship data was collected exclusively in the current study, limiting conclusions that may be drawn. Because mother-daughter data was not collected, it cannot be determined whether father variables alone are related to reported relationship quality or whether the combined influence of parenting in general is responsible for the association. Finally, the population of the current study is young women away from home at a university in the modern western society. The nature of the father-daughter relationship is complex and likely includes many cultural nuances (Flinn et al., 1996). These results may not be generalizable to all cultures or settings, and future studies may show cultural differences.

Conclusions

This is the first study to our knowledge to demonstrate that the quality of father-daughter relationships are potentially related to coping with psychosocial stress in peer relationships through HPA axis activation. Fathers whose interactions with their daughters emphasize, or at least, appear to the daughters to emphasize rejection, chaos, or coercion might prime the daughter toward emotional and cognitive dysregulation later in life. It is speculated that early, positive interactions with fathers that are marked by qualities such as warmth, structure, and respect for autonomy may program the HPA axis to moderately respond to life stressors throughout development and into adulthood. Knowing more about the verbal and nonverbal communication processes that influence and moderate the relationship between early paternal interaction, stress system development, and later peer interactions would add significant clarity to these findings (Afifi, Granger, Denes, Joseph & Aldeis, 2011).

On the basis of our results, it is suggested that HPA regulation, through warm father-daughter interactions, may serve to influence social cognition such that when discussing social problems with peers, women with warm fathers would be less inclined to focus on the elements of the problem that are uncontrollable or unpredictable, components of cognition that reliability elicit a strong HPA response (Dickerson & Kemeny, 2004). Future research should, of course, investigate the causal nature of this relationship as well as down-stream effects of modification of stress response systems. Young women who report more negative father-daughter relationships may be more likely to interpret a given social stressor or problem as being more novel, uncontrollable, or unpredictable, and would therefore be expected to exhibit greater HPA axis reactivity and subsequent cortisol release.

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Table 1

Timeline of the tasks and sample collections

Study	Sample Number	Description	Name of Sample
1	1	Cortisol level 20-45 minutes alter awakening on a typical weekday morning.	Morning Cortisol
2	2	Cortisol and sAA level within 10 minutes after entering the lab and 10 minutes prior to the task	Pre-task
2	3	sAA level within 5 minutes of the 17 minute task; measuring peak sAA	sAA Post-task
2	4	Cortisol level 15-20 minutes alter completion of the 17 minute task; measuring peak Cortisol	Cortisol Post-task

Table 2

Problem Content Frequency Counts

Problem Content	Frequency
Pychosocial Stressors	24
Non-Psychosocial Stressors	16